E.T.S. de Ingeniería Industrial,
Informática y de Telecomunicación

Compressors test life bench under wet compression conditions

Grado en Ingeniería
en Tecnologías Industriales

FINAL PROJECT

Natalia Medina Cabello

Jose Ignacio Arocena

Pamplona, 26 de Junio del 2014

THANKS TO MY FAMILY, TEACHERS AND FRIENDS FOR THE GREAT SUPPORT PROVIDED WHEN IT WAS NEEDED THE MOST. WHEN THE PERSPECTIVE OF ENDING THE CAREER WAS STILL TOO FAR AWAY TO ACTUALLY BELIEVE IT.

I ALSO WANT TO THANK B/S/H FOR THE GIVEN OPPORTUNITY.

THANK YOU ALL FOR HELPING ME TO REACH THIS POINT, FOR WATCHING ME PASS TO A NEW PHASE OF MY LIFE AND TO ENCOURAGE ME TO BECOME AN ENGINEER.

Natalia Medina

1.-PROJECT REPORT

INDEX

CHAPTER 1: PROBLEM

FIGURES

TABLES

2.-ANNEX

INDEX

ANNEX I: CALCULATIONS

ANNEX II: SECOND STAGE

ANNEX V: WINCC

FIGURES

TABLES

3.-PLANES

INDEX

E.T.S. de Ingeniería Industrial,
Informática y de Telecomunicación

Compressors test life bench under wet compression conditions

Grado en Ingeniería
en Tecnologías Industriales

PROJECT REPORT

Natalia Medina Cabello

Jose Ignacio Arocena

Pamplona, 26 de Junio del 2014

PROJECT REPORT'S INDEX

PROJECT REPORT’S FIGURES

PROJECT REPORT’S TABLES

CHAPTER 1: PROBLEM

1 PROBLEM APPROACH

The correct operation of the BSH group dryers is guaranteed within a range of temperatures of 10 ºC to 35 ºC.

However, due to the growing trend of placing them on the outside (or in areas not climatically controlled), there is a necessity to check the correct operation of the components at lower temperatures, such as 5 ° C.

The disadvantage of operating at low temperatures is the refrigerant behavior of the “Bottom group”. It is found that the state of the refrigerant at the compressor inlet is biphasic at 5ºC.

The compressors are properly equipped with an accumulator to store the liquid refrigerant, which does not pass through the compressor. Nevertheless, the oil of the compressor has a small proportion of the liquid refrigerant mixed.

Previously, tests proved the correct sizing of the accumulator, as they are prepared to store the total refrigerant charge of the liquid circuit, were made.

2 PROJECT PURPOSE

It is intend to design, control, build and set up, an essay for testing the compressors life when operating in wet compression condition.

The purpose of this “bench”, is to determine the consequences of a biphasic refrigerant inlet, in terms of the rotary compressor reliability, as manufactures recommend to avoid these use.

Therefore, it will be necessary to build a “test bench” that allows the test of different compressors models in a reduced compression-expansion cycle. The “bench” should permit the selection and the constant maintenance of the input conditions of the refrigerant (pressure, temperature, quality) the input condition of the refrigerant in terms of pressure, temperature and steam quality for different refrigerants.

The refrigerants taken into consideration when computing the calculus are: R22, R134a, R410a, and R407c.

The operation of this “bench” shall be governed by a system of controls to access and independently parameterize several test stations, although only one will be developed during the project.

3 PLANIFICATION

3.1 STAGE 1

Since the beginning of the practice (24th February) there would be about a month (until the end of March) to carry out the following assignments:

- Bibliography review.
- Visit to an associate Enterprise with a similar facility in progress.
- Definition of the thermodynamic circuit components taking into consideration the compatibility and the connection to the automatic control system.

3.2 STAGE 2

The second stage is expected to last approximately a two months, so it is supposed to end during the first week of June.

- Purchase orders and reception of the thermodynamic components.
- Design of the control system and necessary equipment.

3.3 STAGE 3

Within June the bench it is supposed to be assembled and the control system must be receipt (once that the purchase orders of the control system have been given).

3.4 STAGE 4

Until the end of the practice in BSH Group, the control system must be connected and the program code optimized.

CHAPTER 2: THEORETICAL INTRODUCTION

1 DEVELOPMENT

Mainly, the tasks that will be developed in chronological order are:

1. Design of the bench, taking into consideration both the equipment and main components, and the instrumentation necessary for its control. For this, the bibliography on the subject must be reviewed.
2. Necessary automatic control design for test bench, taking into consideration the possible raise of the number of station in the bench (up to 12 stations), although initially only one will be established.
3. Participation in the acquisition and management of purchasing the equipment and major components with the support of purchasing departments and engineering processes, ensuring that they fulfill the specifications of the design stage.
4. Construction of the bench, supported by the laboratory technicians.
5. Programming and control setting.
6. Start the test bench. Readjustments of the automatic control system. (*)

(*) This part would not be considered in this project, as the practice in BSH is not concluded. This point would be implemented in July.

2 THEORETICAL BASE

2.1 REFRIGERANT CIRCULATION

The complete refrigeration cycle, that the refrigerant experiment in the bottom group of the dryer appliances, is the illustrated in the Figure 1.

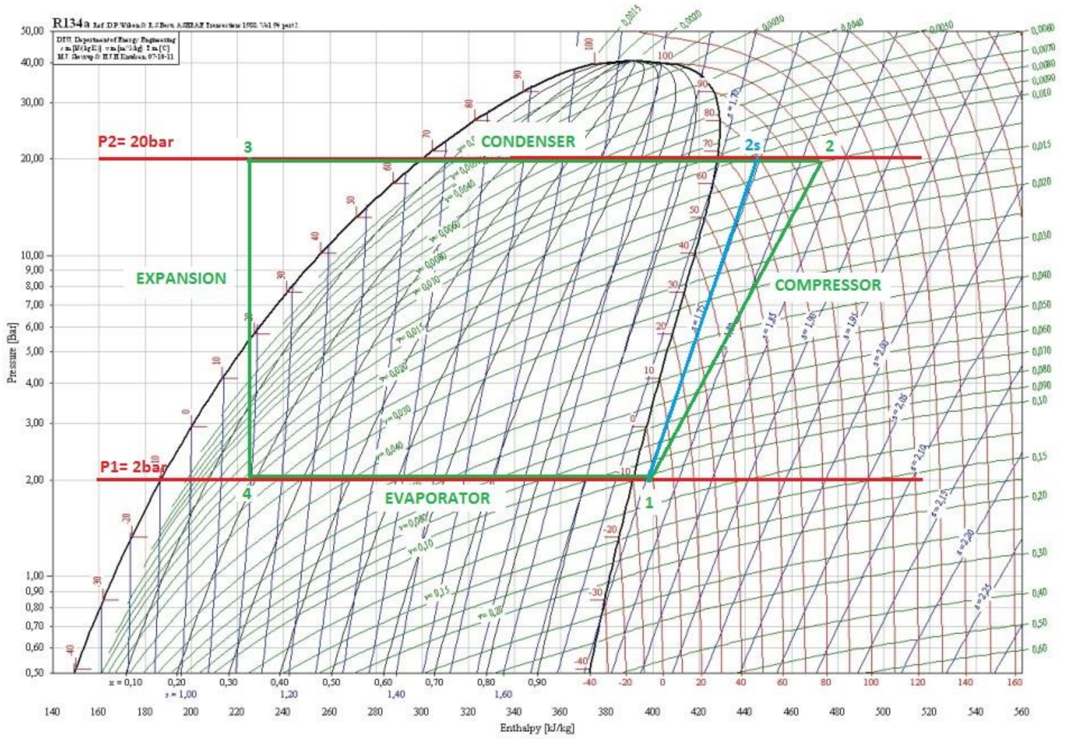


Figure 1- Mollier diagram of a complete refrigeration cycle

THE PRESSURES IN THE GRAPHIC WERE SET IN ORDER TO EASE THE UNDERSTANDING OF IT, THEY DO NOT REPRESENT THE REAL VALUES

In a standard refrigeration cycle, the refrigerant is in a gaseous state at the compressor inlet. Is in it, in which the refrigerant undergoes a pressure increase with the corresponding increase in its temperature.

Then, the refrigerant is subjected to a cooling process, due to its passage through a condenser. Along its stay in the condenser, a heat exchange between the refrigerant and the medium (water or even the air) is produced, so that a liquefaction occurs.

Then the pressure is reduced with the aid of an expansion valve (e.g.: capillary) so it recovers the pressure at the beginning of the cycle.

Finally, despite to have recovered the starting pressure point of the cycle, there is still a difference of enthalpies. To overcome this, it is required the use of an evaporator so that a medium of high temperature (output air of the dryer drum) will yield heat to the refrigerant to reach the state and temperature of the cycle starting point of the required.

2.2 AIR CIRCULATION

Along the previous section the refrigeration cycle experimented in a dryer appliance by the refrigerant was defined. However, in this section it would be described the cycle for air, as shown in Figure 2.

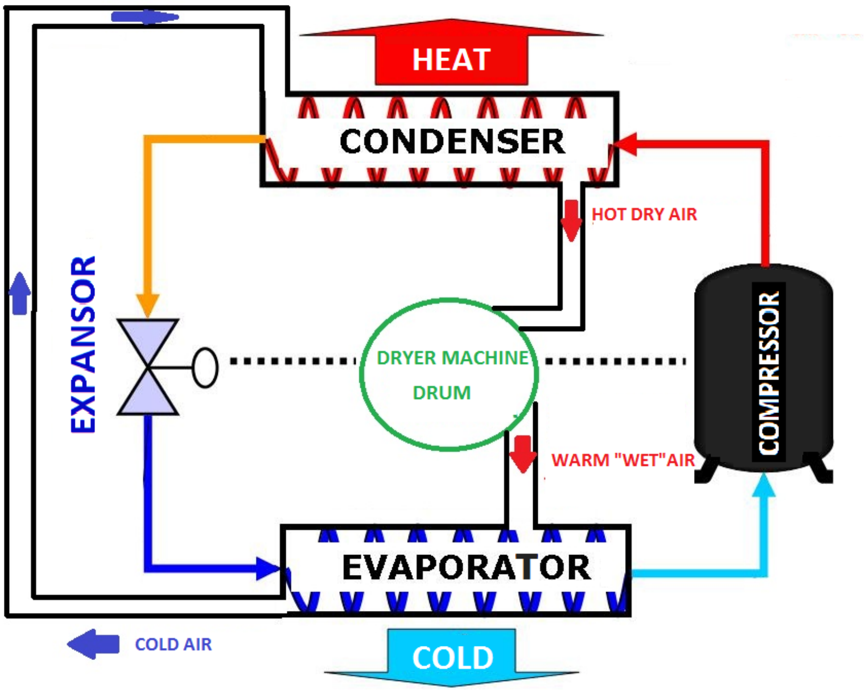


Figure 2-Cycle described by the air in a dryer machine

The air at the condenser inlet is at low temperature and without humidity. Along the condenser, the refrigerant absorbs the heat from the condenser, increasing its temperature. This warm air goes through the dryer drum, and absorbs some of the clothes dampness's. While leaving the drum, the air has gained humidity and its temperature has been decreased (although it is still high).

Straightaway the drum, the air enters the evaporator. Along the evaporator, the refrigerant loses heat and the humidity absorbed from the laundry, is condensed.

Once again, the cold air leaving the evaporator is redirected to the inlet of the condenser, to absorb heat from the refrigerant.

3 RELEVANT VARIABLES

In the complete cooling cycle we have as variables, the pressures and temperatures of the different operating points. In addition to that, if these points are within the biphasic bell, we will need to know other additional thermodynamic magnitude as the enthalpy, title ... in order to calculate the operating point.

Besides, ideally, the flow of the compressor refrigerant and the air flow and its temperature would be monitor.

However, note that a complete refrigeration circuit won't be made for the test of compressors lifes. It is intended to simplify the cycle components simplify, maintaining the operating conditions of the compressor unchanged, as only the consequences of the wet compression are to be considered.

4 CYCLE CONCEPT

At the execution of the cycle, some processes can simplify the theoretical calculation, taking into the account certain assumptions and / or approximations made as certain.

In some cases, these assumptions are taken as certain without using any "correction factors or methods." However, in other procedures, the assumptions are used to calculate ideal intermediate operation points for the later use of corrective methods (such as efficiencies) and find the actual operating point.

4.1 PROCESS 1-2: COMPRESSOR

In this process, an isentropic approximation can be made, due to the fact of the inexistence of a delivered heat exchange.

Nevertheless, there would be some “heat losses” even if there is thermal isolation. For these reason, the isentropic hypothesis will be used to calculate an intermediate ideal operation point (point 2s), knowing the entropy of point 1.

Once that the isentropic operating point is obtained, employing the isentropic efficiency of the compressor in the following formula, an approximation of the real operating point can be made (point two).

$$h_2 = h_1 + \frac{h_{2S} - h_1}{\eta\_iso}$$

4.2 PROCESS 2-3: CONDENSER

The approximation employed in this particular process, is the assumption of the pressure maintenance. We consider this process, as isobaric (even if it does exist a small pressure drop).

4.3 PROCESS 3-4: EXPANSION VALVE

It is considered as an isenthalpic process, and it is noteworthy that it is the most accurate of the hypothesis employed.

This is because, if a proper thermal isolation of the expansion valve is executed, it would barely be any heat losses.

4.4 PROCESS 4-1: EVAPORATOR

The process of heat absorption by the refrigerant from the air, can be considered as the antagonist heat exchange made in the condenser.

In both processes, there is only an action on the thermal state of the refrigerant, so that in this case the process carried out in the evaporator would have also an isobaric consideration.

5 OPERATIONAL DEFINITION

The assumptions, approximations and hypothesis made in the previous section, are helpful when performing a theoretical calculation of the cycle (exclusively employing the inputs of the system).

The calculation process has been defined to employ thermodynamic tables to calculate the results. However, a thermodynamic software, such as EES (Engineering Equations Solver) was also used.

Employing this software, it is possible to calculate a thermodynamic magnitude with two other thermodynamic magnitudes and the substance name, what can be really helpful.

- **PROCES 1-2: COMPRESSOR**

  - Point 2s (isentropic) is calculated: Thermodynamic tables must be employed to calculate the temperature, knowing the entropy and the pressure at this point.
  - Once that the temperature is calculated, and knowing the pressure, the enthalpy can be calculated.
  - To obtain the real point 2: Knowing the isentropic efficiency of the compressor we can employ the following formula

$$h_2 = h_1 + \frac{h_{2S} - h_1}{\eta\_iso}$$

- **PROCESS 2-3: CONDENSER**

  - The pressure and the sub cooling are known, so the temperature can be computed. With these data the enthalpy of point 3 is computed.

    With the enthalpy difference, the heat exchange with the air can be calculated.

$$\dot{Q} = \dot{m_{ref}} \cdot (h_2 - h_3) = \dot{m_{air}} \cdot Cp \cdot (T_{OUT} - T_{IN})$$

- **PROCESS 3-4: EXPANSION VALVE**

  - As it is considered as an isenthalpic process, not only the pressure is known (the same as the pressure in the first operating point). The enthalpy of point 4 is equal to the one calculated in point 3.

- **PROCESS 4-1: EVAPORATOR**

  - All the operating points have already been defined and calculated. With the enthalpies data of points 4 and 1, the heat exchange absorbed by the air can be calculated.

$$\dot{Q} = \dot{m_{ref}} \cdot (h_1 - h_4) = \dot{m_{aire}} \cdot Cp \cdot (T_{IN} - T_{OUT})$$

6 THERMS

EEV: Electronic expansion valve. The valve is controlled by an input signal, to achieve the pressure difference desired.

CONDENSER: A device unit to condense vapor into liquid. The condensing media employed in the complete cycle (performed by the dryer machine) is air. However, in the thermodynamic cycle designed (test rig), water is used due to its ease of control.

SUBCOOLING: Refers to a liquid existing at a temperature below its normal saturation temperature.

ISENTROPIC: An isentropic process is one in which it is assumed that the process takes place without an increase or decrease in the entropy of the system.

ISENTHALPIC: Is a process that proceeds without any change in enthalpy.

OPERATING POINT: Defined points along the thermodynamic cycle, to determine which process comes next and which one has been performed. This notation, provides the author a useful tool to explain the process and name the magnitudes.

EES: Engineering Equations Software. Thermodynamic software used to perform the calculations needed.

S&D: It stands for “Saunier Duval”, and it is used to indicate when an equipment has been provided by them.

VOLUMETRIC EFFICIENCY: Refers to the efficiency with which the engine can move the charge into and out.

QUALITY: It refers to the proportion of refrigerant that is in vapor state over the total refrigerant mass.

CW: It stands to “Calendar Week”.

CHAPTER 3: FIRST STAGE

1 ALTERNATIVES

1.1 OPTION 1: DESIGN ADAPTATION

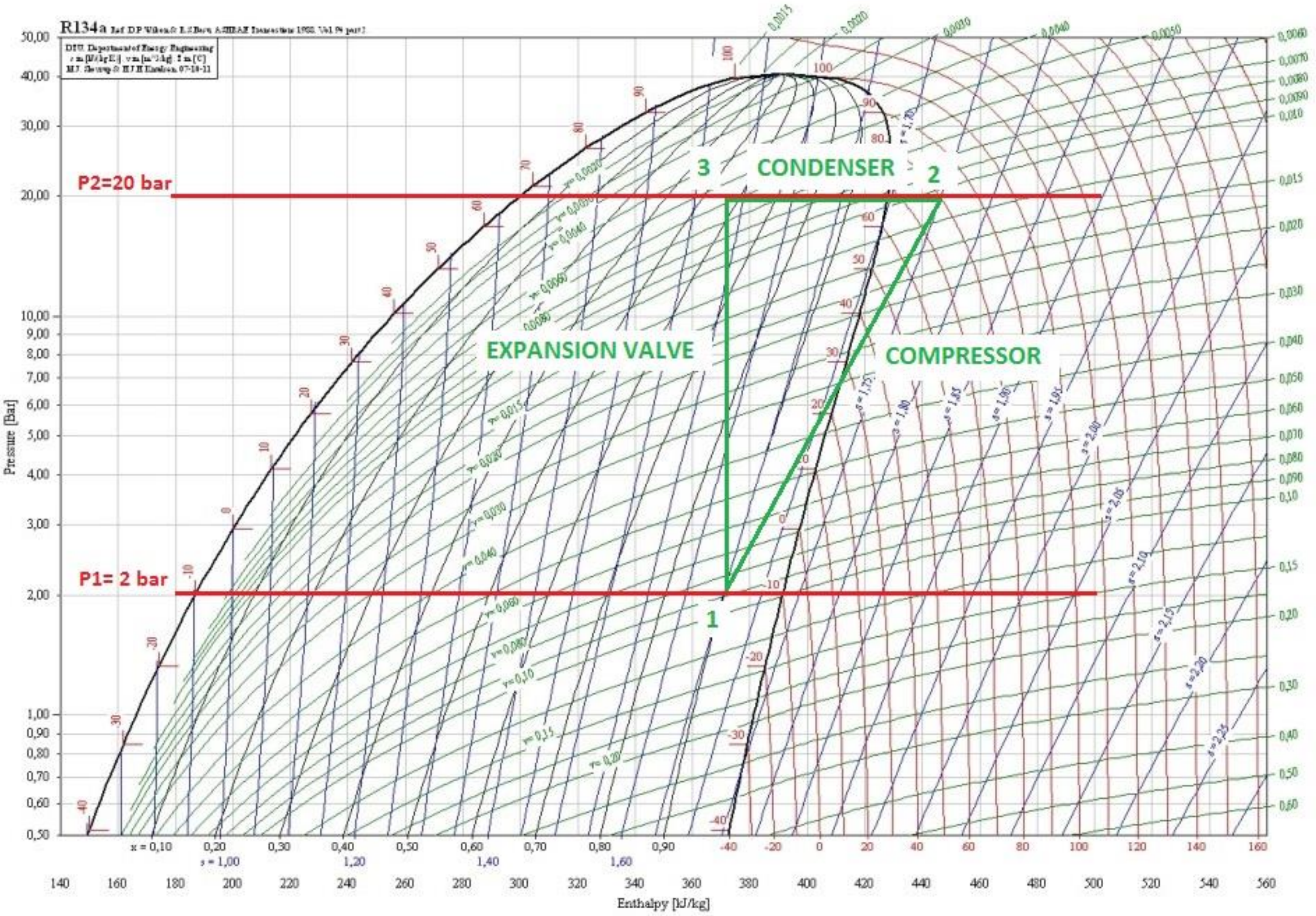


Figure 3--Mollier diagram of the first cycle designed

The compressor would determine the pressure difference of the cycle. The expansion valve will fix the pressure at the firs operating point (P1), so the pressure of the second operating point would be determined by the compression achieve by the compressor.

On the other hand, with the condenser it is determined the heat exchange, therefore it would be possible to determine the enthalpy difference experimented by the refrigerant.

As conclusion, the cycle would be perfectly determined.

1.1.1 OPERATING POINT TWO CALCULATIONS

At this point, the temperature and pressure are measured ($P2_{EXP}$ and $T2_{EXP}$). Depending on the compressor type it would be possible to obtain a greater compression, and therefore a bigger pressure difference.

Temperature Sensor	$T2_{EXP}$
Pressure sensor	$P2_{EXP}$
Flux sensor	m_{REF}

For determining the zone in which the refrigerant works (biphasic or overheated steam), the temperature measured ($T2_{EXP}$) can be compared with the saturation temperature at the pressure $P2_{EXP}$.

With the values of the temperature and pressure, and the knowledge of the zone in which the refrigerant works, the enthalpy of the operating point 2 can be calculated. There are several way to obtain its value (thermodynamic software programs…) one of them would be:

$$h_{2\_EXP} = u_2 + P_{2\_EXP} \cdot \Upsilon_2$$

The specific volume must be calculated in order to use the previous formula. When the refrigerant is in the overheated steam zone, it is obtained using the thermodynamic and the values of pressure and temperature measured.

On the other hand, if the refrigerant is in the biphasic zone to calculate the specific volume the use of a thermodynamic software would be needed.

To avoid its use, some assumptions can be made: The process can be considered as isentropic, so the enthalpy at the operating point two can be calculate with the help of the entropy of the operating point one. This way, the enthalpy "h2s" (enthalpy of the isentropic point two) would be obtained:

1. The operating point 2s and its enthalpy are calculated. To do so, theoretical values of point one must be used.
   Knowing the entropy at the point 2s (s1=s2s), and the vaporization and liquefaction entropies the quality of the operating point it is calculated. Once the quality has been obtained, the enthalpy of the isentropic operating point 2 (h2s) can be calculated.

2. With the isentropic efficiency of the compressor, and the values of the enthalpies of the points one, and the isentropic point two:

$$h_2 = h_1 + \frac{h_{2S} - h_1}{\eta\_iso}$$

After the compressor, the refrigerant goes through the first electronic expansion valve decreasing its pressure and temperature. There would be another expansion valve, so between both of them the pressure difference generated by the compressor must be equated. Modifying the pressure drop proportion in the first and second valve, the pressure desired in the operating point three can be achieve at the same time that the operating point one and two are properly defined.

In the condenser, the enthalpies difference required to force the operating point four to have the same enthalpy as in the operating point one, it is achieved.

Finally, the second expansion valve recovers the pressure at the starting operating point.

One important aspect of this point is the possible biphasic nature of the refrigerant at the exit of the compressor. This aspect would be specially conditioned by the quality at the entering of the compressor.

The main problem of this biphasic nature is the impossibility (or the unviability) to measure the refrigerant flux. The value of the refrigerant flux, as it would be explained later, will be necessary to obtain the heat exchange between the refrigerant and the water, and therefore the water flux.

All the calculation can be directly computed using the “Engineering Equations Solver” (EES), a thermodynamic program. It is possible to create personalized thermodynamic tables, to avoid intermediate calculations.

1.1.2 OPERATING POINT ONE CALCULATIONS

As inputs, the quality and pressures of the compressor would be introduced.

Temperature Sensor	$T1_{EXP}$
Pressure sensor	$P1_{EXP}$

With the stored data of the pressure and temperature of the first operating point, the thermodynamic tables can be employed to obtain the fusion and vaporization enthalpies to calculate the enthalpy at the operating point, as it is shown below:

$$h_1 = h_{f1} + x_1 \cdot (h_{g1} - h_{f1})$$

This enthalpy value, is the one to be achieved once that the cycle has been stabilized and works according to the parameters fixed.

This value of enthalpy is also the one that, theoretically should be at the operating point four, since the expansion is considered an isenthalpic process.

(*) EES CAN BE USED TO CALCULATE THE ENTHALPY DIRECTLY

1.1.3 CONDENSER

After going through the compressor, the refrigerant is ready to come across the condenser.

The operating point three is determined, since it is supposed to have the same pressure value as the one in the second operating point of the cycle ($P2=P3_{TH}$), and the same enthalpy of the first operating point ($h1= h3_{TH}$). The pressure is not going to be the exact same value, due to the drop pressure of the condenser.

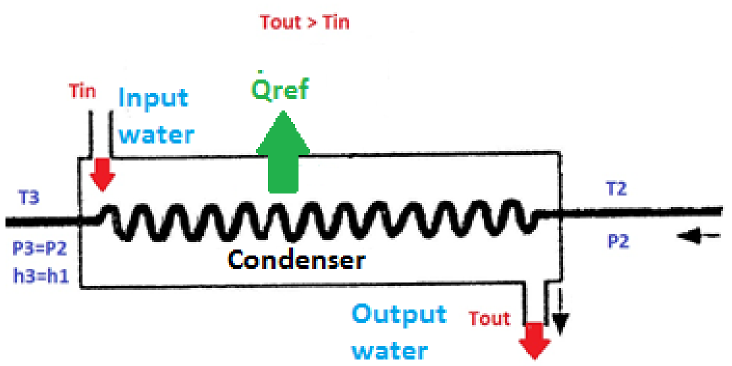


Figure 4-Condenser behavior

The enthalpy difference that must be achieve by the cooling process of the condenser is calculated, as the enthalpies of the operating points two and three are known: $\Delta h = h3 - h2 \sim h1 - h2$

This cooling process would be determined by the input water temperature (Tw_{IN}) and by the existing water flux in the condenser. Studying the equations, it is shown that there are two possible magnitudes which control would give us the chance to modify the heat exchanged:

$$\dot{Q} = \dot{m_{REF}} \cdot (h_3 - h_2)$$
$$\dot{Q} = \dot{m_W} \cdot Cp \cdot (T_{OUT\_W} - T_{IN\_W})$$

Temperature Sensor	Tw_{IN}, Tw_{OUT}
Flux sensor	m_W

As the thermodynamic magnitudes have an important thermal inertia, to control the heat exchanged it is better to modify the water flux instead its input temperature, because it would occasioned a faster response. For being able to change the water flux, a variable speed pump would have to be chosen.

1.1.4 OPERATING POINT THREE

It would be possible to determine whether the refrigerant works in the biphasic or in the subcooled zone.

Temperature Sensor	$T3_{EXP}$
Pressure sensor	$P3_{EXP}$

Employing the thermodynamic tables to determine the saturation temperature for the pressure measured at the operating point three ($P3_{EXP}$), and comparing it with the corresponding temperature measured at the same point.

Whether the measured temperature is lower than the corresponding temperature for the measured pressure at the operating point three, the refrigerant would be working in the subcooled zone, and viceversa.

The ascertainment of the situation of the operating point three would be different depending on the refrigerant zone in which the refrigerant works:

- **ENTHALPY ASCERTAINMENT AT THE BIPHASIC ZONE**

  With the measured values of pressure and temperature and the access to the thermodynamic tables the calculation of the enthalpy at that point is performed.

$$h_{3\_EXP} = u_3 + P_{3\_EXP} \cdot \Upsilon_3$$

- **ENTHALPY ASCERTAINMENT AT THE SUBCOOLED ZONE**

With the same measured data, the Access to the thermodynamic tables is performed to directly obtain the value of the enthalpy at the operating point three ($h3_{EXP}$).

$\boldsymbol{h_{3\_TH} - h_{3_{EXP}} > 0}$	The refrigerant has been cooled in excess.
$\boldsymbol{h_{3_{TH}} - h_{3_{EXP}} = 0}$	The real value is the same as the theoretical. The operating point has been achieved.
$\boldsymbol{h_{3\_TH} - h_{3\_EXP} < 0}$	The refrigerant needs to be cooled.

If the refrigerant needs to be cooled, then the heat exchange needs to be increased. In order to do so, the water flux must also be raised. The opposite control action (decreased the water flux) would have to be taken, if the refrigerant has been cooled in excess.

After the condenser, the refrigerant must pass through the electronic expansion valve (considered as an isenthalpic process).

As the expansion valve generates a pressure drop without any heat losses (at least not perceptible ones), the refrigerant will return to the firs operating point state, closing the cycle.

The conditions after the expansion valve (the first operating point) must be double checked to obtain the exact same values as at the beginning of the cycle to make the cycle stable. To do so, the circuit would be thermally isolated, to minimize the heat loses at the compressor and at the expansion valve.

1.1.5 ADVANTAGES AND DISADVANTAGES

The cycle has been simplified by removing an electronic expansion valve, and modifying the processes order. However, the cycle still needs the acquisition and analysis of multiple analogue signals.

The main inconvenient of this cycle, is the possibility of the refrigerant to be working in the biphasic zone at the exit of the compressor, which would complicate the measurement of the compressor flux.

This phenomena, theoretically occurs when the input quality of the refrigerant is low. Besides, the heat exchange between the compressor walls and the refrigerant has not been taken into consideration, so it is possible that the refrigerant at the exit of the compressor would be overheated steam, even if the calculations shows the opposite.

1.2 OPTION 2: MODIFICATIONS

Given that the main inconvenient for the previous design is the possible (according to the theoretical results in ANNEX I) biphasic nature of the refrigerant at the exit of the compressor, it is intended to be solved with a small modification of the cycle design.

With the effect of a heating resistance, it is intended to provide the heat needed for the fully evaporation of the refrigerant.

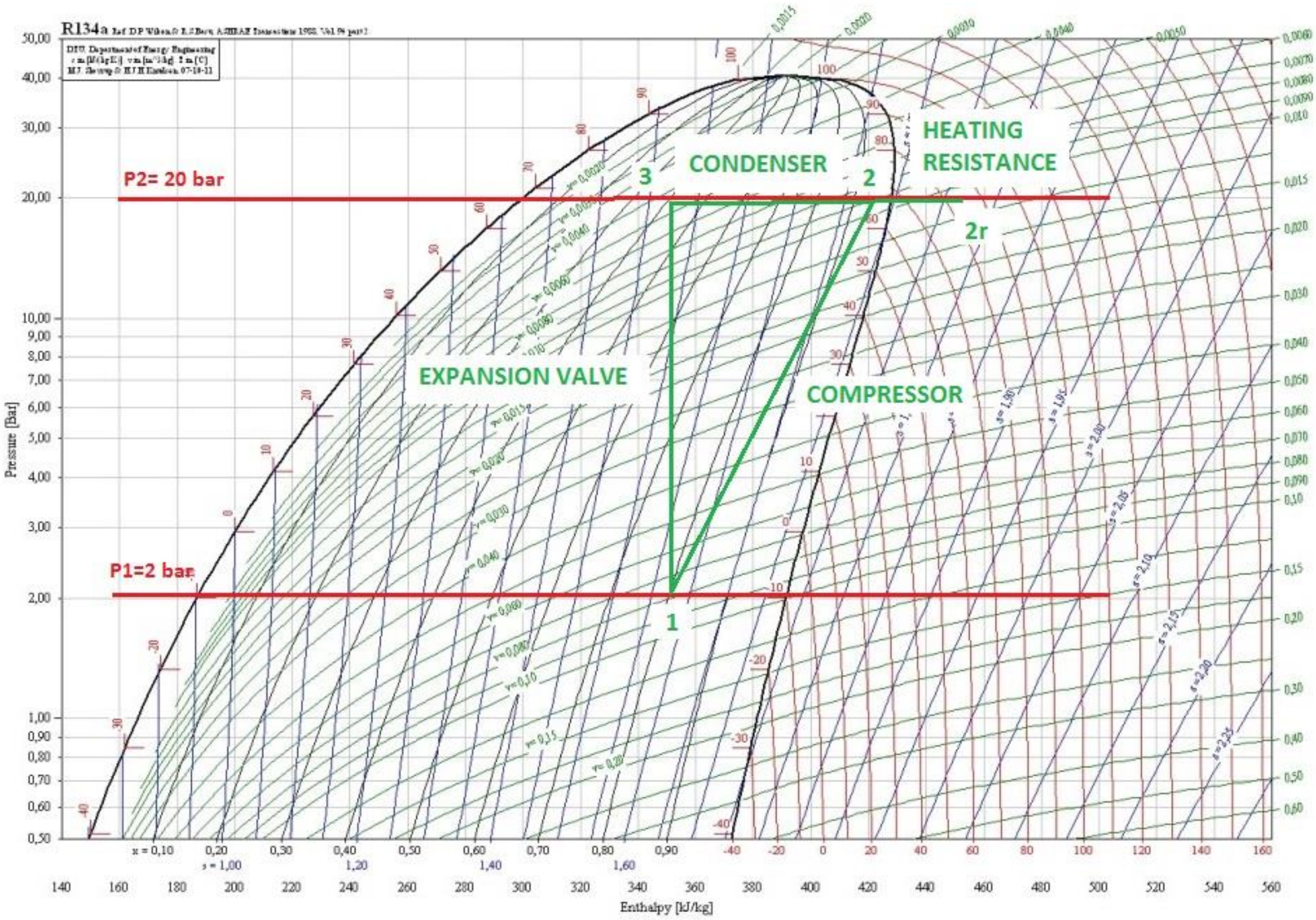


Figure 5- Option two, modified cycle

The cycle would be kept in the exact same way, except for this modification. The introduction of other component of the thermodynamic circuit will generate a new operating point that would be called “operating point 2r” (the “r” stands for the heating resistance).

For a better understanding, the added process will be explained in detail.

1.2.1 HEATING PROCESS 2-2r

At the operating point two the thermodynamic magnitudes will not be measured, they would be checked after the heating resistance. The heating resistance would provide to the refrigerant the heat required to evaporate (its temperature would be three degree increased above the saturation temperature at pressure P2r).

Temperature Sensor	$T2r_{EXP}$
Pressure sensor	$P2r_{EXP}$

If after the temperature ascertainment, the refrigerant is conclude to be at the biphasic zone then the heating resistance must be turned on to guarantee its fully evaporation.

The heat provide by the heating resistance would be calculated to make the refrigerant achieve a temperature higher (e.g. three degrees more) than the saturation temperature at the pressure measured P2r. This way, the refrigerant would be at the overheated zone, and its flux will be measured.

The enthalpy of the operating point 2r can be calculated with the data measures (P2r, T2r) and the assistance of the thermodynamic tables.

$$h_{2r} = u_2 + P_{2r} \cdot \Upsilon_2$$

Depending on the working zone in which the refrigerant is, the value of the enthalpy could be obtain directly from the thermodynamic tables.

1.2.2 ADVANTAGES AND DISADVANTAGES

With this design, the main problem in the previous design is solved, while its advantages are maintain.

The cycle control it's simplified at the same time that the problem with the measurement of the refrigerant flux is solved.

2 WATER REFRIGERATION

A chiller machine would be disposed to keep constant the input water temperature of the condenser. The input water temperature (Tw_{IN}) would be fixed and the signal controlling the water pump speed would be varied to generate a minor or greater water flux, so the heat exchange in the condenser could be controlled.

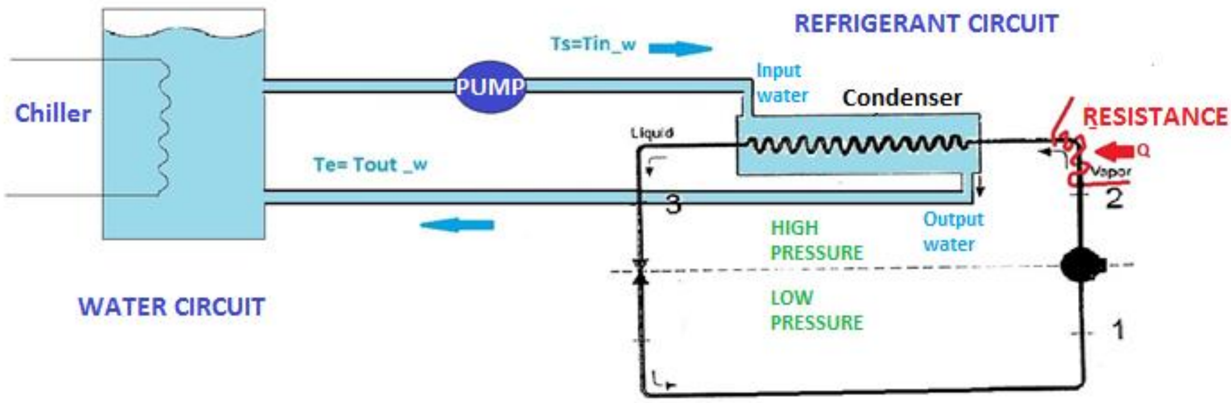


Figure 6-Water circuit

The pump speed control, and its flux, must be implemented in an automatically way employing a compatible software such as STEP7 or LABVIEW.

3 SELECTION PROCESS

Among the two options considered, the second one is chosen due to its relative simplicity and the resolution of the refrigerant flux measurement.

Nevertheless, the supplier’s management was developed for both, the first and second option. Besides, the calculation for option 2 were also made (for refrigerants R134A, R407C, R410A and R22), to determine its viability for the refrigerant measurement. The change in the refrigerants considered also create a new supplier’s management stage, since the components specifications were altered.

The quality of the refrigerant at the entrance of the compressor, even though in the calculations it is considered a range between x1ϵ (0’5-1), the actual range in which the quality might vary would be reduced and with higher values (x1=0’8, 0’9…).

It is proved that for quality values higher than 0’96, the refrigerant at the exit of the compressor would be in a complete gaseous state. In case of working with minor quality values, the heating resistance would be activate to avoid the possible biphasic nature of the refrigerant.

The heating resistance control would done fixing the temperature to be achieve, and controling it with a pulse PID.

4 COMPONENTS FOR THE THERMODYNAMIC CIRCUIT

The thermodynamic components needed for the cycle defined in option three are the followings:

4.1 COMPRESSOR

The objective of the test bench was to check different compressors to determine its use at adverse conditions. Therefore, this component would not be able to be fixed because the interest resides in the possibility of changing the compressors tested.

4.2 CONDENSER

It must be able to absorb the heat necessary to recover the enthalpy state that the refrigerant had at the entering of the compressor.

The condensing medium employed would be the water, this is due to the ease of the water flux and temperature control.

Studying the calculations of the ANNEX I, the maximum enthalpy differences requested and therefore, the maximum heats exchanged are:

Table 1-Condenser limit

	R134a		R410a		R407c		R22	
	Q min [kW]	Q máx. [kW]	Q min [kW]	Q máx. [kW]	Q min [kW]	Q máx. [kW]	Q min [kW]	Q máx. [kW]
3000 rpm and 7 cc/rev	0.18	1.29	0.41	1.15	0.27	1.08	0.27	1.04
5000 rpm and 11,4 cc/rev	0.48	2.58	1.13	3.12	0.73	2.93	0.73	2.81

Applying an oversizing of 20%:

$$\dot{Q} = 3.516\ kW \sim 3.6\ kW$$

Besides, the condenser must be able to stand a pressure of 50-60 bars, and the possible corrosion due to the refrigerants.

4.3 ELECTRONIC EXPANSION VALVE (EEV)

The electronic expansion valve must be capable of reducing a pressure of 50 bars, to a pressure of 3 bars (the refrigerant R410A has a pressure of 40 bars when its temperature achieve the 70 ºC).

This is the most extreme case, so if this pressure requirement is fulfilled the rest of pressure specifications would be as well fulfilled.

4.4 PLOMBING

The adaptors used for the equipment annexing and the rest of materials must be taken into consideration when the budget is calculated.

4.5 VARIABLE SPEED PUMP

The heat exchange dissipated in the condenser, can be modified varying the water flux within it, or the water temperature.

To be able to vary the water flux through the condenser, the use of a variable speed pump is required.

The water flux ranges for the project, depending on the refrigerant employed, is shown below:

Table 2-Water flux limits

	R134a		R410a		R407c		R22	
	$\dot{m}_W$ min [l/min]	$\dot{m}_W$ max [l/min]	$\dot{m}_W$ min [l/min]	$\dot{m}_W$ max [l/min]	$\dot{m}_W$ min [l/min]	$\dot{m}_W$ max [l/min]	$\dot{m}_W$ min [l/min]	$\dot{m}_W$ max [l/min]
3000 rpm and 7 cc/rev	0.26	1.85	0.6	1.65	0.39	1.55	0.38	1.49
5000 rpm and 11,4 cc/rev	0.68	3.71	1.62	4.47	1.05	4.21	1.04	4.03

Applying an oversizing of 10%:

$$\dot{m}w = 4.95\frac{l}{min} \sim 5\ l/min$$

4.6 CHILLER

A "water cooler machine" is needed, in order to keep the input water temperature of the condenser at a constant value. This way, to modify the heat exchanged in the condenser the program would have to act on the value of the water flux.

4.7 HEATING RESISTANCE

As it was explained above, when the input quality of the refrigerant is below 0'9, the calculations leads us to biphasic nature of the refrigerant at the exit of the compressor.

Therefore, the heating resistance is needed to evaporate the refrigerant at the output of the condenser and be able to measure its flux.

Depending on the refrigerant employed, and the input quality of the refrigerant at the entering of the compressor, a different amount of heat would be demanded. A representative summary of the calculations made are shown in the following table.

Table 3-Heating resistance limits

	R134a		R410a		R407c		R22	
	$\dot{Q}$min [kW]	$\dot{Q}$max [kW]	$\dot{Q}$min [kW]	$\dot{Q}$max [kW]	$\dot{Q}$min [kW]	$\dot{Q}$max [kW]	$\dot{Q}$min [kW]	$\dot{Q}$max [kW]
3000 rpm and 7 cc/rev	0.0	0.50	0.0	0.53	0.0	0.44	0.0	0.42
5000 rpm and 11,4 cc/rev	0.0	1.34	0.0	1.43	0.0	1.19	0.0	1.15

As expected, the minimum heat to be provided by the heating resistance is zero, that would mean that the quality of the input refrigerant has a "high" value (E.g.: greater than 0,96 for the refrigerant R134A).

5 SELECTION OF THE THERMODYNAMIC EQUIPMENT AND THE INSTRUMENTATION

The data sheets of the selected equipment are in ANNEX IX

5.1 EQUIPMENT

5.1.1 CONDENSER

A 5'5 kW condenser has been selected. It would be provided by PEKOMARK for 166.14 €.

(S&D) HOWEVER, SAUNIER & DUVAL HAS ACCEDED TO PROVIDED US A CONDENSER OF 3,5 KW, A CHILLER AND THREE DIFFERENT ELECTRONIC EXPANSION VALVES AMONG OTHERS.

5.1.2 EEV

An E2V05BSF00 Carel expansion valve was selected for its 50 bar of maximum pressure and its 35 bar of maximum pressure difference to be achieved. It would also be provided by pekomark and it would cost 515.67 € (drivers and electronic included).

(S&D)

5.1.3 CHILLER

Although other suppliers were considered, as Saunier Duval offered to provided us a chiller machine save us 5390 € (the price of the chiller 15 kW selected).

(S&D)

5.1.4 VARIABLE SPEED WATER PUMP

The pump selected had to have a control over the water flux provided, such as: EGO ROSCADA ER 15-130/40.

This pump, has an input signal 0-10 V to control the water flux.

The suppliers is EBARA, and it has a cost of 322.90 €.

5.1.5 HEATING RESISTANCE

Even if different options were considered, at the end CSH5082000/240 of the OMEGA supplier was selected. It can provide the system 2kW, so it fulfilled the specifications.

5.2 INSTRUMENTATION

5.2.1 PREASSURE & TEMPERATURE SENSOR

Both sensors have been ordered to the same supplier, JUMO. For the temperature sensor, a thermocouple K has been chosen specially for its oxidation properties (it also has a wide range of temperatures to me measured).

The pressure sensor has a limit of 60 bars, enough to assure its correct functioning.

Each temperature sensor (plus its support) has a cost of 106€, and for the pressure transmitter (output of 4-20 mA, two wire) 432 €.

5.2.2 WATER FLUX SENSOR

For the water flux and its corresponding electronic and adaptors, the SMR12GGXFRKG/US-100 for 304 € (water flux sensor) and the ADOAH040MSS0005H04 4.2€ have been offered, and selected, by IFM components. It measures 0.1-25 l/min and has an output of 4-20 mA (4 wire).

5.2.3 CORIOLIS REFRIGERANT FLUX SENSOR

EMERSON has offered F025S1115CCANSZZZZ sensor (2774.70 €) and 1700I13ABMSZZZ (691.65 €).

This sensor and its electronic have been selected because of their accuracy (<1%) at the refrigerant flux range: 4 g/s-160 g/s.

6 SENSORS, INPUTS Y OUTPUTS

6.1 SENSORS

Once that the thermodynamic cycle has been determined, the amount of sensors to be employed must be decided.

The following table represents the summary of possible options, when the selecting decision was to be made.

Table 4-Distribution of sensors

OPTION 1	5 temperature sensors (in the operating points 1, 2r, 3, and at the input-output water of the condenser). 3 pressure sensors (at the three operating points of the cycle). [2] It has both flux sensors, for the water and the refrigerant, [1] It has a heating resistance**.**
OPTION 2	5 temperature sensors (in the operating points 1, 2r, 3, and at the input-output water of the condenser). 3 pressure sensors (at the three operating points of the cycle). [1] It has only the water flux sensor [1] It has a heating resistance.
OPTION 3	4 temperature sensors (in the operating points 1, 2r and at the input-output water of the condenser). 2 pressure sensors (at the first and second operating points of the cycle). For the third operation point, a manometer would be set. [1] It has only the water flux sensor
OPTION 4	4 temperature sensors (in the operating points 1, 2r and at the input-output water of the condenser). 3 pressure sensors (at the three operating points of the cycle). [2] It has both flux sensors, for the water and the refrigerant, [1] It has a heating resistance.
OPTION 5	4 temperature sensors (in the operating points 1, 2r and at the input-output water of the condenser). 3 pressure sensors (at the three operating points of the cycle). [1] It has both flux sensors, for the water and the refrigerant,

For the first station, OPTION 1 would be chosen as it is the more complete. Once, their measurements have been studied the employment of sensors could be re-evaluated.

A priory, option two will be used for the rest of the stations, but the election of the sensors distribution would be conditioned by the data measured in station one.

6.1.1 OPTION 1

In this project, it is intend to begin with the installation of one station of the test bench, and extend its capacity up to 12 stations.

When implementing the first station, it is advisable that it was well monitored with sensors, even if it means measures that would not be strictly necessaries. Once the measurements of this first station are studied, it may be determined that sensors are "redundant" or without whose contributions the system can continue to operate within the range of accuracy required. This knowledge will permit a reduction in the cost of sensors employed. The possibility of use less sensors, must be considered when the programing code is being developed.

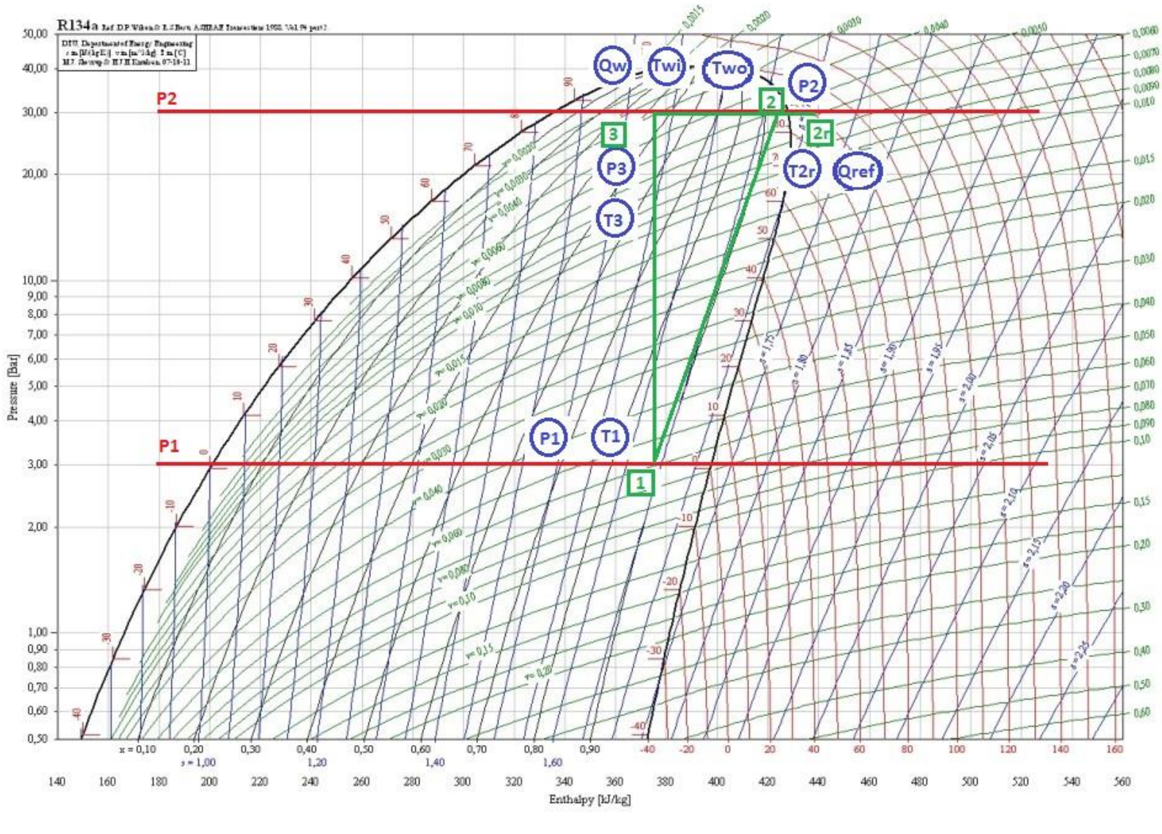


Figure 7- OPTION1- Thermodynamic cycle and the sensors empoyed

In the Figure 7 (and in the table below), it is shown the sensors employed and their location in the thermodynamic cycle.

Table 5-Option 1-Distribution of sensors

	REFRIGERANT CIRCUIT			WATER CIRCUIT	
SENSORS	POINT 1	POINT 2r	POINT 3	INLET OF THE CONDENSER	OUTLET OF THE CONDENSER
TEMPERATURE SENSOR	X	X	X	X	X
PRESSURE SENSOR	X	X	X		
FLUX SENSOR		X		X	

6.1.1.1 SIGNALS

Table 6-Option 1- Signals

Signals			**1x Compressor**	**11x Compressors**
Analog Inputs	Temperature	Thermocouple K	5	55
	Pressure	4-20 mA	3	33
	Flux	0-5V/4-20mA 0-5V/4-20 mA	2	22
TOTAL AI			10	110
Analog Outputs	Variable speed pump	0-10 V	1	11
	EEV	0-5V/4-20mA	1	11
TOTAL AO			2	22
Digital outputs	Compressor	Relay	1	11
	Heating resistance	Relay	1	11
TOTAL DO			2	22
TOTAL SIGNALS			**14**	**154**

6.1.2 OPTION 2

The only difference between this option and the option 1 considered above, is the use of the refrigerant coriolis sensor. It means one less analog signal to be process, and a reduction in the budget, since the coriolis sensor is very expensive.

After the study of the measurements of the station one, the value of the measured value of the refrigerant flux would be compared with the theoretical value calculated. If calculations and corrections in the formula can be made to improve the accuracy of the calculated value, the use of the coriolis sensor would no longer be needed.

As it was explained above, this option is being considered for the rest of the stations, but it would depend on the results of station one.

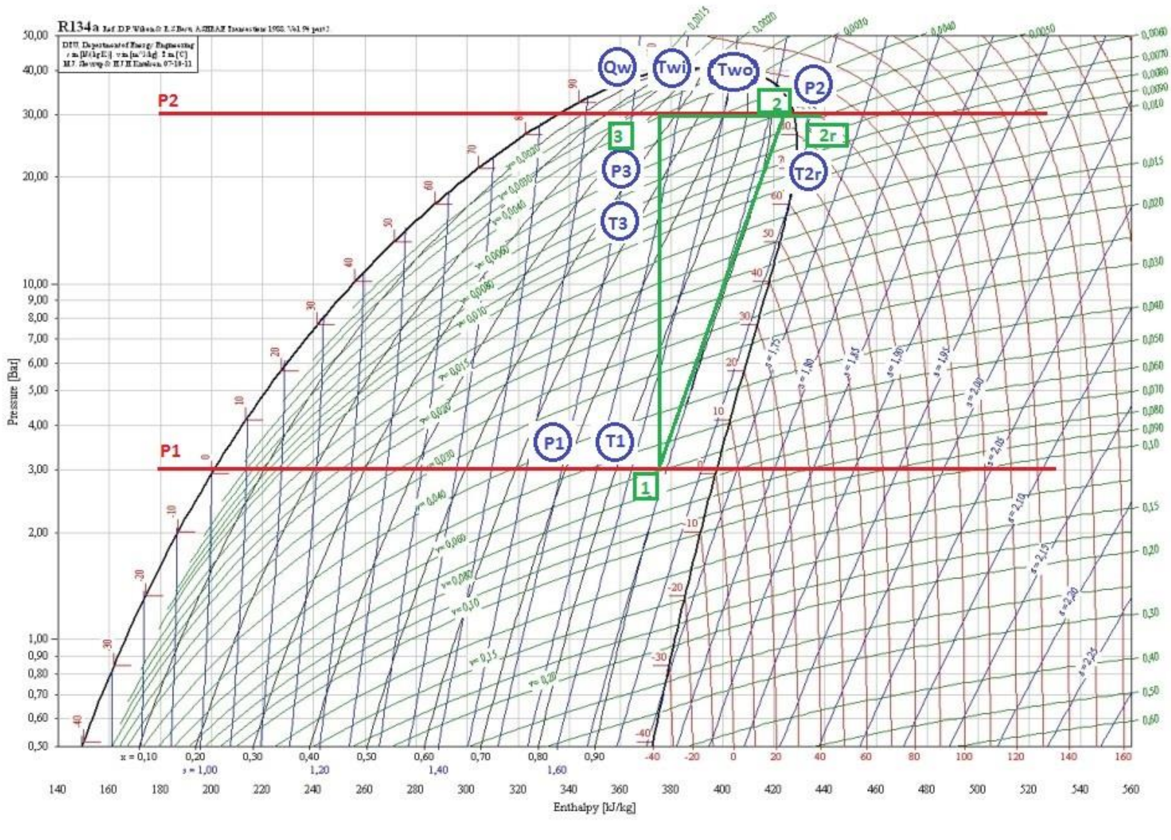


Figure 8-OPTION2-Thermodynamic cycle and the sensors employed

Table 7-Option 2- Distribution of sensors

	REFRIGERANT CIRCUIT			**WATER CIRCUIT**	
SENSORS	POINT 1	POINT 2r	POINT 3	INLET OF THE CONDENSER	OUTLET OF THE CONDENSER
TEMPERATURE SENSOR	X	X	X	X	X
PRESSURE SENSOR	X	X	X		
FLUX SENSOR				X	

6.1.2.1 SIGNALS

Table 8-Option 2- Signals

Signals			**1x Compressor**	**11x Compressors**
Analog Inputs	Temperature	Thermocouple K	5	55
	Pressure	4-20 mA	3	33
	Flux	0-5V/4-20mA	1	11
TOTAL AI			9	99
Analog Outputs	Variable speed pump	0-10 V	1	11
	EEV	0-5V/4-20mA	1	11
TOTAL AO			2	22
Digital outputs	Compressor	Relay	1	11
	Heating resistance	Relay	1	11
TOTAL DO			2	22
TOTAL SIGNALS			**13**	**143**

6.2 BUDGET

6.2.1 OPTION 1

Table 9-Option 1- Budget

EQUIPMENT	**QUANTITY FOR 1**	**POINTS**	**PRICE FOR 1**
Temperature	5	Tin,Tout,T1,T2r,T3	530,00 €
Pressure	3	P1,P2,P3	432,00 €
Water flux	1	Input water	322,90 €
Refrigerant flux	1	Punto 2	3.286,35 €
Pump	1	Input water	212,70 €
Condenser	(S&D)	(S&D)	- €
Chiller	(S&D)	(S&D)	- €
Electronic Expansion Valve	(S&D)	(S&D)	- €
Rele	1	Point 2r	63,00 €
Heating resistence	1	Exit of the compressor	72,30 €
Manual Valve	3		13,80 €
SUBTOTAL			**4.933,05 €**
Distribution Panel	1		2.000,00 €
PLC+HMI	1		5.440,00 €
Closet	1		500,00 €
Plumbing	1		1.000,00 €
TOTAL			**13.873,05 €**

6.2.2 OPTION 2

Table 10-Option 2- Budget

EQUIPMENT	**QUANTITY FOR 1**	**POINTS**	**PRICE FOR 1**
Temperature	5	T1,Tin,Tout,T2r,T3	530,00 €
Pressure	3	P1,P2,P3	432,00 €
Water flux	1	Input water	322,90 €
Refrigerant flux	0	Point 2	- €
Pump	1	Input water	212,70 €
Condenser	(S&D)	(S&D)	- €
Chiller	(S&D)	(S&D)	- €
Electronic Expansion Valve	(S&D)	(S&D)	- €
Rele	1	Point 2r	63,00 €
Heating resistence	1	Exit of the compressor	72,30 €
Manual Valve	3		13,80 €
SUBTOTAL			**1.646,70 €**
Distribution Panel	1		2.000,00 €
PLC+HMI	1		5.440,00 €
Closet	1		500,00 €
Plumbing	1		1.000,00 €
TOTAL			**10.586,70 €**

7 OBSTACLES AND CALCULATIONS

7.1 REFRIGERANT’S FLOW AND CORIOLIS SENSOR

To measure the refrigerant’s mass flow a Coriolis sensor is used. This kind of sensor should measure the substance in an only stage. If we expect to do the same with a two-phase substance, important unpredictable variations (noise) will appear due to the gas bubbles dissolved in the liquid.

It is necessary to find out if there is a kind of coriolis sensor that helps measuring the overheated vapour. It could be placed at the output of the compressor and obtain the measurement when we get overheated vapour.

Nevertheless, as the working point is variable, it could happen that two-phase coolant’s mixture appears at the output of the compressor, so we couldn’t trust the sensor’s measurements.

To assure the gas state of the coolant, we could overheat it at the compressor’s output.

For the cases where the measurement cannot be trusted, it will be necessary calculate the coolant’s flow theoretically (it can always be calculated theoretically with the purpose of supporting the experimental data).

Having the density of the coolant (of the specific volume) for a given temperature and pressure. Also, as technical compressor’s specifications, we have capacity $\frac{cc}{rev}$ (it will turn into $\frac{m^3}{rev}$), of the compresor’s rpm (The units will have to be turned into RPS) and its isentropic efficiency.

$$\dot{m}_{R134a} = \frac{1}{\gamma} \cdot \frac{rev}{s} \cdot \frac{m^3}{rev} \cdot \eta = {}^{kg}/_{s}$$

7.1.1 RESEARCHING GROUPS

Matching information with other researching groups from the University of Valencia, we know that the measure of the coolant at the output of the compressor, even if it is believed that it will be gas in each case (due to the overheating of the compressor’s sides which will cause the coolant’s evaporation), will cause problems.

In order to do a suitable measure, other kind of devices should be used, which will raise the bench testing’s price.

As the coolant’s flow can be calculated theoretically we will do without it (as it has already been explained at point five).

7.2 CALCULATIONS

The aim of the testing bench is to introduce to the compressor a two-phase coolant and check how it Works under this untraditional circumstances. Theoretically, we would be able to modify the two-phase’s title in a range of x1= (0’5, 1), even if during the practice we will be working with higher values (>0,85).

The calculations will be done supposing a difference between water’s temperature at the inlet and outlet of the condenser of 10ºC.

These calculations are shown at ANNEX I.

CHAPTER 4: FOURTH STAGE

Once the budgets are done (and matched between different suppliers) the buying orders are sent.

The control system’s design follow the next structure.

1 CONTROL DESIGN

The first objective is fixing the pressures which are being used.

- The enthalpy at point 1 is calculated with the desired information of the title and pressure (adjusted so the desired pressure and the theoretical one are the same). To succeed in this the diagrams about de values of fusion and vaporization will be checked or, as it is done in the project, a thermodynamic table depending on the pressure ant the quality would be defined.

P[1] [bar]	x[1]	h[1] [kJ/kg]	rho[1] [kg/m3]
1	0,5	125,9	10,35
1	0,5183	129,8	9,985
1	0,5373	134	9,635
1	0,5569	138,2	9,297
1	0,5773	142,7	8,971
1	0,5985	147,2	8,656
1	0,6204	152	8,352
1	0,6431	156,9	8,059
1	0,6666	162	7,776
1	0,691	167,3	7,503
1	0,7163	172,8	7,24
1	0,7425	178,5	6,985
1	0,7697	184,4	6,74
1	0,7979	190,6	6,503

Figure 9-Thermodynamic table 1-Biphasic

At this operating point, the refrigerant density would also have to be calculated, in order to be able to compute the refrigerant flux theoretically.

- The pressure and temperature at point 2 (at the entering of the condenser, or after the heating resistance) are measured and the enthalpy of the point is calculated. As it was explained above, it has opted to use thermodynamic tables created from EES, so the tables are customize.

P[3] [bar]	T_sat [º C]	Delta_T	T[3] [º C]	h[3] [kJ/kg]	rho[3] [kg/m3]
1	-26,37	5	-21,37	238,4	5,072
1	-26,37	10	-16,37	242,4	4,958
1	-26,37	15	-11,37	246,4	4,85
1	-26,37	20	-6,375	250,4	4,747
1	-26,37	25	-1,375	254,5	4,649
1	-26,37	30	3,625	258,5	4,556
1	-26,37	35	8,625	262,7	4,467
1	-26,37	40	13,63	266,8	4,382
1	-26,37	45	18,63	271	4,3
1	-26,37	50	23,63	275,2	4,222
1	-26,37	55	28,63	279,5	4,147
1	-26,37	60	33,63	283,8	4,074

Figure 10-Thermodynamic table 2- Superheated

- Once the enthalpy values of points one and two are written down, as in point 3 it is necessary to have the same enthalpy as in point 1, the heat exchange can be fixed in the condenser. The temperatures of the water inlet and outlet to the condenser are measured and with the theoretical refrigerant flux, the water's mass flux is calculated. The suitable control signal will be emitted, and therefore the bomb will provide the flow desired.

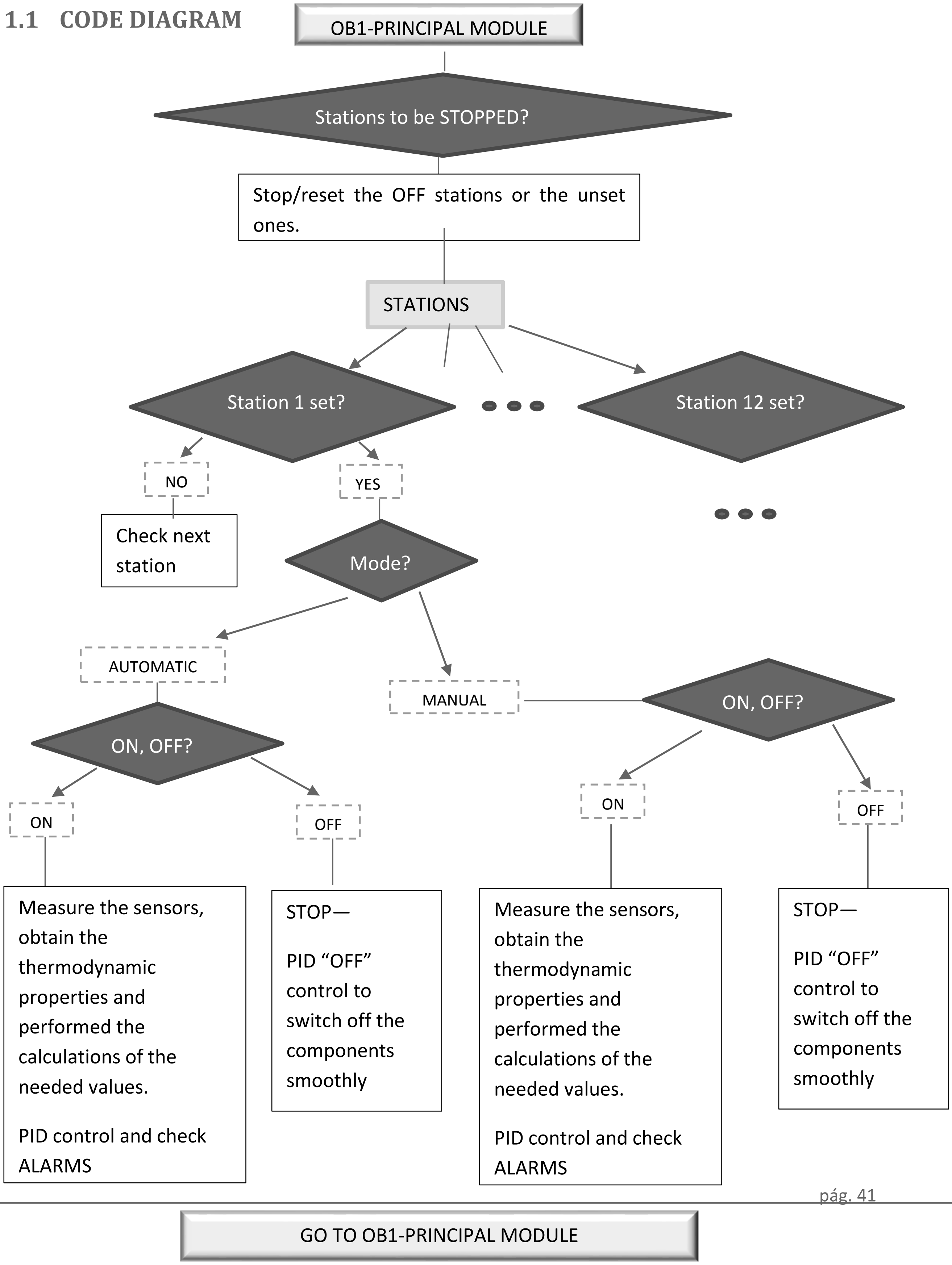
- Pressure at point 3 is measured, so it can be calculated the drop pressure in the condenser.

- It is possible to know where the refrigerant "is" (refers to its pressure-temperature condition) in each step.

The state of the measures should be checked and the needed parameters recalculated constantly. It is essential during the first seconds after starting the bench testing, as until the desired points are reached.

The Excel in which the calculation would be performed ("Station1"), would be "refresh" each five seconds. This "refreshing" time can be modified, changing the visual basic code of the "excel_interface" (it is in charge of obtaining the inputs needed from the WINCC, and to return the result of the calculations of the "Station1" file).

1.1 CODE DIAGRAM



1.2 STEP 7

The code has been added in the **ANNEX VII**, and it would also be included in a zip file along the whole project.

In the main program (OB1) the user would "called" the functions in charge of every station, and the Start all/Stop all security subroutine.

The function in charge of every station (FC10 for the first one) would managed the use of the rest of subroutines in charge of: sensor measurement, etc…

The subroutines for the first station have been defined:

1. **Sensor measurement**

   In this subroutine a scale procedure of the input signals is set, fixing the limits of the magnitude measured and improving its resolution.

2. **Configuration**

   It would be mainly done through the WINCC tactile panel. The selection of the refrigerant employed, the specification of the "rpm", the efficiencies, the displacement…and other parameter would have to be set.

   In an intuitive way, the stations to be tested and the sensors employed in each one, would be indicated through the tactile panel.

3. **Start/Stop**

   The start/stop code in STEP 7, is closely related to the graphic interface. If all the stations implemented happened to be in "stop" mode, then the "ALL STOP" indicator would be activated and turned off softly.

   To turn off the stations, except for the compressor, it would be done by a PID controller, so the components do not suffer.

The same would happened if all the stations were in the "start "mode, but in this case it would be activate the "ALL START "indicator, and the next time that the OB1 is execute, the Station would be execute.

4. Sensors not employed

The theoretical values of pressure, temperature, etc… of each operating point have been calculated.

If during the configuration, one sensor was not set as "employed", then it would not be possible to employ the signal measured and the theoretical value would be used instead.

5. PID control orders

The three PID controls of the Pump, the EEV and the heating resistance are mostly done (Must be reviewed).

- Pump: It would have to compare the water flux measured with the water fluxed desired[1)] (exported from the EES program), and determined an action in the corresponding analog output to achieve that goal.

- EEV: The ratio of the pressure P3/P1 would be given, in order to achieve that difference of pressures desired[1)], modifying the value of its control analog output.

- Heating resistance: It would be control through a digital output (and a relay). With the PID control, you fixed whether the digital output must be active or not, according to the temperature value measured, and the temperature[1)] that must be achieve.

The functions/subroutines employed for the first station program code, were parameterized[2)] in order to allow their use, for the rest of the stations code.

1) **All these "desired values" are already calculated but must be exported from the EES**

2) **For "parameterized", we referred to the possibility of define a function so when it is summoned, the input/output variable's labels, can be related with the convenient input/output directions. This will allow using the same program code, changing the input/output directions, from the ones employed for the first station to the directions for the rest of the bench's stations.**

6. Mode

Two different modes can be selected:

- **Manual:** It is defined to check the correct functioning of the components. In the tactile panel a proportional controller has been defined to check the components without making them suffer.

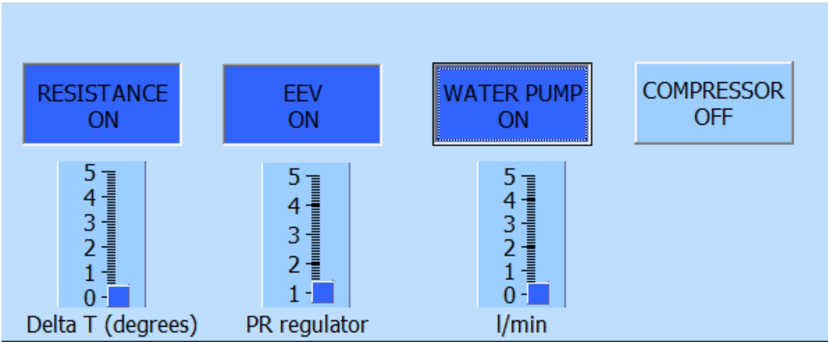


Figure 11- Manual control detail

- **Automatic:** It is the mode that would currently be execute. Settings and alarms must be defined, employing the tactile panel.

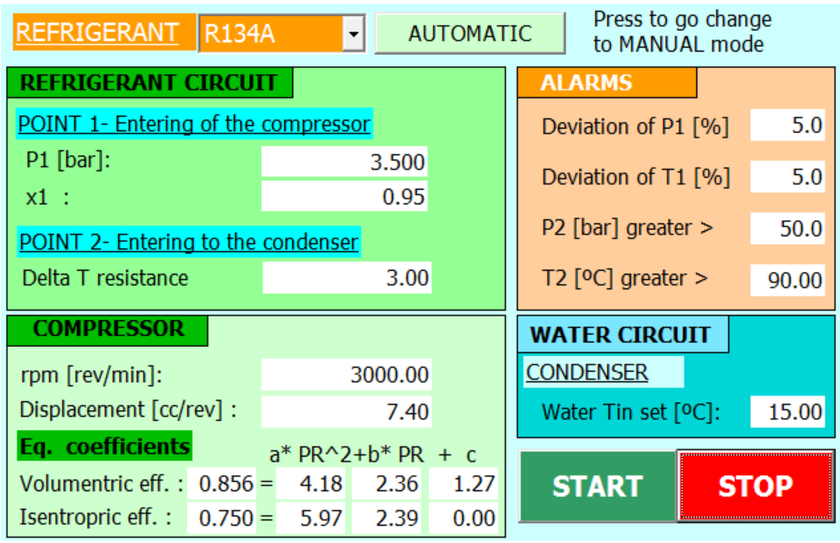


Figure 12-Automatic control detail

1.3 WINCC

The graphic interface for the first station has been programed. For the rest of the future stations, we would have to copy the "images" of the first one, and defined/change the variables employed.

There is a "Main Menu" with four different options:

1. Habilitation of the stations
2. Equipment of the stations abled
3. Settings of the stations
4. Station Menu

The configuration of the stations must follow the order shown.

In the station menu, you can only choose between the accesses to the different stations that have been habilitated.

1.4 VISUAL BASIC

It is explained in detail in **ANNEX VI**.

The refrigerant tables are stored in excel, and besides the operations to calculate the enthalpies... it must act like a data logger.

Some variables would be exported from the station DB, as well as others would be imported (enthalpies, saturation temperatures…).

1.5 EES

It has been used for the calculations of **ANNEX I**, and **ANNEX IV**. It was intended to use this software to obtain the enthalpies corresponding to the pressures and temperatures measured, however it cannot be run "automatically", so it had to be excluded.

The thermodynamic tables of the excel, that were employed in the "excel_interface", were created using this software.

	FINAL PROJECT	Date: **19.06.2014** Page: **46**
PROJECT: **“Compressors test life bench under wet compression conditions”**		PROJECT REPORT: **1**

2 CONNECTION

2.1 HARDWARE

The hardware connection, between the remotes, the HMI and the PLC has been defined in the STEP 7 program. Besides, it has been added to the remotes the external modules needed.

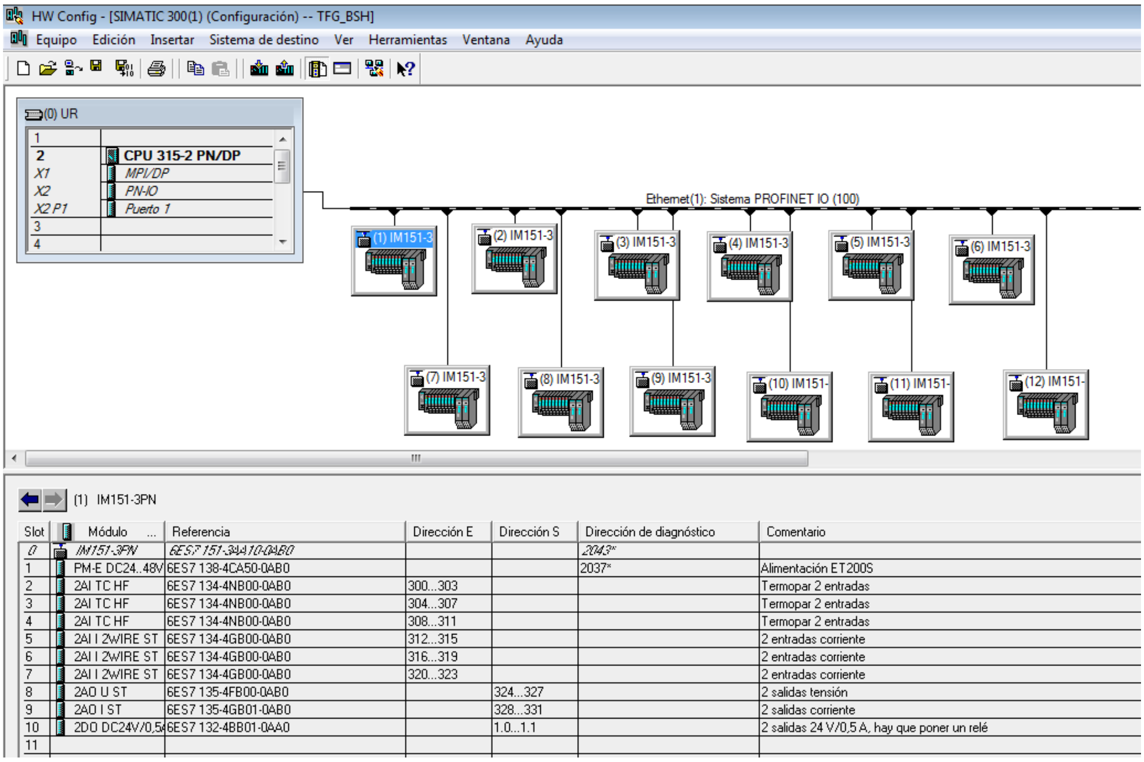


Figure 13- Hardware

2.2 INDUSTRIAL ETHERNET

As the CPU selected has two different type of connection (PN/DP), it must be specified.

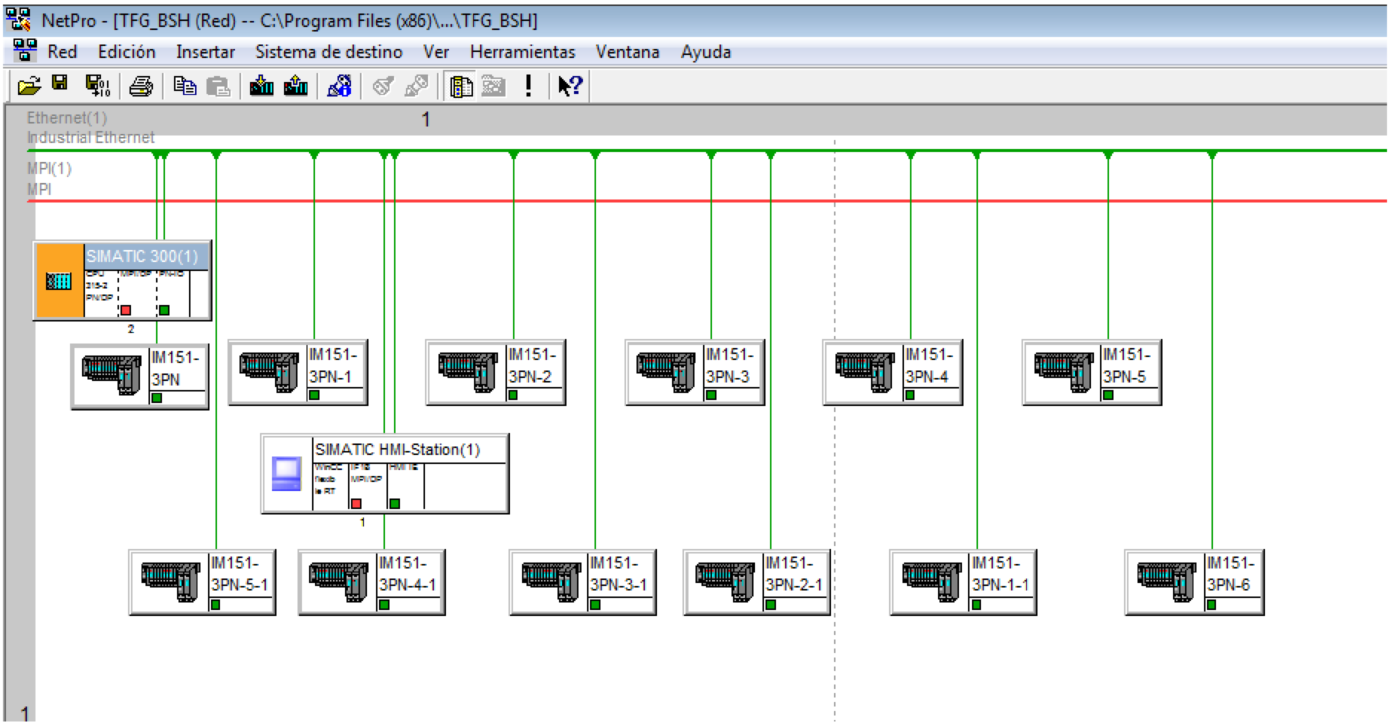


Figure 14-Connection of the PLC, the remotes (ET200S) and the HMI tactile panel

Each component has its own IP adress, belonging to the same network:

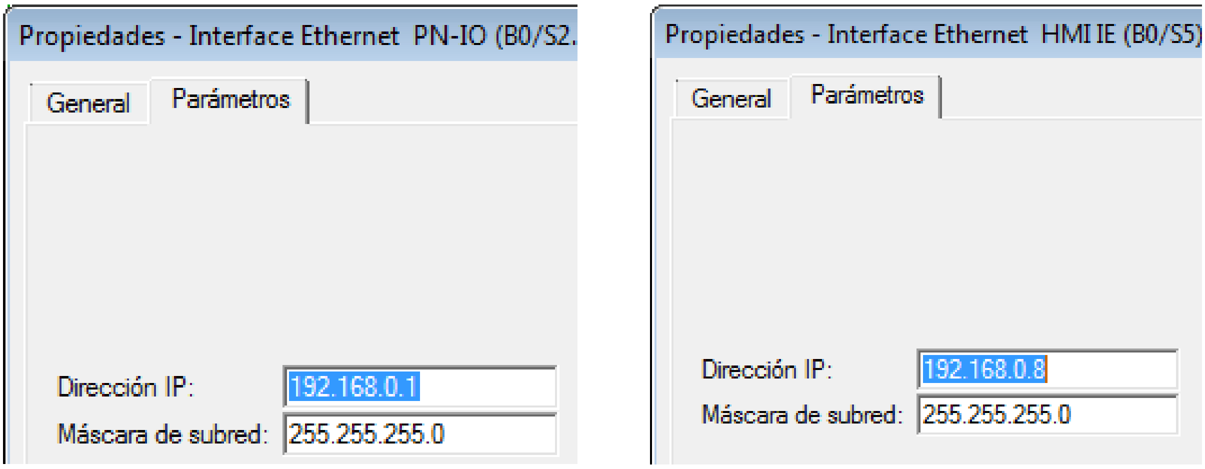


Figure 15-CPU's IP and HMI's IP

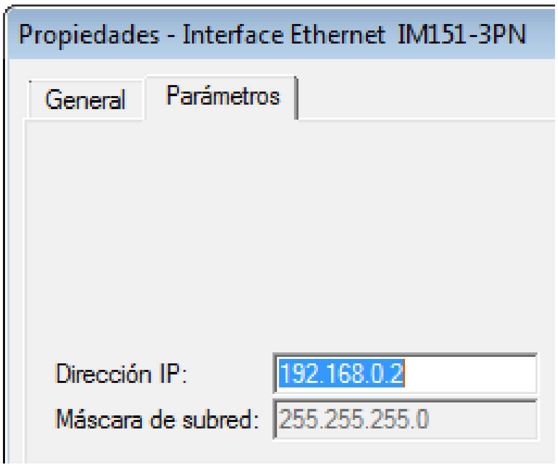


Figure 16- Station 1 IP

CHAPER 5: CONCLUSIONS

1 OBJECTIVES ACHIEVE

The thermodynamic cycle has been defined and the purchase order has been sent, however not all the equipment has been received. This is due to the multiple changes of the circuit limitations, such as the number of refrigerants that can be employed, or even the cycle itself.

Besides, some of the components such as the coriolis refrigerant flux sensor which delivery time is 5 weeks:

Table 11- Component's delivery time

COMPANY	EQUIPMENT	PURCHASE ORDER STATUS (DATE)	DELIVERY TIME	DELIVERY DATE
JUMO	Temperature sensor	SENT CW 22	4 Weeks	CW 26 approx.
	Pressure sensor		3 / 4 Weeks	CW 26 approx.
IFM	Water flux sensor	SENT- CW 19	1 /2 Weeks	CW 21 received
EMERSON	Refrigerant flux sensor	SENT CW 22	5 Weeks	CW 27
EBARA-SALTOKI	Pump	SENT- CW 22	2 Weeks	CW 24 approx
OMEGA	Heating resistance	SENT- CW 22	1 / 2 Weeks	CW 22 received

The task to be developed in the "Stage 3", are been developed. The bench's being assembled and the reception of the control system is about to be complete.

In general, it has been a delay in the development of the task. However, the practical's period has been extended two month, in order to be able to finish the project.

2 LIMITATIONS

The components of the cycle can stands up to 50 bars ant 90 ºC, nevertheless the critical pressure of some of the refrigerant is below this limit. Besides, even if for some refrigerants, its critical pressure was above the limit, the compressors would not achieve a pressure greater than this value.

3 IMPROVEMENTS

The improvements to be included are explained in detail, along with its calculations, in **ANNEX IV.** A resume of what can be found in this annex:

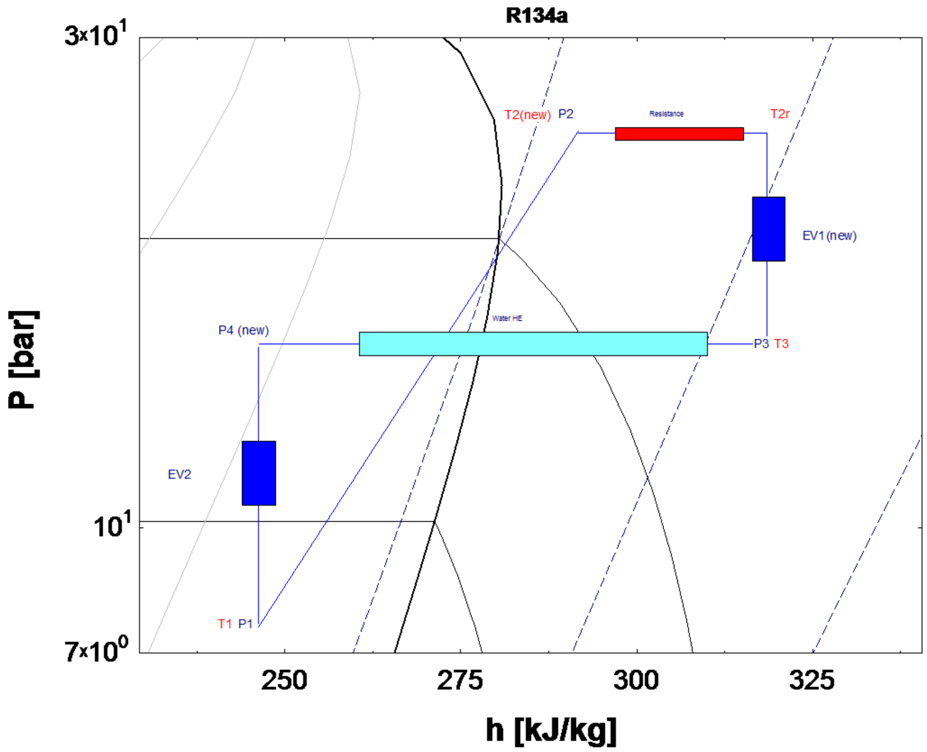


Figure 17-Improvement- cycle to be implemented

This would be the thermodynamic cycle to be implemented in the test rig bench.

The reason why this cycled is preferred to the other option considered, is mainly the stability of point 2. The effect of the condenser water flux was dismissed, but it can vary the pressure of the point 2, and therefore, perturb the stability of the cycle.

This cycle is been programed and it is supposed to be functioning in two months' time, after the code had been checked and reviewed.

E.T.S. de Ingeniería Industrial,
Informática y de Telecomunicación

Compressors test life bench under wet compression conditions

Grado en Ingeniería
en Tecnologías Industriales

ANNEX

Natalia Medina Cabello

Jose Ignacio Arocena

Pamplona, 26 de Junio del 2014

ANNEX’S INDEX

ANNEX I: CALCULATIONS

ANNEX II: SECOND STAGE

ANNEX V: WINCC

ANNEX VIII: UNCERTAINTIES

ANNEX IX: DATA SHEETS

ANNEX'S FIGURES

ANNEX'S TABLES

	FINAL PROJECT	Date: **19.06.2014** Page: **1**
PROJECT: **“Compressors test live bench under wet compression conditions”**		PLANES: **3**

ANNEX I: CALCULATIONS

1 CODE “EES”

```
"Functions"

"Enthalpy 2"

Function f_h2 (rend_iso; h1; h2s)
h2=h1+((h2s-h1)/rend_iso)
f_h2=h2
end

"Refrigerant flux"

function f_m_ref(rho_ref ; rend_vol ; rps ; displ)
m_ref=(rho_ref*displ*rps*rend_vol)/(1000000)
f_m_ref=m_ref
end

"Water flux"

function f_m_w(Q; Cp ;delta_T)
m_w=(Q/( Cp *delta_T))
f_m_w=m_w
end

"Compressor data"

displ=7  "cc"                      " Displacement of the compressor"
rpm=3000                           " Revolutions per minute of the compressor"
rps=rpm/60                         " Rev. per second"
rend_vol=0,9                       " Assumption of constant volumetric efficiency"
rend_iso=0,5                       " Assumption of constant isentropic efficiency"

"Water circuit data"

Cp=Cp(Water;T=Tout;P=P_atm)   "kJ/kg-K"    " Cp of the water at a given temperature”
Tin=15  "ºC"                       " Input temperature of the water at the entering of the condenser"
Tout=25    "ºC”                    " Outout temperature of the water, at the exit of the condenser, after the heat exchange had taken place”

delta_T=(Tout-Tin)   "K"
```

```
P_atm=101,3            "kPa"

"REFRIGERANT"

R$='R134a'

"INPUTS"
{T[1]=5   "ºC"                              " Temperature at the charging point of the
                                             compressor"

x1=0,8                                      " Quality of the refrigerant at the entering of
                                            the
                                            compressor"

T[2]= 70   "ºC"}                            " Temperature at the discharge point of the
                                             compressor"

P1sat=pressure(R$;T=T[1]; x=1)
P2sat=pressure(R$;T=T[2];x=1)

"*****POINT 1******"

h1=ENTHALPY(R$; P=P1sat; x=x1)
s1=ENTROPY(R$;P=P1sat ;x=x1)

"****POINT 2 ISENTROPIC*****"

s2s=s1
h2s=enthalpy(R$;P=P2sat;s=s2s)

"*****POINT 2***** DISCHARGE OF THE COMPRESSOR"

h2=f_h2 (rend_iso; h1; h2s)
T2_real=temperature(R$;h=h2;P=P2sat)

"*****POINT 3*****AFTER THE HEAING RESISTANCE "

T[3]=T[2]+3                                 "We set the temperature 3 degrees over the
                                             saturation temperature, to assure the
                                             gaseous nature of the refrigerant"

h3=enthalpy(R$;P=P2sat;T=T[3])

"*****POINT 4******"
h4=h1
T[4]=temperature(R$;P=P2sat; h=h4)
```

"*******HEAT EXCHANGE*****"

delta_enthalpy=h3-h4	"Difference of enthalpies that must be obtained with the condenser, in order to return to the enthalpic state in POINT 1"
rho_ref=density(R$; h=h1; P=P1sat)	"Density at the entering of the compressor, to calculate the flux"
rho_ref_after_resistance=density(R$; h=h3; P=P2sat)	"Density of the refrigerant gas, after the heating resistance, to dimensionate the refrigerant flux sensor"
m_ref=f_m_ref(rho_ref ; rend_vol ; rps ; displ)	"Call the function 'refrigerant flux' "
Q=m_ref * delta_enthalpy "kW"	"Heat exchange in the condenser"
m_w=f_m_w(Q; Cp ;delta_T)	"Water flux needed to exchange the calculated heat"
rho_water=Density(Water;T=Tin;P=P_atm) "kg/m3"	"Density of the water at a given temperature”
flow_w_lit_min=m_w/rho_water*60000	"Water flux in liters per minute"
{flow_w_lit_h=flow_w_lit_min*60	"Water flux in liters per hour""}

"****HEATING RESISTANCE ****"

delta_h_res=h3-h2	"Difference of enthalpies that must be obtained with the heating resistance"
Qres=delta_h_res*m_ref	" Heat flux that must be exchange within the resistance and the refrigerant flux, to fully evaporate the refrigerant"

This is the program code of the EES software that was used in the solving process. By employing a parametric table, it can return the values of the enthalpies, the heat exchange, etc… according to different values of T1, T2 and X1.

Below, the resulting calculations are shown. In some cases, the software was not able to calculate the parameters, due to an overflow issue.

2 CALCULATIONS

2.1 REFRIGERANT R134A--- 5000 rpm 11.4 cc/rev

Table 12- R134 A- 5000 rpm, 11.4 cc/rev-cycle 1

T1	T2	X1	mref	flow_l_min	P1	P2	Q	Qres	desnsity after resistance	h1	h2	h3	h4
5,00	30,00	0,75	0,02	1,82	349,90	770,64	1,26817	0,802393	36,85	204,66	228,59	269,83	204,66
8,33	34,44	0,75	0,02	2,00	392,28	873,87	1,39400	0,866412	41,91	207,69	232,05	272,04	207,69
11,67	38,89	0,76	0,02	2,19	438,48	987,17	1,52686	0,931968	47,55	210,71	235,43	274,15	210,71
15,00	43,33	0,76	0,03	2,39	488,70	1111,16	1,66637	0,998443	53,85	213,69	238,73	276,16	213,69
18,33	47,78	0,76	0,03	2,60	543,17	1246,48	1,81192	1,065007	60,88	216,63	241,95	278,06	216,63
21,67	52,22	0,76	0,03	2,82	602,12	1393,83	1,96260	1,130562	68,75	219,55	245,10	279,82	219,55
25,00	56,67	0,77	0,04	3,04	665,78	1553,90	2,11716	1,193642	77,57	222,43	248,17	281,43	222,43
28,33	61,11	0,77	0,04	3,26	734,40	1727,45	2,27380	1,252289	87,50	225,26	251,15	282,87	225,26
31,67	65,56	0,77	0,04	3,49	808,21	1915,28	2,43006	1,303872	98,71	228,06	254,04	284,11	228,06
35,00	70,00	0,77	0,05	3,71	887,47	2118,24	2,58250	1,344821	111,44	230,81	256,84	285,12	230,81
5,00	30,00	0,78	0,02	1,63	349,90	770,64	1,13496	0,667440	36,85	209,57	234,40	269,83	209,57
8,33	34,44	0,78	0,02	1,79	392,28	873,87	1,24788	0,718214	41,91	212,55	237,80	272,04	212,55
11,67	38,89	0,78	0,02	1,96	438,48	987,17	1,36709	0,769730	47,55	215,49	241,12	274,15	215,49
15,00	43,33	0,78	0,03	2,14	488,70	1111,16	1,49221	0,821372	53,85	218,40	244,37	276,16	218,40

18,33	47,78	0,79	0,03	2,33	543,17	1246,48	1,62266	0,872329	60,88	221,27	247,53	278,06	221,27
21,67	52,22	0,79	0,03	2,52	602,12	1393,83	1,75756	0,921522	68,75	224,11	250,61	279,82	224,11
25,00	56,67	0,79	0,03	2,72	665,78	1553,90	1,89570	0,967527	77,57	226,92	253,61	281,43	226,92
28,33	61,11	0,79	0,04	2,92	734,40	1727,45	2,03534	1,008442	87,50	229,68	256,52	282,87	229,68
31,67	65,56	0,80	0,04	3,12	808,21	1915,28	2,17412	1,041715	98,71	232,39	259,33	284,11	232,39
35,00	70,00	0,80	0,05	3,31	887,47	2118,24	2,30871	1,063888	111,44	235,06	262,05	285,12	235,06
5,00	30,00	0,80	0,02	1,45	349,90	770,64	1,01001	0,540859	36,85	214,49	240,20	269,83	214,49
8,33	34,44	0,80	0,02	1,59	392,28	873,87	1,11077	0,579161	41,91	217,40	243,55	272,04	217,40
11,67	38,89	0,81	0,02	1,75	438,48	987,17	1,21712	0,617448	47,55	220,27	246,82	274,15	220,27
15,00	43,33	0,81	0,03	1,91	488,70	1111,16	1,32868	0,655108	53,85	223,11	250,00	276,16	223,11
18,33	47,78	0,81	0,03	2,07	543,17	1246,48	1,44488	0,691339	60,88	225,91	253,11	278,06	225,91
21,67	52,22	0,81	0,03	2,25	602,12	1393,83	1,56488	0,725085	68,75	228,68	256,12	279,82	228,68
25,00	56,67	0,82	0,03	2,42	665,78	1553,90	1,68749	0,754955	77,57	231,40	259,05	281,43	231,40
28,33	61,11	0,82	0,04	2,60	734,40	1727,45	1,81107	0,779099	87,50	234,09	261,89	282,87	234,09
31,67	65,56	0,82	0,04	2,78	808,21	1915,28	1,93329	0,795039	98,71	236,72	264,62	284,11	236,72
35,00	70,00	0,82	0,04	2,94	887,47	2118,24	2,05096	0,799417	111,44	239,30	267,26	285,12	239,30
5,00	30,00	0,83	0,02	1,28	349,90	770,64	0,89257	0,421895	36,85	219,41	246,00	269,83	219,41
8,33	34,44	0,83	0,02	1,41	392,28	873,87	0,98187	0,448433	41,91	222,25	249,30	272,04	222,25
11,67	38,89	0,83	0,02	1,54	438,48	987,17	1,07608	0,474235	47,55	225,05	252,51	274,15	225,05
15,00	43,33	0,83	0,02	1,69	488,70	1111,16	1,17483	0,498690	53,85	227,82	255,64	276,16	227,82
18,33	47,78	0,84	0,03	1,83	543,17	1246,48	1,27757	0,521005	60,88	230,55	258,68	278,06	230,55
21,67	52,22	0,84	0,03	1,99	602,12	1393,83	1,38347	0,540144	68,75	233,25	261,64	279,82	233,25
25,00	56,67	0,84	0,03	2,14	665,78	1553,90	1,49140	0,554745	77,57	235,89	264,49	281,43	235,89

28,33	61,11	0,84	0,04	2,30	734,40	1727,45	1,59975	0,563005	87,50	238,50	267,26	282,87	238,50
31,67	65,56	0,85	0,04	2,45	808,21	1915,28	1,70627	0,562512	98,71	241,05	269,92	284,11	241,05
35,00	70,00	0,85	0,04	2,60	887,47	2118,24	1,80789	0,550003	111,44	243,55	272,47	285,12	243,55
5,00	30,00	0,85	0,02	1,12	349,90	770,64	0,78200	0,309879	36,85	224,33	251,80	269,83	224,33
8,33	34,44	0,85	0,02	1,24	392,28	873,87	0,86047	0,325304	41,91	227,10	255,05	272,04	227,10
11,67	38,89	0,86	0,02	1,35	438,48	987,17	0,94320	0,339303	47,55	229,83	258,21	274,15	229,83
15,00	43,33	0,86	0,02	1,48	488,70	1111,16	1,02984	0,351269	53,85	232,53	261,28	276,16	232,53
18,33	47,78	0,86	0,03	1,61	543,17	1246,48	1,11983	0,360414	60,88	235,19	264,26	278,06	235,19
21,67	52,22	0,86	0,03	1,74	602,12	1393,83	1,21238	0,365719	68,75	237,81	267,15	279,82	237,81
25,00	56,67	0,87	0,03	1,88	665,78	1553,90	1,30639	0,365850	77,57	240,38	269,94	281,43	240,38
28,33	61,11	0,87	0,04	2,01	734,40	1727,45	1,40029	0,359043	87,50	242,91	272,63	282,87	242,91
31,67	65,56	0,87	0,04	2,14	808,21	1915,28	1,49192	0,342950	98,71	245,38	275,21	284,11	245,38
35,00	70,00	0,87	0,04	2,27	887,47	2118,24	1,57827	0,314395	111,44	247,80	277,68	285,12	247,80
5,00	30,00	0,88	0,02	0,97	349,90	770,64	0,67770	0,204222	36,85	229,24	257,60	269,83	229,24
8,33	34,44	0,88	0,02	1,07	392,28	873,87	0,74592	0,209129	41,91	231,95	260,80	272,04	231,95
11,67	38,89	0,88	0,02	1,17	438,48	987,17	0,81779	0,211955	47,55	234,61	263,91	274,15	234,61
15,00	43,33	0,88	0,02	1,28	488,70	1111,16	0,89295	0,212090	53,85	237,24	266,92	276,16	237,24
18,33	47,78	0,89	0,03	1,39	543,17	1246,48	0,97086	0,208753	60,88	239,83	269,84	278,06	239,83
21,67	52,22	0,89	0,03	1,51	602,12	1393,83	1,05075	0,200938	68,75	242,38	272,66	279,82	242,38
25,00	56,67	0,89	0,03	1,62	665,78	1553,90	1,13155	0,187335	77,57	244,87	275,38	281,43	244,87
28,33	61,11	0,89	0,03	1,74	734,40	1727,45	1,21172	0,166220	87,50	247,32	278,00	282,87	247,32
31,67	65,56	0,90	0,04	1,85	808,21	1915,28	1,28919	0,135299	98,71	249,71	280,50	284,11	249,71
35,00	70,00	0,90	0,04	1,95	887,47	2118,24	1,36101	0,091477	111,44	252,04	282,89	285,12	252,04

5,00	30,00	0,90	0,02	0,83	349,90	770,64	0,57916	0,104395	36,85	234,16	263,40	269,83	234,16
8,33	34,44	0,90	0,02	0,92	392,28	873,87	0,63767	0,099336	41,91	236,80	266,55	272,04	236,80
11,67	38,89	0,91	0,02	1,00	438,48	987,17	0,69923	0,091569	47,55	239,40	269,60	274,15	239,40
15,00	43,33	0,91	0,02	1,10	488,70	1111,16	0,76350	0,080481	53,85	241,96	272,56	276,16	241,96
18,33	47,78	0,91	0,02	1,19	543,17	1246,48	0,82995	0,065297	60,88	244,47	275,42	278,06	244,47
21,67	52,22	0,91	0,03	1,29	602,12	1393,83	0,89782	0,045022	68,75	246,94	278,17	279,82	246,94
25,00	56,67	0,92	0,03	1,39	665,78	1553,90	0,96605	0,018369	77,57	249,36	280,82	281,43	249,36
28,33	61,11	0,92	0,03	1,51	734,40	1727,45	1,05	0,000000	87,19	251,73	283,37	283,37	251,73
31,67	65,56	0,92	0,04	1,66	808,21	1915,28	1,16	0,000000	97,49	254,04	285,80	285,80	254,04
35,00	70,00	0,92	0,04	1,83	887,47	2118,24	1,27	0,000000	108,92	256,29	288,11	288,11	256,29
5,00	30,00	0,93	0,02	0,70	349,90	770,64	0,48591	0,009931	36,85	239,08	269,20	269,83	239,08
8,33	34,44	0,93	0,02	0,77	392,28	873,87	0,54	0,000000	41,84	241,65	272,30	272,30	241,65
11,67	38,89	0,93	0,02	0,87	438,48	987,17	0,61	0,000000	47,22	244,18	275,30	275,30	244,18
15,00	43,33	0,93	0,02	0,98	488,70	1111,16	0,69	0,000000	53,17	246,67	278,20	278,20	246,67
18,33	47,78	0,94	0,02	1,10	543,17	1246,48	0,77	0,000000	59,76	249,11	280,99	280,99	249,11
21,67	52,22	0,94	0,03	1,23	602,12	1393,83	0,86	0,000000	67,04	251,51	283,68	283,68	251,51
25,00	56,67	0,94	0,03	1,37	665,78	1553,90	0,95	0,000000	75,11	253,85	286,27	286,27	253,85
28,33	61,11	0,94	0,03	1,51	734,40	1727,45	1,05	0,000000	84,04	256,14	288,74	288,74	256,14
31,67	65,56	0,95	0,04	1,67	808,21	1915,28	1,16	0,000000	93,92	258,37	291,09	291,09	258,37
35,00	70,00	0,95	0,04	1,84	887,47	2118,24	1,28	0,000000	104,88	260,54	293,32	293,32	260,54
5,00	30,00	0,95	0,02	0,68	349,90	770,64	0,48	0,000000	35,77	244,00	275,01	275,01	244,00
8,33	34,44	0,95	0,02	0,78	392,28	873,87	0,54	0,000000	40,46	246,50	278,05	278,05	246,50
11,67	38,89	0,96	0,02	0,88	438,48	987,17	0,61	0,000000	45,66	248,96	280,99	280,99	248,96

15,00	43,33	0,96	0,02	0,99	488,70	1111,16	0,69	0,000000	51,41	251,38	283,83	283,83	251,38
18,33	47,78	0,96	0,02	1,10	543,17	1246,48	0,77	0,000000	57,78	253,75	286,57	286,57	253,75
21,67	52,22	0,96	0,03	1,23	602,12	1393,83	0,86	0,000000	64,81	256,07	289,20	289,20	256,07
25,00	56,67	0,97	0,03	1,37	665,78	1553,90	0,95	0,000000	72,59	258,34	291,71	291,71	258,34
28,33	61,11	0,97	0,03	1,52	734,40	1727,45	1,06	0,000000	81,19	260,55	294,11	294,11	260,55
31,67	65,56	0,97	0,03	1,68	808,21	1915,28	1,17	0,000000	90,71	262,70	296,38	296,38	262,70
35,00	70,00	0,97	0,04	1,84	887,47	2118,24	1,28	0,000000	101,25	264,78	298,53	298,53	264,78
5,00	30,00	0,98	0,01	0,69	349,90	770,64	0,48	0,000000	34,66	248,91	280,81	280,81	248,91
8,33	34,44	0,98	0,02	0,78	392,28	873,87	0,54	0,000000	39,21	251,35	283,80	283,80	251,35
11,67	38,89	0,98	0,02	0,88	438,48	987,17	0,61	0,000000	44,25	253,74	286,69	286,69	253,74
15,00	43,33	0,98	0,02	0,99	488,70	1111,16	0,69	0,000000	49,82	256,09	289,47	289,47	256,09
18,33	47,78	0,99	0,02	1,11	543,17	1246,48	0,77	0,000000	55,97	258,39	292,15	292,15	258,39
21,67	52,22	0,99	0,03	1,24	602,12	1393,83	0,86	0,000000	62,78	260,64	294,71	294,71	260,64
25,00	56,67	0,99	0,03	1,37	665,78	1553,90	0,96	0,000000	70,29	262,83	297,17	297,17	262,83
28,33	61,11	0,99	0,03	1,52	734,40	1727,45	1,06	0,000000	78,59	264,96	299,50	299,50	264,96
31,67	65,56	1,00	0,03	1,68	808,21	1915,28	1,17	0,000000	87,77	267,03	301,72	301,72	267,03
35,00	70,00	1,00	0,04	0,86	887,47	2118,24	0,60	-0,69	111,44	269,03	303,81	285,12	269,03

2.1.1 Summary R134 A --- 5000 rpm 11.4 cc/rev

Table 13-Summary R134A- 5000 rpm, 11.4 cc/rev- cycle 1

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	Q (kW)	Qres (kW)	desnsity after resistence	h1	h2	h3	h4
min	14,99	0,68	349,90	770,64	0,47714	0,000000	34,66	204,66	228,59	269,83	204,66
max	47,55	3,71	887,47	2118,24	2,58250	1,344821	111,44	269,03	303,81	303,81	269,03
X1_para minimo	0,98	0,95	0,75	0,75	0,95202	0,919192	0,98	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77273	0,772727	0,77	1,00	1,00	1,00	1,00

2.2 REFRIGERANT R134 A---3000rpm, 7 cc/rev

Table 14-R134 A -3000rpm, 7 cc/rev- cycle 1

T1	T2	X1	mref	flow_l_min	P1	P2	Q	Qres	desnsity after resistence	h1	h2	h3	h4
5,00	30,00	0,75	0,01	0,67	349,90	770,64	0,46722	0,295618	36,85	204,66	228,59	269,83	204,66
8,33	34,44	0,75	0,01	0,74	392,28	873,87	0,51358	0,319204	41,91	207,69	232,05	272,04	207,69
11,67	38,89	0,76	0,01	0,81	438,48	987,17	0,56253	0,343357	47,55	210,71	235,43	274,15	210,71
15,00	43,33	0,76	0,01	0,88	488,70	1111,16	0,61393	0,367847	53,85	213,69	238,73	276,16	213,69
18,33	47,78	0,76	0,01	0,96	543,17	1246,48	0,66755	0,392371	60,88	216,63	241,95	278,06	216,63
21,67	52,22	0,76	0,01	1,04	602,12	1393,83	0,72306	0,416523	68,75	219,55	245,10	279,82	219,55
25,00	56,67	0,77	0,01	1,12	665,78	1553,90	0,78001	0,439763	77,57	222,43	248,17	281,43	222,43
28,33	61,11	0,77	0,01	1,20	734,40	1727,45	0,83772	0,461370	87,50	225,26	251,15	282,87	225,26
31,67	65,56	0,77	0,02	1,29	808,21	1915,28	0,89529	0,480374	98,71	228,06	254,04	284,11	228,06
35,00	70,00	0,77	0,02	1,37	887,47	2118,24	0,95145	0,495460	111,44	230,81	256,84	285,12	230,81
5,00	30,00	0,78	0,01	0,60	349,90	770,64	0,41814	0,245899	36,85	209,57	234,40	269,83	209,57
8,33	34,44	0,78	0,01	0,66	392,28	873,87	0,45974	0,264605	41,91	212,55	237,80	272,04	212,55
11,67	38,89	0,78	0,01	0,72	438,48	987,17	0,50366	0,283585	47,55	215,49	241,12	274,15	215,49
15,00	43,33	0,78	0,01	0,79	488,70	1111,16	0,54976	0,302611	53,85	218,40	244,37	276,16	218,40

18,33	47,78	0,79	0,01	0,86	543,17	1246,48	0,59782	0,321384	60,88	221,27	247,53	278,06	221,27
21,67	52,22	0,79	0,01	0,93	602,12	1393,83	0,64752	0,339508	68,75	224,11	250,61	279,82	224,11
25,00	56,67	0,79	0,01	1,00	665,78	1553,90	0,69841	0,356457	77,57	226,92	253,61	281,43	226,92
28,33	61,11	0,79	0,01	1,08	734,40	1727,45	0,74986	0,371531	87,50	229,68	256,52	282,87	229,68
31,67	65,56	0,80	0,02	1,15	808,21	1915,28	0,80099	0,383790	98,71	232,39	259,33	284,11	232,39
35,00	70,00	0,80	0,02	1,22	887,47	2118,24	0,85058	0,391959	111,44	235,06	262,05	285,12	235,06
5,00	30,00	0,80	0,01	0,53	349,90	770,64	0,37211	0,199264	36,85	214,49	240,20	269,83	214,49
8,33	34,44	0,80	0,01	0,59	392,28	873,87	0,40923	0,213375	41,91	217,40	243,55	272,04	217,40
11,67	38,89	0,81	0,01	0,64	438,48	987,17	0,44841	0,227481	47,55	220,27	246,82	274,15	220,27
15,00	43,33	0,81	0,01	0,70	488,70	1111,16	0,48951	0,241356	53,85	223,11	250,00	276,16	223,11
18,33	47,78	0,81	0,01	0,76	543,17	1246,48	0,53232	0,254704	60,88	225,91	253,11	278,06	225,91
21,67	52,22	0,81	0,01	0,83	602,12	1393,83	0,57653	0,267137	68,75	228,68	256,12	279,82	228,68
25,00	56,67	0,82	0,01	0,89	665,78	1553,90	0,62171	0,278141	77,57	231,40	259,05	281,43	231,40
28,33	61,11	0,82	0,01	0,96	734,40	1727,45	0,66724	0,287037	87,50	234,09	261,89	282,87	234,09
31,67	65,56	0,82	0,02	1,02	808,21	1915,28	0,71226	0,292909	98,71	236,72	264,62	284,11	236,72
35,00	70,00	0,82	0,02	1,08	887,47	2118,24	0,75562	0,294522	111,44	239,30	267,26	285,12	239,30
5,00	30,00	0,83	0,01	0,47	349,90	770,64	0,32884	0,155435	36,85	219,41	246,00	269,83	219,41
8,33	34,44	0,83	0,01	0,52	392,28	873,87	0,36174	0,165212	41,91	222,25	249,30	272,04	222,25
11,67	38,89	0,83	0,01	0,57	438,48	987,17	0,39645	0,174718	47,55	225,05	252,51	274,15	225,05
15,00	43,33	0,83	0,01	0,62	488,70	1111,16	0,43283	0,183728	53,85	227,82	255,64	276,16	227,82
18,33	47,78	0,84	0,01	0,68	543,17	1246,48	0,47068	0,191949	60,88	230,55	258,68	278,06	230,55
21,67	52,22	0,84	0,01	0,73	602,12	1393,83	0,50970	0,199001	68,75	233,25	261,64	279,82	233,25

25,00	56,67	0,84	0,01	0,79	665,78	1553,90	0,54946	0,204380	77,57	235,89	264,49	281,43	235,89
28,33	61,11	0,84	0,01	0,85	734,40	1727,45	0,58938	0,207423	87,50	238,50	267,26	282,87	238,50
35,00	70,00	0,90	0,02	0,72	887,47	2118,24	0,50143	0,033702	111,44	252,04	282,89	285,12	252,04
5,00	30,00	0,90	0,01	0,31	349,90	770,64	0,21338	0,038461	36,85	234,16	263,40	269,83	234,16
8,33	34,44	0,90	0,01	0,34	392,28	873,87	0,23493	0,036598	41,91	236,80	266,55	272,04	236,80
11,67	38,89	0,91	0,01	0,37	438,48	987,17	0,25761	0,033736	47,55	239,40	269,60	274,15	239,40
15,00	43,33	0,91	0,01	0,40	488,70	1111,16	0,28129	0,029651	53,85	241,96	272,56	276,16	241,96
18,33	47,78	0,91	0,01	0,44	543,17	1246,48	0,30577	0,024057	60,88	244,47	275,42	278,06	244,47
21,67	52,22	0,91	0,01	0,47	602,12	1393,83	0,33078	0,016587	68,75	246,94	278,17	279,82	246,94
25,00	56,67	0,92	0,01	0,51	665,78	1553,90	0,35591	0,006767	77,57	249,36	280,82	281,43	249,36
28,33	61,11	0,92	0,03	1,51	734,40	1727,45	1,05	0,000000	87,19	251,73	283,37	283,37	251,73
31,67	65,56	0,92	0,04	1,66	808,21	1915,28	1,16	0,000000	97,49	254,04	285,80	285,80	254,04
35,00	70,00	0,92	0,04	1,83	887,47	2118,24	1,27	0,000000	108,92	256,29	288,11	288,11	256,29
5,00	30,00	0,93	0,01	0,26	349,90	770,64	0,17902	0,003659	36,85	239,08	269,20	269,83	239,08
8,33	34,44	0,93	0,02	0,77	392,28	873,87	0,54	0,000000	41,84	241,65	272,30	272,30	241,65
11,67	38,89	0,93	0,02	0,87	438,48	987,17	0,61	0,000000	47,22	244,18	275,30	275,30	244,18
15,00	43,33	0,93	0,02	0,98	488,70	1111,16	0,69	0,000000	53,17	246,67	278,20	278,20	246,67
18,33	47,78	0,94	0,02	1,10	543,17	1246,48	0,77	0,000000	59,76	249,11	280,99	280,99	249,11
21,67	52,22	0,94	0,03	1,23	602,12	1393,83	0,86	0,000000	67,04	251,51	283,68	283,68	251,51
25,00	56,67	0,94	0,03	1,37	665,78	1553,90	0,95	0,000000	75,11	253,85	286,27	286,27	253,85
28,33	61,11	0,94	0,03	1,51	734,40	1727,45	1,05	0,000000	84,04	256,14	288,74	288,74	256,14
31,67	65,56	0,95	0,04	1,67	808,21	1915,28	1,16	0,000000	93,92	258,37	291,09	291,09	258,37
35,00	70,00	0,95	0,04	1,84	887,47	2118,24	1,28	0,000000	104,88	260,54	293,32	293,32	260,54

5,00	30,00	0,95	0,02	0,68	349,90	770,64	0,48	0,000000	35,77	244,00	275,01	275,01	244,00
8,33	34,44	0,95	0,02	0,78	392,28	873,87	0,54	0,000000	40,46	246,50	278,05	278,05	246,50
11,67	38,89	0,96	0,02	0,88	438,48	987,17	0,61	0,000000	45,66	248,96	280,99	280,99	248,96
15,00	43,33	0,96	0,02	0,99	488,70	1111,16	0,69	0,000000	51,41	251,38	283,83	283,83	251,38
18,33	47,78	0,96	0,02	1,10	543,17	1246,48	0,77	0,000000	57,78	253,75	286,57	286,57	253,75
21,67	52,22	0,96	0,03	1,23	602,12	1393,83	0,86	0,000000	64,81	256,07	289,20	289,20	256,07
25,00	56,67	0,97	0,03	1,37	665,78	1553,90	0,95	0,000000	72,59	258,34	291,71	291,71	258,34
28,33	61,11	0,97	0,03	1,52	734,40	1727,45	1,06	0,000000	81,19	260,55	294,11	294,11	260,55
31,67	65,56	0,97	0,03	1,68	808,21	1915,28	1,17	0,000000	90,71	262,70	296,38	296,38	262,70
35,00	70,00	0,97	0,04	1,84	887,47	2118,24	1,28	0,000000	101,25	264,78	298,53	298,53	264,78
5,00	30,00	0,98	0,01	0,69	349,90	770,64	0,48	0,000000	34,66	248,91	280,81	280,81	248,91
8,33	34,44	0,98	0,02	0,78	392,28	873,87	0,54	0,000000	39,21	251,35	283,80	283,80	251,35
11,67	38,89	0,98	0,02	0,88	438,48	987,17	0,61	0,000000	44,25	253,74	286,69	286,69	253,74
15,00	43,33	0,98	0,02	0,99	488,70	1111,16	0,69	0,000000	49,82	256,09	289,47	289,47	256,09
18,33	47,78	0,99	0,02	1,11	543,17	1246,48	0,77	0,000000	55,97	258,39	292,15	292,15	258,39
21,67	52,22	0,99	0,03	1,24	602,12	1393,83	0,86	0,000000	62,78	260,64	294,71	294,71	260,64
25,00	56,67	0,99	0,03	1,37	665,78	1553,90	0,96	0,000000	70,29	262,83	297,17	297,17	262,83
28,33	61,11	0,99	0,03	1,52	734,40	1727,45	1,06	0,000000	78,59	264,96	299,50	299,50	264,96
31,67	65,56	1,00	0,03	1,68	808,21	1915,28	1,17	0,000000	87,77	267,03	301,72	301,72	267,03
35,00	70,00	1,00	0,04	1,85	887,47	2118,24	1,29	0,000000	97,92	269,03	303,81	303,81	269,03

2.2.1 Summary R134 A ---3000 rpm, 7 cc/rev

Table 15-Summary R134 A- 3000rpm, 7 cc/rev- cycle 1

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	Q (kW)	Qres (kW)	desnsity after resistence	h1	h2	h3	h4
min	5,82	0,26	349,90	770,64	0,17902	0,000000	34,66	204,66	228,59	269,83	204,66
max	40,07	1,85	887,47	2118,24	1,29185	0,495460	111,44	269,03	303,81	303,81	269,03
X1_para minimo	0,93	0,93	0,75	0,75	0,92677	0,919192	0,98	0,75	0,75	0,75	0,75
X1_para maximo	0,92	1,00	0,77	0,77	1,00000	0,772727	0,77	1,00	1,00	1,00	1,00

2.3 REFRIGERANT R410 A ---5000 rpm, 11.4 cc/rev

Table 16-R410 A- 5000 rpm, 11.4 cc/rev- cycle 1

T1	T2	X1	mref	flow_l_min	P1	P2	Q	Qres	desnsity after resistence	h1	h2	h3	h4
5,00	30,00	0,75	0,04	3,60	933,18	1883,41	2,51	1,40	74,08	369,01	396,38	430,96	369,01
8,33	34,44	0,75	0,04	3,82	1032,35	2108,78	2,66	1,42	84,28	371,47	399,22	431,06	371,47
11,67	38,89	0,76	0,05	4,04	1139,26	2354,04	2,81	1,43	95,92	373,85	401,91	430,84	373,85
15,00	43,33	0,76	0,05	4,22	1254,29	2620,47	2,94	1,40	109,27	376,15	404,46	430,26	376,15
18,33	47,78	0,76	0,06	4,37	1377,83	2909,51	3,05	1,34	124,69	378,36	406,85	429,26	378,36
21,67	52,22	0,76	0,07	4,47	1510,31	3222,74	3,11	1,23	142,72	380,48	409,08	427,74	380,48
25,00	56,67	0,77	0,07	4,47	1652,14	3562,00	3,12	1,05	164,06	382,49	411,13	425,60	382,49
28,33	61,11	0,77	0,08	4,36	1803,77	3929,48	3,04	0,77	189,79	384,38	413,00	422,66	384,38
31,67	65,56	0,77	0,09	4,08	1965,67	4327,98	2,84	0,35	221,50	386,14	414,66	418,71	386,14
35,00	70,00	0,77	0,10	3,90	2138,33	4761,73	2,72	0,00	254,73	387,76	416,13	416,13	387,76
5,00	30,00	0,78	0,04	3,18	933,18	1883,41	2,22	1,10	74,08	374,45	402,79	430,96	374,45
8,33	34,44	0,78	0,04	3,37	1032,35	2108,78	2,35	1,11	84,28	376,79	405,53	431,06	376,79
11,67	38,89	0,78	0,05	3,55	1139,26	2354,04	2,48	1,09	95,92	379,06	408,12	430,84	379,06
15,00	43,33	0,78	0,05	3,71	1254,29	2620,47	2,58	1,04	109,27	381,24	410,55	430,26	381,24

18,33	47,78	0,79	0,06	3,83	1377,83	2909,51	2,67	0,95	124,69	383,33	412,83	429,26	383,33
21,67	52,22	0,79	0,06	3,89	1510,31	3222,74	2,71	0,82	142,72	385,32	414,93	427,74	385,32
25,00	56,67	0,79	0,07	3,87	1652,14	3562,00	2,69	0,61	164,06	387,20	416,85	425,60	387,20
28,33	61,11	0,79	0,08	3,73	1803,77	3929,48	2,60	0,32	189,79	388,95	418,57	422,66	388,95
31,67	65,56	0,80	0,08	3,59	1965,67	4327,98	2,50	0,00	218,59	390,57	420,07	420,07	390,57
35,00	70,00	0,80	0,09	3,92	2138,33	4761,73	2,73	0,00	241,89	392,03	421,41	421,41	392,03
5,00	30,00	0,80	0,04	2,79	933,18	1883,41	1,94	0,83	74,08	379,88	409,20	430,96	379,88
8,33	34,44	0,80	0,04	2,95	1032,35	2108,78	2,06	0,81	84,28	382,12	411,84	431,06	382,12
11,67	38,89	0,81	0,05	3,10	1139,26	2354,04	2,16	0,77	95,92	384,28	414,32	430,84	384,28
15,00	43,33	0,81	0,05	3,23	1254,29	2620,47	2,25	0,70	109,27	386,34	416,65	430,26	386,34
18,33	47,78	0,81	0,06	3,31	1377,83	2909,51	2,31	0,59	124,69	388,31	418,80	429,26	388,31
21,67	52,22	0,81	0,06	3,34	1510,31	3222,74	2,33	0,43	142,72	390,17	420,78	427,74	390,17
25,00	56,67	0,82	0,07	3,30	1652,14	3562,00	2,30	0,21	164,06	391,91	422,56	425,60	391,91
28,33	61,11	0,82	0,07	3,29	1803,77	3929,48	2,29	0,00	187,22	393,53	424,13	424,13	393,53
31,67	65,56	0,82	0,08	3,61	1965,67	4327,98	2,51	0,00	207,73	395,00	425,50	425,50	395,00
35,00	70,00	0,82	0,09	3,95	2138,33	4761,73	2,75	0,00	230,21	396,31	426,71	426,71	396,31
5,00	30,00	0,83	0,04	2,42	933,18	1883,41	1,68	0,57	74,08	385,32	415,61	430,96	385,32
8,33	34,44	0,83	0,04	2,55	1032,35	2108,78	1,78	0,53	84,28	387,45	418,15	431,06	387,45
11,67	38,89	0,83	0,05	2,67	1139,26	2354,04	1,86	0,46	95,92	389,49	420,53	430,84	389,49
15,00	43,33	0,83	0,05	2,77	1254,29	2620,47	1,93	0,37	109,27	391,44	422,74	430,26	391,44
18,33	47,78	0,84	0,05	2,83	1377,83	2909,51	1,97	0,25	124,69	393,28	424,78	429,26	393,28
21,67	52,22	0,84	0,06	2,83	1510,31	3222,74	1,97	0,07	142,72	395,01	426,62	427,74	395,01
25,00	56,67	0,84	0,07	3,01	1652,14	3562,00	2,10	0,00	160,28	396,63	428,27	428,27	396,63

28,33	61,11	0,84	0,07	3,31	1803,77	3929,48	2,30	0,00	178,17	398,10	429,70	429,70	398,10
31,67	65,56	0,85	0,08	3,63	1965,67	4327,98	2,53	0,00	197,87	399,43	430,95	430,95	399,43
35,00	70,00	0,85	0,09	3,98	2138,33	4761,73	2,77	0,00	219,55	400,58	432,03	432,03	400,58
5,00	30,00	0,85	0,04	2,07	933,18	1883,41	1,44	0,32	74,08	390,75	422,02	430,96	390,75
8,33	34,44	0,85	0,04	2,18	1032,35	2108,78	1,52	0,26	84,28	392,77	424,46	431,06	392,77
11,67	38,89	0,86	0,04	2,27	1139,26	2354,04	1,58	0,18	95,92	394,70	426,74	430,84	394,70
15,00	43,33	0,86	0,05	2,34	1254,29	2620,47	1,63	0,07	109,27	396,53	428,84	430,26	396,53
18,33	47,78	0,86	0,05	2,48	1377,83	2909,51	1,73	0,00	123,21	398,25	430,75	430,75	398,25
21,67	52,22	0,86	0,06	2,74	1510,31	3222,74	1,91	0,00	137,27	399,86	432,47	432,47	399,86
25,00	56,67	0,87	0,06	3,02	1652,14	3562,00	2,10	0,00	152,81	401,34	433,98	433,98	401,34
28,33	61,11	0,87	0,07	3,32	1803,77	3929,48	2,31	0,00	169,97	402,67	435,30	435,30	402,67
31,67	65,56	0,87	0,08	3,65	1965,67	4327,98	2,54	0,00	188,90	403,85	436,44	436,44	403,85
35,00	70,00	0,87	0,09	4,01	2138,33	4761,73	2,79	0,00	209,81	404,85	437,39	437,39	404,85
5,00	30,00	0,88	0,03	1,74	933,18	1883,41	1,21	0,09	74,08	396,19	428,43	430,96	396,19
8,33	34,44	0,88	0,04	1,82	1032,35	2108,78	1,27	0,01	84,28	398,10	430,77	431,06	398,10
11,67	38,89	0,88	0,04	2,02	1139,26	2354,04	1,41	0,00	94,44	399,91	432,94	432,94	399,91
15,00	43,33	0,88	0,05	2,25	1254,29	2620,47	1,56	0,00	105,47	401,63	434,93	434,93	401,63
18,33	47,78	0,89	0,05	2,49	1377,83	2909,51	1,73	0,00	117,66	403,23	436,73	436,73	403,23
21,67	52,22	0,89	0,06	2,75	1510,31	3222,74	1,92	0,00	131,14	404,71	438,32	438,32	404,71
25,00	56,67	0,89	0,06	3,03	1652,14	3562,00	2,11	0,00	146,05	406,05	439,72	439,72	406,05
28,33	61,11	0,89	0,07	3,34	1803,77	3929,48	2,33	0,00	162,51	407,25	440,94	440,94	407,25
31,67	65,56	0,90	0,08	3,68	1965,67	4327,98	2,56	0,00	180,71	408,28	441,97	441,97	408,28
35,00	70,00	0,90	0,08	4,04	2138,33	4761,73	2,82	0,00	200,89	409,12	442,79	442,79	409,12

5,00	30,00	0,90	0,03	1,62	933,18	1883,41	1,13	0,00	72,12	401,62	434,83	434,83	401,62
8,33	34,44	0,90	0,04	1,81	1032,35	2108,78	1,26	0,00	80,78	403,42	437,08	437,08	403,42
11,67	38,89	0,91	0,04	2,02	1139,26	2354,04	1,41	0,00	90,35	405,12	439,15	439,15	405,12
15,00	43,33	0,91	0,05	2,25	1254,29	2620,47	1,57	0,00	100,94	406,72	441,02	441,02	406,72
18,33	47,78	0,91	0,05	2,50	1377,83	2909,51	1,74	0,00	112,64	408,20	442,71	442,71	408,20
21,67	52,22	0,91	0,06	2,76	1510,31	3222,74	1,93	0,00	125,58	409,55	444,21	444,21	409,55
25,00	56,67	0,92	0,06	3,05	1652,14	3562,00	2,13	0,00	139,87	410,76	445,53	445,53	410,76
28,33	61,11	0,92	0,07	3,37	1803,77	3929,48	2,34	0,00	155,68	411,82	446,65	446,65	411,82
31,67	65,56	0,92	0,07	3,71	1965,67	4327,98	2,58	0,00	173,21	412,71	447,55	447,55	412,71
35,00	70,00	0,92											
5,00	30,00	0,93	0,03	1,62	933,18	1883,41	1,13	0,00	69,13	407,05	441,24	441,24	407,05
8,33	34,44	0,93	0,04	1,82	1032,35	2108,78	1,27	0,00	77,46	408,75	443,39	443,39	408,75
11,67	38,89	0,93	0,04	2,03	1139,26	2354,04	1,41	0,00	86,66	410,34	445,36	445,36	410,34
15,00	43,33	0,93	0,04	2,26	1254,29	2620,47	1,57	0,00	96,83	411,81	447,15	447,15	411,81
18,33	47,78	0,94	0,05	2,51	1377,83	2909,51	1,75	0,00	108,06	413,17	448,77	448,77	413,17
21,67	52,22	0,94	0,05	2,78	1510,31	3222,74	1,94	0,00	120,47	414,40	450,19	450,19	414,40
25,00	56,67	0,94	0,06	3,08	1652,14	3562,00	2,14	0,00	134,21	415,47	451,41	451,41	415,47
28,33	61,11	0,94	0,07	3,39	1803,77	3929,48	2,36	0,00	149,42	416,39	452,41	452,41	416,39
31,67	65,56	0,95	0,07	3,74	1965,67	4327,98	2,61	0,00	166,31	417,13	453,19	453,19	417,13
35,00	70,00	0,95	0,08	4,12	2138,33	4761,73	2,87	0,00	185,13	417,67	453,73	453,73	417,67
5,00	30,00	0,95	0,03	1,62	933,18	1883,41	1,13	0,00	66,41	412,49	447,68	447,68	412,49
8,33	34,44	0,95	0,04	1,82	1032,35	2108,78	1,27	0,00	74,42	414,07	449,76	449,76	414,07
11,67	38,89	0,96	0,04	2,04	1139,26	2354,04	1,42	0,00	83,27	415,55	451,67	451,67	415,55

15,00	43,33	0,96	0,04	2,28	1254,29	2620,47	1,59	0,00	93,04	416,91	453,40	453,40	416,91
18,33	47,78	0,96	0,05	2,53	1377,83	2909,51	1,76	0,00	103,83	418,14	454,93	454,93	418,14
21,67	52,22	0,96	0,05	2,81	1510,31	3222,74	1,95	0,00	115,77	419,24	456,25	456,25	419,24
25,00	56,67	0,97	0,06	3,11	1652,14	3562,00	2,16	0,00	128,99	420,19	457,36	457,36	420,19
28,33	61,11	0,97	0,06	3,43	1803,77	3929,48	2,39	0,00	143,65	420,96	458,25	458,25	420,96
31,67	65,56	0,97	0,07	3,78	1965,67	4327,98	2,63	0,00	159,96	421,56	458,89	458,89	421,56
35,00	70,00	0,97	0,08	4,17	2138,33	4761,73	2,90	0,00	178,15	421,94	459,28	459,28	421,94
5,00	30,00	0,98	0,03	1,64	933,18	1883,41	1,14	0,00	63,89	417,92	454,26	454,26	417,92
8,33	34,44	0,98	0,03	1,84	1032,35	2108,78	1,28	0,00	71,60	419,40	456,28	456,28	419,40
11,67	38,89	0,98	0,04	2,06	1139,26	2354,04	1,43	0,00	80,12	420,76	458,12	458,12	420,76
15,00	43,33	0,98	0,04	2,30	1254,29	2620,47	1,60	0,00	89,53	422,00	459,76	459,76	422,00
18,33	47,78	0,99	0,05	2,56	1377,83	2909,51	1,78	0,00	99,92	423,12	461,19	461,19	423,12
21,67	52,22	0,99	0,05	2,84	1510,31	3222,74	1,98	0,00	111,43	424,09	462,41	462,41	424,09
25,00	56,67	0,99	0,06	3,14	1652,14	3562,00	2,19	0,00	124,17	424,90	463,41	463,41	424,90
28,33	61,11	0,99	0,06	3,47	1803,77	3929,48	2,42	0,00	138,32	425,54	464,16	464,16	425,54
31,67	65,56	1,00	0,07	3,83	1965,67	4327,98	2,66	0,00	154,07	425,98	464,66	464,66	425,98
35,00	70,00	1,00	0,08	4,22	2138,33	4761,73	2,94	0,00	171,69	426,21	464,89	464,89	426,21

2.3.1 Summary R410 A--- 5000 rpm ,11.4 cc/rev

Table 17-Summary R410 A- 5000 rpm, 11.4 cc/rev- cycle 1

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	Q (kW)	Qres (kW)	desnsity after resistence	h1	h2	h3	h4
min	31,35	1,62	933,18	1883,41	1,13	0,00	63,89	369,01	396,38	416,13	369,01
max	95,75	4,47	2138,33	4761,73	3,12	1,43	254,73	426,21	464,89	464,89	426,21
X1_para minimo	0,98	0,90	0,75	0,75	0,90	0,77	0,98	0,75	0,75	0,77	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,76	0,77	1,00	1,00	1,00	1,00

2.4 REFRIGERANT R 410 A --- 3000rpm, 7 cc/rev

Table 18- R410 A- 3000 rpm, 7 cc/rev- cycle 1

T1	T2	X1	mref	flow_l_min	P1	P2	Q	Qres	desnsity after resistance	h1	h2	h3	h4
5,00	30,00	0,75	0,01	1,33	933,18	1883,41	0,92	0,52	74,08	369,01	396,38	430,96	369,01
8,33	34,44	0,75	0,02	1,41	1032,35	2108,78	0,98	0,52	84,28	371,47	399,22	431,06	371,47
11,67	38,89	0,76	0,02	1,49	1139,26	2354,04	1,04	0,53	95,92	373,85	401,91	430,84	373,85
15,00	43,33	0,76	0,02	1,56	1254,29	2620,47	1,08	0,52	109,27	376,15	404,46	430,26	376,15
18,33	47,78	0,76	0,02	1,61	1377,83	2909,51	1,12	0,49	124,69	378,36	406,85	429,26	378,36
21,67	52,22	0,76	0,02	1,65	1510,31	3222,74	1,15	0,45	142,72	380,48	409,08	427,74	380,48
25,00	56,67	0,77	0,03	1,65	1652,14	3562,00	1,15	0,39	164,06	382,49	411,13	425,60	382,49
28,33	61,11	0,77	0,03	1,61	1803,77	3929,48	1,12	0,28	189,79	384,38	413,00	422,66	384,38
31,67	65,56	0,77	0,03	1,50	1965,67	4327,98	1,05	0,13	221,50	386,14	414,66	418,71	386,14
35,00	70,00	0,77	0,04	1,44	2138,33	4761,73	1,00	0,00	254,73	387,76	416,13	416,13	387,76
5,00	30,00	0,78	0,01	1,17	933,18	1883,41	0,82	0,41	74,08	374,45	402,79	430,96	374,45
8,33	34,44	0,78	0,02	1,24	1032,35	2108,78	0,87	0,41	84,28	376,79	405,53	431,06	376,79
11,67	38,89	0,78	0,02	1,31	1139,26	2354,04	0,91	0,40	95,92	379,06	408,12	430,84	379,06
15,00	43,33	0,78	0,02	1,37	1254,29	2620,47	0,95	0,38	109,27	381,24	410,55	430,26	381,24
18,33	47,78	0,79	0,02	1,41	1377,83	2909,51	0,98	0,35	124,69	383,33	412,83	429,26	383,33
21,67	52,22	0,79	0,02	1,43	1510,31	3222,74	1,00	0,30	142,72	385,32	414,93	427,74	385,32

25,00	56,67	0,79	0,03	1,43	1652,14	3562,00	0,99	0,23	164,06	387,20	416,85	425,60	387,20
28,33	61,11	0,79	0,03	1,37	1803,77	3929,48	0,96	0,12	189,79	388,95	418,57	422,66	388,95
31,67	65,56	0,80	0,03	1,32	1965,67	4327,98	0,92	0,00	218,59	390,57	420,07	420,07	390,57
35,00	70,00	0,80	0,03	1,45	2138,33	4761,73	1,01	0,00	241,89	392,03	421,41	421,41	392,03
5,00	30,00	0,80	0,01	1,03	933,18	1883,41	0,72	0,30	74,08	379,88	409,20	430,96	379,88
8,33	34,44	0,80	0,02	1,09	1032,35	2108,78	0,76	0,30	84,28	382,12	411,84	431,06	382,12
11,67	38,89	0,81	0,02	1,14	1139,26	2354,04	0,80	0,28	95,92	384,28	414,32	430,84	384,28
15,00	43,33	0,81	0,02	1,19	1254,29	2620,47	0,83	0,26	109,27	386,34	416,65	430,26	386,34
18,33	47,78	0,81	0,02	1,22	1377,83	2909,51	0,85	0,22	124,69	388,31	418,80	429,26	388,31
21,67	52,22	0,81	0,02	1,23	1510,31	3222,74	0,86	0,16	142,72	390,17	420,78	427,74	390,17
25,00	56,67	0,82	0,03	1,21	1652,14	3562,00	0,85	0,08	164,06	391,91	422,56	425,60	391,91
28,33	61,11	0,82	0,03	1,21	1803,77	3929,48	0,84	0,00	187,22	393,53	424,13	424,13	393,53
31,67	65,56	0,82	0,03	1,33	1965,67	4327,98	0,93	0,00	207,73	395,00	425,50	425,50	395,00
35,00	70,00	0,82	0,03	1,45	2138,33	4761,73	1,01	0,00	230,21	396,31	426,71	426,71	396,31
5,00	30,00	0,83	0,01	0,89	933,18	1883,41	0,62	0,21	74,08	385,32	415,61	430,96	385,32
8,33	34,44	0,83	0,02	0,94	1032,35	2108,78	0,66	0,19	84,28	387,45	418,15	431,06	387,45
11,67	38,89	0,83	0,02	0,99	1139,26	2354,04	0,69	0,17	95,92	389,49	420,53	430,84	389,49
15,00	43,33	0,83	0,02	1,02	1254,29	2620,47	0,71	0,14	109,27	391,44	422,74	430,26	391,44
18,33	47,78	0,84	0,02	1,04	1377,83	2909,51	0,73	0,09	124,69	393,28	424,78	429,26	393,28
21,67	52,22	0,84	0,02	1,04	1510,31	3222,74	0,73	0,02	142,72	395,01	426,62	427,74	395,01
25,00	56,67	0,84	0,02	1,11	1652,14	3562,00	0,77	0,00	160,28	396,63	428,27	428,27	396,63
28,33	61,11	0,84	0,03	1,22	1803,77	3929,48	0,85	0,00	178,17	398,10	429,70	429,70	398,10
31,67	65,56	0,85	0,03	1,34	1965,67	4327,98	0,93	0,00	197,87	399,43	430,95	430,95	399,43

35,00	70,00	0,85	0,03	1,47	2138,33	4761,73	1,02	0,00	219,55	400,58	432,03	432,03	400,58
5,00	30,00	0,85	0,01	0,76	933,18	1883,41	0,53	0,12	74,08	390,75	422,02	430,96	390,75
8,33	34,44	0,85	0,01	0,80	1032,35	2108,78	0,56	0,10	84,28	392,77	424,46	431,06	392,77
11,67	38,89	0,86	0,02	0,84	1139,26	2354,04	0,58	0,07	95,92	394,70	426,74	430,84	394,70
15,00	43,33	0,86	0,02	0,86	1254,29	2620,47	0,60	0,03	109,27	396,53	428,84	430,26	396,53
18,33	47,78	0,86	0,02	0,91	1377,83	2909,51	0,64	0,00	123,21	398,25	430,75	430,75	398,25
21,67	52,22	0,86	0,02	1,01	1510,31	3222,74	0,70	0,00	137,27	399,86	432,47	432,47	399,86
25,00	56,67	0,87	0,02	1,11	1652,14	3562,00	0,78	0,00	152,81	401,34	433,98	433,98	401,34
28,33	61,11	0,87	0,03	1,22	1803,77	3929,48	0,85	0,00	169,97	402,67	435,30	435,30	402,67
31,67	65,56	0,87	0,03	1,34	1965,67	4327,98	0,94	0,00	188,90	403,85	436,44	436,44	403,85
35,00	70,00	0,87	0,03	1,48	2138,33	4761,73	1,03	0,00	209,81	404,85	437,39	437,39	404,85
5,00	30,00	0,88	0,01	0,64	933,18	1883,41	0,45	0,03	74,08	396,19	428,43	430,96	396,19
8,33	34,44	0,88	0,01	0,67	1032,35	2108,78	0,47	0,00	84,28	398,10	430,77	431,06	398,10
11,67	38,89	0,88	0,02	0,74	1139,26	2354,04	0,52	0,00	94,44	399,91	432,94	432,94	399,91
15,00	43,33	0,88	0,02	0,83	1254,29	2620,47	0,58	0,00	105,47	401,63	434,93	434,93	401,63
18,33	47,78	0,89	0,02	0,92	1377,83	2909,51	0,64	0,00	117,66	403,23	436,73	436,73	403,23
21,67	52,22	0,89	0,02	1,01	1510,31	3222,74	0,71	0,00	131,14	404,71	438,32	438,32	404,71
25,00	56,67	0,89	0,02	1,12	1652,14	3562,00	0,78	0,00	146,05	406,05	439,72	439,72	406,05
28,33	61,11	0,89	0,03	1,23	1803,77	3929,48	0,86	0,00	162,51	407,25	440,94	440,94	407,25
31,67	65,56	0,90	0,03	1,35	1965,67	4327,98	0,94	0,00	180,71	408,28	441,97	441,97	408,28
35,00	70,00	0,90	0,03	1,49	2138,33	4761,73	1,04	0,00	200,89	409,12	442,79	442,79	409,12
5,00	30,00	0,90	0,01	0,60	933,18	1883,41	0,41	0,00	72,12	401,62	434,83	434,83	401,62
8,33	34,44	0,90	0,01	0,67	1032,35	2108,78	0,47	0,00	80,78	403,42	437,08	437,08	403,42

11,67	38,89	0,91	0,02	0,75	1139,26	2354,04	0,52	0,00	90,35	405,12	439,15	439,15	405,12
15,00	43,33	0,91	0,02	0,83	1254,29	2620,47	0,58	0,00	100,94	406,72	441,02	441,02	406,72
18,33	47,78	0,91	0,02	0,92	1377,83	2909,51	0,64	0,00	112,64	408,20	442,71	442,71	408,20
21,67	52,22	0,91	0,02	1,02	1510,31	3222,74	0,71	0,00	125,58	409,55	444,21	444,21	409,55
25,00	56,67	0,92	0,02	1,12	1652,14	3562,00	0,78	0,00	139,87	410,76	445,53	445,53	410,76
28,33	61,11	0,92	0,02	1,24	1803,77	3929,48	0,86	0,00	155,68	411,82	446,65	446,65	411,82
31,67	65,56	0,92	0,03	1,37	1965,67	4327,98	0,95	0,00	173,21	412,71	447,55	447,55	412,71
35,00	70,00	0,92											
5,00	30,00	0,93	0,01	0,60	933,18	1883,41	0,42	0,00	69,13	407,05	441,24	441,24	407,05
8,33	34,44	0,93	0,01	0,67	1032,35	2108,78	0,47	0,00	77,46	408,75	443,39	443,39	408,75
11,67	38,89	0,93	0,01	0,75	1139,26	2354,04	0,52	0,00	86,66	410,34	445,36	445,36	410,34
15,00	43,33	0,93	0,02	0,83	1254,29	2620,47	0,58	0,00	96,83	411,81	447,15	447,15	411,81
18,33	47,78	0,94	0,02	0,93	1377,83	2909,51	0,64	0,00	108,06	413,17	448,77	448,77	413,17
21,67	52,22	0,94	0,02	1,03	1510,31	3222,74	0,71	0,00	120,47	414,40	450,19	450,19	414,40
25,00	56,67	0,94	0,02	1,13	1652,14	3562,00	0,79	0,00	134,21	415,47	451,41	451,41	415,47
28,33	61,11	0,94	0,02	1,25	1803,77	3929,48	0,87	0,00	149,42	416,39	452,41	452,41	416,39
31,67	65,56	0,95	0,03	1,38	1965,67	4327,98	0,96	0,00	166,31	417,13	453,19	453,19	417,13
35,00	70,00	0,95	0,03	1,52	2138,33	4761,73	1,06	0,00	185,13	417,67	453,73	453,73	417,67
5,00	30,00	0,95	0,01	0,60	933,18	1883,41	0,42	0,00	66,41	412,49	447,68	447,68	412,49
8,33	34,44	0,95	0,01	0,67	1032,35	2108,78	0,47	0,00	74,42	414,07	449,76	449,76	414,07
11,67	38,89	0,96	0,01	0,75	1139,26	2354,04	0,52	0,00	83,27	415,55	451,67	451,67	415,55
15,00	43,33	0,96	0,02	0,84	1254,29	2620,47	0,58	0,00	93,04	416,91	453,40	453,40	416,91
18,33	47,78	0,96	0,02	0,93	1377,83	2909,51	0,65	0,00	103,83	418,14	454,93	454,93	418,14

21,67	52,22	0,96	0,02	1,03	1510,31	3222,74	0,72	0,00	115,77	419,24	456,25	456,25	419,24
25,00	56,67	0,97	0,02	1,14	1652,14	3562,00	0,80	0,00	128,99	420,19	457,36	457,36	420,19
28,33	61,11	0,97	0,02	1,26	1803,77	3929,48	0,88	0,00	143,65	420,96	458,25	458,25	420,96
31,67	65,56	0,97	0,03	1,39	1965,67	4327,98	0,97	0,00	159,96	421,56	458,89	458,89	421,56
35,00	70,00	0,97	0,03	1,53	2138,33	4761,73	1,07	0,00	178,15	421,94	459,28	459,28	421,94
5,00	30,00	0,98	0,01	0,60	933,18	1883,41	0,42	0,00	63,89	417,92	454,26	454,26	417,92
8,33	34,44	0,98	0,01	0,68	1032,35	2108,78	0,47	0,00	71,60	419,40	456,28	456,28	419,40
11,67	38,89	0,98	0,01	0,76	1139,26	2354,04	0,53	0,00	80,12	420,76	458,12	458,12	420,76
15,00	43,33	0,98	0,02	0,85	1254,29	2620,47	0,59	0,00	89,53	422,00	459,76	459,76	422,00
18,33	47,78	0,99	0,02	0,94	1377,83	2909,51	0,66	0,00	99,92	423,12	461,19	461,19	423,12
21,67	52,22	0,99	0,02	1,05	1510,31	3222,74	0,73	0,00	111,43	424,09	462,41	462,41	424,09
25,00	56,67	0,99	0,02	1,16	1652,14	3562,00	0,81	0,00	124,17	424,90	463,41	463,41	424,90
28,33	61,11	0,99	0,02	1,28	1803,77	3929,48	0,89	0,00	138,32	425,54	464,16	464,16	425,54
31,67	65,56	1,00	0,03	1,41	1965,67	4327,98	0,98	0,00	154,07	425,98	464,66	464,66	425,98
35,00	70,00	1,00	0,03	1,55	2138,33	4761,73	1,08	0,00	171,69	426,21	464,89	464,89	426,21

2.4.1 Summary R410 A--- 3000 rpm, 7 cc/rev

Table 19-Summary R410 A- 3000 rpm, 7 cc/rev- cycle 1

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	Q (kW)	Qres (kW)	desnsity after resistence	h1	h2	h3	h4
min	11,55	0,60	933,18	1883,41	0,41	0,00	63,89	369,01	396,38	416,13	369,01
max	35,27	1,65	2138,33	4761,73	1,15	0,53	254,73	426,21	464,89	464,89	426,21
X1_para minimo	0,98	0,90	0,75	0,75	0,90	0,77	0,98	0,75	0,75	0,77	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,76	0,77	1,00	1,00	1,00	1,00

2.5 REFRIGERANT R407 C --- 5000 rpm, 11.4 cc/rev

Table 20- R407 C- 5000rpm, 11.4 cc/rev- cycle 1

T1	T2	X1	mref	flow_l_min	P1	P2	Q	Qres	desnsity after resistance	h1	h2	h3	h4
5,00	30,00	0,75	0,03	2,47	546,52	1175,14	1,72	0,967	49,65	359,51	388,30	425,23	359,51
8,33	34,44	0,75	0,03	2,69	610,42	1328,23	1,87	1,023	56,52	362,40	391,55	426,69	362,40
11,67	38,89	0,76	0,03	2,91	679,86	1496,04	2,02	1,074	64,25	365,25	394,71	427,99	365,25
15,00	43,33	0,76	0,04	3,13	755,15	1679,57	2,18	1,120	72,97	368,06	397,76	429,11	368,06
18,33	47,78	0,76	0,04	3,35	836,60	1879,91	2,34	1,156	82,83	370,81	400,71	430,02	370,81
21,67	52,22	0,76	0,04	3,57	924,55	2098,22	2,49	1,180	94,03	373,50	403,55	430,67	373,50
25,00	56,67	0,77	0,05	3,78	1019,34	2335,84	2,63	1,187	106,83	376,14	406,29	431,04	376,14
28,33	61,11	0,77	0,05	3,96	1121,33	2594,27	2,76	1,168	121,59	378,71	408,90	431,06	378,71
31,67	65,56	0,77	0,06	4,11	1230,88	2875,31	2,87	1,115	138,79	381,21	411,40	430,65	381,21
35,00	70,00	0,77	0,06	4,21	1348,38	3181,21	2,93	1,013	159,13	383,63	413,78	429,70	383,63
5,00	30,00	0,78	0,03	2,20	546,52	1175,14	1,53	0,781	49,65	364,82	394,45	425,23	364,82
8,33	34,44	0,78	0,03	2,39	610,42	1328,23	1,67	0,819	56,52	367,63	397,64	426,69	367,63
11,67	38,89	0,78	0,03	2,59	679,86	1496,04	1,80	0,853	64,25	370,40	400,72	427,99	370,40
15,00	43,33	0,78	0,03	2,78	755,15	1679,57	1,94	0,880	72,97	373,11	403,70	429,11	373,11
18,33	47,78	0,79	0,04	2,98	836,60	1879,91	2,08	0,897	82,83	375,76	406,57	430,02	375,76
21,67	52,22	0,79	0,04	3,17	924,55	2098,22	2,21	0,901	94,03	378,36	409,33	430,67	378,36

25,00	56,67	0,79	0,05	3,35	1019,34	2335,84	2,33	0,887	106,83	380,89	411,97	431,04	380,89
28,33	61,11	0,79	0,05	3,50	1121,33	2594,27	2,44	0,848	121,59	383,36	414,49	431,06	383,36
31,67	65,56	0,80	0,06	3,63	1230,88	2875,31	2,53	0,775	138,79	385,75	416,88	430,65	385,75
35,00	70,00	0,80	0,06	3,69	1348,38	3181,21	2,57	0,652	159,13	388,06	419,15	429,70	388,06
5,00	30,00	0,80	0,02	1,95	546,52	1175,14	1,36	0,606	49,65	370,13	400,58	425,23	370,13
8,33	34,44	0,80	0,03	2,11	610,42	1328,23	1,47	0,629	56,52	372,86	403,70	426,69	372,86
11,67	38,89	0,81	0,03	2,29	679,86	1496,04	1,59	0,646	64,25	375,53	406,71	427,99	375,53
15,00	43,33	0,81	0,03	2,46	755,15	1679,57	1,71	0,655	72,97	378,15	409,62	429,11	378,15
18,33	47,78	0,81	0,04	2,63	836,60	1879,91	1,83	0,654	82,83	380,71	412,41	430,02	380,71
21,67	52,22	0,81	0,04	2,79	924,55	2098,22	1,95	0,639	94,03	383,21	415,08	430,67	383,21
25,00	56,67	0,82	0,05	2,94	1019,34	2335,84	2,05	0,606	106,83	385,64	417,63	431,04	385,64
28,33	61,11	0,82	0,05	3,07	1121,33	2594,27	2,14	0,547	121,59	388,00	420,05	431,06	388,00
31,67	65,56	0,82	0,05	3,17	1230,88	2875,31	2,21	0,454	138,79	390,29	422,35	430,65	390,29
35,00	70,00	0,82	0,06	3,21	1348,38	3181,21	2,23	0,312	159,13	392,49	424,50	429,70	392,49
5,00	30,00	0,83	0,02	1,71	546,52	1175,14	1,19	0,443	49,65	375,43	406,69	425,23	375,43
8,33	34,44	0,83	0,03	1,85	610,42	1328,23	1,29	0,450	56,52	378,07	409,74	426,69	378,07
11,67	38,89	0,83	0,03	2,00	679,86	1496,04	1,40	0,451	64,25	380,65	412,68	427,99	380,65
15,00	43,33	0,83	0,03	2,15	755,15	1679,57	1,50	0,444	72,97	383,18	415,51	429,11	383,18
18,33	47,78	0,84	0,04	2,30	836,60	1879,91	1,60	0,426	82,83	385,65	418,22	430,02	385,65
21,67	52,22	0,84	0,04	2,44	924,55	2098,22	1,70	0,393	94,03	388,05	420,81	430,67	388,05
25,00	56,67	0,84	0,04	2,56	1019,34	2335,84	1,79	0,341	106,83	390,38	423,27	431,04	390,38
28,33	61,11	0,84	0,05	2,67	1121,33	2594,27	1,86	0,264	121,59	392,64	425,60	431,06	392,64
31,67	65,56	0,85	0,05	2,74	1230,88	2875,31	1,91	0,152	138,79	394,82	427,79	430,65	394,82

35,00	70,00	0,85	0,06	2,76	1348,38	3181,21	1,92	0,000	158,94	396,90	429,83	429,83	396,90
5,00	30,00	0,85	0,02	1,48	546,52	1175,14	1,03	0,289	49,65	380,72	412,77	425,23	380,72
8,33	34,44	0,85	0,03	1,61	610,42	1328,23	1,12	0,282	56,52	383,28	415,76	426,69	383,28
11,67	38,89	0,86	0,03	1,74	679,86	1496,04	1,21	0,268	64,25	385,77	418,63	427,99	385,77
15,00	43,33	0,86	0,03	1,86	755,15	1679,57	1,30	0,245	72,97	388,21	421,39	429,11	388,21
18,33	47,78	0,86	0,04	1,99	836,60	1879,91	1,38	0,210	82,83	390,58	424,02	430,02	390,58
21,67	52,22	0,86	0,04	2,10	924,55	2098,22	1,46	0,161	94,03	392,89	426,52	430,67	392,89
25,00	56,67	0,87	0,04	2,20	1019,34	2335,84	1,53	0,092	106,83	395,12	428,89	431,04	395,12
28,33	61,11	0,87	0,05	2,29	1121,33	2594,27	1,59	0,00	121,53	397,27	431,12	431,12	397,27
31,67	65,56	0,87	0,05	2,52	1230,88	2875,31	1,75	0,00	135,92	399,34	433,21	433,21	399,34
35,00	70,00	0,87	0,06	2,76	1348,38	3181,21	1,93	0,00	151,96	401,31	435,15	435,15	401,31
5,00	30,00	0,88	0,02	1,27	546,52	1175,14	0,89	0,144	49,65	386,01	418,83	425,23	386,01
8,33	34,44	0,88	0,03	1,38	610,42	1328,23	0,96	0,124	56,52	388,48	421,75	426,69	388,48
11,67	38,89	0,88	0,03	1,48	679,86	1496,04	1,03	0,096	64,25	390,88	424,56	427,99	390,88
15,00	43,33	0,88	0,03	1,59	755,15	1679,57	1,11	0,058	72,97	393,23	427,24	429,11	393,23
18,33	47,78	0,89	0,03	1,69	836,60	1879,91	1,18	0,008	82,83	395,51	429,79	430,02	395,51
21,67	52,22	0,89	0,04	1,87	924,55	2098,22	1,30	0,00	93,00	397,71	432,21	432,21	397,71
25,00	56,67	0,89	0,04	2,07	1019,34	2335,84	1,44	0,00	104,15	399,84	434,49	434,49	399,84
28,33	61,11	0,89	0,05	2,28	1121,33	2594,27	1,59	0,00	116,54	401,89	436,63	436,63	401,89
31,67	65,56	0,90	0,05	2,52	1230,88	2875,31	1,75	0,00	130,33	403,85	438,61	438,61	403,85
35,00	70,00	0,90	0,06	2,76	1348,38	3181,21	1,93	0,00	145,72	405,71	440,44	440,44	405,71
5,00	30,00	0,90	0,02	1,06	546,52	1175,14	0,74	0,00	49,77	391,29	424,87	424,87	391,29
8,33	34,44	0,90	0,02	1,19	610,42	1328,23	0,83	0,00	56,15	393,67	427,73	427,73	393,67

11,67	38,89	0,91	0,03	1,34	679,86	1496,04	0,94	0,00	63,23	395,98	430,46	430,46	395,98
15,00	43,33	0,91	0,03	1,50	755,15	1679,57	1,05	0,00	71,08	398,24	433,07	433,07	398,24
18,33	47,78	0,91	0,03	1,68	836,60	1879,91	1,17	0,00	79,78	400,42	435,54	435,54	400,42
21,67	52,22	0,91	0,04	1,86	924,55	2098,22	1,30	0,00	89,43	402,53	437,88	437,88	402,53
25,00	56,67	0,92	0,04	2,07	1019,34	2335,84	1,44	0,00	100,15	404,56	440,07	440,07	404,56
28,33	61,11	0,92	0,04	2,28	1121,33	2594,27	1,59	0,00	112,06	406,50	442,11	442,11	406,50
31,67	65,56	0,92											
35,00	70,00	0,92											
5,00	30,00	0,93	0,02	1,05	546,52	1175,14	0,73	0,00	47,97	396,56	430,88	430,88	396,56
8,33	34,44	0,93	0,02	1,19	610,42	1328,23	0,83	0,00	54,13	398,85	433,68	433,68	398,85
11,67	38,89	0,93	0,03	1,34	679,86	1496,04	0,93	0,00	60,96	401,08	436,34	436,34	401,08
15,00	43,33	0,93	0,03	1,50	755,15	1679,57	1,04	0,00	68,53	403,24	438,88	438,88	403,24
18,33	47,78	0,94	0,03	1,67	836,60	1879,91	1,17	0,00	76,92	405,33	441,27	441,27	405,33
21,67	52,22	0,94	0,04	1,86	924,55	2098,22	1,30	0,00	86,22	407,34	443,52	443,52	407,34
25,00	56,67	0,94											
28,33	61,11	0,94											
31,67	65,56	0,95											
35,00	70,00	0,95											
5,00	30,00	0,95	0,02	1,05	546,52	1175,14	0,73	0,00	46,34	401,82	436,87	436,87	401,82
8,33	34,44	0,95	0,02	1,19	610,42	1328,23	0,83	0,00	52,30	404,02	439,60	439,60	404,02
11,67	38,89	0,96	0,03	1,33	679,86	1496,04	0,93	0,00	58,90	406,16	442,20	442,20	406,16
15,00	43,33	0,96											
18,33	47,78	0,96											

21,67	52,22	0,96											
25,00	56,67	0,97											
28,33	61,11	0,97	0,04	2,29	1121,33	2594,27	1,60	0,00	104,21	415,70	453,25	453,25	415,70
31,67	65,56	0,97	0,05	2,53	1230,88	2875,31	1,76	0,00	116,46	417,32	455,02	455,02	417,32
35,00	70,00	0,97	0,05	2,79	1348,38	3181,21	1,95	0,00	130,10	418,84	456,64	456,64	418,84
5,00	30,00	0,98	0,02	1,05	546,52	1175,14	0,73	0,00	44,83	407,07	442,93	442,93	407,07
8,33	34,44	0,98	0,02	1,18	610,42	1328,23	0,82	0,00	50,60	409,19	445,63	445,63	409,19
11,67	38,89	0,98	0,03	1,33	679,86	1496,04	0,93	0,00	56,98	411,24	448,21	448,21	411,24
15,00	43,33	0,98	0,03	1,50	755,15	1679,57	1,04	0,00	64,04	413,22	450,64	450,64	413,22
18,33	47,78	0,99	0,03	1,68	836,60	1879,91	1,17	0,00	71,86	415,12	452,94	452,94	415,12
21,67	52,22	0,99	0,03	1,87	924,55	2098,22	1,30	0,00	80,51	416,93	455,09	455,09	416,93
25,00	56,67	0,99	0,04	2,08	1019,34	2335,84	1,45	0,00	90,10	418,65	457,09	457,09	418,65
28,33	61,11	0,99	0,04	2,30	1121,33	2594,27	1,60	0,00	100,74	420,28	458,94	458,94	420,28
31,67	65,56	1,00	0,05	2,55	1230,88	2875,31	1,77	0,00	112,55	421,80	460,62	460,62	421,80
35,00	70,00	1,00	0,05	2,81	1348,38	3181,21	1,96	0,00	125,71	423,20	462,15	462,15	423,20

2.5.1 Summary R407 C ---5000 rpm, 11.4 cc/rev

Table 21- Summary R407 C- 5000 rpm, 11.4 cc/rev- cycle 1

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	Q (kW)	Qres (kW)	desnsity after resistence	h1	h2	h3	h4
min	20,33	1,05	546,52	1175,14	0,73	0,000	44,83	359,51	388,30	424,87	359,51
max	63,61	4,21	1348,38	3181,21	2,93	1,187	159,13	423,20	462,15	462,15	423,20
X1_para minimo	0,98	0,98	0,75	0,75	0,98	0,848	0,98	0,75	0,75	0,90	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,765	0,77	1,00	1,00	1,00	1,00

2.6 REFRIGERANT R407 C ---3000 rpm , 7 cc/rev

Table 22- Summary R407 C- 3000 rpm, 7cc/rev- cycle 1

T1	T2	X1	mref	flow_l_min	P1	P2	Q	Qres	desnsity after resistance	h1	h2	h3	h4
5,00	30,00	0,75	0,01	0,91	546,52	1175,14	0,63	0,356	49,65	359,51	388,30	425,23	359,51
8,33	34,44	0,75	0,01	0,99	610,42	1328,23	0,69	0,377	56,52	362,40	391,55	426,69	362,40
11,67	38,89	0,76	0,01	1,07	679,86	1496,04	0,75	0,396	64,25	365,25	394,71	427,99	365,25
15,00	43,33	0,76	0,01	1,15	755,15	1679,57	0,80	0,412	72,97	368,06	397,76	429,11	368,06
18,33	47,78	0,76	0,01	1,24	836,60	1879,91	0,86	0,426	82,83	370,81	400,71	430,02	370,81
21,67	52,22	0,76	0,02	1,32	924,55	2098,22	0,92	0,435	94,03	373,50	403,55	430,67	373,50
25,00	56,67	0,77	0,02	1,39	1019,34	2335,84	0,97	0,437	106,83	376,14	406,29	431,04	376,14
28,33	61,11	0,77	0,02	1,46	1121,33	2594,27	1,02	0,430	121,59	378,71	408,90	431,06	378,71
31,67	65,56	0,77	0,02	1,52	1230,88	2875,31	1,06	0,411	138,79	381,21	411,40	430,65	381,21
35,00	70,00	0,77	0,02	1,55	1348,38	3181,21	1,08	0,373	159,13	383,63	413,78	429,70	383,63
5,00	30,00	0,78	0,01	0,81	546,52	1175,14	0,56	0,288	49,65	364,82	394,45	425,23	364,82
8,33	34,44	0,78	0,01	0,88	610,42	1328,23	0,61	0,302	56,52	367,63	397,64	426,69	367,63
11,67	38,89	0,78	0,01	0,95	679,86	1496,04	0,66	0,314	64,25	370,40	400,72	427,99	370,40
15,00	43,33	0,78	0,01	1,03	755,15	1679,57	0,71	0,324	72,97	373,11	403,70	429,11	373,11
18,33	47,78	0,79	0,01	1,10	836,60	1879,91	0,76	0,331	82,83	375,76	406,57	430,02	375,76
21,67	52,22	0,79	0,02	1,17	924,55	2098,22	0,81	0,332	94,03	378,36	409,33	430,67	378,36

25,00	56,67	0,79	0,02	1,23	1019,34	2335,84	0,86	0,327	106,83	380,89	411,97	431,04	380,89
28,33	61,11	0,79	0,02	1,29	1121,33	2594,27	0,90	0,312	121,59	383,36	414,49	431,06	383,36
31,67	65,56	0,80	0,02	1,34	1230,88	2875,31	0,93	0,285	138,79	385,75	416,88	430,65	385,75
35,00	70,00	0,80	0,02	1,36	1348,38	3181,21	0,95	0,240	159,13	388,06	419,15	429,70	388,06
5,00	30,00	0,80	0,01	0,72	546,52	1175,14	0,50	0,223	49,65	370,13	400,58	425,23	370,13
8,33	34,44	0,80	0,01	0,78	610,42	1328,23	0,54	0,232	56,52	372,86	403,70	426,69	372,86
11,67	38,89	0,81	0,01	0,84	679,86	1496,04	0,59	0,238	64,25	375,53	406,71	427,99	375,53
15,00	43,33	0,81	0,01	0,91	755,15	1679,57	0,63	0,241	72,97	378,15	409,62	429,11	378,15
18,33	47,78	0,81	0,01	0,97	836,60	1879,91	0,67	0,241	82,83	380,71	412,41	430,02	380,71
21,67	52,22	0,81	0,02	1,03	924,55	2098,22	0,72	0,236	94,03	383,21	415,08	430,67	383,21
25,00	56,67	0,82	0,02	1,08	1019,34	2335,84	0,76	0,223	106,83	385,64	417,63	431,04	385,64
28,33	61,11	0,82	0,02	1,13	1121,33	2594,27	0,79	0,202	121,59	388,00	420,05	431,06	388,00
31,67	65,56	0,82	0,02	1,17	1230,88	2875,31	0,81	0,167	138,79	390,29	422,35	430,65	390,29
35,00	70,00	0,82	0,02	1,18	1348,38	3181,21	0,82	0,115	159,13	392,49	424,50	429,70	392,49
5,00	30,00	0,83	0,01	0,63	546,52	1175,14	0,44	0,163	49,65	375,43	406,69	425,23	375,43
8,33	34,44	0,83	0,01	0,68	610,42	1328,23	0,48	0,166	56,52	378,07	409,74	426,69	378,07
11,67	38,89	0,83	0,01	0,74	679,86	1496,04	0,51	0,166	64,25	380,65	412,68	427,99	380,65
15,00	43,33	0,83	0,01	0,79	755,15	1679,57	0,55	0,164	72,97	383,18	415,51	429,11	383,18
18,33	47,78	0,84	0,01	0,85	836,60	1879,91	0,59	0,157	82,83	385,65	418,22	430,02	385,65
21,67	52,22	0,84	0,01	0,90	924,55	2098,22	0,63	0,145	94,03	388,05	420,81	430,67	388,05
25,00	56,67	0,84	0,02	0,94	1019,34	2335,84	0,66	0,126	106,83	390,38	423,27	431,04	390,38
28,33	61,11	0,84	0,02	0,98	1121,33	2594,27	0,68	0,097	121,59	392,64	425,60	431,06	392,64
31,67	65,56	0,85	0,02	1,01	1230,88	2875,31	0,70	0,056	138,79	394,82	427,79	430,65	394,82

35,00	70,00	0,85	0,02	1,02	1348,38	3181,21	0,71	0,00	158,94	396,90	429,83	429,83	396,90
5,00	30,00	0,85	0,01	0,55	546,52	1175,14	0,38	0,106	49,65	380,72	412,77	425,23	380,72
8,33	34,44	0,85	0,01	0,59	610,42	1328,23	0,41	0,104	56,52	383,28	415,76	426,69	383,28
11,67	38,89	0,86	0,01	0,64	679,86	1496,04	0,45	0,099	64,25	385,77	418,63	427,99	385,77
15,00	43,33	0,86	0,01	0,69	755,15	1679,57	0,48	0,090	72,97	388,21	421,39	429,11	388,21
18,33	47,78	0,86	0,01	0,73	836,60	1879,91	0,51	0,078	82,83	390,58	424,02	430,02	390,58
21,67	52,22	0,86	0,01	0,77	924,55	2098,22	0,54	0,059	94,03	392,89	426,52	430,67	392,89
25,00	56,67	0,87	0,02	0,81	1019,34	2335,84	0,57	0,034	106,83	395,12	428,89	431,04	395,12
28,33	61,11	0,87	0,02	0,84	1121,33	2594,27	0,59	0,00	121,53	397,27	431,12	431,12	397,27
31,67	65,56	0,87	0,02	0,93	1230,88	2875,31	0,65	0,00	135,92	399,34	433,21	433,21	399,34
35,00	70,00	0,87	0,02	1,02	1348,38	3181,21	0,71	0,00	151,96	401,31	435,15	435,15	401,31
5,00	30,00	0,88	0,01	0,47	546,52	1175,14	0,33	0,053	49,65	386,01	418,83	425,23	386,01
8,33	34,44	0,88	0,01	0,51	610,42	1328,23	0,35	0,046	56,52	388,48	421,75	426,69	388,48
11,67	38,89	0,88	0,01	0,55	679,86	1496,04	0,38	0,035	64,25	390,88	424,56	427,99	390,88
15,00	43,33	0,88	0,01	0,59	755,15	1679,57	0,41	0,021	72,97	393,23	427,24	429,11	393,23
18,33	47,78	0,89	0,01	0,62	836,60	1879,91	0,43	0,003	82,83	395,51	429,79	430,02	395,51
21,67	52,22	0,89	0,01	0,69	924,55	2098,22	0,48	0,00	93,00	397,71	432,21	432,21	397,71
25,00	56,67	0,89	0,02	0,76	1019,34	2335,84	0,53	0,00	104,15	399,84	434,49	434,49	399,84
28,33	61,11	0,89	0,02	0,84	1121,33	2594,27	0,59	0,00	116,54	401,89	436,63	436,63	401,89
31,67	65,56	0,90	0,02	0,93	1230,88	2875,31	0,65	0,00	130,33	403,85	438,61	438,61	403,85
35,00	70,00	0,90	0,02	1,02	1348,38	3181,21	0,71	0,00	145,72	405,71	440,44	440,44	405,71
5,00	30,00	0,90	0,01	0,39	546,52	1175,14	0,27	0,003	49,65	391,29	424,87	425,23	391,29
8,33	34,44	0,90	0,01	0,44	610,42	1328,23	0,31	0,00	56,15	393,67	427,73	427,73	393,67

11,67	38,89	0,91	0,01	0,49	679,86	1496,04	0,34	0,00	63,23	395,98	430,46	430,46	395,98
15,00	43,33	0,91	0,01	0,55	755,15	1679,57	0,39	0,00	71,08	398,24	433,07	433,07	398,24
18,33	47,78	0,91	0,01	0,62	836,60	1879,91	0,43	0,00	79,78	400,42	435,54	435,54	400,42
21,67	52,22	0,91	0,01	0,69	924,55	2098,22	0,48	0,00	89,43	402,53	437,88	437,88	402,53
25,00	56,67	0,92	0,01	0,76	1019,34	2335,84	0,53	0,00	100,15	404,56	440,07	440,07	404,56
28,33	61,11	0,92	0,02	0,84	1121,33	2594,27	0,59	0,00	112,06	406,50	442,11	442,11	406,50
31,67	65,56	0,92											
35,00	70,00	0,92											
5,00	30,00	0,93	0,01	0,39	546,52	1175,14	0,27	0,00	47,97	396,56	430,88	430,88	396,56
8,33	34,44	0,93	0,01	0,44	610,42	1328,23	0,31	0,00	54,13	398,85	433,68	433,68	398,85
11,67	38,89	0,93	0,01	0,49	679,86	1496,04	0,34	0,00	60,96	401,08	436,34	436,34	401,08
15,00	43,33	0,93	0,01	0,55	755,15	1679,57	0,38	0,00	68,53	403,24	438,88	438,88	403,24
18,33	47,78	0,94	0,01	0,62	836,60	1879,91	0,43	0,00	76,92	405,33	441,27	441,27	405,33
21,67	52,22	0,94	0,01	0,69	924,55	2098,22	0,48	0,00	86,22	407,34	443,52	443,52	407,34
25,00	56,67	0,94											
28,33	61,11	0,94											
31,67	65,56	0,95											
35,00	70,00	0,95											
5,00	30,00	0,95	0,01	0,39	546,52	1175,14	0,27	0,00	46,34	401,82	436,87	436,87	401,82
8,33	34,44	0,95	0,01	0,44	610,42	1328,23	0,30	0,00	52,30	404,02	439,60	439,60	404,02
11,67	38,89	0,96	0,01	0,49	679,86	1496,04	0,34	0,00	58,90	406,16	442,20	442,20	406,16
15,00	43,33	0,96											
18,33	47,78	0,96											

21,67	52,22	0,96											
25,00	56,67	0,97											
28,33	61,11	0,97	0,02	0,84	1121,33	2594,27	0,59	0,00	104,21	415,70	453,25	453,25	415,70
31,67	65,56	0,97	0,02	0,93	1230,88	2875,31	0,65	0,00	116,46	417,32	455,02	455,02	417,32
35,00	70,00	0,97	0,02	1,03	1348,38	3181,21	0,72	0,00	130,10	418,84	456,64	456,64	418,84
5,00	30,00	0,98	0,01	0,39	546,52	1175,14	0,27	0,00	44,83	407,07	442,93	442,93	407,07
8,33	34,44	0,98	0,01	0,44	610,42	1328,23	0,30	0,00	50,60	409,19	445,63	445,63	409,19
11,67	38,89	0,98	0,01	0,49	679,86	1496,04	0,34	0,00	56,98	411,24	448,21	448,21	411,24
15,00	43,33	0,98	0,01	0,55	755,15	1679,57	0,38	0,00	64,04	413,22	450,64	450,64	413,22
18,33	47,78	0,99	0,01	0,62	836,60	1879,91	0,43	0,00	71,86	415,12	452,94	452,94	415,12
21,67	52,22	0,99	0,01	0,69	924,55	2098,22	0,48	0,00	80,51	416,93	455,09	455,09	416,93
25,00	56,67	0,99	0,01	0,77	1019,34	2335,84	0,53	0,00	90,10	418,65	457,09	457,09	418,65
28,33	61,11	0,99	0,02	0,85	1121,33	2594,27	0,59	0,00	100,74	420,28	458,94	458,94	420,28
31,67	65,56	1,00	0,02	0,94	1230,88	2875,31	0,65	0,00	112,55	421,80	460,62	460,62	421,80
35,00	70,00	1,00	0,02	1,04	1348,38	3181,21	0,72	0,00	125,71	423,20	462,15	462,15	423,20

2.6.1 Summary R407 C --- 3000 rpm, 7 cc/rev

Table 23- Summary R407 C- 3000 rpm , 7 cc/rev- cycle 1

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	Q (kW)	Qres (kW)	desnsity after resistence	h1	h2	h3	h4
min	7,49	0,39	546,52	1175,14	0,27	0,000	44,83	359,51	388,30	425,23	359,51
max	23,43	1,55	1348,38	3181,21	1,08	0,437	159,13	423,20	462,15	462,15	423,20
X1_para minimo	0,98	0,98	0,75	0,75	0,98	0,848	0,98	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,765	0,77	1,00	1,00	1,00	1,00

2.7 REFRIGERANT R22 ---5000 rpm, 11.4 cc/rev

Table 24- R22- 5000 rpm, 11.4 cc/rev-cycle 1

T1	T2	X1	mref	flow_l_min	P1	P2	Q	Qres	desnsity after resistance	h1	h2	h3	h4
5,00	30,00	0,75	0,03	2,44	584,29	1192,30	1,70	0,9814	49,71	356,58	382,06	416,99	356,58
8,33	34,44	0,75	0,03	2,63	647,63	1336,40	1,83	1,0260	55,95	358,95	384,91	418,07	358,95
11,67	38,89	0,76	0,03	2,82	715,98	1492,97	1,96	1,0662	62,88	361,28	387,68	419,02	361,28
15,00	43,33	0,76	0,04	3,02	789,57	1662,66	2,10	1,1005	70,56	363,56	390,37	419,83	363,56
18,33	47,78	0,76	0,04	3,21	868,65	1846,17	2,24	1,1268	79,10	365,81	392,96	420,50	365,81
21,67	52,22	0,76	0,04	3,40	953,47	2044,22	2,37	1,1427	88,61	368,00	395,46	420,99	368,00
25,00	56,67	0,77	0,05	3,59	1044,28	2257,56	2,50	1,1453	99,24	370,15	397,86	421,28	370,15
28,33	61,11	0,77	0,05	3,76	1141,34	2486,99	2,62	1,1304	111,17	372,24	400,16	421,35	372,24
31,67	65,56	0,77	0,06	3,91	1244,92	2733,38	2,73	1,0931	124,63	374,27	402,36	421,16	374,27
35,00	70,00	0,77	0,06	4,03	1355,28	2997,65	2,81	1,0264	139,91	376,24	404,44	420,67	376,24
5,00	30,00	0,78	0,03	2,16	584,29	1192,30	1,51	0,7874	49,71	361,65	388,04	416,99	361,65
8,33	34,44	0,78	0,03	2,33	647,63	1336,40	1,62	0,8159	55,95	363,95	390,84	418,07	363,95
11,67	38,89	0,78	0,03	2,50	715,98	1492,97	1,74	0,8393	62,88	366,21	393,55	419,02	366,21
15,00	43,33	0,78	0,04	2,67	789,57	1662,66	1,86	0,8561	70,56	368,42	396,17	419,83	368,42
18,33	47,78	0,79	0,04	2,84	868,65	1846,17	1,98	0,8644	79,10	370,58	398,70	420,50	370,58
21,67	52,22	0,79	0,04	3,01	953,47	2044,22	2,10	0,8618	88,61	372,69	401,12	420,99	372,69

25,00	56,67	0,79	0,05	3,17	1044,28	2257,56	2,21	0,8453	99,24	374,76	403,45	421,28	374,76
28,33	61,11	0,79	0,05	3,31	1141,34	2486,99	2,31	0,8112	111,17	376,76	405,67	421,35	376,76
31,67	65,56	0,80	0,06	3,44	1244,92	2733,38	2,39	0,7545	124,63	378,71	407,78	421,16	378,71
35,00	70,00	0,80	0,06	3,53	1355,28	2997,65	2,46	0,6685	139,91	380,59	409,78	420,67	380,59
5,00	30,00	0,80	0,03	1,90	584,29	1192,30	1,33	0,6054	49,71	366,73	394,03	416,99	366,73
8,33	34,44	0,80	0,03	2,05	647,63	1336,40	1,43	0,6187	55,95	368,95	396,77	418,07	368,95
11,67	38,89	0,81	0,03	2,20	715,98	1492,97	1,53	0,6262	62,88	371,13	399,42	419,02	371,13
15,00	43,33	0,81	0,04	2,35	789,57	1662,66	1,63	0,6265	70,56	373,27	401,98	419,83	373,27
18,33	47,78	0,81	0,04	2,49	868,65	1846,17	1,74	0,6177	79,10	375,35	404,44	420,50	375,35
21,67	52,22	0,81	0,04	2,63	953,47	2044,22	1,84	0,5975	88,61	377,39	406,79	420,99	377,39
25,00	56,67	0,82	0,05	2,77	1044,28	2257,56	1,93	0,5631	99,24	379,37	409,04	421,28	379,37
28,33	61,11	0,82	0,05	2,89	1141,34	2486,99	2,01	0,5107	111,17	381,29	411,18	421,35	381,29
31,67	65,56	0,82	0,05	2,99	1244,92	2733,38	2,08	0,4355	124,63	383,15	413,21	421,16	383,15
35,00	70,00	0,82	0,06	3,06	1355,28	2997,65	2,13	0,3312	139,91	384,94	415,11	420,67	384,94
5,00	30,00	0,83	0,03	1,66	584,29	1192,30	1,16	0,4342	49,71	371,80	400,01	416,99	371,80
8,33	34,44	0,83	0,03	1,79	647,63	1336,40	1,24	0,4332	55,95	373,95	402,70	418,07	373,95
11,67	38,89	0,83	0,03	1,91	715,98	1492,97	1,33	0,4257	62,88	376,06	405,29	419,02	376,06
15,00	43,33	0,83	0,03	2,04	789,57	1662,66	1,42	0,4103	70,56	378,12	407,79	419,83	378,12
18,33	47,78	0,84	0,04	2,16	868,65	1846,17	1,51	0,3854	79,10	380,13	410,18	420,50	380,13
21,67	52,22	0,84	0,04	2,28	953,47	2044,22	1,59	0,3485	88,61	382,08	412,46	420,99	382,08
25,00	56,67	0,84	0,04	2,39	1044,28	2257,56	1,67	0,2971	99,24	383,98	414,63	421,28	383,98
28,33	61,11	0,84	0,05	2,49	1141,34	2486,99	1,73	0,2273	111,17	385,82	416,69	421,35	385,82
31,67	65,56	0,85	0,05	2,56	1244,92	2733,38	1,79	0,1346	124,63	387,59	418,63	421,16	387,59

35,00	70,00	0,85	0,06	2,61	1355,28	2997,65	1,82	0,0127	139,91	389,29	420,45	420,67	389,29
5,00	30,00	0,85	0,02	1,43	584,29	1192,30	1,00	0,2730	49,71	376,87	406,00	416,99	376,87
8,33	34,44	0,85	0,03	1,54	647,63	1336,40	1,07	0,2583	55,95	378,95	408,63	418,07	378,95
11,67	38,89	0,86	0,03	1,64	715,98	1492,97	1,15	0,2366	62,88	380,99	411,16	419,02	380,99
15,00	43,33	0,86	0,03	1,75	789,57	1662,66	1,22	0,2065	70,56	382,97	413,59	419,83	382,97
18,33	47,78	0,86	0,04	1,85	868,65	1846,17	1,29	0,1662	79,10	384,90	415,92	420,50	384,90
21,67	52,22	0,86	0,04	1,95	953,47	2044,22	1,36	0,1136	88,61	386,78	418,13	420,99	386,78
25,00	56,67	0,87	0,04	2,04	1044,28	2257,56	1,42	0,0459	99,24	388,59	420,23	421,28	388,59
28,33	61,11	0,87	0,05	2,17	1141,34	2486,99	1,51	0,00	110,36	390,34	422,20	422,20	390,34
31,67	65,56	0,87	0,05	2,38	1244,92	2733,38	1,66	0,00	121,51	392,02	424,06	424,06	392,02
35,00	70,00	0,87	0,06	2,60	1355,28	2997,65	1,81	0,00	133,65	393,63	425,79	425,79	393,63
5,00	30,00	0,88	0,02	1,21	584,29	1192,30	0,85	0,1209	49,71	381,94	411,98	416,99	381,94
8,33	34,44	0,88	0,03	1,30	647,63	1336,40	0,91	0,0933	55,95	383,95	414,56	418,07	383,95
11,67	38,89	0,88	0,03	1,39	715,98	1492,97	0,97	0,0581	62,88	385,92	417,04	419,02	385,92
15,00	43,33	0,88	0,03	1,48	789,57	1662,66	1,03	0,0139	70,56	387,82	419,40	419,83	387,82
18,33	47,78	0,89	0,04	1,62	868,65	1846,17	1,13	0,00	78,38	389,68	421,66	421,66	389,68
21,67	52,22	0,89	0,04	1,79	953,47	2044,22	1,25	0,00	86,65	391,47	423,80	423,80	391,47
25,00	56,67	0,89	0,04	1,98	1044,28	2257,56	1,38	0,00	95,65	393,20	425,82	425,82	393,20
28,33	61,11	0,89	0,05	2,18	1141,34	2486,99	1,52	0,00	105,46	394,87	427,72	427,72	394,87
31,67	65,56	0,90	0,05	2,39	1244,92	2733,38	1,66	0,00	116,15	396,46	429,49	429,49	396,46
35,00	70,00	0,90	0,05	2,61	1355,28	2997,65	1,82	0,00	127,80	397,98	431,12	431,12	397,98
5,00	30,00	0,90	0,02	1,04	584,29	1192,30	0,73	0,00	49,35	387,02	417,97	417,97	387,02
8,33	34,44	0,90	0,03	1,17	647,63	1336,40	0,82	0,00	54,96	388,96	420,49	420,49	388,96

11,67	38,89	0,91	0,03	1,31	715,98	1492,97	0,91	0,00	61,08	390,84	422,91	422,91	390,84
15,00	43,33	0,91	0,03	1,46	789,57	1662,66	1,02	0,00	67,77	392,68	425,21	425,21	392,68
18,33	47,78	0,91	0,03	1,62	868,65	1846,17	1,13	0,00	75,05	394,45	427,40	427,40	394,45
21,67	52,22	0,91	0,04	1,80	953,47	2044,22	1,25	0,00	82,99	396,17	429,46	429,46	396,17
25,00	56,67	0,92	0,04	1,98	1044,28	2257,56	1,38	0,00	91,65	397,82	431,41	431,41	397,82
28,33	61,11	0,92	0,04	2,18	1141,34	2486,99	1,52	0,00	101,08	399,40	433,23	433,23	399,40
31,67	65,56	0,92	0,05	2,39	1244,92	2733,38	1,67	0,00	111,36	400,90	434,91	434,91	400,90
35,00	70,00	0,92	0,05	2,62	1355,28	2997,65	1,83	0,00	122,55	402,33	436,47	436,47	402,33
5,00	30,00	0,93	0,02	1,05	584,29	1192,30	0,73	0,00	47,31	392,09	423,95	423,95	392,09
8,33	34,44	0,93	0,03	1,17	647,63	1336,40	0,82	0,00	52,71	393,96	426,42	426,42	393,96
11,67	38,89	0,93	0,03	1,31	715,98	1492,97	0,92	0,00	58,61	395,77	428,78	428,78	395,77
15,00	43,33	0,93	0,03	1,47	789,57	1662,66	1,02	0,00	65,04	397,53	431,02	431,02	397,53
18,33	47,78	0,94	0,03	1,63	868,65	1846,17	1,13	0,00	72,06	399,23	433,14	433,14	399,23
21,67	52,22	0,94	0,04	1,80	953,47	2044,22	1,26	0,00	79,71	400,86	435,13	435,13	400,86
25,00	56,67	0,94	0,04	1,99	1044,28	2257,56	1,39	0,00	88,04	402,43	437,01	437,01	402,43
28,33	61,11	0,94	0,04	2,19	1141,34	2486,99	1,53	0,00	97,11	403,92	438,77	438,77	403,92
31,67	65,56	0,95	0,05	2,41	1244,92	2733,38	1,68	0,00	106,98	405,34	440,41	440,41	405,34
35,00	70,00	0,95	0,05	2,64	1355,28	2997,65	1,84	0,00	117,73	406,67	441,92	441,92	406,67
5,00	30,00	0,95	0,02	1,05	584,29	1192,30	0,73	0,00	45,47	397,16	429,94	429,94	397,16
8,33	34,44	0,95	0,02	1,18	647,63	1336,40	0,82	0,00	50,68	398,96	432,35	432,35	398,96
11,67	38,89	0,96	0,03	1,32	715,98	1492,97	0,92	0,00	56,37	400,70	434,65	434,65	400,70
15,00	43,33	0,96	0,03	1,47	789,57	1662,66	1,02	0,00	62,58	402,38	436,85	436,85	402,38
18,33	47,78	0,96	0,03	1,63	868,65	1846,17	1,14	0,00	69,34	404,00	438,92	438,92	404,00

21,67	52,22	0,96	0,04	1,81	953,47	2044,22	1,26	0,00	76,70	405,56	440,89	440,89	405,56
25,00	56,67	0,97	0,04	2,00	1044,28	2257,56	1,39	0,00	84,72	407,04	442,72	442,72	407,04
28,33	61,11	0,97	0,04	2,21	1141,34	2486,99	1,54	0,00	93,44	408,45	444,44	444,44	408,45
31,67	65,56	0,97	0,05	2,42	1244,92	2733,38	1,69	0,00	102,95	409,78	446,02	446,02	409,78
35,00	70,00	0,97	0,05	2,66	1355,28	2997,65	1,85	0,00	113,29	411,02	447,46	447,46	411,02
5,00	30,00	0,98	0,02	1,05	584,29	1192,30	0,73	0,00	43,78	402,23	436,00	436,00	402,23
8,33	34,44	0,98	0,02	1,18	647,63	1336,40	0,82	0,00	48,81	403,96	438,40	438,40	403,96
11,67	38,89	0,98	0,03	1,33	715,98	1492,97	0,92	0,00	54,30	405,63	440,68	440,68	405,63
15,00	43,33	0,98	0,03	1,48	789,57	1662,66	1,03	0,00	60,28	407,23	442,84	442,84	407,23
18,33	47,78	0,99	0,03	1,65	868,65	1846,17	1,15	0,00	66,80	408,78	444,88	444,88	408,78
21,67	52,22	0,99	0,03	1,83	953,47	2044,22	1,27	0,00	73,90	410,25	446,79	446,79	410,25
25,00	56,67	0,99	0,04	2,02	1044,28	2257,56	1,41	0,00	81,63	411,65	448,58	448,58	411,65
28,33	61,11	0,99	0,04	2,23	1141,34	2486,99	1,55	0,00	90,05	412,98	450,23	450,23	412,98
31,67	65,56	1,00	0,05	2,45	1244,92	2733,38	1,71	0,00	99,21	414,22	451,75	451,75	414,22
35,00	70,00	1,00	0,05	2,69	1355,28	2997,65	1,87	0,00	109,18	415,37	453,12	453,12	415,37

2.7.1 Summary R22--- 5000 rpm, 11.4 cc/rev

Table 25-Summary R22- 5000 rpm, 11.4 cc/rev-cycle 1

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	Q (kW)	Qres (kW)	desnsity after resistence	h1	h2	h3	h4
min	21,69	1,04	584,29	1192,30	0,73	0,0000	43,78	356,58	382,06	416,99	356,58
max	63,26	4,03	1355,28	2997,65	2,81	1,1453	139,91	415,37	453,12	453,12	415,37
X1_para minimo	0,98	0,90	0,75	0,75	0,90	0,8687	0,98	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,7652	0,77	1,00	1,00	1,00	1,00

2.8 REFRIGERANT R 22 --- 3000 rpm, 7 cc/rev

Table 26- R22- 3000 rpm, 7 cc/rev-cycle 1

T1	T2	X1	mref	flow_l_min	P1	P2	Q	Qres	desnsity after resistance	h1	h2	h3	h4
5,00	30,00	0,75	0,01	0,90	584,29	1192,30	0,63	0,3616	49,71	356,58	382,06	416,99	356,58
8,33	34,44	0,75	0,01	0,97	647,63	1336,40	0,67	0,3780	55,95	358,95	384,91	418,07	358,95
11,67	38,89	0,76	0,01	1,04	715,98	1492,97	0,72	0,3928	62,88	361,28	387,68	419,02	361,28
15,00	43,33	0,76	0,01	1,11	789,57	1662,66	0,77	0,4054	70,56	363,56	390,37	419,83	363,56
18,33	47,78	0,76	0,02	1,18	868,65	1846,17	0,82	0,4151	79,10	365,81	392,96	420,50	365,81
21,67	52,22	0,76	0,02	1,25	953,47	2044,22	0,87	0,4210	88,61	368,00	395,46	420,99	368,00
25,00	56,67	0,77	0,02	1,32	1044,28	2257,56	0,92	0,4219	99,24	370,15	397,86	421,28	370,15
28,33	61,11	0,77	0,02	1,39	1141,34	2486,99	0,97	0,4165	111,17	372,24	400,16	421,35	372,24
31,67	65,56	0,77	0,02	1,44	1244,92	2733,38	1,00	0,4027	124,63	374,27	402,36	421,16	374,27
35,00	70,00	0,77	0,02	1,49	1355,28	2997,65	1,04	0,3781	139,91	376,24	404,44	420,67	376,24
5,00	30,00	0,78	0,01	0,80	584,29	1192,30	0,55	0,2901	49,71	361,65	388,04	416,99	361,65
8,33	34,44	0,78	0,01	0,86	647,63	1336,40	0,60	0,3006	55,95	363,95	390,84	418,07	363,95
11,67	38,89	0,78	0,01	0,92	715,98	1492,97	0,64	0,3092	62,88	366,21	393,55	419,02	366,21
15,00	43,33	0,78	0,01	0,98	789,57	1662,66	0,69	0,3154	70,56	368,42	396,17	419,83	368,42
18,33	47,78	0,79	0,01	1,05	868,65	1846,17	0,73	0,3184	79,10	370,58	398,70	420,50	370,58
21,67	52,22	0,79	0,02	1,11	953,47	2044,22	0,77	0,3175	88,61	372,69	401,12	420,99	372,69

25,00	56,67	0,79	0,02	1,17	1044,28	2257,56	0,81	0,3114	99,24	374,76	403,45	421,28	374,76
28,33	61,11	0,79	0,02	1,22	1141,34	2486,99	0,85	0,2989	111,17	376,76	405,67	421,35	376,76
31,67	65,56	0,80	0,02	1,27	1244,92	2733,38	0,88	0,2780	124,63	378,71	407,78	421,16	378,71
35,00	70,00	0,80	0,02	1,30	1355,28	2997,65	0,91	0,2463	139,91	380,59	409,78	420,67	380,59
5,00	30,00	0,80	0,01	0,70	584,29	1192,30	0,49	0,2230	49,71	366,73	394,03	416,99	366,73
8,33	34,44	0,80	0,01	0,75	647,63	1336,40	0,53	0,2279	55,95	368,95	396,77	418,07	368,95
11,67	38,89	0,81	0,01	0,81	715,98	1492,97	0,56	0,2307	62,88	371,13	399,42	419,02	371,13
15,00	43,33	0,81	0,01	0,86	789,57	1662,66	0,60	0,2308	70,56	373,27	401,98	419,83	373,27
18,33	47,78	0,81	0,01	0,92	868,65	1846,17	0,64	0,2276	79,10	375,35	404,44	420,50	375,35
21,67	52,22	0,81	0,02	0,97	953,47	2044,22	0,68	0,2201	88,61	377,39	406,79	420,99	377,39
25,00	56,67	0,82	0,02	1,02	1044,28	2257,56	0,71	0,2075	99,24	379,37	409,04	421,28	379,37
28,33	61,11	0,82	0,02	1,06	1141,34	2486,99	0,74	0,1882	111,17	381,29	411,18	421,35	381,29
31,67	65,56	0,82	0,02	1,10	1244,92	2733,38	0,77	0,1605	124,63	383,15	413,21	421,16	383,15
35,00	70,00	0,82	0,02	1,13	1355,28	2997,65	0,78	0,1220	139,91	384,94	415,11	420,67	384,94
5,00	30,00	0,83	0,01	0,61	584,29	1192,30	0,43	0,1600	49,71	371,80	400,01	416,99	371,80
8,33	34,44	0,83	0,01	0,66	647,63	1336,40	0,46	0,1596	55,95	373,95	402,70	418,07	373,95
11,67	38,89	0,83	0,01	0,70	715,98	1492,97	0,49	0,1568	62,88	376,06	405,29	419,02	376,06
15,00	43,33	0,83	0,01	0,75	789,57	1662,66	0,52	0,1512	70,56	378,12	407,79	419,83	378,12
18,33	47,78	0,84	0,01	0,80	868,65	1846,17	0,56	0,1420	79,10	380,13	410,18	420,50	380,13
21,67	52,22	0,84	0,02	0,84	953,47	2044,22	0,59	0,1284	88,61	382,08	412,46	420,99	382,08
25,00	56,67	0,84	0,02	0,88	1044,28	2257,56	0,61	0,1094	99,24	383,98	414,63	421,28	383,98
28,33	61,11	0,84	0,02	0,92	1141,34	2486,99	0,64	0,0837	111,17	385,82	416,69	421,35	385,82
31,67	65,56	0,85	0,02	0,94	1244,92	2733,38	0,66	0,0496	124,63	387,59	418,63	421,16	387,59

35,00	70,00	0,85	0,02	0,96	1355,28	2997,65	0,67	0,0047	139,91	389,29	420,45	420,67	389,29
5,00	30,00	0,85	0,01	0,53	584,29	1192,30	0,37	0,1006	49,71	376,87	406,00	416,99	376,87
8,33	34,44	0,85	0,01	0,57	647,63	1336,40	0,39	0,0952	55,95	378,95	408,63	418,07	378,95
11,67	38,89	0,86	0,01	0,61	715,98	1492,97	0,42	0,0872	62,88	380,99	411,16	419,02	380,99
15,00	43,33	0,86	0,01	0,65	789,57	1662,66	0,45	0,0761	70,56	382,97	413,59	419,83	382,97
18,33	47,78	0,86	0,01	0,68	868,65	1846,17	0,48	0,0612	79,10	384,90	415,92	420,50	384,90
21,67	52,22	0,86	0,01	0,72	953,47	2044,22	0,50	0,0418	88,61	386,78	418,13	420,99	386,78
25,00	56,67	0,87	0,02	0,75	1044,28	2257,56	0,52	0,0169	99,24	388,59	420,23	421,28	388,59
28,33	61,11	0,87	0,02	0,80	1141,34	2486,99	0,56	0,00	110,36	390,34	422,20	422,20	390,34
31,67	65,56	0,87	0,02	0,88	1244,92	2733,38	0,61	0,00	121,51	392,02	424,06	424,06	392,02
35,00	70,00	0,87	0,02	0,96	1355,28	2997,65	0,67	0,00	133,65	393,63	425,79	425,79	393,63
5,00	30,00	0,88	0,01	0,45	584,29	1192,30	0,31	0,0445	49,71	381,94	411,98	416,99	381,94
8,33	34,44	0,88	0,01	0,48	647,63	1336,40	0,33	0,0344	55,95	383,95	414,56	418,07	383,95
11,67	38,89	0,88	0,01	0,51	715,98	1492,97	0,36	0,0214	62,88	385,92	417,04	419,02	385,92
15,00	43,33	0,88	0,01	0,54	789,57	1662,66	0,38	0,0051	70,56	387,82	419,40	419,83	387,82
18,33	47,78	0,89	0,01	0,60	868,65	1846,17	0,42	0,00	78,38	389,68	421,66	421,66	389,68
21,67	52,22	0,89	0,01	0,66	953,47	2044,22	0,46	0,00	86,65	391,47	423,80	423,80	391,47
25,00	56,67	0,89	0,02	0,73	1044,28	2257,56	0,51	0,00	95,65	393,20	425,82	425,82	393,20
28,33	61,11	0,89	0,02	0,80	1141,34	2486,99	0,56	0,00	105,46	394,87	427,72	427,72	394,87
31,67	65,56	0,90	0,02	0,88	1244,92	2733,38	0,61	0,00	116,15	396,46	429,49	429,49	396,46
35,00	70,00	0,90	0,02	0,96	1355,28	2997,65	0,67	0,00	127,80	397,98	431,12	431,12	397,98
5,00	30,00	0,90	0,01	0,38	584,29	1192,30	0,27	0,00	49,35	387,02	417,97	417,97	387,02
8,33	34,44	0,90	0,01	0,43	647,63	1336,40	0,30	0,00	54,96	388,96	420,49	420,49	388,96

11,67	38,89	0,91	0,01	0,48	715,98	1492,97	0,34	0,00	61,08	390,84	422,91	422,91	390,84
15,00	43,33	0,91	0,01	0,54	789,57	1662,66	0,38	0,00	67,77	392,68	425,21	425,21	392,68
18,33	47,78	0,91	0,01	0,60	868,65	1846,17	0,42	0,00	75,05	394,45	427,40	427,40	394,45
21,67	52,22	0,91	0,01	0,66	953,47	2044,22	0,46	0,00	82,99	396,17	429,46	429,46	396,17
25,00	56,67	0,92	0,02	0,73	1044,28	2257,56	0,51	0,00	91,65	397,82	431,41	431,41	397,82
28,33	61,11	0,92	0,02	0,80	1141,34	2486,99	0,56	0,00	101,08	399,40	433,23	433,23	399,40
31,67	65,56	0,92	0,02	0,88	1244,92	2733,38	0,61	0,00	111,36	400,90	434,91	434,91	400,90
35,00	70,00	0,92	0,02	0,97	1355,28	2997,65	0,67	0,00	122,55	402,33	436,47	436,47	402,33
5,00	30,00	0,93	0,01	0,39	584,29	1192,30	0,27	0,00	47,31	392,09	423,95	423,95	392,09
8,33	34,44	0,93	0,01	0,43	647,63	1336,40	0,30	0,00	52,71	393,96	426,42	426,42	393,96
11,67	38,89	0,93	0,01	0,48	715,98	1492,97	0,34	0,00	58,61	395,77	428,78	428,78	395,77
15,00	43,33	0,93	0,01	0,54	789,57	1662,66	0,38	0,00	65,04	397,53	431,02	431,02	397,53
18,33	47,78	0,94	0,01	0,60	868,65	1846,17	0,42	0,00	72,06	399,23	433,14	433,14	399,23
21,67	52,22	0,94	0,01	0,66	953,47	2044,22	0,46	0,00	79,71	400,86	435,13	435,13	400,86
25,00	56,67	0,94	0,01	0,73	1044,28	2257,56	0,51	0,00	88,04	402,43	437,01	437,01	402,43
28,33	61,11	0,94	0,02	0,81	1141,34	2486,99	0,56	0,00	97,11	403,92	438,77	438,77	403,92
31,67	65,56	0,95	0,02	0,89	1244,92	2733,38	0,62	0,00	106,98	405,34	440,41	440,41	405,34
35,00	70,00	0,95	0,02	0,97	1355,28	2997,65	0,68	0,00	117,73	406,67	441,92	441,92	406,67
5,00	30,00	0,95	0,01	0,39	584,29	1192,30	0,27	0,00	45,47	397,16	429,94	429,94	397,16
8,33	34,44	0,95	0,01	0,43	647,63	1336,40	0,30	0,00	50,68	398,96	432,35	432,35	398,96
11,67	38,89	0,96	0,01	0,49	715,98	1492,97	0,34	0,00	56,37	400,70	434,65	434,65	400,70
15,00	43,33	0,96	0,01	0,54	789,57	1662,66	0,38	0,00	62,58	402,38	436,85	436,85	402,38
18,33	47,78	0,96	0,01	0,60	868,65	1846,17	0,42	0,00	69,34	404,00	438,92	438,92	404,00

21,67	52,22	0,96	0,01	0,67	953,47	2044,22	0,46	0,00	76,70	405,56	440,89	440,89	405,56
25,00	56,67	0,97	0,01	0,74	1044,28	2257,56	0,51	0,00	84,72	407,04	442,72	442,72	407,04
28,33	61,11	0,97	0,02	0,81	1141,34	2486,99	0,57	0,00	93,44	408,45	444,44	444,44	408,45
31,67	65,56	0,97	0,02	0,89	1244,92	2733,38	0,62	0,00	102,95	409,78	446,02	446,02	409,78
35,00	70,00	0,97	0,02	0,98	1355,28	2997,65	0,68	0,00	113,29	411,02	447,46	447,46	411,02
5,00	30,00	0,98	0,01	0,39	584,29	1192,30	0,27	0,00	43,78	402,23	436,00	436,00	402,23
8,33	34,44	0,98	0,01	0,44	647,63	1336,40	0,30	0,00	48,81	403,96	438,40	438,40	403,96
11,67	38,89	0,98	0,01	0,49	715,98	1492,97	0,34	0,00	54,30	405,63	440,68	440,68	405,63
15,00	43,33	0,98	0,01	0,55	789,57	1662,66	0,38	0,00	60,28	407,23	442,84	442,84	407,23
18,33	47,78	0,99	0,01	0,61	868,65	1846,17	0,42	0,00	66,80	408,78	444,88	444,88	408,78
21,67	52,22	0,99	0,01	0,67	953,47	2044,22	0,47	0,00	73,90	410,25	446,79	446,79	410,25
25,00	56,67	0,99	0,01	0,74	1044,28	2257,56	0,52	0,00	81,63	411,65	448,58	448,58	411,65
28,33	61,11	0,99	0,02	0,82	1141,34	2486,99	0,57	0,00	90,05	412,98	450,23	450,23	412,98
31,67	65,56	1,00	0,02	0,90	1244,92	2733,38	0,63	0,00	99,21	414,22	451,75	451,75	414,22
35,00	70,00	1,00	0,02	0,99	1355,28	2997,65	0,69	0,00	109,18	415,37	453,12	453,12	415,37

2.8.1 Summary R 22 ---3000 rpm, 7 cc/rev

Table 27-Summary R22- 3000 rpm, 7cc/rev- cycle 1

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	Q (kW)	Qres (kW)	desnsity after resistence	h1	h2	h3	h4
min	7,99	0,38	584,29	1192,30	0,27	0,0000	43,78	356,58	382,06	416,99	356,58
max	23,31	1,49	1355,28	2997,65	1,04	0,4219	139,91	415,37	453,12	453,12	415,37
X1_para minimo	0,98	0,90	0,75	0,75	0,90	0,8687	0,98	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,7652	0,77	1,00	1,00	1,00	1,00

ANNEX II: SECOND STAGE

The search of the equipment had multiple stages, since the thermodynamic cycle changed continuously.

The followings tables represents a part of the

A useful, and well employed website was “RS COMPONENTs”(http://es.rs-online.com/web/)

1 PRESSURE SENSORS

Table 28-Pressure sensors

€	Ref. AMI DATA	Fabricant	P. MIN (bar)	P. MAX (bar)	Accuracy	Medium	AO	Power supply	Temp MIN	Temp MAX
111,9129	455-4646	Gems Sensors	0	25	0,25	--	4 -> 20 mA	10->36 Vdc	-40	120
115,2404	742-0978	Telemecanique	0	25	--	Aire, Agua,gas, líquido de refrigeración	0 -> 10 V	24 Vac/dc	-30	100
115,2404	**742-0969**	**Telemecanique**	**0**	**25**	**--**	**Aire, Agua,gas, líquido de refrigeración**	**4 -> 20 mA**	**24 Vac/dc**	**-30**	**100**
115,2404	742-0971	Telemecanique	0	25	--	Aire, Agua,gas, líquido de refrigeración	4 -> 20 mA	24 Vac/dc	-30	100
133,3541	739-6771	Sick	0	25	0,25%	Líquido, gas	4 -> 20 mA	8->30 Vdc	0	80
225,5803	455-4567	Gems Sensors	0	25	0,25%	Líquido,gas	4 -> 20 mA	7->35 Vdc	-40	100

“rs-online.com”

The maximum pressure considered at the first stages of the project was 25 bar (it was only considered the R134A refrigerant, and a lower action range was specified).

2 TEMPERATURE SENSORS

2.1 THERMORESISTANCES

Table 29-Thermoresistances

€	Ref. AMIDATA	Fabricant	TYPE	Temp. MIN	Temp. MAX	Diam. (mm)	Length (mm)	ACCURACY
5,0336	362-9840	RS	PT100	-50	500	--	2,3	CLASE B
5,4813	362-9913	RS	PT1000	-50	500	--	10	CLASE B
7,8771	**362-9834**	**RS**	**PT100**	**-50**	**400**	**--**	**2,3**	**CLASE A**
8,2885	181-2012	Correge	PT100	-50	600	2	2,3	--

“es.rs-online.com”

At first, PT100 sensors were considered for their linear response. In the table, the third component is highlighted since the class A is the more accurate (±0.15 ªC).

3 WATER FLUX

Table 30- Water flux

€	Ref. AMIDATA	Fabricante	Type	Power supply	Q. MIN	Q. MAX	Diameter	P. MAX	Temperature
202,07	725-9969	Cynergy 3	Sensor/ Interruptor sin indicador	7,5->26 Vdc	0,4 l/min	8 l/min	10mm	10	-10 ->85
47,35	616-2693	Gems Sensors	Sensor/interruptor sin indicador	5 → 24 Vdc	0,1196 l/min	2,925 l/min	6,35 mm	24 bar	-20-> 100
132,02	395-7173	Gems Sensors	Sensor/interruptor sin indicador	220 V	0 l/min	55 l/min	3/8 pulg	50 bar	90

“es.rs-online.com”

4 ELECTRONIC EXAPANSION VALVE

According to the first calculations, the maximum pressure to be achieve was 22 bars, so the DANFOSS (ETS 6-25) expansion valve, that could achieve up to 35 bars of pressure difference.

However an offer directly from DANFOSS was not possible so, one of their suppliers was contacted (PEKOMARK).

Table 31-Electronic expansion valve

€	Model	Temperature (fluid)	Temperature (ambient)	kW	Pressure. max (bar)	Diff pressure	Max reverse pressure	Code
	ETS 6 - 25	(-30ºC-70ºC)	(-30ºC-70ºC)	15,3	47	35	22	034G5035

4.1 PECOMARK

They have made an offer for the condenser and the expansion valve (drivers and electronic included)).

Table 32- Pekomark

CODE	UDS.	DESCRIPTION	€
428075	1	VALV. EXPAN. ELECTRONICA CAREL E2V05BSF00	81.4
428313	1	TRANSMISOR PRESION CAREL SPKT0013R0	33.04
428544	1	SONDA NTC CAREL NTC030HF01/WF00	5.94
428576	1	TRANSFORMADOR CARRIL DIN TRADRFE240	30.64
428579	1	DRIVER EVO PARA EEV CAREL EVD0000E50	92.41
428670	1	CABLE CONECTOR 2MTS CAREL SPKC002310	5.27
428699	1	CABLE APANTALLADO CAREL E2VCABS600	18.48
		SUMA:	**€ 515.67**

5 VARIABLE SPEED PUMP

5.1 EBARA

Since the water flux needed is very low, they suggest the EGO pumps. Those pump are specialized in low fluxes.

Besides, the "EGO ROSCADAS" have an extra version "ER" that include an input of 0-10 V to control the flux created. There are also, the "EGO EASSY" (more complete) that include as well a control input signal.

BUDGET 380-480 € (sin iva)

5.2 PRODEL

A continuous current pump that Works 0-7 V. Its maximum flux is 132L/h and to control it a continuous power supply is needed.

Imax=2.2 A Tmax= 60ºC connections 6mm diam connector spacing 50 mm

STE 2/50 579220

PRICE: 157.3€

DELIVERY TIME: 12 SEMANAS

*****If it is more tan 9ud, 5 weeks**

6 CONDENSER

6.1 JOSE NEGREDO

The enterprise "Jose Negredo" has prepared a Budget for the condenser.

PRICE: 255 €.

DELIVERY TIME: 3-4 SEMANAS

BSH ELECTRODOMESTICOS – Sra. Natalia Medina

N/REF 140417809 - FECHA 14/03/14

PHE-Type	SL23-BR25-10-TL-COND	Hot side	Cold side
Flowrate	(kg/s)/(m3/h)	0,01	0,17
Inlet temperature	(°C)	40,00	15,00
Outlet Temp. Cond./Fluid	(°C)	40,00 (40)	25,00
Pressure drop / velocity	(bar)	0,01 / 0,64	0,02
Heat exchanged	(kW)	2	

Thermodynamic properties:		R134A	Water
Density	(kg/m³)		997,71
Specific heat	(kJ/kg*K)		4,19
Thermal conductivity	(W/m*K)		0,60
Mean viscosity	(mPa*s)		1,01
Wall viscosity	(mPa*s)		0,66
Fouling factors	(m²*K/kW)		0,64
Dimensioning factor	%	213,20	
Inlet branch		F1	F3
Outlet branch		F4	F2

Design of Frame / Plates:

Plate arrangement (passes*channel)		1 x 4 + 0 x 0	
Plate arrangement (passes*channel)		1 x 5 + 0 x 0	
Number of plates		10	
Effective heat surface	(m²)	0,19	
Overall K-value Duty/Clean	(W/m²*K)	528,80	1.656,20
Plate material		0.4 mm AISI 316	

Gasket material / Max. temp.		COPPER/BRAZED / 185
Max. design temperature	(°C)	130,00
Max. Working/test pressure	(bar)	25,00 32,50
Max. Differential pressure	(bar)	25,00
Approval		Sondex Standard
Liquid volume	(liter)	0
Frame length	(mm)	30
Net weight	(kg)	2
Frame type		BR

Connections HOT side : Ø22.3

Connections COLD side: 0.75 inch. Thread BSP

PRICE **210€ NETO**

Cond. de entrega SIN IVA, PORTES INCLUIDOS EN PENINSULA, ENTREGA SOBRE CAMION

Condiciones de pago **30% al pedido, 70% a 60 días fecha de entrega

Plazo de entrega 3 semanas (+1 transporte), a confirmar por fábrica sobre pedido

Validez de la oferta 30 DIAS

Diseñado por: ROGER NEGRE

6.2 PECOMARK

Table 33-Pekomark-condenser

CODE	UDS.	DESCRIPTION	SUPPLIER	PRICE (€)
309010	1	INTERCAMBIADOR DE PLACAS SWEP B 5THX 10	PECOMARK	166.14

ANNEX III: SOFTWARE SELECTION

1 LABVIEW

1.1 PROS

- ***The control process can be done remotely, when both computers are connected to the intranet.***
- ***Placing an external card, that is installed on the computer, or connected via USB, it can function as a data logger.***
- ***LABVIEW allows the communication by different protocols, such as Ethernet (it is easier to find Pc’s compatibles with this protocol).***
- ***Depending on the signals to be treated, different external modules must be bought to its correct treatment.***
- ***The behavior of the sensor or other components can be linearized, when their response curve is known.***
- ***The data can be exported/imported easily using EXCEL.***
- ***It has an intuitive and “automatic” HMI. It also dispose of a design option to look like SACADA.***
- ***To employ the refrigerant thermodynamic properties, an excel file can be used or a graphic can be created (polyfit) and obtained the data needed.***
- ***Technical support for the programming (Upna).***
- ***No need to buy any software licenses, because of my student condition. If a modification in the program is needed, then it would have to buy a “debug” license (1800 €).***

1.2 *CONS*

- ***If a modification in the program is required, a debug license is needed (1800 €).***

- *Estella staff are not familiar with this software.*

2 SIMATIC- STEP 7

2.1 PROS

- *It is specialized in working in real time.*
- *The process can be controlled remotely, while both computers are connected to the same net.*
- *Depending on the type of signal, different external modules are bought.*
- *At the beginning, it was intended to use the PLC of the carrousel (Estella). However, due to the amount of signals to treat it would be necessary two of these PLC (CPU 224), or the disposal of a higher level PLC (S7-300), to be able to control all the stations to be implemented in the test rig bench.*
- *Estella staff are familiar with this software, SIMATIC.*
- *Data can be export to an Excel file easily.*
- *The possibility of use the material present in Estella.*

2.2 CONS

- *There would be no technical support for the programation.*
- *License of WINCC needed.*
- *Programation of the interface human machine (HMI), the tactile panel.*

2.3 WEIGHTED METHODS

Table 34-Software selection procedure

CHARACTERISTICS	WEIGHT	LABVIEW			SUM.	SIMATIC			SUM.
		High (3)	Med. (2)	Few (1)		High (3)	Med. (2)	Few (1)	
Simplicity	1	X			3		X		2
HMI	1	X			3			X	1
Import/ Export	3		X		6		X		6
Licence	2			X	2		X		4
Programation support	1		X		2		X		2
Staff knowledge	5			X	5		X		10
PRICE	4		X		8		X	X	6
SUM		29				31			

ANNEX IV: IMPROVEMENTS

1 IMPROVEMENT: SAUNIER DUVAL PROPOSAL

As the chosen option cannot completely assure the pressure after the heating resistance, another expansion valve is added so the water flux don’t modified the refrigerant pressure.

Firstly, the refrigerant experiments a raise of its pressure and temperature, once it enters to the compressor. So, the pressure difference achieve by the cycle can be fixed with this component.

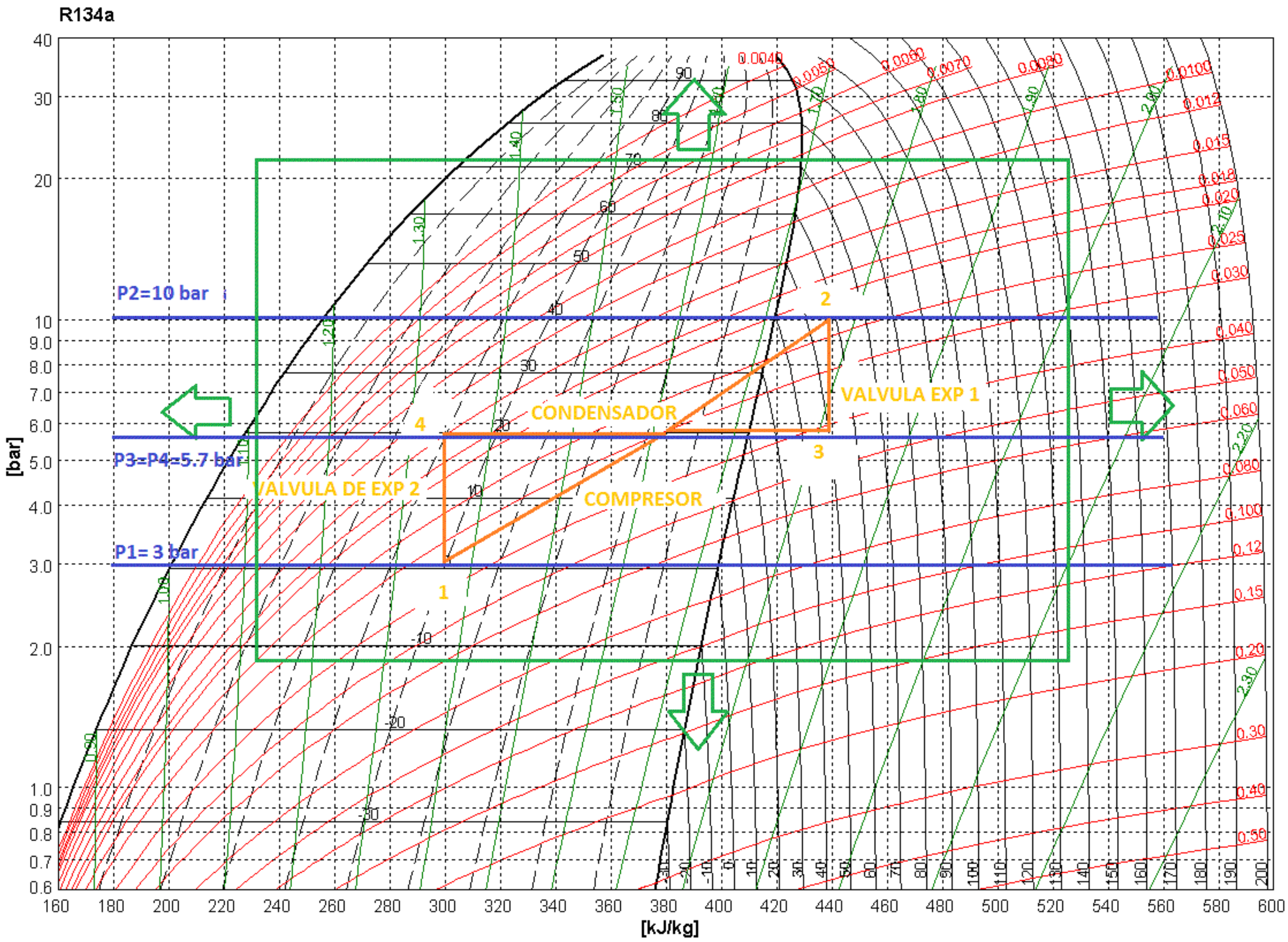


Figure 18.-Improvement, S&D cycle

The pressure difference achieve by the compressor, must be obtained by the combination of the two electronic expansion valves, so the pressure of the final operating point was the same as the pressure at the beginning of the cycle.

In the Figure 1, the difference between the operating points one and two (besides the pressure difference achieve by the compressor) can be appreciated by studying its abscise distance. This abscise distance represents an enthalpy difference which must be eliminate employing a condenser, in order to complete the cycle and make it stable.

In other words, the condenser will have to get a heat exchange to obtain in point four, the same enthalpy as in point one. This way, the only difference between the first operating point and the last one, would be the pressure difference that would be later corrected by the use of an electronic expansion valve.

1.1.1 OPERATING POINT TWO CALCULATIONS

The pressure and temperature are measured at this operating point ($P2_{EXP}$ and $T2_{EXP}$) will be determined by the operating conditions of the compressor and fixed by the electronic expansions valves. Depending on the compressor type, it would be possible to obtain a bigger pressure ratio.

Temperature Sensor	**$T2_{EXP}$**
Pressure sensor	$P2_{EXP}$
Flux sensor	m_{REF} (refrigerant sensor)

For determining the zone in which the refrigerant works (biphasic or overheated steam), the temperature measured ($T2_{EXP}$) can be compared with the saturation temperature at the pressure $P2_{EXP}$.

With the values of the temperature and pressure, and the knowledge of the zone in which the refrigerant works, the enthalpy of the operating point 2 can be calculated. There are several way to obtain its value (thermodynamic software programs…) one of them would be:

$$h_{2\_EXP} = u_2 + P_{2\_EXP} \cdot \Upsilon_2$$

The specific volume must be calculated in order to use the previous formula. When the refrigerant is in the overheated steam zone, it is obtained using the thermodynamic and the values of pressure and temperature measured.

On the other hand, if the refrigerant is in the biphasic zone to calculate the specific volume the use of a thermodynamic software would be needed.

To avoid its use, some assumptions can be made: The process can be considered as isentropic, so the enthalpy at the operating point two can be calculate with the help of the entropy of the operating point one. This way, the enthalpy "h2s" (enthalpy of the isentropic point two) would be obtained:

1. The operating point 2s and its enthalpy are calculated. To do so, theoretical values of point one must be used.

   Knowing the entropy at the point 2s (s1=s2s), and the vaporization and liquefaction entropies the quality of the operating point it is calculated. Once the quality has been obtained, the enthalpy of the isentropic operating point 2 (h2s) can be calculated.

2. With the isentropic efficiency of the compressor, and the values of the enthalpies of the points one, and the isentropic point two:

$$h_2 = h_1 + \frac{h_{2S} - h_1}{\eta\_iso}$$

After the compressor, the refrigerant goes through the first electronic expansion valve decreasing its pressure and temperature. There would be another expansion valve, so between both of them the pressure difference generated by the compressor must be equated. Modifying the pressure drop proportion in the first and second valve, the pressure desired in the operating point three can be achieve at the same time that the operating point one and two are properly defined.

In the condenser, the enthalpies difference required to force the operating point four to have the same enthalpy as in the operating point one, it is achieved.

Finally, the second expansion valve recovers the pressure at the starting operating point.

One important aspect of this point is the possible biphasic nature of the refrigerant at the exit of the compressor. This aspect would be specially conditioned by the quality at the entering of the compressor.

The main problem of this biphasic nature is the impossibility (or the unviability) to measure the refrigerant flux. The value of the refrigerant flux, as it would be explained later, will be necessary to obtain the heat exchange between the refrigerant and the water, and therefore the water flux.

1.1.2 OPERATING POINT ONE CALCULATIONS

As inputs, the quality and pressures of the compressor would be introduced.

With the stored data of the pressure and temperature of the first operating point, the thermodynamic tables can be employed to obtain the fusion and vaporization enthalpies to calculate the enthalpy at the operating point.

Temperature Sensor	**$T1_{EXP}$**
Pressure sensor	$P1_{EXP}$

$$h_1 = h_{f1} + x_1 \cdot (h_{g1} - h_{f1})$$

This enthalpy value, is the one to be achieved once that the cycle has been stabilized and Works according to the parameters fixed.

This value of enthalpy is also the one that, theoretically should be at the operating point four, since the expansion is considered an isenthalpic process.

1.1.3 CONTROL OF THE OPERATING POINT THREE AND FOUR

With the strangulation ratio of each expansion valve, the pressure of the operating points three and four can be fixed. With the expansion achieve by both valves, the pressure difference obtained by the compressor must be obtained. In other words, if the pressure difference caused by the compressor is 6 bars, then the sum of the pressure difference achieve by each expansion vale must also be 6 bars. However, the pressure drop ratio in each valve is not defined.

The drop pressure ratio can be used to fix the pressure of the operating points three and four. These operating points would have the same enthalpy values as the operating points two and one respectively speaking (due to the isenthalpic nature of the expansion process).

The values of pressure and temperature must be empirically checked so they reach the adequate values, to obtain the calculated enthalpies. Furthermore, thanks to the previous expansion of the condensation and the behavior of the refrigerant, there is a possibility to make the operating point three be in the overheated steam zone.

Temperature Sensor	**$T3_{EXP}$, $T4_{EXP}$**
Pressure sensor	$P3_{EXP}$, $P4_{EXP}$

1.1.4 CONDENSER

Once that the operating points three and four have been fixed, with its enthalpy difference the necessary heat that must be exchanged (to reach the point 4) is calculated.

1. The difference of enthalpies that must be achieve by the cooling effect of the condenser in the refrigerant is known.

$$\Delta h = h3 - h4$$

2. This cooling effect will be conditioned by the water input temperature (Tw_{IN}) and by its flux. Studying the formulas, the heat exchanged between the refrigerant and the condenser water is:

$$\dot{Q} = \dot{m}_{R134a} \cdot (h_3 - h_2)$$
$$\dot{Q} = -\dot{m}_W \cdot Cp \cdot (T_{OUT\_W} - T_{IN\_W})$$

To control the heat exchanged needed between the refrigerant and the water, two magnitudes can be used (according to the equations studied): The water input temperature of the condenser and the water flux.

Temperature Sensor	**Tw_{IN}, Tw_{OUT}**
Flux sensor	m_W

As the thermodynamic magnitudes have an important thermal inertia, to control the heat exchanged it is better to modify the water flux instead its input temperature, because it would occasioned a faster response. For being able to change the water flux, a variable speed pump would have to be chosen.

1.1.5 SECOND EXPANSION AND FINAL PROCESS

It has been achieved to obtain the same enthalpy value at the operating point four as the value in the first operating point. Therefore, to complete the cycle there is only one more process needed, an expansion to return to the first pressure value.

1.1.6 ADVANTAGES AND DISADVANTAGES

Developing this cycle, the pressures at the exit of the compressor and condenser are completely fixed and stabilized.

Other important aspect, is that with the first expansion process, the refrigerant could be displaced to the overheated steam zone so the measure of its flux refrigerant can be done. However it is not guarantee and could be useful to employ a heating resistance, as it was employed in the chosen cycle.

2 MODIFICATION

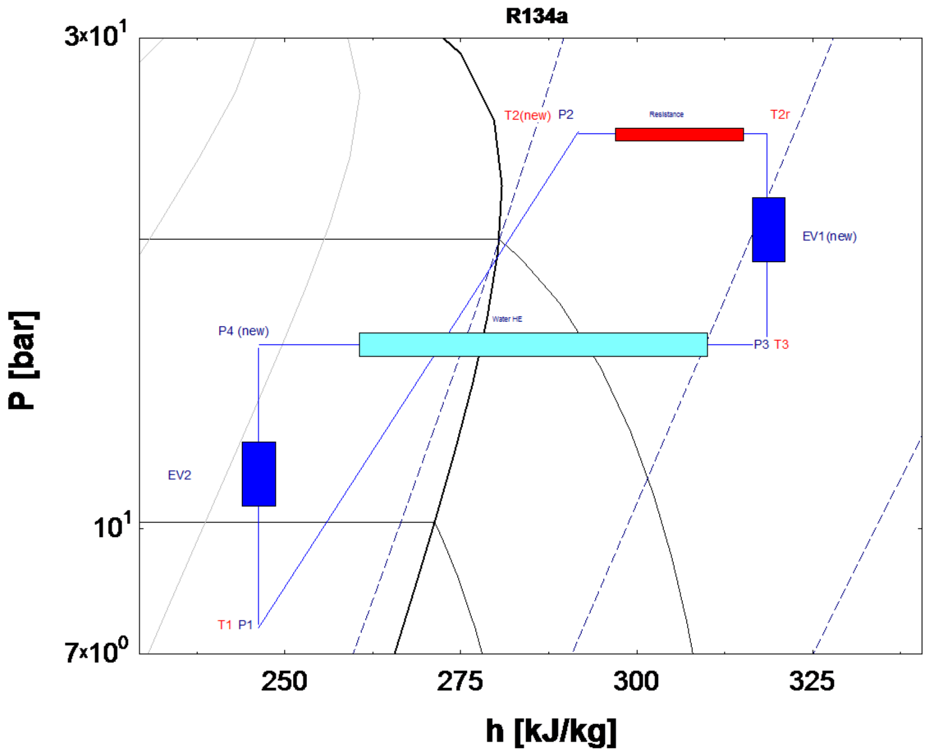


Figure 19-Thermodynamic components cycle

Base on “Saunier & Duval cycle” it is added a heating resistance at the compressor outlet, so the refrigerant flux can be measured without any problems.

This would be a better option to be implemented, an in fact, is the one that would be developed during the followings months.

3 CALCULATIONS

3.1 “EES” CODE

```
"Functions"

"Enthalpy 2"

Function f_h2 (rend_iso; h1; h2s)
h2=h1+((h2s-h1)/rend_iso)
f_h2=h2
end

"Refrigerant flux"

function f_m_ref(rho_ref ; rend_vol ; rps ; displ)
m_ref=(rho_ref*displ*rps*rend_vol)/(1000000)
f_m_ref=m_ref
end

"Water flux"

function f_m_w(Q; Cp ;delta_T)
m_w=(Q/( Cp *delta_T))
f_m_w=m_w
end

"Compressor data"

displ=7  "cc"                    " Displacement of the compressor"
rpm=3000                         " Revolutions per minute of the compressor"

rps=rpm/60                       " Rev. per second"
rend_vol=0,9                     " Assumption of constant volumetric efficiency"
```

```
rend_iso=0,5                                  " Assumption of constant isentropic efficiency"

"Water circuit data"

Cp=Cp(Water;T=Tout;P=P_atm)    "kJ/kg-K"      " Cp of the water at a given temperature, Tout"
Tin=15  "ºC"                                  " Input temperature of the water at the entering of the condenser"
Tout=25    "ºC"                               " Outout temperature of the water, at the exit of the condenser, after the heat exchange had taken place"

delta_T=(Tout-Tin)   "K"

P_atm=101,3              "kPa"

"REFRIGERANT"

R$='R134a'                                    "Refrigerant"

"INPUTS"

{T[1]=5   "ºC"                                " Temperature at the charging point of the

compressor"
x1=0,8                                        " Quality of the refrigerant at the entering of the

compressor"

T[2]= 70   "ºC"}
p=0,5
T[3]= p*(T[2]-T[1])+T[1]                      " Temperature at the discharge point of the compressor"

P1sat=pressure(R$;T=T[1]; x=1)
P2sat=pressure(R$;T=T[2];x=1)
P3=pressure(R$;T=T[3]; x=1)

"*****POINT 1******"

h1=ENTHALPY(R$; P=P1sat; x=x1)
s1=ENTROPY(R$;P=P1sat ;x=x1)
```

"****POINT 2 ISENTROPIC*****"

s2s=s1
h2s=enthalpy(R$;P=P2sat;s=s2s)

"*****POINT 2***** DISCHARGE OF THE COMPRESSOR"

h2=f_h2 (rend_iso; h1; h2s)
T2_real=temperature(R$;h=h2;P=P2sat)

"****POINT 2**** AFTER RESISTENCE"

T2_resist=T[2]+3
h2_resist=enthalpy(R$;T=T2_resist;P=P2sat)

"*****PUNTO 3*****AFTER THE EEV "

h3= h2_resist

{P3comp=pressure(R$;T=T[3];h=h3)}

"*****POINT 4****** AFTER THE CONDENSER"

h4=h1
T[4]=T[3]

"*******HEAT EXCHANGE*****"

delta_enthalpy=h3-h4 "Difference of enthalpies that must be obtained with the condenser, in order to return to the enthalpy state in POINT 1"

rho_ref=density(R$; h=h1; P=P1sat) "Density at the entering of the compressor, to calculate the flux"

rho_ref_after_resistence=density(R$; h=h3; P=P2sat)"Density of the refrigerant gas, after the heating resistance, to dimensionate the refrigerant flux sensor"

m_ref=f_m_ref(rho_ref ; rend_vol ; rps ; displ) "Call the function 'refrigerant flux' "

Q=m_ref * delta_enthalpy "kW" "Heat exchange in the condenser"

m_w=f_m_w(Q; Cp ;delta_T) "Water flux needed to exchange the calculated heat"

rho_water=Density(Water;T=Tin;P=P_atm) "kg/m3" "Density of the water at a given , Tin, Temperature"

flow_w_lit_min=m_w/rho_water*60000 "Water flux in liters per minute"
{flow_w_lit_h=flow_w_lit_min*60 "Water flux in liters per hour""}

"****CALOR RESISTENCIA****"

delta_h_res=h3-h2 "Difference of enthalpies that must be obtained with the heating resistance"

Qres=delta_h_res*m_ref " Heat flux that must be exchange within the resistance and the refrigerant flux, to fully evaporate the refrigerant"

3.2 REFRIGERANT R134 A--> 5000 rpm, 11 cc/rev

Table 35-R134 A- 5000rpm, 11.4 cc/rev- improvement

T1	T2	T3	T4	X1	mref	flow_l_min	P1	P2	Q	Qres	h1	h2	h3	h4
5,00	30,00	17,50	17,50	0,75	0,02	1,82	349,90	770,64	1,27	0,80	204,66	228,59	269,83	204,66
8,33	34,44	21,39	21,39	0,75	0,02	2,00	392,28	873,87	1,39	0,87	207,69	232,05	272,04	207,69
11,67	38,89	25,28	25,28	0,76	0,02	2,19	438,48	987,17	1,53	0,93	210,71	235,43	274,15	210,71
15,00	43,33	29,17	29,17	0,76	0,03	2,39	488,70	1111,16	1,67	1,00	213,69	238,73	276,16	213,69
18,33	47,78	33,06	33,06	0,76	0,03	2,60	543,17	1246,48	1,81	1,07	216,63	241,95	278,06	216,63
21,67	52,22	36,94	36,94	0,76	0,03	2,82	602,12	1393,83	1,96	1,13	219,55	245,10	279,82	219,55
25,00	56,67	40,83	40,83	0,77	0,04	3,04	665,78	1553,90	2,12	1,19	222,43	248,17	281,43	222,43
28,33	61,11	44,72	44,72	0,77	0,04	3,26	734,40	1727,45	2,27	1,25	225,26	251,15	282,87	225,26
31,67	65,56	48,61	48,61	0,77	0,04	3,49	808,21	1915,28	2,43	1,30	228,06	254,04	284,11	228,06
35,00	70,00	52,50	52,50	0,77	0,05	3,71	887,47	2118,24	2,58	1,34	230,81	256,84	285,12	230,81
5,00	30,00	17,50	17,50	0,78	0,02	1,63	349,90	770,64	1,13	0,67	209,57	234,40	269,83	209,57
8,33	34,44	21,39	21,39	0,78	0,02	1,79	392,28	873,87	1,25	0,72	212,55	237,80	272,04	212,55
11,67	38,89	25,28	25,28	0,78	0,02	1,96	438,48	987,17	1,37	0,77	215,49	241,12	274,15	215,49
15,00	43,33	29,17	29,17	0,78	0,03	2,14	488,70	1111,16	1,49	0,82	218,40	244,37	276,16	218,40
18,33	47,78	33,06	33,06	0,79	0,03	2,33	543,17	1246,48	1,62	0,87	221,27	247,53	278,06	221,27
21,67	52,22	36,94	36,94	0,79	0,03	2,52	602,12	1393,83	1,76	0,92	224,11	250,61	279,82	224,11
25,00	56,67	40,83	40,83	0,79	0,03	2,72	665,78	1553,90	1,90	0,97	226,92	253,61	281,43	226,92

28,33	61,11	44,72	44,72	0,79	0,04	2,92	734,40	1727,45	2,04	1,01	229,68	256,52	282,87	229,68
31,67	65,56	48,61	48,61	0,80	0,04	3,12	808,21	1915,28	2,17	1,04	232,39	259,33	284,11	232,39
35,00	70,00	52,50	52,50	0,80	0,05	3,31	887,47	2118,24	2,31	1,06	235,06	262,05	285,12	235,06
5,00	30,00	17,50	17,50	0,80	0,02	1,45	349,90	770,64	1,01	0,54	214,49	240,20	269,83	214,49
8,33	34,44	21,39	21,39	0,80	0,02	1,59	392,28	873,87	1,11	0,58	217,40	243,55	272,04	217,40
11,67	38,89	25,28	25,28	0,81	0,02	1,75	438,48	987,17	1,22	0,62	220,27	246,82	274,15	220,27
15,00	43,33	29,17	29,17	0,81	0,03	1,91	488,70	1111,16	1,33	0,66	223,11	250,00	276,16	223,11
18,33	47,78	33,06	33,06	0,81	0,03	2,07	543,17	1246,48	1,44	0,69	225,91	253,11	278,06	225,91
21,67	52,22	36,94	36,94	0,81	0,03	2,25	602,12	1393,83	1,56	0,73	228,68	256,12	279,82	228,68
25,00	56,67	40,83	40,83	0,82	0,03	2,42	665,78	1553,90	1,69	0,75	231,40	259,05	281,43	231,40
28,33	61,11	44,72	44,72	0,82	0,04	2,60	734,40	1727,45	1,81	0,78	234,09	261,89	282,87	234,09
31,67	65,56	48,61	48,61	0,82	0,04	2,78	808,21	1915,28	1,93	0,80	236,72	264,62	284,11	236,72
35,00	70,00	52,50	52,50	0,82	0,04	2,94	887,47	2118,24	2,05	0,80	239,30	267,26	285,12	239,30
5,00	30,00	17,50	17,50	0,83	0,02	1,28	349,90	770,64	0,89	0,42	219,41	246,00	269,83	219,41
8,33	34,44	21,39	21,39	0,83	0,02	1,41	392,28	873,87	0,98	0,45	222,25	249,30	272,04	222,25
11,67	38,89	25,28	25,28	0,83	0,02	1,54	438,48	987,17	1,08	0,47	225,05	252,51	274,15	225,05
15,00	43,33	29,17	29,17	0,83	0,02	1,69	488,70	1111,16	1,17	0,50	227,82	255,64	276,16	227,82
18,33	47,78	33,06	33,06	0,84	0,03	1,83	543,17	1246,48	1,28	0,52	230,55	258,68	278,06	230,55
21,67	52,22	36,94	36,94	0,84	0,03	1,99	602,12	1393,83	1,38	0,54	233,25	261,64	279,82	233,25
25,00	56,67	40,83	40,83	0,84	0,03	2,14	665,78	1553,90	1,49	0,55	235,89	264,49	281,43	235,89
28,33	61,11	44,72	44,72	0,84	0,04	2,30	734,40	1727,45	1,60	0,56	238,50	267,26	282,87	238,50
31,67	65,56	48,61	48,61	0,85	0,04	2,45	808,21	1915,28	1,71	0,56	241,05	269,92	284,11	241,05
35,00	70,00	52,50	52,50	0,85	0,04	2,60	887,47	2118,24	1,81	0,55	243,55	272,47	285,12	243,55

5,00	30,00	17,50	17,50	0,85	0,02	1,12	349,90	770,64	0,78	0,31	224,33	251,80	269,83	224,33
8,33	34,44	21,39	21,39	0,85	0,02	1,24	392,28	873,87	0,86	0,33	227,10	255,05	272,04	227,10
11,67	38,89	25,28	25,28	0,86	0,02	1,35	438,48	987,17	0,94	0,34	229,83	258,21	274,15	229,83
15,00	43,33	29,17	29,17	0,86	0,02	1,48	488,70	1111,16	1,03	0,35	232,53	261,28	276,16	232,53
18,33	47,78	33,06	33,06	0,86	0,03	1,61	543,17	1246,48	1,12	0,36	235,19	264,26	278,06	235,19
21,67	52,22	36,94	36,94	0,86	0,03	1,74	602,12	1393,83	1,21	0,37	237,81	267,15	279,82	237,81
25,00	56,67	40,83	40,83	0,87	0,03	1,88	665,78	1553,90	1,31	0,37	240,38	269,94	281,43	240,38
28,33	61,11	44,72	44,72	0,87	0,04	2,01	734,40	1727,45	1,40	0,36	242,91	272,63	282,87	242,91
31,67	65,56	48,61	48,61	0,87	0,04	2,14	808,21	1915,28	1,49	0,34	245,38	275,21	284,11	245,38
35,00	70,00	52,50	52,50	0,87	0,04	2,27	887,47	2118,24	1,58	0,31	247,80	277,68	285,12	247,80
5,00	30,00	17,50	17,50	0,88	0,02	0,97	349,90	770,64	0,68	0,20	229,24	257,60	269,83	229,24
8,33	34,44	21,39	21,39	0,88	0,02	1,07	392,28	873,87	0,75	0,21	231,95	260,80	272,04	231,95
11,67	38,89	25,28	25,28	0,88	0,02	1,17	438,48	987,17	0,82	0,21	234,61	263,91	274,15	234,61
15,00	43,33	29,17	29,17	0,88	0,02	1,28	488,70	1111,16	0,89	0,21	237,24	266,92	276,16	237,24
18,33	47,78	33,06	33,06	0,89	0,03	1,39	543,17	1246,48	0,97	0,21	239,83	269,84	278,06	239,83
21,67	52,22	36,94	36,94	0,89	0,03	1,51	602,12	1393,83	1,05	0,20	242,38	272,66	279,82	242,38
25,00	56,67	40,83	40,83	0,89	0,03	1,62	665,78	1553,90	1,13	0,19	244,87	275,38	281,43	244,87
28,33	61,11	44,72	44,72	0,89	0,03	1,74	734,40	1727,45	1,21	0,17	247,32	278,00	282,87	247,32
31,67	65,56	48,61	48,61	0,90	0,04	1,85	808,21	1915,28	1,29	0,14	249,71	280,50	284,11	249,71
35,00	70,00	52,50	52,50	0,90	0,04	1,95	887,47	2118,24	1,36	0,09	252,04	282,89	285,12	252,04
5,00	30,00	17,50	17,50	0,90	0,02	0,83	349,90	770,64	0,58	0,10	234,16	263,40	269,83	234,16
8,33	34,44	21,39	21,39	0,90	0,02	0,92	392,28	873,87	0,64	0,10	236,80	266,55	272,04	236,80
11,67	38,89	25,28	25,28	0,91	0,02	1,00	438,48	987,17	0,70	0,09	239,40	269,60	274,15	239,40

15,00	43,33	29,17	29,17	0,91	0,02	1,10	488,70	1111,16	0,76	0,08	241,96	272,56	276,16	241,96
18,33	47,78	33,06	33,06	0,91	0,02	1,19	543,17	1246,48	0,83	0,07	244,47	275,42	278,06	244,47
21,67	52,22	36,94	36,94	0,91	0,03	1,29	602,12	1393,83	0,90	0,05	246,94	278,17	279,82	246,94
25,00	56,67	40,83	40,83	0,92	0,03	1,39	665,78	1553,90	0,97	0,02	249,36	280,82	281,43	249,36
28,33	61,11	44,72	44,72	0,92	0,03	1,48	734,40	1727,45	1,03	-0,02	251,73	283,37	282,87	251,73
31,67	65,56	48,61	48,61	0,92	0,04	1,58	808,21	1915,28	1,10	-0,06	254,04	285,80	284,11	254,04
35,00	70,00	52,50	52,50	0,92	0,04	1,66	887,47	2118,24	1,16	-0,12	256,29	288,11	285,12	256,29
5,00	30,00	17,50	17,50	0,93	0,02	0,70	349,90	770,64	0,49	0,01	239,08	269,20	269,83	239,08
8,33	34,44	21,39	21,39	0,93	0,02	0,77	392,28	873,87	0,54	0,00	241,65	272,30	272,04	241,65
11,67	38,89	25,28	25,28	0,93	0,02	0,84	438,48	987,17	0,59	-0,02	244,18	275,30	274,15	244,18
15,00	43,33	29,17	29,17	0,93	0,02	0,92	488,70	1111,16	0,64	-0,04	246,67	278,20	276,16	246,67
18,33	47,78	33,06	33,06	0,94	0,02	1,00	543,17	1246,48	0,70	-0,07	249,11	280,99	278,06	249,11
21,67	52,22	36,94	36,94	0,94	0,03	1,08	602,12	1393,83	0,75	-0,10	251,51	283,68	279,82	251,51
25,00	56,67	40,83	40,83	0,94	0,03	1,16	665,78	1553,90	0,81	-0,14	253,85	286,27	281,43	253,85
28,33	61,11	44,72	44,72	0,94	0,03	1,24	734,40	1727,45	0,86	-0,19	256,14	288,74	282,87	256,14
31,67	65,56	48,61	48,61	0,95	0,04	1,31	808,21	1915,28	0,92	-0,25	258,37	291,09	284,11	258,37
35,00	70,00	52,50	52,50	0,95	0,04	1,38	887,47	2118,24	0,96	-0,32	260,54	293,32	285,12	260,54
5,00	30,00	17,50	17,50	0,95	0,02	0,57	349,90	770,64	0,40	-0,08	244,00	275,01	269,83	244,00
8,33	34,44	21,39	21,39	0,95	0,02	0,63	392,28	873,87	0,44	-0,10	246,50	278,05	272,04	246,50
11,67	38,89	25,28	25,28	0,96	0,02	0,69	438,48	987,17	0,48	-0,13	248,96	280,99	274,15	248,96
15,00	43,33	29,17	29,17	0,96	0,02	0,75	488,70	1111,16	0,52	-0,16	251,38	283,83	276,16	251,38
18,33	47,78	33,06	33,06	0,96	0,02	0,82	543,17	1246,48	0,57	-0,20	253,75	286,57	278,06	253,75
21,67	52,22	36,94	36,94	0,96	0,03	0,88	602,12	1393,83	0,62	-0,24	256,07	289,20	279,82	256,07

25,00	56,67	40,83	40,83	0,97	0,03	0,95	665,78	1553,90	0,66	-0,29	258,34	291,71	281,43	258,34
28,33	61,11	44,72	44,72	0,97	0,03	1,01	734,40	1727,45	0,70	-0,35	260,55	294,11	282,87	260,55
31,67	65,56	48,61	48,61	0,97	0,03	1,07	808,21	1915,28	0,74	-0,43	262,70	296,38	284,11	262,70
35,00	70,00	52,50	52,50	0,97	0,04	1,11	887,47	2118,24	0,77	-0,51	264,78	298,53	285,12	264,78
5,00	30,00	17,50	17,50	0,98	0,01	0,45	349,90	770,64	0,31	-0,16	248,91	280,81	269,83	248,91
8,33	34,44	21,39	21,39	0,98	0,02	0,50	392,28	873,87	0,35	-0,20	251,35	283,80	272,04	251,35
11,67	38,89	25,28	25,28	0,98	0,02	0,54	438,48	987,17	0,38	-0,23	253,74	286,69	274,15	253,74
15,00	43,33	29,17	29,17	0,98	0,02	0,59	488,70	1111,16	0,41	-0,27	256,09	289,47	276,16	256,09
18,33	47,78	33,06	33,06	0,99	0,02	0,65	543,17	1246,48	0,45	-0,32	258,39	292,15	278,06	258,39
21,67	52,22	36,94	36,94	0,99	0,03	0,70	602,12	1393,83	0,48	-0,38	260,64	294,71	279,82	260,64
25,00	56,67	40,83	40,83	0,99	0,03	0,74	665,78	1553,90	0,52	-0,44	262,83	297,17	281,43	262,83
28,33	61,11	44,72	44,72	0,99	0,03	0,79	734,40	1727,45	0,55	-0,51	264,96	299,50	282,87	264,96
31,67	65,56	48,61	48,61	1,00	0,03	0,83	808,21	1915,28	0,58	-0,60	267,03	301,72	284,11	267,03
35,00	70,00	52,50	52,50	1,00	0,04	0,86	887,47	2118,24	0,60	-0,69	269,03	303,81	285,12	269,03

3.2.1 Summary R134 A--- 5000 rpm, 11.4 cc/rev

Table 36-Summary R134 A-5000rpm, 11.4 cc/rev- improvement

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	P3	Q (kW)	Qres (kW)	h1	h2	h3	h4
min	14,99	0,45	349,90	770,64	560,271414	0,31	-0,69	204,66	228,59	269,83	204,66
max	47,55	3,71	887,47	2118,24	1502,85679	2,58	1,34	269,03	303,81	285,12	269,03
X1_para minimo	0,98	0,98	0,75	0,75	0,75	0,98	1,00	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,77	0,77	1,00	1,00	0,77	1,00

3.3 REFRIGERANT R 134A --> 3000rpm, 7 cc/rev

Table 37-R134 A- 3000rpm, 7 cc/rev- improvement

T1	T2	T3	T4	X1	mref	flow_l_min	P1	P2	Q	Qres	h1	h2	h3	h4
5,00	30,00	17,50	17,50	0,75	0,01	0,67	349,90	770,64	0,47	0,30	204,66	228,59	269,83	204,66
8,33	34,44	21,39	21,39	0,75	0,01	0,74	392,28	873,87	0,51	0,32	207,69	232,05	272,04	207,69
11,67	38,89	25,28	25,28	0,76	0,01	0,81	438,48	987,17	0,56	0,34	210,71	235,43	274,15	210,71
15,00	43,33	29,17	29,17	0,76	0,01	0,88	488,70	1111,16	0,61	0,37	213,69	238,73	276,16	213,69
18,33	47,78	33,06	33,06	0,76	0,01	0,96	543,17	1246,48	0,67	0,39	216,63	241,95	278,06	216,63
21,67	52,22	36,94	36,94	0,76	0,01	1,04	602,12	1393,83	0,72	0,42	219,55	245,10	279,82	219,55
25,00	56,67	40,83	40,83	0,77	0,01	1,12	665,78	1553,90	0,78	0,44	222,43	248,17	281,43	222,43
28,33	61,11	44,72	44,72	0,77	0,01	1,20	734,40	1727,45	0,84	0,46	225,26	251,15	282,87	225,26
31,67	65,56	48,61	48,61	0,77	0,02	1,29	808,21	1915,28	0,90	0,48	228,06	254,04	284,11	228,06
35,00	70,00	52,50	52,50	0,77	0,02	1,37	887,47	2118,24	0,95	0,50	230,81	256,84	285,12	230,81
5,00	30,00	17,50	17,50	0,78	0,01	0,60	349,90	770,64	0,42	0,25	209,57	234,40	269,83	209,57
8,33	34,44	21,39	21,39	0,78	0,01	0,66	392,28	873,87	0,46	0,26	212,55	237,80	272,04	212,55
11,67	38,89	25,28	25,28	0,78	0,01	0,72	438,48	987,17	0,50	0,28	215,49	241,12	274,15	215,49
15,00	43,33	29,17	29,17	0,78	0,01	0,79	488,70	1111,16	0,55	0,30	218,40	244,37	276,16	218,40
18,33	47,78	33,06	33,06	0,79	0,01	0,86	543,17	1246,48	0,60	0,32	221,27	247,53	278,06	221,27
21,67	52,22	36,94	36,94	0,79	0,01	0,93	602,12	1393,83	0,65	0,34	224,11	250,61	279,82	224,11

25,00	56,67	40,83	40,83	0,79	0,01	1,00	665,78	1553,90	0,70	0,36	226,92	253,61	281,43	226,92
28,33	61,11	44,72	44,72	0,79	0,01	1,08	734,40	1727,45	0,75	0,37	229,68	256,52	282,87	229,68
31,67	65,56	48,61	48,61	0,80	0,02	1,15	808,21	1915,28	0,80	0,38	232,39	259,33	284,11	232,39
35,00	70,00	52,50	52,50	0,80	0,02	1,22	887,47	2118,24	0,85	0,39	235,06	262,05	285,12	235,06
5,00	30,00	17,50	17,50	0,80	0,01	0,53	349,90	770,64	0,37	0,20	214,49	240,20	269,83	214,49
8,33	34,44	21,39	21,39	0,80	0,01	0,59	392,28	873,87	0,41	0,21	217,40	243,55	272,04	217,40
11,67	38,89	25,28	25,28	0,81	0,01	0,64	438,48	987,17	0,45	0,23	220,27	246,82	274,15	220,27
15,00	43,33	29,17	29,17	0,81	0,01	0,70	488,70	1111,16	0,49	0,24	223,11	250,00	276,16	223,11
18,33	47,78	33,06	33,06	0,81	0,01	0,76	543,17	1246,48	0,53	0,25	225,91	253,11	278,06	225,91
21,67	52,22	36,94	36,94	0,81	0,01	0,83	602,12	1393,83	0,58	0,27	228,68	256,12	279,82	228,68
25,00	56,67	40,83	40,83	0,82	0,01	0,89	665,78	1553,90	0,62	0,28	231,40	259,05	281,43	231,40
28,33	61,11	44,72	44,72	0,82	0,01	0,96	734,40	1727,45	0,67	0,29	234,09	261,89	282,87	234,09
31,67	65,56	48,61	48,61	0,82	0,02	1,02	808,21	1915,28	0,71	0,29	236,72	264,62	284,11	236,72
35,00	70,00	52,50	52,50	0,82	0,02	1,08	887,47	2118,24	0,76	0,29	239,30	267,26	285,12	239,30
5,00	30,00	17,50	17,50	0,83	0,01	0,47	349,90	770,64	0,33	0,16	219,41	246,00	269,83	219,41
8,33	34,44	21,39	21,39	0,83	0,01	0,52	392,28	873,87	0,36	0,17	222,25	249,30	272,04	222,25
11,67	38,89	25,28	25,28	0,83	0,01	0,57	438,48	987,17	0,40	0,17	225,05	252,51	274,15	225,05
15,00	43,33	29,17	29,17	0,83	0,01	0,62	488,70	1111,16	0,43	0,18	227,82	255,64	276,16	227,82
18,33	47,78	33,06	33,06	0,84	0,01	0,68	543,17	1246,48	0,47	0,19	230,55	258,68	278,06	230,55
21,67	52,22	36,94	36,94	0,84	0,01	0,73	602,12	1393,83	0,51	0,20	233,25	261,64	279,82	233,25
25,00	56,67	40,83	40,83	0,84	0,01	0,79	665,78	1553,90	0,55	0,20	235,89	264,49	281,43	235,89
28,33	61,11	44,72	44,72	0,84	0,01	0,85	734,40	1727,45	0,59	0,21	238,50	267,26	282,87	238,50
31,67	65,56	48,61	48,61	0,85	0,01	0,90	808,21	1915,28	0,63	0,21	241,05	269,92	284,11	241,05

35,00	70,00	52,50	52,50	0,85	0,02	0,96	887,47	2118,24	0,67	0,20	243,55	272,47	285,12	243,55
5,00	30,00	17,50	17,50	0,85	0,01	0,41	349,90	770,64	0,29	0,11	224,33	251,80	269,83	224,33
8,33	34,44	21,39	21,39	0,85	0,01	0,46	392,28	873,87	0,32	0,12	227,10	255,05	272,04	227,10
11,67	38,89	25,28	25,28	0,86	0,01	0,50	438,48	987,17	0,35	0,13	229,83	258,21	274,15	229,83
15,00	43,33	29,17	29,17	0,86	0,01	0,54	488,70	1111,16	0,38	0,13	232,53	261,28	276,16	232,53
18,33	47,78	33,06	33,06	0,86	0,01	0,59	543,17	1246,48	0,41	0,13	235,19	264,26	278,06	235,19
21,67	52,22	36,94	36,94	0,86	0,01	0,64	602,12	1393,83	0,45	0,13	237,81	267,15	279,82	237,81
25,00	56,67	40,83	40,83	0,87	0,01	0,69	665,78	1553,90	0,48	0,13	240,38	269,94	281,43	240,38
28,33	61,11	44,72	44,72	0,87	0,01	0,74	734,40	1727,45	0,52	0,13	242,91	272,63	282,87	242,91
31,67	65,56	48,61	48,61	0,87	0,01	0,79	808,21	1915,28	0,55	0,13	245,38	275,21	284,11	245,38
35,00	70,00	52,50	52,50	0,87	0,02	0,83	887,47	2118,24	0,58	0,12	247,80	277,68	285,12	247,80
5,00	30,00	17,50	17,50	0,88	0,01	0,36	349,90	770,64	0,25	0,08	229,24	257,60	269,83	229,24
8,33	34,44	21,39	21,39	0,88	0,01	0,39	392,28	873,87	0,27	0,08	231,95	260,80	272,04	231,95
11,67	38,89	25,28	25,28	0,88	0,01	0,43	438,48	987,17	0,30	0,08	234,61	263,91	274,15	234,61
15,00	43,33	29,17	29,17	0,88	0,01	0,47	488,70	1111,16	0,33	0,08	237,24	266,92	276,16	237,24
18,33	47,78	33,06	33,06	0,89	0,01	0,51	543,17	1246,48	0,36	0,08	239,83	269,84	278,06	239,83
21,67	52,22	36,94	36,94	0,89	0,01	0,56	602,12	1393,83	0,39	0,07	242,38	272,66	279,82	242,38
25,00	56,67	40,83	40,83	0,89	0,01	0,60	665,78	1553,90	0,42	0,07	244,87	275,38	281,43	244,87
28,33	61,11	44,72	44,72	0,89	0,01	0,64	734,40	1727,45	0,45	0,06	247,32	278,00	282,87	247,32
31,67	65,56	48,61	48,61	0,90	0,01	0,68	808,21	1915,28	0,47	0,05	249,71	280,50	284,11	249,71
35,00	70,00	52,50	52,50	0,90	0,02	0,72	887,47	2118,24	0,50	0,03	252,04	282,89	285,12	252,04
5,00	30,00	17,50	17,50	0,90	0,01	0,31	349,90	770,64	0,21	0,04	234,16	263,40	269,83	234,16
8,33	34,44	21,39	21,39	0,90	0,01	0,34	392,28	873,87	0,23	0,04	236,80	266,55	272,04	236,80

11,67	38,89	25,28	25,28	0,91	0,01	0,37	438,48	987,17	0,26	0,03	239,40	269,60	274,15	239,40
15,00	43,33	29,17	29,17	0,91	0,01	0,40	488,70	1111,16	0,28	0,03	241,96	272,56	276,16	241,96
18,33	47,78	33,06	33,06	0,91	0,01	0,44	543,17	1246,48	0,31	0,02	244,47	275,42	278,06	244,47
21,67	52,22	36,94	36,94	0,91	0,01	0,47	602,12	1393,83	0,33	0,02	246,94	278,17	279,82	246,94
25,00	56,67	40,83	40,83	0,92	0,01	0,51	665,78	1553,90	0,36	0,01	249,36	280,82	281,43	249,36
28,33	61,11	44,72	44,72	0,92	0,01	0,55	734,40	1727,45	0,38	-0,01	251,73	283,37	282,87	251,73
31,67	65,56	48,61	48,61	0,92	0,01	0,58	808,21	1915,28	0,40	-0,02	254,04	285,80	284,11	254,04
35,00	70,00	52,50	52,50	0,92	0,01	0,61	887,47	2118,24	0,43	-0,04	256,29	288,11	285,12	256,29
5,00	30,00	17,50	17,50	0,93	0,01	0,26	349,90	770,64	0,18	0,00	239,08	269,20	269,83	239,08
8,33	34,44	21,39	21,39	0,93	0,01	0,28	392,28	873,87	0,20	0,00	241,65	272,30	272,04	241,65
11,67	38,89	25,28	25,28	0,93	0,01	0,31	438,48	987,17	0,22	-0,01	244,18	275,30	274,15	244,18
15,00	43,33	29,17	29,17	0,93	0,01	0,34	488,70	1111,16	0,24	-0,02	246,67	278,20	276,16	246,67
18,33	47,78	33,06	33,06	0,94	0,01	0,37	543,17	1246,48	0,26	-0,03	249,11	280,99	278,06	249,11
21,67	52,22	36,94	36,94	0,94	0,01	0,40	602,12	1393,83	0,28	-0,04	251,51	283,68	279,82	251,51
25,00	56,67	40,83	40,83	0,94	0,01	0,43	665,78	1553,90	0,30	-0,05	253,85	286,27	281,43	253,85
28,33	61,11	44,72	44,72	0,94	0,01	0,46	734,40	1727,45	0,32	-0,07	256,14	288,74	282,87	256,14
31,67	65,56	48,61	48,61	0,95	0,01	0,48	808,21	1915,28	0,34	-0,09	258,37	291,09	284,11	258,37
35,00	70,00	52,50	52,50	0,95	0,01	0,51	887,47	2118,24	0,35	-0,12	260,54	293,32	285,12	260,54
5,00	30,00	17,50	17,50	0,00	0,40	122,08	349,90	770,64	85,04	84,77	58,61	59,27	269,83	58,61
8,33	34,44	21,39	21,39	0,95	0,01	0,23	392,28	873,87	0,16	-0,04	246,50	278,05	272,04	246,50
11,67	38,89	25,28	25,28	0,96	0,01	0,25	438,48	987,17	0,18	-0,05	248,96	280,99	274,15	248,96
15,00	43,33	29,17	29,17	0,96	0,01	0,28	488,70	1111,16	0,19	-0,06	251,38	283,83	276,16	251,38
18,33	47,78	33,06	33,06	0,96	0,01	0,30	543,17	1246,48	0,21	-0,07	253,75	286,57	278,06	253,75

21,67	52,22	36,94	36,94	0,96	0,01	0,33	602,12	1393,83	0,23	-0,09	256,07	289,20	279,82	256,07
25,00	56,67	40,83	40,83	0,97	0,01	0,35	665,78	1553,90	0,24	-0,11	258,34	291,71	281,43	258,34
28,33	61,11	44,72	44,72	0,97	0,01	0,37	734,40	1727,45	0,26	-0,13	260,55	294,11	282,87	260,55
31,67	65,56	48,61	48,61	0,97	0,01	0,39	808,21	1915,28	0,27	-0,16	262,70	296,38	284,11	262,70
35,00	70,00	52,50	52,50	0,97	0,01	0,41	887,47	2118,24	0,29	-0,19	264,78	298,53	285,12	264,78
5,00	30,00	17,50	17,50	0,98	0,01	0,17	349,90	770,64	0,12	-0,06	248,91	280,81	269,83	248,91
8,33	34,44	21,39	21,39	0,98	0,01	0,18	392,28	873,87	0,13	-0,07	251,35	283,80	272,04	251,35
11,67	38,89	25,28	25,28	0,98	0,01	0,20	438,48	987,17	0,14	-0,09	253,74	286,69	274,15	253,74
15,00	43,33	29,17	29,17	0,98	0,01	0,22	488,70	1111,16	0,15	-0,10	256,09	289,47	276,16	256,09
18,33	47,78	33,06	33,06	0,99	0,01	0,24	543,17	1246,48	0,17	-0,12	258,39	292,15	278,06	258,39
21,67	52,22	36,94	36,94	0,99	0,01	0,26	602,12	1393,83	0,18	-0,14	260,64	294,71	279,82	260,64
25,00	56,67	40,83	40,83	0,99	0,01	0,27	665,78	1553,90	0,19	-0,16	262,83	297,17	281,43	262,83
28,33	61,11	44,72	44,72	0,99	0,01	0,29	734,40	1727,45	0,20	-0,19	264,96	299,50	282,87	264,96
31,67	65,56	48,61	48,61	1,00	0,01	0,31	808,21	1915,28	0,21	-0,22	267,03	301,72	284,11	267,03
35,00	70,00	52,50	52,50	1,00	0,01	0,32	887,47	2118,24	0,22	-0,26	269,03	303,81	285,12	269,03

3.3.1 Summary R 134 A--- 3000 rpm, 7 cc/rev

Table 38- Summary R134A- 3000rpm, 7 cc/rev - improvement

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	P3	Q (kW)	Qres (kW)	h1	h2	h3	h4
min	5,52	0,17	349,90	770,64	560,271414	0,12	-0,26	58,61	59,27	269,83	58,61
max	402,59	122,08	887,47	2118,24	1502,85679	85,04	84,77	269,03	303,81	285,12	269,03
X1_para minimo	0,98	0,98	0,75	0,75	0,75	0,98	1,00	0,00	0,00	0,75	0,00
X1_para maximo	0,00	0,00	0,77	0,77	0,77	0,00	0,00	1,00	1,00	0,77	1,00

3.4 REFRIGERANT R410 A --> 5000 rpm, 11.4 cc/rev

Table 39-R410 A-5000 rpm, 11.4 cc/rev- improvement

T1	T2	T3	T4	X1	mref	flow_l_min	P1	P2	Q	Qres	h1	h2	h3	h4
5,00	30,00	17,50	17,50	0,75	0,04	3,60	933,18	1883,41	2,51	1,40	369,01	396,38	430,96	369,01
8,33	34,44	21,39	21,39	0,75	0,04	3,82	1032,35	2108,78	2,66	1,42	371,47	399,22	431,06	371,47
11,67	38,89	25,28	25,28	0,76	0,05	4,04	1139,26	2354,04	2,81	1,43	373,85	401,91	430,84	373,85
15,00	43,33	29,17	29,17	0,76	0,05	4,22	1254,29	2620,47	2,94	1,40	376,15	404,46	430,26	376,15
18,33	47,78	33,06	33,06	0,76	0,06	4,37	1377,83	2909,51	3,05	1,34	378,36	406,85	429,26	378,36
21,67	52,22	36,94	36,94	0,76	0,07	4,47	1510,31	3222,74	3,11	1,23	380,48	409,08	427,74	380,48
25,00	56,67	40,83	40,83	0,77	0,07	4,47	1652,14	3562,00	3,12	1,05	382,49	411,13	425,60	382,49
28,33	61,11	44,72	44,72	0,77	0,08	4,36	1803,77	3929,48	3,04	0,77	384,38	413,00	422,66	384,38
31,67	65,56	48,61	48,61	0,77	0,09	4,08	1965,67	4327,98	2,84	0,35	386,14	414,66	418,71	386,14
35,00	70,00	52,50	52,50	0,77	0,10	3,54	2138,33	4761,73	2,46	-0,25	387,76	416,13	413,50	387,76
5,00	30,00	17,50	17,50	0,78	0,04	3,18	933,18	1883,41	2,22	1,10	374,45	402,79	430,96	374,45
8,33	34,44	21,39	21,39	0,78	0,04	3,37	1032,35	2108,78	2,35	1,11	376,79	405,53	431,06	376,79
11,67	38,89	25,28	25,28	0,78	0,05	3,55	1139,26	2354,04	2,48	1,09	379,06	408,12	430,84	379,06
15,00	43,33	29,17	29,17	0,78	0,05	3,71	1254,29	2620,47	2,58	1,04	381,24	410,55	430,26	381,24
18,33	47,78	33,06	33,06	0,79	0,06	3,83	1377,83	2909,51	2,67	0,95	383,33	412,83	429,26	383,33
21,67	52,22	36,94	36,94	0,79	0,06	3,89	1510,31	3222,74	2,71	0,82	385,32	414,93	427,74	385,32

25,00	56,67	40,83	40,83	0,79	0,07	3,87	1652,14	3562,00	2,69	0,61	387,20	416,85	425,60	387,20
28,33	61,11	44,72	44,72	0,79	0,08	3,73	1803,77	3929,48	2,60	0,32	388,95	418,57	422,66	388,95
31,67	65,56	48,61	48,61	0,80	0,08	3,42	1965,67	4327,98	2,38	-0,12	390,57	420,07	418,71	390,57
35,00	70,00	52,50	52,50	0,80	0,09	2,87	2138,33	4761,73	2,00	-0,74	392,03	421,41	413,50	392,03
5,00	30,00	17,50	17,50	0,80	0,04	2,79	933,18	1883,41	1,94	0,83	379,88	409,20	430,96	379,88
8,33	34,44	21,39	21,39	0,80	0,04	2,95	1032,35	2108,78	2,06	0,81	382,12	411,84	431,06	382,12
11,67	38,89	25,28	25,28	0,81	0,05	3,10	1139,26	2354,04	2,16	0,77	384,28	414,32	430,84	384,28
15,00	43,33	29,17	29,17	0,81	0,05	3,23	1254,29	2620,47	2,25	0,70	386,34	416,65	430,26	386,34
18,33	47,78	33,06	33,06	0,81	0,06	3,31	1377,83	2909,51	2,31	0,59	388,31	418,80	429,26	388,31
21,67	52,22	36,94	36,94	0,81	0,06	3,34	1510,31	3222,74	2,33	0,43	390,17	420,78	427,74	390,17
25,00	56,67	40,83	40,83	0,82	0,07	3,30	1652,14	3562,00	2,30	0,21	391,91	422,56	425,60	391,91
28,33	61,11	44,72	44,72	0,82	0,07	3,13	1803,77	3929,48	2,18	-0,11	393,53	424,13	422,66	393,53
31,67	65,56	48,61	48,61	0,82	0,08	2,80	1965,67	4327,98	1,95	-0,56	395,00	425,50	418,71	395,00
35,00	70,00	52,50	52,50	0,82	0,09	2,23	2138,33	4761,73	1,56	-1,20	396,31	426,71	413,50	396,31
5,00	30,00	17,50	17,50	0,83	0,04	2,42	933,18	1883,41	1,68	0,57	385,32	415,61	430,96	385,32
8,33	34,44	21,39	21,39	0,83	0,04	2,55	1032,35	2108,78	1,78	0,53	387,45	418,15	431,06	387,45
11,67	38,89	25,28	25,28	0,83	0,05	2,67	1139,26	2354,04	1,86	0,46	389,49	420,53	430,84	389,49
15,00	43,33	29,17	29,17	0,83	0,05	2,77	1254,29	2620,47	1,93	0,37	391,44	422,74	430,26	391,44
18,33	47,78	33,06	33,06	0,84	0,05	2,83	1377,83	2909,51	1,97	0,25	393,28	424,78	429,26	393,28
21,67	52,22	36,94	36,94	0,84	0,06	2,83	1510,31	3222,74	1,97	0,07	395,01	426,62	427,74	395,01
25,00	56,67	40,83	40,83	0,84	0,07	2,76	1652,14	3562,00	1,92	-0,18	396,63	428,27	425,60	396,63
28,33	61,11	44,72	44,72	0,84	0,07	2,57	1803,77	3929,48	1,79	-0,51	398,10	429,70	422,66	398,10
31,67	65,56	48,61	48,61	0,85	0,08	2,22	1965,67	4327,98	1,54	-0,98	399,43	430,95	418,71	399,43

35,00	70,00	52,50	52,50	0,85	0,09	1,63	2138,33	4761,73	1,14	-1,63	400,58	432,03	413,50	400,58
5,00	30,00	17,50	17,50	0,85	0,04	2,07	933,18	1883,41	1,44	0,32	390,75	422,02	430,96	390,75
8,33	34,44	21,39	21,39	0,85	0,04	2,18	1032,35	2108,78	1,52	0,26	392,77	424,46	431,06	392,77
11,67	38,89	25,28	25,28	0,86	0,04	2,27	1139,26	2354,04	1,58	0,18	394,70	426,74	430,84	394,70
15,00	43,33	29,17	29,17	0,86	0,05	2,34	1254,29	2620,47	1,63	0,07	396,53	428,84	430,26	396,53
18,33	47,78	33,06	33,06	0,86	0,05	2,37	1377,83	2909,51	1,65	-0,08	398,25	430,75	429,26	398,25
21,67	52,22	36,94	36,94	0,86	0,06	2,35	1510,31	3222,74	1,63	-0,28	399,86	432,47	427,74	399,86
25,00	56,67	40,83	40,83	0,87	0,06	2,25	1652,14	3562,00	1,56	-0,54	401,34	433,98	425,60	401,34
28,33	61,11	44,72	44,72	0,87	0,07	2,03	1803,77	3929,48	1,42	-0,90	402,67	435,30	422,66	402,67
31,67	65,56	48,61	48,61	0,87	0,08	1,66	1965,67	4327,98	1,16	-1,38	403,85	436,44	418,71	403,85
35,00	70,00	52,50	52,50	0,87	0,09	1,06	2138,33	4761,73	0,74	-2,05	404,85	437,39	413,50	404,85
5,00	30,00	17,50	17,50	0,88	0,03	1,74	933,18	1883,41	1,21	0,09	396,19	428,43	430,96	396,19
8,33	34,44	21,39	21,39	0,88	0,04	1,82	1032,35	2108,78	1,27	0,01	398,10	430,77	431,06	398,10
11,67	38,89	25,28	25,28	0,88	0,04	1,89	1139,26	2354,04	1,32	-0,09	399,91	432,94	430,84	399,91
15,00	43,33	29,17	29,17	0,88	0,05	1,93	1254,29	2620,47	1,35	-0,22	401,63	434,93	430,26	401,63
18,33	47,78	33,06	33,06	0,89	0,05	1,94	1377,83	2909,51	1,35	-0,39	403,23	436,73	429,26	403,23
21,67	52,22	36,94	36,94	0,89	0,06	1,89	1510,31	3222,74	1,31	-0,60	404,71	438,32	427,74	404,71
25,00	56,67	40,83	40,83	0,89	0,06	1,76	1652,14	3562,00	1,23	-0,89	406,05	439,72	425,60	406,05
28,33	61,11	44,72	44,72	0,89	0,07	1,53	1803,77	3929,48	1,06	-1,26	407,25	440,94	422,66	407,25
31,67	65,56	48,61	48,61	0,90	0,08	1,14	1965,67	4327,98	0,79	-1,77	408,28	441,97	418,71	408,28
35,00	70,00	52,50	52,50	0,90	0,08	0,52	2138,33	4761,73	0,37	-2,45	409,12	442,79	413,50	409,12
5,00	30,00	17,50	17,50	0,90	0,03	1,43	933,18	1883,41	0,99	-0,13	401,62	434,83	430,96	401,62
8,33	34,44	21,39	21,39	0,90	0,04	1,49	1032,35	2108,78	1,04	-0,23	403,42	437,08	431,06	403,42

11,67	38,89	25,28	25,28	0,91	0,04	1,53	1139,26	2354,04	1,07	-0,34	405,12	439,15	430,84	405,12
15,00	43,33	29,17	29,17	0,91	0,05	1,55	1254,29	2620,47	1,08	-0,49	406,72	441,02	430,26	406,72
18,33	47,78	33,06	33,06	0,91	0,05	1,52	1377,83	2909,51	1,06	-0,68	408,20	442,71	429,26	408,20
21,67	52,22	36,94	36,94	0,91	0,06	1,45	1510,31	3222,74	1,01	-0,92	409,55	444,21	427,74	409,55
25,00	56,67	40,83	40,83	0,92	0,06	1,30	1652,14	3562,00	0,91	-1,22	410,76	445,53	425,60	410,76
28,33	61,11	44,72	44,72	0,92	0,07	1,05	1803,77	3929,48	0,73	-1,62	411,82	446,65	422,66	411,82
31,67	65,56	48,61	48,61	0,92	0,07	0,64	1965,67	4327,98	0,44	-2,14	412,71	447,55	418,71	412,71
35,00	70,00			0,92										
5,00	30,00	17,50	17,50	0,93	0,03	1,13	933,18	1883,41	0,79	-0,34	407,05	441,24	430,96	407,05
8,33	34,44	21,39	21,39	0,93	0,04	1,17	1032,35	2108,78	0,81	-0,45	408,75	443,39	431,06	408,75
11,67	38,89	25,28	25,28	0,93	0,04	1,19	1139,26	2354,04	0,83	-0,59	410,34	445,36	430,84	410,34
15,00	43,33	29,17	29,17	0,93	0,04	1,18	1254,29	2620,47	0,82	-0,75	411,81	447,15	430,26	411,81
18,33	47,78	33,06	33,06	0,94	0,05	1,14	1377,83	2909,51	0,79	-0,96	413,17	448,77	429,26	413,17
21,67	52,22	36,94	36,94	0,94	0,05	1,04	1510,31	3222,74	0,72	-1,22	414,40	450,19	427,74	414,40
25,00	56,67	40,83	40,83	0,94	0,06	0,87	1652,14	3562,00	0,60	-1,54	415,47	451,41	425,60	415,47
28,33	61,11	44,72	44,72	0,94	0,07	0,59	1803,77	3929,48	0,41	-1,95	416,39	452,41	422,66	416,39
31,67	65,56	48,61	48,61	0,95	0,07	0,16	1965,67	4327,98	0,11	-2,49	417,13	453,19	418,71	417,13
35,00	70,00	52,50	52,50	0,95	0,08	-0,48	2138,33	4761,73	-0,33	-3,20	417,67	453,73	413,50	417,67
5,00	30,00	17,50	17,50	0,95	0,03	0,85	933,18	1883,41	0,59	-0,54	412,49	447,68	430,96	412,49
8,33	34,44	21,39	21,39	0,95	0,04	0,87	1032,35	2108,78	0,60	-0,67	414,07	449,76	431,06	414,07
11,67	38,89	25,28	25,28	0,96	0,04	0,86	1139,26	2354,04	0,60	-0,82	415,55	451,67	430,84	415,55
15,00	43,33	29,17	29,17	0,96	0,04	0,83	1254,29	2620,47	0,58	-1,01	416,91	453,40	430,26	416,91
18,33	47,78	33,06	33,06	0,96	0,05	0,76	1377,83	2909,51	0,53	-1,23	418,14	454,93	429,26	418,14

21,67	52,22	36,94	36,94	0,96	0,05	0,64	1510,31	3222,74	0,45	-1,51	419,24	456,25	427,74	419,24
25,00	56,67	40,83	40,83	0,97	0,06	0,45	1652,14	3562,00	0,31	-1,85	420,19	457,36	425,60	420,19
28,33	61,11	44,72	44,72	0,97	0,06	0,16	1803,77	3929,48	0,11	-2,28	420,96	458,25	422,66	420,96
31,67	65,56	48,61	48,61	0,97	0,07	-0,29	1965,67	4327,98	-0,20	-2,83	421,56	458,89	418,71	421,56
35,00	70,00	52,50	52,50	0,97	0,08	-0,94	2138,33	4761,73	-0,66	-3,56	421,94	459,28	413,50	421,94
5,00	30,00	17,50	17,50	0,98	0,03	0,59	933,18	1883,41	0,41	-0,73	417,92	454,26	430,96	417,92
8,33	34,44	21,39	21,39	0,98	0,03	0,58	1032,35	2108,78	0,40	-0,88	419,40	456,28	431,06	419,40
11,67	38,89	25,28	25,28	0,98	0,04	0,56	1139,26	2354,04	0,39	-1,05	420,76	458,12	430,84	420,76
15,00	43,33	29,17	29,17	0,98	0,04	0,50	1254,29	2620,47	0,35	-1,25	422,00	459,76	430,26	422,00
18,33	47,78	33,06	33,06	0,99	0,05	0,41	1377,83	2909,51	0,29	-1,49	423,12	461,19	429,26	423,12
21,67	52,22	36,94	36,94	0,99	0,05	0,27	1510,31	3222,74	0,19	-1,79	424,09	462,41	427,74	424,09
25,00	56,67	40,83	40,83	0,99	0,06	0,06	1652,14	3562,00	0,04	-2,15	424,90	463,41	425,60	424,90
28,33	61,11	44,72	44,72	0,99	0,06	-0,26	1803,77	3929,48	-0,18	-2,60	425,54	464,16	422,66	425,54
31,67	65,56	48,61	48,61	1,00	0,07	-0,72	1965,67	4327,98	-0,50	-3,17	425,98	464,66	418,71	425,98
35,00	70,00	52,50	52,50	1,00	0,08	-1,39	2138,33	4761,73	-0,97	-3,90	426,21	464,89	413,50	426,21

3.4.1 Summary R410 A--- 5000 rpm, 11.4 cc/rev

Table 40-Summary R410 -5000rpm, 11.4 cc/rev- improvement

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	P3	Q (kW)	Qres (kW)	h1	h2	h3	h4
min	31,35	-1,39	933,18	1883,41	1408,29229	-0,97	-3,90	369,01	396,38	413,50	369,01
max	95,75	4,47	2138,33	4761,73	3450,02858	3,12	1,43	426,21	464,89	431,06	426,21
X1_para minimo	0,98	1,00	0,75	0,75	0,75	1,00	1,00	0,75	0,75	0,77	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,77	0,76	1,00	1,00	0,75	1,00

3.5 REFRIGERANT R410 A--> 3000 rpm, 7 cc/rev

Table 41-R410 A- 3000 rpm, 7 cc/rev- improvement

T1	T2	T3	T4	X1	mref	flow_l_min	P1	P2	Q	Qres	h1	h2	h3	h4
5,00	30,00	17,50	17,50	0,75	0,02	1,82	349,90	770,64	1,27	0,80	204,66	228,59	269,83	204,66
8,33	34,44	21,39	21,39	0,75	0,02	2,00	392,28	873,87	1,39	0,87	207,69	232,05	272,04	207,69
11,67	38,89	25,28	25,28	0,76	0,02	2,19	438,48	987,17	1,53	0,93	210,71	235,43	274,15	210,71
15,00	43,33	29,17	29,17	0,76	0,03	2,39	488,70	1111,16	1,67	1,00	213,69	238,73	276,16	213,69
18,33	47,78	33,06	33,06	0,76	0,03	2,60	543,17	1246,48	1,81	1,07	216,63	241,95	278,06	216,63
21,67	52,22	36,94	36,94	0,76	0,03	2,82	602,12	1393,83	1,96	1,13	219,55	245,10	279,82	219,55
25,00	56,67	40,83	40,83	0,77	0,04	3,04	665,78	1553,90	2,12	1,19	222,43	248,17	281,43	222,43
28,33	61,11	44,72	44,72	0,77	0,04	3,26	734,40	1727,45	2,27	1,25	225,26	251,15	282,87	225,26
31,67	65,56	48,61	48,61	0,77	0,04	3,49	808,21	1915,28	2,43	1,30	228,06	254,04	284,11	228,06
35,00	70,00	52,50	52,50	0,77	0,05	3,71	887,47	2118,24	2,58	1,34	230,81	256,84	285,12	230,81
5,00	30,00	17,50	17,50	0,78	0,02	1,63	349,90	770,64	1,13	0,67	209,57	234,40	269,83	209,57
8,33	34,44	21,39	21,39	0,78	0,02	1,79	392,28	873,87	1,25	0,72	212,55	237,80	272,04	212,55
11,67	38,89	25,28	25,28	0,78	0,02	1,96	438,48	987,17	1,37	0,77	215,49	241,12	274,15	215,49
15,00	43,33	29,17	29,17	0,78	0,03	2,14	488,70	1111,16	1,49	0,82	218,40	244,37	276,16	218,40
18,33	47,78	33,06	33,06	0,79	0,03	2,33	543,17	1246,48	1,62	0,87	221,27	247,53	278,06	221,27
21,67	52,22	36,94	36,94	0,79	0,03	2,52	602,12	1393,83	1,76	0,92	224,11	250,61	279,82	224,11

25,00	56,67	40,83	40,83	0,79	0,03	2,72	665,78	1553,90	1,90	0,97	226,92	253,61	281,43	226,92
28,33	61,11	44,72	44,72	0,79	0,04	2,92	734,40	1727,45	2,04	1,01	229,68	256,52	282,87	229,68
31,67	65,56	48,61	48,61	0,80	0,04	3,12	808,21	1915,28	2,17	1,04	232,39	259,33	284,11	232,39
35,00	70,00	52,50	52,50	0,80	0,05	3,31	887,47	2118,24	2,31	1,06	235,06	262,05	285,12	235,06
5,00	30,00	17,50	17,50	0,80	0,02	1,45	349,90	770,64	1,01	0,54	214,49	240,20	269,83	214,49
8,33	34,44	21,39	21,39	0,80	0,02	1,59	392,28	873,87	1,11	0,58	217,40	243,55	272,04	217,40
11,67	38,89	25,28	25,28	0,81	0,02	1,75	438,48	987,17	1,22	0,62	220,27	246,82	274,15	220,27
15,00	43,33	29,17	29,17	0,81	0,03	1,91	488,70	1111,16	1,33	0,66	223,11	250,00	276,16	223,11
18,33	47,78	33,06	33,06	0,81	0,03	2,07	543,17	1246,48	1,44	0,69	225,91	253,11	278,06	225,91
21,67	52,22	36,94	36,94	0,81	0,03	2,25	602,12	1393,83	1,56	0,73	228,68	256,12	279,82	228,68
25,00	56,67	40,83	40,83	0,82	0,03	2,42	665,78	1553,90	1,69	0,75	231,40	259,05	281,43	231,40
28,33	61,11	44,72	44,72	0,82	0,04	2,60	734,40	1727,45	1,81	0,78	234,09	261,89	282,87	234,09
31,67	65,56	48,61	48,61	0,82	0,04	2,78	808,21	1915,28	1,93	0,80	236,72	264,62	284,11	236,72
35,00	70,00	52,50	52,50	0,82	0,04	2,94	887,47	2118,24	2,05	0,80	239,30	267,26	285,12	239,30
5,00	30,00	17,50	17,50	0,83	0,02	1,28	349,90	770,64	0,89	0,42	219,41	246,00	269,83	219,41
8,33	34,44	21,39	21,39	0,83	0,02	1,41	392,28	873,87	0,98	0,45	222,25	249,30	272,04	222,25
11,67	38,89	25,28	25,28	0,83	0,02	1,54	438,48	987,17	1,08	0,47	225,05	252,51	274,15	225,05
15,00	43,33	29,17	29,17	0,83	0,02	1,69	488,70	1111,16	1,17	0,50	227,82	255,64	276,16	227,82
18,33	47,78	33,06	33,06	0,84	0,03	1,83	543,17	1246,48	1,28	0,52	230,55	258,68	278,06	230,55
21,67	52,22	36,94	36,94	0,84	0,03	1,99	602,12	1393,83	1,38	0,54	233,25	261,64	279,82	233,25
25,00	56,67	40,83	40,83	0,84	0,03	2,14	665,78	1553,90	1,49	0,55	235,89	264,49	281,43	235,89
28,33	61,11	44,72	44,72	0,84	0,04	2,30	734,40	1727,45	1,60	0,56	238,50	267,26	282,87	238,50
31,67	65,56	48,61	48,61	0,85	0,04	2,45	808,21	1915,28	1,71	0,56	241,05	269,92	284,11	241,05

35,00	70,00	52,50	52,50	0,85	0,04	2,60	887,47	2118,24	1,81	0,55	243,55	272,47	285,12	243,55
5,00	30,00	17,50	17,50	0,85	0,02	1,12	349,90	770,64	0,78	0,31	224,33	251,80	269,83	224,33
8,33	34,44	21,39	21,39	0,85	0,02	1,24	392,28	873,87	0,86	0,33	227,10	255,05	272,04	227,10
11,67	38,89	25,28	25,28	0,86	0,02	1,35	438,48	987,17	0,94	0,34	229,83	258,21	274,15	229,83
15,00	43,33	29,17	29,17	0,86	0,02	1,48	488,70	1111,16	1,03	0,35	232,53	261,28	276,16	232,53
18,33	47,78	33,06	33,06	0,86	0,03	1,61	543,17	1246,48	1,12	0,36	235,19	264,26	278,06	235,19
21,67	52,22	36,94	36,94	0,86	0,03	1,74	602,12	1393,83	1,21	0,37	237,81	267,15	279,82	237,81
25,00	56,67	40,83	40,83	0,87	0,03	1,88	665,78	1553,90	1,31	0,37	240,38	269,94	281,43	240,38
28,33	61,11	44,72	44,72	0,87	0,04	2,01	734,40	1727,45	1,40	0,36	242,91	272,63	282,87	242,91
31,67	65,56	48,61	48,61	0,87	0,04	2,14	808,21	1915,28	1,49	0,34	245,38	275,21	284,11	245,38
35,00	70,00	52,50	52,50	0,87	0,04	2,27	887,47	2118,24	1,58	0,31	247,80	277,68	285,12	247,80
5,00	30,00	17,50	17,50	0,88	0,02	0,97	349,90	770,64	0,68	0,20	229,24	257,60	269,83	229,24
8,33	34,44	21,39	21,39	0,88	0,02	1,07	392,28	873,87	0,75	0,21	231,95	260,80	272,04	231,95
11,67	38,89	25,28	25,28	0,88	0,02	1,17	438,48	987,17	0,82	0,21	234,61	263,91	274,15	234,61
15,00	43,33	29,17	29,17	0,88	0,02	1,28	488,70	1111,16	0,89	0,21	237,24	266,92	276,16	237,24
18,33	47,78	33,06	33,06	0,89	0,03	1,39	543,17	1246,48	0,97	0,21	239,83	269,84	278,06	239,83
21,67	52,22	36,94	36,94	0,89	0,03	1,51	602,12	1393,83	1,05	0,20	242,38	272,66	279,82	242,38
25,00	56,67	40,83	40,83	0,89	0,03	1,62	665,78	1553,90	1,13	0,19	244,87	275,38	281,43	244,87
28,33	61,11	44,72	44,72	0,89	0,03	1,74	734,40	1727,45	1,21	0,17	247,32	278,00	282,87	247,32
31,67	65,56	48,61	48,61	0,90	0,04	1,85	808,21	1915,28	1,29	0,14	249,71	280,50	284,11	249,71
35,00	70,00	52,50	52,50	0,90	0,04	1,95	887,47	2118,24	1,36	0,09	252,04	282,89	285,12	252,04
5,00	30,00	17,50	17,50	0,90	0,02	0,83	349,90	770,64	0,58	0,10	234,16	263,40	269,83	234,16
8,33	34,44	21,39	21,39	0,90	0,02	0,92	392,28	873,87	0,64	0,10	236,80	266,55	272,04	236,80

11,67	38,89	25,28	25,28	0,91	0,02	1,00	438,48	987,17	0,70	0,09	239,40	269,60	274,15	239,40
15,00	43,33	29,17	29,17	0,91	0,02	1,10	488,70	1111,16	0,76	0,08	241,96	272,56	276,16	241,96
18,33	47,78	33,06	33,06	0,91	0,02	1,19	543,17	1246,48	0,83	0,07	244,47	275,42	278,06	244,47
21,67	52,22	36,94	36,94	0,91	0,03	1,29	602,12	1393,83	0,90	0,05	246,94	278,17	279,82	246,94
25,00	56,67	40,83	40,83	0,92	0,03	1,39	665,78	1553,90	0,97	0,02	249,36	280,82	281,43	249,36
28,33	61,11	44,72	44,72	0,92	0,03	1,48	734,40	1727,45	1,03	-0,02	251,73	283,37	282,87	251,73
31,67	65,56	48,61	48,61	0,92	0,04	1,58	808,21	1915,28	1,10	-0,06	254,04	285,80	284,11	254,04
35,00	70,00	52,50	52,50	0,92	0,04	1,66	887,47	2118,24	1,16	-0,12	256,29	288,11	285,12	256,29
5,00	30,00	17,50	17,50	0,93	0,02	0,70	349,90	770,64	0,49	0,01	239,08	269,20	269,83	239,08
8,33	34,44	21,39	21,39	0,93	0,02	0,77	392,28	873,87	0,54	0,00	241,65	272,30	272,04	241,65
11,67	38,89	25,28	25,28	0,93	0,02	0,84	438,48	987,17	0,59	-0,02	244,18	275,30	274,15	244,18
15,00	43,33	29,17	29,17	0,93	0,02	0,92	488,70	1111,16	0,64	-0,04	246,67	278,20	276,16	246,67
18,33	47,78	33,06	33,06	0,94	0,02	1,00	543,17	1246,48	0,70	-0,07	249,11	280,99	278,06	249,11
21,67	52,22	36,94	36,94	0,94	0,03	1,08	602,12	1393,83	0,75	-0,10	251,51	283,68	279,82	251,51
25,00	56,67	40,83	40,83	0,94	0,03	1,16	665,78	1553,90	0,81	-0,14	253,85	286,27	281,43	253,85
28,33	61,11	44,72	44,72	0,94	0,03	1,24	734,40	1727,45	0,86	-0,19	256,14	288,74	282,87	256,14
31,67	65,56	48,61	48,61	0,95	0,04	1,31	808,21	1915,28	0,92	-0,25	258,37	291,09	284,11	258,37
35,00	70,00	52,50	52,50	0,95	0,04	1,38	887,47	2118,24	0,96	-0,32	260,54	293,32	285,12	260,54
5,00	30,00			0,00										
8,33	34,44	21,39	21,39	0,95	0,02	0,63	392,28	873,87	0,44	-0,10	246,50	278,05	272,04	246,50
11,67	38,89	25,28	25,28	0,96	0,02	0,69	438,48	987,17	0,48	-0,13	248,96	280,99	274,15	248,96
15,00	43,33	29,17	29,17	0,96	0,02	0,75	488,70	1111,16	0,52	-0,16	251,38	283,83	276,16	251,38
18,33	47,78	33,06	33,06	0,96	0,02	0,82	543,17	1246,48	0,57	-0,20	253,75	286,57	278,06	253,75

21,67	52,22	36,94	36,94	0,96	0,03	0,88	602,12	1393,83	0,62	-0,24	256,07	289,20	279,82	256,07
25,00	56,67	40,83	40,83	0,97	0,03	0,95	665,78	1553,90	0,66	-0,29	258,34	291,71	281,43	258,34
28,33	61,11	44,72	44,72	0,97	0,03	1,01	734,40	1727,45	0,70	-0,35	260,55	294,11	282,87	260,55
31,67	65,56	48,61	48,61	0,97	0,03	1,07	808,21	1915,28	0,74	-0,43	262,70	296,38	284,11	262,70
35,00	70,00	52,50	52,50	0,97	0,04	1,11	887,47	2118,24	0,77	-0,51	264,78	298,53	285,12	264,78
5,00	30,00	17,50	17,50	0,98	0,01	0,45	349,90	770,64	0,31	-0,16	248,91	280,81	269,83	248,91
8,33	34,44	21,39	21,39	0,98	0,02	0,50	392,28	873,87	0,35	-0,20	251,35	283,80	272,04	251,35
11,67	38,89	25,28	25,28	0,98	0,02	0,54	438,48	987,17	0,38	-0,23	253,74	286,69	274,15	253,74
15,00	43,33	29,17	29,17	0,98	0,02	0,59	488,70	1111,16	0,41	-0,27	256,09	289,47	276,16	256,09
18,33	47,78	33,06	33,06	0,99	0,02	0,65	543,17	1246,48	0,45	-0,32	258,39	292,15	278,06	258,39
21,67	52,22	36,94	36,94	0,99	0,03	0,70	602,12	1393,83	0,48	-0,38	260,64	294,71	279,82	260,64
25,00	56,67	40,83	40,83	0,99	0,03	0,74	665,78	1553,90	0,52	-0,44	262,83	297,17	281,43	262,83
28,33	61,11	44,72	44,72	0,99	0,03	0,79	734,40	1727,45	0,55	-0,51	264,96	299,50	282,87	264,96
31,67	65,56	48,61	48,61	1,00	0,03	0,83	808,21	1915,28	0,58	-0,60	267,03	301,72	284,11	267,03
35,00	70,00	52,50	52,50	1,00	0,04	0,86	887,47	2118,24	0,60	-0,69	269,03	303,81	285,12	269,03

3.5.1 Summary R410 A--- 3000rpm, 7cc/rev

Table 42-Summary R410 A- 3000 rpm, 7 cc/rev- improvement

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	P3	Q (kW)	Qres (kW)	h1	h2	h3	h4
Min	14,99	0,45	349,90	770,64	560,271414	0,31	-0,69	204,66	228,59	269,83	204,66
Max	47,55	3,71	887,47	2118,24	1502,85679	2,58	1,34	269,03	303,81	285,12	269,03
X1_para minimo	0,98	0,98	0,75	0,75	0,75	0,98	1,00	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,77	0,77	1,00	1,00	0,77	1,00

3.6 REFRIGERANT R407 C -->5000 rpm, 11.4 cc/rev

Table 43-R407C-5000 rpm, 11.4 cc/rev- improvement

T1	T2	T3	T4	X1	mref	flow_l_min	P1	P2	Q	Qres	h1	h2	h3	h4
5,00	30,00	17,50	17,50	0,75	0,03	2,47	546,52	1175,14	1,72	0,97	359,51	388,30	425,23	359,51
8,33	34,44	21,39	21,39	0,75	0,03	2,69	610,42	1328,23	1,87	1,02	362,40	391,55	426,69	362,40
11,67	38,89	25,28	25,28	0,76	0,03	2,91	679,86	1496,04	2,02	1,07	365,25	394,71	427,99	365,25
15,00	43,33	29,17	29,17	0,76	0,04	3,13	755,15	1679,57	2,18	1,12	368,06	397,76	429,11	368,06
18,33	47,78	33,06	33,06	0,76	0,04	3,35	836,60	1879,91	2,34	1,16	370,81	400,71	430,02	370,81
21,67	52,22	36,94	36,94	0,76	0,04	3,57	924,55	2098,22	2,49	1,18	373,50	403,55	430,67	373,50
25,00	56,67	40,83	40,83	0,77	0,05	3,78	1019,34	2335,84	2,63	1,19	376,14	406,29	431,04	376,14
28,33	61,11	44,72	44,72	0,77	0,05	3,96	1121,33	2594,27	2,76	1,17	378,71	408,90	431,06	378,71
31,67	65,56	48,61	48,61	0,77	0,06	4,11	1230,88	2875,31	2,87	1,12	381,21	411,40	430,65	381,21
35,00	70,00	52,50	52,50	0,77	0,06	4,21	1348,38	3181,21	2,93	1,01	383,63	413,78	429,70	383,63
5,00	30,00	17,50	17,50	0,78	0,03	2,20	546,52	1175,14	1,53	0,78	364,82	394,45	425,23	364,82
8,33	34,44	21,39	21,39	0,78	0,03	2,39	610,42	1328,23	1,67	0,82	367,63	397,64	426,69	367,63
11,67	38,89	25,28	25,28	0,78	0,03	2,59	679,86	1496,04	1,80	0,85	370,40	400,72	427,99	370,40
15,00	43,33	29,17	29,17	0,78	0,03	2,78	755,15	1679,57	1,94	0,88	373,11	403,70	429,11	373,11
18,33	47,78	33,06	33,06	0,79	0,04	2,98	836,60	1879,91	2,08	0,90	375,76	406,57	430,02	375,76
21,67	52,22	36,94	36,94	0,79	0,04	3,17	924,55	2098,22	2,21	0,90	378,36	409,33	430,67	378,36

25,00	56,67	40,83	40,83	0,79	0,05	3,35	1019,34	2335,84	2,33	0,89	380,89	411,97	431,04	380,89
28,33	61,11	44,72	44,72	0,79	0,05	3,50	1121,33	2594,27	2,44	0,85	383,36	414,49	431,06	383,36
31,67	65,56	48,61	48,61	0,80	0,06	3,63	1230,88	2875,31	2,53	0,77	385,75	416,88	430,65	385,75
35,00	70,00	52,50	52,50	0,80	0,06	3,69	1348,38	3181,21	2,57	0,65	388,06	419,15	429,70	388,06
5,00	30,00	17,50	17,50	0,80	0,02	1,95	546,52	1175,14	1,36	0,61	370,13	400,58	425,23	370,13
8,33	34,44	21,39	21,39	0,80	0,03	2,11	610,42	1328,23	1,47	0,63	372,86	403,70	426,69	372,86
11,67	38,89	25,28	25,28	0,81	0,03	2,29	679,86	1496,04	1,59	0,65	375,53	406,71	427,99	375,53
15,00	43,33	29,17	29,17	0,81	0,03	2,46	755,15	1679,57	1,71	0,66	378,15	409,62	429,11	378,15
18,33	47,78	33,06	33,06	0,81	0,04	2,63	836,60	1879,91	1,83	0,65	380,71	412,41	430,02	380,71
21,67	52,22	36,94	36,94	0,81	0,04	2,79	924,55	2098,22	1,95	0,64	383,21	415,08	430,67	383,21
25,00	56,67	40,83	40,83	0,82	0,05	2,94	1019,34	2335,84	2,05	0,61	385,64	417,63	431,04	385,64
28,33	61,11	44,72	44,72	0,82	0,05	3,07	1121,33	2594,27	2,14	0,55	388,00	420,05	431,06	388,00
31,67	65,56	48,61	48,61	0,82	0,05	3,17	1230,88	2875,31	2,21	0,45	390,29	422,35	430,65	390,29
35,00	70,00	52,50	52,50	0,82	0,06	3,21	1348,38	3181,21	2,23	0,31	392,49	424,50	429,70	392,49
5,00	30,00	17,50	17,50	0,83	0,02	1,71	546,52	1175,14	1,19	0,44	375,43	406,69	425,23	375,43
8,33	34,44	21,39	21,39	0,83	0,03	1,85	610,42	1328,23	1,29	0,45	378,07	409,74	426,69	378,07
11,67	38,89	25,28	25,28	0,83	0,03	2,00	679,86	1496,04	1,40	0,45	380,65	412,68	427,99	380,65
15,00	43,33	29,17	29,17	0,83	0,03	2,15	755,15	1679,57	1,50	0,44	383,18	415,51	429,11	383,18
18,33	47,78	33,06	33,06	0,84	0,04	2,30	836,60	1879,91	1,60	0,43	385,65	418,22	430,02	385,65
21,67	52,22	36,94	36,94	0,84	0,04	2,44	924,55	2098,22	1,70	0,39	388,05	420,81	430,67	388,05
25,00	56,67	40,83	40,83	0,84	0,04	2,56	1019,34	2335,84	1,79	0,34	390,38	423,27	431,04	390,38
28,33	61,11	44,72	44,72	0,84	0,05	2,67	1121,33	2594,27	1,86	0,26	392,64	425,60	431,06	392,64
31,67	65,56	48,61	48,61	0,85	0,05	2,74	1230,88	2875,31	1,91	0,15	394,82	427,79	430,65	394,82

35,00	70,00	52,50	52,50	0,85	0,06	2,75	1348,38	3181,21	1,92	-0,01	396,90	429,83	429,70	396,90
5,00	30,00	17,50	17,50	0,85	0,02	1,48	546,52	1175,14	1,03	0,29	380,72	412,77	425,23	380,72
8,33	34,44	21,39	21,39	0,85	0,03	1,61	610,42	1328,23	1,12	0,28	383,28	415,76	426,69	383,28
11,67	38,89	25,28	25,28	0,86	0,03	1,74	679,86	1496,04	1,21	0,27	385,77	418,63	427,99	385,77
15,00	43,33	29,17	29,17	0,86	0,03	1,86	755,15	1679,57	1,30	0,25	388,21	421,39	429,11	388,21
18,33	47,78	33,06	33,06	0,86	0,04	1,99	836,60	1879,91	1,38	0,21	390,58	424,02	430,02	390,58
21,67	52,22	36,94	36,94	0,86	0,04	2,10	924,55	2098,22	1,46	0,16	392,89	426,52	430,67	392,89
25,00	56,67	40,83	40,83	0,87	0,04	2,20	1019,34	2335,84	1,53	0,09	395,12	428,89	431,04	395,12
28,33	61,11	44,72	44,72	0,87	0,05	2,28	1121,33	2594,27	1,59	0,00	397,27	431,12	431,06	397,27
31,67	65,56	48,61	48,61	0,87	0,05	2,33	1230,88	2875,31	1,62	-0,13	399,34	433,21	430,65	399,34
35,00	70,00	52,50	52,50	0,87	0,06	2,32	1348,38	3181,21	1,62	-0,31	401,31	435,15	429,70	401,31
5,00	30,00	17,50	17,50	0,88	0,02	1,27	546,52	1175,14	0,89	0,14	386,01	418,83	425,23	386,01
8,33	34,44	21,39	21,39	0,88	0,03	1,38	610,42	1328,23	0,96	0,12	388,48	421,75	426,69	388,48
11,67	38,89	25,28	25,28	0,88	0,03	1,48	679,86	1496,04	1,03	0,10	390,88	424,56	427,99	390,88
15,00	43,33	29,17	29,17	0,88	0,03	1,59	755,15	1679,57	1,11	0,06	393,23	427,24	429,11	393,23
18,33	47,78	33,06	33,06	0,89	0,03	1,69	836,60	1879,91	1,18	0,01	395,51	429,79	430,02	395,51
21,67	52,22	36,94	36,94	0,89	0,04	1,78	924,55	2098,22	1,24	-0,06	397,71	432,21	430,67	397,71
25,00	56,67	40,83	40,83	0,89	0,04	1,86	1019,34	2335,84	1,30	-0,14	399,84	434,49	431,04	399,84
28,33	61,11	44,72	44,72	0,89	0,05	1,92	1121,33	2594,27	1,34	-0,25	401,89	436,63	431,06	401,89
31,67	65,56	48,61	48,61	0,90	0,05	1,94	1230,88	2875,31	1,35	-0,40	403,85	438,61	430,65	403,85
35,00	70,00	52,50	52,50	0,90	0,06	1,91	1348,38	3181,21	1,33	-0,60	405,71	440,44	429,70	405,71
5,00	30,00	17,50	17,50	0,90	0,02	1,07	546,52	1175,14	0,75	0,01	391,29	424,87	425,23	391,29
8,33	34,44	21,39	21,39	0,90	0,02	1,16	610,42	1328,23	0,81	-0,03	393,67	427,73	426,69	393,67

11,67	38,89	25,28	25,28	0,91	0,03	1,25	679,86	1496,04	0,87	-0,07	395,98	430,46	427,99	395,98
15,00	43,33	29,17	29,17	0,91	0,03	1,33	755,15	1679,57	0,93	-0,12	398,24	433,07	429,11	398,24
18,33	47,78	33,06	33,06	0,91	0,03	1,41	836,60	1879,91	0,98	-0,18	400,42	435,54	430,02	400,42
21,67	52,22	36,94	36,94	0,91	0,04	1,48	924,55	2098,22	1,03	-0,26	402,53	437,88	430,67	402,53
25,00	56,67	40,83	40,83	0,92	0,04	1,54	1019,34	2335,84	1,07	-0,37	404,56	440,07	431,04	404,56
28,33	61,11	44,72	44,72	0,92	0,04	1,57	1121,33	2594,27	1,10	-0,49	406,50	442,11	431,06	406,50
31,67	65,56			0,92										
35,00	70,00			0,92										
5,00	30,00	17,50	17,50	0,93	0,02	0,88	546,52	1175,14	0,61	-0,12	396,56	430,88	425,23	396,56
8,33	34,44	21,39	21,39	0,93	0,02	0,95	610,42	1328,23	0,66	-0,17	398,85	433,68	426,69	398,85
11,67	38,89	25,28	25,28	0,93	0,03	1,02	679,86	1496,04	0,71	-0,22	401,08	436,34	427,99	401,08
15,00	43,33	29,17	29,17	0,93	0,03	1,09	755,15	1679,57	0,76	-0,29	403,24	438,88	429,11	403,24
18,33	47,78	33,06	33,06	0,94	0,03	1,15	836,60	1879,91	0,80	-0,36	405,33	441,27	430,02	405,33
21,67	52,22	36,94	36,94	0,94	0,04	1,20	924,55	2098,22	0,84	-0,46	407,34	443,52	430,67	407,34
25,00	56,67			0,94										
28,33	61,11			0,94										
31,67	65,56			0,95										
35,00	70,00			0,95										
5,00	30,00	17,50	17,50	0,95	0,02	0,70	546,52	1175,14	0,49	-0,24	401,82	436,87	425,23	401,82
8,33	34,44	21,39	21,39	0,95	0,02	0,75	610,42	1328,23	0,53	-0,30	404,02	439,60	426,69	404,02
11,67	38,89	25,28	25,28	0,96	0,03	0,81	679,86	1496,04	0,56	-0,37	406,16	442,20	427,99	406,16
15,00	43,33			0,96										
18,33	47,78			0,96										

21,67	52,22			0,96										
25,00	56,67			0,97										
28,33	61,11	44,72	44,72	0,97	0,04	0,94	1121,33	2594,27	0,65	-0,94	415,70	453,25	431,06	415,70
31,67	65,56	48,61	48,61	0,97	0,05	0,90	1230,88	2875,31	0,62	-1,14	417,32	455,02	430,65	417,32
35,00	70,00	52,50	52,50	0,97	0,05	0,80	1348,38	3181,21	0,56	-1,39	418,84	456,64	429,70	418,84
5,00	30,00	17,50	17,50	0,98	0,02	0,53	546,52	1175,14	0,37	-0,36	407,07	442,93	425,23	407,07
8,33	34,44	21,39	21,39	0,98	0,02	0,57	610,42	1328,23	0,40	-0,43	409,19	445,63	426,69	409,19
11,67	38,89	25,28	25,28	0,98	0,03	0,60	679,86	1496,04	0,42	-0,51	411,24	448,21	427,99	411,24
15,00	43,33	29,17	29,17	0,98	0,03	0,64	755,15	1679,57	0,44	-0,60	413,22	450,64	429,11	413,22
18,33	47,78	33,06	33,06	0,99	0,03	0,66	836,60	1879,91	0,46	-0,71	415,12	452,94	430,02	415,12
21,67	52,22	36,94	36,94	0,99	0,03	0,67	924,55	2098,22	0,47	-0,83	416,93	455,09	430,67	416,93
25,00	56,67	40,83	40,83	0,99	0,04	0,67	1019,34	2335,84	0,47	-0,98	418,65	457,09	431,04	418,65
28,33	61,11	44,72	44,72	0,99	0,04	0,64	1121,33	2594,27	0,45	-1,16	420,28	458,94	431,06	420,28
31,67	65,56	48,61	48,61	1,00	0,05	0,58	1230,88	2875,31	0,40	-1,37	421,80	460,62	430,65	421,80
35,00	70,00	52,50	52,50	1,00	0,05	0,47	1348,38	3181,21	0,33	-1,63	423,20	462,15	429,70	423,20

3.6.1 Summary R407 C---5000 rpm, 11.4 cc/rev

Table 44-Summary R407C-5000 rpm, 11.4 cc/rev- improvement

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	P3	Q (kW)	Qres (kW)	h1	h2	h3	h4
Min	20,33	0,47	546,52	1175,14	860,82716	0,33	-1,63	359,51	388,30	425,23	359,51
Max	63,61	4,21	1348,38	3181,21	2264,79558	2,93	1,19	423,20	462,15	431,06	423,20
X1_para minimo	0,98	1,00	0,75	0,75	0,75	1,00	1,00	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,77	0,77	1,00	1,00	0,77	1,00

3.7 REFRIGERANT R407 C --> 3000 rpm, 7cc/rev

Table 45-R407C- 3000 rpm, 7cc/rev- improvement

T1	T2	T3	T4	X1	mref	flow_l_min	P1	P2	Q	Qres	h1	h2	h3	h4
5,00	30,00	17,50	17,50	0,75	0,01	0,91	546,52	1175,14	0,63	0,36	359,51	388,30	425,23	359,51
8,33	34,44	21,39	21,39	0,75	0,01	0,99	610,42	1328,23	0,69	0,38	362,40	391,55	426,69	362,40
11,67	38,89	25,28	25,28	0,76	0,01	1,07	679,86	1496,04	0,75	0,40	365,25	394,71	427,99	365,25
15,00	43,33	29,17	29,17	0,76	0,01	1,15	755,15	1679,57	0,80	0,41	368,06	397,76	429,11	368,06
18,33	47,78	33,06	33,06	0,76	0,01	1,24	836,60	1879,91	0,86	0,43	370,81	400,71	430,02	370,81
21,67	52,22	36,94	36,94	0,76	0,02	1,32	924,55	2098,22	0,92	0,43	373,50	403,55	430,67	373,50
25,00	56,67	40,83	40,83	0,77	0,02	1,39	1019,34	2335,84	0,97	0,44	376,14	406,29	431,04	376,14
28,33	61,11	44,72	44,72	0,77	0,02	1,46	1121,33	2594,27	1,02	0,43	378,71	408,90	431,06	378,71
31,67	65,56	48,61	48,61	0,77	0,02	1,52	1230,88	2875,31	1,06	0,41	381,21	411,40	430,65	381,21
35,00	70,00	52,50	52,50	0,77	0,02	1,55	1348,38	3181,21	1,08	0,37	383,63	413,78	429,70	383,63
5,00	30,00	17,50	17,50	0,78	0,01	0,81	546,52	1175,14	0,56	0,29	364,82	394,45	425,23	364,82
8,33	34,44	21,39	21,39	0,78	0,01	0,88	610,42	1328,23	0,61	0,30	367,63	397,64	426,69	367,63
11,67	38,89	25,28	25,28	0,78	0,01	0,95	679,86	1496,04	0,66	0,31	370,40	400,72	427,99	370,40
15,00	43,33	29,17	29,17	0,78	0,01	1,03	755,15	1679,57	0,71	0,32	373,11	403,70	429,11	373,11
18,33	47,78	33,06	33,06	0,79	0,01	1,10	836,60	1879,91	0,76	0,33	375,76	406,57	430,02	375,76
21,67	52,22	36,94	36,94	0,79	0,02	1,17	924,55	2098,22	0,81	0,33	378,36	409,33	430,67	378,36

25,00	56,67	40,83	40,83	0,79	0,02	1,23	1019,34	2335,84	0,86	0,33	380,89	411,97	431,04	380,89
28,33	61,11	44,72	44,72	0,79	0,02	1,29	1121,33	2594,27	0,90	0,31	383,36	414,49	431,06	383,36
31,67	65,56	48,61	48,61	0,80	0,02	1,34	1230,88	2875,31	0,93	0,29	385,75	416,88	430,65	385,75
35,00	70,00	52,50	52,50	0,80	0,02	1,36	1348,38	3181,21	0,95	0,24	388,06	419,15	429,70	388,06
5,00	30,00	17,50	17,50	0,80	0,01	0,72	546,52	1175,14	0,50	0,22	370,13	400,58	425,23	370,13
8,33	34,44	21,39	21,39	0,80	0,01	0,78	610,42	1328,23	0,54	0,23	372,86	403,70	426,69	372,86
11,67	38,89	25,28	25,28	0,81	0,01	0,84	679,86	1496,04	0,59	0,24	375,53	406,71	427,99	375,53
15,00	43,33	29,17	29,17	0,81	0,01	0,91	755,15	1679,57	0,63	0,24	378,15	409,62	429,11	378,15
18,33	47,78	33,06	33,06	0,81	0,01	0,97	836,60	1879,91	0,67	0,24	380,71	412,41	430,02	380,71
21,67	52,22	36,94	36,94	0,81	0,02	1,03	924,55	2098,22	0,72	0,24	383,21	415,08	430,67	383,21
25,00	56,67	40,83	40,83	0,82	0,02	1,08	1019,34	2335,84	0,76	0,22	385,64	417,63	431,04	385,64
28,33	61,11	44,72	44,72	0,82	0,02	1,13	1121,33	2594,27	0,79	0,20	388,00	420,05	431,06	388,00
31,67	65,56	48,61	48,61	0,82	0,02	1,17	1230,88	2875,31	0,81	0,17	390,29	422,35	430,65	390,29
35,00	70,00	52,50	52,50	0,82	0,02	1,18	1348,38	3181,21	0,82	0,12	392,49	424,50	429,70	392,49
5,00	30,00	17,50	17,50	0,83	0,01	0,63	546,52	1175,14	0,44	0,16	375,43	406,69	425,23	375,43
8,33	34,44	21,39	21,39	0,83	0,01	0,68	610,42	1328,23	0,48	0,17	378,07	409,74	426,69	378,07
11,67	38,89	25,28	25,28	0,83	0,01	0,74	679,86	1496,04	0,51	0,17	380,65	412,68	427,99	380,65
15,00	43,33	29,17	29,17	0,83	0,01	0,79	755,15	1679,57	0,55	0,16	383,18	415,51	429,11	383,18
18,33	47,78	33,06	33,06	0,84	0,01	0,85	836,60	1879,91	0,59	0,16	385,65	418,22	430,02	385,65
21,67	52,22	36,94	36,94	0,84	0,01	0,90	924,55	2098,22	0,63	0,14	388,05	420,81	430,67	388,05
25,00	56,67	40,83	40,83	0,84	0,02	0,94	1019,34	2335,84	0,66	0,13	390,38	423,27	431,04	390,38
28,33	61,11	44,72	44,72	0,84	0,02	0,98	1121,33	2594,27	0,68	0,10	392,64	425,60	431,06	392,64
31,67	65,56	48,61	48,61	0,85	0,02	1,01	1230,88	2875,31	0,70	0,06	394,82	427,79	430,65	394,82

35,00	70,00	52,50	52,50	0,85	0,02	1,01	1348,38	3181,21	0,71	0,00	396,90	429,83	429,70	396,90
5,00	30,00	17,50	17,50	0,85	0,01	0,55	546,52	1175,14	0,38	0,11	380,72	412,77	425,23	380,72
8,33	34,44	21,39	21,39	0,85	0,01	0,59	610,42	1328,23	0,41	0,10	383,28	415,76	426,69	383,28
11,67	38,89	25,28	25,28	0,86	0,01	0,64	679,86	1496,04	0,45	0,10	385,77	418,63	427,99	385,77
15,00	43,33	29,17	29,17	0,86	0,01	0,69	755,15	1679,57	0,48	0,09	388,21	421,39	429,11	388,21
18,33	47,78	33,06	33,06	0,86	0,01	0,73	836,60	1879,91	0,51	0,08	390,58	424,02	430,02	390,58
21,67	52,22	36,94	36,94	0,86	0,01	0,77	924,55	2098,22	0,54	0,06	392,89	426,52	430,67	392,89
25,00	56,67	40,83	40,83	0,87	0,02	0,81	1019,34	2335,84	0,57	0,03	395,12	428,89	431,04	395,12
28,33	61,11	44,72	44,72	0,87	0,02	0,84	1121,33	2594,27	0,59	0,00	397,27	431,12	431,06	397,27
31,67	65,56	48,61	48,61	0,87	0,02	0,86	1230,88	2875,31	0,60	-0,05	399,34	433,21	430,65	399,34
35,00	70,00	52,50	52,50	0,87	0,02	0,85	1348,38	3181,21	0,60	-0,11	401,31	435,15	429,70	401,31
5,00	30,00	17,50	17,50	0,88	0,01	0,47	546,52	1175,14	0,33	0,05	386,01	418,83	425,23	386,01
8,33	34,44	21,39	21,39	0,88	0,01	0,51	610,42	1328,23	0,35	0,05	388,48	421,75	426,69	388,48
11,67	38,89	25,28	25,28	0,88	0,01	0,55	679,86	1496,04	0,38	0,04	390,88	424,56	427,99	390,88
15,00	43,33	29,17	29,17	0,88	0,01	0,59	755,15	1679,57	0,41	0,02	393,23	427,24	429,11	393,23
18,33	47,78	33,06	33,06	0,89	0,01	0,62	836,60	1879,91	0,43	0,00	395,51	429,79	430,02	395,51
21,67	52,22	36,94	36,94	0,89	0,01	0,66	924,55	2098,22	0,46	-0,02	397,71	432,21	430,67	397,71
25,00	56,67	40,83	40,83	0,89	0,02	0,69	1019,34	2335,84	0,48	-0,05	399,84	434,49	431,04	399,84
28,33	61,11	44,72	44,72	0,89	0,02	0,71	1121,33	2594,27	0,49	-0,09	401,89	436,63	431,06	401,89
31,67	65,56	48,61	48,61	0,90	0,02	0,71	1230,88	2875,31	0,50	-0,15	403,85	438,61	430,65	403,85
35,00	70,00	52,50	52,50	0,90	0,02	0,70	1348,38	3181,21	0,49	-0,22	405,71	440,44	429,70	405,71
5,00	30,00	17,50	17,50	0,90	0,01	0,39	546,52	1175,14	0,27	0,00	391,29	424,87	425,23	391,29
8,33	34,44	21,39	21,39	0,90	0,01	0,43	610,42	1328,23	0,30	-0,01	393,67	427,73	426,69	393,67

11,67	38,89	25,28	25,28	0,91	0,01	0,46	679,86	1496,04	0,32	-0,02	395,98	430,46	427,99	395,98
15,00	43,33	29,17	29,17	0,91	0,01	0,49	755,15	1679,57	0,34	-0,04	398,24	433,07	429,11	398,24
18,33	47,78	33,06	33,06	0,91	0,01	0,52	836,60	1879,91	0,36	-0,07	400,42	435,54	430,02	400,42
21,67	52,22	36,94	36,94	0,91	0,01	0,55	924,55	2098,22	0,38	-0,10	402,53	437,88	430,67	402,53
25,00	56,67	40,83	40,83	0,92	0,01	0,57	1019,34	2335,84	0,40	-0,13	404,56	440,07	431,04	404,56
28,33	61,11	44,72	44,72	0,92	0,02	0,58	1121,33	2594,27	0,40	-0,18	406,50	442,11	431,06	406,50
31,67	65,56			0,92										
35,00	70,00			0,92										
5,00	30,00	17,50	17,50	0,93	0,01	0,32	546,52	1175,14	0,23	-0,04	396,56	430,88	425,23	396,56
8,33	34,44	21,39	21,39	0,93	0,01	0,35	610,42	1328,23	0,24	-0,06	398,85	433,68	426,69	398,85
11,67	38,89	25,28	25,28	0,93	0,01	0,38	679,86	1496,04	0,26	-0,08	401,08	436,34	427,99	401,08
15,00	43,33	29,17	29,17	0,93	0,01	0,40	755,15	1679,57	0,28	-0,11	403,24	438,88	429,11	403,24
18,33	47,78	33,06	33,06	0,94	0,01	0,42	836,60	1879,91	0,29	-0,13	405,33	441,27	430,02	405,33
21,67	52,22	36,94	36,94	0,94	0,01	0,44	924,55	2098,22	0,31	-0,17	407,34	443,52	430,67	407,34
25,00	56,67			0,94										
28,33	61,11			0,94										
31,67	65,56			0,95										
35,00	70,00			0,95										
5,00	30,00	17,50	17,50	0,95	0,01	0,26	546,52	1175,14	0,18	-0,09	401,82	436,87	425,23	401,82
8,33	34,44	21,39	21,39	0,95	0,01	0,28	610,42	1328,23	0,19	-0,11	404,02	439,60	426,69	404,02
11,67	38,89	25,28	25,28	0,96	0,01	0,30	679,86	1496,04	0,21	-0,13	406,16	442,20	427,99	406,16
15,00	43,33			0,96										
18,33	47,78			0,96										

21,67	52,22			0,96										
25,00	56,67			0,97										
28,33	61,11	44,72	44,72	0,97	0,02	0,35	1121,33	2594,27	0,24	-0,35	415,70	453,25	431,06	415,70
31,67	65,56	48,61	48,61	0,97	0,02	0,33	1230,88	2875,31	0,23	-0,42	417,32	455,02	430,65	417,32
35,00	70,00	52,50	52,50	0,97	0,02	0,30	1348,38	3181,21	0,21	-0,51	418,84	456,64	429,70	418,84
5,00	30,00	17,50	17,50	0,98	0,01	0,20	546,52	1175,14	0,14	-0,13	407,07	442,93	425,23	407,07
8,33	34,44	21,39	21,39	0,98	0,01	0,21	610,42	1328,23	0,15	-0,16	409,19	445,63	426,69	409,19
11,67	38,89	25,28	25,28	0,98	0,01	0,22	679,86	1496,04	0,16	-0,19	411,24	448,21	427,99	411,24
15,00	43,33	29,17	29,17	0,98	0,01	0,23	755,15	1679,57	0,16	-0,22	413,22	450,64	429,11	413,22
18,33	47,78	33,06	33,06	0,99	0,01	0,24	836,60	1879,91	0,17	-0,26	415,12	452,94	430,02	415,12
21,67	52,22	36,94	36,94	0,99	0,01	0,25	924,55	2098,22	0,17	-0,31	416,93	455,09	430,67	416,93
25,00	56,67	40,83	40,83	0,99	0,01	0,25	1019,34	2335,84	0,17	-0,36	418,65	457,09	431,04	418,65
28,33	61,11	44,72	44,72	0,99	0,02	0,24	1121,33	2594,27	0,16	-0,43	420,28	458,94	431,06	420,28
31,67	65,56	48,61	48,61	1,00	0,02	0,21	1230,88	2875,31	0,15	-0,50	421,80	460,62	430,65	421,80
35,00	70,00	52,50	52,50	1,00	0,02	0,17	1348,38	3181,21	0,12	-0,60	423,20	462,15	429,70	423,20

3.7.1 Summary R407 C--- 3000 rpm, 7 cc/rev

Table 46-Summary R407C-3000rpm, 7cc/rev- improvement

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	P3	Q (kW)	Qres (kW)	h1	h2	h3	h4
min	7,49	0,17	546,52	1175,14	860,82716	0,12	-0,60	359,51	388,30	425,23	359,51
max	23,43	1,55	1348,38	3181,21	2264,79558	1,08	0,44	423,20	462,15	431,06	423,20
X1_para minimo	0,98	1,00	0,75	0,75	0,75	1,00	1,00	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,77	0,77	1,00	1,00	0,77	1,00

3.8 REFRIGERANT R 22--> 5000 rpm, 11.4cc/rev

Table 47- R22- 5000rpm, 11.4 cc/rev- improvement

T1	T2	T3	T4	X1	mref	flow_l_min	P1	P2	Q	Qres	h1	h2	h3	h4
5,00	30,00	17,50	17,50	0,75	0,03	2,44	584,29	1192,30	1,70	0,98	356,58	382,06	416,99	356,58
8,33	34,44	21,39	21,39	0,75	0,03	2,63	647,63	1336,40	1,83	1,03	358,95	384,91	418,07	358,95
11,67	38,89	25,28	25,28	0,76	0,03	2,82	715,98	1492,97	1,96	1,07	361,28	387,68	419,02	361,28
15,00	43,33	29,17	29,17	0,76	0,04	3,02	789,57	1662,66	2,10	1,10	363,56	390,37	419,83	363,56
18,33	47,78	33,06	33,06	0,76	0,04	3,21	868,65	1846,17	2,24	1,13	365,81	392,96	420,50	365,81
21,67	52,22	36,94	36,94	0,76	0,04	3,40	953,47	2044,22	2,37	1,14	368,00	395,46	420,99	368,00
25,00	56,67	40,83	40,83	0,77	0,05	3,59	1044,28	2257,56	2,50	1,15	370,15	397,86	421,28	370,15
28,33	61,11	44,72	44,72	0,77	0,05	3,76	1141,34	2486,99	2,62	1,13	372,24	400,16	421,35	372,24
31,67	65,56	48,61	48,61	0,77	0,06	3,91	1244,92	2733,38	2,73	1,09	374,27	402,36	421,16	374,27
35,00	70,00	52,50	52,50	0,77	0,06	4,03	1355,28	2997,65	2,81	1,03	376,24	404,44	420,67	376,24
5,00	30,00	17,50	17,50	0,78	0,03	2,16	584,29	1192,30	1,51	0,79	361,65	388,04	416,99	361,65
8,33	34,44	21,39	21,39	0,78	0,03	2,33	647,63	1336,40	1,62	0,82	363,95	390,84	418,07	363,95
11,67	38,89	25,28	25,28	0,78	0,03	2,50	715,98	1492,97	1,74	0,84	366,21	393,55	419,02	366,21
15,00	43,33	29,17	29,17	0,78	0,04	2,67	789,57	1662,66	1,86	0,86	368,42	396,17	419,83	368,42
18,33	47,78	33,06	33,06	0,79	0,04	2,84	868,65	1846,17	1,98	0,86	370,58	398,70	420,50	370,58
21,67	52,22	36,94	36,94	0,79	0,04	3,01	953,47	2044,22	2,10	0,86	372,69	401,12	420,99	372,69

25,00	56,67	40,83	40,83	0,79	0,05	3,17	1044,28	2257,56	2,21	0,85	374,76	403,45	421,28	374,76
28,33	61,11	44,72	44,72	0,79	0,05	3,31	1141,34	2486,99	2,31	0,81	376,76	405,67	421,35	376,76
31,67	65,56	48,61	48,61	0,80	0,06	3,44	1244,92	2733,38	2,39	0,75	378,71	407,78	421,16	378,71
35,00	70,00	52,50	52,50	0,80	0,06	3,53	1355,28	2997,65	2,46	0,67	380,59	409,78	420,67	380,59
5,00	30,00	17,50	17,50	0,80	0,03	1,90	584,29	1192,30	1,33	0,61	366,73	394,03	416,99	366,73
8,33	34,44	21,39	21,39	0,80	0,03	2,05	647,63	1336,40	1,43	0,62	368,95	396,77	418,07	368,95
11,67	38,89	25,28	25,28	0,81	0,03	2,20	715,98	1492,97	1,53	0,63	371,13	399,42	419,02	371,13
15,00	43,33	29,17	29,17	0,81	0,04	2,35	789,57	1662,66	1,63	0,63	373,27	401,98	419,83	373,27
18,33	47,78	33,06	33,06	0,81	0,04	2,49	868,65	1846,17	1,74	0,62	375,35	404,44	420,50	375,35
21,67	52,22	36,94	36,94	0,81	0,04	2,63	953,47	2044,22	1,84	0,60	377,39	406,79	420,99	377,39
25,00	56,67	40,83	40,83	0,82	0,05	2,77	1044,28	2257,56	1,93	0,56	379,37	409,04	421,28	379,37
28,33	61,11	44,72	44,72	0,82	0,05	2,89	1141,34	2486,99	2,01	0,51	381,29	411,18	421,35	381,29
31,67	65,56	48,61	48,61	0,82	0,05	2,99	1244,92	2733,38	2,08	0,44	383,15	413,21	421,16	383,15
35,00	70,00	52,50	52,50	0,82	0,06	3,06	1355,28	2997,65	2,13	0,33	384,94	415,11	420,67	384,94
5,00	30,00	17,50	17,50	0,83	0,03	1,66	584,29	1192,30	1,16	0,43	371,80	400,01	416,99	371,80
8,33	34,44	21,39	21,39	0,83	0,03	1,79	647,63	1336,40	1,24	0,43	373,95	402,70	418,07	373,95
11,67	38,89	25,28	25,28	0,83	0,03	1,91	715,98	1492,97	1,33	0,43	376,06	405,29	419,02	376,06
15,00	43,33	29,17	29,17	0,83	0,03	2,04	789,57	1662,66	1,42	0,41	378,12	407,79	419,83	378,12
18,33	47,78	33,06	33,06	0,84	0,04	2,16	868,65	1846,17	1,51	0,39	380,13	410,18	420,50	380,13
21,67	52,22	36,94	36,94	0,84	0,04	2,28	953,47	2044,22	1,59	0,35	382,08	412,46	420,99	382,08
25,00	56,67	40,83	40,83	0,84	0,04	2,39	1044,28	2257,56	1,67	0,30	383,98	414,63	421,28	383,98
28,33	61,11	44,72	44,72	0,84	0,05	2,49	1141,34	2486,99	1,73	0,23	385,82	416,69	421,35	385,82
31,67	65,56	48,61	48,61	0,85	0,05	2,56	1244,92	2733,38	1,79	0,13	387,59	418,63	421,16	387,59

35,00	70,00	52,50	52,50	0,85	0,06	2,61	1355,28	2997,65	1,82	0,01	389,29	420,45	420,67	389,29
5,00	30,00	17,50	17,50	0,85	0,02	1,43	584,29	1192,30	1,00	0,27	376,87	406,00	416,99	376,87
8,33	34,44	21,39	21,39	0,85	0,03	1,54	647,63	1336,40	1,07	0,26	378,95	408,63	418,07	378,95
11,67	38,89	25,28	25,28	0,86	0,03	1,64	715,98	1492,97	1,15	0,24	380,99	411,16	419,02	380,99
15,00	43,33	29,17	29,17	0,86	0,03	1,75	789,57	1662,66	1,22	0,21	382,97	413,59	419,83	382,97
18,33	47,78	33,06	33,06	0,86	0,04	1,85	868,65	1846,17	1,29	0,17	384,90	415,92	420,50	384,90
21,67	52,22	36,94	36,94	0,86	0,04	1,95	953,47	2044,22	1,36	0,11	386,78	418,13	420,99	386,78
25,00	56,67	40,83	40,83	0,87	0,04	2,04	1044,28	2257,56	1,42	0,05	388,59	420,23	421,28	388,59
28,33	61,11	44,72	44,72	0,87	0,05	2,11	1141,34	2486,99	1,47	-0,04	390,34	422,20	421,35	390,34
31,67	65,56	48,61	48,61	0,87	0,05	2,16	1244,92	2733,38	1,51	-0,15	392,02	424,06	421,16	392,02
35,00	70,00	52,50	52,50	0,87	0,06	2,19	1355,28	2997,65	1,52	-0,29	393,63	425,79	420,67	393,63
5,00	30,00	17,50	17,50	0,88	0,02	1,21	584,29	1192,30	0,85	0,12	381,94	411,98	416,99	381,94
8,33	34,44	21,39	21,39	0,88	0,03	1,30	647,63	1336,40	0,91	0,09	383,95	414,56	418,07	383,95
11,67	38,89	25,28	25,28	0,88	0,03	1,39	715,98	1492,97	0,97	0,06	385,92	417,04	419,02	385,92
15,00	43,33	29,17	29,17	0,88	0,03	1,48	789,57	1662,66	1,03	0,01	387,82	419,40	419,83	387,82
18,33	47,78	33,06	33,06	0,89	0,04	1,56	868,65	1846,17	1,09	-0,04	389,68	421,66	420,50	389,68
21,67	52,22	36,94	36,94	0,89	0,04	1,64	953,47	2044,22	1,14	-0,11	391,47	423,80	420,99	391,47
25,00	56,67	40,83	40,83	0,89	0,04	1,70	1044,28	2257,56	1,19	-0,19	393,20	425,82	421,28	393,20
28,33	61,11	44,72	44,72	0,89	0,05	1,75	1141,34	2486,99	1,22	-0,29	394,87	427,72	421,35	394,87
31,67	65,56	48,61	48,61	0,90	0,05	1,79	1244,92	2733,38	1,24	-0,42	396,46	429,49	421,16	396,46
35,00	70,00	52,50	52,50	0,90	0,05	1,79	1355,28	2997,65	1,24	-0,57	397,98	431,12	420,67	397,98
5,00	30,00	17,50	17,50	0,90	0,02	1,01	584,29	1192,30	0,70	-0,02	387,02	417,97	416,99	387,02
8,33	34,44	21,39	21,39	0,90	0,03	1,08	647,63	1336,40	0,75	-0,06	388,96	420,49	418,07	388,96

11,67	38,89	25,28	25,28	0,91	0,03	1,15	715,98	1492,97	0,80	-0,11	390,84	422,91	419,02	390,84
15,00	43,33	29,17	29,17	0,91	0,03	1,22	789,57	1662,66	0,85	-0,17	392,68	425,21	419,83	392,68
18,33	47,78	33,06	33,06	0,91	0,03	1,28	868,65	1846,17	0,89	-0,24	394,45	427,40	420,50	394,45
21,67	52,22	36,94	36,94	0,91	0,04	1,34	953,47	2044,22	0,93	-0,32	396,17	429,46	420,99	396,17
25,00	56,67	40,83	40,83	0,92	0,04	1,39	1044,28	2257,56	0,97	-0,42	397,82	431,41	421,28	397,82
28,33	61,11	44,72	44,72	0,92	0,04	1,42	1141,34	2486,99	0,99	-0,53	399,40	433,23	421,35	399,40
31,67	65,56	48,61	48,61	0,92	0,05	1,43	1244,92	2733,38	0,99	-0,67	400,90	434,91	421,16	400,90
35,00	70,00	52,50	52,50	0,92	0,05	1,41	1355,28	2997,65	0,98	-0,84	402,33	436,47	420,67	402,33
5,00	30,00	17,50	17,50	0,93	0,02	0,82	584,29	1192,30	0,57	-0,16	392,09	423,95	416,99	392,09
8,33	34,44	21,39	21,39	0,93	0,03	0,87	647,63	1336,40	0,61	-0,21	393,96	426,42	418,07	393,96
11,67	38,89	25,28	25,28	0,93	0,03	0,93	715,98	1492,97	0,64	-0,27	395,77	428,78	419,02	395,77
15,00	43,33	29,17	29,17	0,93	0,03	0,98	789,57	1662,66	0,68	-0,34	397,53	431,02	419,83	397,53
18,33	47,78	33,06	33,06	0,94	0,03	1,02	868,65	1846,17	0,71	-0,42	399,23	433,14	420,50	399,23
21,67	52,22	36,94	36,94	0,94	0,04	1,06	953,47	2044,22	0,74	-0,52	400,86	435,13	420,99	400,86
25,00	56,67	40,83	40,83	0,94	0,04	1,08	1044,28	2257,56	0,76	-0,63	402,43	437,01	421,28	402,43
28,33	61,11	44,72	44,72	0,94	0,04	1,10	1141,34	2486,99	0,76	-0,76	403,92	438,77	421,35	403,92
31,67	65,56	48,61	48,61	0,95	0,05	1,09	1244,92	2733,38	0,76	-0,92	405,34	440,41	421,16	405,34
35,00	70,00	52,50	52,50	0,95	0,05	1,05	1355,28	2997,65	0,73	-1,11	406,67	441,92	420,67	406,67
5,00	30,00	17,50	17,50	0,95	0,02	0,63	584,29	1192,30	0,44	-0,29	397,16	429,94	416,99	397,16
8,33	34,44	21,39	21,39	0,95	0,02	0,67	647,63	1336,40	0,47	-0,35	398,96	432,35	418,07	398,96
11,67	38,89	25,28	25,28	0,96	0,03	0,71	715,98	1492,97	0,50	-0,42	400,70	434,65	419,02	400,70
15,00	43,33	29,17	29,17	0,96	0,03	0,74	789,57	1662,66	0,52	-0,51	402,38	436,85	419,83	402,38
18,33	47,78	33,06	33,06	0,96	0,03	0,77	868,65	1846,17	0,54	-0,60	404,00	438,92	420,50	404,00

21,67	52,22	36,94	36,94	0,96	0,04	0,79	953,47	2044,22	0,55	-0,71	405,56	440,89	420,99	405,56
25,00	56,67	40,83	40,83	0,97	0,04	0,80	1044,28	2257,56	0,56	-0,84	407,04	442,72	421,28	407,04
28,33	61,11	44,72	44,72	0,97	0,04	0,79	1141,34	2486,99	0,55	-0,99	408,45	444,44	421,35	408,45
31,67	65,56	48,61	48,61	0,97	0,05	0,76	1244,92	2733,38	0,53	-1,16	409,78	446,02	421,16	409,78
35,00	70,00	52,50	52,50	0,97	0,05	0,70	1355,28	2997,65	0,49	-1,36	411,02	447,46	420,67	411,02
5,00	30,00	17,50	17,50	0,98	0,02	0,46	584,29	1192,30	0,32	-0,41	402,23	436,00	416,99	402,23
8,33	34,44	21,39	21,39	0,98	0,02	0,48	647,63	1336,40	0,34	-0,49	403,96	438,40	418,07	403,96
11,67	38,89	25,28	25,28	0,98	0,03	0,51	715,98	1492,97	0,35	-0,57	405,63	440,68	419,02	405,63
15,00	43,33	29,17	29,17	0,98	0,03	0,52	789,57	1662,66	0,36	-0,67	407,23	442,84	419,83	407,23
18,33	47,78	33,06	33,06	0,99	0,03	0,53	868,65	1846,17	0,37	-0,77	408,78	444,88	420,50	408,78
21,67	52,22	36,94	36,94	0,99	0,03	0,54	953,47	2044,22	0,37	-0,90	410,25	446,79	420,99	410,25
25,00	56,67	40,83	40,83	0,99	0,04	0,53	1044,28	2257,56	0,37	-1,04	411,65	448,58	421,28	411,65
28,33	61,11	44,72	44,72	0,99	0,04	0,50	1141,34	2486,99	0,35	-1,20	412,98	450,23	421,35	412,98
31,67	65,56	48,61	48,61	1,00	0,05	0,45	1244,92	2733,38	0,32	-1,39	414,22	451,75	421,16	414,22
35,00	70,00	52,50	52,50	1,00	0,05	0,38	1355,28	2997,65	0,26	-1,61	415,37	453,12	420,67	415,37

3.8.1 Summary R 22--- 5000 rpm, 11.4 cc/rev

Table 48-Summary R22- 5000rpm, 11.4 cc/rev- improvement

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	P3	Q (kW)	Qres (kW)	h1	h2	h3	h4
min	21,69	0,38	584,29	1192,30	888,295375	0,26	-1,61	356,58	382,06	416,99	356,58
max	63,26	4,03	1355,28	2997,65	2176,46532	2,81	1,15	415,37	453,12	421,35	415,37
X1_para minimo	0,98	1,00	0,75	0,75	0,75	1,00	1,00	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,77	0,77	1,00	1,00	0,77	1,00

3.9 REFRIGERANT R 22--> 3000 rpm, 7cc/rev

Table 49-R22- 3000 rpm, 7 cc/rev- improvement

T1	T2	T3	T4	X1	mref	flow_l_min	P1	P2	Q	Qres	h1	h2	h3	h4
5,00	30,00	17,50	17,50	0,75	0,01	0,90	584,29	1192,30	0,63	0,36	356,58	382,06	416,99	356,58
8,33	34,44	21,39	21,39	0,75	0,01	0,97	647,63	1336,40	0,67	0,38	358,95	384,91	418,07	358,95
11,67	38,89	25,28	25,28	0,76	0,01	1,04	715,98	1492,97	0,72	0,39	361,28	387,68	419,02	361,28
15,00	43,33	29,17	29,17	0,76	0,01	1,11	789,57	1662,66	0,77	0,41	363,56	390,37	419,83	363,56
18,33	47,78	33,06	33,06	0,76	0,02	1,18	868,65	1846,17	0,82	0,42	365,81	392,96	420,50	365,81
21,67	52,22	36,94	36,94	0,76	0,02	1,25	953,47	2044,22	0,87	0,42	368,00	395,46	420,99	368,00
25,00	56,67	40,83	40,83	0,77	0,02	1,32	1044,28	2257,56	0,92	0,42	370,15	397,86	421,28	370,15
28,33	61,11	44,72	44,72	0,77	0,02	1,39	1141,34	2486,99	0,97	0,42	372,24	400,16	421,35	372,24
31,67	65,56	48,61	48,61	0,77	0,02	1,44	1244,92	2733,38	1,00	0,40	374,27	402,36	421,16	374,27
35,00	70,00	52,50	52,50	0,77	0,02	1,49	1355,28	2997,65	1,04	0,38	376,24	404,44	420,67	376,24
5,00	30,00	17,50	17,50	0,78	0,01	0,80	584,29	1192,30	0,55	0,29	361,65	388,04	416,99	361,65
8,33	34,44	21,39	21,39	0,78	0,01	0,86	647,63	1336,40	0,60	0,30	363,95	390,84	418,07	363,95
11,67	38,89	25,28	25,28	0,78	0,01	0,92	715,98	1492,97	0,64	0,31	366,21	393,55	419,02	366,21
15,00	43,33	29,17	29,17	0,78	0,01	0,98	789,57	1662,66	0,69	0,32	368,42	396,17	419,83	368,42
18,33	47,78	33,06	33,06	0,79	0,01	1,05	868,65	1846,17	0,73	0,32	370,58	398,70	420,50	370,58
21,67	52,22	36,94	36,94	0,79	0,02	1,11	953,47	2044,22	0,77	0,32	372,69	401,12	420,99	372,69

25,00	56,67	40,83	40,83	0,79	0,02	1,17	1044,28	2257,56	0,81	0,31	374,76	403,45	421,28	374,76
28,33	61,11	44,72	44,72	0,79	0,02	1,22	1141,34	2486,99	0,85	0,30	376,76	405,67	421,35	376,76
31,67	65,56	48,61	48,61	0,80	0,02	1,27	1244,92	2733,38	0,88	0,28	378,71	407,78	421,16	378,71
35,00	70,00	52,50	52,50	0,80	0,02	1,30	1355,28	2997,65	0,91	0,25	380,59	409,78	420,67	380,59
5,00	30,00	17,50	17,50	0,80	0,01	0,70	584,29	1192,30	0,49	0,22	366,73	394,03	416,99	366,73
8,33	34,44	21,39	21,39	0,80	0,01	0,75	647,63	1336,40	0,53	0,23	368,95	396,77	418,07	368,95
11,67	38,89	25,28	25,28	0,81	0,01	0,81	715,98	1492,97	0,56	0,23	371,13	399,42	419,02	371,13
15,00	43,33	29,17	29,17	0,81	0,01	0,86	789,57	1662,66	0,60	0,23	373,27	401,98	419,83	373,27
18,33	47,78	33,06	33,06	0,81	0,01	0,92	868,65	1846,17	0,64	0,23	375,35	404,44	420,50	375,35
21,67	52,22	36,94	36,94	0,81	0,02	0,97	953,47	2044,22	0,68	0,22	377,39	406,79	420,99	377,39
25,00	56,67	40,83	40,83	0,82	0,02	1,02	1044,28	2257,56	0,71	0,21	379,37	409,04	421,28	379,37
28,33	61,11	44,72	44,72	0,82	0,02	1,06	1141,34	2486,99	0,74	0,19	381,29	411,18	421,35	381,29
31,67	65,56	48,61	48,61	0,82	0,02	1,10	1244,92	2733,38	0,77	0,16	383,15	413,21	421,16	383,15
35,00	70,00	52,50	52,50	0,82	0,02	1,13	1355,28	2997,65	0,78	0,12	384,94	415,11	420,67	384,94
5,00	30,00	17,50	17,50	0,83	0,01	0,61	584,29	1192,30	0,43	0,16	371,80	400,01	416,99	371,80
8,33	34,44	21,39	21,39	0,83	0,01	0,66	647,63	1336,40	0,46	0,16	373,95	402,70	418,07	373,95
11,67	38,89	25,28	25,28	0,83	0,01	0,70	715,98	1492,97	0,49	0,16	376,06	405,29	419,02	376,06
15,00	43,33	29,17	29,17	0,83	0,01	0,75	789,57	1662,66	0,52	0,15	378,12	407,79	419,83	378,12
18,33	47,78	33,06	33,06	0,84	0,01	0,80	868,65	1846,17	0,56	0,14	380,13	410,18	420,50	380,13
21,67	52,22	36,94	36,94	0,84	0,02	0,84	953,47	2044,22	0,59	0,13	382,08	412,46	420,99	382,08
25,00	56,67	40,83	40,83	0,84	0,02	0,88	1044,28	2257,56	0,61	0,11	383,98	414,63	421,28	383,98
28,33	61,11	44,72	44,72	0,84	0,02	0,92	1141,34	2486,99	0,64	0,08	385,82	416,69	421,35	385,82
31,67	65,56	48,61	48,61	0,85	0,02	0,94	1244,92	2733,38	0,66	0,05	387,59	418,63	421,16	387,59

35,00	70,00	52,50	52,50	0,85	0,02	0,96	1355,28	2997,65	0,67	0,00	389,29	420,45	420,67	389,29
5,00	30,00	17,50	17,50	0,85	0,01	0,53	584,29	1192,30	0,37	0,10	376,87	406,00	416,99	376,87
8,33	34,44	21,39	21,39	0,85	0,01	0,57	647,63	1336,40	0,39	0,10	378,95	408,63	418,07	378,95
11,67	38,89	25,28	25,28	0,86	0,01	0,61	715,98	1492,97	0,42	0,09	380,99	411,16	419,02	380,99
15,00	43,33	29,17	29,17	0,86	0,01	0,65	789,57	1662,66	0,45	0,08	382,97	413,59	419,83	382,97
18,33	47,78	33,06	33,06	0,86	0,01	0,68	868,65	1846,17	0,48	0,06	384,90	415,92	420,50	384,90
21,67	52,22	36,94	36,94	0,86	0,01	0,72	953,47	2044,22	0,50	0,04	386,78	418,13	420,99	386,78
25,00	56,67	40,83	40,83	0,87	0,02	0,75	1044,28	2257,56	0,52	0,02	388,59	420,23	421,28	388,59
28,33	61,11	44,72	44,72	0,87	0,02	0,78	1141,34	2486,99	0,54	-0,01	390,34	422,20	421,35	390,34
31,67	65,56	48,61	48,61	0,87	0,02	0,80	1244,92	2733,38	0,56	-0,06	392,02	424,06	421,16	392,02
35,00	70,00	52,50	52,50	0,87	0,02	0,81	1355,28	2997,65	0,56	-0,11	393,63	425,79	420,67	393,63
5,00	30,00	17,50	17,50	0,88	0,01	0,45	584,29	1192,30	0,31	0,04	381,94	411,98	416,99	381,94
8,33	34,44	21,39	21,39	0,88	0,01	0,48	647,63	1336,40	0,33	0,03	383,95	414,56	418,07	383,95
11,67	38,89	25,28	25,28	0,88	0,01	0,51	715,98	1492,97	0,36	0,02	385,92	417,04	419,02	385,92
15,00	43,33	29,17	29,17	0,88	0,01	0,54	789,57	1662,66	0,38	0,01	387,82	419,40	419,83	387,82
18,33	47,78	33,06	33,06	0,89	0,01	0,58	868,65	1846,17	0,40	-0,02	389,68	421,66	420,50	389,68
21,67	52,22	36,94	36,94	0,89	0,01	0,60	953,47	2044,22	0,42	-0,04	391,47	423,80	420,99	391,47
25,00	56,67	40,83	40,83	0,89	0,02	0,63	1044,28	2257,56	0,44	-0,07	393,20	425,82	421,28	393,20
28,33	61,11	44,72	44,72	0,89	0,02	0,65	1141,34	2486,99	0,45	-0,11	394,87	427,72	421,35	394,87
31,67	65,56	48,61	48,61	0,90	0,02	0,66	1244,92	2733,38	0,46	-0,15	396,46	429,49	421,16	396,46
35,00	70,00	52,50	52,50	0,90	0,02	0,66	1355,28	2997,65	0,46	-0,21	397,98	431,12	420,67	397,98
5,00	30,00	17,50	17,50	0,90	0,01	0,37	584,29	1192,30	0,26	-0,01	387,02	417,97	416,99	387,02
8,33	34,44	21,39	21,39	0,90	0,01	0,40	647,63	1336,40	0,28	-0,02	388,96	420,49	418,07	388,96

11,67	38,89	25,28	25,28	0,91	0,01	0,42	715,98	1492,97	0,30	-0,04	390,84	422,91	419,02	390,84
15,00	43,33	29,17	29,17	0,91	0,01	0,45	789,57	1662,66	0,31	-0,06	392,68	425,21	419,83	392,68
18,33	47,78	33,06	33,06	0,91	0,01	0,47	868,65	1846,17	0,33	-0,09	394,45	427,40	420,50	394,45
21,67	52,22	36,94	36,94	0,91	0,01	0,49	953,47	2044,22	0,34	-0,12	396,17	429,46	420,99	396,17
25,00	56,67	40,83	40,83	0,92	0,02	0,51	1044,28	2257,56	0,36	-0,15	397,82	431,41	421,28	397,82
28,33	61,11	44,72	44,72	0,92	0,02	0,52	1141,34	2486,99	0,36	-0,20	399,40	433,23	421,35	399,40
31,67	65,56	48,61	48,61	0,92	0,02	0,53	1244,92	2733,38	0,37	-0,25	400,90	434,91	421,16	400,90
35,00	70,00	52,50	52,50	0,92	0,02	0,52	1355,28	2997,65	0,36	-0,31	402,33	436,47	420,67	402,33
5,00	30,00	17,50	17,50	0,93	0,01	0,30	584,29	1192,30	0,21	-0,06	392,09	423,95	416,99	392,09
8,33	34,44	21,39	21,39	0,93	0,01	0,32	647,63	1336,40	0,22	-0,08	393,96	426,42	418,07	393,96
11,67	38,89	25,28	25,28	0,93	0,01	0,34	715,98	1492,97	0,24	-0,10	395,77	428,78	419,02	395,77
15,00	43,33	29,17	29,17	0,93	0,01	0,36	789,57	1662,66	0,25	-0,13	397,53	431,02	419,83	397,53
18,33	47,78	33,06	33,06	0,94	0,01	0,38	868,65	1846,17	0,26	-0,16	399,23	433,14	420,50	399,23
21,67	52,22	36,94	36,94	0,94	0,01	0,39	953,47	2044,22	0,27	-0,19	400,86	435,13	420,99	400,86
25,00	56,67	40,83	40,83	0,94	0,01	0,40	1044,28	2257,56	0,28	-0,23	402,43	437,01	421,28	402,43
28,33	61,11	44,72	44,72	0,94	0,02	0,40	1141,34	2486,99	0,28	-0,28	403,92	438,77	421,35	403,92
31,67	65,56	48,61	48,61	0,95	0,02	0,40	1244,92	2733,38	0,28	-0,34	405,34	440,41	421,16	405,34
35,00	70,00	52,50	52,50	0,95	0,02	0,39	1355,28	2997,65	0,27	-0,41	406,67	441,92	420,67	406,67
5,00	30,00	17,50	17,50	0,95	0,01	0,23	584,29	1192,30	0,16	-0,11	397,16	429,94	416,99	397,16
8,33	34,44	21,39	21,39	0,95	0,01	0,25	647,63	1336,40	0,17	-0,13	398,96	432,35	418,07	398,96
11,67	38,89	25,28	25,28	0,96	0,01	0,26	715,98	1492,97	0,18	-0,16	400,70	434,65	419,02	400,70
15,00	43,33	29,17	29,17	0,96	0,01	0,27	789,57	1662,66	0,19	-0,19	402,38	436,85	419,83	402,38
18,33	47,78	33,06	33,06	0,96	0,01	0,28	868,65	1846,17	0,20	-0,22	404,00	438,92	420,50	404,00

21,67	52,22	36,94	36,94	0,96	0,01	0,29	953,47	2044,22	0,20	-0,26	405,56	440,89	420,99	405,56
25,00	56,67	40,83	40,83	0,97	0,01	0,29	1044,28	2257,56	0,21	-0,31	407,04	442,72	421,28	407,04
28,33	61,11	44,72	44,72	0,97	0,02	0,29	1141,34	2486,99	0,20	-0,36	408,45	444,44	421,35	408,45
31,67	65,56	48,61	48,61	0,97	0,02	0,28	1244,92	2733,38	0,20	-0,43	409,78	446,02	421,16	409,78
35,00	70,00	52,50	52,50	0,97	0,02	0,26	1355,28	2997,65	0,18	-0,50	411,02	447,46	420,67	411,02
5,00	30,00	17,50	17,50	0,98	0,01	0,17	584,29	1192,30	0,12	-0,15	402,23	436,00	416,99	402,23
8,33	34,44	21,39	21,39	0,98	0,01	0,18	647,63	1336,40	0,12	-0,18	403,96	438,40	418,07	403,96
11,67	38,89	25,28	25,28	0,98	0,01	0,19	715,98	1492,97	0,13	-0,21	405,63	440,68	419,02	405,63
15,00	43,33	29,17	29,17	0,98	0,01	0,19	789,57	1662,66	0,13	-0,25	407,23	442,84	419,83	407,23
18,33	47,78	33,06	33,06	0,99	0,01	0,20	868,65	1846,17	0,14	-0,29	408,78	444,88	420,50	408,78
21,67	52,22	36,94	36,94	0,99	0,01	0,20	953,47	2044,22	0,14	-0,33	410,25	446,79	420,99	410,25
25,00	56,67	40,83	40,83	0,99	0,01	0,19	1044,28	2257,56	0,14	-0,38	411,65	448,58	421,28	411,65
28,33	61,11	44,72	44,72	0,99	0,02	0,18	1141,34	2486,99	0,13	-0,44	412,98	450,23	421,35	412,98
31,67	65,56	48,61	48,61	1,00	0,02	0,17	1244,92	2733,38	0,12	-0,51	414,22	451,75	421,16	414,22
35,00	70,00	52,50	52,50	1,00	0,02	0,14	1355,28	2997,65	0,10	-0,59	415,37	453,12	420,67	415,37

3.9.1 Summary R 22-->3000 rpm, 7 cc/rev

Table 50- Summary R22- 3000rpm, 7 cc/rev- improvement

	mref [g/s]	flow (l/min)	P1 (kPa)	P2	P3	Q (kW)	Qres (kW)	h1	h2	h3	h4
min	7,99	0,14	584,29	1192,30	888,295375	0,10	-0,59	356,58	382,06	416,99	356,58
max	23,31	1,49	1355,28	2997,65	2176,46532	1,04	0,42	415,37	453,12	421,35	415,37
X1_para minimo	0,98	1,00	0,75	0,75	0,75	1,00	1,00	0,75	0,75	0,75	0,75
X1_para maximo	0,77	0,77	0,77	0,77	0,77	0,77	0,77	1,00	1,00	0,77	1,00

ANNEX V: WINCC

1. SCADA STRUCTURE

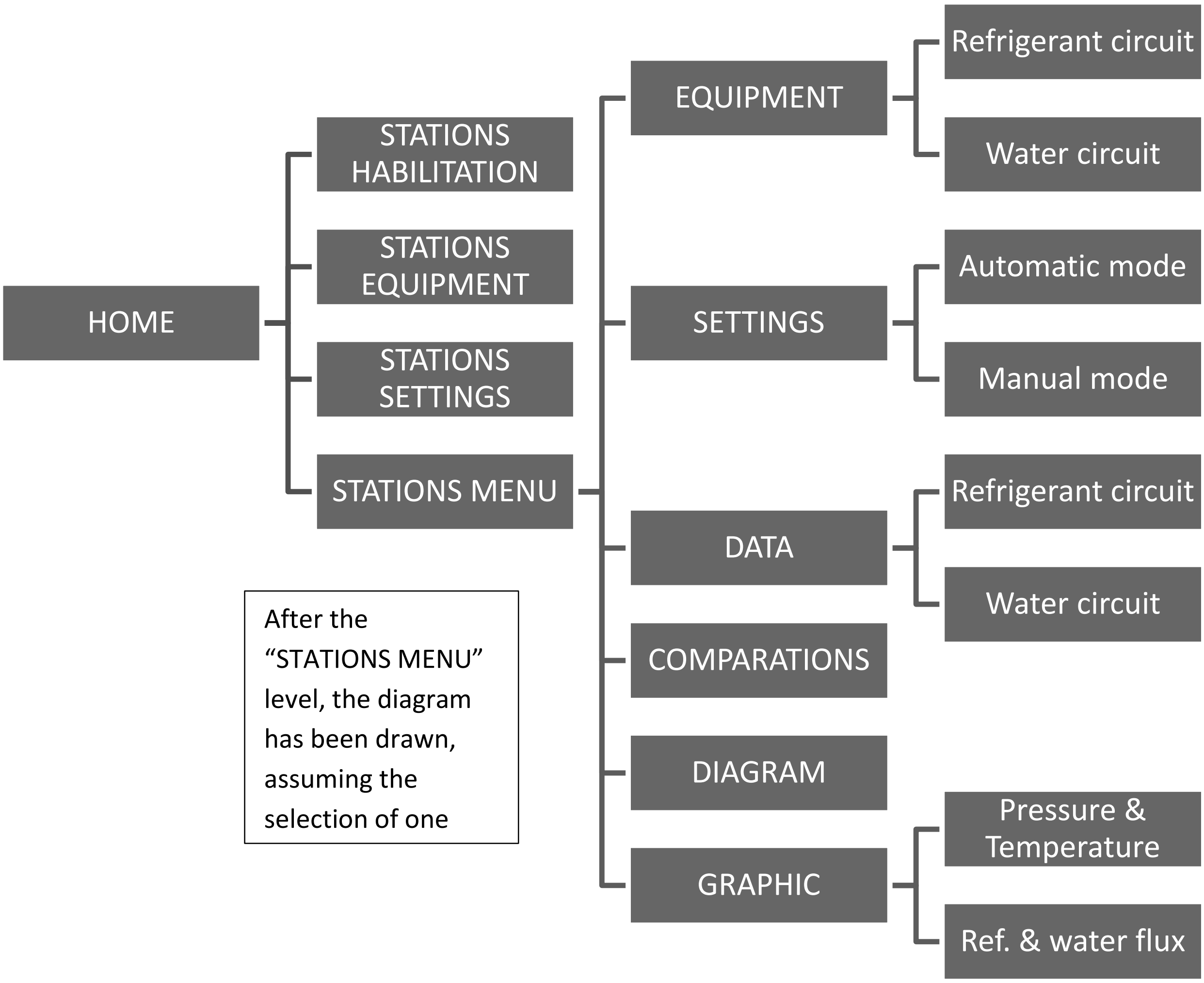


Figure 20-WINCC structure

The process has been defined when the T1,T3 or m_ref sensors haven' t been connected.

Instead to store the value of the sensor (to be used later), the program store its theoretical value, this way it can continue with the rest of the calculations.

2 SCREENS

2.1 HOME SCREEN

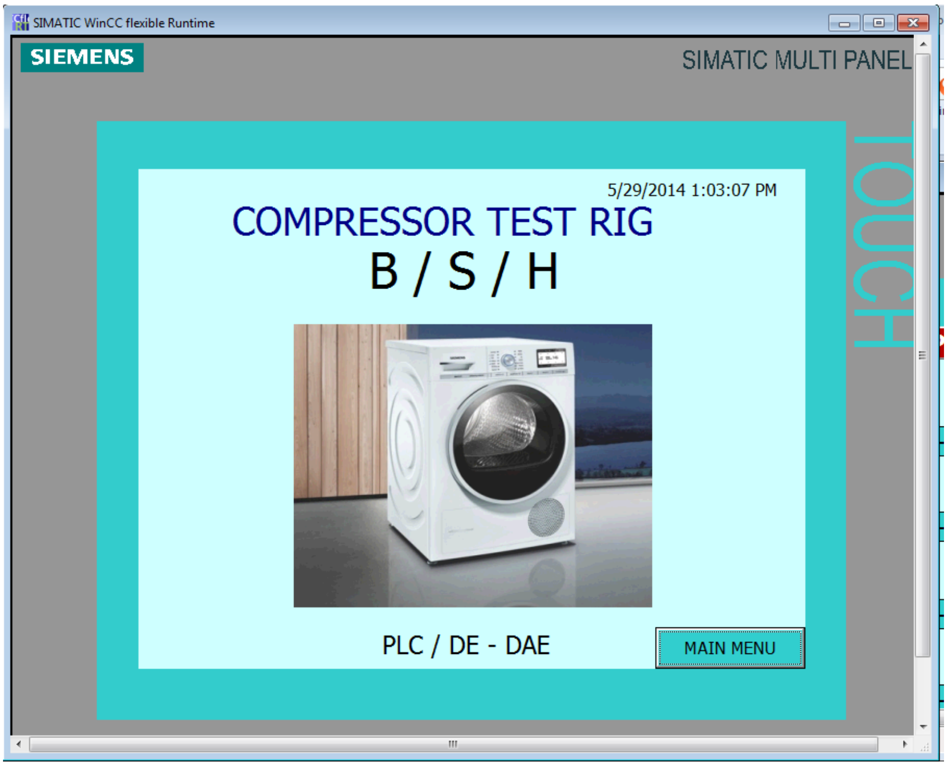
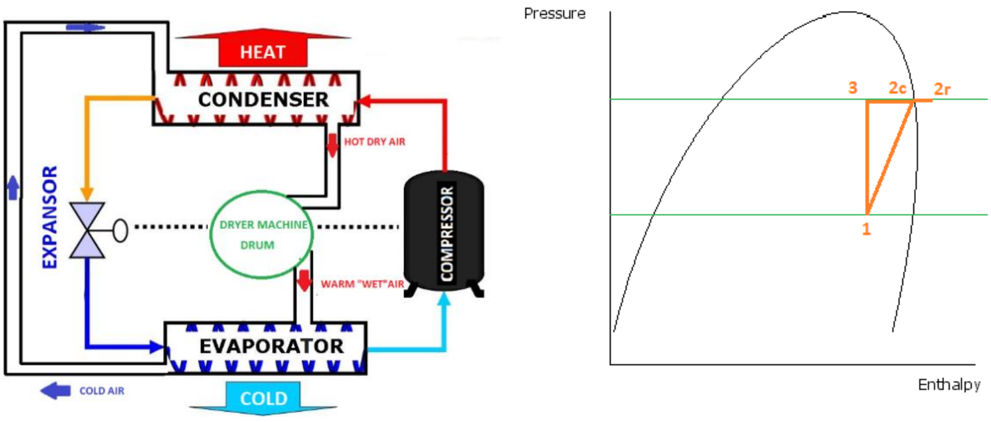


Figure 21-Home screen

Although a picture of a dryer machine have seen selected, although other options are available.



2.2 MAIN MENU

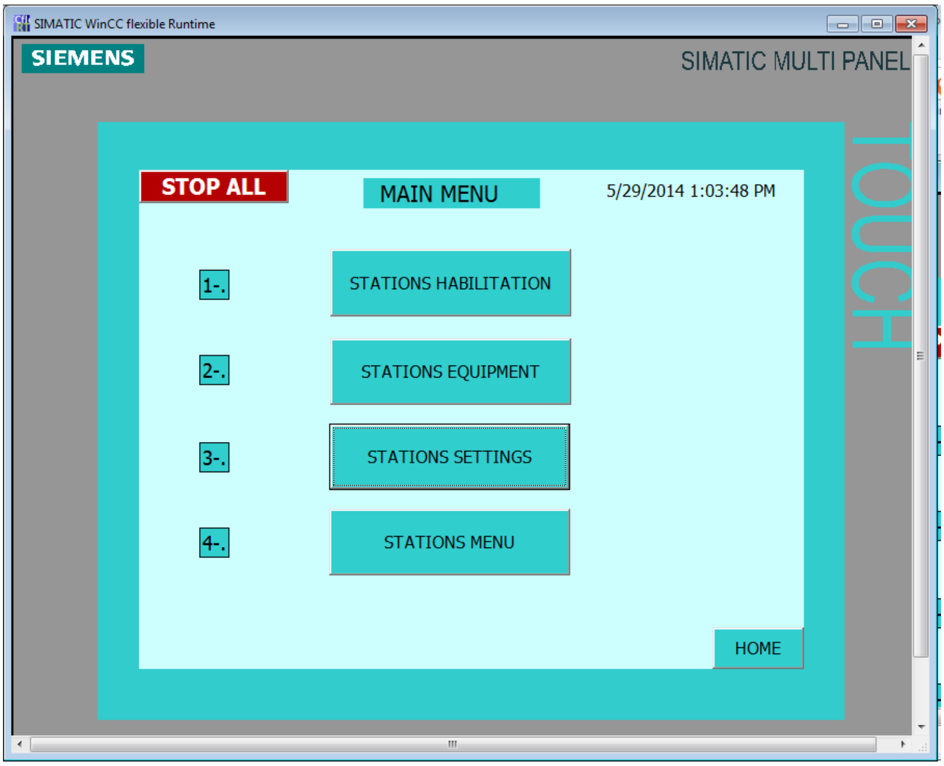


Figure 22-Main menu

The order off the buttons have been defined following a logical development, although it can be done differently. The only order that must be respected is the first one.

The "STATIONS EQUIPMENT", "STATIONS SETTINGS" and "SATIONS MENU" would only give the user the possibility of access, to those stations that were implemented in the first point: "STATIONS HABILITATION".

2.3 STATIONS HABILITATION

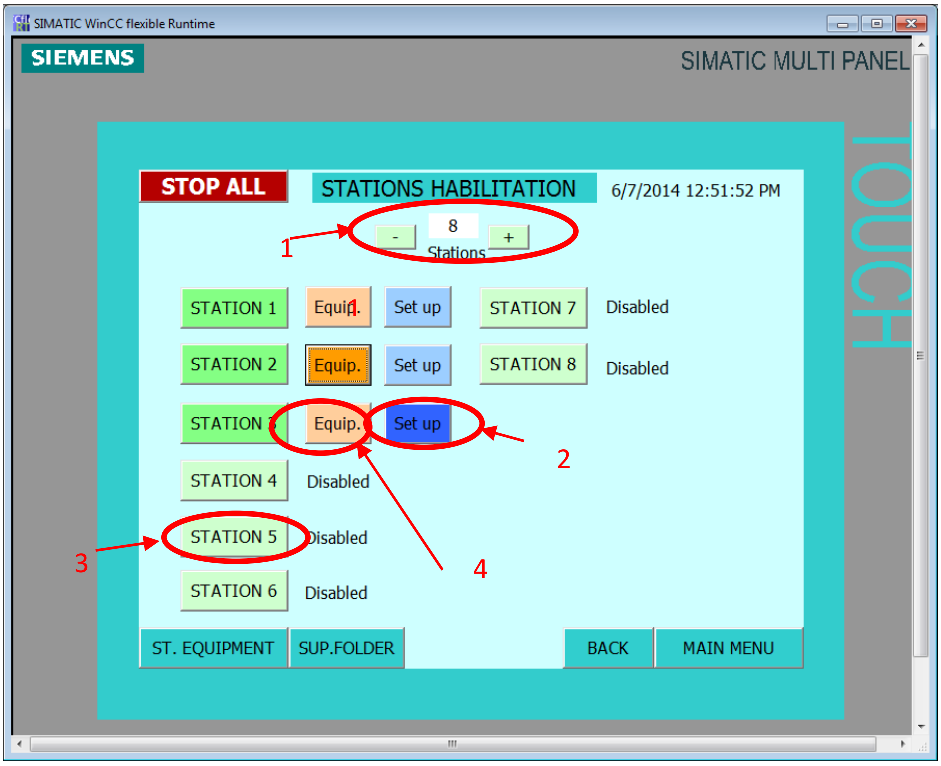


Figure 23-Stations habilitation

1	**It varies the number of stations shown in the screen that could be habilitated**
2	Once that the station has been habilitated, this access guide the user directly to the settings screen of the station. It changes its color once that has been pressed.
3	Pressing the button, the habilitation of the station is completed
4	Once that the station has been habilitated, this access guide the user directly to the equipment screen of the station. It changes its color once that has been pressed.
EQUIPMENT	It guides the user
SUP. FOLDER	It guides the user to the superior folder, in this case : MAIN MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

2.4 STATIONS EQUIPMENT

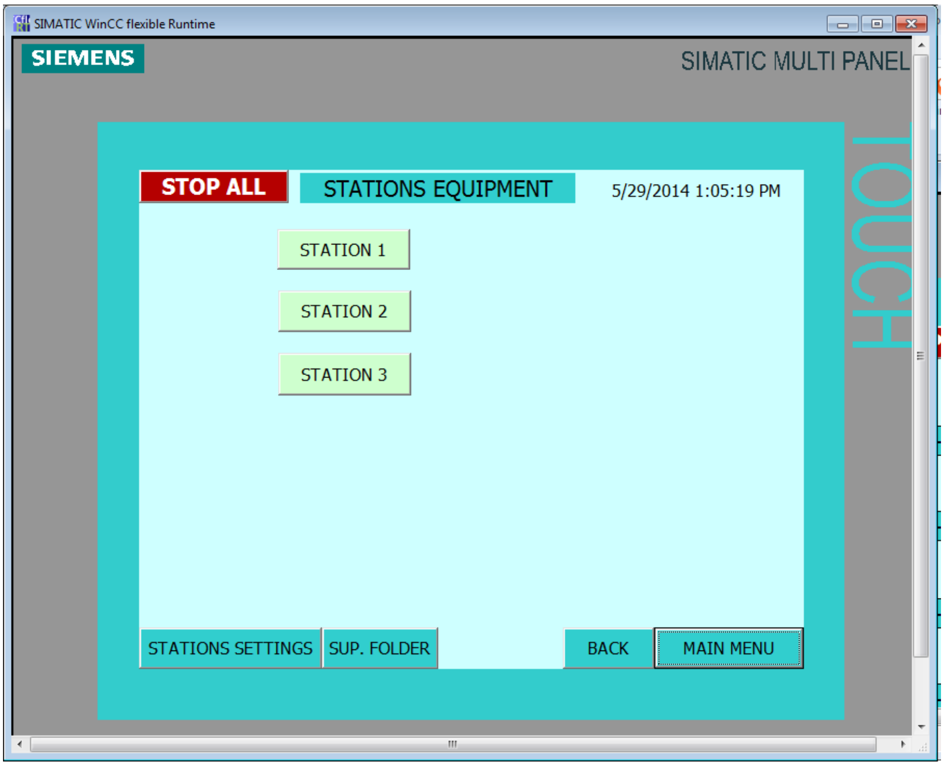


Figure 24-Stations equipment

The stations that have been habilitated appear in the STATIONS MENU. “Clicking” in the stations buttons the specific equipments screen of each station would appear.

STATIONS SETTINGS	It guides the user to the “STATIONS SETTINGS” screen
SUP. FOLDER	It guides the user to the superior folder, in this case : MAIN MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

2.5 STATIONS SETTINGS

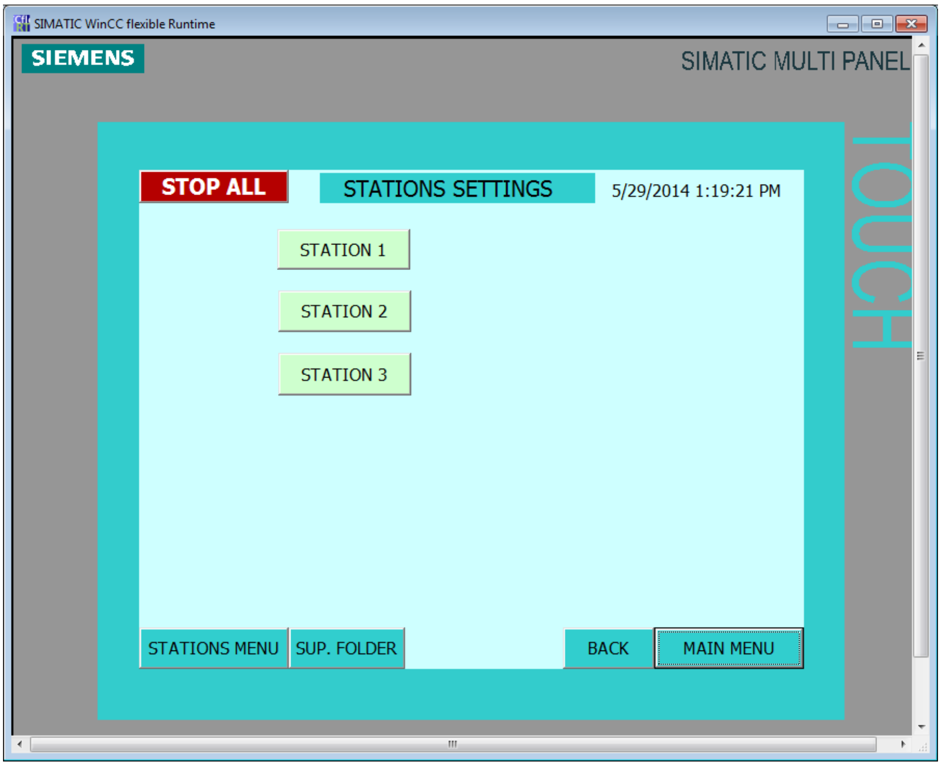


Figure 25-Stations settings

The stations that have been habilitated appear in the STATIONS MENU. “Clicking” in the stations buttons the specific settings screen of each station would appear.

STATIONS MENU	It guides the user to the “STATIONS MENU” screen
SUP. FOLDER	It guides the user to the superior folder, in this case : MAIN MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

2.6 STATIONS MENU

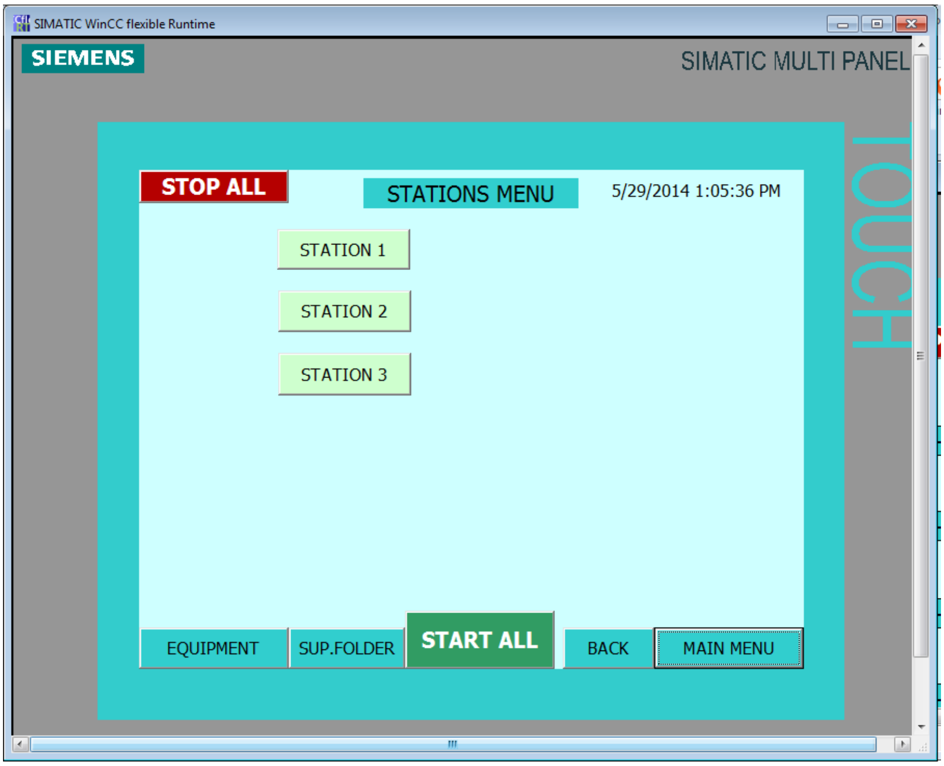


Figure 26-Stations menu

The stations that have been habilitated appear in the STATIONS MENU. “Clicking” in the stations buttons the specific menu of each station would appear.

EQUIPMENT	**It guides the user to the “STATIONS EQUIPMENT” screen**
SUP. FOLDER	It guides the user to the superior folder, in this case : MAIN MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

2.7 MENU 1

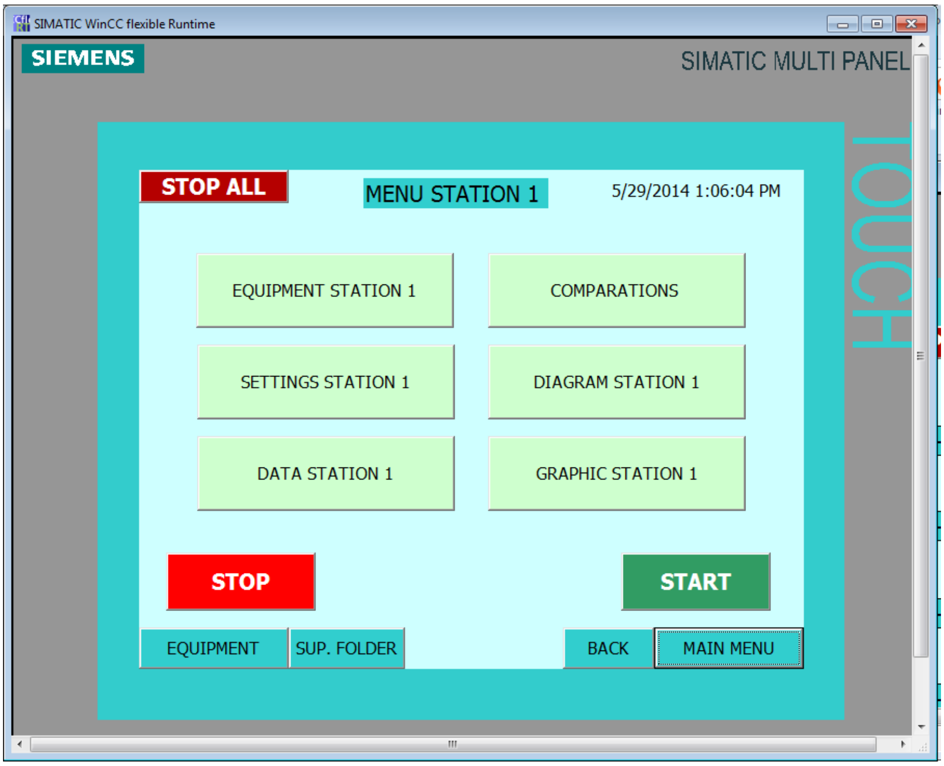


Figure 27-Station 1 Menu

The buttons in this screen guides the user to the specific screens of its station.

EQUIPMENT STATION 1	**To determine the equipment used in this station**
SETTINGS STATION 1	To configure the station 1 (Refrigerant, alarms, set points..)
DATA STATION 1	Access to the measured data of the station
COMPARATIONS	Comparation between the measured values and the Set/ Calculated values
DIAGRAM STATION 1	Diagram of the functioning with the measured and set values
GRAPHIC STATION 1	Access to the magnitudes graphics

EQUIPMENT	**It guides the user to the "STATIONS EQUIPMENT" screen**
SUP. FOLDER	It guides the user to the superior folder, in this case : STATIONS MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

2.8 EQUIPMENT 1

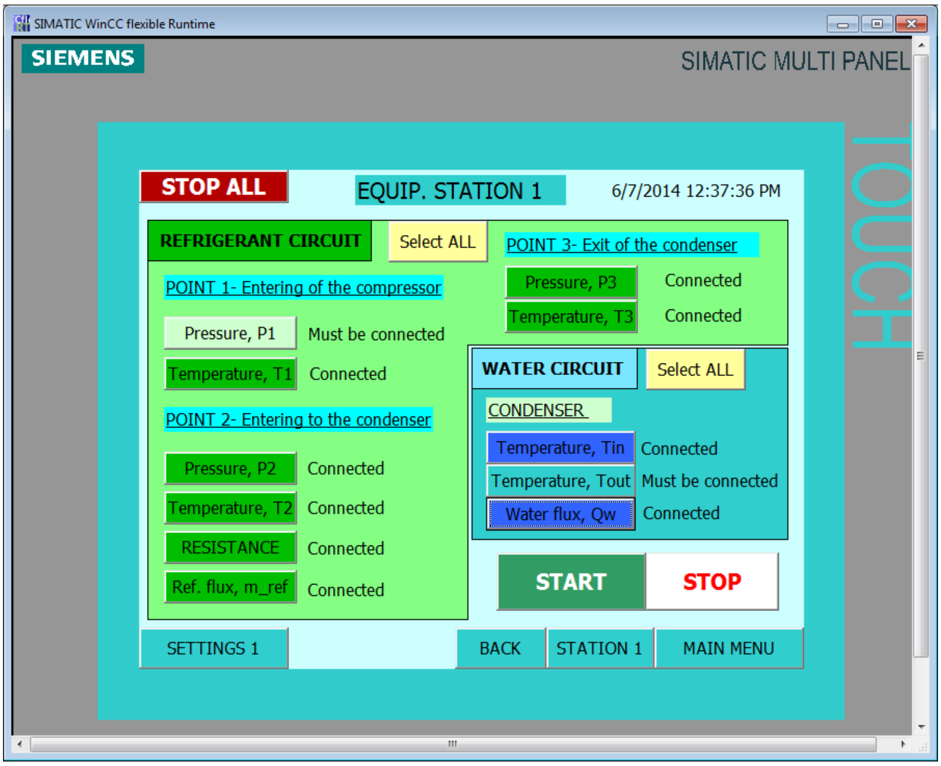


Figure 28-Station 1 Equipment

It is divided in two parts: the refrigerant circuit, and the water circuit. In both of them the user must select the sensors/ equipment that have been implemented in the station. For both cases, there is a “SELEC ALL” button, which “connect” all the sensor/ equipment (of the corresponding circuit) to configure the station faster.

As it is shown, some sensors MUST BE CONNECTED, and so is shown in the HMI.

SETTINGS 1	**It guides the user to the “SETTINGS 1” screen**
STATION 1	It guides the user to the STATION 1 MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

2.9 SETTING AUTOMATIC

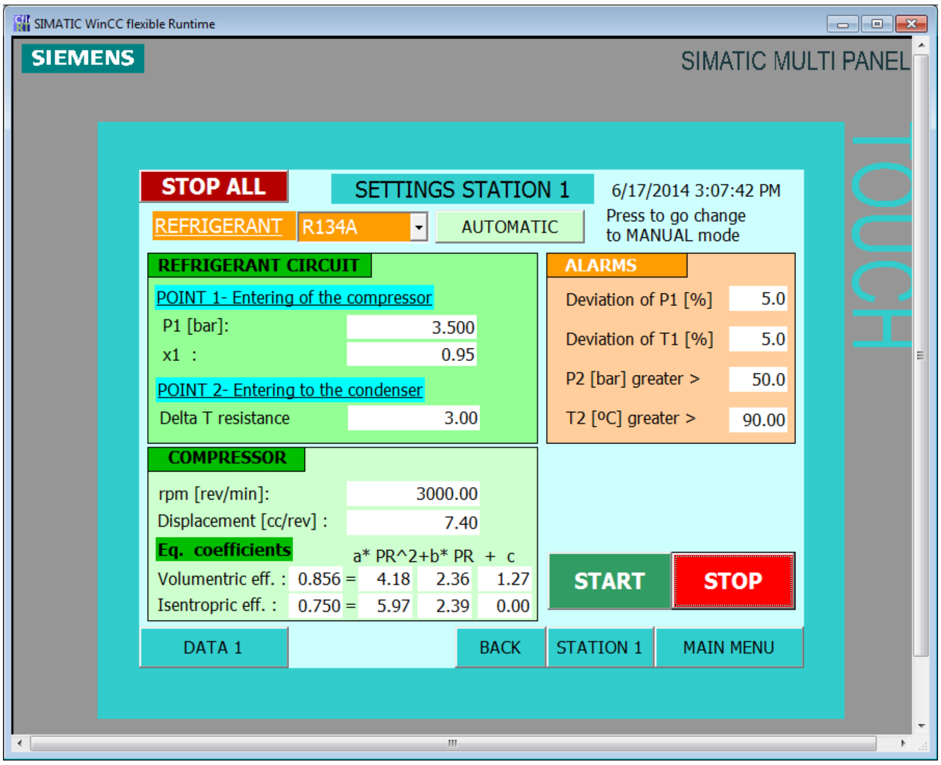


Figure 29-Settings station 1, automatic

In this screen the user can choose between the automatic or manual mode. When the automatic mode is set, the desired value of the pressure and the quality at the operating point 1 have to be fixed. At this point, the user must also fix the parameters of the compressor (used to calculate the refrigerant flux). For the efficiencies, the parameters of the second degree equation that compute the efficiencies must be introduced.

DATA 1	**It guides the user to the “DATA 1” screen**
STATION 1	It guides the user to the STATION 1 MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

The “Alarm block” has been implemented to assure the correct functioning of the test bench as well as for safety reasons. The thermodynamic components, the circuit in general, have been chosen for a maximum pressure and temperature.

DEVIATION P1 [%]	**Indicates the percentage over the P1_set, that the measured value can be bellow or above the pressure desired.**
DEVIATION T1 [%]	Indicates the percentage over the T1sat, that the measured value can be bellow or above the temperature desired.
P2 [bar] greater >	Maximum value that the pressure can achieve
T2 [ºC] greater >	Maximum value that the temperature can achieve

When the “Tin” sensor (water input temperature sensor) has not been connected, it can be fixed theoretically assuming that the temperature fixed in the chiller would be the same.

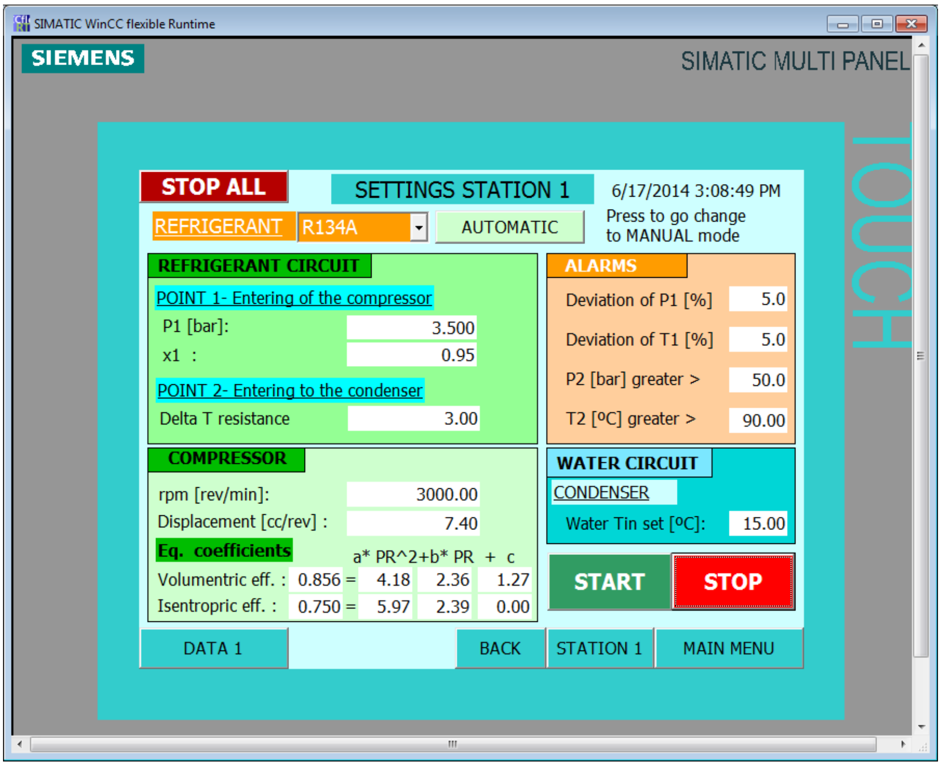


Figure 30-Settings station1, automatic (No Tin sensor)

2.10 SETTING MANUAL

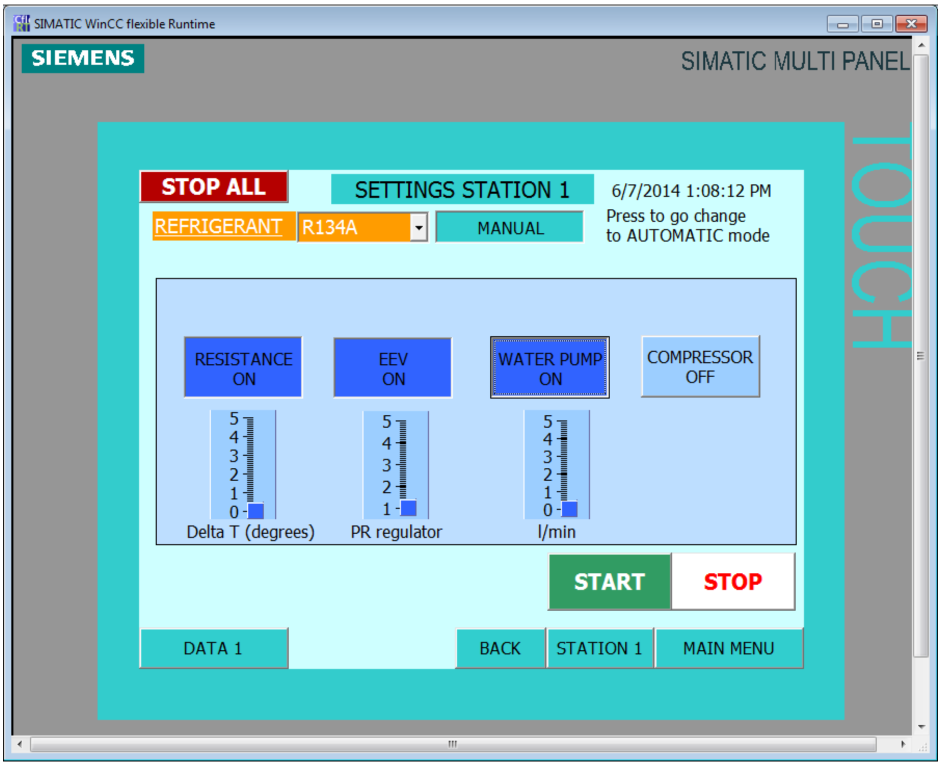


Figure 31-Settings station 1, manual

The manual mode, has been defined so the individual components could be tested. Once the user press a button it change its color and; either an “ON” statement appears, slide control does.

DATA 1	**It guides the user to the “DATA 1” screen**
STATION 1	It guides the user to the STATION 1 MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

The resistance control is with the difference of temperature to be achieved. The pump, with the water flux. And the EEV control is with the pressure ratio (P2/P1~P3/P1) to be achieved.

2.11 DATA 1

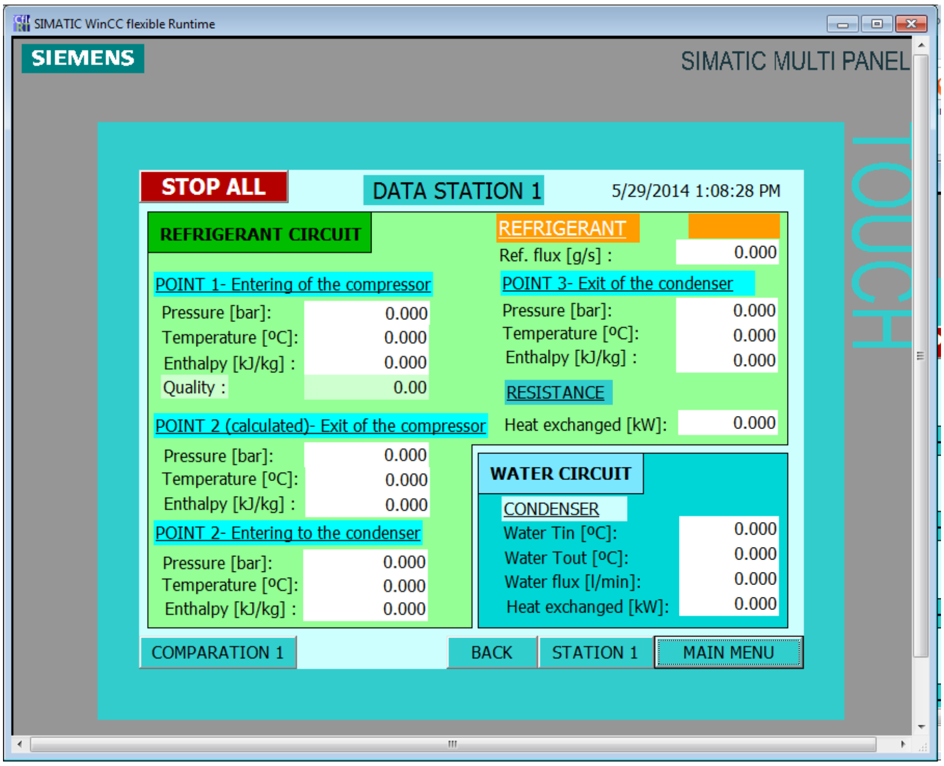


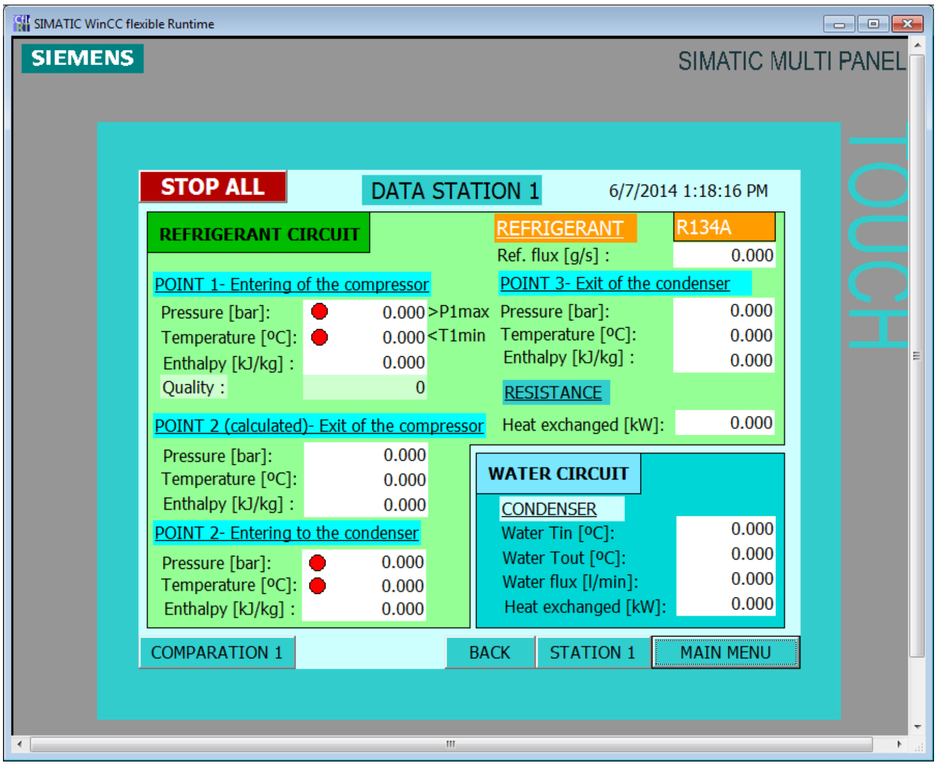
Figure 32-Data station 1

The measured values of the station are shown separately (depending on if it’s a refrigerant measurement, or a water circuit one) in this screen. There are some values such as the point 2 calculates, or the quality at point 1, that are nor measured.

COMPARATION 1	**It guides the user to the “COMPARATION 1” screen**
STATION 1	It guides the user to the STATION 1 MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

When the values of T1, P1, T2 or P2 don’t fulfil the “ALARM” specifications, the red indicator is only visible when the error has occurred, furthermore, it bliks.

When a sensor is not connected, it doesn’t appear in this screen. Eg: P3,T3, m_ref not connected.



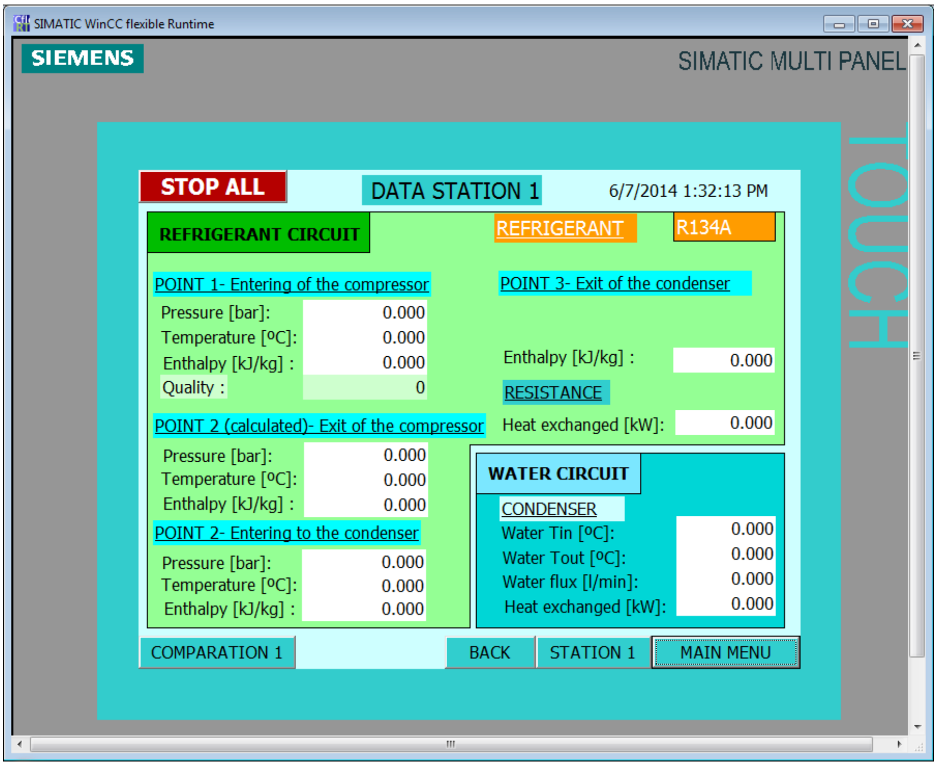


Figure 33-Data station 1, alarms

2.12 COMPARATIONS 1

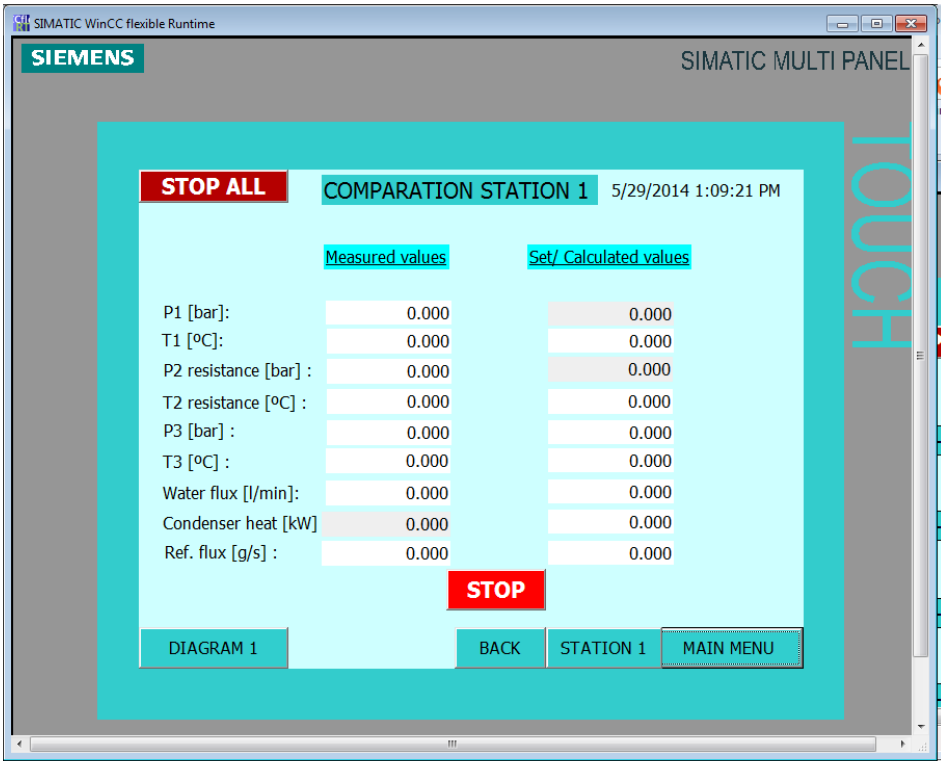


Figure 34-Comparation 1

At this screen the comparations between the measured values and the set / calculated ones are compared. This way it can be shown, the “ideality” of the station.

DIAGRAM 1	**It guides the user to the “DIAGRAM 1” screen**
STATION 1	It guides the user to the STATION 1 MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

If a sensor is not connected, its name would be gray and there would be no “measured value”.

When the values of T1, P1, T2 or P2 don’t fulfil the “ALARM” specifications:

The red indicator is only visible when the error has occurred, furthermore, it bliks. When a sensor is not connected, it doesn’t appear in this screen. Eg: P3, T3, m_ref not connected.

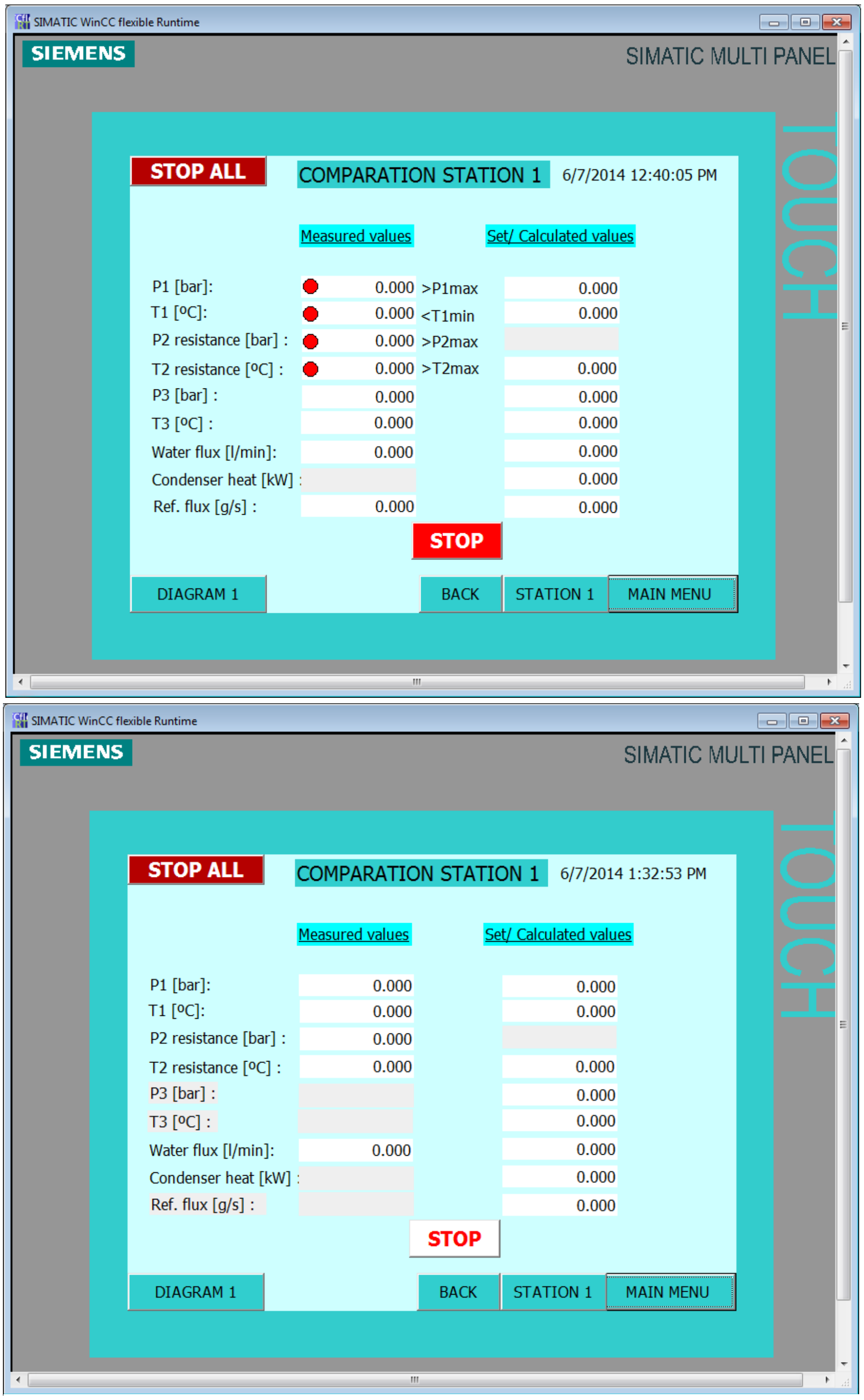


Figure 35-Comparation 1, alarms

2.13 DIAGRAM 1

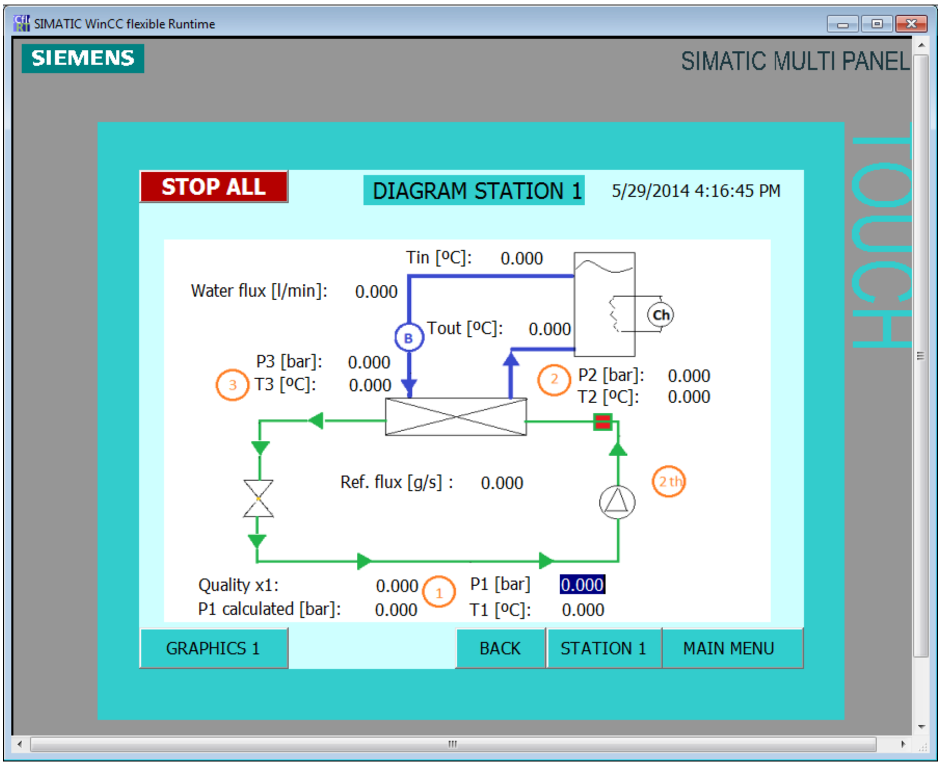


Figure 36- Diagram station 1

The measured values are situated next to the operating point in which they were measured. The set values "x1" and "P1 set" are also shown next to the operating point 1.

GRAPHICS 1	It guides the user to the "GRAPHICS 1" screen
STATION 1	It guides the user to the STATION 1 MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

When the values of T1, P1, T2 or P2 don’t fulfil the “ALARM” specifications. When a sensor is not connected, it doesn’t appear in this screen. Eg: P3, T3, m_ref not connected.

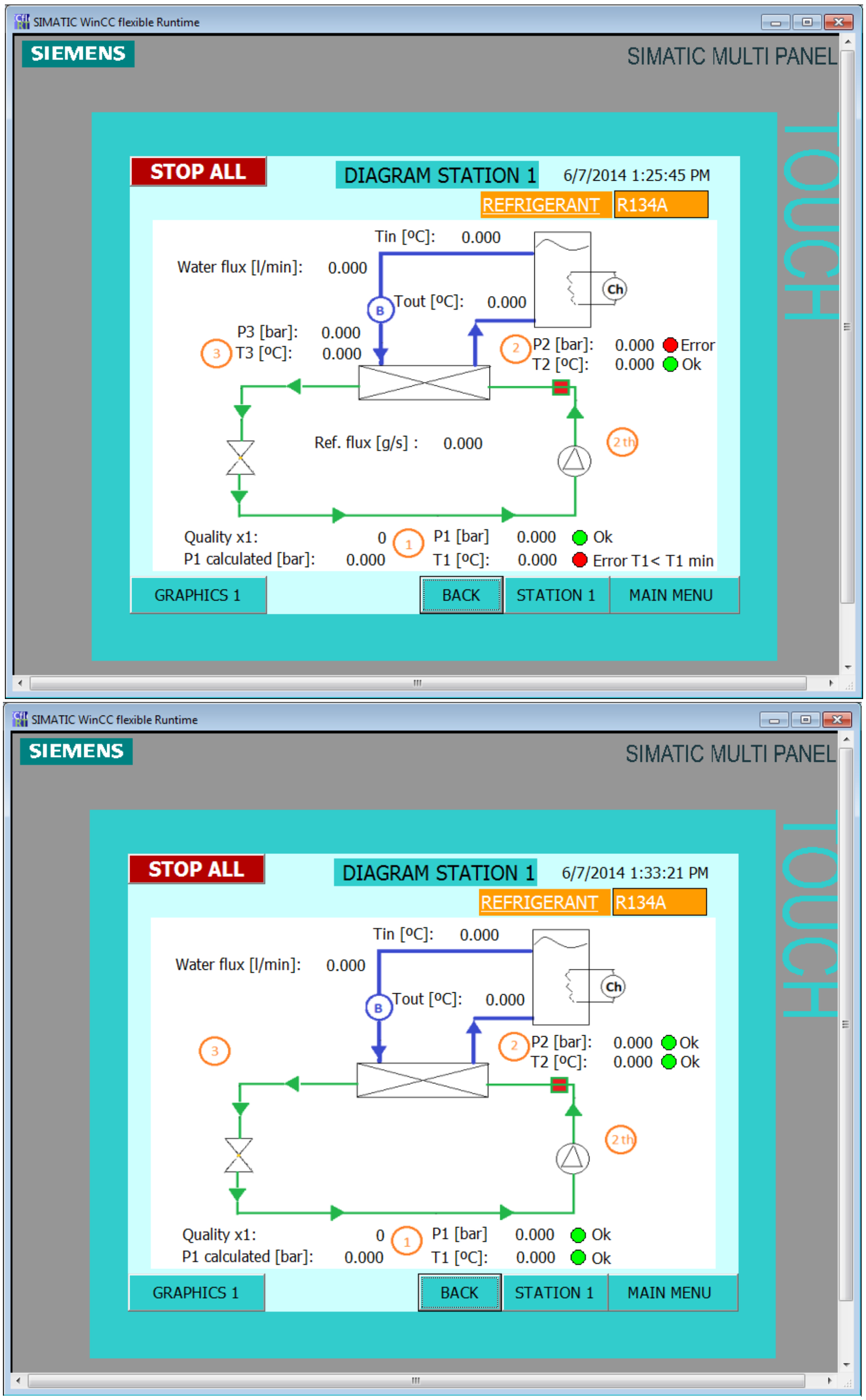


Figure 37-Diagram station 1, alarms

2.14 GRAPHICS 1

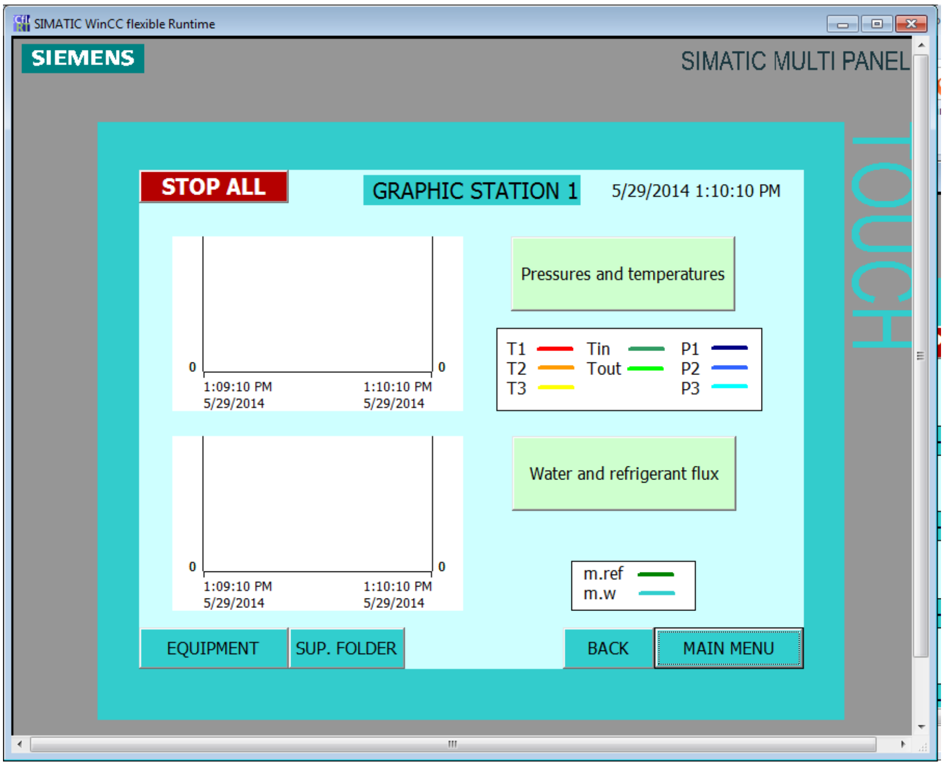


Figure 38-Graphics station 1

In this screen, the user can visualize one minute of the variables values shown in the legends (values registered every 2 seconds). If there is an interest to see more time or bigger, the corresponding buttons must be pressed; “Pressures and temperatures” or “Water and refrigerant flux”.

GRAPHICS 1	It guides the user to the “GRAPHICS 1” screen
STATION 1	It guides the user to the STATION 1 MENU
BACK	Goes to the previous screen
MAIN MENU	This button is at the same place in all the project. It guides the user to the MAIN MENU

When a sensor has not been connected, its theoretical value would appear in the graphic. However, it would be shown a “Th” (stand for theoretical) to indicate that the value shown is not a measured value. Eg: P3, T3 and m_ref haven’t been connected

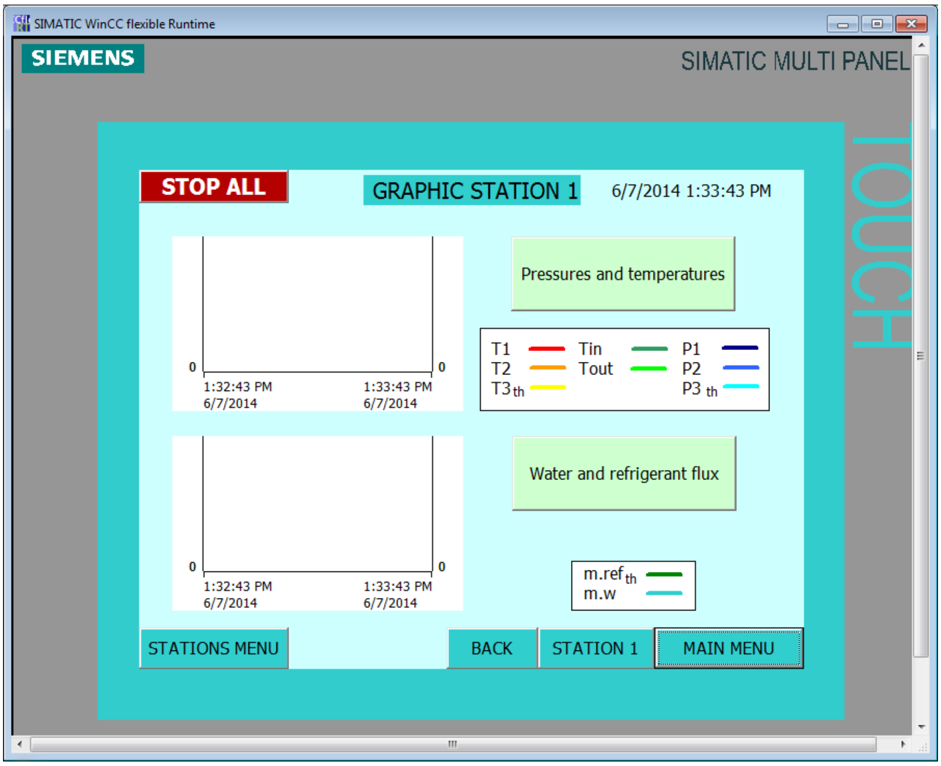


Figure 39-Graphic station 1, no sensors connected

2.15 GRAPHIC P&T

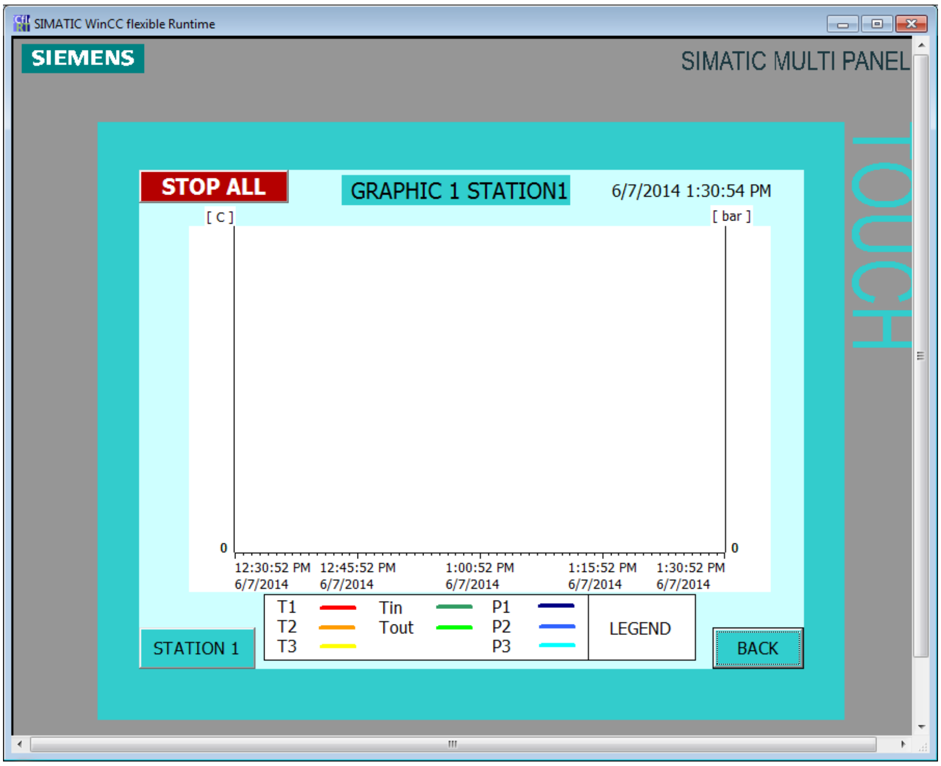


Figure 40-T&P graphic

This screens shows the graphic of pressures and temperatures maximize. It can show up to an hour of the variables values (values registered every 5 seconds).

STATION 1	It guides the user to the STATION 1 MENU
BACK	Goes to the previous screen: GRAPHICS 1

When a sensor has not been connected, its theoretical value would appear in the graphic. However, it would be shown a “Th” (stand for theoretical) to indicate that the value shown is not a measured value. Eg: P3, T3 and m_ref haven’t been connected

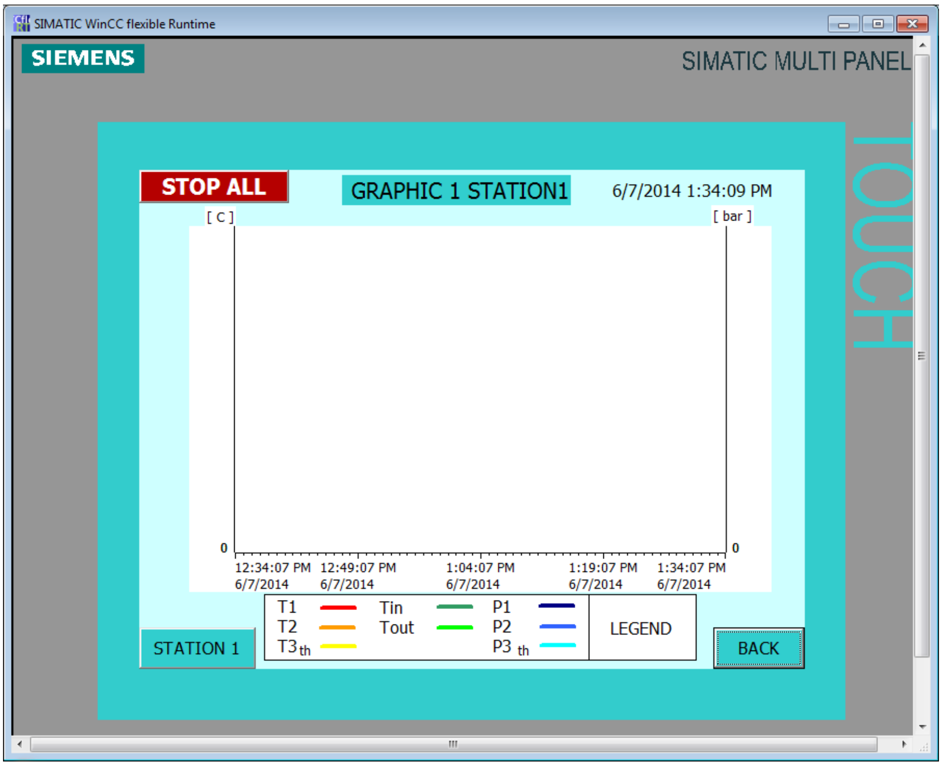


Figure 41- T&P graphic, no sensors connected

2.16 GRAPHIC FLUX

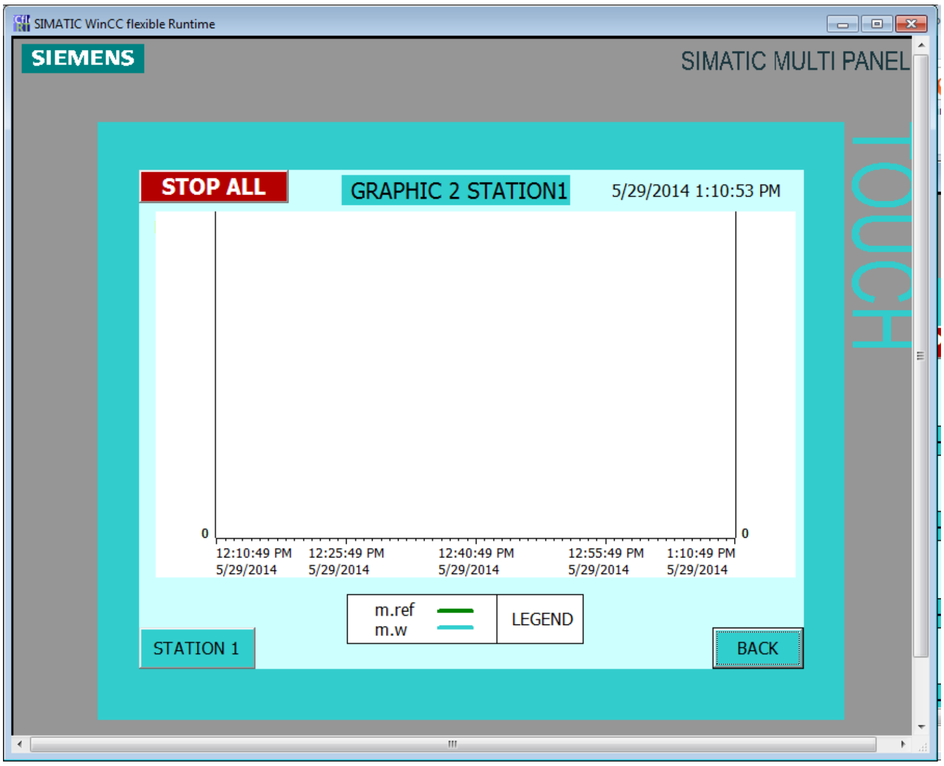


Figure 42- Flux graphic

It shows the refrigerant and water flux graphic maximize. As the other graphic, it can show up to an hour of the variables values (values registered every 5 seconds).

STATION 1	**It guides the user to the STATION 1 MENU**
BACK	Goes to the previous screen: GRAPHICS 1

When a sensor has not been connected, its theoretical value would appear in the graphic. However, it would be shown a “Th” (stand for theoretical) to indicate that the value shown is not a measured value. Eg: P3, T3 and m_ref haven’t been connected

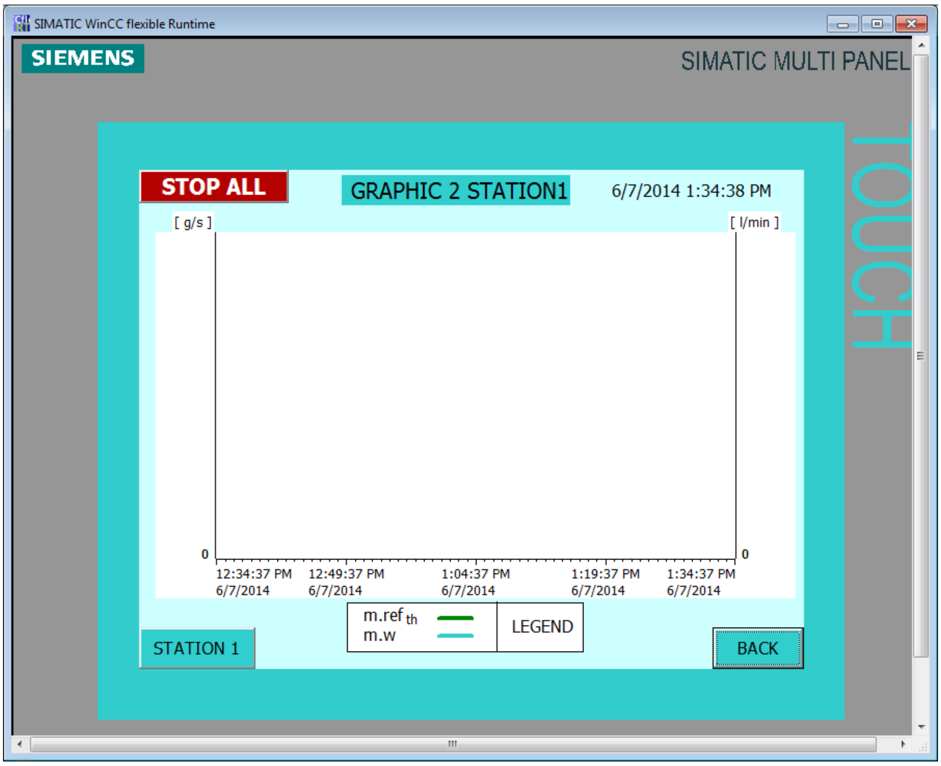


Figure 43-Flux graphic, no sensors connected

3 CONNECTIVITY & VARIABLES & TEXT LISTS

3.1 CONNECTIVITY

As an interface between the PLC and excel is needed to compute the calculations, WINCC would be used as an intermediate.

Besides the variables that must be defined and import, for the proper visualization of the data, as well as for the graphic events that have been programed (blinks…), the variables to be exported to an excel file would have to be also defined.

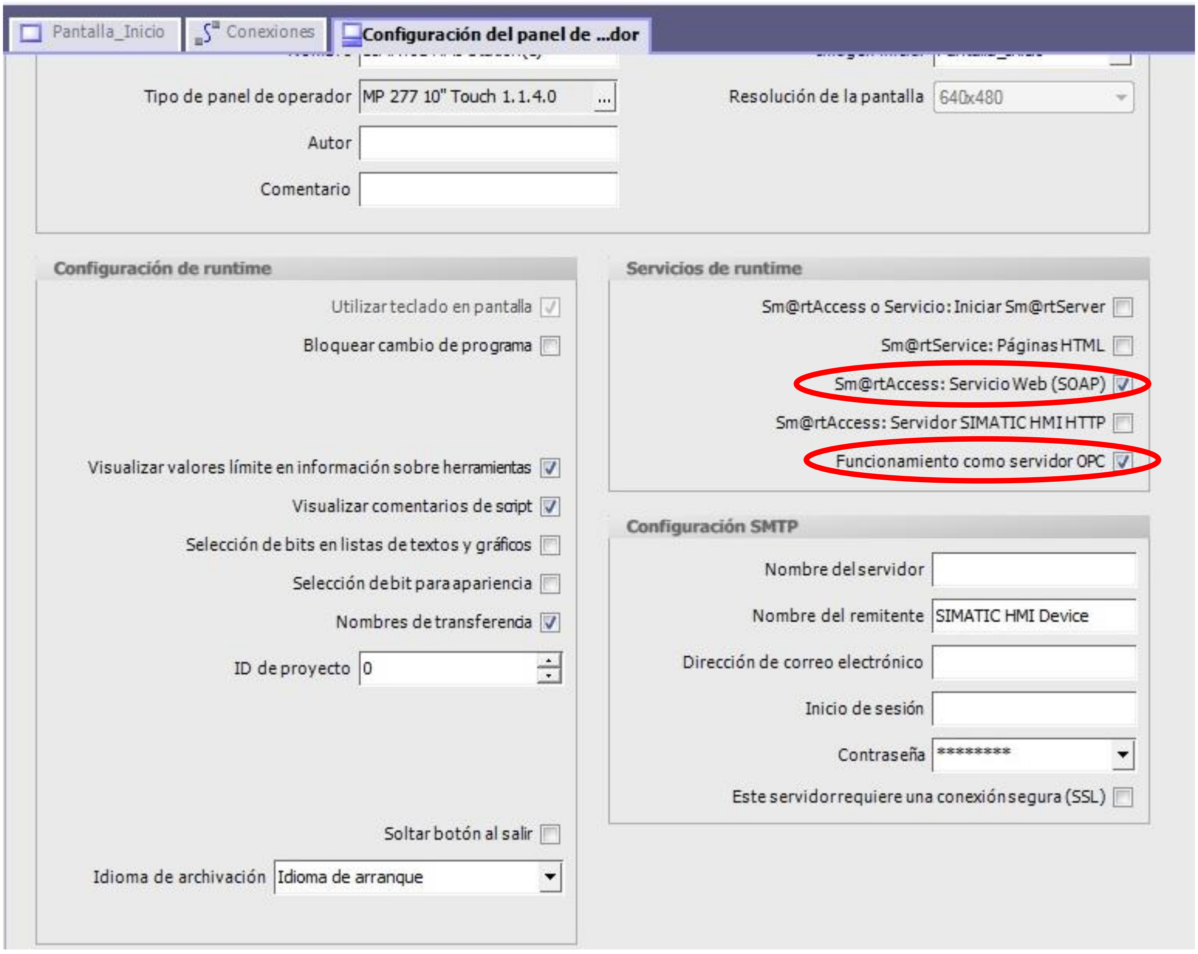


Figure 44-Connectivity

To enable the communication, and the exportation, those options must be selected.

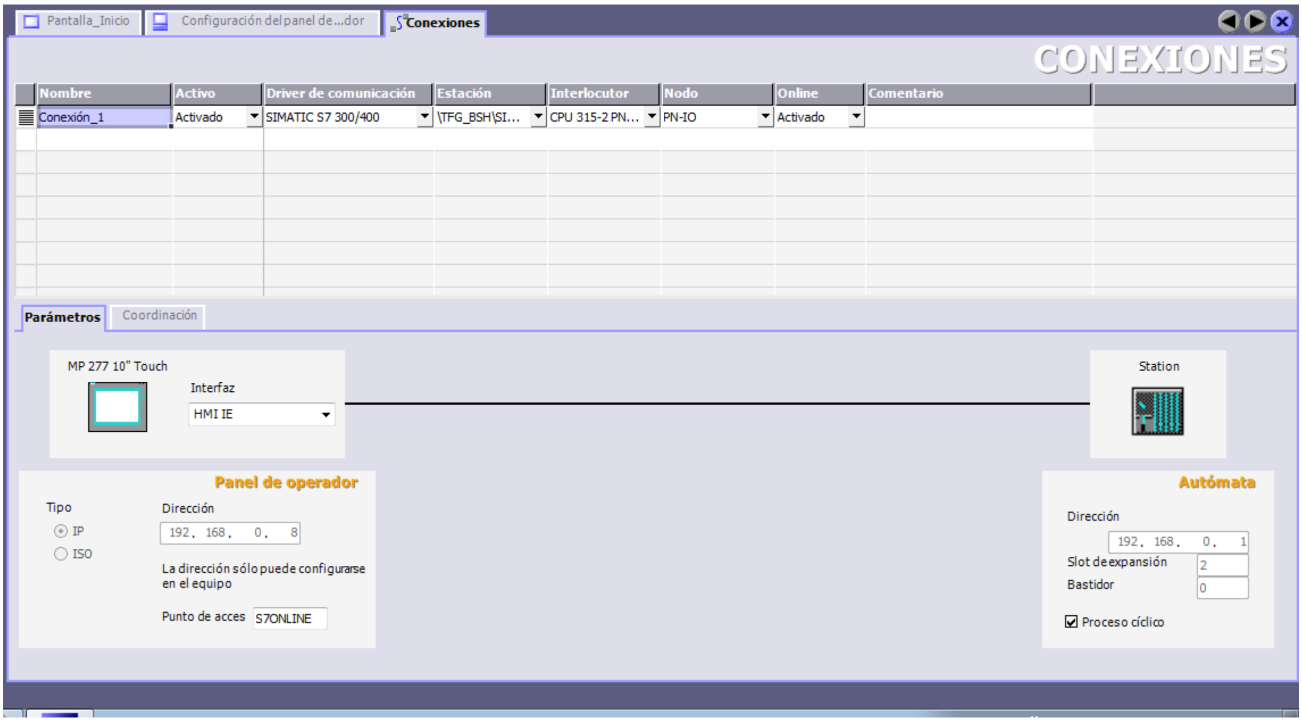
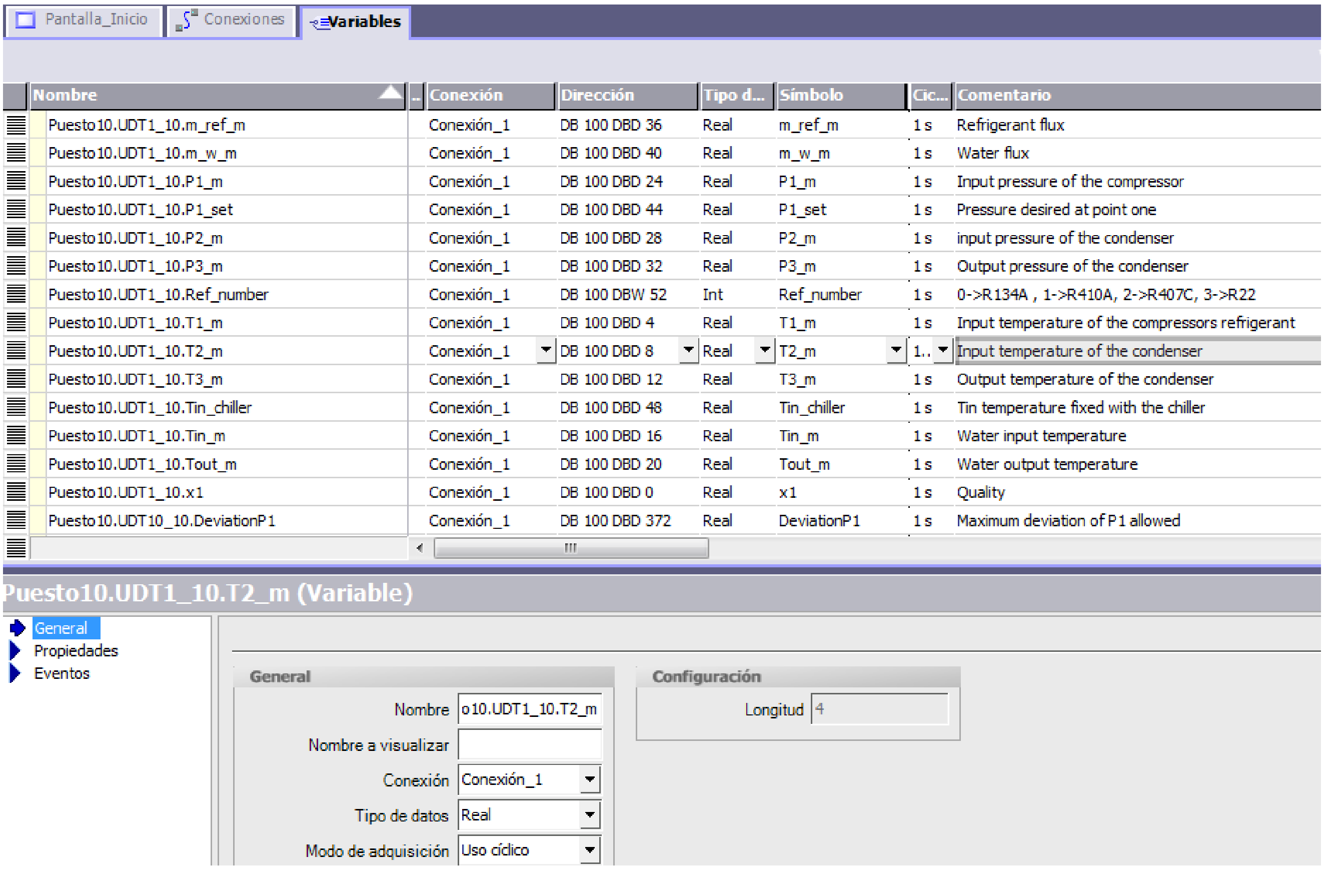


Figure 45-IP Adress. Connection between PLC and the HMI

3.2 VARIABLES

The variables for the 12 stations have been included in WINCC to leave everything ready for their implementation.

When defining the variables, the programmer must define the connection. In this case is the “conexion_1”, besides, the direction of the variable must be introduce along with its data type.



Nombre	Conexión	Dirección	Tipo d...	Símbolo	Cic...	Comentario
Puesto10.UDT1_10.m_ref_m	Conexión_1	DB 100 DBD 36	Real	m_ref_m	1 s	Refrigerant flux
Puesto10.UDT1_10.m_w_m	Conexión_1	DB 100 DBD 40	Real	m_w_m	1 s	Water flux
Puesto10.UDT1_10.P1_m	Conexión_1	DB 100 DBD 24	Real	P1_m	1 s	Input pressure of the compressor
Puesto10.UDT1_10.P1_set	Conexión_1	DB 100 DBD 44	Real	P1_set	1 s	Pressure desired at point one
Puesto10.UDT1_10.P2_m	Conexión_1	DB 100 DBD 28	Real	P2_m	1 s	input pressure of the condenser
Puesto10.UDT1_10.P3_m	Conexión_1	DB 100 DBD 32	Real	P3_m	1 s	Output pressure of the condenser
Puesto10.UDT1_10.Ref_number	Conexión_1	DB 100 DBW 52	Int	Ref_number	1 s	0->R134A , 1->R410A, 2->R407C, 3->R22
Puesto10.UDT1_10.T1_m	Conexión_1	DB 100 DBD 4	Real	T1_m	1 s	Input temperature of the compressors refrigerant
Puesto10.UDT1_10.T2_m	Conexión_1	DB 100 DBD 8	Real	T2_m	1..	Input temperature of the condenser
Puesto10.UDT1_10.T3_m	Conexión_1	DB 100 DBD 12	Real	T3_m	1 s	Output temperature of the condenser
Puesto10.UDT1_10.Tin_chiller	Conexión_1	DB 100 DBD 48	Real	Tin_chiller	1 s	Tin temperature fixed with the chiller
Puesto10.UDT1_10.Tin_m	Conexión_1	DB 100 DBD 16	Real	Tin_m	1 s	Water input temperature
Puesto10.UDT1_10.Tout_m	Conexión_1	DB 100 DBD 20	Real	Tout_m	1 s	Water output temperature
Puesto10.UDT1_10.x1	Conexión_1	DB 100 DBD 0	Real	x1	1 s	Quality
Puesto10.UDT10_10.DeviationP1	Conexión_1	DB 100 DBD 372	Real	DeviationP1	1 s	Maximum deviation of P1 allowed

Figure 46-WINCC Variables

3.3 TEXT LISTS

WINCC offers the possibility to create text lists (and graphic lists). E.g: To develop the displayable multiple-choice menu for the refrigerant, a text list was created.

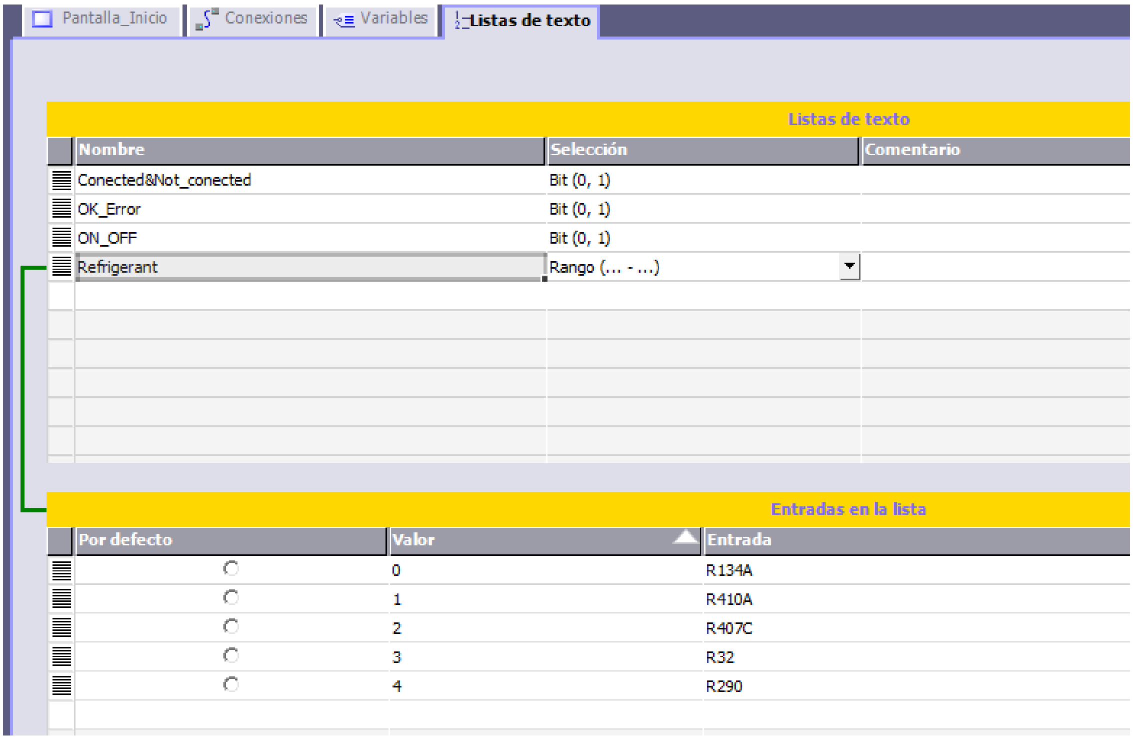


Figure 47- Text Lists

ANNEX VI: EXCEL AND VISUAL BASIC CODE

1 INTERFACE WITH WINCC

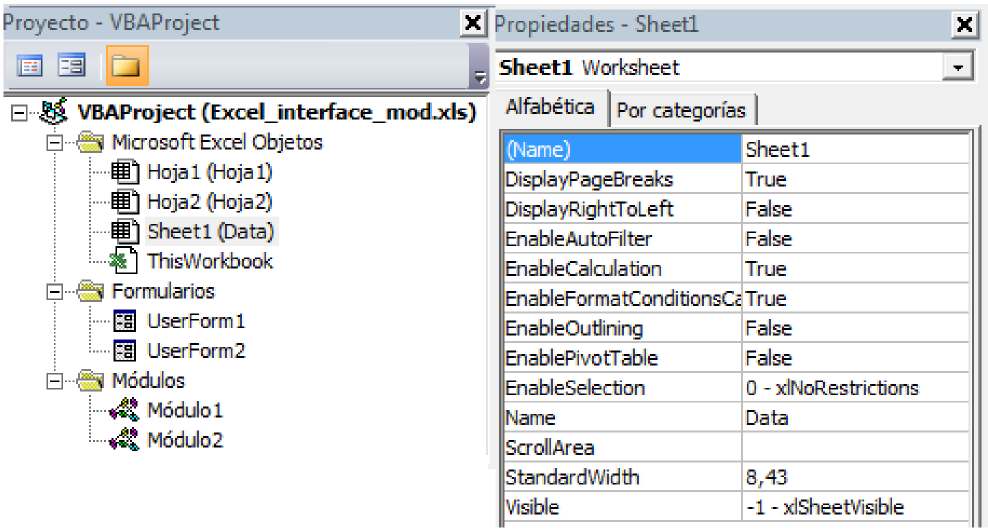


Figure 48-WINCC Structure

1.1 WORKBOOK

```
VERSION 1.0 CLASS
BEGIN
  MultiUse = -1  'True
END
Attribute VB_Name = "ThisWorkbook"
Attribute VB_GlobalNameSpace = False
Attribute VB_Creatable = False
Attribute VB_PredeclaredId = True
Attribute VB_Exposed = True
Dim Server_Avail As Boolean

Private Sub Workbook_Open()
    Server_Avail = False

   ' update_data
End Sub
```

```
Public Sub check_server()
    Dim xml As New XMLHTTP60
    Dim sURL As String
    Dim sEnv As String
    Dim xmlhtp As New MSXML2.XMLHTTP60
    Dim xmlDoc As New DOMDocument
    Dim soap_server As String

    soap_server = Cells(1, 2)

    On Error Resume Next


    sURL = "http://" & soap_server & "/soap/RuntimeAccess?wsdl"
    xmlhtp.Open "GET", sURL, False
    xmlhtp.send

    If (Err.Number > 0 Or xmlhtp.Status <> 200) Then
        Server_Avail = False
        MsgBox "There is a problem contacting the SOAP server at " &
soap_server
    Else
        Server_Avail = True
    End If
End Sub


Public Function get_response(tag As String) As String
    Dim xml As New XMLHTTP60
    Dim sURL As String
    Dim sEnv As String
    Dim xmlhtp As New MSXML2.XMLHTTP60
    Dim xmlDoc As New DOMDocument
    Dim soap_server As String

    soap_server = Cells(1, 2)

    sURL = "http://" & soap_server & "/soap/RuntimeAccess"

    sEnv = "<?xml version=""1.0"" encoding=""utf-8""?>"
    sEnv = sEnv & "<soap:Envelope
targetNamespace=""http://tempuri.org/wsdl/""
xmlns:wsdlns=""http://tempuri.org/wsdl/""
xmlns:soap=""http://schemas.xmlsoap.org/wsdl/soap/""
xmlns:xsd=""http://www.w3.org/2001/XMLSchema""
xmlns=""http://schemas.xmlsoap.org/wsdl/"" >"
    sEnv = sEnv & "  <soap:Body>"
    sEnv = sEnv & "    <GetValue xmlns=""http://tempuri.org/wsdl/"">"
    sEnv = sEnv & "      <A type=""xsd:string"">""" & tag & """</A>"
    sEnv = sEnv & "    </GetValue>"
```

```
    sEnv = sEnv & "  </soap:Body>"
    sEnv = sEnv & "</soap:Envelope>"

    With xmlhtp
        .Open "post", sURL, False, "administrator", "100"
        '.Open "post", sURL, False, "HH", "200"
        .setRequestHeader "Host", soap_server
        .setRequestHeader "Content-Type", "text/xml; charset=utf-8"
        .setRequestHeader "soapAction", "http://" & soap_server &
":80/soap/RuntimeAccess"
        .setRequestHeader "Accept-encoding", "zip"
        .send sEnv
        xmlDoc.LoadXML .responseText
    '    MsgBox .responseText
    End With

    get_response = xmlDoc.Text


End Function

Public Function set_value(tag As String, value As String) As String
    Dim xml As New XMLHTTP60
    Dim sURL As String
    Dim sEnv As String
    Dim xmlhtp As New MSXML2.XMLHTTP60
    Dim xmlDoc As New DOMDocument
    Dim soap_server As String

    soap_server = Cells(1, 2)

    sURL = "http://" & soap_server & "/soap/RuntimeAccess"

    sEnv = "<?xml version=""1.0"" encoding=""utf-8""?>"
    sEnv = sEnv & "<soap:Envelope
targetNamespace=""http://tempuri.org/wsdl/""
xmlns:wsdlns=""http://tempuri.org/wsdl/""
xmlns:soap=""http://schemas.xmlsoap.org/wsdl/soap/""
xmlns:xsd=""http://www.w3.org/2001/XMLSchema""
xmlns=""http://schemas.xmlsoap.org/wsdl/"" >"
    sEnv = sEnv & "  <soap:Body>"
    sEnv = sEnv & "    <SetValue xmlns=""http://tempuri.org/wsdl/"">"
    sEnv = sEnv & "      <A type=""xsd:string"">" & tag & "</A>"
    sEnv = sEnv & "      <B type=""xsd:string"">" & value & "</B>"
    sEnv = sEnv & "    </SetValue>"
    sEnv = sEnv & "  </soap:Body>"
    sEnv = sEnv & "</soap:Envelope>"

    With xmlhtp
        .Open "post", sURL, False, "administrator", "100"
```

```
        '.Open "post", sURL, False, "HH", "200"
        .setRequestHeader "Host", soap_server
        .setRequestHeader "Content-Type", "text/xml; charset=utf-8"
        .setRequestHeader "soapAction", "http://" & soap_server &
":80/soap/RuntimeAccess"
        .setRequestHeader "Accept-encoding", "zip"
        .send sEnv
        xmlDoc.LoadXML .responseText
    '    MsgBox .responseText
    End With

    set_value = xmlDoc.Text


End Function


Public Sub update_data()

    Dim row As Integer
    Dim tag As String
    Dim value As String
    Dim objWorksheet
    Set objWorksheet = Excel.Worksheets("Data")

    If (Server_Avail = False) Then
        check_server
    End If

    If (Server_Avail = True) Then

        'Startwert, an welcher Zeile die erste HMI Variable steht
        'Start value at which row the first HMI variable begins
        row = 3

        Do

        'Vorgabe, in welcher Spalte die HMI Variablen angegeben sind.
In diesem Fall "Spalte B"
        'Setting the column in which the HMI variables are specified.
In this case, "Column B"
        tag = objWorksheet.Cells(row, 2)

        'Auswertung, steht in der Spalte 4 der Buchstabe "W" oder "w"
f³r "writing"
        'Evaluation, in Column 4 are the character "W" or "w" for
"writing"
        If (objWorksheet.Cells(row, 4) = "W") Or
(objWorksheet.Cells(row, 4) = "w") Then
```

```
            'Schreibe den Variablenwert aus der Excelliste in die HMI
Variable
            'Write the excel tag value into the HMI tag
            value = objWorksheet.Cells(row, 3)

                'Schreibe die Statusinfo in die Zeile 5
                'Write status info into row 5
                If set_value(tag, value) <> 0 Then
                    objWorksheet.Cells(row, 5) = "Fault"

                    'Meldung, wenn die Variable nicht vorhanden ist
                    'Message if the variable does not exist
                    'MsgBox "Der angegebene Variablen Name in der
Spalte B Zeile" & " " & row & " " & "ist nicht vorhanden!"
                    MsgBox "The specified variable name in the column B
line" & " " & row & " " & "does not exist!"
                Else
                    objWorksheet.Cells(row, 5) = "done"
                End If
        End If

        'Auswertung, steht in der Spalte 4 der Buchstabe "R" oder "r"
f³r "reading"
        'Evaluation, in Column 4 are the character "R" or "r" for
"reading"
        If (objWorksheet.Cells(row, 4) = "R") Or
(objWorksheet.Cells(row, 4) = "r") Then

            'Schreibe Wert der HMI Variable in die Excelliste
            'Write HMI tag value into the Excel list
            objWorksheet.Cells(row, 3) = get_response(tag)

                'Schreibe die Statusinfo in die Zeile 5
                'Write status info into row 5
                If objWorksheet.Cells(row, 3) = "###" Then
                    objWorksheet.Cells(row, 5) = "Fault"

                    'Meldung, wenn die Variable nicht vorhanden ist
                    'Message if the variable does not exist
                    'MsgBox "Der angegebene Variablen Name in der
Spalte B Zeile" & " " & row & " " & "ist nicht vorhanden!"
                    MsgBox "The specified variable name in the column B
line" & " " & row & " " & "does not exist!"
                Else
                    objWorksheet.Cells(row, 5) = "done"
                End If
        End If

        row = row + 1
```

```
    'Wiederhole die Schleife solange, bis in der Zeile 2 ein "end"
steht bzw. die Zeile "500" erreicht ist.
    'Repeat the loop until in line 2 comes the word "end" or the line
"500" has been reached.
    Loop Until tag = "end" Or row > 500

    End If

    'Call the function that permorms the calculations with the data
imported from WINCC, and save the results
    'in the parameters to be exported to WINCC again
     Call calc

         'Call the functions that save the values of the magnitudes and
allows itsposterior study

    Call DataLogger

     End Sub
```

1.2 MODULE 1

```
Attribute VB_Name = "M¾dulo1"
Sub mimacro()
On Error GoTo lin1
 Sheets("Data").Select
 Range("H1").value = "OK"
  ActiveWorkbook.update_data

lin1:
   Windows("Excel_interface_mod.xls").Activate
    'ChDir "E:\040_Claudio-Javier"
    'Workbooks.Open Filename:="E:\040_Claudio-
Javier\Excel_interface_mod.xls"
Sheets("Data").Select
Range("H1").value = "Error"
End Sub
Sub programarMacro()

Worksheets("Data").Range("I7").Formula = "=Now()"
Application.OnTime Now + TimeValue("00:00:01"), "tiempo2"
Range("I7").value = Time
tiempoac = Range("I7").value + Range("I9").value
' TimeValue("00:15:00")
Range("I8").value = tiempoac
Application.OnTime tiempoac, "mimacro", , True
Worksheets("Data").Select
```

```
End Sub

Public Sub update_data()

    Dim row As Integer
    Dim tag As String
    Dim value As String
    Dim objWorksheet
    Set objWorksheet = Excel.Worksheets("Data")

    If (Server_Avail = False) Then
        check_server
    End If

    If (Server_Avail = True) Then

        'Startwert, an welcher Zeile die erste HMI Variable steht
        'Start value at which row the first HMI variable begins
        row = 3

        Do

        'Vorgabe, in welcher Spalte die HMI Variablen angegeben sind.
In diesem Fall "Spalte B"
        'Setting the column in which the HMI variables are specified.
In this case, "Column B"
        tag = objWorksheet.Cells(row, 2)

        'Auswertung, steht in der Spalte 4 der Buchstabe "W" oder "w"
f³r "writing"
        'Evaluation, in Column 4 are the character "W" or "w" for
"writing"
        If (objWorksheet.Cells(row, 4) = "W") Or
(objWorksheet.Cells(row, 4) = "w") Then

            'Schreibe den Variablenwert aus der Excelliste in die HMI
Variable
            'Write the excel tag value into the HMI tag
            value = objWorksheet.Cells(row, 3)

                'Schreibe die Statusinfo in die Zeile 5
                'Write status info into row 5
                If set_value(tag, value) <> 0 Then
                    objWorksheet.Cells(row, 5) = "Fault"

                    'Meldung, wenn die Variable nicht vorhanden ist
                    'Message if the variable does not exist
                    'MsgBox "Der angegebene Variablen Name in der
Spalte B Zeile" & " " & row & " " & "ist nicht vorhanden!"
```

```
                    MsgBox "The specified variable name in the column B
line" & " " & row & " " & "does not exist!"
                Else
                    objWorksheet.Cells(row, 5) = "done"
                End If
        End If

        'Auswertung, steht in der Spalte 4 der Buchstabe "R" oder "r"
f³r "reading"
        'Evaluation, in Column 4 are the character "R" or "r" for
"reading"
        If (objWorksheet.Cells(row, 4) = "R") Or
(objWorksheet.Cells(row, 4) = "r") Then

            'Schreibe Wert der HMI Variable in die Excelliste
            'Write HMI tag value into the Excel list
            objWorksheet.Cells(row, 3) = get_response(tag)

                'Schreibe die Statusinfo in die Zeile 5
                'Write status info into row 5
                If objWorksheet.Cells(row, 3) = "###" Then
                    objWorksheet.Cells(row, 5) = "Fault"

                    'Meldung, wenn die Variable nicht vorhanden ist
                    'Message if the variable does not exist
                    'MsgBox "Der angegebene Variablen Name in der
Spalte B Zeile" & " " & row & " " & "ist nicht vorhanden!"
                    MsgBox "The specified variable name in the column B
line" & " " & row & " " & "does not exist!"
                Else
                    objWorksheet.Cells(row, 5) = "done"
                End If
        End If

        row = row + 1

    'Wiederhole die Schleife solange, bis in der Zeile 2 ein "end"
steht bzw. die Zeile "500" erreicht ist.
    'Repeat the loop until in line 2 comes the word "end" or the line
"500" has been reached.
    Loop Until tag = "end" Or row > 500


    End If

     'Call the function that permorms the calculations with the data
imported from WINCC, and save the results
     'in the parameters to be exported to WINCC again

    Call calc
```

```
    'Call the functions that save the values of the magnitudes and
allows itsposterior study

    Call DataLogger


End Sub

Temporizador

Dim tiempoac As Variant
Dim ejecutando As Boolean
Dim celdam20 As Variant
Public Cont_Err_Resume_Next


Private Sub tiempo2()
On Error GoTo lin3
'Worbook.Unprotect (abc9999)
Worksheets("Data").Range("I7").Formula = "=Now()"
Application.OnTime Now + TimeValue("00:00:30"), "tiempo2"
'Worbook.Protect (abc9999)
lin3:
Worksheets("Data").Select
End Sub
```

1.3 MODULE 2

```
Attribute VB_Name = "M¾dulo2"
Sub calc()
Attribute calc.VB_ProcData.VB_Invoke_Func = " \n14"
'
' calc Macro
'

'Open the calculation book
   ChDir _

"E:\010_BSH_USB\120_Programation\040_TABLAS_EXCEL_MACROS\020_Density_En
thalpy_Temperature\040_Improvements_DirectCalculations"
    Workbooks.Open Filename:= _

"E:\010_BSH_USB\120_Programation\040_TABLAS_EXCEL_MACROS\020_Density_En
thalpy_Temperature\040_Improvements_DirectCalculations\Station1_rho_imp
2.xlsx"
```

```
    'COPY THE INPUTS
    'VALUES FROM "EXCEL_INTERFACE" TO "STATION1_RHO_IMP2"

    'Copy the value of the Ref.number to the calculation sheet
    Windows("Excel_interface.xls").Activate
    Range("C3").Select
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
    Range("A6").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False


    Windows("Excel_interface.xls").Activate
    Range("C4").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
    Range("B6").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Excel_interface.xls").Activate
    Range("C5").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
    Range("C6").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Excel_interface.xls").Activate
    Range("C6").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
    Range("D6").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Excel_interface.xls").Activate
    Range("C7").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
```

```
    Range("E6").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Excel_interface.xls").Activate
    Range("C8").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
    Range("F6").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Excel_interface.xls").Activate
    Range("C9").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
    Range("G6").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Excel_interface.xls").Activate
    Range("C10").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
    Range("B9").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Excel_interface.xls").Activate
    Range("C11").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
    Range("C9").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Excel_interface.xls").Activate
    Range("C12").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Station1_rho_imp2.xlsx").Activate
```

```
    Range("D9").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    'COPY THE OUTPUTS
    'VALUES FROM "STATION1_RHO_IMP2" TO "EXCEL_INTERFACE"

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("A23").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C20").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("B23").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C21").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("C23").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C22").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("D23").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C23").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Range("D1").Select
    Windows("Station1_rho_imp2.xlsx").Activate
```

```
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C16").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("E23").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C24").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("F23").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C25").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("G23").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C26").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("A26").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C27").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("B26").Select
```

```
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C28").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("C26").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C29").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("D26").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C30").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False

    Windows("Station1_rho_imp2.xlsx").Activate
    Range("E26").Select
    Application.CutCopyMode = False
    Selection.Copy
    Windows("Excel_interface.xls").Activate
    Range("C31").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False


      'Save and close "STATION1_RHO_IMP2"

    Windows("Station1_rho_imp2.xlsx").Activate
    Application.CutCopyMode = False
    ActiveWorkbook.Save
    ActiveWorkbook.Close

End Sub

Sub DataLogger()
'
```

```
' DataLogger Macro
'
' Acceso directo: CTRL+a
'Hour
    Sheets("Data Logger").Select
    Range("A2").value = Now()


'Insert a new empty row

    Rows("5:5").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    With Selection.Interior
        .Pattern = xlNone
        .TintAndShade = 0
        .PatternTintAndShade = 0
    End With

    'Copy the value of the magnitudes

    Rows("2:2").Select
    Selection.Copy
    Rows("5:5").Select
    Rows("2:2").Select
    Application.CutCopyMode = False
    Selection.Copy
    Rows("5:5").Select
    Selection.PasteSpecial Paste:=xlPasteAll, Operation:=xlNone,
SkipBlanks:= _
        False, Transpose:=False
    Application.CutCopyMode = False
    'Select the principal sheet
    Sheets("Data").Select
End Sub
```

1.4 SHEET 1

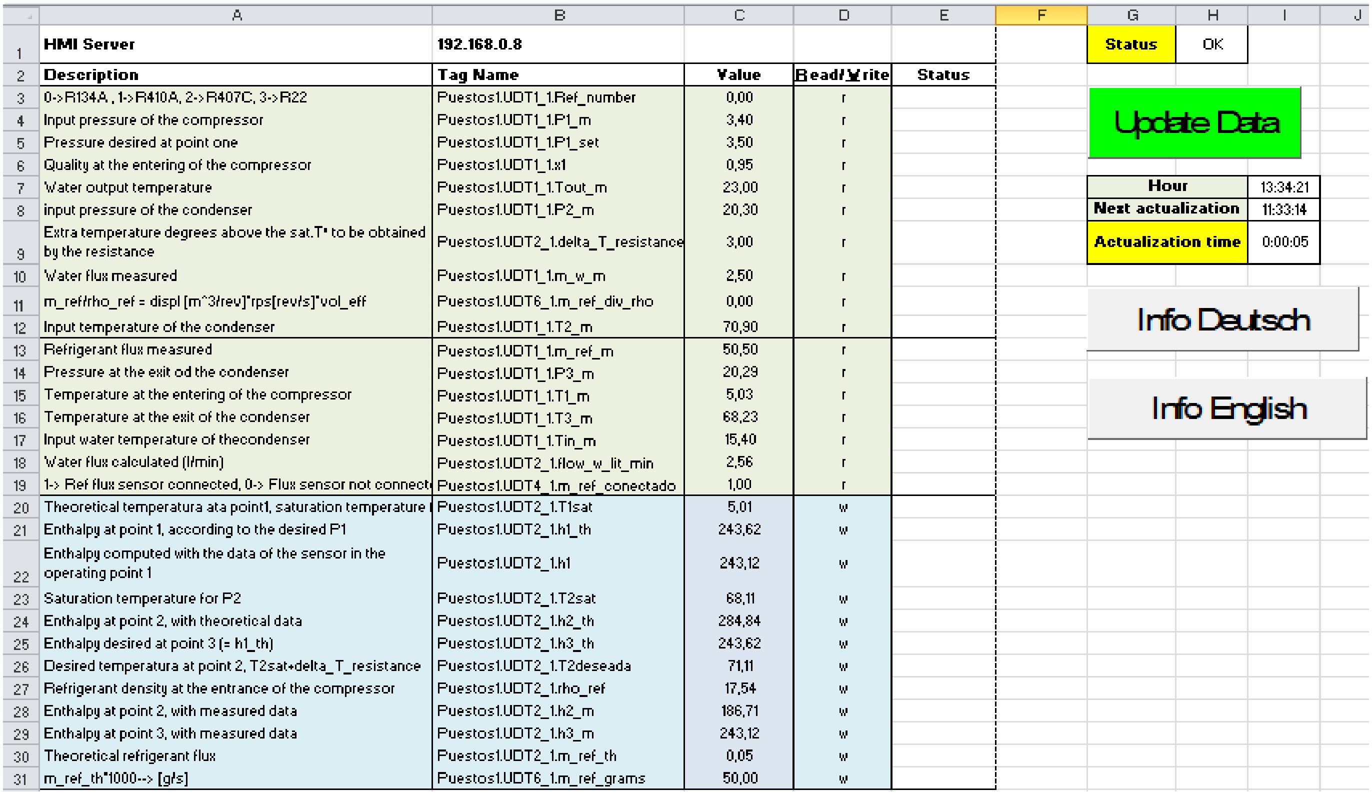
```
VERSION 1.0 CLASS
BEGIN
  MultiUse = -1  'True
END
Attribute VB_Name = "Sheet1"
Attribute VB_GlobalNameSpace = False
Attribute VB_Creatable = False
Attribute VB_PredeclaredId = True
Attribute VB_Exposed = True
```

```
Private Sub CommandButton1_Click()
    ActiveWorkbook.update_data
End Sub

Private Sub CommandButton2_Click()
    UserForm1.Show vbModeless
End Sub

Private Sub CommandButton3_Click()
    UserForm2.Show vbModeless
End Sub
```

In order to know how the interface looks, in the figure bellow is shown a fragment of the “Data” sheet (of the excel interface).



	A	B	C	D	E
1	**HMI Server**	**192.168.0.8**			
2	**Description**	**Tag Name**	**Value**	**Read/Write**	**Status**
3	0->R134A , 1->R410A, 2->R407C, 3->R22	Puestos1.UDT1_1.Ref_number	0,00	r	
4	Input pressure of the compressor	Puestos1.UDT1_1.P1_m	3,40	r	
5	Pressure desired at point one	Puestos1.UDT1_1.P1_set	3,50	r	
6	Quality at the entering of the compressor	Puestos1.UDT1_1.x1	0,95	r	
7	Water output temperature	Puestos1.UDT1_1.Tout_m	23,00	r	
8	input pressure of the condenser	Puestos1.UDT1_1.P2_m	20,30	r	
9	Extra temperature degrees above the sat.T° to be obtained by the resistance	Puestos1.UDT2_1.delta_T_resistance	3,00	r	
10	Water flux measured	Puestos1.UDT1_1.m_w_m	2,50	r	
11	m_ref/rho_ref = displ [m^3/rev]*rps[rev/s]*vol_eff	Puestos1.UDT6_1.m_ref_div_rho	0,00	r	
12	Input temperature of the condenser	Puestos1.UDT1_1.T2_m	70,90	r	
13	Refrigerant flux measured	Puestos1.UDT1_1.m_ref_m	50,50	r	
14	Pressure at the exit od the condenser	Puestos1.UDT1_1.P3_m	20,29	r	
15	Temperature at the entering of the compressor	Puestos1.UDT1_1.T1_m	5,03	r	
16	Temperature at the exit of the condenser	Puestos1.UDT1_1.T3_m	68,23	r	
17	Input water temperature of thecondenser	Puestos1.UDT1_1.Tin_m	15,40	r	
18	Water flux calculated (l/min)	Puestos1.UDT2_1.flow_w_lit_min	2,56	r	
19	1-> Ref flux sensor connected, 0-> Flux sensor not connect	Puestos1.UDT4_1.m_ref_conectado	1,00	r	
20	Theoretical temperatura ata point1, saturation temperature	Puestos1.UDT2_1.T1sat	5,01	w	
21	Enthalpy at point 1, according to the desired P1	Puestos1.UDT2_1.h1_th	243,62	w	
22	Enthalpy computed with the data of the sensor in the operating point 1	Puestos1.UDT2_1.h1	243,12	w	
23	Saturation temperature for P2	Puestos1.UDT2_1.T2sat	68,11	w	
24	Enthalpy at point 2, with theoretical data	Puestos1.UDT2_1.h2_th	284,84	w	
25	Enthalpy desired at point 3 (= h1_th)	Puestos1.UDT2_1.h3_th	243,62	w	
26	Desired temperatura at point 2, T2sat+delta_T_resistance	Puestos1.UDT2_1.T2deseada	71,11	w	
27	Refrigerant density at the entrance of the compressor	Puestos1.UDT2_1.rho_ref	17,54	w	
28	Enthalpy at point 2, with measured data	Puestos1.UDT2_1.h2_m	186,71	w	
29	Enthalpy at point 3, with measured data	Puestos1.UDT2_1.h3_m	243,12	w	
30	Theoretical refrigerant flux	Puestos1.UDT2_1.m_ref_th	0,05	w	
31	m_ref_th*1000--> [g/s]	Puestos1.UDT6_1.m_ref_grams	50,00	w	

Figure 49-Excel interface

2 DATA LOGGER

There is a possibility to store the values of the magnitudes exported, with date-time register. It could be useful when the study of the data is been performed, in order to determine whether the test was valid or not.

2.1 DATA LOGGER FUNCTION

It is stored in the “Module 2”:

```
Sub DataLogger()
'
' DataLogger Macro
'
' Acceso directo: CTRL+a
'Hour
    Sheets("Data Logger").Select
    Range("A2").value = Now()


'Insert a new empty row

    Rows("5:5").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    With Selection.Interior
        .Pattern = xlNone
        .TintAndShade = 0
        .PatternTintAndShade = 0
    End With

    'Copy the value of the magnitudes

    Rows("2:2").Select
    Selection.Copy
    Rows("5:5").Select
    Rows("2:2").Select
    Application.CutCopyMode = False
    Selection.Copy
    Rows("5:5").Select
    Selection.PasteSpecial Paste:=xlPasteAll, Operation:=xlNone,
SkipBlanks:= _
        False, Transpose:=False
    Application.CutCopyMode = False
    'Select the principal sheet
    Sheets("Data").Select
End Sub
```

In order to know how the interface looks, in the figure bellow is shown a fragment of the “Data Logger” sheet (of the excel interface).

F13 =Data!C$12

	A	B	C	D	E	F	G
1	Time&Date	Puestos1.UDT1_1.P1_m	Puestos1.UDT1_1.P2_m	Puestos1.UDT1_1.P3_m	Puestos1.UDT1_1.T1_m	Puestos1.UDT1_1.T2_m	Puestos1.UDT1_1.T3_m
2	17/06/2014 13:19	3,40	20,30	20,29	5,03	70,90	68,23
3							
4	Time&Date	Puestos1.UDT1_1.P1_m	Puestos1.UDT1_1.P2_m	Puestos1.UDT1_1.P3_m	Puestos1.UDT1_1.T1_m	Puestos1.UDT1_1.T2_m	Puestos1.UDT1_1.T3_m
5	17/06/2014 13:19	3,40	20,30	20,29	5,03	70,90	68,23
6	17/06/2014 13:18	3,40	20,30	20,29	5,03	70,90	68,23
7	17/06/2014 13:18	3,40	20,30	20,29	5,03	70,90	68,23
8	17/06/2014 13:18	3,40	20,30	20,29	5,03	70,90	68,23
9	17/06/2014 13:18	3,40	20,30	20,29	5,03	70,90	68,23
10	17/06/2014 13:17	3,40	20,30	20,29	5,03	70,90	68,23
11	17/06/2014 13:17	3,40	20,30	20,29	5,03	70,90	68,23

Figure 50- Data Logger

3 CALCULATION FILE

There would be defined a file for each station in which the thermodynamic tables could be found. The first sheet of the excel file, would be a “summary”: The inputs would be copy from the “excel_interface”, and once that the output have been computed they would be transpose as well to the “excel_interface”, to return to the WINCC and PLC.

As the refrigerant number is provided, even if the calculations would be made in each refrigerant sheet, the summary would only contain the results of the selected refrigerant (“0” for the R134A, “1” for R410A, “2” for R407C, “3” for R32 and “4”for R290).

Mainly, the operations computed is the “search” in the corresponding thermodynamic tables, the pressure, temperature and /or quality import, to return a value of enthalpy, density,….As finding the same value in the tables as the one that was imported is difficult to achieve (the tables have limited values), interpolations have been defined.

DATA IMPORT-EXPORT

INPUTS.-Second calculations

Num.Ref	P1_m	P1_set	x1	Tout	P2_m	delta_T_res
0,00	3,40	3,50	0,95	23,00	20,30	3,00

Refrigerant	m_w_m	mrefDivRho	T2_m
R134A	2,50	0,00	70,90

OUTPUTS.-Second calculations

T1sat	h1_th	h1	T2sat	h2_th	h3_th	T2desired
5,01	243,62	243,12	68,11	284,84	243,62	71,11

rho_ref	h2_m	h3_m	m_ref_th	m_ref_gram
17,54	186,71	243,12	0,05	50,00

Figure 51-Summary data import-export

For the “refrigerant sheets”, the same structure as the “summary” has been employed. However, as interpolations must be made, another section has had to be added.

DATA IMPORT-EXPORT FOR R134A

R134A.-INPUTS.-Second calculations

Num.Ref	P1_m	P1_set	x1	Tout	P2_m	delta_T_res
0	3,4	3,5	0,95	23	20,3	3

Refrigerant	m_w_m	mrefDivRho	T2_m
R134A	2,5	0,00285	70,9

R134A.-OUTPUTS.-Second calculations

T1sat	h1_th	h1	T2sat	h2_th	h3_th	T2desired
5,008	243,620772	243,120772	68,11	284,84	243,620772	71,11

rho_ref	h2_m	h3_m	m_ref_th	m_ref_gram
17,5434718	186,7082	243,120772	0,04999889	49,9988947

R134A.-AUXILIAR-Second calculations

h1_m_min	x1_min	h1_m_max	x1_max
237,5	0,9213	244,1	0,955

h1_th_min	x1_min	h1_th_max	x1_max
238	0,9213	244,6	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
287,6	73,11	294,5	78,11

rho_ref_min	x1_min	rho_ref_max	x1_max
18,08	0,9213	17,45	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
287,6	73,11	294,5	78,11

Figure 52-R134A import-export data

DATA IMPORT-EXPORT FOR R410A

R410A.-INPUTS.-Second calculations

Num.Ref	P1_m	P1_set	x1	Tout	P2_m	delta_T_res
1	3,4	3,5	0,95	23	20,3	3

Refrigerant	m_w_m	mrefDivRho	T2_m
R410A	2,5	0,00285	70,9

R410A.-OUTPUTS.-Second calculations

T1sat	h1_th	h1	T2sat	h2_th	h3_th	T2desired
-23,45	400,368546	399,968546	32,93	427	400,368546	32,93

rho_ref	h2_m	h3_m	m_ref_th	m_ref_gram
13,8827003	380,898	399,968546	0,0395657	39,5656958

R410A.-AUXILIAR-Second calculations

h1_m_min	x1_min	h1_m_max	x1_max
392,9	0,9213	401,2	0,955

h1_th_min	x1_min	h1_th_max	x1_max
393,3	0,9213	401,6	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
434	37,93	441	42,93

rho_ref_min	x1_min	rho_ref_max	x1_max
14,3	0,9213	13,81	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
434	37,93	441	42,93

DATA IMPORT-EXPORT FOR R407C

R407C.-INPUTS.-Second calculations

Num.Ref	P1_m	P1_set	x1	Tout	P2_m	delta_T_res
2	3,4	3,5	0,95	23	20,3	3

Refrigerant	m_w_m	mrefDivRho	T2_m
R407C	2,5	0,00285	70,9

R407C.-OUTPUTS.-Second calculations

T1sat	h1_th	h1	T2sat	h2_th	h3_th	T2desired
-7,586	394,602077	394,18724	50,87	426,6	394,602077	50,87

rho_ref	h2_m	h3_m	m_ref_th	m_ref_gram
15,2208309	358,4342	394,18724	0,04337937	43,379368

R407C.-AUXILIAR-Second calculations

h1_m_min	x1_min	h1_m_max	x1_max
387,8	0,9213	395,3	0,955

h1_th_min	x1_min	h1_th_max	x1_max
388,3	0,9213	395,7	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
433,3	55,87	440	60,87

rho_ref_min	x1_min	rho_ref_max	x1_max
15,57	0,9213	15,16	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
433,3	55,87	440	60,87

Figure 53-R410A & R407C import_export data

DATA IMPORT-EXPORT FOR R32

R32.-INPUTS.-Second calculations

Num.Ref	P1_m	P1_set	x1	Tout	P2_m	delta_T_res
3	3,4	3,5	0,95	23	20,3	3

Refrigerant	m_w_m	mrefDivRho	T2_m
R32	2,5	0,00285	70,9

R32.-OUTPUTS.-Second calculations

T1sat	h1_th	h1	T2sat	h2_th	h3_th	T2desired
-23,85	491,164095	490,849258	32,01	520,52	491,164095	35,01

rho_ref	h2_m	h3_m	m_ref_th	m_ref_gram
9,90256083	466,6046	490,849258	0,0282223	28,2222984

R32.-AUXILIAR-Second calculations

h1_m_min	x1_min	h1_m_max	x1_max
480,8	0,9213	492,6	0,955

h1_th_min	x1_min	h1_th_max	x1_max
481,2	0,9213	492,9	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
523,6	37,01	531,3	42,01

rho_ref_min	x1_min	rho_ref_max	x1_max
10,21	0,9213	9,849	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
523,6	37,01	531,3	42,01

DATA IMPORT-EXPORT FOR R290

R290.-INPUTS.-Second calculations

Num.Ref	P1_m	P1_set	x1	Tout	P2_m	delta_T_res
4	3,4	3,5	0,95	23	20,3	3

Refrigerant	m_w_m	mrefDivRho	T2_m
R290	2,5	0,00285	70,9

R290.-OUTPUTS.-Second calculations

T1sat	h1_th	h1	T2sat	h2_th	h3_th	T2desired
-9,593	544,55638	543,45638	57,97	635,18	544,55638	60,97

rho_ref	h2_m	h3_m	m_ref_th	m_ref_gram
7,9181365	479,0968	543,45638	0,02256669	22,566689

R290.-AUXILIAR-Second calculations

h1_m_min	x1_min	h1_m_max	x1_max
532,3	0,9213	545,4	0,955

h1_th_min	x1_min	h1_th_max	x1_max
533,4	0,9213	546,5	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
640,3	62,97	653,1	67,97

rho_ref_min	x1_min	rho_ref_max	x1_max
8,16	0,9213	7,876	0,955

h2_th_min	T2th_min	h2_th_max	T2th_max
640,3	62,97	653,1	67,97

Figure 54-R32 & R290 import_export data

The same structure would be implemented for all the refrigerant sheets, only the color would vary from one to another.

ANNEX VII: STEP 7

1 STRUCTURE

SIMATIC TFG_BSH\SIMATIC 300(1)\CPU 315-2 PN/DP\...\Bloques -- Estructura del programa 16/06/2014 09:25:46

Estructura del programa (estructura de llamada)

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
Programa S7			
OB1 [máximo: 664]	[22]		
FC1 (START_STOP_HMI_button)	[48]	AWL	Seg 1 Ins 1
DB10 (Puestos1)	[48]	AWL	Seg 1 Ins 1
DB20 (Puesto2)	[48]	AWL	Seg 1 Ins 6
DB30 (Puesto3)	[48]	AWL	Seg 1 Ins 11
DB40 (Puesto4)	[48]	AWL	Seg 1 Ins 16
DB50 (Puesto5)	[48]	AWL	Seg 1 Ins 21
DB60 (Puesto6)	[48]	AWL	Seg 1 Ins 26
DB70 (Puesto7)	[48]	AWL	Seg 1 Ins 31
DB80 (Puesto8)	[48]	AWL	Seg 1 Ins 36
DB90 (Puesto9)	[48]	AWL	Seg 1 Ins 41
DB100 (Puesto10)	[48]	AWL	Seg 1 Ins 46
DB110 (Puesto11)	[48]	AWL	Seg 1 Ins 51
DB120 (Puesto12)	[48]	AWL	Seg 1 Ins 56
FC8 (STOP_manual&automatic)	[70]	AWL	Seg 1 Ins 66
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 4 Ins 12
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[252]	AWL	Seg 5 Ins 19
DB10 (Puestos1)	[252]	AWL	Seg 1 Ins 1
FC97 (Station_AUT_ON)	[446]	AWL	Seg 2 Ins 8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg 1 Ins 1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 1 Ins 11
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 13
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 21
FC94 (Excel_DB)	[640]	AWL	Seg 3 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 4 Ins 2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 21
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 23
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 25
FC94 (Excel_DB)	[640]	AWL	Seg 6 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 7 Ins 3
FC7 (AUT_Control PID)	[468]	AWL	Seg 2 Ins 1
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 1 Ins 10
FC10 (Station1_set)	[650]	AWL	Seg 1 Ins 11
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 12

Página 1 de 38

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación			
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	2	Ins	2
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	3
FC2 (Real->Int->Word)	[468]	AWL	Seg	3	Ins	1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg	3	Ins	2
FC4 (Alarm)	[278]	AWL	Seg	2	Ins	9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	2	Ins	13
FC96 (Station_MAN_ON)	[314]	AWL	Seg	3	Ins	21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg	1	Ins	1
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	6
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	7
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	11
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	13
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	15
FC9 (MAN_ControlPID)	[340]	AWL	Seg	2	Ins	9
FC2 (Real->Int->Word)	[340]	AWL	Seg	1	Ins	14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg	1	Ins	15
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	12
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	13
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	14
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	25
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	26
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	27
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	6
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	7
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	10
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	3	Ins	23
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg	1	Ins	83
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	4	Ins	12
DB41 (PID_1)	[70]	AWL	Seg	4	Ins	12
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	13
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	5	Ins	18
DB41 (PID_1)	[70]	AWL	Seg	5	Ins	18
FC10 (Station1_set)	[252]	AWL	Seg	5	Ins	19
DB10 (Puestos1)	[252]	AWL	Seg	1	Ins	1
FC97 (Station_AUT_ON)	[446]	AWL	Seg	2	Ins	8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg	1	Ins	1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	1	Ins	11
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	13
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	21
FC94 (Excel_DB)	[640]	AWL	Seg	3	Ins	3

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación			
FC6 (OperationCalculation)	[664]	AWL	Seg	4	Ins	2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	21
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	23
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	25
FC94 (Excel_DB)	[640]	AWL	Seg	6	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	7	Ins	3
FC7 (AUT_Control PID)	[468]	AWL	Seg	2	Ins	1
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	1	Ins	10
FC10 (Station1_set)	[650]	AWL	Seg	1	Ins	11
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	12
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	2	Ins	2
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	3
FC2 (Real->Int->Word)	[468]	AWL	Seg	3	Ins	1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg	3	Ins	2
FC4 (Alarm)	[278]	AWL	Seg	2	Ins	9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	2	Ins	13
FC96 (Station_MAN_ON)	[314]	AWL	Seg	3	Ins	21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg	1	Ins	1
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	6
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	7
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	11
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	13
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	15
FC9 (MAN_ControlPID)	[340]	AWL	Seg	2	Ins	9
FC2 (Real->Int->Word)	[340]	AWL	Seg	1	Ins	14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg	1	Ins	15
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	12
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	13
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	14
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	25
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	26
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	27
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	6
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	7
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	10
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	3	Ins	23

SIMATIC TFG_BSH\SIMATIC 300(1)\CPU 315-2 PN/DP\...\Bloques -- Estructura del programa 16/06/2014 09:25:50

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg 1 Ins 100
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 4 Ins 12
DB41 (PID_1)	[70]	AWL	Seg 4 Ins 12
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 5 Ins 18
DB41 (PID_1)	[70]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[252]	AWL	Seg 5 Ins 19
DB10 (Puestos1)	[252]	AWL	Seg 1 Ins 1
FC97 (Station_AUT_ON)	[446]	AWL	Seg 2 Ins 8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg 1 Ins 1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 1 Ins 11
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 13
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 21
FC94 (Excel_DB)	[640]	AWL	Seg 3 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 4 Ins 2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 21
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 23
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 25
FC94 (Excel_DB)	[640]	AWL	Seg 6 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 7 Ins 3
FC7 (AUT_Control PID)	[468]	AWL	Seg 2 Ins 1
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 1 Ins 10
FC10 (Station1_set)	[650]	AWL	Seg 1 Ins 11
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 12
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 2 Ins 2
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 3
FC2 (Real->Int->Word)	[468]	AWL	Seg 3 Ins 1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg 3 Ins 2
FC4 (Alarm)	[278]	AWL	Seg 2 Ins 9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 2 Ins 13
FC96 (Station_MAN_ON)	[314]	AWL	Seg 3 Ins 21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg 1 Ins 1
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 6
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 7

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 11
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 13
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 15
FC9 (MAN_ControlPID)	[340]	AWL	Seg 2 Ins 9
FC2 (Real->Int->Word)	[340]	AWL	Seg 1 Ins 14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg 1 Ins 15
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 12
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 13
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 14
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 25
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 26
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 27
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 6
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 7
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 10
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 3 Ins 23
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg 1 Ins 117
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 4 Ins 12
DB41 (PID_1)	[70]	AWL	Seg 4 Ins 12
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 5 Ins 18
DB41 (PID_1)	[70]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[252]	AWL	Seg 5 Ins 19
DB10 (Puestos1)	[252]	AWL	Seg 1 Ins 1
FC97 (Station_AUT_ON)	[446]	AWL	Seg 2 Ins 8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg 1 Ins 1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 1 Ins 11
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 13
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 21
FC94 (Excel_DB)	[640]	AWL	Seg 3 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 4 Ins 2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 21
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 23
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 25

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC94 (Excel_DB)	[640]	AWL	Seg 6 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 7 Ins 3
FC7 (AUT_Control PID)	[468]	AWL	Seg 2 Ins 1
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 1 Ins 10
FC10 (Station1_set)	[650]	AWL	Seg 1 Ins 11
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 12
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 2 Ins 2
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 3
FC2 (Real->Int->Word)	[468]	AWL	Seg 3 Ins 1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg 3 Ins 2
FC4 (Alarm)	[278]	AWL	Seg 2 Ins 9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 2 Ins 13
FC96 (Station_MAN_ON)	[314]	AWL	Seg 3 Ins 21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg 1 Ins 1
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 6
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 7
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 11
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 13
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 15
FC9 (MAN_ControlPID)	[340]	AWL	Seg 2 Ins 9
FC2 (Real->Int->Word)	[340]	AWL	Seg 1 Ins 14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg 1 Ins 15
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 12
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 13
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 14
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 25
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 26
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 27
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 6
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 7
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 10
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 3 Ins 23
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg 1 Ins 134
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 4 Ins 12
DB41 (PID_1)	[70]	AWL	Seg 4 Ins 12
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 5 Ins 18
DB41 (PID_1)	[70]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[252]	AWL	Seg 5 Ins 19
DB10 (Puestos1)	[252]	AWL	Seg 1 Ins 1
FC97 (Station_AUT_ON)	[446]	AWL	Seg 2 Ins 8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg 1 Ins 1

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación			
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	1	Ins	11
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	13
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	21
FC94 (Excel_DB)	[640]	AWL	Seg	3	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	4	Ins	2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	21
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	23
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	25
FC94 (Excel_DB)	[640]	AWL	Seg	6	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	7	Ins	3
FC7 (AUT_Control PID)	[468]	AWL	Seg	2	Ins	1
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	1	Ins	10
FC10 (Station1_set)	[650]	AWL	Seg	1	Ins	11
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	12
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	2	Ins	2
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	3
FC2 (Real->Int->Word)	[468]	AWL	Seg	3	Ins	1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg	3	Ins	2
FC4 (Alarm)	[278]	AWL	Seg	2	Ins	9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	2	Ins	13
FC96 (Station_MAN_ON)	[314]	AWL	Seg	3	Ins	21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg	1	Ins	1
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	6
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	7
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	11
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	13
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	15
FC9 (MAN_ControlPID)	[340]	AWL	Seg	2	Ins	9
FC2 (Real->Int->Word)	[340]	AWL	Seg	1	Ins	14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg	1	Ins	15
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	12
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	13
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	14
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	25
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	26

SIMATIC TFG_BSH\SIMATIC 300(1)\CPU 315-2 PN/DP\...\Bloques -- Estructura del programa 16/06/2014 09:25:55

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación			
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	27
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	6
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	7
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	10
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	3	Ins	23
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg	1	Ins	151
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	4	Ins	12
DB41 (PID_1)	[70]	AWL	Seg	4	Ins	12
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	13
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	5	Ins	18
DB41 (PID_1)	[70]	AWL	Seg	5	Ins	18
FC10 (Station1_set)	[252]	AWL	Seg	5	Ins	19
DB10 (Puestos1)	[252]	AWL	Seg	1	Ins	1
FC97 (Station_AUT_ON)	[446]	AWL	Seg	2	Ins	8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg	1	Ins	1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	1	Ins	11
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	13
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	21
FC94 (Excel_DB)	[640]	AWL	Seg	3	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	4	Ins	2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	21
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	23
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	25
FC94 (Excel_DB)	[640]	AWL	Seg	6	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	7	Ins	3
FC7 (AUT_Control PID)	[468]	AWL	Seg	2	Ins	1
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	1	Ins	10
FC10 (Station1_set)	[650]	AWL	Seg	1	Ins	11
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	12
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	2	Ins	2
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	3
FC2 (Real->Int->Word)	[468]	AWL	Seg	3	Ins	1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg	3	Ins	2
FC4 (Alarm)	[278]	AWL	Seg	2	Ins	9

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación			
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	2	Ins	13
FC96 (Station_MAN_ON)	[314]	AWL	Seg	3	Ins	21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg	1	Ins	1
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	6
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	7
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	11
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	13
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	15
FC9 (MAN_ControlPID)	[340]	AWL	Seg	2	Ins	9
FC2 (Real->Int->Word)	[340]	AWL	Seg	1	Ins	14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg	1	Ins	15
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	12
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	13
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	14
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	25
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	26
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	27
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	6
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	7
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	10
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	3	Ins	23
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg	1	Ins	168
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	4	Ins	12
DB41 (PID_1)	[70]	AWL	Seg	4	Ins	12
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	13
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	5	Ins	18
DB41 (PID_1)	[70]	AWL	Seg	5	Ins	18
FC10 (Station1_set)	[252]	AWL	Seg	5	Ins	19
DB10 (Puestos1)	[252]	AWL	Seg	1	Ins	1
FC97 (Station_AUT_ON)	[446]	AWL	Seg	2	Ins	8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg	1	Ins	1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	1	Ins	11
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	13
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	21
FC94 (Excel_DB)	[640]	AWL	Seg	3	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	4	Ins	2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	9

SIMATIC TFG_BSH\SIMATIC 300(1)\CPU 315-2 PN/DP\...\Bloques -- Estructura del programa 16/06/2014 09:25:59

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 21
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 23
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 25
FC94 (Excel_DB)	[640]	AWL	Seg 6 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 7 Ins 3
FC7 (AUT_Control PID)	[468]	AWL	Seg 2 Ins 1
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 1 Ins 10
FC10 (Station1_set)	[650]	AWL	Seg 1 Ins 11
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 12
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 2 Ins 2
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 3
FC2 (Real->Int->Word)	[468]	AWL	Seg 3 Ins 1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg 3 Ins 2
FC4 (Alarm)	[278]	AWL	Seg 2 Ins 9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 2 Ins 13
FC96 (Station_MAN_ON)	[314]	AWL	Seg 3 Ins 21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg 1 Ins 1
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 6
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 7
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 11
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 13
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 15
FC9 (MAN_ControlPID)	[340]	AWL	Seg 2 Ins 9
FC2 (Real->Int->Word)	[340]	AWL	Seg 1 Ins 14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg 1 Ins 15
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 12
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 13
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 14
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 25
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 26
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 27
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 6
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 7
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 10
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 3 Ins 23
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg 1 Ins 185
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 4 Ins 12
DB41 (PID_1)	[70]	AWL	Seg 4 Ins 12

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 5 Ins 18
DB41 (PID_1)	[70]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[252]	AWL	Seg 5 Ins 19
DB10 (Puestos1)	[252]	AWL	Seg 1 Ins 1
FC97 (Station_AUT_ON)	[446]	AWL	Seg 2 Ins 8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg 1 Ins 1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 1 Ins 11
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 13
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 21
FC94 (Excel_DB)	[640]	AWL	Seg 3 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 4 Ins 2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 21
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 23
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 25
FC94 (Excel_DB)	[640]	AWL	Seg 6 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 7 Ins 3
FC7 (AUT_Control PID)	[468]	AWL	Seg 2 Ins 1
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 1 Ins 10
FC10 (Station1_set)	[650]	AWL	Seg 1 Ins 11
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 12
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 2 Ins 2
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 3
FC2 (Real->Int->Word)	[468]	AWL	Seg 3 Ins 1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg 3 Ins 2
FC4 (Alarm)	[278]	AWL	Seg 2 Ins 9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 2 Ins 13
FC96 (Station_MAN_ON)	[314]	AWL	Seg 3 Ins 21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg 1 Ins 1
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 6
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 7
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 11
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 13
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 15
FC9 (MAN_ControlPID)	[340]	AWL	Seg 2 Ins 9
FC2 (Real->Int->Word)	[340]	AWL	Seg 1 Ins 14

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg 1 Ins 15
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 12
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 13
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 14
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 25
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 26
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 27
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 6
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 7
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 10
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 3 Ins 23
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg 1 Ins 202
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 4 Ins 12
DB41 (PID_1)	[70]	AWL	Seg 4 Ins 12
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 5 Ins 18
DB41 (PID_1)	[70]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[252]	AWL	Seg 5 Ins 19
DB10 (Puestos1)	[252]	AWL	Seg 1 Ins 1
FC97 (Station_AUT_ON)	[446]	AWL	Seg 2 Ins 8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg 1 Ins 1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 1 Ins 11
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 13
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 21
FC94 (Excel_DB)	[640]	AWL	Seg 3 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 4 Ins 2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 5 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 19
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 21
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 23
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 25
FC94 (Excel_DB)	[640]	AWL	Seg 6 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 7 Ins 3
FC7 (AUT_Control PID)	[468]	AWL	Seg 2 Ins 1
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 1 Ins 10

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC10 (Station1_set)	[650]	AWL	Seg 1 Ins 11
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 12
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 2 Ins 2
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 3
FC2 (Real->Int->Word)	[468]	AWL	Seg 3 Ins 1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg 3 Ins 2
FC4 (Alarm)	[278]	AWL	Seg 2 Ins 9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 2 Ins 13
FC96 (Station_MAN_ON)	[314]	AWL	Seg 3 Ins 21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg 1 Ins 1
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 6
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 7
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 11
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 13
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 15
FC9 (MAN_ControlPID)	[340]	AWL	Seg 2 Ins 9
FC2 (Real->Int->Word)	[340]	AWL	Seg 1 Ins 14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg 1 Ins 15
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 12
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 13
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 14
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 25
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 26
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 27
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 6
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 7
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 10
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 3 Ins 23
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg 1 Ins 219
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 4 Ins 12
DB41 (PID_1)	[70]	AWL	Seg 4 Ins 12
FC2 (Real->Int->Word)	[70]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg 5 Ins 18
DB41 (PID_1)	[70]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[252]	AWL	Seg 5 Ins 19
DB10 (Puestos1)	[252]	AWL	Seg 1 Ins 1
FC97 (Station_AUT_ON)	[446]	AWL	Seg 2 Ins 8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg 1 Ins 1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg 1 Ins 11
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 13
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 15
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 17
FC105 (SCALE)	[660]	AWL	Seg 1 Ins 19

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación			
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	21
FC94 (Excel_DB)	[640]	AWL	Seg	3	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	4	Ins	2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	21
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	23
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	25
FC94 (Excel_DB)	[640]	AWL	Seg	6	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	7	Ins	3
FC7 (AUT_Control PID)	[468]	AWL	Seg	2	Ins	1
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	1	Ins	10
FC10 (Station1_set)	[650]	AWL	Seg	1	Ins	11
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	12
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	2	Ins	2
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	3
FC2 (Real->Int->Word)	[468]	AWL	Seg	3	Ins	1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg	3	Ins	2
FC4 (Alarm)	[278]	AWL	Seg	2	Ins	9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	2	Ins	13
FC96 (Station_MAN_ON)	[314]	AWL	Seg	3	Ins	21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg	1	Ins	1
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	6
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	7
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	11
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	13
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	15
FC9 (MAN_ControlPID)	[340]	AWL	Seg	2	Ins	9
FC2 (Real->Int->Word)	[340]	AWL	Seg	1	Ins	14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg	1	Ins	15
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	12
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	13
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	14
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	25
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	26
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	27
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	6
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	7
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	10

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación			
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	3	Ins	23
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg	1	Ins	236
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	4	Ins	12
DB41 (PID_1)	[70]	AWL	Seg	4	Ins	12
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	13
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	5	Ins	18
DB41 (PID_1)	[70]	AWL	Seg	5	Ins	18
FC10 (Station1_set)	[252]	AWL	Seg	5	Ins	19
DB10 (Puestos1)	[252]	AWL	Seg	1	Ins	1
FC97 (Station_AUT_ON)	[446]	AWL	Seg	2	Ins	8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg	1	Ins	1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	1	Ins	11
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	13
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	21
FC94 (Excel_DB)	[640]	AWL	Seg	3	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	4	Ins	2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	21
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	23
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	25
FC94 (Excel_DB)	[640]	AWL	Seg	6	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	7	Ins	3
FC7 (AUT_Control PID)	[468]	AWL	Seg	2	Ins	1
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	1	Ins	10
FC10 (Station1_set)	[650]	AWL	Seg	1	Ins	11
FC2 (Real->Int->Word)	[468]	AWL	Seg	1	Ins	12
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg	2	Ins	2
FC2 (Real->Int->Word)	[468]	AWL	Seg	2	Ins	3
FC2 (Real->Int->Word)	[468]	AWL	Seg	3	Ins	1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg	3	Ins	2
FC4 (Alarm)	[278]	AWL	Seg	2	Ins	9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	2	Ins	13
FC96 (Station_MAN_ON)	[314]	AWL	Seg	3	Ins	21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg	1	Ins	1
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	6
FC105 (SCALE)	[350]	AWL	Seg	1	Ins	8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	4

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación			
FC3 (Sensor conect/desconect)	[330]	AWL	Seg	3	Ins	7
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	11
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	13
FC105 (SCALE)	[350]	AWL	Seg	3	Ins	15
FC9 (MAN_ControlPID)	[340]	AWL	Seg	2	Ins	9
FC2 (Real->Int->Word)	[340]	AWL	Seg	1	Ins	14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg	1	Ins	15
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	12
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	13
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	14
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	2	Ins	25
FC10 (Station1_set)	[522]	AWL	Seg	2	Ins	26
FC2 (Real->Int->Word)	[340]	AWL	Seg	2	Ins	27
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	6
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	7
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg	3	Ins	10
FC2 (Real->Int->Word)	[340]	AWL	Seg	3	Ins	11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg	3	Ins	23
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	20
FC8 (STOP_manual&automatic)	[70]	AWL	Seg	1	Ins	253
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	1
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	4	Ins	12
DB41 (PID_1)	[70]	AWL	Seg	4	Ins	12
FC2 (Real->Int->Word)	[70]	AWL	Seg	4	Ins	13
FC2 (Real->Int->Word)	[70]	AWL	Seg	5	Ins	7
FB41 (CONT_C), DB41 (PID_1)	[144]	AWL	Seg	5	Ins	18
DB41 (PID_1)	[70]	AWL	Seg	5	Ins	18
FC10 (Station1_set)	[252]	AWL	Seg	5	Ins	19
DB10 (Puestos1)	[252]	AWL	Seg	1	Ins	1
FC97 (Station_AUT_ON)	[446]	AWL	Seg	2	Ins	8
FC5 (AUT_SensON/OFF->th/calc)	[640]	AWL	Seg	1	Ins	1
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	1	Ins	11
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	13
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	1	Ins	21
FC94 (Excel_DB)	[640]	AWL	Seg	3	Ins	3
FC6 (OperationCalculation)	[664]	AWL	Seg	4	Ins	2
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	3
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	6
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	9
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	12
FC3 (Sensor conect/desconect)	[640]	AWL	Seg	5	Ins	15
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	17
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	19
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	21
FC105 (SCALE)	[660]	AWL	Seg	5	Ins	23

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC105 (SCALE)	[660]	AWL	Seg 5 Ins 25
FC94 (Excel_DB)	[640]	AWL	Seg 6 Ins 3
FC6 (OperationCalculation)	[664]	AWL	Seg 7 Ins 3
FC7 (AUT_Control PID)	[468]	AWL	Seg 2 Ins 1
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 1 Ins 10
FC10 (Station1_set)	[650]	AWL	Seg 1 Ins 11
FC2 (Real->Int->Word)	[468]	AWL	Seg 1 Ins 12
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[542]	AWL	Seg 2 Ins 2
FC2 (Real->Int->Word)	[468]	AWL	Seg 2 Ins 3
FC2 (Real->Int->Word)	[468]	AWL	Seg 3 Ins 1
FB42 (CONT_S), DB42 (PID_2)	[520]	AWL	Seg 3 Ins 2
FC4 (Alarm)	[278]	AWL	Seg 2 Ins 9
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 2 Ins 13
FC96 (Station_MAN_ON)	[314]	AWL	Seg 3 Ins 21
FC98 (MAN_SensON/SensOFF->th)	[330]	AWL	Seg 1 Ins 1
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 6
FC105 (SCALE)	[350]	AWL	Seg 1 Ins 8
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 4
FC3 (Sensor conect/desconect)	[330]	AWL	Seg 3 Ins 7
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 11
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 13
FC105 (SCALE)	[350]	AWL	Seg 3 Ins 15
FC9 (MAN_ControlPID)	[340]	AWL	Seg 2 Ins 9
FC2 (Real->Int->Word)	[340]	AWL	Seg 1 Ins 14
FB42 (CONT_S), DB42 (PID_2)	[392]	AWL	Seg 1 Ins 15
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 11
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 12
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 13
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 14
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 24
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 2 Ins 25
FC10 (Station1_set)	[522]	AWL	Seg 2 Ins 26
FC2 (Real->Int->Word)	[340]	AWL	Seg 2 Ins 27
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 5
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 6
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 7
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[414]	AWL	Seg 3 Ins 10
FC2 (Real->Int->Word)	[340]	AWL	Seg 3 Ins 11
FC8 (STOP_manual&automatic)	[274]	AWL	Seg 3 Ins 23
FC2 (Real->Int->Word)	[70]	AWL	Seg 5 Ins 20
DB10 (Puestos1)	[22]	AWL	Seg 2 Ins 1
FC95 (Reset_StationNOT_SET)	[22]	AWL	Seg 2 Ins 3
FC10 (Station1_set)	[204]	AWL	Seg 2 Ins 5
DB10 (Puestos1)	[204]	AWL	Seg 1 Ins 1
FC97 (Station_AUT_ON)	[398]	AWL	Seg 2 Ins 8
FC5 (AUT_SensON/OFF->th/calc)	[592]	AWL	Seg 1 Ins 1
FC3 (Sensor conect/desconect)	[592]	AWL	Seg 1 Ins 11
FC105 (SCALE)	[612]	AWL	Seg 1 Ins 13
FC105 (SCALE)	[612]	AWL	Seg 1 Ins 15
FC105 (SCALE)	[612]	AWL	Seg 1 Ins 17
FC105 (SCALE)	[612]	AWL	Seg 1 Ins 19

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC105 (SCALE)	[612]	AWL	Seg 1 Ins 21
FC94 (Excel_DB)	[592]	AWL	Seg 3 Ins 3
FC6 (OperationCalculation)	[616]	AWL	Seg 4 Ins 2
FC3 (Sensor conect/desconect)	[592]	AWL	Seg 5 Ins 3
FC3 (Sensor conect/desconect)	[592]	AWL	Seg 5 Ins 6
FC3 (Sensor conect/desconect)	[592]	AWL	Seg 5 Ins 9
FC3 (Sensor conect/desconect)	[592]	AWL	Seg 5 Ins 12
FC3 (Sensor conect/desconect)	[592]	AWL	Seg 5 Ins 15
FC105 (SCALE)	[612]	AWL	Seg 5 Ins 17
FC105 (SCALE)	[612]	AWL	Seg 5 Ins 19
FC105 (SCALE)	[612]	AWL	Seg 5 Ins 21
FC105 (SCALE)	[612]	AWL	Seg 5 Ins 23
FC105 (SCALE)	[612]	AWL	Seg 5 Ins 25
FC94 (Excel_DB)	[592]	AWL	Seg 6 Ins 3
FC6 (OperationCalculation)	[616]	AWL	Seg 7 Ins 3
FC7 (AUT_Control PID)	[420]	AWL	Seg 2 Ins 1
FC2 (Real->Int->Word)	[420]	AWL	Seg 1 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[494]	AWL	Seg 1 Ins 10
FC10 (Station1_set)	[602]	AWL	Seg 1 Ins 11
FC2 (Real->Int->Word)	[420]	AWL	Seg 1 Ins 12
FC2 (Real->Int->Word)	[420]	AWL	Seg 2 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[494]	AWL	Seg 2 Ins 2
FC2 (Real->Int->Word)	[420]	AWL	Seg 2 Ins 3
FC2 (Real->Int->Word)	[420]	AWL	Seg 3 Ins 1
FB42 (CONT_S), DB42 (PID_2)	[472]	AWL	Seg 3 Ins 2
FC4 (Alarm)	[230]	AWL	Seg 2 Ins 9
FC8 (STOP_manual&automatic)	[226]	AWL	Seg 2 Ins 13
FC2 (Real->Int->Word)	[226]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[300]	AWL	Seg 4 Ins 12
DB41 (PID_1)	[226]	AWL	Seg 4 Ins 12
FC2 (Real->Int->Word)	[226]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[226]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[300]	AWL	Seg 5 Ins 18
DB41 (PID_1)	[226]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[408]	AWL	Seg 5 Ins 19
FC2 (Real->Int->Word)	[226]	AWL	Seg 5 Ins 20
FC96 (Station_MAN_ON)	[266]	AWL	Seg 3 Ins 21
FC98 (MAN_SensON/SensOFF->th)	[282]	AWL	Seg 1 Ins 1
FC105 (SCALE)	[302]	AWL	Seg 1 Ins 6
FC105 (SCALE)	[302]	AWL	Seg 1 Ins 8
FC3 (Sensor conect/desconect)	[282]	AWL	Seg 3 Ins 4
FC3 (Sensor conect/desconect)	[282]	AWL	Seg 3 Ins 7
FC105 (SCALE)	[302]	AWL	Seg 3 Ins 11
FC105 (SCALE)	[302]	AWL	Seg 3 Ins 13
FC105 (SCALE)	[302]	AWL	Seg 3 Ins 15
FC9 (MAN_ControlPID)	[292]	AWL	Seg 2 Ins 9
FC2 (Real->Int->Word)	[292]	AWL	Seg 1 Ins 14
FB42 (CONT_S), DB42 (PID_2)	[344]	AWL	Seg 1 Ins 15
FC2 (Real->Int->Word)	[292]	AWL	Seg 2 Ins 11
FB41 (CONT_C), DB41 (PID_1)	[366]	AWL	Seg 2 Ins 12
FC10 (Station1_set)	[474]	AWL	Seg 2 Ins 13
FC2 (Real->Int->Word)	[292]	AWL	Seg 2 Ins 14
FC2 (Real->Int->Word)	[292]	AWL	Seg 2 Ins 24
FB41 (CONT_C), DB41 (PID_1)	[366]	AWL	Seg 2 Ins 25
FC10 (Station1_set)	[474]	AWL	Seg 2 Ins 26

SIMATIC TFG_BSH\SIMATIC 300(1)\CPU 315-2 PN/DP\...\Bloques -- Estructura del programa 16/06/2014 09:26:23

Bloque (símbolo), DB de instancia (símbolo)	Datos	Lenguaje	Punto de aplicación
FC2 (Real->Int->Word)	[292]	AWL	Seg 2 Ins 27
FC2 (Real->Int->Word)	[292]	AWL	Seg 3 Ins 5
FB41 (CONT_C), DB41 (PID_1)	[366]	AWL	Seg 3 Ins 6
FC2 (Real->Int->Word)	[292]	AWL	Seg 3 Ins 7
FC2 (Real->Int->Word)	[292]	AWL	Seg 3 Ins 9
FB41 (CONT_C), DB41 (PID_1)	[366]	AWL	Seg 3 Ins 10
FC2 (Real->Int->Word)	[292]	AWL	Seg 3 Ins 11
FC8 (STOP_manual&automatic)	[226]	AWL	Seg 3 Ins 23
FC2 (Real->Int->Word)	[226]	AWL	Seg 4 Ins 1
FB41 (CONT_C), DB41 (PID_1)	[300]	AWL	Seg 4 Ins 12
DB41 (PID_1)	[226]	AWL	Seg 4 Ins 12
FC2 (Real->Int->Word)	[226]	AWL	Seg 4 Ins 13
FC2 (Real->Int->Word)	[226]	AWL	Seg 5 Ins 7
FB41 (CONT_C), DB41 (PID_1)	[300]	AWL	Seg 5 Ins 18
DB41 (PID_1)	[226]	AWL	Seg 5 Ins 18
FC10 (Station1_set)	[408]	AWL	Seg 5 Ins 19
FC2 (Real->Int->Word)	[226]	AWL	Seg 5 Ins 20
DB20 (Puesto2)	[22]	AWL	Seg 3 Ins 1
DB11 (Excel_Interface)	[0]		
FC99 (DiagramIntermitences)	[2]		
FC106 (UNSCALE)	[16]		
SFC20 (BLKMOV)	[0]		
SFC24 (TEST_DB)	[0]		
SFC55 (WR_PARM)	[0]		
SFC105 (READ_SI)	[0]		
SFC106 (DEL_SI)	[0]		
FB1 (Excel)	[0]		
SFB41	[0]		

2 INPUTS & OUTPUTS

Operando (símbolo)	Bloque (símbolo)	Acceso	Lenguaje	Punto de aplicación
	FC10 (Station1_set)	R	AWL	Seg 2 Ins 8 /CALL
				Seg 3 Ins 21 /CALL
	FC7 (AUT_Control PID)	W	AWL	Seg 1 Ins 10 /CALL
				Seg 1 Ins 10 /CALL
				Seg 2 Ins 2 /CALL
				Seg 2 Ins 2 /CALL

	FC8 (STOP_manual&automatic)	W	AWL	Seg 3 Ins 2 /CALL Seg 4 Ins 12 /CALL
				Seg 4 Ins 12 /CALL
				Seg 5 Ins 18 /CALL
	FC9 (MAN_ControlPID)	W	AWL	Seg 5 Ins 18 /CALL Seg 1 Ins 15 /CALL
				Seg 2 Ins 12 /CALL
				Seg 2 Ins 12 /CALL
				Seg 2 Ins 25 /CALL
				Seg 2 Ins 25 /CALL
				Seg 3 Ins 6 /CALL
				Seg 3 Ins 6 /CALL
				Seg 3 Ins 10 /CALL
	FC99 (DiagramIntermitenc es) FC99 (DiagramIntermitenc es) FC7 (AUT_Control PID)	R W W	AWL AWL AWL	Seg 3 Ins 10 /CALL Seg 2 Ins 6 /U Seg 2 Ins 5 /T Seg 1 Ins 10 /CALL
				Seg 1 Ins 10 /CALL
				Seg 1 Ins 10 /CALL
				Seg 1 Ins 10 /CALL
				Seg 1 Ins 10 /CALL
				Seg 2 Ins 2 /CALL
				Seg 2 Ins 2 /CALL
				Seg 2 Ins 2 /CALL
				Seg 2 Ins 2 /CALL
				Seg 2 Ins 2 /CALL

				Seg 3 Ins 2 /CALL
				Seg 3 Ins 2 /CALL
Operando (símbolo)	Bloque (símbolo)	Acceso	Lenguaje	Punto de aplicación
MW 0	FC8 (STOP_manual&automatic)	W	AWL	Seg 4 Ins 12 /CALL
				Seg 4 Ins 12 /CALL
				Seg 4 Ins 12 /CALL
				Seg 4 Ins 12 /CALL
				Seg 4 Ins 12 /CALL
				Seg 5 Ins 18 /CALL
				Seg 5 Ins 18 /CALL
				Seg 5 Ins 18 /CALL
				Seg 5 Ins 18 /CALL
				Seg 5 Ins 18 /CALL
	FC9 (MAN_ControlPID)	W	AWL	Seg 1 Ins 15 /CALL
				Seg 1 Ins 15 /CALL
				Seg 2 Ins 12 /CALL
				Seg 2 Ins 12 /CALL
				Seg 2 Ins 12 /CALL
				Seg 2 Ins 12 /CALL
				Seg 2 Ins 12 /CALL
				Seg 2 Ins 25 /CALL
				Seg 2 Ins 25 /CALL
				Seg 2 Ins 25 /CALL
				Seg 2 Ins 25 /CALL
				Seg 2 Ins 25 /CALL
				Seg 3 Ins 6 /CALL
				Seg 3 Ins 6 /CALL

				Seg 3 Ins 6 /CALL
				Seg 3 Ins 6 /CALL
				Seg 3 Ins 6 /CALL
				Seg 3 Ins 10 /CALL
				Seg 3 Ins 10 /CALL
				Seg 3 Ins 10 /CALL
				Seg 3 Ins 10 /CALL
	FC5 (AUT_SensON/OFF->th /calc)	W	AWL	Seg 3 Ins 10 /CALL Seg 1 Ins 13 /CALL
				Seg 1 Ins 15 /CALL
Operando (símbolo)	Bloque (símbolo)	Acceso	Lenguaje	Punto de aplicación
T 99	FC99 (DiagramIntermitenc es)	W	AWL	Seg 8 Ins 12 /FR
				Seg 8 Ins 15 /SE Seg 1 Ins 6 /U
		R	AWL	Seg 2 Ins 1 /UN
				Seg 2 Ins 4 /L
Z 0	FC4 (Alarm)	W	AWL	Seg 1 Ins 2 /FR
				Seg 1 Ins 5 /SE
		R	AWL	Seg 2 Ins 3 /SE Seg 7 Ins 32 /L
		W	AWL	Seg 7 Ins 31 /ZV

OB1 - <offline>

""

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 16/06/2014 09:14:59
Interface: 15/02/1996 16:51:12
Longitud (bloque / código / datos): 00360 00236 00022

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
TEMP		0.0	
OB1_EV_CLASS	Byte	0.0	Bits 0-3 = 1 (Coming event), Bits 4-7 = 1 (Event class 1)
OB1_SCAN_1	Byte	1.0	1 (Cold restart scan 1 of OB 1), 3 (Scan 2-n of OB 1)
OB1_PRIORITY	Byte	2.0	Priority of OB Execution
OB1_OB_NUMBR	Byte	3.0	1 (Organization block 1, OB1)
OB1_RESERVED_1	Byte	4.0	Reserved for system
OB1_RESERVED_2	Byte	5.0	Reserved for system
OB1_PREV_CYCLE	Int	6.0	Cycle time of previous OB1 scan (milliseconds)
OB1_MIN_CYCLE	Int	8.0	Minimum cycle time of OB1 (milliseconds)
OB1_MAX_CYCLE	Int	10.0	Maximum cycle time of OB1 (milliseconds)
OB1_DATE_TIME	Date_And_Time	12.0	Date and time OB1 started

Bloque: OB1 "Main Program Sweep (Cycle)"

From here, the rest of subroutines (for the different stations) are summoned
(if
they are set).
The STAR/ STOP functions are also control.

Segm.: 1 Start-Stop

Define the state of each individual station,or for all at once.
It determine the status of the buttons depending on the status selected of the
stations.
It also performs the swich off, of the stations, in case they are no
habilitated or their status habe been changed to "OFF".

```
      CALL  "START_STOP_HMI_button"  FC1
```

Segm.: 2 Station 1

If the station has been set, the function that controls the individual station
would be summoned.

```
      U     "Puestos1".UDT4_1.Puesto_habilitado                     DB10.DBX234.0      -- In
                                                                    dicates if the station i
                                                                    s "built", if it can be
                                                                    turned ON
      SPB   C_1                                  //Go to CALL station 1

      CALL  "Reset_StationNOT_SET"                                  FC95
       T1_conectado        :="Puestos1".UDT4_1.T1_conec             DB10.DBX234.1      -- In
tado                                                                dicates the connection s
                                                                    tate of the sensor T1
       T2_conectado        :="Puestos1".UDT4_1.T2_conec             DB10.DBX234.3      -- In
tado                                                                dicates the connection s
                                                                    tate of the sensor T2
       T3_conectado        :="Puestos1".UDT4_1.T3_conec             DB10.DBX234.5      -- In
tado                                                                dicates the connection s
                                                                    tate of the sensor T3
       Tin_conectado       :="Puestos1".UDT4_1.Tin_cone             DB10.DBX234.7      -- In
ctado                                                               dicates the connection s
                                                                    tate of the sensor Tin
```

```
       Tout_conectado      :="Puestos1".UDT4_1.Tout_con                               DB10.DBX235.0      -- In
ectado                                                                                dicates the connection s
                                                                                      tate of the sensor Tout
       P1_conectado        :="Puestos1".UDT4_1.P1_conec                               DB10.DBX234.2      -- In
tado                                                                                  dicates the connection s
                                                                                      tate of the sensor P1
       P2_conectado        :="Puestos1".UDT4_1.P2_conec                               DB10.DBX234.4      -- In
tado                                                                                  dicates the connection s
                                                                                      tate of the sensor P2
       P3_conectado        :="Puestos1".UDT4_1.P3_conec                               DB10.DBX234.6      -- In
tado                                                                                  dicates the connection s
                                                                                      tate of the sensor P3
       m_ref_conectado     :="Puestos1".UDT4_1.m_ref_co                               DB10.DBX235.3      -- In
nectado                                                                               dicates the connection s
                                                                                      tate of the sensor m_ref
       Qw_conectado        :="Puestos1".UDT4_1.Qw_conec                               DB10.DBX235.1      -- In
tado                                                                                  dicates the connection s
                                                                                      tate of the sensor Qw
       Resistance_conectado:="Puestos1".UDT4_1.Resistan                               DB10.DBX235.2      -- In
ce_conectado                                                                          dicates ifa heating resi
                                                                                      stance can be uses
       dir_compressor      :=A1.0
       dir_resistance      :=A1.1
       dir_EEV             :=AW328
       dir_pump            :=AW324

      SPA   ST2

C_1:  CALL  "Station1_set"                                                            FC10
```

Segm.: 3 Station 2
If the station has been set, the function that controls the individual station would be summoned.

```
ST2:  U     "Puesto2".UDT4_2.Puesto_habilitado  DB20.DBX234.0      -- Indicates if the station is "built", if
                                                it can be turned ON
//Go to call station 2
//  SPA  ST3
```

Segm.: 4 END
END segment

```
      NOP   0
```

FC1 - <offline>

"START_STOP_HMI_button"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 09/06/2014 09:46:32
Interface: 13/05/2014 12:47:36
Longitud (bloque / código / datos): 05340 05110 00026

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC1 START ALL/ STOP ALL

When all the station are in the STOP mode, all the corresponding buttons/indicators of each station must be activated, besides de button/indicator of "STOP ALL" must be activate (only if all the stations implemented are in the STOP mode).

For the "START", and "START ALL"buttons/indicatos the exact opposite operations must be realized.

If the sations are not implemented, the function FC 8 ("Stop") is summonded to guarantee their OFF state.

Segm.: 1 Station state

If the station is disabled, its ON_OFF state would not be taken into the comparation to calculate the state of the "STAR ALL/STOP ALL" button/indicator.

If the station is disabled, habilitado=0, then the station would be configured as OFF and the variable AUXI_COMP=1.
If on the contrary, habilitado=1, then AUXI_COMP=ON_OFF since the station is set, its state must be taken into the comparation.

If the stations are set, the value of the AUXI_COMP would be equal to the station state, if not, the AUXI_COMP would be set as 1.

```
      U     "Puestos1".UDT4_1.Puesto_habilitado              DB10.DBX234.0      -- Indicates if the
                                                              station is "built", if it can be turn
                                                             ed ON
      SPBN  P1A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station

      U     "Puestos1".UDT4_1.ON_OFF                         DB10.DBX235.4      -- Indicates if the
                                                              station is ON (ON=1, OFF=0)
      =     "Puestos1".UDT4_1.AUXI_COMP                      DB10.DBX235.6      -- Its an auxiliar
                                                             variable,in order to make the comparat
                                                             ions
      SPBN  P1O


IR2:  U     "Puesto2".UDT4_2.Puesto_habilitado               DB20.DBX234.0      -- Indicates if the
                                                              station is "built", if it can be turn
                                                             ed ON
      SPBN  P2A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto2".UDT4_2.ON_OFF                          DB20.DBX235.4      -- Indicates if the
                                                              station is ON (ON=1, OFF=0)
```

```
      =     "Puesto2".UDT4_2.AUXI_COMP                  DB20.DBX235.6      -- Its an auxiliar
                                                        variable,in order to make the comparat
                                                        ions
      SPBN  P2O

IR3:  U     "Puesto3".UDT4_3.Puesto_habilitado          DB30.DBX234.0      -- Indicates if the
                                                         station is "built", if it can be turn
                                                        ed ON
      SPBN  P3A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto3".UDT4_3.ON_OFF                     DB30.DBX235.4      -- Indicates if the
                                                         station is ON (ON=1, OFF=0)
      =     "Puesto3".UDT4_3.AUXI_COMP                  DB30.DBX235.6      -- Its an auxiliar
                                                        variable,in order to make the comparat
                                                        ions
      SPBN  P3O

IR4:  U     "Puesto4".UDT4_4.Puesto_habilitado          DB40.DBX234.0      -- Indicates if the
                                                         station is "built", if it can be turn
                                                        ed ON
      SPBN  P4A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto4".UDT4_4.ON_OFF                     DB40.DBX235.4      -- Indicates if the
                                                         station is ON (ON=1, OFF=0)
      =     "Puesto4".UDT4_4.AUXI_COMP                  DB40.DBX235.6      -- Its an auxiliar
                                                        variable,in order to make the comparat
                                                        ions
      SPBN  P4O

IR5:  U     "Puesto5".UDT4_5.Puesto_habilitado          DB50.DBX234.0      -- Indicates if the
                                                         station is "built", if it can be turn
                                                        ed ON
      SPBN  P5A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto5".UDT4_5.ON_OFF                     DB50.DBX235.4      -- Indicates if the
                                                         station is ON (ON=1, OFF=0)
      =     "Puesto5".UDT4_5.AUXI_COMP                  DB50.DBX235.6      -- Its an auxiliar
                                                        variable,in order to make the comparat
                                                        ions
      SPBN  P5O

IR6:  U     "Puesto6".UDT4_6.Puesto_habilitado          DB60.DBX234.0      -- Indicates if the
                                                         station is "built", if it can be turn
                                                        ed ON
      SPBN  P6A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto6".UDT4_6.ON_OFF                     DB60.DBX235.4      -- Indicates if the
                                                         station is ON (ON=1, OFF=0)
      =     "Puesto6".UDT4_6.AUXI_COMP                  DB60.DBX235.6      -- Its an auxiliar
                                                        variable,in order to make the comparat
                                                        ions
      SPBN  P6O


IR7:  U     "Puesto7".UDT4_7.Puesto_habilitado          DB70.DBX234.0      -- Indicates if the
                                                         station is "built", if it can be turn
                                                        ed ON
      SPBN  P7A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto7".UDT4_7.ON_OFF                     DB70.DBX235.4      -- Indicates if the
                                                         station is ON (ON=1, OFF=0)
      =     "Puesto7".UDT4_7.AUXI_COMP                  DB70.DBX235.6      -- Its an auxiliar
                                                        variable,in order to make the comparat
                                                        ions
      SPBN  P7O

IR8:  U     "Puesto8".UDT4_8.Puesto_habilitado          DB80.DBX234.0      -- Indicates if the
                                                         station is "built", if it can be turn
                                                        ed ON
      SPBN  P8A
```

```
///if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station

      U     "Puesto8".UDT4_8.ON_OFF                        DB80.DBX235.4      -- Indicates if the
                                                            station is ON (ON=1, OFF=0)
      =     "Puesto8".UDT4_8.AUXI_COMP                     DB80.DBX235.6      -- Its an auxiliar
                                                           variable,in order to make the comparat
                                                           ions
      SPBN  P8O

IR9:  U     "Puesto9".UDT4_9.Puesto_habilitado             DB90.DBX234.0      -- Indicates if the
                                                            station is "built", if it can be turn
                                                           ed ON
      SPBN  P9A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto9".UDT4_9.ON_OFF                        DB90.DBX235.4      -- Indicates if the
                                                            station is ON (ON=1, OFF=0)
      =     "Puesto9".UDT4_9.AUXI_COMP                     DB90.DBX235.6      -- Its an auxiliar
                                                           variable,in order to make the comparat
                                                           ions
      SPBN  P9O

IR10: U     "Puesto10".UDT4_10.Puesto_habilitado           DB100.DBX234.0     -- Indicates if the
                                                            station is "built", if it can be turn
                                                           ed ON
      SPBN  P10A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto10".UDT4_10.ON_OFF                      DB100.DBX235.4     -- Indicates if the
                                                            station is ON (ON=1, OFF=0)
      =     "Puesto10".UDT4_10.AUXI_COMP                   DB100.DBX235.6     -- Its an auxiliar
                                                           variable,in order to make the comparat
                                                           ions
      SPBN  P10O

IR11: U     "Puesto11".UDT4_11.Puesto_habilitado           DB110.DBX234.0     -- Indicates if the
                                                            station is "built", if it can be turn
                                                           ed ON
      SPBN  P11A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station


      U     "Puesto11".UDT4_11.ON_OFF                      DB110.DBX235.4     -- Indicates if the
                                                            station is ON (ON=1, OFF=0)
      =     "Puesto11".UDT4_11.AUXI_COMP                   DB110.DBX235.6     -- Its an auxiliar
                                                           variable,in order to make the comparat
                                                           ions
      SPBN  P11O

IR12: U     "Puesto12".UDT4_12.Puesto_habilitado           DB120.DBX234.0     -- Indicates if the
                                                            station is "built", if it can be turn
                                                           ed ON
      SPBN  P12A

//if it is activated, the the auxiliar variable
//AUXI_COMP would copy the value ON_OFF of the station

      U     "Puesto12".UDT4_12.ON_OFF                      DB120.DBX235.4     -- Indicates if the
                                                            station is ON (ON=1, OFF=0)
      =     "Puesto12".UDT4_12.AUXI_COMP                   DB120.DBX235.6     -- Its an auxiliar
                                                           variable,in order to make the comparat
                                                           ions
      SPBN  P12O
      SPA   SEG2


//************************//
//NOT IMPLEMENTED STATIONS//
//************************//

//Part of the following code would be execute when the stations are habilitated but OFF

//___ST1____//

//If the station is not implemented, then the station would be set as OFF
//and the auxiliar variable AUXI_COMP=1
```

```
P1A:  S     "Puestos1".UDT4_1.AUXI_COMP                            DB10.DBX235.6      -- Its an auxiliar
                                                                   variable,in order to make the comparat
                                                                   ions
      R     "Puestos1".UDT4_1.ON_OFF                               DB10.DBX235.4      -- Indicates if the
                                                                    station is ON (ON=1, OFF=0)

P1O:  UN    "Puestos1".UDT4_1.ON_OFF                               DB10.DBX235.4      -- Indicates if the
                                                                    station is ON (ON=1, OFF=0)
      =     "Puestos1".UDT4_1.OFF                                  DB10.DBX235.5      -- Indicates if the
                                                                    station is OFF(OFF=1, ON=0)

//The programs leads to P10when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions


      CALL  "STOP_manual&automatic"                                FC8
       Dir_compressor       :=A1.0
       Dir_resistance       :=A1.1
       P3                   :="Puestos1".UDT1_1.P3_m               DB10.DBD32         -- Output pressure
                                                                   of the condenser
       P1                   :="Puestos1".UDT1_1.P1_m               DB10.DBD24         -- Input pressure o
                                                                   f the compressor
       OFF                  :="Puestos1".UDT4_1.OFF                DB10.DBX235.5      -- Indicates if the
                                                                    station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puestos1".UDT8_1.Mode_manual_automatic   DB10.DBX358.5      -- It determine weh
                                                                   ter the cycle works automatically (0)
                                                                   or in a manual way (1)
       Manual_Resistance    :="Puestos1".UDT8_1.Manual_resistance  DB10.DBX358.2      -- Test the correct
                                                                    functioning of the resistance
       Manual_EEV           :="Puestos1".UDT8_1.Manual_EEV         DB10.DBX358.3      -- test the correct
                                                                    funtioning of the EEV
       Manual_compressor    :="Puestos1".UDT8_1.Manual_compressor  DB10.DBX358.1      -- Test the correct
                                                                    functioning of the compressor in the
                                                                   manual mode
       Manual_pump          :="Puestos1".UDT8_1.Manual_Pump        DB10.DBX358.4      -- Test the correct
                                                                    functioning of the pump
       m_w                  :="Puestos1".UDT1_1.m_w_m              DB10.DBD40         -- Water flux
       orden_pump_int       :="Puestos1".UDT3_1.Orden_pump_int     DB10.DBW200        -- Control signal o
                                                                   f the water pump
       orden_EEVreal        :="Puestos1".UDT5_1.orden_EEVreal      DB10.DBD244        -- EEV control orde
                                                                   r
       Dir_pump             :=AW324
       Dir_EEV              :=AW328
       orden_EEV            :="Puestos1".UDT3_1.Orden_EEV_int      DB10.DBW198        -- Control signal o
                                                                   f the EEV
       orden_pump_real      :="Puestos1".UDT5_1.orden_pump_real    DB10.DBD248        -- Pump control ord
                                                                   er, REAL

//RESET of the connected sensors signals//

      R     "Puestos1".UDT4_1.T1_conectado                         DB10.DBX234.1      -- Indicates the co
                                                                   nnection state of the sensor T1
      R     "Puestos1".UDT4_1.T2_conectado                         DB10.DBX234.3      -- Indicates the co
                                                                   nnection state of the sensor T2
      R     "Puestos1".UDT4_1.T3_conectado                         DB10.DBX234.5      -- Indicates the co
                                                                   nnection state of the sensor T3
      R     "Puestos1".UDT4_1.Tin_conectado                        DB10.DBX234.7      -- Indicates the co
                                                                   nnection state of the sensor Tin
      R     "Puestos1".UDT4_1.Tout_conectado                       DB10.DBX235.0      -- Indicates the co
                                                                   nnection state of the sensor Tout
      R     "Puestos1".UDT4_1.P1_conectado                         DB10.DBX234.2      -- Indicates the co
                                                                   nnection state of the sensor P1
      R     "Puestos1".UDT4_1.P2_conectado                         DB10.DBX234.4      -- Indicates the co
                                                                   nnection state of the sensor P2
      R     "Puestos1".UDT4_1.P3_conectado                         DB10.DBX234.6      -- Indicates the co
                                                                   nnection state of the sensor P3
      R     "Puestos1".UDT4_1.m_ref_conectado                      DB10.DBX235.3      -- Indicates the co
                                                                   nnection state of the sensor m_ref
      R     "Puestos1".UDT4_1.Qw_conectado                         DB10.DBX235.1      -- Indicates the co
                                                                   nnection state of the sensor Qw
      R     "Puestos1".UDT4_1.Resistance_conectado                 DB10.DBX235.2      -- Indicates ifa he
                                                                   ating resistance can be uses


      SPA   IR2


//___ST2___//

P2A:  S     "Puesto2".UDT4_2.AUXI_COMP                             DB20.DBX235.6      -- Its an auxiliar
                                                                   variable,in order to make the comparat
                                                                   ions
      R     "Puesto2".UDT4_2.ON_OFF                                DB20.DBX235.4      -- Indicates if the
                                                                    station is ON (ON=1, OFF=0)

P2O:  UN    "Puesto2".UDT4_2.ON_OFF                                DB20.DBX235.4      -- Indicates if the
                                                                    station is ON (ON=1, OFF=0)
      =     "Puesto2".UDT4_2.OFF                                   DB20.DBX235.5      -- Indicates if the
                                                                    station is OFF(OFF=1, ON=0)
```

```
//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions


      CALL  "STOP_manual&automatic"                                   FC8
       Dir_compressor       :=A2.0
       Dir_resistance       :=A2.1
       P3                   :="Puesto2".UDT1_2.P3_m                   DB20.DBD32         -- Output pressure
                                                                      of the condenser
       P1                   :="Puesto2".UDT1_2.P1_m                   DB20.DBD24         -- Input pressure o
                                                                      f the compressor
       OFF                  :="Puesto2".UDT4_2.OFF                    DB20.DBX235.5      -- Indicates if the
                                                                       station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto2".UDT8_2.Mode_manual_automatic  DB20.DBX358.5      -- It determine weh
                                                                      ter the cycle works automatically (0)
                                                                      or in a manual way (1)
       Manual_Resistance    :="Puesto2".UDT8_2.Manual_resistance      DB20.DBX358.2      -- Test the correct
                                                                       functioning of the resistance
       Manual_EEV           :="Puesto2".UDT8_2.Manual_EEV             DB20.DBX358.3      -- test the correct
                                                                       funtioning of the EEV
       Manual_compressor    :="Puesto2".UDT8_2.Manual_compressor      DB20.DBX358.1      -- Test the correct
                                                                       functioning of the compressor in the
                                                                      manual mode
       Manual_pump          :="Puesto2".UDT8_2.Manual_Pump            DB20.DBX358.4      -- Test the correct
                                                                       functioning of the pump
       m_w                  :="Puesto2".UDT1_2.m_w_m                  DB20.DBD40         -- Water flux
       orden_pump_int       :="Puesto2".UDT3_2.Orden_pump_int         DB20.DBW200        -- Control signal o
                                                                      f the water pump
       orden_EEVreal        :="Puesto2".UDT5_2.orden_EEVreal          DB20.DBD244        -- EEV control orde
                                                                      r
       Dir_pump             :=AW424
       Dir_EEV              :=AW428
       orden_EEV            :="Puesto2".UDT3_2.Orden_EEV_int          DB20.DBW198        -- Control signal o
                                                                      f the EEV
       orden_pump_real      :="Puesto2".UDT5_2.orden_pump_real        DB20.DBD248        -- Pump control ord
                                                                      er, REAL

//RESET of the connected sensors signals//

      R     "Puesto2".UDT4_2.T1_conectado                             DB20.DBX234.1      -- Indicates the co
                                                                      nnection state of the sensor T1
      R     "Puesto2".UDT4_2.T2_conectado                             DB20.DBX234.3      -- Indicates the co
                                                                      nnection state of the sensor T2
      R     "Puesto2".UDT4_2.T3_conectado                             DB20.DBX234.5      -- Indicates the co
                                                                      nnection state of the sensor T3
      R     "Puesto2".UDT4_2.Tin_conectado                            DB20.DBX234.7      -- Indicates the co
                                                                      nnection state of the sensor Tin
      R     "Puesto2".UDT4_2.Tout_conectado                           DB20.DBX235.0      -- Indicates the co
                                                                      nnection state of the sensor Tout
      R     "Puesto2".UDT4_2.P1_conectado                             DB20.DBX234.2      -- Indicates the co
                                                                      nnection state of the sensor P1
      R     "Puesto2".UDT4_2.P2_conectado                             DB20.DBX234.4      -- Indicates the co
                                                                      nnection state of the sensor P2
      R     "Puesto2".UDT4_2.P3_conectado                             DB20.DBX234.6      -- Indicates the co
                                                                      nnection state of the sensor P3
      R     "Puesto2".UDT4_2.m_ref_conectado                          DB20.DBX235.3      -- Indicates the co
                                                                      nnection state of the sensor m_ref
      R     "Puesto2".UDT4_2.Qw_conectado                             DB20.DBX235.1      -- Indicates the co
                                                                      nnection state of the sensor Qw
      R     "Puesto2".UDT4_2.Resistance_conectado                     DB20.DBX235.2      -- Indicates ifa he
                                                                      ating resistance can be uses


      SPA   IR3

//___ST3___//

P3A:  R     "Puesto3".UDT4_3.ON_OFF                                   DB30.DBX235.4      -- Indicates if the
                                                                       station is ON (ON=1, OFF=0)
      S     "Puesto3".UDT4_3.AUXI_COMP                                DB30.DBX235.6      -- Its an auxiliar
                                                                      variable,in order to make the comparat
                                                                      ions

P3O:  UN    "Puesto3".UDT4_3.ON_OFF                                   DB30.DBX235.4      -- Indicates if the
                                                                       station is ON (ON=1, OFF=0)
      =     "Puesto3".UDT4_3.OFF                                      DB30.DBX235.5      -- Indicates if the
                                                                       station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions


      CALL  "STOP_manual&automatic"                                   FC8
       Dir_compressor       :=A3.0
       Dir_resistance       :=A3.1
       P3                   :="Puesto3".UDT1_3.P3_m                   DB30.DBD32         -- Output pressure
                                                                      of the condenser
```

```
       P1                   :="Puesto3".UDT1_3.P1_m                   DB30.DBD24          -- Input pressure o
                                                                      f the compressor
       OFF                  :="Puesto3".UDT4_3.OFF                    DB30.DBX235.5       -- Indicates if the
                                                                       station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto3".UDT8_3.Mode_manual_automatic  DB30.DBX358.5       -- It determine weh
                                                                      ter the cycle works automatically (0)
                                                                      or in a manual way (1)
       Manual_Resistance    :="Puesto3".UDT8_3.Manual_resistance      DB30.DBX358.2       -- Test the correct
                                                                       functioning of the resistance
       Manual_EEV           :="Puesto3".UDT8_3.Manual_EEV             DB30.DBX358.3       -- test the correct
                                                                       funtioning of the EEV
       Manual_compressor    :="Puesto3".UDT8_3.Manual_compressor      DB30.DBX358.1       -- Test the correct
                                                                       functioning of the compressor in the
                                                                      manual mode
       Manual_pump          :="Puesto3".UDT8_3.Manual_Pump            DB30.DBX358.4       -- Test the correct
                                                                       functioning of the pump
       m_w                  :="Puesto3".UDT1_3.m_w_m                  DB30.DBD40          -- Water flux
       orden_pump_int       :="Puesto3".UDT3_3.Orden_pump_int         DB30.DBW200         -- Control signal o
                                                                      f the water pump
       orden_EEVreal        :="Puesto3".UDT5_3.orden_EEVreal          DB30.DBD244         -- EEV control orde
                                                                      r
       Dir_pump             :=AW524
       Dir_EEV              :=AW528
       orden_EEV            :="Puesto3".UDT3_3.Orden_EEV_int          DB30.DBW198         -- Control signal o
                                                                      f the EEV
       orden_pump_real      :="Puesto3".UDT5_3.orden_pump_real        DB30.DBD248         -- Pump control ord
                                                                      er, REAL

//RESET of the connected sensors signals//

      R     "Puesto3".UDT4_3.T1_conectado                             DB30.DBX234.1       -- Indicates the co
                                                                      nnection state of the sensor T1
      R     "Puesto3".UDT4_3.T2_conectado                             DB30.DBX234.3       -- Indicates the co
                                                                      nnection state of the sensor T2
      R     "Puesto3".UDT4_3.T3_conectado                             DB30.DBX234.5       -- Indicates the co
                                                                      nnection state of the sensor T3
      R     "Puesto3".UDT4_3.Tin_conectado                            DB30.DBX234.7       -- Indicates the co
                                                                      nnection state of the sensor Tin
      R     "Puesto3".UDT4_3.Tout_conectado                           DB30.DBX235.0       -- Indicates the co
                                                                      nnection state of the sensor Tout
      R     "Puesto3".UDT4_3.P1_conectado                             DB30.DBX234.2       -- Indicates the co
                                                                      nnection state of the sensor P1
      R     "Puesto3".UDT4_3.P2_conectado                             DB30.DBX234.4       -- Indicates the co
                                                                      nnection state of the sensor P2
      R     "Puesto3".UDT4_3.P3_conectado                             DB30.DBX234.6       -- Indicates the co
                                                                      nnection state of the sensor P3
      R     "Puesto3".UDT4_3.m_ref_conectado                          DB30.DBX235.3       -- Indicates the co
                                                                      nnection state of the sensor m_ref
      R     "Puesto3".UDT4_3.Qw_conectado                             DB30.DBX235.1       -- Indicates the co
                                                                      nnection state of the sensor Qw
      R     "Puesto3".UDT4_3.Resistance_conectado                     DB30.DBX235.2       -- Indicates ifa he
                                                                      ating resistance can be uses


      SPA   IR4

//___ST4___//

P4A:  R     "Puesto4".UDT4_4.ON_OFF                                   DB40.DBX235.4       -- Indicates if the
                                                                       station is ON (ON=1, OFF=0)
      S     "Puesto4".UDT4_4.AUXI_COMP                                DB40.DBX235.6       -- Its an auxiliar
                                                                      variable,in order to make the comparat
                                                                      ions

P4O:  UN    "Puesto4".UDT4_4.ON_OFF                                   DB40.DBX235.4       -- Indicates if the
                                                                       station is ON (ON=1, OFF=0)
      =     "Puesto4".UDT4_4.OFF                                      DB40.DBX235.5       -- Indicates if the
                                                                       station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions


      CALL  "STOP_manual&automatic"                                   FC8
       Dir_compressor       :=A4.0
       Dir_resistance       :=A4.1
       P3                   :="Puesto4".UDT1_4.P3_m                   DB40.DBD32          -- Output pressure
                                                                      of the condenser
       P1                   :="Puesto4".UDT1_4.P1_m                   DB40.DBD24          -- Input pressure o
                                                                      f the compressor
       OFF                  :="Puesto4".UDT4_4.OFF                    DB40.DBX235.5       -- Indicates if the
                                                                       station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto4".UDT8_4.Mode_manual_automatic  DB40.DBX358.5       -- It determine weh
                                                                      ter the cycle works automatically (0)
                                                                      or in a manual way (1)
       Manual_Resistance    :="Puesto4".UDT8_4.Manual_resistance      DB40.DBX358.2       -- Test the correct
                                                                       functioning of the resistance
```

```
      Manual_EEV           :="Puesto4".UDT8_4.Manual_EEV            DB40.DBX358.3      -- test the correct
                                                                     funtioning of the EEV
      Manual_compressor    :="Puesto4".UDT8_4.Manual_compressor     DB40.DBX358.1      -- Test the correct
                                                                     functioning of the compressor in the
                                                                    manual mode
      Manual_pump          :="Puesto4".UDT8_4.Manual_Pump           DB40.DBX358.4      -- Test the correct
                                                                     functioning of the pump
      m_w                  :="Puesto4".UDT1_4.m_w_m                 DB40.DBD40         -- Water flux
      orden_pump_int       :="Puesto4".UDT3_4.Orden_pump_int        DB40.DBW200        -- Control signal o
                                                                    f the water pump
      orden_EEVreal        :="Puesto4".UDT5_4.orden_EEVreal         DB40.DBD244        -- EEV control orde
                                                                    r
      Dir_pump             :=AW624
      Dir_EEV              :=AW628
      orden_EEV            :="Puesto4".UDT3_4.Orden_EEV_int         DB40.DBW198        -- Control signal o
                                                                    f the EEV
      orden_pump_real      :="Puesto4".UDT5_4.orden_pump_real       DB40.DBD248        -- Pump control ord
                                                                    er, REAL

//RESET of the connected sensors signals//

      R     "Puesto4".UDT4_4.T1_conectado                           DB40.DBX234.1      -- Indicates the co
                                                                    nnection state of the sensor T1
      R     "Puesto4".UDT4_4.T2_conectado                           DB40.DBX234.3      -- Indicates the co
                                                                    nnection state of the sensor T2
      R     "Puesto4".UDT4_4.T3_conectado                           DB40.DBX234.5      -- Indicates the co
                                                                    nnection state of the sensor T3
      R     "Puesto4".UDT4_4.Tin_conectado                          DB40.DBX234.7      -- Indicates the co
                                                                    nnection state of the sensor Tin
      R     "Puesto4".UDT4_4.Tout_conectado                         DB40.DBX235.0      -- Indicates the co
                                                                    nnection state of the sensor Tout
      R     "Puesto4".UDT4_4.P1_conectado                           DB40.DBX234.2      -- Indicates the co
                                                                    nnection state of the sensor P1
      R     "Puesto4".UDT4_4.P2_conectado                           DB40.DBX234.4      -- Indicates the co
                                                                    nnection state of the sensor P2
      R     "Puesto4".UDT4_4.P3_conectado                           DB40.DBX234.6      -- Indicates the co
                                                                    nnection state of the sensor P3
      R     "Puesto4".UDT4_4.m_ref_conectado                        DB40.DBX235.3      -- Indicates the co
                                                                    nnection state of the sensor m_ref
      R     "Puesto4".UDT4_4.Qw_conectado                           DB40.DBX235.1      -- Indicates the co
                                                                    nnection state of the sensor Qw
      R     "Puesto4".UDT4_4.Resistance_conectado                   DB40.DBX235.2      -- Indicates ifa he
                                                                    ating resistance can be uses


      SPA   IR5

//___ST5___//


P5A:  R     "Puesto5".UDT4_5.ON_OFF                                 DB50.DBX235.4      -- Indicates if the
                                                                     station is ON (ON=1, OFF=0)
      S     "Puesto5".UDT4_5.AUXI_COMP                              DB50.DBX235.6      -- Its an auxiliar
                                                                    variable,in order to make the comparat
                                                                    ions

P5O:  UN    "Puesto5".UDT4_5.ON_OFF                                 DB50.DBX235.4      -- Indicates if the
                                                                     station is ON (ON=1, OFF=0)
      =     "Puesto5".UDT4_5.OFF                                    DB50.DBX235.5      -- Indicates if the
                                                                     station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions

      CALL  "STOP_manual&automatic"                                 FC8
       Dir_compressor      :=A5.0
       Dir_resistance      :=A5.1
       P3                  :="Puesto5".UDT1_5.P3_m                  DB50.DBD32         -- Output pressure
                                                                    of the condenser
       P1                  :="Puesto5".UDT1_5.P1_m                  DB50.DBD24         -- Input pressure o
                                                                    f the compressor
       OFF                 :="Puesto5".UDT4_5.OFF                   DB50.DBX235.5      -- Indicates if the
                                                                     station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto5".UDT8_5.Mode_manual_automatic DB50.DBX358.5     -- It determine weh
                                                                    ter the cycle works automatically (0)
                                                                    or in a manual way (1)
       Manual_Resistance   :="Puesto5".UDT8_5.Manual_resistance     DB50.DBX358.2      -- Test the correct
                                                                     functioning of the resistance
       Manual_EEV          :="Puesto5".UDT8_5.Manual_EEV            DB50.DBX358.3      -- test the correct
                                                                     funtioning of the EEV
       Manual_compressor   :="Puesto5".UDT8_5.Manual_compressor     DB50.DBX358.1      -- Test the correct
                                                                     functioning of the compressor in the
                                                                    manual mode
       Manual_pump         :="Puesto5".UDT8_5.Manual_Pump           DB50.DBX358.4      -- Test the correct
                                                                     functioning of the pump
       m_w                 :="Puesto5".UDT1_5.m_w_m                 DB50.DBD40         -- Water flux
       orden_pump_int      :="Puesto5".UDT3_5.Orden_pump_int        DB50.DBW200        -- Control signal o
                                                                    f the water pump
       orden_EEVreal       :="Puesto5".UDT5_5.orden_EEVreal         DB50.DBD244        -- EEV control orde
                                                                    r
```

```
      Dir_pump             :=AW724
      Dir_EEV              :=AW728
      orden_EEV            :="Puesto5".UDT3_5.Orden_EEV_int         DB50.DBW198        -- Control signal o
                                                                    f the EEV
      orden_pump_real      :="Puesto5".UDT5_5.orden_pump_real       DB50.DBD248        -- Pump control ord
                                                                    er, REAL


//RESET of the connected sensors signals//

      R     "Puesto5".UDT4_5.T1_conectado                           DB50.DBX234.1      -- Indicates the co
                                                                    nnection state of the sensor T1
      R     "Puesto5".UDT4_5.T2_conectado                           DB50.DBX234.3      -- Indicates the co
                                                                    nnection state of the sensor T2
      R     "Puesto5".UDT4_5.T3_conectado                           DB50.DBX234.5      -- Indicates the co
                                                                    nnection state of the sensor T3
      R     "Puesto5".UDT4_5.Tin_conectado                          DB50.DBX234.7      -- Indicates the co
                                                                    nnection state of the sensor Tin
      R     "Puesto5".UDT4_5.Tout_conectado                         DB50.DBX235.0      -- Indicates the co
                                                                    nnection state of the sensor Tout
      R     "Puesto5".UDT4_5.P1_conectado                           DB50.DBX234.2      -- Indicates the co
                                                                    nnection state of the sensor P1
      R     "Puesto5".UDT4_5.P2_conectado                           DB50.DBX234.4      -- Indicates the co
                                                                    nnection state of the sensor P2
      R     "Puesto5".UDT4_5.P3_conectado                           DB50.DBX234.6      -- Indicates the co
                                                                    nnection state of the sensor P3
      R     "Puesto5".UDT4_5.m_ref_conectado                        DB50.DBX235.3      -- Indicates the co
                                                                    nnection state of the sensor m_ref
      R     "Puesto5".UDT4_5.Qw_conectado                           DB50.DBX235.1      -- Indicates the co
                                                                    nnection state of the sensor Qw
      R     "Puesto5".UDT4_5.Resistance_conectado                   DB50.DBX235.2      -- Indicates ifa he
                                                                    ating resistance can be uses


      SPA   IR6

//___ST6___//


P6A:  R     "Puesto6".UDT4_6.ON_OFF                                 DB60.DBX235.4      -- Indicates if the
                                                                     station is ON (ON=1, OFF=0)
      S     "Puesto6".UDT4_6.AUXI_COMP                              DB60.DBX235.6      -- Its an auxiliar
                                                                    variable,in order to make the comparat
                                                                    ions

P6O:  UN    "Puesto6".UDT4_6.ON_OFF                                 DB60.DBX235.4      -- Indicates if the
                                                                     station is ON (ON=1, OFF=0)
      =     "Puesto6".UDT4_6.OFF                                    DB60.DBX235.5      -- Indicates if the
                                                                     station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions


      CALL  "STOP_manual&automatic"                                 FC8
       Dir_compressor       :=A6.0
       Dir_resistance       :=A6.1
       P3                   :="Puesto6".UDT1_6.P3_m                 DB60.DBD32         -- Output pressure
                                                                    of the condenser
       P1                   :="Puesto6".UDT1_6.P1_m                 DB60.DBD24         -- Input pressure o
                                                                    f the compressor
       OFF                  :="Puesto6".UDT4_6.OFF                  DB60.DBX235.5      -- Indicates if the
                                                                     station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto6".UDT8_6.Mode_manual_automatic DB60.DBX358.5     -- It determine weh
                                                                    ter the cycle works automatically (0)
                                                                    or in a manual way (1)
       Manual_Resistance    :="Puesto6".UDT8_6.Manual_resistance    DB60.DBX358.2      -- Test the correct
                                                                     functioning of the resistance
       Manual_EEV           :="Puesto6".UDT8_6.Manual_EEV           DB60.DBX358.3      -- test the correct
                                                                     funtioning of the EEV
       Manual_compressor    :="Puesto6".UDT8_6.Manual_compressor    DB60.DBX358.1      -- Test the correct
                                                                     functioning of the compressor in the
                                                                    manual mode
       Manual_pump          :="Puesto6".UDT8_6.Manual_Pump          DB60.DBX358.4      -- Test the correct
                                                                     functioning of the pump
       m_w                  :="Puesto6".UDT1_6.m_w_m                DB60.DBD40         -- Water flux
       orden_pump_int       :="Puesto6".UDT3_6.Orden_pump_int       DB60.DBW200        -- Control signal o
                                                                    f the water pump
       orden_EEVreal        :="Puesto6".UDT5_6.orden_EEVreal        DB60.DBD244        -- EEV control orde
                                                                    r
       Dir_pump             :=AW824
       Dir_EEV              :=AW828
       orden_EEV            :="Puesto6".UDT3_6.Orden_EEV_int        DB60.DBW198        -- Control signal o
                                                                    f the EEV
       orden_pump_real      :="Puesto6".UDT5_6.orden_pump_real      DB60.DBD248        -- Pump control ord
                                                                    er, REAL


//RESET of the connected sensors signals//
```

```
      R     "Puesto6".UDT4_6.T1_conectado                            DB60.DBX234.1      -- Indicates the co
                                                                     nnection state of the sensor T1
      R     "Puesto6".UDT4_6.T2_conectado                            DB60.DBX234.3      -- Indicates the co
                                                                     nnection state of the sensor T2
      R     "Puesto6".UDT4_6.T3_conectado                            DB60.DBX234.5      -- Indicates the co
                                                                     nnection state of the sensor T3
      R     "Puesto6".UDT4_6.Tin_conectado                           DB60.DBX234.7      -- Indicates the co
                                                                     nnection state of the sensor Tin
      R     "Puesto6".UDT4_6.Tout_conectado                          DB60.DBX235.0      -- Indicates the co
                                                                     nnection state of the sensor Tout
      R     "Puesto6".UDT4_6.P1_conectado                            DB60.DBX234.2      -- Indicates the co
                                                                     nnection state of the sensor P1
      R     "Puesto6".UDT4_6.P2_conectado                            DB60.DBX234.4      -- Indicates the co
                                                                     nnection state of the sensor P2
      R     "Puesto6".UDT4_6.P3_conectado                            DB60.DBX234.6      -- Indicates the co
                                                                     nnection state of the sensor P3
      R     "Puesto6".UDT4_6.m_ref_conectado                         DB60.DBX235.3      -- Indicates the co
                                                                     nnection state of the sensor m_ref
      R     "Puesto6".UDT4_6.Qw_conectado                            DB60.DBX235.1      -- Indicates the co
                                                                     nnection state of the sensor Qw
      R     "Puesto6".UDT4_6.Resistance_conectado                    DB60.DBX235.2      -- Indicates ifa he
                                                                     ating resistance can be uses


      SPA   IR7

//___ST7___//

P7A:  R     "Puesto7".UDT4_7.ON_OFF                                  DB70.DBX235.4      -- Indicates if the
                                                                      station is ON (ON=1, OFF=0)
      S     "Puesto7".UDT4_7.AUXI_COMP                               DB70.DBX235.6      -- Its an auxiliar
                                                                     variable,in order to make the comparat
                                                                     ions

P7O:  UN    "Puesto7".UDT4_7.ON_OFF                                  DB70.DBX235.4      -- Indicates if the
                                                                      station is ON (ON=1, OFF=0)
      =     "Puesto7".UDT4_7.OFF                                     DB70.DBX235.5      -- Indicates if the
                                                                      station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions

      CALL  "STOP_manual&automatic"                                  FC8
       Dir_compressor       :=A7.0
       Dir_resistance       :=A7.1
       P3                   :="Puesto7".UDT1_7.P3_m                  DB70.DBD32         -- Output pressure
                                                                     of the condenser
       P1                   :="Puesto7".UDT1_7.P1_m                  DB70.DBD24         -- Input pressure o
                                                                     f the compressor
       OFF                  :="Puesto7".UDT4_7.OFF                   DB70.DBX235.5      -- Indicates if the
                                                                      station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto7".UDT8_7.Mode_manual_automatic DB70.DBX358.5      -- It determine weh
                                                                     ter the cycle works automatically (0)
                                                                     or in a manual way (1)
       Manual_Resistance    :="Puesto7".UDT8_7.Manual_resistance     DB70.DBX358.2      -- Test the correct
                                                                      functioning of the resistance
       Manual_EEV           :="Puesto7".UDT8_7.Manual_EEV            DB70.DBX358.3      -- test the correct
                                                                      funtioning of the EEV
       Manual_compressor    :="Puesto7".UDT8_7.Manual_compressor     DB70.DBX358.1      -- Test the correct
                                                                      functioning of the compressor in the
                                                                     manual mode
       Manual_pump          :="Puesto7".UDT8_7.Manual_Pump           DB70.DBX358.4      -- Test the correct
                                                                      functioning of the pump
       m_w                  :="Puesto7".UDT1_7.m_w_m                 DB70.DBD40         -- Water flux
       orden_pump_int       :="Puesto7".UDT3_7.Orden_pump_int        DB70.DBW200        -- Control signal o
                                                                     f the water pump
       orden_EEVreal        :="Puesto7".UDT5_7.orden_EEVreal         DB70.DBD244        -- EEV control orde
                                                                     r
       Dir_pump             :=AW924
       Dir_EEV              :=AW928
       orden_EEV            :="Puesto7".UDT3_7.Orden_EEV_int         DB70.DBW198        -- Control signal o
                                                                     f the EEV
       orden_pump_real      :="Puesto7".UDT5_7.orden_pump_real       DB70.DBD248        -- Pump control ord
                                                                     er, REAL


//RESET of the connected sensors signals//

      R     "Puesto7".UDT4_7.T1_conectado                            DB70.DBX234.1      -- Indicates the co
                                                                     nnection state of the sensor T1
      R     "Puesto7".UDT4_7.T2_conectado                            DB70.DBX234.3      -- Indicates the co
                                                                     nnection state of the sensor T2
      R     "Puesto7".UDT4_7.T3_conectado                            DB70.DBX234.5      -- Indicates the co
                                                                     nnection state of the sensor T3
      R     "Puesto7".UDT4_7.Tin_conectado                           DB70.DBX234.7      -- Indicates the co
                                                                     nnection state of the sensor Tin
      R     "Puesto7".UDT4_7.Tout_conectado                          DB70.DBX235.0      -- Indicates the co
                                                                     nnection state of the sensor Tout
```

```
      R     "Puesto7".UDT4_7.P1_conectado                              DB70.DBX234.2      -- Indicates the co
                                                                       nnection state of the sensor P1
      R     "Puesto7".UDT4_7.P2_conectado                              DB70.DBX234.4      -- Indicates the co
                                                                       nnection state of the sensor P2
      R     "Puesto7".UDT4_7.P3_conectado                              DB70.DBX234.6      -- Indicates the co
                                                                       nnection state of the sensor P3
      R     "Puesto7".UDT4_7.m_ref_conectado                           DB70.DBX235.3      -- Indicates the co
                                                                       nnection state of the sensor m_ref
      R     "Puesto7".UDT4_7.Qw_conectado                              DB70.DBX235.1      -- Indicates the co
                                                                       nnection state of the sensor Qw
      R     "Puesto7".UDT4_7.Resistance_conectado                      DB70.DBX235.2      -- Indicates ifa he
                                                                       ating resistance can be uses


      SPA   IR8

//___ST8___//

P8A:  R     "Puesto8".UDT4_8.ON_OFF                                    DB80.DBX235.4      -- Indicates if the
                                                                        station is ON (ON=1, OFF=0)
      S     "Puesto8".UDT4_8.AUXI_COMP                                 DB80.DBX235.6      -- Its an auxiliar
                                                                       variable,in order to make the comparat
                                                                       ions

P8O:  UN    "Puesto8".UDT4_8.ON_OFF                                    DB80.DBX235.4      -- Indicates if the
                                                                        station is ON (ON=1, OFF=0)
      =     "Puesto8".UDT4_8.OFF                                       DB80.DBX235.5      -- Indicates if the
                                                                        station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions



      CALL  "STOP_manual&automatic"                                    FC8
       Dir_compressor       :=A8.0
       Dir_resistance       :=A8.1
       P3                   :="Puesto8".UDT1_8.P3_m                    DB80.DBD32         -- Output pressure
                                                                       of the condenser
       P1                   :="Puesto8".UDT1_8.P1_m                    DB80.DBD24         -- Input pressure o
                                                                       f the compressor
       OFF                  :="Puesto8".UDT4_8.OFF                     DB80.DBX235.5      -- Indicates if the
                                                                        station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto8".UDT8_8.Mode_manual_automatic   DB80.DBX358.5      -- It determine weh
                                                                       ter the cycle works automatically (0)
                                                                       or in a manual way (1)
       Manual_Resistance    :="Puesto8".UDT8_8.Manual_resistance       DB80.DBX358.2      -- Test the correct
                                                                        functioning of the resistance
       Manual_EEV           :="Puesto8".UDT8_8.Manual_EEV              DB80.DBX358.3      -- test the correct
                                                                        funtioning of the EEV
       Manual_compressor    :="Puesto8".UDT8_8.Manual_compressor       DB80.DBX358.1      -- Test the correct
                                                                        functioning of the compressor in the
                                                                       manual mode
       Manual_pump          :="Puesto8".UDT8_8.Manual_Pump             DB80.DBX358.4      -- Test the correct
                                                                        functioning of the pump
       m_w                  :="Puesto8".UDT1_8.m_w_m                   DB80.DBD40         -- Water flux
       orden_pump_int       :="Puesto8".UDT3_8.Orden_pump_int          DB80.DBW200        -- Control signal o
                                                                       f the water pump
       orden_EEVreal        :="Puesto8".UDT5_8.orden_EEVreal           DB80.DBD244        -- EEV control orde
                                                                       r
       Dir_pump             :=AW1024
       Dir_EEV              :=AW1028
       orden_EEV            :="Puesto8".UDT3_8.Orden_EEV_int           DB80.DBW198        -- Control signal o
                                                                       f the EEV
       orden_pump_real      :="Puesto8".UDT5_8.orden_pump_real         DB80.DBD248        -- Pump control ord
                                                                       er, REAL


//RESET of the connected sensors signals//

      R     "Puesto8".UDT4_8.T1_conectado                              DB80.DBX234.1      -- Indicates the co
                                                                       nnection state of the sensor T1
      R     "Puesto8".UDT4_8.T2_conectado                              DB80.DBX234.3      -- Indicates the co
                                                                       nnection state of the sensor T2
      R     "Puesto8".UDT4_8.T3_conectado                              DB80.DBX234.5      -- Indicates the co
                                                                       nnection state of the sensor T3
      R     "Puesto8".UDT4_8.Tin_conectado                             DB80.DBX234.7      -- Indicates the co
                                                                       nnection state of the sensor Tin
      R     "Puesto8".UDT4_8.Tout_conectado                            DB80.DBX235.0      -- Indicates the co
                                                                       nnection state of the sensor Tout
      R     "Puesto8".UDT4_8.P1_conectado                              DB80.DBX234.2      -- Indicates the co
                                                                       nnection state of the sensor P1
      R     "Puesto8".UDT4_8.P2_conectado                              DB80.DBX234.4      -- Indicates the co
                                                                       nnection state of the sensor P2
      R     "Puesto8".UDT4_8.P3_conectado                              DB80.DBX234.6      -- Indicates the co
                                                                       nnection state of the sensor P3
      R     "Puesto8".UDT4_8.m_ref_conectado                           DB80.DBX235.3      -- Indicates the co
                                                                       nnection state of the sensor m_ref
      R     "Puesto8".UDT4_8.Qw_conectado                              DB80.DBX235.1      -- Indicates the co
                                                                       nnection state of the sensor Qw
```

```
      R     "Puesto8".UDT4_8.Resistance_conectado                         DB80.DBX235.2      -- Indicates ifa he
                                                                          ating resistance can be uses



      SPA   IR9

//___ST9___//


P9A:  R     "Puesto9".UDT4_9.ON_OFF                                       DB90.DBX235.4      -- Indicates if the
                                                                           station is ON (ON=1, OFF=0)
      S     "Puesto9".UDT4_9.AUXI_COMP                                    DB90.DBX235.6      -- Its an auxiliar
                                                                          variable,in order to make the comparat
                                                                          ions

P9O:  UN    "Puesto9".UDT4_9.ON_OFF                                       DB90.DBX235.4      -- Indicates if the
                                                                           station is ON (ON=1, OFF=0)
      =     "Puesto9".UDT4_9.OFF                                          DB90.DBX235.5      -- Indicates if the
                                                                           station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions

      CALL  "STOP_manual&automatic"                                       FC8
       Dir_compressor       :=A9.0
       Dir_resistance       :=A9.1
       P3                   :="Puesto9".UDT1_9.P3_m                       DB90.DBD32         -- Output pressure
                                                                          of the condenser
       P1                   :="Puesto9".UDT1_9.P1_m                       DB90.DBD24         -- Input pressure o
                                                                          f the compressor
       OFF                  :="Puesto9".UDT4_9.OFF                        DB90.DBX235.5      -- Indicates if the
                                                                           station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto9".UDT8_9.Mode_manual_automatic      DB90.DBX358.5      -- It determine weh
                                                                          ter the cycle works automatically (0)
                                                                          or in a manual way (1)
       Manual_Resistance    :="Puesto9".UDT8_9.Manual_resistance          DB90.DBX358.2      -- Test the correct
                                                                           functioning of the resistance
       Manual_EEV           :="Puesto9".UDT8_9.Manual_EEV                 DB90.DBX358.3      -- test the correct
                                                                           funtioning of the EEV
       Manual_compressor    :="Puesto9".UDT8_9.Manual_compressor          DB90.DBX358.1      -- Test the correct
                                                                           functioning of the compressor in the
                                                                          manual mode
       Manual_pump          :="Puesto9".UDT8_9.Manual_Pump                DB90.DBX358.4      -- Test the correct
                                                                           functioning of the pump
       m_w                  :="Puesto9".UDT1_9.m_w_m                      DB90.DBD40         -- Water flux
       orden_pump_int       :="Puesto9".UDT3_9.Orden_pump_int             DB90.DBW200        -- Control signal o
                                                                          f the water pump
       orden_EEVreal        :="Puesto9".UDT5_9.orden_EEVreal              DB90.DBD244        -- EEV control orde
                                                                          r
       Dir_pump             :=AW1124
       Dir_EEV              :=AW1128
       orden_EEV            :="Puesto9".UDT3_9.Orden_EEV_int              DB90.DBW198        -- Control signal o
                                                                          f the EEV
       orden_pump_real      :="Puesto9".UDT5_9.orden_pump_real            DB90.DBD248        -- Pump control ord
                                                                          er, REAL

//RESET of the connected sensors signals//

      R     "Puesto9".UDT4_9.T1_conectado                                 DB90.DBX234.1      -- Indicates the co
                                                                          nnection state of the sensor T1
      R     "Puesto9".UDT4_9.T2_conectado                                 DB90.DBX234.3      -- Indicates the co
                                                                          nnection state of the sensor T2
      R     "Puesto9".UDT4_9.T3_conectado                                 DB90.DBX234.5      -- Indicates the co
                                                                          nnection state of the sensor T3
      R     "Puesto9".UDT4_9.Tin_conectado                                DB90.DBX234.7      -- Indicates the co
                                                                          nnection state of the sensor Tin
      R     "Puesto9".UDT4_9.Tout_conectado                               DB90.DBX235.0      -- Indicates the co
                                                                          nnection state of the sensor Tout
      R     "Puesto9".UDT4_9.P1_conectado                                 DB90.DBX234.2      -- Indicates the co
                                                                          nnection state of the sensor P1
      R     "Puesto9".UDT4_9.P2_conectado                                 DB90.DBX234.4      -- Indicates the co
                                                                          nnection state of the sensor P2
      R     "Puesto9".UDT4_9.P3_conectado                                 DB90.DBX234.6      -- Indicates the co
                                                                          nnection state of the sensor P3
      R     "Puesto9".UDT4_9.m_ref_conectado                              DB90.DBX235.3      -- Indicates the co
                                                                          nnection state of the sensor m_ref
      R     "Puesto9".UDT4_9.Qw_conectado                                 DB90.DBX235.1      -- Indicates the co
                                                                          nnection state of the sensor Qw
      R     "Puesto9".UDT4_9.Resistance_conectado                         DB90.DBX235.2      -- Indicates ifa he
                                                                          ating resistance can be uses


      SPA   IR10

//___ST10___//
```

```
P10A: R     "Puesto10".UDT4_10.ON_OFF                              DB100.DBX235.4     -- Indicates if the
                                                                    station is ON (ON=1, OFF=0)
      S     "Puesto10".UDT4_10.AUXI_COMP                           DB100.DBX235.6     -- Its an auxiliar
                                                                   variable,in order to make the comparat
                                                                   ions

P10O: UN    "Puesto10".UDT4_10.ON_OFF                              DB100.DBX235.4     -- Indicates if the
                                                                    station is ON (ON=1, OFF=0)
      =     "Puesto10".UDT4_10.OFF                                 DB100.DBX235.5     -- Indicates if the
                                                                    station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions



      CALL  "STOP_manual&automatic"                                FC8
       Dir_compressor       :=A10.0
       Dir_resistance       :=A10.1
       P3                   :="Puesto10".UDT1_10.P3_m              DB100.DBD32        -- Output pressure
                                                                   of the condenser
       P1                   :="Puesto10".UDT1_10.P1_m              DB100.DBD24        -- Input pressure o
                                                                   f the compressor
       OFF                  :="Puesto10".UDT4_10.OFF               DB100.DBX235.5     -- Indicates if the
                                                                    station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto10".UDT8_10.Mode_manual_automatic  DB100.DBX358.5     -- It determine weh
                                                                   ter the cycle works automatically (0)
                                                                   or in a manual way (1)
       Manual_Resistance    :="Puesto10".UDT8_10.Manual_resistance DB100.DBX358.2     -- Test the correct
                                                                    functioning of the resistance
       Manual_EEV           :="Puesto10".UDT8_10.Manual_EEV        DB100.DBX358.3     -- test the correct
                                                                    funtioning of the EEV
       Manual_compressor    :="Puesto10".UDT8_10.Manual_compressor DB100.DBX358.1     -- Test the correct
                                                                    functioning of the compressor in the
                                                                   manual mode
       Manual_pump          :="Puesto10".UDT8_10.Manual_Pump       DB100.DBX358.4     -- Test the correct
                                                                    functioning of the pump
       m_w                  :="Puesto10".UDT1_10.m_w_m             DB100.DBD40        -- Water flux
       orden_pump_int       :="Puesto10".UDT3_10.Orden_pump_int    DB100.DBW200       -- Control signal o
                                                                   f the water pump
       orden_EEVreal        :="Puesto10".UDT5_10.orden_EEVreal     DB100.DBD244       -- EEV control orde
                                                                   r
       Dir_pump             :=AW1224
       Dir_EEV              :=AW1228
       orden_EEV            :="Puesto10".UDT3_10.Orden_EEV_int     DB100.DBW198       -- Control signal o
                                                                   f the EEV
       orden_pump_real      :="Puesto10".UDT5_10.orden_pump_real   DB100.DBD248       -- Pump control ord
                                                                   er, REAL

//RESET of the connected sensors signals//

      R     "Puesto10".UDT4_10.T1_conectado                        DB100.DBX234.1     -- Indicates the co
                                                                   nnection state of the sensor T1
      R     "Puesto10".UDT4_10.T2_conectado                        DB100.DBX234.3     -- Indicates the co
                                                                   nnection state of the sensor T2
      R     "Puesto10".UDT4_10.T3_conectado                        DB100.DBX234.5     -- Indicates the co
                                                                   nnection state of the sensor T3
      R     "Puesto10".UDT4_10.Tin_conectado                       DB100.DBX234.7     -- Indicates the co
                                                                   nnection state of the sensor Tin
      R     "Puesto10".UDT4_10.Tout_conectado                      DB100.DBX235.0     -- Indicates the co
                                                                   nnection state of the sensor Tout
      R     "Puesto10".UDT4_10.P1_conectado                        DB100.DBX234.2     -- Indicates the co
                                                                   nnection state of the sensor P1
      R     "Puesto10".UDT4_10.P2_conectado                        DB100.DBX234.4     -- Indicates the co
                                                                   nnection state of the sensor P2
      R     "Puesto10".UDT4_10.P3_conectado                        DB100.DBX234.6     -- Indicates the co
                                                                   nnection state of the sensor P3
      R     "Puesto10".UDT4_10.m_ref_conectado                     DB100.DBX235.3     -- Indicates the co
                                                                   nnection state of the sensor m_ref
      R     "Puesto10".UDT4_10.Qw_conectado                        DB100.DBX235.1     -- Indicates the co
                                                                   nnection state of the sensor Qw
      R     "Puesto10".UDT4_10.Resistance_conectado                DB100.DBX235.2     -- Indicates ifa he
                                                                   ating resistance can be uses



      SPA   IR11

//___ST11___//

P11A: R     "Puesto11".UDT4_11.ON_OFF                              DB110.DBX235.4     -- Indicates if the
                                                                    station is ON (ON=1, OFF=0)
      S     "Puesto11".UDT4_11.AUXI_COMP                           DB110.DBX235.6     -- Its an auxiliar
                                                                   variable,in order to make the comparat
                                                                   ions

P11O: UN    "Puesto11".UDT4_11.ON_OFF                              DB110.DBX235.4     -- Indicates if the
                                                                    station is ON (ON=1, OFF=0)
```

```
      =     "Puesto11".UDT4_11.OFF                                      DB110.DBX235.5     -- Indicates if the
                                                                         station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions

      CALL  "STOP_manual&automatic"                                     FC8
       Dir_compressor       :=A11.0
       Dir_resistance       :=A11.1
       P3                   :="Puesto11".UDT1_11.P3_m                   DB110.DBD32        -- Output pressure
                                                                        of the condenser
       P1                   :="Puesto11".UDT1_11.P1_m                   DB110.DBD24        -- Input pressure o
                                                                        f the compressor
       OFF                  :="Puesto11".UDT4_11.OFF                    DB110.DBX235.5     -- Indicates if the
                                                                         station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puesto11".UDT8_11.Mode_manual_automatic  DB110.DBX358.5     -- It determine weh
                                                                        ter the cycle works automatically (0)
                                                                        or in a manual way (1)
       Manual_Resistance    :="Puesto11".UDT8_11.Manual_resistance      DB110.DBX358.2     -- Test the correct
                                                                         functioning of the resistance
       Manual_EEV           :="Puesto11".UDT8_11.Manual_EEV             DB110.DBX358.3     -- test the correct
                                                                         funtioning of the EEV
       Manual_compressor    :="Puesto11".UDT8_11.Manual_compressor      DB110.DBX358.1     -- Test the correct
                                                                         functioning of the compressor in the
                                                                        manual mode
       Manual_pump          :="Puesto11".UDT8_11.Manual_Pump            DB110.DBX358.4     -- Test the correct
                                                                         functioning of the pump
       m_w                  :="Puesto11".UDT1_11.m_w_m                  DB110.DBD40        -- Water flux
       orden_pump_int       :="Puesto11".UDT3_11.Orden_pump_int         DB110.DBW200       -- Control signal o
                                                                        f the water pump
       orden_EEVreal        :="Puesto11".UDT5_11.orden_EEVreal          DB110.DBD244       -- EEV control orde
                                                                        r
       Dir_pump             :=AW1324
       Dir_EEV              :=AW1328
       orden_EEV            :="Puesto11".UDT3_11.Orden_EEV_int          DB110.DBW198       -- Control signal o
                                                                        f the EEV
       orden_pump_real      :="Puesto11".UDT5_11.orden_pump_real        DB110.DBD248       -- Pump control ord
                                                                        er, REAL

//RESET of the connected sensors signals//

      R     "Puesto11".UDT4_11.T1_conectado                             DB110.DBX234.1     -- Indicates the co
                                                                        nnection state of the sensor T1
      R     "Puesto11".UDT4_11.T2_conectado                             DB110.DBX234.3     -- Indicates the co
                                                                        nnection state of the sensor T2
      R     "Puesto11".UDT4_11.T3_conectado                             DB110.DBX234.5     -- Indicates the co
                                                                        nnection state of the sensor T3
      R     "Puesto11".UDT4_11.Tin_conectado                            DB110.DBX234.7     -- Indicates the co
                                                                        nnection state of the sensor Tin
      R     "Puesto11".UDT4_11.Tout_conectado                           DB110.DBX235.0     -- Indicates the co
                                                                        nnection state of the sensor Tout
      R     "Puesto11".UDT4_11.P1_conectado                             DB110.DBX234.2     -- Indicates the co
                                                                        nnection state of the sensor P1
      R     "Puesto11".UDT4_11.P2_conectado                             DB110.DBX234.4     -- Indicates the co
                                                                        nnection state of the sensor P2
      R     "Puesto11".UDT4_11.P3_conectado                             DB110.DBX234.6     -- Indicates the co
                                                                        nnection state of the sensor P3
      R     "Puesto11".UDT4_11.m_ref_conectado                          DB110.DBX235.3     -- Indicates the co
                                                                        nnection state of the sensor m_ref
      R     "Puesto11".UDT4_11.Qw_conectado                             DB110.DBX235.1     -- Indicates the co
                                                                        nnection state of the sensor Qw
      R     "Puesto11".UDT4_11.Resistance_conectado                     DB110.DBX235.2     -- Indicates ifa he
                                                                        ating resistance can be uses



      SPA   IR12

//___ST12___//


P12A: R     "Puesto12".UDT4_12.ON_OFF                                   DB120.DBX235.4     -- Indicates if the
                                                                         station is ON (ON=1, OFF=0)
      S     "Puesto12".UDT4_12.AUXI_COMP                                DB120.DBX235.6     -- Its an auxiliar
                                                                        variable,in order to make the comparat
                                                                        ions

P12O: UN    "Puesto12".UDT4_12.ON_OFF                                   DB120.DBX235.4     -- Indicates if the
                                                                         station is ON (ON=1, OFF=0)
      =     "Puesto12".UDT4_12.OFF                                      DB120.DBX235.5     -- Indicates if the
                                                                         station is OFF(OFF=1, ON=0)

//The programs leads to PX0 when the station is habilitated but it is off
//It calculates the OFF variable and execute the OFF functions


      CALL  "STOP_manual&automatic"                                     FC8
       Dir_compressor       :=A12.0
       Dir_resistance       :=A12.1
```

```
      P3                    :="Puesto12".UDT1_12.P3_m                  DB120.DBD32         -- Output pressure
                                                                       of the condenser
      P1                    :="Puesto12".UDT1_12.P1_m                  DB120.DBD24         -- Input pressure o
                                                                       f the compressor
      OFF                   :="Puesto12".UDT4_12.OFF                   DB120.DBX235.5      -- Indicates if the
                                                                        station is OFF(OFF=1, ON=0)
      Mode_manual_automatic:="Puesto12".UDT8_12.Mode_manual_automatic  DB120.DBX358.5      -- It determine weh
                                                                       ter the cycle works automatically (0)
                                                                       or in a manual way (1)
      Manual_Resistance     :="Puesto12".UDT8_12.Manual_resistance     DB120.DBX358.2      -- Test the correct
                                                                        functioning of the resistance
      Manual_EEV            :="Puesto12".UDT8_12.Manual_EEV            DB120.DBX358.3      -- test the correct
                                                                        funtioning of the EEV
      Manual_compressor     :="Puesto12".UDT8_12.Manual_compressor     DB120.DBX358.1      -- Test the correct
                                                                        functioning of the compressor in the
                                                                       manual mode
      Manual_pump           :="Puesto12".UDT8_12.Manual_Pump           DB120.DBX358.4      -- Test the correct
                                                                        functioning of the pump
      m_w                   :="Puesto12".UDT1_12.m_w_m                 DB120.DBD40         -- Water flux
      orden_pump_int        :="Puesto12".UDT3_12.Orden_pump_int        DB120.DBW200        -- Control signal o
                                                                       f the water pump
      orden_EEVreal         :="Puesto12".UDT5_12.orden_EEVreal         DB120.DBD244        -- EEV control orde
                                                                       r
      Dir_pump              :=AW1424
      Dir_EEV               :=AW1428
      orden_EEV             :="Puesto12".UDT3_12.Orden_EEV_int         DB120.DBW198        -- Control signal o
                                                                       f the EEV
      orden_pump_real       :="Puesto12".UDT5_12.orden_pump_real       DB120.DBD248        -- Pump control ord
                                                                       er, REAL

//RESET of the connected sensors signals//

      R     "Puesto12".UDT4_12.T1_conectado                            DB120.DBX234.1      -- Indicates the co
                                                                       nnection state of the sensor T1
      R     "Puesto12".UDT4_12.T2_conectado                            DB120.DBX234.3      -- Indicates the co
                                                                       nnection state of the sensor T2
      R     "Puesto12".UDT4_12.T3_conectado                            DB120.DBX234.5      -- Indicates the co
                                                                       nnection state of the sensor T3
      R     "Puesto12".UDT4_12.Tin_conectado                           DB120.DBX234.7      -- Indicates the co
                                                                       nnection state of the sensor Tin
      R     "Puesto12".UDT4_12.Tout_conectado                          DB120.DBX235.0      -- Indicates the co
                                                                       nnection state of the sensor Tout
      R     "Puesto12".UDT4_12.P1_conectado                            DB120.DBX234.2      -- Indicates the co
                                                                       nnection state of the sensor P1
      R     "Puesto12".UDT4_12.P2_conectado                            DB120.DBX234.4      -- Indicates the co
                                                                       nnection state of the sensor P2
      R     "Puesto12".UDT4_12.P3_conectado                            DB120.DBX234.6      -- Indicates the co
                                                                       nnection state of the sensor P3
      R     "Puesto12".UDT4_12.m_ref_conectado                         DB120.DBX235.3      -- Indicates the co
                                                                       nnection state of the sensor m_ref
      R     "Puesto12".UDT4_12.Qw_conectado                            DB120.DBX235.1      -- Indicates the co
                                                                       nnection state of the sensor Qw
      R     "Puesto12".UDT4_12.Resistance_conectado                    DB120.DBX235.2      -- Indicates ifa he
                                                                       ating resistance can be uses


      NOP   0
```

Segm.: 2 Simultaneous start of the stations
The stations can be activated all at once. If one of them is stopped, then the start button/indicator should stop being active.

```
SEG2: U     "Puestos1".UDT4_1.AUXI_COMP        DB10.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto2".UDT4_2.AUXI_COMP         DB20.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto3".UDT4_3.AUXI_COMP         DB30.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto4".UDT4_4.AUXI_COMP         DB40.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto5".UDT4_5.AUXI_COMP         DB50.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto6".UDT4_6.AUXI_COMP         DB60.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto7".UDT4_7.AUXI_COMP         DB70.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto8".UDT4_8.AUXI_COMP         DB80.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto9".UDT4_9.AUXI_COMP         DB90.DBX235.6       -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto10".UDT4_10.AUXI_COMP       DB100.DBX235.6      -- Its an auxiliar variable,in order to mak
                                               e the comparations
      U     "Puesto11".UDT4_11.AUXI_COMP       DB110.DBX235.6      -- Its an auxiliar variable,in order to mak
                                               e the comparations
```

```
      U     "Puesto12".UDT4_12.AUXI_COMP       DB120.DBX235.6     -- Its an auxiliar variable,in order to mak
                                               e the comparations

      =     "Puestos1".UDT9_1.Button_start_all  DB10.DBX370.2      -- Just for the HMI
```

Segm.: 3 Simultaneous stop for all the stations
If all theimplemented stations are OFF (ON_OFF=0 ot OFF=1), then STOP ALL=1 The programation that stablish that OFF=1 (for all the stations) when the button STOP ALLis pulsed, has been developed in the WINCC program.

```
      UN    "Puestos1".UDT4_1.ON_OFF          DB10.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto2".UDT4_2.ON_OFF           DB20.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto3".UDT4_3.ON_OFF           DB30.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto4".UDT4_4.ON_OFF           DB40.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto5".UDT4_5.ON_OFF           DB50.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto6".UDT4_6.ON_OFF           DB60.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto7".UDT4_7.ON_OFF           DB70.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto8".UDT4_8.ON_OFF           DB80.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto9".UDT4_9.ON_OFF           DB90.DBX235.4      -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto10".UDT4_10.ON_OFF         DB100.DBX235.4     -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto11".UDT4_11.ON_OFF         DB110.DBX235.4     -- Indicates if the station is ON (ON=1, OFF
                                              =0)
      UN    "Puesto12".UDT4_12.ON_OFF         DB120.DBX235.4     -- Indicates if the station is ON (ON=1, OFF
                                              =0)

      =     "Puestos1".UDT9_1.Button_stop_all  DB10.DBX370.3      -- Just for the HMI
```

Segm.: 4 START ALL
When the "START ALL" button is pressed (once, twice...) all the stations IMPLEMENTED are set as "ON".

```
      U     "Puestos1".START_ALL                                           DB10.DBX400.1      -- All th
                                                                           e stations must be turned on
                                                                            simustaneuosly
      SPB   S_AL
      SPA   SEG5                                 //If it is not active, continue the execution of the program
                                                  in the next segment


//The variable is active, so the stations implemented must be set as "ON"

S_AL: U     "Puestos1".UDT4_1.Puesto_habilitado                            DB10.DBX234.0      -- Indica
                                                                           tes if the station is "built
                                                                           ", if it can be turned ON
      SPB   S_1                                  //If  the station is implemented, then set the ON variable
                                                 and reset the OFF
      SPA   P2                                   //If the station is not implemented, check the next station
S_1:  S     "Puestos1".UDT4_1.ON_OFF                                       DB10.DBX235.4      -- Indica
                                                                           tes if the station is ON (ON
                                                                           =1, OFF=0)
      R     "Puestos1".UDT4_1.OFF                                          DB10.DBX235.5      -- Indica
                                                                           tes if the station is OFF(OF
                                                                           F=1, ON=0)

//___ST2___//

P2:   U     "Puesto2".UDT4_2.Puesto_habilitado                             DB20.DBX234.0      -- Indica
                                                                           tes if the station is "built
                                                                           ", if it can be turned ON
      SPB   S_2
      SPA   P3
S_2:  S     "Puesto2".UDT4_2.ON_OFF                                        DB20.DBX235.4      -- Indica
                                                                           tes if the station is ON (ON
                                                                           =1, OFF=0)
      R     "Puesto2".UDT4_2.OFF                                           DB20.DBX235.5      -- Indica
                                                                           tes if the station is OFF(OF
                                                                           F=1, ON=0)

//___ST3___//
```

```
P3:   U     "Puesto3".UDT4_3.Puesto_habilitado          DB30.DBX234.0      -- Indicates if the station is "built", if it can be turned ON
      SPB   S_3
      SPA   P4
S_3:  S     "Puesto3".UDT4_3.ON_OFF                     DB30.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto3".UDT4_3.OFF                        DB30.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)

//___ST4___//

P4:   U     "Puesto4".UDT4_4.Puesto_habilitado          DB40.DBX234.0      -- Indicates if the station is "built", if it can be turned ON
      SPB   S_4
      SPA   P5
S_4:  S     "Puesto4".UDT4_4.ON_OFF                     DB40.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto4".UDT4_4.OFF                        DB40.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)

//___ST5___//

P5:   U     "Puesto5".UDT4_5.Puesto_habilitado          DB50.DBX234.0      -- Indicates if the station is "built", if it can be turned ON
      SPB   S_5
      SPA   P6
S_5:  S     "Puesto5".UDT4_5.ON_OFF                     DB50.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto5".UDT4_5.OFF                        DB50.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)

//___ST6___//

P6:   U     "Puesto6".UDT4_6.Puesto_habilitado          DB60.DBX234.0      -- Indicates if the station is "built", if it can be turned ON
      SPB   S_6
      SPA   P7
S_6:  S     "Puesto6".UDT4_6.ON_OFF                     DB60.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto6".UDT4_6.OFF                        DB60.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)

//___ST7___//

P7:   U     "Puesto7".UDT4_7.Puesto_habilitado          DB70.DBX234.0      -- Indicates if the station is "built", if it can be turned ON
      SPB   S_7
      SPA   P8
S_7:  S     "Puesto7".UDT4_7.ON_OFF                     DB70.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto7".UDT4_7.OFF                        DB70.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)

//___ST8___//

P8:   U     "Puesto8".UDT4_8.Puesto_habilitado          DB80.DBX234.0      -- Indicates if the station is "built", if it can be turned ON
      SPB   S_8
      SPA   P9
S_8:  S     "Puesto8".UDT4_8.ON_OFF                     DB80.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto8".UDT4_8.OFF                        DB80.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)

//___ST9___//

P9:   U     "Puesto9".UDT4_9.Puesto_habilitado          DB90.DBX234.0      -- Indicates if the station is "built", if it can be turned ON
      SPB   S_9
      SPA   P10
```

```
S_9:  S     "Puesto9".UDT4_9.ON_OFF                                     DB90.DBX235.4      -- Indica
                                                                        tes if the station is ON (ON
                                                                        =1, OFF=0)
      R     "Puesto9".UDT4_9.OFF                                        DB90.DBX235.5      -- Indica
                                                                        tes if the station is OFF(OF
                                                                        F=1, ON=0)

//___ST10___//

P10:  U     "Puesto10".UDT4_10.Puesto_habilitado                        DB100.DBX234.0     -- Indica
                                                                        tes if the station is "built
                                                                        ", if it can be turned ON
      SPB   S_10
      SPA   P11
S_10: S     "Puesto10".UDT4_10.ON_OFF                                   DB100.DBX235.4     -- Indica
                                                                        tes if the station is ON (ON
                                                                        =1, OFF=0)
      R     "Puesto10".UDT4_10.OFF                                      DB100.DBX235.5     -- Indica
                                                                        tes if the station is OFF(OF
                                                                        F=1, ON=0)

//___ST11___//

P11:  U     "Puesto11".UDT4_11.Puesto_habilitado                        DB110.DBX234.0     -- Indica
                                                                        tes if the station is "built
                                                                        ", if it can be turned ON
      SPB   S_11
      SPA   P12
S_11: S     "Puesto11".UDT4_11.ON_OFF                                   DB110.DBX235.4     -- Indica
                                                                        tes if the station is ON (ON
                                                                        =1, OFF=0)
      R     "Puesto11".UDT4_11.OFF                                      DB110.DBX235.5     -- Indica
                                                                        tes if the station is OFF(OF
                                                                        F=1, ON=0)

//___ST12___//

P12:  U     "Puesto12".UDT4_12.Puesto_habilitado                        DB120.DBX234.0     -- Indica
                                                                        tes if the station is "built
                                                                        ", if it can be turned ON
      SPB   S_12
      SPA   SEG5
S_12: S     "Puesto12".UDT4_12.ON_OFF                                   DB120.DBX235.4     -- Indica
                                                                        tes if the station is ON (ON
                                                                        =1, OFF=0)
      R     "Puesto12".UDT4_12.OFF                                      DB120.DBX235.5     -- Indica
                                                                        tes if the station is OFF(OF
                                                                        F=1, ON=0)
```

Segm.: 5 STOP ALL

When the STOP all button is pressed (once, twice...) all the stations are set as "OFF".
We could repeat the code for the "START ALL" button, and invert it. However, since when a station has not been implemented we configurate it as "OFF" then there would be no need The code would be much easier .

```
SEG5: U     "Puestos1".STOP_ALL        DB10.DBX400.0      -- All the stations must be turned off simustaneousl
                                       y
      SPB   R_AL
      SPA   END

R_AL: R     "Puestos1".UDT4_1.ON_OFF   DB10.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto2".UDT4_2.ON_OFF    DB20.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto3".UDT4_3.ON_OFF    DB30.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto4".UDT4_4.ON_OFF    DB40.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto5".UDT4_5.ON_OFF    DB50.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto6".UDT4_6.ON_OFF    DB60.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto7".UDT4_7.ON_OFF    DB70.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto8".UDT4_8.ON_OFF    DB80.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto9".UDT4_9.ON_OFF    DB90.DBX235.4      -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto10".UDT4_10.ON_OFF  DB100.DBX235.4     -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto11".UDT4_11.ON_OFF  DB110.DBX235.4     -- Indicates if the station is ON (ON=1, OFF=0)
      R     "Puesto12".UDT4_12.ON_OFF  DB120.DBX235.4     -- Indicates if the station is ON (ON=1, OFF=0)


      S     "Puestos1".UDT4_1.OFF      DB10.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto2".UDT4_2.OFF       DB20.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto3".UDT4_3.OFF       DB30.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto4".UDT4_4.OFF       DB40.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto5".UDT4_5.OFF       DB50.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto6".UDT4_6.OFF       DB60.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto7".UDT4_7.OFF       DB70.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
```

```
      S     "Puesto8".UDT4_8.OFF      DB80.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto9".UDT4_9.OFF      DB90.DBX235.5      -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto10".UDT4_10.OFF    DB100.DBX235.5     -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto11".UDT4_11.OFF    DB110.DBX235.5     -- Indicates if the station is OFF(OFF=1, ON=0)
      S     "Puesto12".UDT4_12.OFF    DB120.DBX235.5     -- Indicates if the station is OFF(OFF=1, ON=0)
```

Segm.: 6 END
END segment

```
END:  NOP   0
```

FC2 - <offline>

"Real->Int->Word"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 27/05/2014 09:21:49
Interface: 14/05/2014 15:25:04
Longitud (bloque / código / datos): 00122 00024 00000

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
valor_REAL	Real	0.0	
OUT		0.0	
valor_INT	Int	4.0	
valor_WORD	Word	6.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC2 REAL->INT->WORD

Convertion:
REAL--> DINT
DINT--> BCD
BCD--> INT
INT--> WORD

Segm.: 1 Convertion

RND-> From REAL to DINT
DTB-> From DINT to BCD
BTD-> From BCD to INT

```
//REAL--> WORD

      L     #valor_REAL  //Value REAL (32 bits)                  #valor_REAL
      RND                //Convertion to DINT
      DTB                //Convertion to BCD
      BTD                //From BCD to INT
      T     #valor_INT   //The INT value is stored               #valor_INT

      L     #valor_INT                                           #valor_INT
      T     #valor_WORD  //We save the INT value as a WORD       #valor_WORD
```

FC3 - <offline>

"Sensor conect/desconect"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 30/05/2014 18:21:32
Interface: 21/05/2014 13:15:41
Longitud (bloque / código / datos): 00120 00020 00000

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
Sensor_conectado	Bool	0.0	It indicates if the sensor has been connected
Valor_teorico	Real	2.0	The theoretical value that should have
OUT		0.0	
Valor_a_GUARDAR	Real	6.0	If it is not connected, the theoretical value would be stored to use it
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC3 Connected sensor

If the sensorhas been connected, then it would measure the real value and store it.
Otherwise, the theoretical value calculated would have to be store as if it was the real value.

Segm.: 1 Not connected sensor

The program is written for when the sensor IS connected.
The code below is a correction of this fact, in other words, what have to me done if the sensor hasn't been implemented.

```
      U     #Sensor_conectado  #Sensor_conectado  -- It indicates if the sensor has been connected
      SPBN  NO_C

NO_C: L     #Valor_teorico     #Valor_teorico     -- The theoretical value that should have
      T     #Valor_a_GUARDAR   #Valor_a_GUARDAR   -- If it is not connected, the theoretical value would be st
                               ored to use it
      NOP   0
```

FC4 - <offline>

"Alarm"
Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 11/06/2014 16:27:54
Interface: 11/06/2014 16:27:54
Longitud (bloque / código / datos): 00772 00522 00026

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
DeviationT1	Real	0.0	Deviation of T1 allowed (%)
DeviationP1	Real	4.0	Deviation of P1 allowed (%)
MaxP2	Real	8.0	Maximum pressure allowed at point 2 (bar)
MaxT2	Real	12.0	Maximum temperature allowed at point 2 (ªC)
T1_m	Real	16.0	Temperature at point 1, measured
P1_m	Real	20.0	Pressure at point 1, measured
T2_m	Real	24.0	Temperature at point 2, measured
P2_m	Real	28.0	Pressure at point 2 , measured
OUT		0.0	
IN_OUT		0.0	
T1sat	Real	32.0	Saturation temperature at P1_set
P1_set	Real	36.0	Set pressure at point 1
ON_OFF	Bool	40.0	O->OFF When an error occurs
OFF	Bool	40.1	1->OFF when an error occurs
T1_Low	Bool	40.2	Indicator of T1< T1min->1
T1_High	Bool	40.3	Indicator of T1> T1max->1
T1_Error	Bool	40.4	Temperature 1 is not between the limits->1
P1_Low	Bool	40.5	Indicator of P1< P1min->1
P1_High	Bool	40.6	Indicator of P1> P1max->1
P1_Error	Bool	40.7	Pressure 1 is not between the limits->1
T2_Error	Bool	41.0	Temperature 2> T2 maximum
P2_Error	Bool	41.1	Pressure 2 > P2 maximum
Stable	Bool	41.2	Indicates when the bench has been stabilized for the first time
Alarm	Bool	41.3	The bench needs to be stopped, and a signal must be emited
TEMP		0.0	
T1_max	Real	0.0	Max temperature at point 1 allowed
T1_min	Real	4.0	MIn temperature at point 1 allowed
P1_max	Real	8.0	Max pressure at point 1 allowed
P1_min	Real	12.0	Min pressure at point 1 alloxed
ToleranceT1	Real	16.0	Tolerance of T1
ToleranceP1	Real	20.0	Tolerance of P1
Point1_failure	Bool	24.0	Indicates when an error has occurred in point 1
Point2_failure	Bool	24.1	Indicates when an error has occurred in point 2
ST	Bool	24.2	Auxiliar variable to increment the counter
Wait_settling_time_max	Bool	24.3	Active while it is in the settling time (15min,..)
Wait_sample_time	Bool	24.4	
Sample	Bool	24.5	
Failure_time_P1_done	Bool	24.6	The failure in Point 1 has persist the time allowed
Failure_time_P2_done	Bool	24.7	The failure in Point 2 has persist the time allowed
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC4 ALARM

When the station is working (ON) in the AUTOMATIC mode, some parameters must be checked in orden to gurantee the correct funtioning of the station.

Segm.: 1 Maximum settling time

During the settling time, the alarm actions would not be performed. The station needs time to stabilize.
There woulb be different samples of the error status.(EVERY 3 MIN)

```
//Set the maximum settling time (no alarm actions would be performed)

      U     #ON_OFF                  #ON_OFF            -- O->OFF When an error occurs
      L     S5T#5M
      SE    T      0
      UN    T      0
      =     #Wait_settling_time_max  #Wait_settling_time_max -- Active while it is in the settling time (15min
                                     ,..)

      UN    #Wait_settling_time_max  #Wait_settling_time_max -- Active while it is in the settling time (15min
                                     ,..)
      SPB   SEG1

//SI no relanzar el timer


      SPA   END
```

Segm.: 2 Temperature at point 1

Alarm settings have been defined. A deviation (expresed in %)would be permitted for the temperature T1 and the pressure P1

```
SEG1: L     #DeviationT1                                      #DeviationT1       -- Deviation of T1 a
                                                              llowed (%)
      L     1.000000e+002
      /R

//It is expressed in %, we must divided it

      L     #T1sat                                            #T1sat             -- Saturation temper
                                                              ature at P1_set
      *R
      T     #ToleranceT1                                      #ToleranceT1       -- Tolerance of T1

//By multiplying the deviation by the value desired we obtain the tolerance

//Tol+Desired value=Max value allowed

      L     #T1sat                                            #T1sat             -- Saturation temper
                                                              ature at P1_set
      +R
      T     #T1_max                                           #T1_max            -- Max temperature a
                                                              t point 1 allowed

//Desired value- Tol=Min value allowed

      L     #T1sat                                            #T1sat             -- Saturation temper
                                                              ature at P1_set
      L     #ToleranceT1                                      #ToleranceT1       -- Tolerance of T1
      -R
      T     #T1_min                                           #T1_min            -- MIn temperature a
                                                              t point 1 allowed

//COMPARATION T1_m>T1_min?

      L     #T1_m                                             #T1_m              -- Temperature at po
                                                              int 1, measured
      L     #T1_min                                           #T1_min            -- MIn temperature a
                                                              t point 1 allowed
      >R
      SPB   OT1L           //If it is OK RESET its error indicator and check if it is greater than the maximum
      SPA   ET1L           //If it is lower than the minimum, go to Error T1 Lower (ET1L)

//COMPARATION T1_m<T1_max?

CT1H: L     #T1_m          //Check if it is greater than the maximum  #T1_m      -- Temperature at po
                                                              int 1, measured
      L     #T1_max                                           #T1_max            -- Max temperature a
                                                              t point 1 allowed
      <R
```

```
      SPB   OT1H          //If it is OK (less than maximum)RESET its error indicator AND go to the SEGment2 a
                          nd check the pressure 1
      SPA   ET1H          //If it is higher than the maximum, go  to Error T1 Higher (ET1H)
```

Segm.: 3 Pressure at point 1

Alarm settings have been defined. A deviation (expresed in %)would be permitted
for P1 .

```
SEG2: L     #DeviationP1                                          #DeviationP1      -- Deviation of P1 a
                                                                  llowed (%)
      L     1.000000e+002
      /R

//It is expressed in %, we must divided

      L     #P1_set                                               #P1_set           -- Set pressure at p
                                                                  oint 1
      *R
      T     #ToleranceP1                                          #ToleranceP1      -- Tolerance of P1

//By multiplying the deviation by the value desired we obtain the tolerance

//Tol+Desired value=Max value allowed

      L     #P1_set                                               #P1_set           -- Set pressure at p
                                                                  oint 1
      +R
      T     #P1_max                                               #P1_max           -- Max pressure at p
                                                                  oint 1 allowed

////Desired value- Tol=Min value allowed

      L     #P1_set                                               #P1_set           -- Set pressure at p
                                                                  oint 1
      L     #ToleranceT1                                          #ToleranceT1      -- Tolerance of T1
      -R
      T     #P1_min                                               #P1_min           -- Min pressure at p
                                                                  oint 1 alloxed

//COMPARATION P1_m>P1_min?

      L     #P1_m                                                 #P1_m             -- Pressure at point
                                                                   1, measured
      L     #P1_min                                               #P1_min           -- Min pressure at p
                                                                  oint 1 alloxed
      >R
      SPB   OP1L          //If it is OK RESET its error indicator, check if it is greater than the maximum
      SPA   EP1L          //If it is lower than the minimum, go to Error P1 Lower (EP1L)

//COMPARATION T1_m<T1_max?

CP1H: L     #P1_m                                                 #P1_m             -- Pressure at point
                                                                   1, measured
      L     #P1_max                                               #P1_max           -- Max pressure at p
                                                                  oint 1 allowed
      <R
      SPB   OP1H          //If it is OK (less than maximum)RESET its error indicator go to the SEGment3 and c
                          heck the temperature 2
      SPA   EP1H          //If it is higher than the maximum, go  to Error P1 Higher (EP1H)
```

Segm.: 4 Temperature at point 2

The temperature T2 has been defined so it has a maximum value allowed

```
//COMPARATION MaxT2>T2_m?
SEG3: L     #MaxT2                                            #MaxT2            -- Maximum temperature a
                                                              llowed at point 2 (ªC)
      L     #T2_m                                             #T2_m             -- Temperature at point
                                                              2, measured
      >R
      SPB   OKT2    //If the value measured is lower than the maximum RESET its error indicator, AND then chec
                    k the pressure 2
      SPA   ET2     //If the value measured is greater than the maximum, then go to Error T2 (ET2)
```

Segm.: 5 Pressure at point 2
The pressure P2 has been defined so it has a maximum value allowed

```
//COMPARATION MaxP2>P2_m?

SEG4: L     #MaxP2                                                   #MaxP2            -- Maximum pressure allo
                                                                     wed at point 2 (bar)
      L     #P2_m                                                    #P2_m             -- Pressure at point 2 ,
                                                                      measured
      >R
      SPB   OKP2    //If the value measured is lower than the maximum, then check the pressure 2
      SPA   EP2     //If the value measured is greater than the maximum, then go to Error T2 (ET2
```

Segm.: 6 ERRORS
When a variable does not fullfield the conditions then, in this segments, the actions related to its failure are performed.

```
ET1L: S     #T1_Low    #T1_Low           -- Indicator of T1< T1min->1
      SPA   SEG2

ET1H: S     #T1_High   #T1_High          -- Indicator of T1> T1max->1
      SPA   SEG2

EP1L: S     #P1_Low    #P1_Low           -- Indicator of P1< P1min->1
      SPA   SEG3

EP1H: S     #P1_High   #P1_High          -- Indicator of P1> P1max->1
      SPA   SEG3

ET2:  S     #T2_Error  #T2_Error         -- Temperature 2> T2 maximum
      SPA   SEG4

EP2:  S     #P2_Error  #P2_Error         -- Pressure 2 > P2 maximum
      SPA   TEST
```

Segm.: 7 OK and TEST
When the measurements are between the limits stablished, then the indicators must be turn OFF (Green).

```
OT1L: R     #T1_Low                                                  #T1_Low           -- Indicator of T1<
                                                                      T1min->1
      SPA   CT1H

OT1H: R     #T1_High                                                 #T1_High          -- Indicator of T1>
                                                                      T1max->1
      SPA   SEG2

OP1L: R     #P1_Low                                                  #P1_Low           -- Indicator of P1<
                                                                      P1min->1
      SPA   CP1H

OP1H: R     #P1_High                                                 #P1_High          -- Indicator of P1>
                                                                      P1max->1
      SPA   SEG3

OKT2: R     #T2_Error                                                #T2_Error         -- Temperature 2> T
                                                                     2 maximum
      SPA   SEG4

OKP2: R     #P2_Error                                                #P2_Error         -- Pressure 2 > P2
                                                                     maximum

//In the case of the indicators of P1 and T1, wether the error is because of they
//are bellow the minimum or above the maximum the indicator must turn ON (red)

TEST: U     #T1_Low                                                  #T1_Low           -- Indicator of T1<
                                                                      T1min->1
      O     #T1_High                                                 #T1_High          -- Indicator of T1>
                                                                      T1max->1
```

```
      =     #T1_Error                                                        #T1_Error          -- Temperature 1 is
                                                                              not between the limits->1

      U     #P1_Low                                                          #P1_Low            -- Indicator of P1<
                                                                              P1min->1
      O     #P1_High                                                         #P1_High           -- Indicator of P1>
                                                                              P1max->1
      =     #P1_Error                                                        #P1_Error          -- Pressure 1  is n
                                                                             ot between the limits->1

//ERROR IN POINT 1

      U     #P1_Error                                                        #P1_Error          -- Pressure 1  is n
                                                                             ot between the limits->1
      O     #T1_Error                                                        #T1_Error          -- Temperature 1 is
                                                                              not between the limits->1
      =     #Point1_failure                                                  #Point1_failure    -- Indicates when a
                                                                             n error has occurred in point 1

//ERROR IN POINT 2

      U     #P2_Error                                                        #P2_Error          -- Pressure 2 > P2
                                                                             maximum
      O     #T2_Error                                                        #T2_Error          -- Temperature 2> T
                                                                             2 maximum
      =     #Point2_failure                                                  #Point2_failure    -- Indicates when a
                                                                             n error has occurred in point 2

//STABLE?


      U     #Stable                                                          #Stable            -- Indicates when t
                                                                             he bench has been stabilized for the f
                                                                             irst time
      SPB   STBL
//If the station has already been stabilized, don' t execute this part of the code

      R     #ST                                                              #ST                -- Auxiliar variabl
                                                                             e to increment the counter

      UN    #Point1_failure                                                  #Point1_failure    -- Indicates when a
                                                                             n error has occurred in point 1
      UN    #Point2_failure                                                  #Point2_failure    -- Indicates when a
                                                                             n error has occurred in point 2
      =     #ST                                                              #ST                -- Auxiliar variabl
                                                                             e to increment the counter

//As ST has been reset, when it changes its value to 1, (meaning that there is no errors in either of the oper
ating points) the counter increases its value.

      U     #ST                                                              #ST                -- Auxiliar variabl
                                                                             e to increment the counter
      ZV    Z      0

//If it has reach its maximum load 2 (one is only to indicate when it has been stabilized)
//    L     Z      0
//    L     999
//    ==I
//    SPB   CONT
//    SPA  Z0_1

//CONT: L     C#2
//     S     Z      0


//When it is 1, it means that the station has stabilized, for the first time

      L     Z      0
      L     1
      ==I
      SPB   STBL             //It is STABLE
      R     #Stable          //It is not stable                              #Stable            -- Indicates when t
                                                                             he bench has been stabilized for the f
                                                                             irst time
      SPA   END
```

Segm.: 8	STABLE station

```
STBL: S     #Stable                  //In WINCC a message would have to be   #Stable            -- Indicates whe
                                      shown                                  n the bench has been stabilized for
                                                                              the first time


      U     #Point2_failure                                                  #Point2_failure    -- Indicates whe
                                                                             n an error has occurred in point 2
```

```
      SPB   T_P2

CP1F: U     #Point1_failure                                              #Point1_failure    -- Indicates whe
                                                                         n an error has occurred in point 1
      SPB   T_P1

CALP: U     #Failure_time_P1_done                                        #Failure_time_P1_done -- The failur
                                                                         e in Point 1 has persist the time a
                                                                         llowed
      U     #Failure_time_P2_done                                        #Failure_time_P2_done -- The failur
                                                                         e in Point 2 has persist the time a
                                                                         llowed
      =     #Alarm                                                       #Alarm             -- The bench nee
                                                                         ds to be stopped, and a signal must
                                                                          be emited
      SPB   ALAR

      SPA   END


//When it is stable X_failure=0. So when  it changes to 1 (there is an error) the timer starts
//If there is an error, but during a short time then the next time  that the error occurrs the timer must be r
eset.


T_P2: U     #Point2_failure                                              #Point2_failure    -- Indicates whe
                                                                         n an error has occurred in point 2
      FR    T     3
      U     #Point2_failure                                              #Point2_failure    -- Indicates whe
                                                                         n an error has occurred in point 2
      L     S5T#5S
      SE    T     3

      U     T     3
      =     #Failure_time_P2_done                                        #Failure_time_P2_done -- The failur
                                                                         e in Point 2 has persist the time a
                                                                         llowed

      SPA   CP1F


T_P1: U     #Point1_failure                                              #Point1_failure    -- Indicates whe
                                                                         n an error has occurred in point 1
      FR    T     2
      U     #Point1_failure                                              #Point1_failure    -- Indicates whe
                                                                         n an error has occurred in point 1
      L     S5T#10S
      SE    T     2

      U     T     2
      =     #Failure_time_P1_done                                        #Failure_time_P1_done -- The failur
                                                                         e in Point 1 has persist the time a
                                                                         llowed

      SPA   CALP                   //Check if the alarm (because of the points failure) must be turned ON
```

Segm.: 9 ALARM ACTIONS
If the "Error" in one of the poins, has remained more than the time fixed, then the bench would have to be turned OFF

```
ALAR: S     #OFF     #OFF                -- 1->OFF when an error occurs
      R     #ON_OFF  #ON_OFF             -- 0->OFF When an error occurs
```

Segm.: 10 END

```
END:  NOP   0
```

FC5 - <offline>

"AUT_SensON/OFF->th/calc"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 16/06/2014 09:50:32
Interface: 16/06/2014 09:50:32
Longitud (bloque / código / datos): 04058 03702 00194

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
IN_T1	Int	0.0	Analog INPUT of T1
IN_T2	Int	2.0	Analog INPUT of T2
IN_T3	Int	4.0	Analog INPUT of T3
IN_Tin	Int	6.0	Analog INPUT of Tin
IN_Tout	Int	8.0	Analog INPUT of Tout
IN_P1	Int	10.0	Analog INPUT of P1
IN_P2	Int	12.0	Analog INPUT of P2
IN_P3	Int	14.0	Analog INPUT of P3
IN_m_ref	Int	16.0	Analog INPUT of m_ref
IN_m_w	Int	18.0	Analog INPUT of m_w
T1_connected	Bool	20.0	0-> sensor not connected, 1--> sensor connected
T2_connected	Bool	20.1	0-> sensor not connected, 1--> sensor connected
T3_connected	Bool	20.2	0-> sensor not connected, 1--> sensor connected
Tin_connected	Bool	20.3	0-> sensor not connected, 1--> sensor connected
Tout_connected	Bool	20.4	0-> sensor not connected, 1--> sensor connected
P1_connected	Bool	20.5	0-> sensor not connected, 1--> sensor connected
P2_connected	Bool	20.6	0-> sensor not connected, 1--> sensor connected
P3_connected	Bool	20.7	0-> sensor not connected, 1--> sensor connected
m_ref_connected	Bool	21.0	0-> sensor not connected, 1--> sensor connected
m_w_connected	Bool	21.1	0-> sensor not connected, 1--> sensor connected
T1_calc	Real	22.0	Theoretical/set/calculated value of the magnitude
T2_calc	Real	26.0	Theoretical/set/calculated value of the magnitude
T3_calc	Real	30.0	Theoretical/set/calculated value of the magnitude
P3_calc	Real	34.0	Theoretical/set/calculated value of the magnitude->P2
m_ref_calc	Real	38.0	Theoretical/set/calculated value of the magnitude
m_w_calc	Real	42.0	Theoretical/set/calculated value of the magnitude
displ	Real	46.0	Displacement of the compressor
rpm	Real	50.0	rpm of the compressor
Cp_w	Real	54.0	
delta_T_resistance	Real	58.0	Extra temperature degrees to be obtained above the sat. T by the resistance
P1_set	Real	62.0	Set pressured at the operating point 1
c_vol	Real	66.0	Coefficient of the second degree equation to calculate the volumetric eff.
b_iso	Real	70.0	Coefficient of the second degree equation to calculate the isentropic eff.
c_iso	Real	74.0	Coefficient of the second degree equation to calculate the isentropic eff.
a_iso	Real	78.0	Coefficient of the second degree equation to calculate the isentropic eff.
a_vol	Real	82.0	Coefficient of the second degree equation to calculate the volumetric eff.
b_vol	Real	86.0	Coefficient of the second degree equation to calculate the volumetric eff.
Mode_manual_automatic	Bool	90.0	When mode is manual->1, UDT8

Nombre	Tipo de datos	Dirección	Comentario
UDT11_12	Bool	90.1	When it is 1->inputs to the UDT 11, when it is 0->outputs to UDT12
x1	Real	92.0	Quality of the refrigerant, UDT 1
ref_number	Int	96.0	Refrigerant number (0->r134a, 1->r410a, 2->r407c, 3->r22, 4->r290)
rho_water	Real	98.0	
OUT		0.0	
DB_T1	Real	102.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_T3	Real	106.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_P3	Real	110.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_m_ref	Real	114.0	Indicate the direction in which the value (measured/theorical) must be stored
IN_OUT		0.0	
Tin_chiller	Real	118.0	Tin set by the chiller, theoretically it should be equal to the Tin measured
DB_Tout	Real	122.0	Indicate the direction in which the value (measured/theorical) must be stored
m_ref_grams	Real	126.0	Refirgerant flux calculated in g/s
flow_w_lit_min	Real	130.0	Water flux calculated in l/min
T2_deseada	Real	134.0	Temperature desired at point 2
m_ref_th	Real	138.0	Refrigerant flux in kg/s
Qcond_necesitado	Real	142.0	Heat exchanged needed in the condenser
m_w_th	Real	146.0	Water flux in kg/s
rend_iso_th	Real	150.0	Isentropc efficiency computed with the second degree equation
PR	Real	154.0	Pressure ratio P2measured/P1 set
rend_vol_th	Real	158.0	Volumetric efficiency computed with the second degree equation
DB_P2	Real	162.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_Tin	Real	166.0	Indicate the direction in which the value (measured/theorical) must be stored
h1	Real	170.0	Enthalpy at x1 and P1_m
h1_th	Real	174.0	Enthalpy at the desired pressure and quality
h3_th	Real	178.0	Equal to the enthalpy h1_th
h2_th	Real	182.0	Enthalpy at point 2, with the theoretical values
h3_m	Real	186.0	Enthalpy measured (equal to h1)
h2_m	Real	190.0	Enthalpy computed with the data of the sensors
T2sat	Real	194.0	Saturation temperature at pressure P2
m_ref_div_rho	Real	198.0	m_ref/rho--> displ [m^3/rev]*rps [rev/s]*vol_eff
DB_P1	Real	202.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_m_w	Real	206.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_T2	Real	210.0	Indicate the direction in which the value (measured/theorical) must be stored
Ref_number_11	Int	214.0	Refrigerant number, UDT 11
P1_m_11	Real	216.0	P1_m, UDT 11
P1_set_11	Real	220.0	P1_set, UDT 11
x1_11	Real	224.0	x1, UDT 11
Tout_m_11	Real	228.0	Tout_m, UDT 11
P2_m_11	Real	232.0	P2_m, UDT 11
delta_T_resistance_11	Real	236.0	delta_T_resistance, UDT 11
m_w_m_11	Real	240.0	m_w_m, UDT 11
m_ref_div_rho_11	Real	244.0	m-ref_div_rho, UDT 11
T2_m_11	Real	248.0	T2_m, UDT 11

Nombre	Tipo de datos	Dirección	Comentario
T1sat_12	Real	252.0	T1_sat,UDT 12
h1_th_12	Real	256.0	h1_th, UDT 12
h1_12	Real	260.0	h1, UDT 12
T2sat_12	Real	264.0	T2sat, UDT 12
h2_th_12	Real	268.0	h2_th,UDT 12
h3_th_12	Real	272.0	h3_th, UDT 12
T2desired_12	Real	276.0	T2desired, UDT 12
rho_ref_12	Real	280.0	rho_ref, UDT 12
h2_m_12	Real	284.0	h2_m, UDT 12
h3_m_12	Real	288.0	h3_m, UDT 12
m_ref_th_12	Real	292.0	m_ref_th, UDT 12
m_ref_grams_12	Real	296.0	m_ref_grams, UDT 12
T1sat	Real	300.0	T1sat, UDT2
T2desired	Real	304.0	Desired temperature after the heating resistance
rho_ref	Real	308.0	Refrigerant density (entering of the compressor)
TEMP		0.0	
delta_T	Real	0.0	Tout-Tin
rps	Real	4.0	rpm/60
rend_div_1000000	Real	8.0	rend_vol/100000
a_vol_X_PR	Real	12.0	
a_iso_X_PR	Real	16.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC5 Meassurement of the sensors/calculate the theoretical values

The meassurements of the sensors will be conditionate and stored. First the sensors that MUST BE CONECTED would be measured.
With this measured values, the theoretial ones can be computed.
Then the progam check wether T1, T2, P3 andm_ref are connected. If they are, it measures their values, otherwise, the thoeretical values calculated are stored.

Segm.: 1 Meassurement of the sensors IMPLEMENTED FOR SURE

The data will be meassured, conditionate and stored.

The FC 105 "SCALE" takes an input between the Hi and Lo limits, and transforms it in a biòlar way (-27.648, +27.648) or unipolar(0,+ 27.648), obtaining an output between K1 and K2 (0,27.648)--> unipolar

```
//TEMPERATURE T_OUT

      U     #Tout_connected                    #Tout_connected    -- 0-> sensor
                                               not connected, 1--> sensor connec
                                               ted
      SPB   To_M

//PRESSURE 1

C_P1: U     #P1_connected                      #P1_connected      -- 0-> sensor
                                               not connected, 1--> sensor connec
                                               ted
      SPB   M_P1

//PRESSURE 2

C_P2: U     #P2_connected                      #P2_connected      -- 0-> sensor
                                               not connected, 1--> sensor connec
                                               ted
      SPB   M_P2

//WATER

C_WF: U     #m_w_connected                     #m_w_connected     -- 0-> sensor
                                               not connected, 1--> sensor connec
                                               ted
      SPB   W_M
```

```
//TEMPERATURE 2

C_T2: U     #T2_connected                                                 #T2_connected      -- 0-> sensor
                                                                          not connected, 1--> sensor connec
                                                                          ted
      SPB   T2_M

      CALL  "Sensor conect/desconect"                                     FC3
       Sensor_conectado:=#T2_connected                                    #T2_connected      -- 0-> sensor
                                                                          not connected, 1--> sensor connec
                                                                          ted
       Valor_teorico   :=#T2_calc       //T2 sat + delta_T                #T2_calc           -- Theoretical
                                                                          /set/calculated value of the magn
                                                                          itude
       Valor_a_GUARDAR :=#DB_T2                                           #DB_T2             -- Indicate th
                                                                          e direction in which the value (m
                                                                          easured/theorical) must be stored

      SPA   SEG2


//If the sensor T2 is connected, then the value meassured (after the aconditionating processs)
//then, it will be storaged in the UDT1_1.T2
//If not, the corresponding value of T2sat ( saturation temperature at the pressure P2)
//will be considered as valid, and storaged in the UDT



//MEASUREMENTS AND SCALING


To_M: CALL  "SCALE"                     // Termopar Tout                  FC105              -- Scaling Val
                                                                          ues
       IN     :=#IN_Tout                                                  #IN_Tout           -- Analog INPU
                                                                          T of Tout
       HI_LIM :=3.000000e+001
       LO_LIM :=5.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_Tout                                                  #DB_Tout           -- Indicate th
                                                                          e direction in which the value (m
                                                                          easured/theorical) must be stored
//Check the sensor P2
      SPA   C_P1


M_P1: CALL  "SCALE"                     //Presión 1, puesto 1             FC105              -- Scaling Val
                                                                          ues
       IN     :=#IN_P1                                                    #IN_P1             -- Analog INPU
                                                                          T of P1
       HI_LIM :=6.000000e+001
       LO_LIM :=1.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_P1                                                    #DB_P1             -- Indicate th
                                                                          e direction in which the value (m
                                                                          easured/theorical) must be stored
// Check the sensor P2
      SPA   C_P2


M_P2: CALL  "SCALE"                     //Presión 2, puesto 1             FC105              -- Scaling Val
                                                                          ues
       IN     :=#IN_P2                                                    #IN_P2             -- Analog INPU
                                                                          T of P2
       HI_LIM :=6.000000e+001
       LO_LIM :=1.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_P2                                                    #DB_P2             -- Indicate th
                                                                          e direction in which the value (m
                                                                          easured/theorical) must be stored
      SPA   C_WF


W_M:  CALL  "SCALE"                     //m_w_P1,caudal del agua del puesto  FC105           -- Scaling Val
                                         1                                ues
       IN     :=#IN_m_w                                                   #IN_m_w            -- Analog INPU
                                                                          T of m_w
       HI_LIM :=5.500000e+001           //lo máximo son 5 l/min, pongo 5,5 l/min
       LO_LIM :=1.000000e-001           //lo mínimo es 0.25 l/min, pongo 0.1 l/min
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_m_w                                                   #DB_m_w            -- Indicate th
                                                                          e direction in which the value (m
                                                                          easured/theorical) must be stored
      SPA   C_T2
```

```
T2_M: CALL  "SCALE"                    // Measured  T2                          FC105               -- Scaling Val
                                                                                ues
       IN     :=#IN_T2                                                          #IN_T2              -- Analog INPU
                                                                                T of T2
       HI_LIM :=8.000000e+001
       LO_LIM :=5.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_T2                                                          #DB_T2              -- Indicate th
                                                                                e direction in which the value (m
                                                                                easured/theorical) must be stored

      SPA   SEG2
```

Segm.: 2   Volumetric efficiency and m_ref_div_rho
We calculate the volumetric efficiency and the variable m_ref_div_rho. This last variable only needs to be multiplied by the rho_ref to became the m_ref (kg/s).

```
//CALCULATIONS

//  First, we calculate the pressure ratio

      L     #DB_P2                                                          #DB_P2              -- Indicate the di
                                                                            rection in which the value (measured/
                                                                            theorical) must be stored
      L     #P1_set                                                         #P1_set             -- Set pressured a
                                                                            t the operating point 1
      /R
      T     #PR                                                             #PR                 -- Pressure ratio
                                                                            P2measured/P1 set

//The equations for the efficiencies are second degree equations
//Eff=a·PR^2+ b·PR + c


//**********************//
// VOLUMETRIC EFFICIENCY//
//**********************//

      L     #PR                                                             #PR                 -- Pressure ratio
                                                                            P2measured/P1 set
      L     #PR                                                             #PR                 -- Pressure ratio
                                                                            P2measured/P1 set
      *R
// PR^2

      L     #a_vol                                                          #a_vol              -- Coefficient  of
                                                                              the second degree equation to calcu
                                                                            late the volumetric eff.
      *R
      T     #a_vol_X_PR                                                     #a_vol_X_PR

//a_vol x PR^2
      L     #b_vol                                                          #b_vol              -- Coefficient  of
                                                                              the second degree equation to calcu
                                                                            late the volumetric eff.
      L     #PR                                                             #PR                 -- Pressure ratio
                                                                            P2measured/P1 set
      *R
// b_vol  ·PR

      L     #a_vol_X_PR                                                     #a_vol_X_PR
      +R

//a_vol x PR^2 +  b_vol  ·PR
      L     #c_vol                                                          #c_vol              -- Coefficient  of
                                                                              the second degree equation to calcu
                                                                            late the volumetric eff.
      +R
      T     #rend_vol_th                                                    #rend_vol_th        -- Volumetric effi
                                                                            ciency computed  with the second degr
                                                                            ee equation
//Is the result of:  a_vol x PR^2 +  b_vol ·PR +c_vol



//***************//
// M_REF_DIV_RHO //
//***************//


//The operations are performed by "blocks"
// rps //
```

```
      L     #rpm                                                      #rpm              -- rpm of the comp
                                                                      ressor
      L     6.000000e+001
      /R
      T     #rps                                                      #rps              -- rpm/60

//The las "block":  rend_vol_th/1000000

      L     #rend_vol_th                                              #rend_vol_th      -- Volumetric effi
                                                                      ciency computed  with the second degr
                                                                      ee equation
      L     1.000000e+006      //factor de corrección cm^3/m^3
      /R
      T     #rend_div_1000000                                         #rend_div_1000000  -- rend_vol/100000

//We multiplicate the three "blocks" defined

      L     #rps                                                      #rps              -- rpm/60
      *R
      L     #displ                                                    #displ            -- Displacement of
                                                                       the compressor
      *R
      T     #m_ref_div_rho                                            #m_ref_div_rho    -- m_ref/rho--> di
                                                                      spl [m^3/rev]*rps [rev/s]*vol_eff
```

Segm.: 3 EXCEL INTERFACE
To execute the excel interface we first need the isentropic efficiency

```
SEG2: NOP   0

//Set the variable, so the inputsthat must be export to the excel file, are copy to the  UDT 11
      S     #UDT11_12                              #UDT11_12           -- When it is 1->inputs to the UDT 11
                                                   , when it is 0->outputs to UDT12

      CALL  "Excel_DB"                             FC94
       Ref_number            :=#ref_number         #ref_number         -- Refrigerant number (0->r134a, 1->r
                                                   410a, 2->r407c, 3->r22, 4->r290)
       P1_m                  :=#DB_P1              #DB_P1              -- Indicate the direction in which th
                                                   e value (measured/theorical) must be stored
       P1_set                :=#P1_set             #P1_set             -- Set pressured at the operating poi
                                                   nt 1
       x1                    :=#x1                 #x1                 -- Quality of the refrigerant, UDT 1
       Tout_m                :=#DB_Tout            #DB_Tout            -- Indicate the direction in which th
                                                   e value (measured/theorical) must be stored
       P2_m                  :=#DB_P2              #DB_P2              -- Indicate the direction in which th
                                                   e value (measured/theorical) must be stored
       delta_T_resistance    :=#delta_T_resistance  #delta_T_resistance -- Extra temperature degrees to be o
                                                   btained above the sat. T by the  resistance
       m_w_m                 :=#DB_m_w             #DB_m_w             -- Indicate the direction in which th
                                                   e value (measured/theorical) must be stored
       m_ref_div_rho         :=#m_ref_div_rho      #m_ref_div_rho      -- m_ref/rho--> displ [m^3/rev]*rps [
                                                   rev/s]*vol_eff
       T2_m                  :=#DB_T2              #DB_T2              -- Indicate the direction in which th
                                                   e value (measured/theorical) must be stored
       T1sat_12              :=#T1sat_12           #T1sat_12           -- T1_sat,UDT 12
       h1_th_12              :=#h1_th_12           #h1_th_12           -- h1_th, UDT 12
       h1_12                 :=#h1_12              #h1_12              -- h1, UDT 12
       T2sat_12              :=#T2sat_12           #T2sat_12           -- T2sat, UDT 12
       h2_th_12              :=#h2_th_12           #h2_th_12           --  h2_th,UDT 12
       h3_th_12              :=#h3_th_12           #h3_th_12           -- h3_th, UDT 12
       T2desired_12          :=#T2desired_12       #T2desired_12       -- T2desired, UDT 12
       rho_ref_12            :=#rho_ref_12         #rho_ref_12         -- rho_ref, UDT 12
       h2_m_12               :=#h2_m_12            #h2_m_12            -- h2_m, UDT 12
       h3_m_12               :=#h3_m_12            #h3_m_12            -- h3_m, UDT 12
       m_ref_th_12           :=#m_ref_th_12        #m_ref_th_12        -- m_ref_th, UDT 12
       m_ref_grams_12        :=#m_ref_grams_12     #m_ref_grams_12     -- m_ref_grams, UDT 12
       UDT11_12              :=#UDT11_12           #UDT11_12           -- When it is 1->inputs to the UDT 11
                                                   , when it is 0->outputs to UDT12
       Ref_number_11         :=#Ref_number_11      #Ref_number_11      -- Refrigerant number, UDT 11
       P1_m_11               :=#P1_m_11            #P1_m_11            -- P1_m, UDT 11
       P1_set_11             :=#P1_set_11          #P1_set_11          -- P1_set, UDT 11
       x1_11                 :=#x1_11              #x1_11              -- x1, UDT 11
       Tout_m_11             :=#Tout_m_11          #Tout_m_11          -- Tout_m, UDT 11
       P2_m_11               :=#P2_m_11            #P2_m_11            -- P2_m, UDT 11
       delta_T_resistance_11:=#delta_T_resistance_11  #delta_T_resistance_11 -- delta_T_resistance, UDT 11
       m_w_m_11              :=#m_w_m_11           #m_w_m_11           -- m_w_m, UDT 11
       m_ref_div_rho_11      :=#m_ref_div_rho_11   #m_ref_div_rho_11   -- m-ref_div_rho, UDT 11
       T2_m_11               :=#T2_m_11            #T2_m_11            -- T2_m, UDT 11
       T1sat                 :=#T1sat              #T1sat              -- T1sat, UDT2
       h1_th                 :=#h1_th              #h1_th              -- Enthalpy at the desired pressure a
                                                   nd quality
       h1                    :=#h1                 #h1                 -- Enthalpy at x1 and P1_m
```

```
       T2sat                 :=#T2sat                    #T2sat             -- Saturation temperature at pressure
                                                          P2
       h2_th                 :=#h2_th                    #h2_th             -- Enthalpy at point 2, with the theo
                                                         retical values
       h3_th                 :=#h3_th                    #h3_th             -- Equal to the enthalpy h1_th
       T2desired             :=#T2desired                #T2desired         -- Desired temperature after the heat
                                                         ing resistance
       rho_ref               :=#rho_ref                  #rho_ref           -- Refrigerant density (entering of t
                                                         he compressor)
       h2_m                  :=#h2_m                     #h2_m              -- Enthalpy computed with the data of
                                                          the sensors
       h3_m                  :=#h3_m                     #h3_m              -- Enthalpy measured (equal to h1)
       m_ref_th              :=#m_ref_th                 #m_ref_th          -- Refrigerant flux in kg/s
       m_ref_grams           :=#m_ref_grams              #m_ref_grams       -- Refirgerant flux calculated in g/s

//**WITH THE DATA MEASURED  WE HAVE TO OBTAIN rho_ref....
//SENT
//-->P1measured,P1_set,x1, P2mesaured,delta_T_resistence,T2desired
//-->Tout measured,T2measured, Refrigerant--> Num_ref(0->134a,1->410a,2->407c, 3->22 , 4->290)
//-->Water flux measured,m_ref_div_rho

//RECEIVE
//--> T1sat, T2 sat
//-->h1_th(P1set,x1),h1(P1,x1), h2_th (P2,T2desired), h3_th (=h1_th),h2_m, h3_m(=h1_m)
//--> rho_ref,m_ref_th (kg/s), m_ref_grams (g/s), T2desired


      SPA   SEG3
```

Segm.: 4 Theoretical values
This function to calculate the theoretical values is been summonded with the measured data of P2, Tout. When P1 must be used, the P1 set by the user is the value considered.

```
SEG3: NOP   0

//There is no need to calculate it because the desired values in the manual mode are set by the HMI
//and the measured values needed to permormed the PID control have already been measured.


      CALL  "OperationCalculation"                       FC6
       Tout                  :=#DB_Tout                  #DB_Tout           -- Indicate the direction in which th
                                                         e value (measured/theorical) must be stored
       Tin                   :=#Tin_chiller              #Tin_chiller       -- Tin set by the chiller, theoretica
                                                         lly it should be equal to the Tin measured
       rho_ref               :=#rho_ref                  #rho_ref           -- Refrigerant density (entering of t
                                                         he compressor)
       displ                 :=#displ                    #displ             -- Displacement of the compressor
       rpm                   :=#rpm                      #rpm               -- rpm of the compressor
       h1_th                 :=#h1_th                    #h1_th             -- Enthalpy at the desired pressure a
                                                         nd quality
       h2_th                 :=#h2_th                    #h2_th             -- Enthalpy at point 2, with the theo
                                                         retical values
       Cp_w                  :=4.180000e+000
       rho_water             :=9.970000e-001
       T2sat                 :=#T2sat                    #T2sat             -- Saturation temperature at pressure
                                                          P2
       delta_T_resistance    :=#delta_T_resistance       #delta_T_resistance -- Extra temperature degrees to be o
                                                         btained above the sat. T by the  resistance
       P2                    :=#DB_P2                    #DB_P2             -- Indicate the direction in which th
                                                         e value (measured/theorical) must be stored
       P1_set                :=#P1_set                   #P1_set            -- Set pressured at the operating poi
                                                         nt 1
       c_vol                 :=#c_vol                    #c_vol             -- Coefficient  of  the second degree
                                                          equation to calculate the volumetric eff.
       b_iso                 :=#b_iso                    #b_iso             -- Coefficient  of  the second degree
                                                          equation to calculate the isentropic eff.
       c_iso                 :=#c_iso                    #c_iso             -- Coefficient  of  the second degree
                                                          equation to calculate the isentropic eff.
       a_iso                 :=#a_iso                    #a_iso             -- Coefficient  of  the second degree
                                                          equation to calculate the isentropic eff.
       a_vol                 :=#a_vol                    #a_vol             -- Coefficient  of  the second degree
                                                          equation to calculate the volumetric eff.
       b_vol                 :=#b_vol                    #b_vol             -- Coefficient  of  the second degree
                                                          equation to calculate the volumetric eff.
       Tin_conectado         :=#Tin_connected            #Tin_connected     -- 0-> sensor not connected, 1--> sen
                                                         sor connected
       Tin_chiller           :=#Tin_chiller              #Tin_chiller       -- Tin set by the chiller, theoretica
                                                         lly it should be equal to the Tin measured
       Mode_manual_automatic:=#Mode_manual_automatic     #Mode_manual_automatic -- When mode is manual->1, UDT8
       m_ref_grams           :=#m_ref_grams              #m_ref_grams       -- Refirgerant flux calculated in g/s
       flow_w_lit_min        :=#flow_w_lit_min           #flow_w_lit_min    -- Water flux calculated in l/min
       T2_deseada            :=#T2_deseada               #T2_deseada        -- Temperature desired at point 2
       m_ref_th              :=#m_ref_th                 #m_ref_th          -- Refrigerant flux in kg/s
       Qcond_necesitado      :=#Qcond_necesitado         #Qcond_necesitado  -- Heat exchanged needed in the conde
                                                         nser
```

```
       m_w_th             :=#m_w_th                  #m_w_th            -- Water flux in kg/s
       PR                 :=#PR                      #PR                -- Pressure ratio P2measured/P1 set
       rend_vol_th        :=#rend_vol_th             #rend_vol_th       -- Volumetric efficiency computed  wi
                                                     th the second degree equation
       rend_iso_th        :=#rend_iso_th             #rend_iso_th       -- Isentropc efficiency computed with
                                                      the second degree equation
```

Segm.: 5 Check and measured the rest of the sensors
If the rest of the sensors are not connected, the theroretical values calculated above must be stored.

```
//TEMPERATURE 1

      U     #T1_connected                                                 #T1_connected      -- 0-> senso
                                                                          r not connected, 1--> sensor co
                                                                          nnected
      SPB   T1_M

//If the sensor is not connected, we employ de theoretical value
//NO se si esto debería hacerse.Cuando no haya sensor, nos lo incica el X_conectado
//Si no está conecttado en las parametrizado habrá que poner el valor teórico y el "medido"
//Yque el código emplee para los cálculos uno o otro dependiendo del resultado.

//La gráfica dibuja lo del DB_T1 (medido) si queremos evitar que dibuje el valor teórico cuando no esta conect
ado
//habria que guardar el teórico en otro lado

      CALL  "Sensor conect/desconect"                                     FC3
       Sensor_conectado:=#T1_connected                                    #T1_connected      -- 0-> senso
                                                                          r not connected, 1--> sensor co
                                                                          nnected
       Valor_teorico   :=#T1_calc                                         #T1_calc           -- Theoretic
                                                                          al/set/calculated value of the
                                                                          magnitude
       Valor_a_GUARDAR :=#DB_T1                                           #DB_T1             -- Indicate
                                                                          the direction in which the valu
                                                                          e (measured/theorical) must be
                                                                          stored

//TEMPERATURE 3

C_T3: U     #T3_connected                                                 #T3_connected      -- 0-> senso
                                                                          r not connected, 1--> sensor co
                                                                          nnected
      SPB   T3_M

      CALL  "Sensor conect/desconect"                                     FC3
       Sensor_conectado:=#T3_connected                                    #T3_connected      -- 0-> senso
                                                                          r not connected, 1--> sensor co
                                                                          nnected
       Valor_teorico   :=#T3_calc          //T2sat                        #T3_calc           -- Theoretic
                                                                          al/set/calculated value of the
                                                                          magnitude
       Valor_a_GUARDAR :=#DB_T3                                           #DB_T3             -- Indicate
                                                                          the direction in which the valu
                                                                          e (measured/theorical) must be
                                                                          stored

//If the sensor T3 is connected, then the value meassured (after the aconditionating processs)
//then, it will be storaged in the UDT1_1.T3
//If not, the corresponding value of T2sat ( saturation temperature at the pressure P2=P3)
// will be considered as valid, and storaged in the UDT1_T3

//TEMPERATURE T_IN

C_Ti: U     #Tin_connected                                                #Tin_connected     -- 0-> senso
                                                                          r not connected, 1--> sensor co
                                                                          nnected
      SPB   Ti_M

//If the sensor is not connected, we employ de theoretical value

      CALL  "Sensor conect/desconect"                                     FC3
       Sensor_conectado:=#Tin_connected                                   #Tin_connected     -- 0-> senso
                                                                          r not connected, 1--> sensor co
                                                                          nnected
       Valor_teorico   :=#Tin_chiller                                     #Tin_chiller       -- Tin set b
                                                                          y the chiller, theoretically it
                                                                           should be equal to the Tin mea
                                                                          sured
       Valor_a_GUARDAR :=#DB_Tin                                          #DB_Tin            -- Indicate
                                                                          the direction in which the valu
                                                                          e (measured/theorical) must be
                                                                          stored
```

```
//PRESSURE 3

C_P3: U     #P3_connected                                                    #P3_connected      -- 0-> senso
                                                                             r not connected, 1--> sensor co
                                                                             nnected
      SPB   M_P3

//If the sensor is not connected, we employ the value of P2 MEASSURED

      CALL  "Sensor conect/desconect"                                        FC3
       Sensor_conectado:=#P3_connected                                       #P3_connected      -- 0-> senso
                                                                             r not connected, 1--> sensor co
                                                                             nnected
       Valor_teorico   :=#P3_calc                                            #P3_calc           -- Theoretic
                                                                             al/set/calculated value of the
                                                                             magnitude->P2
       Valor_a_GUARDAR :=#DB_P3                                              #DB_P3             -- Indicate
                                                                             the direction in which the valu
                                                                             e (measured/theorical) must be
                                                                             stored



// Aunque el sensor nos lo de en kg/s , se está haciendo que esté en un rango de g/s

//REFRIGERANT

C_RF: U     #m_ref_connected                                                 #m_ref_connected   -- 0-> senso
                                                                             r not connected, 1--> sensor co
                                                                             nnected
      SPB   R_M

//If it is not connected

      CALL  "Sensor conect/desconect"                                        FC3
       Sensor_conectado:=#m_ref_connected                                    #m_ref_connected   -- 0-> senso
                                                                             r not connected, 1--> sensor co
                                                                             nnected
       Valor_teorico   :=#m_ref_calc                                         #m_ref_calc        -- Theoretic
                                                                             al/set/calculated value of the
                                                                             magnitude
       Valor_a_GUARDAR :=#DB_m_ref                                           #DB_m_ref          -- Indicate
                                                                             the direction in which the valu
                                                                             e (measured/theorical) must be
                                                                             stored

//We use the theoretical value of m_ref (in grams) as if it was
//the real value meassured



      SPA   SEG5



//IF THE SENSORS ARE CONNECTED//

T1_M: CALL  "SCALE"                    // Meassure T1, T1                    FC105              -- Scaling V
                                                                             alues
       IN     :=#IN_T1                                                       #IN_T1             -- Analog IN
                                                                             PUT of T1
       HI_LIM :=8.000000e+001
       LO_LIM :=5.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_T1                                                       #DB_T1             -- Indicate
                                                                             the direction in which the valu
                                                                             e (measured/theorical) must be
                                                                             stored
//Go to the comprobation of the sensor T2
      SPA   C_T3


T3_M: CALL  "SCALE"                    // Termopar 1, T3_P1                  FC105              -- Scaling V
                                                                             alues
       IN     :=#IN_T3                                                       #IN_T3             -- Analog IN
                                                                             PUT of T3
       HI_LIM :=8.000000e+001
       LO_LIM :=5.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_T3                                                       #DB_T3             -- Indicate
                                                                             the direction in which the valu
                                                                             e (measured/theorical) must be
                                                                             stored

// Check the sensor Tin
```

```
      SPA   C_Ti


Ti_M: CALL  "SCALE"                      // Termopar 1, Tin_P1             FC105              -- Scaling V
                                                                           alues
       IN     :=#IN_Tin                                                    #IN_Tin            -- Analog IN
                                                                           PUT of Tin
       HI_LIM :=3.000000e+001
       LO_LIM :=5.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_Tin                                                    #DB_Tin            -- Indicate
                                                                           the direction in which the valu
                                                                           e (measured/theorical) must be
                                                                           stored

// Check the sensor P3
      SPA   C_P3

M_P3: CALL  "SCALE"                      //Presión 3, puesto 1             FC105              -- Scaling V
                                                                           alues
       IN     :=#IN_P3                                                     #IN_P3             -- Analog IN
                                                                           PUT of P3
       HI_LIM :=6.000000e+001
       LO_LIM :=1.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_P3                                                     #DB_P3             -- Indicate
                                                                           the direction in which the valu
                                                                           e (measured/theorical) must be
                                                                           stored
// Check the sensor m_ref
      SPA   C_RF


R_M:  CALL  "SCALE"                      //m_ref_P1,flujo másico del refri FC105              -- Scaling V
                                         gerante del puesto 1              alues
       IN     :=#IN_m_ref                                                  #IN_m_ref          -- Analog IN
                                                                           PUT of m_ref
       HI_LIM :=1.100000e+002            //lo máximo son 100g, pongo 110g
       LO_LIM :=3.500000e+000            // lo  mínimo son 5.8g, pongo 3.5g
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_m_ref                                                  #DB_m_ref          -- Indicate
                                                                           the direction in which the valu
                                                                           e (measured/theorical) must be
                                                                           stored
//Check the water flux sensor


      SPA   SEG5
```

Segm.: 6 EXCEL INTERFACE 2.0
h2, h3, rho_w....with the new measurements of the sensors (in case that they have been connected)their values might change

```
SEG5: NOP   0
      R     #UDT11_12                                 #UDT11_12         -- When it is 1->inputs to the UDT 11
                                                      , when it is 0->outputs to UDT12
      CALL  "Excel_DB"                                FC94
       Ref_number          :=#ref_number              #ref_number       -- Refrigerant number (0->r134a, 1->r
                                                      410a, 2->r407c, 3->r22, 4->r290)
       P1_m                :=#DB_P1                   #DB_P1            -- Indicate the direction in which th
                                                      e value (measured/theorical) must be stored
       P1_set              :=#P1_set                  #P1_set           -- Set pressured at the operating poi
                                                      nt 1
       x1                  :=#x1                      #x1               -- Quality of the refrigerant, UDT 1
       Tout_m              :=#DB_Tout                 #DB_Tout          -- Indicate the direction in which th
                                                      e value (measured/theorical) must be stored
       P2_m                :=#DB_P2                   #DB_P2            -- Indicate the direction in which th
                                                      e value (measured/theorical) must be stored
       delta_T_resistance  :=#delta_T_resistance      #delta_T_resistance -- Extra temperature degrees to be o
                                                      btained above the sat. T by the  resistance
       m_w_m               :=#DB_m_w                  #DB_m_w           -- Indicate the direction in which th
                                                      e value (measured/theorical) must be stored
       m_ref_div_rho       :=#m_ref_div_rho           #m_ref_div_rho    -- m_ref/rho--> displ [m^3/rev]*rps [
                                                      rev/s]*vol_eff
       T2_m                :=#DB_T2                   #DB_T2            -- Indicate the direction in which th
                                                      e value (measured/theorical) must be stored
       T1sat_12            :=#T1sat_12                #T1sat_12         -- T1_sat,UDT 12
       h1_th_12            :=#h1_th_12                #h1_th_12         -- h1_th, UDT 12
       h1_12               :=#h1_12                   #h1_12            -- h1, UDT 12
       T2sat_12            :=#T2sat_12                #T2sat_12         -- T2sat, UDT 12
       h2_th_12            :=#h2_th_12                #h2_th_12         --  h2_th,UDT 12
       h3_th_12            :=#h3_th_12                #h3_th_12         -- h3_th, UDT 12
       T2desired_12        :=#T2desired_12            #T2desired_12     -- T2desired, UDT 12
       rho_ref_12          :=#rho_ref_12              #rho_ref_12       -- rho_ref, UDT 12
```

```
      h2_m_12             :=#h2_m_12              #h2_m_12          -- h2_m, UDT 12
      h3_m_12             :=#h3_m_12              #h3_m_12          -- h3_m, UDT 12
      m_ref_th_12         :=#m_ref_th_12          #m_ref_th_12      -- m_ref_th, UDT 12
      m_ref_grams_12      :=#m_ref_grams_12       #m_ref_grams_12   -- m_ref_grams, UDT 12
      UDT11_12            :=#UDT11_12             #UDT11_12         -- When it is 1->inputs to the UDT 11
                                                  , when it is 0->outputs to UDT12
      Ref_number_11       :=#Ref_number_11        #Ref_number_11    -- Refrigerant number, UDT 11
      P1_m_11             :=#P1_m_11              #P1_m_11          -- P1_m, UDT 11
      P1_set_11           :=#P1_set_11            #P1_set_11        -- P1_set, UDT 11
      x1_11               :=#x1_11                #x1_11            -- x1, UDT 11
      Tout_m_11           :=#Tout_m_11            #Tout_m_11        -- Tout_m, UDT 11
      P2_m_11             :=#P2_m_11              #P2_m_11          -- P2_m, UDT 11
      delta_T_resistance_11:=#delta_T_resistance_11 #delta_T_resistance_11 -- delta_T_resistance, UDT 11
      m_w_m_11            :=#m_w_m_11             #m_w_m_11         -- m_w_m, UDT 11
      m_ref_div_rho_11    :=#m_ref_div_rho_11     #m_ref_div_rho_11 -- m-ref_div_rho, UDT 11
      T2_m_11             :=#T2_m_11              #T2_m_11          -- T2_m, UDT 11
      T1sat               :=#T1sat                #T1sat            -- T1sat, UDT2
      h1_th               :=#h1_th                #h1_th            -- Enthalpy at the desired pressure a
                                                  nd quality
      h1                  :=#h1                   #h1               -- Enthalpy at x1 and P1_m
      T2sat               :=#T2sat                #T2sat            -- Saturation temperature at pressure
                                                   P2
      h2_th               :=#h2_th                #h2_th            -- Enthalpy at point 2, with the theo
                                                  retical values
      h3_th               :=#h3_th                #h3_th            -- Equal to the enthalpy h1_th
      T2desired           :=#T2desired            #T2desired        -- Desired temperature after the heat
                                                  ing resistance
      rho_ref             :=#rho_ref              #rho_ref          -- Refrigerant density (entering of t
                                                  he compressor)
      h2_m                :=#h2_m                 #h2_m             -- Enthalpy computed with the data of
                                                   the sensors
      h3_m                :=#h3_m                 #h3_m             -- Enthalpy measured (equal to h1)
      m_ref_th            :=#m_ref_th             #m_ref_th         -- Refrigerant flux in kg/s
      m_ref_grams         :=#m_ref_grams          #m_ref_grams      -- Refirgerant flux calculated in g/s


//**WITH THE DATA MEASURED  WE HAVE TO OBTAIN rho_ref....
//SENT
//-->T1 measured, P1measured,P1_set,x1, P2mesaured, T2 measured, P3 measured, T3 measured
//--> Tin_chiller, Tout measured,

//RECEIVE
//-->h1_th,h1, h2,h3,rho_ref, rho_water, Cp_w


      SPA   SEG6
```

Segm.: 7 Theoretical values 2.0
This function to calculate the theoretical values is been summonded with the measured data of P2, Tout and the possible values measured with the sensors T1, T2, T3, Tin, m_ref, m_w. Those sensors could not be implemented, nevertheless, the calculations of the desired values are done again in case theyaport some neww data.

```
//If it is MANUAL don't CALL FC6
//There is no need to calculate it because the desired values in the manual mode are set by the HMI
//and the measured values needed to permormed the PID control have already been measured.

SEG6: U     #Mode_manual_automatic                    //"WINCC".UDT8 Manual?        #Mode_manual_automatic --
                                                                                     When mode is manual->1, UD
                                                                                     T8

      SPB   END

      CALL  "OperationCalculation"                                                   FC6
       Tout               :=#DB_Tout                                                 #DB_Tout            -- Indi
                                                                                     cate the direction in whic
                                                                                     h the value (measured/theo
                                                                                     rical) must be stored
       Tin                :=#DB_Tin                                                  #DB_Tin             -- Indi
                                                                                     cate the direction in whic
                                                                                     h the value (measured/theo
                                                                                     rical) must be stored
       rho_ref            :=#rho_ref                                                 #rho_ref            -- Refr
                                                                                     igerant density (entering
                                                                                     of the compressor)
       displ              :=#displ                                                   #displ              -- Disp
                                                                                     lacement of the compressor
       rpm                :=#rpm                                                     #rpm                -- rpm
                                                                                     of the compressor
       h1_th              :=#h1_th                                                   #h1_th              -- Enth
                                                                                     alpy at the desired pressu
                                                                                     re and quality
       h2_th              :=#h2_th                                                   #h2_th              -- Enth
                                                                                     alpy at point 2, with the
                                                                                     theoretical values
```

```
Cp_w                 :=#Cp_w                                   #Cp_w
rho_water            :=#rho_water                              #rho_water
T2sat                :=#T2sat                                  #T2sat            -- Satu
                                                               ration temperature at pres
                                                               sure P2
delta_T_resistance   :=#delta_T_resistance                     #delta_T_resistance -- Ext
                                                               ra temperature degrees to
                                                               be obtained above the sat.
                                                                T by the  resistance
P2                   :=#DB_P2                                  #DB_P2            -- Indi
                                                               cate the direction in whic
                                                               h the value (measured/theo
                                                               rical) must be stored
P1_set               :=#P1_set                                 #P1_set           -- Set
                                                               pressured at the operating
                                                                point 1
c_vol                :=#c_vol                                  #c_vol            -- Coef
                                                               ficient  of  the second de
                                                               gree equation to calculate
                                                                the volumetric eff.
b_iso                :=#b_iso                                  #b_iso            -- Coef
                                                               ficient  of  the second de
                                                               gree equation to calculate
                                                                the isentropic eff.
c_iso                :=#c_iso                                  #c_iso            -- Coef
                                                               ficient  of  the second de
                                                               gree equation to calculate
                                                                the isentropic eff.
a_iso                :=#a_iso                                  #a_iso            -- Coef
                                                               ficient  of  the second de
                                                               gree equation to calculate
                                                                the isentropic eff.
a_vol                :=#a_vol                                  #a_vol            -- Coef
                                                               ficient  of  the second de
                                                               gree equation to calculate
                                                                the volumetric eff.
b_vol                :=#b_vol                                  #b_vol            -- Coef
                                                               ficient  of  the second de
                                                               gree equation to calculate
                                                                the volumetric eff.
Tin_conectado        :=#Tin_connected                          #Tin_connected     -- 0->
                                                               sensor not connected, 1-->
                                                                sensor connected
Tin_chiller          :=#Tin_chiller                            #Tin_chiller       -- Tin
                                                               set by the chiller, theore
                                                               tically it should be equal
                                                                to the Tin measured
Mode_manual_automatic:=#Mode_manual_automatic                  #Mode_manual_automatic --
                                                               When mode is manual->1, UD
                                                               T8
m_ref_grams          :=#m_ref_grams                            #m_ref_grams       -- Refi
                                                               rgerant flux calculated in
                                                                g/s
flow_w_lit_min       :=#flow_w_lit_min                         #flow_w_lit_min    -- Wate
                                                               r flux calculated in l/min
T2_deseada           :=#T2_deseada                             #T2_deseada        -- Temp
                                                               erature desired at point 2
m_ref_th             :=#m_ref_th                               #m_ref_th          -- Refr
                                                               igerant flux in kg/s
Qcond_necesitado     :=#Qcond_necesitado                       #Qcond_necesitado  -- Heat
                                                                exchanged needed in the c
                                                               ondenser
m_w_th               :=#m_w_th                                 #m_w_th            -- Wate
                                                               r flux in kg/s
PR                   :=#PR                                     #PR                -- Pres
                                                               sure ratio P2measured/P1 s
                                                               et
rend_vol_th          :=#rend_vol_th                            #rend_vol_th       -- Volu
                                                               metric efficiency computed
                                                                 with the second degree e
                                                               quation
rend_iso_th          :=#rend_iso_th                            #rend_iso_th       -- Isen
                                                               tropc efficiency computed
                                                               with the second degree equ
                                                               ation
```

Segm.: 8 END
END segment

```
END:  NOP   0
```

FC6 - <offline>

"OperationCalculation"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 13/06/2014 10:06:09
Interface: 03/06/2014 13:00:16
Longitud (bloque / código / datos): 00506 00316 00024

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
Tout	Real	0.0	Water output temperaure of the condenser
Tin	Real	4.0	Water input temperature (condenser)
rho_ref	Real	8.0	Refrigerant density (entering of the compressor)
displ	Real	12.0	Displacement of the compressor
rpm	Real	16.0	rpm of the compressor
h1_th	Real	20.0	Enthalpy at the desired pressure and quality
h2_th	Real	24.0	Enthalpy computed with the data of P2 and T2 desired
Cp_w	Real	28.0	
rho_water	Real	32.0	
T2sat	Real	36.0	Saturation temperature at pressure P2
delta_T_resistance	Real	40.0	Extra temperature degrees to be obtained above the sat. T by the resistance
P2	Real	44.0	Pressure at operating point 2 (measured)
P1_set	Real	48.0	Set pressured at the operating point 1
c_vol	Real	52.0	Coefficient of the second degree equation to calculate the volumetric eff.
b_iso	Real	56.0	Coefficient of the second degree equation to calculate the isentropic eff.
c_iso	Real	60.0	Coefficient of the second degree equation to calculate the isentropic eff.
a_iso	Real	64.0	Coefficient of the second degree equation to calculate the isentropic eff.
a_vol	Real	68.0	Coefficient of the second degree equation to calculate the volumetric eff.
b_vol	Real	72.0	Coefficient of the second degree equation to calculate the volumetric eff.
Tin_conectado	Bool	76.0	Indicates if the sensor is connected
Tin_chiller	Real	78.0	The Tin fixed in the chiller
Mode_manual_automatic	Bool	82.0	When the mode is manual=1, automatic=0(UDT8)
OUT		0.0	
m_ref_grams	Real	84.0	Refirgerant flux in g/s
flow_w_lit_min	Real	88.0	Water flux in l/min
T2_deseada	Real	92.0	Temperature desired at point 2
IN_OUT		0.0	
m_ref_th	Real	96.0	Refrigerant flux in kg/s
Qcond_necesitado	Real	100.0	Heat exchanged needed in the condenser
m_w_th	Real	104.0	Water flux in kg/s
PR	Real	108.0	Pressure ratio P2measured/P1 set
rend_vol_th	Real	112.0	Volumetric efficiency computed with the second degree equation
rend_iso_th	Real	116.0	Isentropc efficiency computed with the second degree equation
TEMP		0.0	
a_vol_X_PR	Real	0.0	Intermediate calculation a_vol·PR^2
a_iso_X_PR	Real	4.0	Intermediate calculation a_iso·PR^2
rho_x_displ	Real	8.0	The result of the multiplication of the ref density and the displacement

Nombre	Tipo de datos	Dirección	Comentario
rps	Real	12.0	rps=rpm/60
rend_div_1000000	Real	16.0	volumetric efficiency/1000000-->Is part of the formula
delta_T	Real	20.0	Tout-Tin
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC6 Operations_Calculations

The math to calculate the flow,etc...are going to be done

These functions are implemented in the EES. However, due to the "difficult" for sequentially calculating program variables and functions in this software will be defined below.

To define them, you will need to have a set of outputs, as enthalpies, densities, ... etc.
If, as suspected, the use of EES is not feasible, we must perform interpolations with data from a database or otherwise with thermodynamic tables.

Segm.: 1 Temperature delta of the condenser

We calculate Tout-Tin and storage it in the auxiliar data bench.

```
//CALCULATIONS
      U     #Tin_conectado  #Tin_conectado     -- Indicates if the sensor is connected
      SPB   Ti_S

      L     #Tout           #Tout              -- Water output temperaure of the condenser
      L     #Tin_chiller    #Tin_chiller       -- The Tin fixed in the chiller
      -R
      T     #delta_T        #delta_T           -- Tout-Tin
      NOP   0


Ti_S: L     #Tout           #Tout              -- Water output temperaure of the condenser
      L     #Tin            #Tin               -- Water input temperature (condenser)
      -R
      T     #delta_T        #delta_T           -- Tout-Tin

      NOP   0
```

Segm.: 2 Temperature to be achieve at operating point 2r

With the delta_T_resistance and the saturation temperature at pressure 2, the desired temperature to be obtained can be calculatd.

```
//CALCULATIONS -->done in the excel

      L     #T2sat               #T2sat             -- Saturation temperature at pressure P2
      L     #delta_T_resistance  #delta_T_resistance -- Extra temperature degrees to be obtained above the sat
                                 . T by the  resistance
      +R
      T     #T2_deseada          #T2_deseada        -- Temperature desired at point 2

      NOP   0
```

Segm.: 3 Pressure ratio and efficiencies

Calculating the pressure ratio, and with the second degree coefficients the efficiencies are defined.

```
//CALCULATIONS

//  First, we calculate the pressure ratio

      L     #P2          #P2                -- Pressure at operating point 2 (measured)
      L     #P1_set      #P1_set            -- Set pressured at the operating point 1
      /R
      T     #PR          #PR                -- Pressure ratio P2measured/P1 set

//The equations for the efficiencies are second degree equations
//Eff=a·PR^2+ b·PR + c


//**********************//
```

```
// VOLUMETRIC EFFICIENCY//
//**********************//

      L     #PR           #PR               -- Pressure ratio P2measured/P1 set
      L     #PR           #PR               -- Pressure ratio P2measured/P1 set
      *R
// PR^2

      L     #a_vol        #a_vol            -- Coefficient  of  the second degree equation to calculate the v
                          olumetric eff.
      *R
      T     #a_vol_X_PR   #a_vol_X_PR       -- Intermediate calculation a_vol·PR^2

//a_vol x PR^2
      L     #b_vol        #b_vol            -- Coefficient  of  the second degree equation to calculate the v
                          olumetric eff.
      L     #PR           #PR               -- Pressure ratio P2measured/P1 set
      *R
// b_vol ·PR

      L     #a_vol_X_PR   #a_vol_X_PR       -- Intermediate calculation a_vol·PR^2
      +R

//a_vol x PR^2 +  b_vol ·PR
      L     #c_vol        #c_vol            -- Coefficient  of  the second degree equation to calculate the v
                          olumetric eff.
      +R
      T     #rend_vol_th  #rend_vol_th      -- Volumetric efficiency computed  with the second degree equatio
                          n
//Is the result of:  a_vol x PR^2 +  b_vol ·PR +c_vol


//**********************//
// ISENTROPIC EFFICIENCY //
//**********************//

      L     #PR           #PR               -- Pressure ratio P2measured/P1 set
      L     #PR           #PR               -- Pressure ratio P2measured/P1 set
      *R
// PR^2

      L     #a_iso        #a_iso            -- Coefficient  of  the second degree equation to calculate the i
                          sentropic eff.
      *R
      T     #a_iso_X_PR   #a_iso_X_PR       -- Intermediate calculation a_iso·PR^2

//a_iso x PR^2
      L     #b_iso        #b_iso            -- Coefficient  of  the second degree equation to calculate the i
                          sentropic eff.
      L     #PR           #PR               -- Pressure ratio P2measured/P1 set
      *R
// b_iso ·PR

      L     #a_iso_X_PR   #a_iso_X_PR       -- Intermediate calculation a_iso·PR^2
      +R

//a_iso x PR^2 +  b_iso ·PR
      L     #c_iso        #c_iso            -- Coefficient  of  the second degree equation to calculate the i
                          sentropic eff.
      +R
      T     #rend_iso_th  #rend_iso_th      -- Isentropc efficiency computed with the second degree equation
//Is the result of:  a_iso x PR^2 +  b_iso ·PR +c_iso

      NOP   0
```

Segm.: 4 Theoretical refrigerant flux
We will employ this value when the coriolis sensor is not connected

```
//CALCULATIONS

//The operations are performed by "blocks"
// rho_ref*displ

      L     #rho_ref                                               #rho_ref          -- Refrigerant den
                                                                   sity (entering of the compressor)
      L     #displ                                                 #displ            -- Displacement of
                                                                    the compressor
      *R
      T     #rho_x_displ                                           #rho_x_displ      -- The result of t
                                                                   he multiplication of the ref density
                                                                   and the displacement

// rps
```

```
      L     #rpm                                                         #rpm               -- rpm of the comp
                                                                         ressor
      L     6.000000e+001
      /R
      T     #rps                                                         #rps               -- rps=rpm/60

//The las "block":  rend_vol_th/1000000

      L     #rend_vol_th                                                 #rend_vol_th       -- Volumetric effi
                                                                         ciency computed  with the second degr
                                                                         ee equation
      L     1.000000e+006      //factor de corrección lit/m^3
      /R
      T     #rend_div_1000000                                            #rend_div_1000000  -- volumetric effi
                                                                         ciency/1000000-->Is part of the formu
                                                                         la

//We multiplicate the three "blocks" defined

      L     #rho_x_displ                                                 #rho_x_displ       -- The result of t
                                                                         he multiplication of the ref density
                                                                         and the displacement
      L     #rps                                                         #rps               -- rps=rpm/60
      *R
      L     #rend_div_1000000                                            #rend_div_1000000  -- volumetric effi
                                                                         ciency/1000000-->Is part of the formu
                                                                         la
      *R
      T     #m_ref_th                                                    #m_ref_th          -- Refrigerant flu
                                                                         x in kg/s

//The final formula calculated:
//m_ref_th=(rho_ref*displ*rend_vol*rpm)/(60*1000000) --> [kg/s]


//To obtain its value in [g/s]

      L     #m_ref_th                                                    #m_ref_th          -- Refrigerant flu
                                                                         x in kg/s
      L     1.000000e+003      //factor de conversión de kg->g
      *R
      T     #m_ref_grams                                                 #m_ref_grams       -- Refirgerant flu
                                                                         x in g/s

      NOP   0
```

Segm.: 5 Heat exchanged in the condenser
Calculations for obtaining the heat exchanged needed are to be made.

```
//THE HEAT EXCHANGE IS CALCULATED WITH H2_TH
//H2_TH HAS BEEN COMPUTED WITH THE T2 DESIRED,THEREFORE THE VALUES CALCULATED WOULD BE
//THE VALUES TO BE ACHIEVE

      L     #h2_th             #h2_th             -- Enthalpy computed with the data of P2 and T2 desired
      L     #h1_th             #h1_th             -- Enthalpy at the desired pressure and quality
      -R

//We have calculated h2-h1-> enthalpy difference that
// must be obtained in the condenser

      L     #m_ref_th          #m_ref_th          -- Refrigerant flux in kg/s
      *R
      T     #Qcond_necesitado  #Qcond_necesitado  -- Heat exchanged needed in the condenser

//The result is the corresponding to the formula:
//Qcond_necesitado=m_ref_th*(h2-h1)

      NOP   0
```

Segm.: 6 Water flux needed
Knowing the formula, we calculate the kg/s and the lit/min needed.

```
//CALCULATIONS

      L     #Qcond_necesitado                                            #Qcond_necesitado  -- Heat exchanged
                                                                         needed in the condenser
      L     #Cp_w                                                        #Cp_w
      /R

//Qcond/Cp_w
```

```
      L     #delta_T                                                        #delta_T           -- Tout-Tin
      /R
      T     #m_w_th                                                         #m_w_th            -- Water flux in k
                                                                            g/s

//According to the formula, we have calculated the kg/s
//m_w_th=Qcond_necesitado/(Cp_w*delta_T)->[kg/s]


//For expresing it in [l/mi]

      L     #m_w_th                                                         #m_w_th            -- Water flux in k
                                                                            g/s
      L     #rho_water                                                      #rho_water
      /R

//And we multiplied it for 60*1000 lit->m^3 and seg->min)

      L     6.000000e+004      //cambio de seg-min y de m^3-lit
      *R
      T     #flow_w_lit_min                                                 #flow_w_lit_min    -- Water flux in l
                                                                            /min

//We storaged it in flow_w_lit_min
//flow_w_lit_min= m_w_th*60000/rho_water


      NOP   0
```

FC7 - <offline>

"AUT_Control PID"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 07/06/2014 10:43:59
Interface: 03/06/2014 10:04:35
Longitud (bloque / código / datos): 01222 01086 00022

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
P3	Real	0.0	Pressure at operating point 3, REAL
P1_set	Real	4.0	Set pressure at operating point 1,REAL
OFF	Bool	8.0	Indicates if the satation is OFF (OFF=1)
m_w_th	Real	10.0	Desired water flux , REAL
m_w	Real	14.0	Measured water flux, REAL
T2deseada	Real	18.0	Desired temperature 2, REAL
T2	Real	22.0	Measured temperature 2, REAL
P1	Real	26.0	Measured pressure at the operating point 1, REAL
OUT		0.0	
resistance_relay_dir	Bool	30.0	Direction of the digital output that controls the resistance
Dir_pump	Word	32.0	Direction of the analog output of the pump
Dir_EEV	Word	34.0	Direction of the EEV analog output
IN_OUT		0.0	
orden_EEV	Int	36.0	EEV control signal,INT
orden_pump	Real	38.0	Pump control order, REAL
orden_pump_int	Int	42.0	Pump control order,INT
orden_EEVreal	Real	44.0	EEV control signal, REAL
TEMP		0.0	
delta_Pressure_EEV	Real	0.0	Ratio of pressures
delta_Pword	Word	4.0	Pressure ratio, WORD
delta_P_set_EEV	Real	6.0	Ratio of pressures ,P3 measured/ P1 set, REAL
mw_word	Word	10.0	Measured water flux, WORD
T2word	Word	12.0	Measures temperature 2,WORD
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC7 CONTROL ACTIONS

The output signals would be calculated

Segm.: 1 EEV action

To determine the control action for the EEV, as we know the values of P1 and P3, a proportional order must be employed.
P3/P1 is defines as the signal that would determine the control
The block funstion FB41 is chosen because of iis continuos input and output signals.

```
//Desired value//

      L     #P3                                        #P3                 -- Pressure at
                                                        operating point 3, REAL
      L     #P1_set                                    #P1_set             -- Set pressur
                                                       e at operating point 1,REAL
      /R
```

```
      T     #delta_P_set_EEV                                              #delta_P_set_EEV   --  Ratio of p
                                                                          ressures ,P3 measured/ P1 set, RE
                                                                          AL


//Measured value//

      L     #P3                                                           #P3                -- Pressure at
                                                                           operating point 3, REAL
      L     #P1                                                           #P1                -- Measured pr
                                                                          essure at the operating point 1,
                                                                          REAL
      /R
      T     #delta_Pressure_EEV                                           #delta_Pressure_EEV -- Ratio of p
                                                                          ressures

//REAL->INT-> WORD actual value of the sensors

      CALL  "Real->Int->Word"                                             FC2
       valor_REAL:=#delta_Pressure_EEV                                    #delta_Pressure_EEV -- Ratio of p
                                                                          ressures
       valor_INT :=MW4                  //Not needed
       valor_WORD:=#delta_Pword                                           #delta_Pword       -- Pressure ra
                                                                          tio, WORD




// PID control

      CALL  "CONT_C" , "PID_1"                                            FB41 / DB41        -- Continuous
                                                                          Control
       COM_RST :=#OFF                   //When the station is OFF         #OFF               -- Indicates i
                                                                          f the satation is OFF (OFF=1)
       MAN_ON  :=FALSE                  //DESACTIVATE, the manual set value
       PVPER_ON:=TRUE                   //valor de periferia activada
       P_SEL   :=TRUE                   //acción proporcional
       I_SEL   :=TRUE                   //acción integral activa
       INT_HOLD:=FALSE                  //congelar la integración
       I_ITL_ON:=#OFF                   //Indica cuando se reinicia la acci  #OFF               -- Indicates i
                                        ón integral                       f the satation is OFF (OFF=1)
       D_SEL   :=TRUE                   //acción derivatiba
       CYCLE   :=T#100MS
       SP_INT  :=#delta_P_set_EEV       //consigna interna-->aqui el valor   #delta_P_set_EEV   --  Ratio of p
                                        deseado                           ressures ,P3 measured/ P1 set, RE
                                                                          AL
       PV_IN   :=0.000000e+000          //Una especie de offset entorno al valor real (precision...)
       PV_PER  :=#delta_Pword           // entrada en WORD                #delta_Pword       -- Pressure ra
                                                                          tio, WORD
       MAN     :=0.000000e+000          //Establece un valor de visualización para el HMI, fijas el valor
       GAIN    :=2.000000e+000          //ganancia
       TI      :=T#2S
       TD      :=T#1S
       TM_LAG  :=T#100MS
       DEADB_W :=2.500000e+001          //está en porcentaje
       LMN_HLM :=1.000000e+002          //lo máximo que t puedes exceder
       LMN_LLM :=0.000000e+000          //lo maximo que te puedes quedar por debajo
       PV_FAC  :=1.000000e+000          //medir lo que tenemos
       PV_OFF  :=0.000000e+000          //offset
       LMN_FAC :=1.000000e+000          //se multiplica por el valor manipulado y sirve para establecer los lí
                                        mites
       LMN_OFF :=0.000000e+000
       I_ITLVAL:=8.500000e+001          //porcentaje
       DISV    :=0.000000e+000
       LMN     :=#orden_EEVreal         //valor manipulado que actua (REAL)  #orden_EEVreal     -- EEV control
                                                                           signal, REAL
       LMN_PER :=#Dir_EEV               //valor manipulado en la periferia,  #Dir_EEV           -- Direction o
                                         word                             f the EEV analog output
       QLMN_HLM:=M4.0
       QLMN_LLM:=M4.0
       LMN_P   :=MD4
       LMN_I   :=MD4
       LMN_D   :=MD4
       PV      :=MD4                    //No interesa
       ER      :=MD4

// Storage of the order in the data block DBX0
// REAL-->INT

      CALL  "Station1_set"                                                FC10
      CALL  "Real->Int->Word"                                             FC2
       valor_REAL:=#orden_EEVreal                                         #orden_EEVreal     -- EEV control
                                                                           signal, REAL
       valor_INT :=#orden_EEV                                             #orden_EEV         -- EEV control
                                                                           signal,INT
       valor_WORD:=MW4                  // No interesa su valor
```

Segm.: 2 PUMP action
A theoretical water flux must be obtained to get the heat exchange needed. The real water flux value must achieve the water flux desired.

```
// REAL desired value  m_w_th


// REAL->INT-> WORD actual sensor value

      CALL  "Real->Int->Word"                                           FC2
       valor_REAL:=#m_w            //valor real medido del sensor        #m_w              -- Measured wate
                                                                         r flux, REAL
       valor_INT :=MW4             //guardamos el valor en INT
       valor_WORD:=#mw_word        // Lo pasamos a word                  #mw_word          -- Measured wate
                                                                         r flux, WORD

//PID control

      CALL  "CONT_C" , "PID_1"                                          FB41 / DB41       -- Continuous Co
                                                                         ntrol
       COM_RST :=#OFF                                                    #OFF              -- Indicates if
                                                                         the satation is OFF (OFF=1)
       MAN_ON  :=FALSE             //Introducción manual por HMI desactivada
       PVPER_ON:=TRUE              //Introducción por periféricos ON
       P_SEL   :=TRUE
       I_SEL   :=TRUE
       INT_HOLD:=FALSE
       I_ITL_ON:=#OFF                                                    #OFF              -- Indicates if
                                                                         the satation is OFF (OFF=1)
       D_SEL   :=TRUE
       CYCLE   :=T#100MS
       SP_INT  :=#m_w_th           //Desired value, REAL                 #m_w_th           -- Desired water
                                                                          flux , REAL
       PV_IN   :=0.000000e+000     //offse
       PV_PER  :=#mw_word          //Measured value, WORD                #mw_word          -- Measured wate
                                                                         r flux, WORD
       MAN     :=0.000000e+000
       GAIN    :=2.000000e+000
       TI      :=T#2S
       TD      :=T#1S
       TM_LAG  :=T#100MS
       DEADB_W :=2.500000e+001     //esta en porcentaje
       LMN_HLM :=1.000000e+002     //100%
       LMN_LLM :=0.000000e+000     //0% (desde el o% hasta el 100% de lo q he fijado)
       PV_FAC  :=1.000000e+000     // la entrada mutiplicada por "1"
       PV_OFF  :=0.000000e+000     //sin offset
       LMN_FAC :=1.000000e+000     //Ampliamos el valor superior? No, lo multiplicamos por 1m así que se qued
                                   a en el 100%
       LMN_OFF :=0.000000e+000     //0%
       I_ITLVAL:=8.500000e+001     //Empieza a integrar al 85 % del valor consigna
       DISV    :=0.000000e+000     // acción perturbadora
       LMN     :=#orden_pump       // valor de orden real                #orden_pump       -- Pump control
                                                                         order, REAL
       LMN_PER :=#Dir_pump                                               #Dir_pump         -- Direction of
                                                                         the analog output of the pump
       QLMN_HLM:=M4.0
       QLMN_LLM:=M4.0
       LMN_P   :=MD4
       LMN_I   :=MD4
       LMN_D   :=MD4
       PV      :=MD4               //no interesa
       ER      :=MD4


// Storage of the order in the data block DBX0
// REAL->INT

      CALL  "Real->Int->Word"                                           FC2
       valor_REAL:=#orden_pump                                           #orden_pump       -- Pump control
                                                                         order, REAL
       valor_INT :=#orden_pump_int                                       #orden_pump_int   -- Pump control
                                                                         order,INT
       valor_WORD:=MW4
```

Segm.: 3 Heating Resistance control
The PID employed must have a pulse output signal,since the resistance would be controlled by a relay.

```
// REAL desired T2deseada


// REAL--> WORD actual sensor value

      CALL  "Real->Int->Word"                                                    FC2
       valor_REAL:=#T2               //valor real                                #T2                -- Measured te
                                                                                 mperature 2, REAL
       valor_INT :=MW4               // guardamos el valor en INT
       valor_WORD:=#T2word           // Lo pasamos a word                        #T2word            -- Measures te
                                                                                 mperature 2,WORD


// PID control

      CALL  "CONT_S" , "PID_2"                                                   FB42 / DB42        -- Step Contro
                                                                                 l
       COM_RST :=#OFF                //Indica cuando el puesto está a OF         #OFF               -- Indicates i
                                     F, cuando se reinicia                       f the satation is OFF (OFF=1)
       LMNR_HS :=FALSE               // Señal de límite superior
       LMNR_LS :=TRUE                // el control se enncuentra en su tope inferior
       LMNS_ON :=FALSE               // Conectar consigna de modo manual nNO,se  obtiene del periferico
       LMNUP   :=TRUE                // señal de salida QLMNUP
       LMNDN   :=FALSE               //no se tiene como salida QLMNDN
       PVPER_ON:=TRUE                // valor de periferia, sensor T2
       CYCLE   :=T#100MS             //Tiempo de muestreo
       SP_INT  :=#T2deseada          //Consigna interna!!T2 deseada              #T2deseada         -- Desired tem
                                                                                 perature 2, REAL
       PV_IN   :=0.000000e+000
       PV_PER  :=#T2word             // valor real de entrada en WORD            #T2word            -- Measures te
                                                                                 mperature 2,WORD
       GAIN    :=1.000000e+000
       TI      :=T#2S
       DEADB_W :=2.500000e-001       //ancho de zona muerta
       PV_FAC  :=1.000000e+000       //factor por el que se multiplica la entrada
       PV_OFF  :=0.000000e+000       //offset de la entrada
       PULSE_TM:=T#1S                // duración minima de impulso
       BREAK_TM:=T#200MS             //duración minima depausa
       MTR_TM  :=T#20S               //Tiempo de desplazamiento de tope a tope ¿lo que le cuesta llegar?
       DISV    :=0.000000e+000       //magnitud perturbadora
       QLMNUP  :=#resistance_relay_dir  //debe activarse el relé de la resi      #resistance_relay_dir -- Directio
                                     stencia                                     n of the digital output that cont
                                                                                 rols the resistance
       QLMNDN  :=M4.0                //debe desactivarse el relé  ??
       PV      :=MD4                 //valor real que actua
       ER      :=MD4                 // diferencia o error de regulación que actúa realmente


//The digital output than controls the realy would be activate
//(and control the resistance) with the parameter
//QLMNU
```

FC8 - <offline>

"STOP_manual&automatic"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 07/06/2014 10:44:05
Interface: 03/06/2014 17:04:05
Longitud (bloque / código / datos): 01228 01036 00022

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
Dir_compressor	Bool	0.0	Digital output of the compressor (Ax.0)
Dir_resistance	Bool	0.1	Digital output of the resistance(Ax.1)
P3	Real	2.0	Measured pressure at the point 3
P1	Real	6.0	Measured pressure at point 1
OFF	Bool	10.0	Station off signal (OFF=1)
Mode_manual_automatic	Bool	10.1	MANUAL=1, AUTOMATIC=0 (UDT8)
Manual_Resistance	Bool	10.2	In manual mode, if the resistance is being tested->1
Manual_EEV	Bool	10.3	In manual mode, if the EEV is being tested->1
Manual_compressor	Bool	10.4	In manual mode,if the compressor is beeing tested->1
Manual_pump	Bool	10.5	In manual mode, if the pump is being tested->1
m_w	Real	12.0	Water flux measured, UDT1, REAL
OUT		0.0	
IN_OUT		0.0	
orden_pump_int	Int	16.0	Pump order, INT (UDT3)
orden_EEVreal	Real	18.0	EEV order, REAL
Dir_pump	Word	22.0	Analog output of the pump ((3+x)28)
Dir_EEV	Word	24.0	Analog output of the EEV ((3+x)24)
orden_EEV	Int	26.0	EEV order, INT
orden_pump_real	Real	28.0	Pump order, REAL
TEMP		0.0	
delta_Pressure_eev	Real	0.0	P3measured/P1 measured, REAL
delta_Pword	Word	4.0	P3 measured/P1 measured, WORD
delta_P_set_EEV	Real	6.0	Desired value of P3/P1=1-->real
Mode_automatic_manual	Bool	10.0	
mw_word	Word	12.0	
Man_compressor_OFF	Bool	14.0	
Man_EEV_OFF	Bool	14.1	
Man_Pump_OFF	Bool	14.2	
Man_Resistance_OFF	Bool	14.3	
OFF_1	Bool	14.4	To make the"OFF" distintions between the manual mode and the automatic
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC8 STOP_manual&automatic
Stop the station regardless the funtioning mode (Manual or automatic)

```
Segm.: 1      MANUAL OR AUTOMATIC

Depending on the mode selected, there would have different procedures.
MANUAL: Each component can be turned off separately
AUTOMATIC: All the components should be turned off.

//If it is set -->manual mode
      U     #Mode_manual_automatic                                                #Mode_manual_automatic -- MANUAL=1,
                                                                                   AUTOMATIC=0 (UDT8)
      SPB   MAN

      U     #Mode_manual_automatic                                                #Mode_manual_automatic -- MANUAL=1,
                                                                                   AUTOMATIC=0 (UDT8)
      SPBN  AUT

//If it is set in automatic, go to the compressor off segment
//it would keep executing all the segments


AUT:  SPA   C_OF
      SPA   SEG2                    //end, it would continue from C_OF


//******//
//MANUAL//
//******//

//If it is set in manual then a comprobation should be done to turn off every component individually


MAN:  UN    #Mode_manual_automatic                                                #Mode_manual_automatic -- MANUAL=1,
                                                                                   AUTOMATIC=0 (UDT8)
      =     #Mode_automatic_manual                                                #Mode_automatic_manual

      UN    #Manual_compressor                                                    #Manual_compressor -- In manual mod
                                                                                  e,if the compressor is beeing teste
                                                                                  d->1
      =     #Man_compressor_OFF                                                   #Man_compressor_OFF

      UN    #Manual_Resistance                                                    #Manual_Resistance -- In manual mod
                                                                                  e, if the resistance is being teste
                                                                                  d->1
      =     #Man_Resistance_OFF                                                   #Man_Resistance_OFF

      UN    #Manual_pump                                                          #Manual_pump       -- In manual mod
                                                                                  e, if the pump is being tested->1
      =     #Man_Pump_OFF                                                         #Man_Pump_OFF

      UN    #Manual_EEV                                                           #Manual_EEV        -- In manual mod
                                                                                  e, if the EEV is being tested->1
      =     #Man_EEV_OFF                                                          #Man_EEV_OFF


      UN    #Manual_compressor                                                    #Manual_compressor -- In manual mod
                                                                                  e,if the compressor is beeing teste
                                                                                  d->1
      SPB   C_OF

COM2: UN    #Manual_Resistance                                                    #Manual_Resistance -- In manual mod
                                                                                  e, if the resistance is being teste
                                                                                  d->1
      SPB   R_OF

COM3: UN    #Manual_pump                                                          #Manual_pump       -- In manual mod
                                                                                  e, if the pump is being tested->1
      SPB   P_OF

COM4: UN    #Manual_EEV                                                           #Manual_EEV        -- In manual mod
                                                                                  e, if the EEV is being tested->1
      SPB   E_OF

      NOP   0

Segm.: 2      Compresor

Disconect  the compressor abruptly.

//Compresor
SEG2: NOP   0
C_OF: R     #Dir_compressor         //Compressor OFF                              #Dir_compressor    -- Digital outpu
                                                                                  t of the compressor (Ax.0)

//If it has been set as Manual, we need to check if the rest of components must be turned off
      U     #Mode_manual_automatic                                                #Mode_manual_automatic -- MANUAL=1,
                                                                                   AUTOMATIC=0 (UDT8)
      SPB   COM2
```

```
//If it is automatic, it would continue in the next segment
```

Segm.: 3 Resistance
Disconect the heating resistance

```
// Resistance

R_OF: R     #Dir_resistance         //Resistance OFF                         #Dir_resistance    -- Digital outpu
                                                                             t of the resistance(Ax.1)

//If it has been set as Manual, we need to check if the rest of components must be turned off
      U     #Mode_manual_automatic                                           #Mode_manual_automatic -- MANUAL=1,
                                                                              AUTOMATIC=0 (UDT8)
      SPB   COM3

//If it is automatic, it would continue in the next segment
```

Segm.: 4 PUMP
For the pump, a PID control to turned it off would be performed. The desired value would be water flux=0

```
//PUMP

// REAL desired value  m_w=0

// REAL->INT-> WORD actual sensor value

P_OF: CALL  "Real->Int->Word"                                                FC2
       valor_REAL:=#m_w              //valor real medido del sensor          #m_w               -- Water flux m
                                                                             easured, UDT1, REAL
       valor_INT :=MW4               //guardamos el valor en INT
       valor_WORD:=#mw_word          // Lo pasamos a word                    #mw_word

//----------------------//
// PUMP PID OFF control //
//----------------------//

//Change of the "RESET" variable

      U     #Mode_manual_automatic                                           #Mode_manual_automatic -- MANUAL=1
                                                                             , AUTOMATIC=0 (UDT8)
      SPB   POFM

      UN    #Mode_manual_automatic                                           #Mode_manual_automatic -- MANUAL=1
                                                                             , AUTOMATIC=0 (UDT8)
      SPB   POFA

//In Manual mode

POFM: U     #Man_Pump_OFF                                                    #Man_Pump_OFF
      =     #OFF_1                                                           #OFF_1             -- To make the"
                                                                             OFF" distintions between the manua
                                                                             l mode and the automatic
      SPA   PPID

//Automatic MOde

POFA: U     #OFF                                                             #OFF               -- Station off
                                                                             signal (OFF=1)
      =     #OFF_1                                                           #OFF_1             -- To make the"
                                                                             OFF" distintions between the manua
                                                                             l mode and the automatic
      SPA   PPID

//Either way, the both paths go to PPID (Pump PID control)

//----------------------//
// PUMP PID OFF control //
//----------------------//


PPID: CALL  "CONT_C" , "PID_1"                                               FB41 / DB41        -- Continuous C
                                                                             ontrol
       COM_RST :=#OFF_1                                                      #OFF_1             -- To make the"
                                                                             OFF" distintions between the manua
                                                                             l mode and the automatic
       MAN_ON  :=FALSE               //Introducción manual por HMI desactivada
       PVPER_ON:=TRUE                //Introducción por periféricos ON
       P_SEL   :=TRUE
       I_SEL   :=TRUE
       INT_HOLD:=FALSE
       I_ITL_ON:=#OFF                                                        #OFF               -- Station off
                                                                             signal (OFF=1)
       D_SEL   :=TRUE
       CYCLE   :=T#100MS
```

```
      SP_INT  :=0.000000e+000       //Desired value, REAL -->OFF
      PV_IN   :=0.000000e+000       //offset
      PV_PER  :=#mw_word            //Measured value, WORD                    #mw_word
      MAN     :=0.000000e+000
      GAIN    :=2.000000e+000
      TI      :=T#2S
      TD      :=T#1S
      TM_LAG  :=T#100MS
      DEADB_W :=2.500000e+001       //esta en porcentaje
      LMN_HLM :=1.000000e+002       //100%
      LMN_LLM :=0.000000e+000       //0% (desde el o% hasta el 100% de lo q he fijado)
      PV_FAC  :=1.000000e+000       // la entrada mutiplicada por "1"
      PV_OFF  :=0.000000e+000       //sin offset
      LMN_FAC :=1.000000e+000       //Ampliamos el valor superior? No, lo multiplicamos por 1m así que se que
                                    da en el 100%
      LMN_OFF :=0.000000e+000       //0%
      I_ITLVAL:=8.500000e+001       //Empieza a integrar al 85 % del valor consigna
      DISV    :=0.000000e+000       // acción perturbadora
      LMN     :=#orden_pump_real    // valor de orden real                    #orden_pump_real   -- Pump order,
                                                                              REAL
      LMN_PER :=#Dir_pump                                                     #Dir_pump          -- Analog outpu
                                                                              t of the pump ((3+x)28)
      QLMN_HLM:=M4.0
      QLMN_LLM:=M4.0
      LMN_P   :=MD4
      LMN_I   :=MD4
      LMN_D   :=MD4
      PV      :=MD4                 //no interesa
      ER      :=MD4

// Storage of the order in the data block DBX0
// REAL->INT

     CALL  "Real->Int->Word"                                                  FC2
      valor_REAL:=#orden_pump_real                                            #orden_pump_real   -- Pump order,
                                                                              REAL
      valor_INT :=#orden_pump_int                                             #orden_pump_int    -- Pump order,
                                                                              INT (UDT3)
      valor_WORD:=MW4

//If it has been set as Manual, we need to check if the rest of components must be turned off
     U     #Mode_manual_automatic                                             #Mode_manual_automatic -- MANUAL=1
                                                                              , AUTOMATIC=0 (UDT8)
     SPB   COM4

//If it is automatic, it would continue in the next segment
```

Segm.: 5 EEV
Must be turned off after the pressure has been released. That means that the delta_Pressure-set=P3/P1-->1

```
//Desired value  delta_P_set_EEV=1
E_OF: L     1.000000e+000
      T     #delta_P_set_EEV                                                  #delta_P_set_EEV   -- Desired val
                                                                              ue of P3/P1=1-->real

//Measured value//

      L     #P3                                                               #P3                -- Measured pr
                                                                              essure at the point 3
      L     #P1                                                               #P1                -- Measured pr
                                                                              essure at point 1
      /R
      T     #delta_Pressure_eev                                               #delta_Pressure_eev -- P3measured
                                                                              /P1 measured, REAL

//REAL->INT-> WORD actual value of the sensors

      CALL  "Real->Int->Word"                                                 FC2
       valor_REAL:=#delta_Pressure_eev                                        #delta_Pressure_eev -- P3measured
                                                                              /P1 measured, REAL
       valor_INT :=MW4                  //Not needed
       valor_WORD:=#delta_Pword                                               #delta_Pword       -- P3 measured
                                                                              /P1 measured, WORD

//Change of the "RESET" variable

      U     #Mode_manual_automatic                                            #Mode_manual_automatic -- MANUAL=
                                                                              1, AUTOMATIC=0 (UDT8)
      SPB   EOFM
```

```
      UN    #Mode_manual_automatic                                          #Mode_manual_automatic -- MANUAL=
                                                                            1, AUTOMATIC=0 (UDT8)
      SPB   EOFA

//Manual Mode

EOFM: U     #Man_Pump_OFF                                                   #Man_Pump_OFF
      =     #OFF_1                                                          #OFF_1              -- To make the
                                                                            "OFF" distintions between the man
                                                                            ual mode and the automatic
      SPA   EPID

//Automatic mode

EOFA: U     #OFF                                                            #OFF                -- Station off
                                                                             signal (OFF=1)
      =     #OFF_1                                                          #OFF_1              -- To make the
                                                                            "OFF" distintions between the man
                                                                            ual mode and the automatic
      SPA   EPID

//Either way, both paths leads to the EPID (EEV PID control)

//---------------------//
// EEV PID OFF control //
//---------------------//


EPID: CALL  "CONT_C" , "PID_1"                                              FB41 / DB41         -- Continuous
                                                                            Control
       COM_RST :=#OFF_1                 //When the station is OFF           #OFF_1              -- To make the
                                                                            "OFF" distintions between the man
                                                                            ual mode and the automatic
       MAN_ON  :=FALSE                  //DESACTIVATE, the manual set value
       PVPER_ON:=TRUE                   //valor de periferia activada
       P_SEL   :=TRUE                   //acción proporcional
       I_SEL   :=TRUE                   //acción integral activa
       INT_HOLD:=FALSE                  //congelar la integración
       I_ITL_ON:=#OFF                   //Indica cuando se reinicia la acci  #OFF               -- Station off
                                        ón integral                          signal (OFF=1)
       D_SEL   :=TRUE                   //acción derivatiba
       CYCLE   :=T#100MS
       SP_INT  :=#delta_P_set_EEV       //consigna interna-->aqui el valor  #delta_P_set_EEV   -- Desired val
                                        deseado                             ue of P3/P1=1-->real
       PV_IN   :=0.000000e+000          //Una especie de offset entorno al valor real (precision...)
       PV_PER  :=#delta_Pword           // entrada en WORD                  #delta_Pword       -- P3 measured
                                                                            /P1 measured, WORD
       MAN     :=0.000000e+000          //Establece un valor de visualización para el HMI, fijas el valor
       GAIN    :=2.000000e+000          //ganancia
       TI      :=T#2S
       TD      :=T#1S
       TM_LAG  :=T#100MS
       DEADB_W :=2.500000e+001          //está en porcentaje
       LMN_HLM :=1.000000e+002          //lo máximo que t puedes exceder
       LMN_LLM :=0.000000e+000          //lo maximo que te puedes quedar por debajo
       PV_FAC  :=1.000000e+000          //medir lo que tenemos
       PV_OFF  :=0.000000e+000          //offset
       LMN_FAC :=1.000000e+000          //se multiplica por el valor manipulado y sirve para establecer los lí
                                        mites
       LMN_OFF :=0.000000e+000
       I_ITLVAL:=8.500000e+001          //porcentaje
       DISV    :=0.000000e+000
       LMN     :=#orden_EEVreal         //valor manipulado que actua (REAL)  #orden_EEVreal     -- EEV order,
                                                                            REAL
       LMN_PER :=#Dir_EEV               //valor manipulado en la periferia,  #Dir_EEV           -- Analog outp
                                         word                               ut of the EEV ((3+x)24)
       QLMN_HLM:=M4.0
       QLMN_LLM:=M4.0
       LMN_P   :=MD4
       LMN_I   :=MD4
       LMN_D   :=MD4
       PV      :=MD4                    //No interesa
       ER      :=MD4

// Storage of the order in the data block DBX0
// REAL-->INT

      CALL  "Station1_set"                                                  FC10
      CALL  "Real->Int->Word"                                               FC2
       valor_REAL:=#orden_EEVreal                                           #orden_EEVreal     -- EEV order,
                                                                            REAL
       valor_INT :=#orden_EEV                                               #orden_EEV         -- EEV order,
                                                                            INT
       valor_WORD:=MW4                  // No interesa su valor


      NOP   0
```

FC9 - <offline>

"MAN_ControlPID"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 07/06/2014 10:44:10
Interface: 04/06/2014 20:48:37
Longitud (bloque / código / datos): 02194 02016 00026

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
Man_delta_T_res_int	Int	0.0	When manual mode is set, the delta temperature is fixed, INT
Man_delta_P_EEV_int	Int	2.0	Delta P of the EEV in manual mode, INT
Man_WF_pump_int	Int	4.0	Water flux of the pump in manual mode, INT
Man_resistance	Bool	6.0	-->1 Resistance ON
Man_Pump	Bool	6.1	-->1 Pump ON
Man_EEV	Bool	6.2	-->1 EEV ON
Man_Compressor	Bool	6.3	-->1 Compressor ON
T2sat	Real	8.0	Saturation temperature at 2
P1	Real	12.0	Pressure 1 measured
P3	Real	16.0	Pressure 3 measured
m_w_m	Real	20.0	Value measured of the water flux
T2_m	Real	24.0	Temperature at 2 measured
OUT		0.0	
IN_OUT		0.0	
Man_delta_T_res_real	Real	28.0	Delta T of the resistance in manual mode, REAL
Man_delta_P_EEV_real	Real	32.0	Delta P of the EEV in manual mode, REAL
Man_WF_pump_real	Real	36.0	Water flux of the pump in manual mode, REAL
T2deseada	Real	40.0	
Dir_res	Bool	44.0	Direction of the resistance output (A X.1)
Dir_comp	Bool	44.1	Direction of the compressor output (A X.0)
Dir_pump	Word	46.0	Direction of the pump output (PAW (2+x)24)
Dir_EEV	Word	48.0	Direction of the EEV output (PAW (2+x)28)
orden_EEVreal	Real	50.0	EEV order, REAL(UDT5)
Orden_EEV	Int	54.0	EEV order, INT (UDT3)
orden_pump_int	Int	56.0	PUMP order, INT (UDT3)
orden_pump_real	Real	58.0	PUMP order, REAL (UDT5)
TEMP		0.0	
Man_res_OFF	Bool	0.0	
T2word	Word	2.0	
Man_EEV_OFF	Bool	4.0	
delta_P_set_EEV	Real	6.0	
Delta_Pressure_eev	Real	10.0	
delta_Pword	Word	14.0	
mw_word	Word	16.0	
Man_pump_OFF	Bool	18.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC9 PID control in Manual Mode

Each component can be turned ON/OFF individually. Before the PID control is made, it would have to check the state (ON/OFF) of each component.

```
Segm.: 1      Resistance

If the "Resistance Test Button" has been activated, then according to the
delta_T_signal rode (from de HMI interface), a different order would be given.
```

```
//Check if the resistance is ON

      UN    #Man_resistance                                         #Man_resistance    -- -->1 Resistan
                                                                    ce ON
      =     #Man_res_OFF                                            #Man_res_OFF

      U     #Man_resistance                                         #Man_resistance    -- -->1 Resistan
                                                                    ce ON

      SPB   R_ON

//**************************//
//HEATING RESISTANCE TURN OFF//
//**************************//

      R     #Dir_res                                                #Dir_res           -- Direction of
                                                                    the resistance output (A X.1)
      SPA   SEG2


//*********************************//
//HEATING RESISTANCE TURN ON CONTROL//
//*********************************//

//Delta_T-->INT->DINT->REAL

R_ON: L     #Man_delta_T_res_int                                    #Man_delta_T_res_int -- When manual
                                                                     mode is set, the delta temperature
                                                                     is fixed, INT
      ITD                           //INT-->DINT
      DTR                           //DINT-->REAL
      T     #Man_delta_T_res_real                                   #Man_delta_T_res_real -- Delta T of
                                                                     the resistance in manual mode, REA
                                                                    L

      L     #T2sat                                                  #T2sat             -- Saturation te
                                                                    mperature at 2
      +R
      T     #T2deseada                                              #T2deseada
//The temperature to be achievedis the saturatios temperature, plus the delta_res fixed in theHMI

// REAL--> WORD actual sensor value

      CALL  "Real->Int->Word"                                       FC2
       valor_REAL:=#T2_m            //Measured value                #T2_m              -- Temperature a
                                                                    t 2 measured
       valor_INT :=MW4
       valor_WORD:=#T2word                                          #T2word

//----------------//
// PID ON control //
//----------------//


      CALL  "CONT_S" , "PID_2"                                      FB42 / DB42        -- Step Control
       COM_RST :=#Man_res_OFF       //Indica cuando el puesto está a OFF,   #Man_res_OFF
                                     cuando se reinicia
       LMNR_HS :=FALSE              //Señal de límite superior
       LMNR_LS :=TRUE               //el control se enncuentra en su tope inferior
       LMNS_ON :=FALSE              //Conectar consigna de modo manual NO,se  obtiene del periferico
       LMNUP   :=TRUE               //señal de salida QLMNUP
       LMNDN   :=FALSE              //no se tiene como salida QLMNDN
       PVPER_ON:=TRUE               //valor de periferia, sensor T2
       CYCLE   :=T#100MS            //Tiempo de muestreo
       SP_INT  :=#T2deseada         //Consigna interna              #T2deseada
       PV_IN   :=0.000000e+000
       PV_PER  :=#T2word            //valor real de entrada en WORD         #T2word
       GAIN    :=1.000000e+000
       TI      :=T#2S
       DEADB_W :=2.500000e-001      //ancho de zona muerta
       PV_FAC  :=1.000000e+000      //factor por el que se multiplica la entrada
       PV_OFF  :=0.000000e+000      //offset de la entrada
       PULSE_TM:=T#1S               //duración minima de impulso
       BREAK_TM:=T#200MS            //duración minima depausa
       MTR_TM  :=T#20S              //Tiempo de desplazamiento de tope a tope ¿lo que le cuesta llegar?
       DISV    :=0.000000e+000      //magnitud perturbadora
       QLMNUP  :=#Dir_res           //debe activarse el relé de la resist   #Dir_res           -- Direction of
                                    encia                           the resistance output (A X.1)
       QLMNDN  :=M4.0               //debe desactivarse el relé  ??
       PV      :=MD4                //valor real que actua
       ER      :=MD4                //diferencia o error de regulación que actúa realmente
```

```
//The digital output than controls the realy would be activate
//(and control the resistance) with the parameter
//QLMNUP= A X.1

      NOP   0
```

Segm.: 2 EEV
If the "EEV Test Button" has been activated, then according to the delta_P_signal rode (from de HMI interface), a different order would be given.

```
//4-20 mA
//Check if the EEV is ON (being tested) then the signal rode from de HMI must be converted in 4-20 mA

SEG2: U     #Man_EEV                                                #Man_EEV          -- -->1 EEV ON
      SPB   E_ON

//If it is OFF, no signal shoud be emited --> GRADUALLY

//*******************//
//EEV TURN OFF CONTROL//
//*******************//


      UN    #Man_EEV                //Manual mode, EEV ON_OFF  (ON=1, O  #Man_EEV          -- -->1 EEV ON
                                    FF=0)
      =     #Man_EEV_OFF            //Manual mode,EEV OFF (OFF=1, ON=0)  #Man_EEV_OFF

//Desired value:  delta_P_set_EEV=1
//That means that P3=P1, it is open, so there is no pressure difference

      L     1.000000e+000
      T     #delta_P_set_EEV                                        #delta_P_set_EEV


//Measured value//

      L     #P3                                                     #P3               -- Pressure 3
                                                                    measured
      L     #P1                                                     #P1               -- Pressure 1
                                                                    measured
      /R
      T     #Delta_Pressure_eev                                     #Delta_Pressure_eev

//REAL->INT-> WORD actual value of the sensors

      CALL  "Real->Int->Word"                                       FC2
       valor_REAL:=#Delta_Pressure_eev                              #Delta_Pressure_eev
       valor_INT :=MW4              //Not needed
       valor_WORD:=#delta_Pword                                     #delta_Pword


//---------------------//
// EEV PID OFF control //
//---------------------//


      CALL  "CONT_C" , "PID_1"                                      FB41 / DB41       -- Continuous
                                                                    Control
       COM_RST :=#Man_EEV_OFF       //When the station is OFF       #Man_EEV_OFF
       MAN_ON  :=FALSE              //DESACTIVATE, the manual set value
       PVPER_ON:=TRUE               //valor de periferia activada
       P_SEL   :=TRUE               //acción proporcional
       I_SEL   :=TRUE               //acción integral activa
       INT_HOLD:=FALSE              //congelar la integración
       I_ITL_ON:=#Man_EEV_OFF       //Indica cuando se reinicia la acci  #Man_EEV_OFF
                                    ón integral
       D_SEL   :=TRUE               //acción derivatiba
       CYCLE   :=T#100MS
       SP_INT  :=#delta_P_set_EEV   //consigna interna-->aqui el valor   #delta_P_set_EEV
                                    deseado
       PV_IN   :=0.000000e+000      //Una especie de offset entorno al valor real (precision...)
       PV_PER  :=#delta_Pword       // entrada en WORD              #delta_Pword
       MAN     :=0.000000e+000      //Establece un valor de visualización para el HMI, fijas el valor
       GAIN    :=2.000000e+000      //ganancia
       TI      :=T#2S
       TD      :=T#1S
       TM_LAG  :=T#100MS
       DEADB_W :=2.500000e+001      //está en porcentaje
       LMN_HLM :=1.000000e+002      //lo máximo que t puedes exceder
       LMN_LLM :=0.000000e+000      //lo maximo que te puedes quedar por debajo
       PV_FAC  :=1.000000e+000      //medir lo que tenemos
       PV_OFF  :=0.000000e+000      //offset
```

```
       LMN_FAC :=1.000000e+000          //se multiplica por el valor manipulado y sirve para establecer los lí
                                        mites
       LMN_OFF :=0.000000e+000
       I_ITLVAL:=8.500000e+001          //porcentaje
       DISV    :=0.000000e+000
       LMN     :=#orden_EEVreal         //valor manipulado que actua (REAL)  #orden_EEVreal     -- EEV order,
                                                                             REAL(UDT5)
       LMN_PER :=#Dir_EEV               //valor manipulado en la periferia,  #Dir_EEV           -- Direction o
                                         word                                f the EEV output (PAW (2+x)28)
       QLMN_HLM:=M4.0
       QLMN_LLM:=M4.0
       LMN_P   :=MD4
       LMN_I   :=MD4
       LMN_D   :=MD4
       PV      :=MD4                    //No interesa
       ER      :=MD4

// Storage of the order in the data block DBX0
// REAL-->INT

      CALL  "Station1_set"                                                   FC10
      CALL  "Real->Int->Word"                                                FC2
       valor_REAL:=#orden_EEVreal       //UDT5                               #orden_EEVreal     -- EEV order,
                                                                             REAL(UDT5)
       valor_INT :=#Orden_EEV           //UDT3                               #Orden_EEV         -- EEV order,
                                                                             INT (UDT3)
       valor_WORD:=MW4

      SPA   SEG3




//******************//
//EEV TURN ON CONTROL//
//******************//


//If it is ON, the value of the variable set in the HMI should be read and scaled, to be transfered to its ana
log aoutput direction

//ESTO ES LO QUE HABÍA HECHO ANTES, PONER UNA SALIDA PROPORCIONAL A UNA VARIABLE FIJADA EN EL HMI
// CALL  "SCALE"
//       IN     :=#Man_delta_P_EEV_int
//       HI_LIM :=2.000000e-002
//       LO_LIM :=4.000000e-003
//       BIPOLAR:=FALSE
//       RET_VAL:=MW0
//       OUT    :=#Man_delta_P_EEV_real


//     L     #Man_delta_P_EEV_real
//      RND
//      T     #Dir_EEV


//--------------------//
// EEV PID ON control //
//--------------------//


//Desired value--> Man_delta_p_eev_int=P2/P1
//#Man_delta_P_EEV_int--> Fixed in WINCC

E_ON: L     #Man_delta_P_EEV_int                                             #Man_delta_P_EEV_int -- Delta P o
                                                                             f the EEV in manual mode, INT
      ITD                               //INT-->DINT
      DTR                               //DINT-->REAL
      T     #delta_P_set_EEV                                                 #delta_P_set_EEV


//Measured value//

      L     #P3                                                              #P3                -- Pressure 3
                                                                             measured
      L     #P1                                                              #P1                -- Pressure 1
                                                                             measured
      /R
      T     #Delta_Pressure_eev                                              #Delta_Pressure_eev

//REAL->INT-> WORD actual value of the sensors

      CALL  "Real->Int->Word"                                                FC2
       valor_REAL:=#Delta_Pressure_eev                                       #Delta_Pressure_eev
       valor_INT :=MW4                  //Not needed
       valor_WORD:=#delta_Pword                                              #delta_Pword


//------------------//
```

```
// EEV PID ON control//
//-------------------//

      CALL  "CONT_C" , "PID_1"                                          FB41 / DB41        -- Continuous
                                                                        Control
       COM_RST :=#Man_EEV               //When the EEV has to be tested      #Man_EEV           -- -->1 EEV ON
       MAN_ON  :=FALSE                  //DESACTIVATE, the manual set value
       PVPER_ON:=TRUE                   //valor de periferia activada
       P_SEL   :=TRUE                   //acción proporcional
       I_SEL   :=TRUE                   //acción integral activa
       INT_HOLD:=FALSE                  //congelar la integración
       I_ITL_ON:=#Man_EEV               //Indica cuando se reinicia la acci   #Man_EEV           -- -->1 EEV ON
                                        ón integral
       D_SEL   :=TRUE                   //acción derivatiba
       CYCLE   :=T#100MS
       SP_INT  :=#delta_P_set_EEV       //consigna interna-->aqui el valor   #delta_P_set_EEV
                                        deseado
       PV_IN   :=0.000000e+000          //Una especie de offset entorno al valor real (precision...)
       PV_PER  :=#delta_Pword           // entrada en WORD                   #delta_Pword
       MAN     :=0.000000e+000          //Establece un valor de visualización para el HMI, fijas el valor
       GAIN    :=2.000000e+000          //ganancia
       TI      :=T#2S
       TD      :=T#1S
       TM_LAG  :=T#100MS
       DEADB_W :=2.500000e+001          //está en porcentaje
       LMN_HLM :=1.000000e+002          //lo máximo que t puedes exceder
       LMN_LLM :=0.000000e+000          //lo maximo que te puedes quedar por debajo
       PV_FAC  :=1.000000e+000          //medir lo que tenemos
       PV_OFF  :=0.000000e+000          //offset
       LMN_FAC :=1.000000e+000          //se multiplica por el valor manipulado y sirve para establecer los lí
                                        mites
       LMN_OFF :=0.000000e+000
       I_ITLVAL:=8.500000e+001          //porcentaje
       DISV    :=0.000000e+000
       LMN     :=#orden_EEVreal         //valor manipulado que actua (REAL)  #orden_EEVreal     -- EEV order,
                                                                        REAL(UDT5)
       LMN_PER :=#Dir_EEV               //valor manipulado en la periferia,  #Dir_EEV           -- Direction o
                                         word                           f the EEV output (PAW (2+x)28)
       QLMN_HLM:=M4.0
       QLMN_LLM:=M4.0
       LMN_P   :=MD4
       LMN_I   :=MD4
       LMN_D   :=MD4
       PV      :=MD4                    //No interesa
       ER      :=MD4

// Storage of the order in the data block DBX0
// REAL-->INT

      CALL  "Station1_set"                                              FC10
      CALL  "Real->Int->Word"                                           FC2
       valor_REAL:=#orden_EEVreal                                       #orden_EEVreal     -- EEV order,
                                                                        REAL(UDT5)
       valor_INT :=#Orden_EEV                                           #Orden_EEV         -- EEV order,
                                                                        INT (UDT3)
       valor_WORD:=MW4                  // No interesa su valor


      NOP   0
```

Segm.: 3   Pump
If the "Pump Test Button" has been activated, then according to the WF_signal rode (from de HMI interface), a different order would be given.

```
//0-10 V

SEG3: U     #Man_Pump                                                   #Man_Pump          -- -->1 Pump ON
      SPB   P_ON

//*****************//
// PUMP TURNED OFF //
//*****************//

      UN    #Man_Pump                                                   #Man_Pump          -- -->1 Pump ON
      =     #Man_pump_OFF                                               #Man_pump_OFF

// REAL desired value  m_w=0

// REAL->INT-> WORD actual sensor value

      CALL  "Real->Int->Word"                                           FC2
       valor_REAL:=#m_w_m            //valor real medido del sensor     #m_w_m             -- Value measur
                                                                        ed of the water flux
       valor_INT :=MW4               //guardamos el valor en INT
       valor_WORD:=#mw_word          // Lo pasamos a word               #mw_word
```

```
//----------------------//
// PUMP PID OFF control //
//----------------------//

      CALL  "CONT_C" , "PID_1"                                         FB41 / DB41        -- Continuous C
                                                                       ontrol
       COM_RST :=#Man_pump_OFF                                         #Man_pump_OFF
       MAN_ON  :=FALSE              //Introducción manual por HMI desactivada
       PVPER_ON:=TRUE               //Introducción por periféricos ON
       P_SEL   :=TRUE
       I_SEL   :=TRUE
       INT_HOLD:=FALSE
       I_ITL_ON:=#Man_pump_OFF                                         #Man_pump_OFF
       D_SEL   :=TRUE
       CYCLE   :=T#100MS
       SP_INT  :=0.000000e+000      //Desired value, REAL -->OFF
       PV_IN   :=0.000000e+000      //offset
       PV_PER  :=#mw_word           //Measured value, WORD             #mw_word
       MAN     :=0.000000e+000
       GAIN    :=2.000000e+000
       TI      :=T#2S
       TD      :=T#1S
       TM_LAG  :=T#100MS
       DEADB_W :=2.500000e+001      //esta en porcentaje
       LMN_HLM :=1.000000e+002      //100%
       LMN_LLM :=0.000000e+000      //0% (desde el o% hasta el 100% de lo q he fijado)
       PV_FAC  :=1.000000e+000      // la entrada mutiplicada por "1"
       PV_OFF  :=0.000000e+000      //sin offset
       LMN_FAC :=1.000000e+000      //Ampliamos el valor superior? No, lo multiplicamos por 1m así que se que
                                    da en el 100%
       LMN_OFF :=0.000000e+000      //0%
       I_ITLVAL:=8.500000e+001      //Empieza a integrar al 85 % del valor consigna
       DISV    :=0.000000e+000      // acción perturbadora
       LMN     :=#orden_pump_real   // valor de orden real             #orden_pump_real   -- PUMP order,
                                                                       REAL (UDT5)
       LMN_PER :=#Dir_pump                                             #Dir_pump          -- Direction of
                                                                        the pump output (PAW (2+x)24)
       QLMN_HLM:=M4.0
       QLMN_LLM:=M4.0
       LMN_P   :=MD4
       LMN_I   :=MD4
       LMN_D   :=MD4
       PV      :=MD4                //no interesa
       ER      :=MD4


// Storage of the order in the data block DBX0
// REAL->INT

      CALL  "Real->Int->Word"                                          FC2
       valor_REAL:=#orden_pump_real                                    #orden_pump_real   -- PUMP order,
                                                                       REAL (UDT5)
       valor_INT :=#orden_pump_int                                     #orden_pump_int    -- PUMP order,
                                                                       INT  (UDT3)
       valor_WORD:=MW4


      SPA   SEG4

//****************//
// PUMP TURNED ON //
//****************//


//If it is ON, the value of the variable set in the HMI should be read and scaled, to be transfered to its ana
log output direction

//SE HABIA HECHO ANTES
//CALL  "SCALE"
//       IN     :=#Man_WF_pump_int
//       HI_LIM :=1.000000e+001
//       LO_LIM :=0.000000e+000
//       BIPOLAR:=FALSE
//       RET_VAL:=MW0
//       OUT    :=#Man_WF_pump_real

//      L     #Man_WF_pump_real
//    RND
//    T     #Dir_pump



// REAL desired value : Man_WF_pump_real (UDT3)

// REAL->INT-> WORD actual sensor value

P_ON: CALL  "Real->Int->Word"                                          FC2
       valor_REAL:=#m_w_m           //valor real medido del sensor     #m_w_m             -- Value measur
                                                                       ed of the water flux
       valor_INT :=MW4              //guardamos el valor en INT
```

```
       valor_WORD:=#mw_word          // Lo pasamos a word                  #mw_word

//---------------------//
// Pump PID ON control //
//---------------------//

      CALL  "CONT_C" , "PID_1"                                             FB41 / DB41        -- Continuous C
                                                                           ontrol
       COM_RST :=#Man_Pump                                                 #Man_Pump          -- -->1 Pump ON
       MAN_ON  :=FALSE               //Introducción manual por HMI desactivada
       PVPER_ON:=TRUE                //Introducción por periféricos ON
       P_SEL   :=TRUE
       I_SEL   :=TRUE
       INT_HOLD:=FALSE
       I_ITL_ON:=#Man_Pump                                                 #Man_Pump          -- -->1 Pump ON
       D_SEL   :=TRUE
       CYCLE   :=T#100MS
       SP_INT  :=#Man_WF_pump_real   //Desired value, REAL                 #Man_WF_pump_real  -- Water flux o
                                                                           f the pump in manual mode, REAL
       PV_IN   :=0.000000e+000       //offse
       PV_PER  :=#mw_word            //Measured value, WORD                #mw_word
       MAN     :=0.000000e+000
       GAIN    :=2.000000e+000
       TI      :=T#2S
       TD      :=T#1S
       TM_LAG  :=T#100MS
       DEADB_W :=2.500000e+001       //esta en porcentaje
       LMN_HLM :=1.000000e+002       //100%
       LMN_LLM :=0.000000e+000       //0% (desde el o% hasta el 100% de lo q he fijado)
       PV_FAC  :=1.000000e+000       // la entrada mutiplicada por "1"
       PV_OFF  :=0.000000e+000       //sin offset
       LMN_FAC :=1.000000e+000       //Ampliamos el valor superior? No, lo multiplicamos por 1m así que se que
                                     da en el 100%
       LMN_OFF :=0.000000e+000       //0%
       I_ITLVAL:=8.500000e+001       //Empieza a integrar al 85 % del valor consigna
       DISV    :=0.000000e+000       // acción perturbadora
       LMN     :=#orden_pump_real    // valor de orden real                #orden_pump_real   -- PUMP order,
                                                                           REAL (UDT5)
       LMN_PER :=#Dir_pump                                                 #Dir_pump          -- Direction of
                                                                            the pump output (PAW (2+x)24)
       QLMN_HLM:=M4.0
       QLMN_LLM:=M4.0
       LMN_P   :=MD4
       LMN_I   :=MD4
       LMN_D   :=MD4
       PV      :=MD4                 //no interesa
       ER      :=MD4


// Storage of the order in the data block DBX0
// REAL->INT

      CALL  "Real->Int->Word"                                              FC2
       valor_REAL:=#orden_pump_real                                        #orden_pump_real   -- PUMP order,
                                                                           REAL (UDT5)
       valor_INT :=#orden_pump_int                                         #orden_pump_int    -- PUMP order,
                                                                           INT  (UDT3)
       valor_WORD:=MW4
```

Segm.: 4 Compressor
If the "Compressor Test Button" has been activated, then according to the compressor_signal rode (from de HMI interface), a different order would be given.

```
SEG4: U     #Man_Compressor  #Man_Compressor    -- -->1 Compressor ON
      SPB   C_ON

//**************//
//Compressor OFF, its digital output has been desactivated
//*************//

      R     #Dir_comp        #Dir_comp          -- Direction of the compressor output (A X.0)
      SPA   END

//*************//
//Compressor ON, its digital output has been activated
//************//

C_ON: S     #Dir_comp        #Dir_comp          -- Direction of the compressor output (A X.0)


END:  NOP   0
```

FC10 - <offline>

"Station1_set"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 16/06/2014 10:12:51
Interface: 23/05/2014 12:54:00
Longitud (bloque / código / datos): 03706 03584 00290

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC10 STATION 1

Within the followings "segments", the subroutines needed to performed the meassurement of the sensors, the conditionate of the signals, the control,...of the station 1, will be summoned.

Segm.: 1 MODE: ¿AUTOMATIC OR MANUAL??

The test bench has two different working modes. It would be defined by the variable Mode_manual_automatic (by the HMI).

```
// Wincc changes the value of Mode_manual_automatic (1-> manual, 0->automatic)
// the variable mode_automatic_manual is the oppostite

      UN    "Puestos1".UDT8_1.Mode_manual_automatic  DB10.DBX358.5      -- It determine wehter the cycle works
                                                      automatically (0) or in a manual way (1)

      =     "Puestos1".UDT8_1.Mode_Automatic_Manual  DB10.DBX358.0      -- It determine wehter the cycle works
                                                      automatically (1) or in a manual way (0)

//If the automatic mode has benn choosen, then we go to the "AUT" (it stands for
//automatic) part  of the program.

      U     "Puestos1".UDT8_1.Mode_Automatic_Manual  DB10.DBX358.0      -- It determine wehter the cycle works
                                                      automatically (1) or in a manual way (0)
      SPB   AUT


      U     "Puestos1".UDT8_1.Mode_manual_automatic  DB10.DBX358.5      -- It determine wehter the cycle works
                                                      automatically (0) or in a manual way (1)
      SPB   MAN
```

Segm.: 2 STATION AUTOMATIC. ¿ON/OFF?

If the station is set, and the AUTOMATIC mode has been chosen, then the program must check if the "ON" button is activated (values of the sensors and the automatic settings must be read, calculations should be made and the components must be controled and activated).

```
//First RESET the variables that indicate the "ON" state of the components , when the station is beeing checke
d (MANUAL MODE)

AUT:  R     "Puestos1".UDT8_1.Manual_resistance                          DB10.DBX358.2      -- Test the cor
                                                                           rect functioning of the resistance
      R     "Puestos1".UDT8_1.Manual_EEV                                 DB10.DBX358.3      -- test the cor
                                                                           rect funtioning of the EEV
      R     "Puestos1".UDT8_1.Manual_Pump                                DB10.DBX358.4      -- Test the cor
                                                                           rect functioning of the pump
      R     "Puestos1".UDT8_1.Manual_compressor                          DB10.DBX358.1      -- Test the cor
                                                                           rect functioning of the compressor
                                                                            in the manual mode
```

```
//Check  if the STATION is AUTOMATIC and ON, or AUTOMATIC and OFF

      U     "Puestos1".UDT4_1.ON_OFF                                  DB10.DBX235.4      -- Indicates if
                                                                       the station is ON (ON=1, OFF=0)
      SPB   A_ON
      SPA   A_OF

//______________//
// AUTOMATIC ON //
//______________//

A_ON: CALL  "Station_AUT_ON"                                          FC97
       UDT11_12             :="Puestos1".UDT10_1.UDT11_12             DB10.DBX389.2      -- 1-->import t
                                                                      he data to UDT11, 0--> save the ex
                                                                      port data in UDT 12
       x1                   :="Puestos1".UDT1_1.x1                    DB10.DBD0          -- Quality
       ref_number           :="Puestos1".UDT1_1.Ref_number            DB10.DBW52         -- 0->R134A , 1
                                                                      ->R410A, 2->R407C, 3->R22
       IN_T1                :=EW300
       IN_T2                :=EW302
       IN_T3                :=EW304
       IN_Tin               :=EW306
       IN_Tout              :=EW308
       IN_P1                :=EW312
       IN_P2                :=EW314
       IN_P3                :=EW316
       IN_m_ref             :=EW320
       IN_m_w               :=EW322
       T1_connected         :="Puestos1".UDT4_1.T1_conectado          DB10.DBX234.1      -- Indicates th
                                                                      e connection state of the sensor T
                                                                      1
       T2_connected         :="Puestos1".UDT4_1.T2_conectado          DB10.DBX234.3      -- Indicates th
                                                                      e connection state of the sensor T
                                                                      2
       T3_connected         :="Puestos1".UDT4_1.T3_conectado          DB10.DBX234.5      -- Indicates th
                                                                      e connection state of the sensor T
                                                                      3
       Tin_connected        :="Puestos1".UDT4_1.Tin_conectado         DB10.DBX234.7      -- Indicates th
                                                                      e connection state of the sensor T
                                                                      in
       Tout_connected       :="Puestos1".UDT4_1.Tout_conectado        DB10.DBX235.0      -- Indicates th
                                                                      e connection state of the sensor T
                                                                      out
       P1_connected         :="Puestos1".UDT4_1.P1_conectado          DB10.DBX234.2      -- Indicates th
                                                                      e connection state of the sensor P
                                                                      1
       P2_connected         :="Puestos1".UDT4_1.P2_conectado          DB10.DBX234.4      -- Indicates th
                                                                      e connection state of the sensor P
                                                                      2
       P3_connected         :="Puestos1".UDT4_1.P3_conectado          DB10.DBX234.6      -- Indicates th
                                                                      e connection state of the sensor P
                                                                      3
       m_ref_connected      :="Puestos1".UDT4_1.m_ref_conectado       DB10.DBX235.3      -- Indicates th
                                                                      e connection state of the sensor m
                                                                      _ref
       m_w_connected        :="Puestos1".UDT4_1.Qw_conectado          DB10.DBX235.1      -- Indicates th
                                                                      e connection state of the sensor Q
                                                                      w
       T1_calc              :="Puestos1".UDT2_1.T1sat                 DB10.DBD98         -- Theoretical
                                                                      temperatura ata point1, saturation
                                                                       temperature for P1
       T2_calc              :="Puestos1".UDT2_1.T2deseada             DB10.DBD106        -- Desired temp
                                                                      eratura at point 2, T2sat+delta_T_
                                                                      resistance
       T3_calc              :="Puestos1".UDT2_1.T2sat                 DB10.DBD94         -- Saturation t
                                                                      emperature for P2
       P3_calc              :="Puestos1".UDT1_1.P2_m                  DB10.DBD28         -- input pressu
                                                                      re of the condenser
       displ                :="Puestos1".UDT2_1.displ                 DB10.DBD178        -- Displacement
                                                                       -->CC/rev
       rpm                  :="Puestos1".UDT2_1.rpm                   DB10.DBD174        -- Revolutions
                                                                      per minute
       Cp_w                 :=4.180000e+000
       delta_T_resistance   :="Puestos1".UDT2_1.delta_T_resistance    DB10.DBD186        -- Extra temper
                                                                      ature degrees above the sat.T° to
                                                                      be obtained by the resistance
       P1_set               :="Puestos1".UDT1_1.P1_set                DB10.DBD44         -- Pressure des
                                                                      ired at point one
       c_vol                :="Puestos1".UDT7_1.c_vol                 DB10.DBD326        -- Coefficient
                                                                      "c" of the second degree equation
                                                                      to calculate the volumetric eff.
       b_iso                :="Puestos1".UDT7_1.b_iso                 DB10.DBD310        -- Coefficient
                                                                      "b" of the second degree equation
                                                                      to calculate the isentropic eff.
       c_iso                :="Puestos1".UDT7_1.c_iso                 DB10.DBD314        -- Coefficient
                                                                      "c" of the second degree equation
                                                                      to calculate the isentropic eff.
```

```
a_iso                 :="Puestos1".UDT7_1.a_iso                        DB10.DBD306        -- Coefficient
                                                                       "a" of the second degree equation
                                                                       to calculate the isentropic eff.
a_vol                 :="Puestos1".UDT7_1.a_vol                        DB10.DBD318        -- Coefficient
                                                                       "a" of the second degree equation
                                                                       to calculate the volumetric eff.
b_vol                 :="Puestos1".UDT7_1.b_vol                        DB10.DBD322        -- Coefficient
                                                                       "b" of the second degree equation
                                                                       to calculate the volumetric eff.
Mode_manual_automatic:="Puestos1".UDT8_1.Mode_Automatic_Manual         DB10.DBX358.0      -- It determine
                                                                        wehter the cycle works automatica
                                                                       lly (1) or in a manual way (0)
ON_OFF                :="Puestos1".UDT4_1.ON_OFF                       DB10.DBX235.4      -- Indicates if
                                                                        the station is ON (ON=1, OFF=0)
Dir_comp              :=A1.0
Dir_pump              :=AW324
Dir_EEV               :=AW328
Dir_res               :=A1.1
DB_Tout               :="Puestos1".UDT1_1.Tout_m                       DB10.DBD20         -- Water output
                                                                        temperature
m_ref_grams           :="Puestos1".UDT6_1.m_ref_grams                  DB10.DBD268        -- m_ref_th*100
                                                                       0--> [g/s]
flow_w_lit_min        :="Puestos1".UDT2_1.flow_w_lit_min               DB10.DBD162        -- Desired wate
                                                                       r flux (l/min)
m_ref_th              :="Puestos1".UDT2_1.m_ref_th                     DB10.DBD146        -- Theoretical
                                                                       refrigerant flux (kg/s)
Qcond_necesitado      :="Puestos1".UDT2_1.Qcond_necesitado             DB10.DBD154        -- Heat exchang
                                                                       ed in the condenser
m_w_th                :="Puestos1".UDT2_1.m_w_th                       DB10.DBD150        -- Theoretical
                                                                       water flux (kg/s)
rend_iso_th           :="Puestos1".UDT2_1.rend_iso_th                  DB10.DBD170        -- Theorical is
                                                                       entropic efficiency
PR                    :="Puestos1".UDT7_1.PR                           DB10.DBD342        -- Pressure rat
                                                                       io P2measured/P1set--> To calculat
                                                                       e the efficiencies
rend_vol_th           :="Puestos1".UDT2_1.rend_vol_th                  DB10.DBD166        -- Theorical vo
                                                                       lumetric efficiency
DB_P2                 :="Puestos1".UDT1_1.P2_m                         DB10.DBD28         -- input pressu
                                                                       re of the condenser
DB_Tin                :="Puestos1".UDT1_1.Tin_m                        DB10.DBD16         -- Water input
                                                                       temperature
h1_th                 :="Puestos1".UDT2_1.h1_th                        DB10.DBD74         -- Enthalpy at
                                                                       point 1, according to the desired
                                                                       P1
h2_th                 :="Puestos1".UDT2_1.h2_th                        DB10.DBD190        -- Enthalpy at
                                                                       point 2, with theoretical data
h2_m                  :="Puestos1".UDT2_1.h2_m                         DB10.DBD86         -- Enthalpy at
                                                                       point 2, with measured data
rho_water             :="Puestos1".UDT2_1.rho_water                    DB10.DBD122        -- Water densit
                                                                       y
T2sat                 :="Puestos1".UDT2_1.T2sat                        DB10.DBD94         -- Saturation t
                                                                       emperature for P2
T1sat                 :="Puestos1".UDT2_1.T1sat                        DB10.DBD98         -- Theoretical
                                                                       temperatura ata point1, saturation
                                                                        temperature for P1
Tin_chiller           :="Puestos1".UDT1_1.Tin_chiller                  DB10.DBD48         -- Tin temperat
                                                                       ure fixed with the chiller
T2deseada             :="Puestos1".UDT2_1.T2deseada                    DB10.DBD106        -- Desired temp
                                                                       eratura at point 2, T2sat+delta_T_
                                                                       resistance
DB_T1                 :="Puestos1".UDT1_1.T1_m                         DB10.DBD4          -- Input temper
                                                                       ature of the compressors refrigera
                                                                       nt
DB_T2                 :="Puestos1".UDT1_1.T2_m                         DB10.DBD8          -- Input temper
                                                                       ature of the condenser
DB_T3                 :="Puestos1".UDT1_1.T3_m                         DB10.DBD12         -- Output tempe
                                                                       rature of the condenser
DB_P1                 :="Puestos1".UDT1_1.P1_m                         DB10.DBD24         -- Input pressu
                                                                       re of the compressor
DB_P3                 :="Puestos1".UDT1_1.P3_m                         DB10.DBD32         -- Output press
                                                                       ure of the condenser
DB_m_ref              :="Puestos1".UDT1_1.m_ref_m                      DB10.DBD36         -- Refrigerant
                                                                       flux
DB_m_w                :="Puestos1".UDT1_1.m_w_m                        DB10.DBD40         -- Water flux
orden_EEV_int         :="Puestos1".UDT3_1.Orden_EEV_int                DB10.DBW198        -- Control sign
                                                                       al of the EEV
orden_EEVreal         :="Puestos1".UDT5_1.orden_EEVreal                DB10.DBD244        -- EEV control
                                                                       order
orden_pump_int        :="Puestos1".UDT3_1.Orden_pump_int               DB10.DBW200        -- Control sign
                                                                       al of the water pump
orden_pump_real       :="Puestos1".UDT5_1.orden_pump_real              DB10.DBD248        -- Pump control
                                                                        order, REAL
OFF                   :="Puestos1".UDT4_1.OFF                          DB10.DBX235.5      -- Indicates if
                                                                        the station is OFF(OFF=1, ON=0)
Ref_number_11         :="Excel_Interface".UDT11_1.Ref_number           DB11.DBW0          -- Is in UDT 1,
                                                                        for the excel interface
P1_m_11               :="Excel_Interface".UDT11_1.P1_m                 DB11.DBD2          -- P1_measured,
                                                                        UDT1
P1_set_11             :="Excel_Interface".UDT11_1.P1_set               DB11.DBD6          -- P1 set, UDT
                                                                       1
```

```
  x1_11               :="Excel_Interface".UDT11_1.x1                  DB11.DBD10         -- Quality of t
                                                                      he refrigerant, UDT1
  Tout_m_11           :="Excel_Interface".UDT11_1.Tout_m              DB11.DBD14         -- Otput water
                                                                      temperature, UDT 1
  P2_m_11             :="Excel_Interface".UDT11_1.P2_m                DB11.DBD18         -- Pressure aft
                                                                      er the heating resistance measured
                                                                      , UDT1
  delta_T_resistance_11:="Excel_Interface".UDT11_1.delta_T_resistance DB11.DBD22         -- Delta T over
                                                                       the T2sat temperature to be chiev
                                                                      e, UDT 2
  m_w_m_11            :="Excel_Interface".UDT11_1.m_w_m               DB11.DBD26         -- Water flux m
                                                                      easured, UDT 1
  m_ref_div_rho_11    :="Excel_Interface".UDT11_1.m_ref_div_rho       DB11.DBD30         -- Auxiliar var
                                                                      iable to calculate the refrigerant
                                                                       flux in the excel, UDT 6
  T2_m_11             :="Excel_Interface".UDT11_1.T2_m                DB11.DBD34         -- Temperature
                                                                      after the heating resistance, UDT
                                                                      1
  T1sat_12            :="Excel_Interface".UDT12_1.h1_th               DB11.DBD42         -- Enthalpy com
                                                                      puted at pressure P1_set, UDT 2
  h1_th_12            :="Excel_Interface".UDT12_1.h1_th               DB11.DBD42         -- Enthalpy com
                                                                      puted at pressure P1_set, UDT 2
  h1_12               :="Excel_Interface".UDT12_1.h1                  DB11.DBD46         -- Enthalpy com
                                                                      puted at pressure P1_m, UDT 1
  T2sat_12            :="Excel_Interface".UDT12_1.T2sat               DB11.DBD50         -- Saturation t
                                                                      emperature at P2_m, UDT 2
  h2_th_12            :="Excel_Interface".UDT12_1.h2_th               DB11.DBD54         -- Enthalpy com
                                                                      puted with T2desired, UDT 2
  h3_th_12            :="Excel_Interface".UDT12_1.h3_th               DB11.DBD58         -- Enthalpy com
                                                                      puted with P1_set, is h1_th, UDT 2
  T2desired_12        :="Excel_Interface".UDT12_1.T2desired           DB11.DBD62         -- Desired temp
                                                                      erature after the resistance--> T2
                                                                      sat+delta_T, UDT 2
  rho_ref_12          :="Excel_Interface".UDT12_1.rho_ref             DB11.DBD66         -- Refrigerant
                                                                      density at the entering of the com
                                                                      pressor  UDT 1
  h2_m_12             :="Excel_Interface".UDT12_1.h2_m                DB11.DBD70         -- Enthalpy com
                                                                      puted with T2_m, UDT 2
  h3_m_12             :="Excel_Interface".UDT12_1.h3_m                DB11.DBD74         -- Enthalpy equ
                                                                      al to h1, UDT 2
  m_ref_th_12         :="Excel_Interface".UDT12_1.m_ref_th            DB11.DBD78         -- Theoretical
                                                                      refrigernt flux [kg/s], UDT 2
  m_ref_grams_12      :="Excel_Interface".UDT12_1.m_ref_grams         DB11.DBD82         -- Theoretical
                                                                      refrigerant flux [g/s], UDT 6
  T2desired           :="Puestos1".UDT2_1.T2deseada                   DB10.DBD106        -- Desired temp
                                                                      eratura at point 2, T2sat+delta_T_
                                                                      resistance
  m_ref_div_rho       :="Puestos1".UDT6_1.m_ref_div_rho               DB10.DBD272        -- Is m_ref/rho
                                                                      --> displ[m^3/rev]*rps[rev/s]*rend
                                                                      _vol
  h3_th               :="Puestos1".UDT2_1.h3_th                       DB10.DBD194        -- Enthalpy at
                                                                      point 2, with theoretical data
  h3_m                :="Puestos1".UDT2_1.h3_m                        DB10.DBD90         -- Enthalpy at
                                                                      point 3, with measured data
  rho_ref             :="Puestos1".UDT2_1.rho_ref                     DB10.DBD114        -- Refrigerant
                                                                      density at the entering og the com
                                                                      pressor


 CALL  "Alarm"                                                        FC4
  DeviationT1:="Puestos1".UDT10_1.DeviationT1                         DB10.DBD376        -- Maximum devi
                                                                      ation of T1 allowed
  DeviationP1:="Puestos1".UDT10_1.DeviationP1                         DB10.DBD372        -- Maximum devi
                                                                      ation of P1 allowed
  MaxP2      :="Puestos1".UDT10_1.MaxP2                               DB10.DBD380        -- Maximum valu
                                                                      e of P2  allowed
  MaxT2      :="Puestos1".UDT10_1.MaxT2                               DB10.DBD384        -- Maximum valu
                                                                      e of T2 allowed
  T1_m       :="Puestos1".UDT1_1.T1_m                                 DB10.DBD4          -- Input temper
                                                                      ature of the compressors refrigera
                                                                      nt
  P1_m       :="Puestos1".UDT1_1.P1_m                                 DB10.DBD24         -- Input pressu
                                                                      re of the compressor
  T2_m       :="Puestos1".UDT1_1.T2_m                                 DB10.DBD8          -- Input temper
                                                                      ature of the condenser
  P2_m       :="Puestos1".UDT1_1.P2_m                                 DB10.DBD28         -- input pressu
                                                                      re of the condenser
  T1sat      :="Puestos1".UDT2_1.T1sat                                DB10.DBD98         -- Theoretical
                                                                      temperatura ata point1, saturation
                                                                       temperature for P1
  P1_set     :="Puestos1".UDT1_1.P1_set                               DB10.DBD44         -- Pressure des
                                                                      ired at point one
  ON_OFF     :="Puestos1".UDT4_1.ON_OFF                               DB10.DBX235.4      -- Indicates if
                                                                       the station is ON (ON=1, OFF=0)
  OFF        :="Puestos1".UDT4_1.OFF                                  DB10.DBX235.5      -- Indicates if
                                                                       the station is OFF(OFF=1, ON=0)
  T1_Low     :="Puestos1".UDT10_1.T1_Low                              DB10.DBX388.0      -- Indicates wh
                                                                      en the temperaute 1 is beyond the
                                                                      minimum value
```

```
       T1_High    :="Puestos1".UDT10_1.T1_High                          DB10.DBX388.1      -- Indicates wh
                                                                        en the temperature 1 is above the
                                                                        maximum value
       T1_Error   :="Puestos1".UDT10_1.T1_Error                         DB10.DBX388.2      -- Inticates wh
                                                                        en an error because of the tempera
                                                                        ture 1 (lower o greater)
       P1_Low     :="Puestos1".UDT10_1.P1_Low                           DB10.DBX388.3      -- Indicates wh
                                                                        en the pressure 1 is beyond the mi
                                                                        nimum value
       P1_High    :="Puestos1".UDT10_1.P1_High                          DB10.DBX388.4      -- Indicates wh
                                                                        en the pressure 1 is above the max
                                                                        imum value
       P1_Error   :="Puestos1".UDT10_1.P1_Error                         DB10.DBX388.5      -- Indicates wh
                                                                        en an error because of the pressur
                                                                        e 1 (lower o greater)
       T2_Error   :="Puestos1".UDT10_1.T2_Error                         DB10.DBX388.6      -- Indicates wh
                                                                        en the temperature 2 is greater th
                                                                        an the limit, ERROR
       P2_Error   :="Puestos1".UDT10_1.P2_Error                         DB10.DBX388.7      -- Indicates wh
                                                                        en the pressure 2 is greater than
                                                                        the limit, ERROR
       Stable     :="Puestos1".UDT10_1.Stable                           DB10.DBX389.0      -- Indicates wh
                                                                        en the station has been stabilized
                                                                        -->1
       Alarm      :="Puestos1".UDT10_1.Alarm                            DB10.DBX389.1      -- The alarm se
                                                                        tttings haven't been fulfilled (af
                                                                        ter been stabilized) for a X time

      U     "Puestos1".UDT4_1.OFF                                       DB10.DBX235.5      -- Indicates if
                                                                         the station is OFF(OFF=1, ON=0)
      SPB   A_OF

      SPA   END


//______________//
// AUTOMATIC OFF //
//______________//


A_OF: CALL  "STOP_manual&automatic"                                     FC8
       Dir_compressor       :=A1.0
       Dir_resistance       :=A1.1
       P3                   :="Puestos1".UDT1_1.P3_m                    DB10.DBD32         -- Output press
                                                                        ure of the condenser
       P1                   :="Puestos1".UDT1_1.P1_m                    DB10.DBD24         -- Input pressu
                                                                        re of the compressor
       OFF                  :="Puestos1".UDT4_1.OFF                     DB10.DBX235.5      -- Indicates if
                                                                         the station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puestos1".UDT8_1.Mode_manual_automatic   DB10.DBX358.5      -- It determine
                                                                         wehter the cycle works automatica
                                                                        lly (0) or in a manual way (1)
       Manual_Resistance    :="Puestos1".UDT8_1.Manual_resistance       DB10.DBX358.2      -- Test the cor
                                                                        rect functioning of the resistance
       Manual_EEV           :="Puestos1".UDT8_1.Manual_EEV              DB10.DBX358.3      -- test the cor
                                                                        rect funtioning of the EEV
       Manual_compressor    :="Puestos1".UDT8_1.Manual_compressor       DB10.DBX358.1      -- Test the cor
                                                                        rect functioning of the compressor
                                                                         in the manual mode
       Manual_pump          :="Puestos1".UDT8_1.Manual_Pump             DB10.DBX358.4      -- Test the cor
                                                                        rect functioning of the pump
       m_w                  :="Puestos1".UDT1_1.m_w_m                   DB10.DBD40         -- Water flux
       orden_pump_int       :="Puestos1".UDT3_1.Orden_pump_int          DB10.DBW200        -- Control sign
                                                                        al of the water pump
       orden_EEVreal        :="Puestos1".UDT5_1.orden_EEVreal           DB10.DBD244        -- EEV control
                                                                        order
       Dir_pump             :=AW324
       Dir_EEV              :=AW328
       orden_EEV            :="Puestos1".UDT3_1.Orden_EEV_int           DB10.DBW198        -- Control sign
                                                                        al of the EEV
       orden_pump_real      :="Puestos1".UDT5_1.orden_pump_real         DB10.DBD248        -- Pump control
                                                                         order, REAL


      SPA   END
```

Segm.: 3 STATION MANUAL. ¿ON/OFF?
If any of the components is beeing tested, then the manual mode is beeing used-->ON.

```
MAN:  U     "Puestos1".UDT8_1.Manual_compressor                  DB10.DBX358.1      -- Test the correct
                                                                 functioning of the compressor in the ma
                                                                 nual mode
```

```
      O     "Puestos1".UDT8_1.Manual_EEV                          DB10.DBX358.3      -- test the correct
                                                                  funtioning of the EEV
      O     "Puestos1".UDT8_1.Manual_resistance                   DB10.DBX358.2      -- Test the correct
                                                                  functioning of the resistance
      O     "Puestos1".UDT8_1.Manual_Pump                         DB10.DBX358.4      -- Test the correct
                                                                  functioning of the pump
      =     "Puestos1".UDT4_1.ON_OFF                              DB10.DBX235.4      -- Indicates if the
                                                                  station is ON (ON=1, OFF=0)

//If one of them is being tested, the START button would have to show it
//ON_OFF would depend to the state of the components, if one of them is set, then it would be "ON"

//Erase the AUTOMATIC SETTINGS

      L     0.000000e+000
      T     "Puestos1".UDT7_1.a_vol                               DB10.DBD318        -- Coefficient "a" o
                                                                  f the second degree equation to calcula
                                                                  te the volumetric eff.
      T     "Puestos1".UDT7_1.b_vol                               DB10.DBD322        -- Coefficient "b" o
                                                                  f the second degree equation to calcula
                                                                  te the volumetric eff.
      T     "Puestos1".UDT7_1.c_vol                               DB10.DBD326        -- Coefficient "c" o
                                                                  f the second degree equation to calcula
                                                                  te the volumetric eff.
      T     "Puestos1".UDT7_1.a_iso                               DB10.DBD306        -- Coefficient "a" o
                                                                  f the second degree equation to calcula
                                                                  te the isentropic eff.
      T     "Puestos1".UDT7_1.b_iso                               DB10.DBD310        -- Coefficient "b" o
                                                                  f the second degree equation to calcula
                                                                  te the isentropic eff.
      T     "Puestos1".UDT7_1.c_iso                               DB10.DBD314        -- Coefficient "c" o
                                                                  f the second degree equation to calcula
                                                                  te the isentropic eff.
      T     "Puestos1".UDT1_1.P1_set                              DB10.DBD44         -- Pressure desired
                                                                  at point one
      T     "Puestos1".UDT2_1.delta_T_resistance                  DB10.DBD186        -- Extra temperature
                                                                   degrees above the sat.T° to be obtaine
                                                                  d by the resistance
      T     "Puestos1".UDT1_1.x1                                  DB10.DBD0          -- Quality
      T     "Puestos1".UDT2_1.rpm                                 DB10.DBD174        -- Revolutions per m
                                                                  inute
      T     "Puestos1".UDT2_1.displ                               DB10.DBD178        -- Displacement -->C
                                                                  C/rev


      U     "Puestos1".UDT4_1.ON_OFF                              DB10.DBX235.4      -- Indicates if the
                                                                  station is ON (ON=1, OFF=0)
      SPB   M_ON
      SPA   M_OF

//If one component has been activate, we call the STATION_ON_MAN"

M_ON: CALL  "Station_MAN_ON"                                      FC96
       Man_delta_T_res_int  :="Puestos1".UDT3_1.Man_delta_T_res_int    DB10.DBW204   -- When manual mode
                                                                  is activated it gives the "order" for t
                                                                  he resistance
       Man_delta_P_EEV_int  :="Puestos1".UDT3_1.Man_delta_P_EEV_int    DB10.DBW206   -- When manual mode
                                                                  is activated it gives the "order" for t
                                                                  he EEV
       Man_WF_pump_int      :="Puestos1".UDT3_1.Man_WF_pump_int   DB10.DBW208        -- When manual mode
                                                                  is activated it gives the "order" for t
                                                                  he pump
       Man_resistance       :="Puestos1".UDT8_1.Manual_resistance DB10.DBX358.2      -- Test the correct
                                                                  functioning of the resistance
       Man_Pump             :="Puestos1".UDT8_1.Manual_Pump       DB10.DBX358.4      -- Test the correct
                                                                  functioning of the pump
       Man_EEV              :="Puestos1".UDT8_1.Manual_EEV        DB10.DBX358.3      -- test the correct
                                                                  funtioning of the EEV
       Man_Compressor       :="Puestos1".UDT8_1.Manual_compressor DB10.DBX358.1      -- Test the correct
                                                                  functioning of the compressor in the ma
                                                                  nual mode
       IN_T2                :=EW302
       IN_P1                :=EW312
       IN_P2                :=EW314
       IN_P3                :=EW316
       IN_m_w               :=EW322
       T2_connected         :="Puestos1".UDT4_1.T2_conectado      DB10.DBX234.3      -- Indicates the con
                                                                  nection state of the sensor T2
       P1_connected         :="Puestos1".UDT4_1.P1_conectado      DB10.DBX234.2      -- Indicates the con
                                                                  nection state of the sensor P1
       P2_connected         :="Puestos1".UDT4_1.P2_conectado      DB10.DBX234.4      -- Indicates the con
                                                                  nection state of the sensor P2
       P3_connected         :="Puestos1".UDT4_1.P3_conectado      DB10.DBX234.6      -- Indicates the con
                                                                  nection state of the sensor P3
       m_w_connected        :="Puestos1".UDT4_1.Qw_conectado      DB10.DBX235.1      -- Indicates the con
                                                                  nection state of the sensor Qw
       Mode_manual_automatic:="Puestos1".UDT8_1.Mode_manual_automatic  DB10.DBX358.5 -- It determine weht
                                                                  er the cycle works automatically (0) or
                                                                   in a manual way (1)
```

```
      T2deseada           :="Puestos1".UDT2_1.T2deseada          DB10.DBD106        -- Desired temperatu
                                                                 ra at point 2, T2sat+delta_T_resistance

      Dir_res             :=A1.1
      Dir_comp            :=A1.0
      Dir_pump            :=AW324
      Dir_EEV             :=AW328
      orden_EEVreal       :="Puestos1".UDT5_1.orden_EEVreal      DB10.DBD244        -- EEV control order
      Orden_EEV_int       :="Puestos1".UDT3_1.Orden_EEV_int      DB10.DBW198        -- Control signal of
                                                                  the EEV
      DB_T2               :="Puestos1".UDT1_1.T2_m               DB10.DBD8          -- Input temperature
                                                                  of the condenser
      DB_P1               :="Puestos1".UDT1_1.P1_m               DB10.DBD24         -- Input pressure of
                                                                  the compressor
      DB_P2               :="Puestos1".UDT1_1.P2_m               DB10.DBD28         -- input pressure of
                                                                  the condenser
      DB_P3               :="Puestos1".UDT1_1.P3_m               DB10.DBD32         -- Output pressure o
                                                                 f the condenser
      DB_m_w              :="Puestos1".UDT1_1.m_w_m              DB10.DBD40         -- Water flux
      T1sat               :="Puestos1".UDT2_1.T1sat              DB10.DBD98         -- Theoretical tempe
                                                                 ratura ata point1, saturation temperatu
                                                                 re for P1
      T2sat               :="Puestos1".UDT2_1.T2sat              DB10.DBD94         -- Saturation temper
                                                                 ature for P2
      orden_pump_real     :="Puestos1".UDT5_1.orden_pump_real    DB10.DBD248        -- Pump control orde
                                                                 r, REAL
      Orden_pump_int      :="Puestos1".UDT3_1.Orden_pump_int     DB10.DBW200        -- Control signal of
                                                                  the water pump


      SPA   END

M_OF: CALL  "STOP_manual&automatic"                              FC8
       Dir_compressor     :=A1.0
       Dir_resistance     :=A1.1
       P3                 :="Puestos1".UDT1_1.P3_m               DB10.DBD32         -- Output pressure o
                                                                 f the condenser
       P1                 :="Puestos1".UDT1_1.P1_m               DB10.DBD24         -- Input pressure of
                                                                  the compressor
       OFF                :="Puestos1".UDT4_1.OFF                DB10.DBX235.5      -- Indicates if the
                                                                 station is OFF(OFF=1, ON=0)
       Mode_manual_automatic:="Puestos1".UDT8_1.Mode_manual_automatic  DB10.DBX358.5 -- It determine weht
                                                                 er the cycle works automatically (0) or
                                                                  in a manual way (1)
       Manual_Resistance  :="Puestos1".UDT8_1.Manual_resistance  DB10.DBX358.2      -- Test the correct
                                                                 functioning of the resistance
       Manual_EEV         :="Puestos1".UDT8_1.Manual_EEV         DB10.DBX358.3      -- test the correct
                                                                 funtioning of the EEV
       Manual_compressor  :="Puestos1".UDT8_1.Manual_compressor  DB10.DBX358.1      -- Test the correct
                                                                 functioning of the compressor in the ma
                                                                 nual mode
       Manual_pump        :="Puestos1".UDT8_1.Manual_Pump        DB10.DBX358.4      -- Test the correct
                                                                 functioning of the pump
       m_w                :="Puestos1".UDT1_1.m_w_m              DB10.DBD40         -- Water flux
       orden_pump_int     :="Puestos1".UDT3_1.Orden_pump_int     DB10.DBW200        -- Control signal of
                                                                  the water pump
       orden_EEVreal      :="Puestos1".UDT5_1.orden_EEVreal      DB10.DBD244        -- EEV control order
       Dir_pump           :=AW324
       Dir_EEV            :=AW328
       orden_EEV          :="Puestos1".UDT3_1.Orden_EEV_int      DB10.DBW198        -- Control signal of
                                                                  the EEV
       orden_pump_real    :="Puestos1".UDT5_1.orden_pump_real    DB10.DBD248        -- Pump control orde
                                                                 r, REAL


      SPA   END
```

Segm.: 4 END

```
END:  NOP   0
```

FC94 - <offline>

"Excel_DB"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 13/06/2014 17:02:36
Interface: 13/06/2014 17:02:36
Longitud (bloque / código / datos): 00378 00190 00000

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
Ref_number	Int	0.0	Refrigerant number, UDT 1
P1_m	Real	2.0	P1_m, UDT 1
P1_set	Real	6.0	P1_set, UDT 1
x1	Real	10.0	x1, UDT 1
Tout_m	Real	14.0	Tout_m, UDT 1
P2_m	Real	18.0	P2_m, UDT 1
delta_T_resistance	Real	22.0	delta_T_resistance, UDT 2
m_w_m	Real	26.0	m_w_m, UDT 1
m_ref_div_rho	Real	30.0	m-ref_div_rho, UDT 6
T2_m	Real	34.0	T2_m, UDT 1
T1sat_12	Real	38.0	T1_sat,UDT 12
h1_th_12	Real	42.0	h1_th, UDT 12
h1_12	Real	46.0	h1, UDT 12
T2sat_12	Real	50.0	T2sat, UDT 12
h2_th_12	Real	54.0	h2_th,UDT 12
h3_th_12	Real	58.0	h3_th, UDT 12
T2desired_12	Real	62.0	T2desired, UDT 12
rho_ref_12	Real	66.0	rho_ref, UDT 12
h2_m_12	Real	70.0	h2_m, UDT 12
h3_m_12	Real	74.0	h3_m, UDT 12
m_ref_th_12	Real	78.0	m_ref_th, UDT 12
m_ref_grams_12	Real	82.0	m_ref_grams, UDT 12
UDT11_12	Bool	86.0	Indicates wheter the INPUT part or the OUTPUT segment must be executed
OUT		0.0	
IN_OUT		0.0	
Ref_number_11	Int	88.0	Refrigerant number, UDT 11
P1_m_11	Real	90.0	P1_m, UDT 11
P1_set_11	Real	94.0	P1_set, UDT 11
x1_11	Real	98.0	x1, UDT 11
Tout_m_11	Real	102.0	Tout_m, UDT 11
P2_m_11	Real	106.0	P2_m, UDT 11
delta_T_resistance_11	Real	110.0	delta_T_resistance, UDT 11
m_w_m_11	Real	114.0	m_w_m, UDT 11
m_ref_div_rho_11	Real	118.0	m-ref_div_rho, UDT 11
T2_m_11	Real	122.0	T2_m, UDT 11
T1sat	Real	126.0	T1_sat,UDT 2
h1_th	Real	130.0	h1_th, UDT 2
h1	Real	134.0	h1, UDT 2
T2sat	Real	138.0	T2sat, UDT 2
h2_th	Real	142.0	h2_th,UDT 2
h3_th	Real	146.0	h3_th, UDT 2
T2desired	Real	150.0	T2desired, UDT 2
rho_ref	Real	154.0	rho_ref, UDT 2
h2_m	Real	158.0	h2_m, UDT 2
h3_m	Real	162.0	h3_m, UDT 2

Nombre	Tipo de datos	Dirección	Comentario
m_ref_th	Real	166.0	m_ref_th, UDT 2
m_ref_grams	Real	170.0	m_ref_grams, UDT 6
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC94 EXCEL

The objective is to create a DB with all the data needed by the excel. The inputs are stored mainly in UDT 1, (also in UDT 2 and UDT 6).The outputs are mainly stored in UDT 2 (also in UDT 6)

Segm.: 1 INPUTS

Redirectionate the inputs stored in differents UDT, to the UDT 11

```
      U     #UDT11_12                #UDT11_12          -- Indicates wheter the INPUT part or the OUTPUT segmen
                                     t must be executed
      SPB   IN
      SPA   OUT

IN:   L     #Ref_number              #Ref_number        -- Refrigerant number, UDT 1
      T     #Ref_number_11           #Ref_number_11     -- Refrigerant number, UDT 11

      L     #P1_m                    #P1_m              -- P1_m, UDT 1
      T     #P1_m_11                 #P1_m_11           -- P1_m, UDT 11

      L     #P1_set                  #P1_set            -- P1_set, UDT 1
      T     #P1_set_11               #P1_set_11         -- P1_set, UDT 11

      L     #x1                      #x1                -- x1, UDT 1
      T     #x1_11                   #x1_11             -- x1, UDT 11

      L     #Tout_m                  #Tout_m            -- Tout_m, UDT 1
      T     #Tout_m_11               #Tout_m_11         -- Tout_m, UDT 11

      L     #P2_m                    #P2_m              -- P2_m, UDT 1
      T     #P2_m_11                 #P2_m_11           -- P2_m, UDT 11

      L     #delta_T_resistance      #delta_T_resistance -- delta_T_resistance, UDT 2
      T     #delta_T_resistance_11   #delta_T_resistance_11 -- delta_T_resistance, UDT 11

      L     #m_w_m                   #m_w_m             -- m_w_m, UDT 1
      T     #m_w_m_11                #m_w_m_11          -- m_w_m, UDT 11

      L     #m_ref_div_rho           #m_ref_div_rho     -- m-ref_div_rho, UDT 6
      T     #m_ref_div_rho_11        #m_ref_div_rho_11  -- m-ref_div_rho, UDT 11

      L     #T2_m                    #T2_m              -- T2_m, UDT 1
      T     #T2_m_11                 #T2_m_11           -- T2_m, UDT 11
```

Segm.: 2 OUTPUTS

Redirectionate the ouputs stored in the UDT 12,to the UDT 2,UDT 6,...

```
OUT:  L     #T1sat_12        #T1sat_12          -- T1_sat,UDT 12
      T     #T1sat           #T1sat             -- T1_sat,UDT 2

      L     #h1_th_12        #h1_th_12          -- h1_th, UDT 12
      T     #h1_th           #h1_th             -- h1_th, UDT 2

      L     #h1_12           #h1_12             -- h1, UDT 12
      T     #h1              #h1                -- h1, UDT 2

      L     #T2sat_12        #T2sat_12          -- T2sat, UDT 12
      T     #T2sat           #T2sat             -- T2sat, UDT 2

      L     #h2_th_12        #h2_th_12          --  h2_th,UDT 12
      T     #h2_th           #h2_th             --  h2_th,UDT 2

      L     #h3_th_12        #h3_th_12          -- h3_th, UDT 12
      T     #h3_th           #h3_th             -- h3_th, UDT 2

      L     #T2desired_12    #T2desired_12      -- T2desired, UDT 12
      T     #T2desired       #T2desired         -- T2desired, UDT 2

      L     #rho_ref_12      #rho_ref_12        -- rho_ref, UDT 12
      T     #rho_ref         #rho_ref           -- rho_ref, UDT 2
```

FC95 - <offline>

"Reset_StationNOT_SET"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 16/06/2014 09:10:07
Interface: 16/06/2014 09:10:07
Longitud (bloque / código / datos): 00192 00066 00000

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
T1_conectado	Bool	0.0	Sensor conected-->1 (UDT 4)
T2_conectado	Bool	0.1	Sensor conected-->1 (UDT 4)
T3_conectado	Bool	0.2	Sensor conected-->1 (UDT 4)
Tin_conectado	Bool	0.3	Sensor conected-->1 (UDT 4)
Tout_conectado	Bool	0.4	Sensor conected-->1 (UDT 4)
P1_conectado	Bool	0.5	Sensor conected-->1 (UDT 4)
P2_conectado	Bool	0.6	Sensor conected-->1 (UDT 4)
P3_conectado	Bool	0.7	Sensor conected-->1 (UDT 4)
m_ref_conectado	Bool	1.0	Sensor conected-->1 (UDT 4)
Qw_conectado	Bool	1.1	Sensor conected-->1 (UDT 4)
Resistance_conectado	Bool	1.2	Equipment connected-->1 (UDT 4)
OUT		0.0	
IN_OUT		0.0	
dir_compressor	Bool	2.0	Direction of the compressor
dir_resistance	Bool	2.1	Direction of the resistance
dir_EEV	Word	4.0	Direction of the EEV
dir_pump	Word	6.0	Direction of the pump
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC95 RESET

If an station has not been set, then the T1_conected,...,Manual_resistance,...,
and the rest of variables related to the automatic/manual, when the station is
working, must be reseted.

Segm.: 1 Connected sensors

Set all the sensors as "disconected"

```
//RESET of the connected sensors signals//

      R     #T1_conectado          #T1_conectado        -- Sensor conected-->1 (UDT 4)
      R     #T2_conectado          #T2_conectado        -- Sensor conected-->1 (UDT 4)
      R     #T3_conectado          #T3_conectado        -- Sensor conected-->1 (UDT 4)
      R     #Tin_conectado         #Tin_conectado       -- Sensor conected-->1 (UDT 4)
      R     #Tout_conectado        #Tout_conectado      -- Sensor conected-->1 (UDT 4)
      R     #P1_conectado          #P1_conectado        -- Sensor conected-->1 (UDT 4)
      R     #P2_conectado          #P2_conectado        -- Sensor conected-->1 (UDT 4)
      R     #P3_conectado          #P3_conectado        -- Sensor conected-->1 (UDT 4)
      R     #m_ref_conectado       #m_ref_conectado     -- Sensor conected-->1 (UDT 4)
      R     #Qw_conectado          #Qw_conectado        -- Sensor conected-->1 (UDT 4)
      R     #Resistance_conectado  #Resistance_conectado -- Equipment connected-->1 (UDT 4)
```

Segm.: 2 Manual/Automatic Mode
The outputs must be set as zero, even if the station hasn't been set, we must assure that ther won't be current or voltage at the outputs

```
      R     #dir_compressor  #dir_compressor    -- Direction of the compressor
      R     #dir_resistance  #dir_resistance    -- Direction of the resistance

      L     0
      T     #dir_EEV         #dir_EEV           -- Direction of the EEV
      T     #dir_pump        #dir_pump          -- Direction of the pump
```

FC96 - <offline>

"Station_MAN_ON"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 05/06/2014 12:33:20
Interface: 05/06/2014 12:33:20
Longitud (bloque / código / datos): 00854 00666 00062

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
Man_delta_T_res_int	Int	0.0	When manual mode is set, the delta temperature is fixed, INT
Man_delta_P_EEV_int	Int	2.0	Delta P of the EEV in manual mode, INT
Man_WF_pump_int	Int	4.0	Water flux of the pump in manual mode, INT
Man_resistance	Bool	6.0	-->1 Resistance ON
Man_Pump	Bool	6.1	-->1 Pump ON
Man_EEV	Bool	6.2	-->1 EEV ON
Man_Compressor	Bool	6.3	-->1 Compressor ON
IN_T2	Int	8.0	Analog INPUT of T2 (02)
IN_P1	Int	10.0	Analog INPUT of P1 (12)
IN_P2	Int	12.0	Analog INPUT of P2 (14)
IN_P3	Int	14.0	Analog INPUT of P3 (16)
IN_m_w	Int	16.0	Analog INPUT of m_w (22)
T2_connected	Bool	18.0	0-> sensor not connected, 1--> sensor connected
P1_connected	Bool	18.1	0-> sensor not connected, 1--> sensor connected
P2_connected	Bool	18.2	0-> sensor not connected, 1--> sensor connected
P3_connected	Bool	18.3	0-> sensor not connected, 1--> sensor connected
m_w_connected	Bool	18.4	0-> sensor not connected, 1--> sensor connected
Mode_manual_automatic	Bool	18.5	1->Manual, 0->Automatic
OUT		0.0	
IN_OUT		0.0	
T2deseada	Real	20.0	Desired temperature at point 2r (after the heating resistance)
Dir_res	Bool	24.0	Direction of the resistance output (AX.1)
Dir_comp	Bool	24.1	Direction of the compressor output (AX.0)
Dir_pump	Word	26.0	Direction of the pump output (PAW (2+x)24)
Dir_EEV	Word	28.0	Direction of the EEV output (PAW (2+x)28)
orden_EEVreal	Real	30.0	EEV order, REAL(UDT5)
Orden_EEV_int	Int	34.0	EEV order, INT (UDT3)
DB_T2	Real	36.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_P1	Real	40.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_P2	Real	44.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_P3	Real	48.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_m_w	Real	52.0	Indicate the direction in which the value (measured/theorical) must be stored
T1sat	Real	56.0	Saturatio temperature at 1. It would be its theoretical/calculated value
T2sat	Real	60.0	Saturation temperature at 2.It is the theoretical value of T3
orden_pump_real	Real	64.0	Pump order, REAL(UDT5)
Orden_pump_int	Int	68.0	Pump order, INT (UDT3)
TEMP		0.0	
Man_res_OFF	Bool	0.0	When the resistance in manual mode is NOT being tested-->1
Man_EEV_OFF	Bool	0.1	When the pump in manual mode is NOT being tested-->1

Nombre	Tipo de datos	Dirección	Comentario
Man_delta_T_res_real	Real	2.0	Delta T of the resistance in manual mode, REAL
Man_delta_P_EEV_real	Real	6.0	Delta P of the EEV in manual mode, REAL
Man_WF_pump_real	Real	10.0	Water fluxof the pump in manual mode, REAL
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC96 START in Manual Mode

The manual mode was defined so the components could be tested separately

Segm.: 1 Meassurement of sensors or employment of theoretical values

The FC 5 is summoned to storage the meassures of the sensors (after have beeing conditionated),or the theoretical values (in case of not beeing connected)-->call the FC 6

The parameters IN_X correspond to the analog input direcctions of the sensors. Directions of STATION 1 start with a "3".

To developpe the code for the rest of stations,the direcctions would have to be changed.(STATION 2->starts with a "4" STATION 3-> "5"...)

The paremeters DB_X shows the direcction in wich the data must be storaged

```
      CALL  "MAN_SensON/SensOFF->th"                FC98
       IN_T2                :=#IN_T2                #IN_T2              -- Analog INPUT of T2 (02)
       IN_P1                :=#IN_P1                #IN_P1              -- Analog INPUT of P1 (12)
       IN_P2                :=#IN_P2                #IN_P2              -- Analog INPUT of P2 (14)
       IN_P3                :=#IN_P3                #IN_P3              -- Analog INPUT of P3 (16)
       IN_m_w               :=#IN_m_w               #IN_m_w             -- Analog INPUT of m_w (22)
       T2_connected         :=#T2_connected         #T2_connected       -- 0-> sensor not connected, 1--> sen
                                                    sor connected
       P1_connected         :=#P1_connected         #P1_connected       -- 0-> sensor not connected, 1--> sen
                                                    sor connected
       P2_connected         :=#P2_connected         #P2_connected       -- 0-> sensor not connected, 1--> sen
                                                    sor connected
       P3_connected         :=#P3_connected         #P3_connected       -- 0-> sensor not connected, 1--> sen
                                                    sor connected
       m_w_connected        :=#m_w_connected        #m_w_connected      -- 0-> sensor not connected, 1--> sen
                                                    sor connected
       T2_calc              :=#T2deseada            #T2deseada          -- Desired temperature at point 2r (a
                                                    fter the heating resistance)
       P3_calc              :=#DB_P2                #DB_P2              -- Indicate the direction in which th
                                                    e value (measured/theorical) must be stored
       Mode_manual_automatic:=#Mode_manual_automatic  #Mode_manual_automatic -- 1->Manual, 0->Automatic
       DB_P1                :=#DB_P1                #DB_P1              -- Indicate the direction in which th
                                                    e value (measured/theorical) must be stored
       DB_P2                :=#DB_P2                #DB_P2              -- Indicate the direction in which th
                                                    e value (measured/theorical) must be stored
       DB_P3                :=#DB_P3                #DB_P3              -- Indicate the direction in which th
                                                    e value (measured/theorical) must be stored
       DB_T2                :=#DB_T2                #DB_T2              -- Indicate the direction in which th
                                                    e value (measured/theorical) must be stored
       DB_m_w               :=#DB_m_w               #DB_m_w             -- Indicate the direction in which th
                                                    e value (measured/theorical) must be stored
       T2sat                :=#T2sat                #T2sat              -- Saturation temperature at 2.It is
                                                    the theoretical value of T3
```

Segm.: 2 Manual PID control

This segment "calls" the function in which, not only the "ON" control is set, there is also an "OFF" control procedure defined.

```
//INT-->REAL the value of delta_P to be achieved, fixed in the screen
      L     #Man_delta_P_EEV_int                   #Man_delta_P_EEV_int -- Delta P of the EEV in manual mode,
                                                    INT
      ITD
      DTR
      T     #Man_delta_P_EEV_real                  #Man_delta_P_EEV_real -- Delta P of the EEV in manual mode
                                                   , REAL

//INT-->REAL the value of delta_t to be achieved, fixed in the screen
      L     #Man_delta_T_res_int                   #Man_delta_T_res_int -- When manual mode is set, the delta
                                                    temperature is fixed, INT
      ITD
```

```
DTR
T     #Man_delta_T_res_real                    #Man_delta_T_res_real -- Delta T of the resistance in manu
                                               al mode, REAL


CALL  "MAN_ControlPID"                         FC9
 Man_delta_T_res_int :=#Man_delta_T_res_int    #Man_delta_T_res_int -- When manual mode is set, the delta
                                                temperature is fixed, INT
 Man_delta_P_EEV_int :=#Man_delta_P_EEV_int    #Man_delta_P_EEV_int -- Delta P of the EEV in manual mode,
                                                INT
 Man_WF_pump_int     :=#Man_WF_pump_int        #Man_WF_pump_int   -- Water flux of the pump in manual mod
                                               e, INT
 Man_resistance      :=#Man_resistance         #Man_resistance    -- -->1 Resistance ON
 Man_Pump            :=#Man_Pump               #Man_Pump          -- -->1 Pump ON
 Man_EEV             :=#Man_EEV                #Man_EEV           -- -->1 EEV ON
 Man_Compressor      :=#Man_Compressor         #Man_Compressor    -- -->1 Compressor ON
 T2sat               :=#T2sat                  #T2sat             -- Saturation temperature at 2.It is th
                                               e theoretical value of T3
 P1                  :=#DB_P1                  #DB_P1             -- Indicate the direction in which the
                                               value (measured/theorical) must be stored
 P3                  :=#DB_P3                  #DB_P3             -- Indicate the direction in which the
                                               value (measured/theorical) must be stored
 m_w_m               :=#DB_m_w                 #DB_m_w            -- Indicate the direction in which the
                                               value (measured/theorical) must be stored
 T2_m                :=#DB_T2                  #DB_T2             -- Indicate the direction in which the
                                               value (measured/theorical) must be stored
 Man_delta_T_res_real:=#Man_delta_T_res_real   #Man_delta_T_res_real -- Delta T of the resistance in manu
                                               al mode, REAL
 Man_delta_P_EEV_real:=#Man_delta_P_EEV_real   #Man_delta_P_EEV_real -- Delta P of the EEV in manual mode
                                               , REAL
 Man_WF_pump_real    :=#Man_WF_pump_real       #Man_WF_pump_real  -- Water fluxof the pump in manual mode
                                               , REAL
 T2deseada           :=#T2deseada              #T2deseada         -- Desired temperature at point 2r (aft
                                               er the heating resistance)
 Dir_res             :=#Dir_res                #Dir_res           -- Direction of the resistance output (
                                               AX.1)
 Dir_comp            :=#Dir_comp               #Dir_comp          -- Direction of the compressor output (
                                               AX.0)
 Dir_pump            :=#Dir_pump               #Dir_pump          -- Direction of the pump output (PAW (2
                                               +x)24)
 Dir_EEV             :=#Dir_EEV                #Dir_EEV           -- Direction of the EEV output (PAW (2+
                                               x)28)
 orden_EEVreal       :=#orden_EEVreal          #orden_EEVreal     -- EEV order, REAL(UDT5)
 Orden_EEV           :=#Orden_EEV_int          #Orden_EEV_int     -- EEV order, INT (UDT3)
 orden_pump_int      :=#Orden_pump_int         #Orden_pump_int    -- Pump order, INT (UDT3)
 orden_pump_real     :=#orden_pump_real        #orden_pump_real   -- Pump order, REAL(UDT5)
```

FC97 - <offline>

"Station_AUT_ON"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 16/06/2014 09:51:45
Interface: 16/06/2014 09:51:33
Longitud (bloque / código / datos): 02096 01790 00310

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
UDT11_12	Bool	0.0	When it is 1->inputs to the UDT 11, when it is 0->outputs to UDT12
x1	Real	2.0	Quality of the refrigerant, UDT 1
ref_number	Int	6.0	Refrigerant number (0->r134a, 1->r410a, 2->r407c, 3->r22, 4->r290)
IN_T1	Int	8.0	Analog INPUT of T1
IN_T2	Int	10.0	Analog INPUT of T2
IN_T3	Int	12.0	Analog INPUT of T3
IN_Tin	Int	14.0	Analog INPUT of Tin
IN_Tout	Int	16.0	Analog INPUT of Tout
IN_P1	Int	18.0	Analog INPUT of P1
IN_P2	Int	20.0	Analog INPUT of P2
IN_P3	Int	22.0	Analog INPUT of P3
IN_m_ref	Int	24.0	Analog INPUT of m_ref
IN_m_w	Int	26.0	Analog INPUT of m_w
T1_connected	Bool	28.0	0-> sensor not connected, 1--> sensor connected
T2_connected	Bool	28.1	0-> sensor not connected, 1--> sensor connected
T3_connected	Bool	28.2	0-> sensor not connected, 1--> sensor connected
Tin_connected	Bool	28.3	0-> sensor not connected, 1--> sensor connected
Tout_connected	Bool	28.4	0-> sensor not connected, 1--> sensor connected
P1_connected	Bool	28.5	0-> sensor not connected, 1--> sensor connected
P2_connected	Bool	28.6	0-> sensor not connected, 1--> sensor connected
P3_connected	Bool	28.7	0-> sensor not connected, 1--> sensor connected
m_ref_connected	Bool	29.0	0-> sensor not connected, 1--> sensor connected
m_w_connected	Bool	29.1	0-> sensor not connected, 1--> sensor connected
T1_calc	Real	30.0	Theoretical/set/calculated value of the magnitude
T2_calc	Real	34.0	Theoretical/set/calculated value of the magnitude
T3_calc	Real	38.0	Theoretical/set/calculated value of the magnitude
P3_calc	Real	42.0	Theoretical/set/calculated value of the magnitude->P2
displ	Real	46.0	Displacement of the compressor
rpm	Real	50.0	rpm of the compressor
Cp_w	Real	54.0	
delta_T_resistance	Real	58.0	Extra temperature degrees to be obtained above the sat. T by the resistance
P1_set	Real	62.0	Set pressured at the operating point 1
c_vol	Real	66.0	Coefficient of the second degree equation to calculate the volumetric eff.
b_iso	Real	70.0	Coefficient of the second degree equation to calculate the isentropic eff.
c_iso	Real	74.0	Coefficient of the second degree equation to calculate the isentropic eff.
a_iso	Real	78.0	Coefficient of the second degree equation to calculate the isentropic eff.
a_vol	Real	82.0	Coefficient of the second degree equation to calculate the volumetric eff.
b_vol	Real	86.0	Coefficient of the second degree equation to calculate the volumetric eff.

Nombre	Tipo de datos	Dirección	Comentario
Mode_manual_automatic	Bool	90.0	When mode is manual->1, UDT8
ON_OFF	Bool	90.1	Indicates when the station is ON (-->1), or OFF (-->0)
OUT		0.0	
IN_OUT		0.0	
Dir_comp	Bool	92.0	Digital output that controls the compressor (x.0)
Dir_pump	Word	94.0	Analog output-> PUMP ("2+x"24)
Dir_EEV	Word	96.0	Analog output--> EEV ("2+x"28)
Dir_res	Bool	98.0	Digital output--> Resistance (x.1)
DB_Tout	Real	100.0	Indicate the direction in which the value (measured/theorical) must be stored
m_ref_grams	Real	104.0	Refirgerant flux calculated in g/s
flow_w_lit_min	Real	108.0	Water flux calculated in l/min
m_ref_th	Real	112.0	Refrigerant flux in kg/s
Qcond_necesitado	Real	116.0	Heat exchanged needed in the condenser
m_w_th	Real	120.0	Water flux in kg/s
rend_iso_th	Real	124.0	Isentropc efficiency computed with the second degree equation
PR	Real	128.0	Pressure ratio P2measured/P1 set
rend_vol_th	Real	132.0	Volumetric efficiency computed with the second degree equation
DB_P2	Real	136.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_Tin	Real	140.0	Indicate the direction in which the value (measured/theorical) must be stored
h1_th	Real	144.0	Enthalpy at the desired pressure and quality
h2_th	Real	148.0	Enthalpy at point 2, with the theoretical values
h2_m	Real	152.0	Enthalpy at 2, with the "measured"value of T2 (if its implemented)
rho_water	Real	156.0	To determine the l/min of the water flux
T2sat	Real	160.0	Saturation temperature at pressure P2
T1sat	Real	164.0	Saturation temperature at 1, theoretical value of T1
Tin_chiller	Real	168.0	Temperature fixed with the chiller
T2deseada	Real	172.0	Desired temperature at point 2r, after the heating resistance
DB_T1	Real	176.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_T2	Real	180.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_T3	Real	184.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_P1	Real	188.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_P3	Real	192.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_m_ref	Real	196.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_m_w	Real	200.0	Indicate the direction in which the value (measured/theorical) must be stored
orden_EEV_int	Int	204.0	EEV order, INT
orden_EEVreal	Real	206.0	EEV order, REAL
orden_pump_int	Int	210.0	Pump order, INT
orden_pump_real	Real	212.0	Pump order, REAL
OFF	Bool	216.0	Indicator of the OFF state of the station
Ref_number_11	Int	218.0	Refrigerant number, UDT 11
P1_m_11	Real	220.0	P1_m, UDT 11
P1_set_11	Real	224.0	P1_set, UDT 11
x1_11	Real	228.0	x1, UDT 11
Tout_m_11	Real	232.0	Tout_m, UDT 11

Nombre	Tipo de datos	Dirección	Comentario
P2_m_11	Real	236.0	P2_m, UDT 11
delta_T_resistance_11	Real	240.0	delta_T_resistance, UDT 11
m_w_m_11	Real	244.0	m_w_m, UDT 11
m_ref_div_rho_11	Real	248.0	m-ref_div_rho, UDT 11
T2_m_11	Real	252.0	T2_m, UDT 11
T1sat_12	Real	256.0	T1_sat,UDT 12
h1_th_12	Real	260.0	h1_th, UDT 12
h1_12	Real	264.0	h1, UDT 12
T2sat_12	Real	268.0	T2sat, UDT 12
h2_th_12	Real	272.0	h2_th,UDT 12
h3_th_12	Real	276.0	h3_th, UDT 12
T2desired_12	Real	280.0	T2desired, UDT 12
rho_ref_12	Real	284.0	rho_ref, UDT 12
h2_m_12	Real	288.0	h2_m, UDT 12
h3_m_12	Real	292.0	h3_m, UDT 12
m_ref_th_12	Real	296.0	m_ref_th, UDT 12
m_ref_grams_12	Real	300.0	m_ref_grams, UDT 12
T2desired	Real	304.0	Desired temperature after the heating resistance
m_ref_div_rho	real	308.0	m_ref/rho, displ [m^3/rev]*eff_vol*rps [rev/s]
h3_th	real	312.0	Enthalpy at P1_m, x1
h3_m	real	316.0	Enthalpy at point 3
rho_ref	Real	320.0	Refrigerant density (entering of the compressor)
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC97 STATION 1_on_aut

Within the followings "segments", the subroutines needed to performed the meassurement of the sensors, the conditionate of the signals, the control,...of the station 1, will be summoned.

Segm.: 1 Meassurement of sensors or employment of theoretical values

The FC 5 is summoned to storage the meassures of the sensors (after have beeing conditionated),or the theoretical values (in case of not beeing connected)-->call the FC 6

The parameters IN_X correspond to the analog input direcctions of the sensors. Directions of STATION 1 start with a "3".

To developpe the code for the rest of stations,the direcctions would have to be changed.(STATION 2->starts with a "4" STATION 3-> "5"...)

The paremeters DB_X shows the direcction in wich the data must be storaged

```
CALL  "AUT_SensON/OFF->th/calc"                    FC5
 IN_T1          :=#IN_T1                           #IN_T1        -- Analog INPUT of T1
 IN_T2          :=#IN_T2                           #IN_T2        -- Analog INPUT of T2
 IN_T3          :=#IN_T3                           #IN_T3        -- Analog INPUT of T3
 IN_Tin         :=#IN_Tin                          #IN_Tin       -- Analog INPUT of Tin
 IN_Tout        :=#IN_Tout                         #IN_Tout      -- Analog INPUT of Tout
 IN_P1          :=#IN_P1                           #IN_P1        -- Analog INPUT of P1
 IN_P2          :=#IN_P2                           #IN_P2        -- Analog INPUT of P2
 IN_P3          :=#IN_P3                           #IN_P3        -- Analog INPUT of P3
 IN_m_ref       :=#IN_m_ref                        #IN_m_ref     -- Analog INPUT of m_ref
 IN_m_w         :=#IN_m_w                          #IN_m_w       -- Analog INPUT of m_w
```

```
T1_connected        :=#T1_connected                                       #T1_connected      -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
T2_connected        :=#T2_connected                                       #T2_connected      -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
T3_connected        :=#T3_connected                                       #T3_connected      -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
Tin_connected       :=#Tin_connected                                      #Tin_connected     -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
Tout_connected      :=#Tout_connected                                     #Tout_connected    -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
P1_connected        :=#P1_connected                                       #P1_connected      -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
P2_connected        :=#P2_connected                                       #P2_connected      -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
P3_connected        :=#P3_connected                                       #P3_connected      -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
m_ref_connected     :=#m_ref_connected                                    #m_ref_connected   -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
m_w_connected       :=#m_w_connected                                      #m_w_connected     -- 0->
                                                                          sensor not connected, 1-->
                                                                           sensor connected
T1_calc             :=#T1sat                                              #T1sat             -- Satu
                                                                          ration temperature at 1, t
                                                                          heoretical value of T1
T2_calc             :=#T2deseada                                          #T2deseada         -- Desi
                                                                          red temperature at point 2
                                                                          r, after the heating resis
                                                                          tance
T3_calc             :=#T2sat                                              #T2sat             -- Satu
                                                                          ration temperature at pres
                                                                          sure P2
P3_calc             :=#DB_P2                                              #DB_P2             -- Indi
                                                                          cate the direction in whic
                                                                          h the value (measured/theo
                                                                          rical) must be stored
m_ref_calc          :=#m_ref_grams           //M_ref that would be stored #m_ref_grams       -- Refi
                                              if the sensor hasn't been c rgerant flux calculated in
                                             onnected --> in g/s           g/s
m_w_calc            :=#flow_w_lit_min                                     #flow_w_lit_min    -- Wate
                                                                          r flux calculated in l/min
displ               :=#displ                                              #displ             -- Disp
                                                                          lacement of the compressor
rpm                 :=#rpm                                                #rpm               -- rpm
                                                                          of the compressor
Cp_w                :=4.180000e+000
delta_T_resistance  :=#delta_T_resistance                                 #delta_T_resistance -- Ext
                                                                          ra temperature degrees to
                                                                          be obtained above the sat.
                                                                           T by the  resistance
P1_set              :=#P1_set                                             #P1_set            -- Set
                                                                          pressured at the operating
                                                                           point 1
c_vol               :=#c_vol                                              #c_vol             -- Coef
                                                                          ficient  of  the second de
                                                                          gree equation to calculate
                                                                           the volumetric eff.
b_iso               :=#b_iso                                              #b_iso             -- Coef
                                                                          ficient  of  the second de
                                                                          gree equation to calculate
                                                                           the isentropic eff.
c_iso               :=#c_iso                                              #c_iso             -- Coef
                                                                          ficient  of  the second de
                                                                          gree equation to calculate
                                                                           the isentropic eff.
a_iso               :=#a_iso                                              #a_iso             -- Coef
                                                                          ficient  of  the second de
                                                                          gree equation to calculate
                                                                           the isentropic eff.
a_vol               :=#a_vol                                              #a_vol             -- Coef
                                                                          ficient  of  the second de
                                                                          gree equation to calculate
                                                                           the volumetric eff.
b_vol               :=#b_vol                                              #b_vol             -- Coef
                                                                          ficient  of  the second de
                                                                          gree equation to calculate
                                                                           the volumetric eff.
Mode_manual_automatic:=#Mode_manual_automatic                             #Mode_manual_automatic --
                                                                          When mode is manual->1, UD
                                                                          T8
```

```
UDT11_12            :=#UDT11_12                       #UDT11_12           -- When
                                                       it is 1->inputs to the UD
                                                      T 11, when it is 0->output
                                                      s to UDT12
x1                  :=#x1                             #x1                 -- Qual
                                                      ity of the refrigerant, UD
                                                      T 1
ref_number          :=#ref_number                     #ref_number         -- Refr
                                                      igerant number (0->r134a,
                                                      1->r410a, 2->r407c, 3->r22
                                                      , 4->r290)
rho_water           :=9.989000e+002
DB_T1               :=#DB_T1                          #DB_T1              -- Indi
                                                      cate the direction in whic
                                                      h the value (measured/theo
                                                      rical) must be stored
DB_T3               :=#DB_T3                          #DB_T3              -- Indi
                                                      cate the direction in whic
                                                      h the value (measured/theo
                                                      rical) must be stored
DB_P3               :=#DB_P3                          #DB_P3              -- Indi
                                                      cate the direction in whic
                                                      h the value (measured/theo
                                                      rical) must be stored
DB_m_ref            :=#DB_m_ref                       #DB_m_ref           -- Indi
                                                      cate the direction in whic
                                                      h the value (measured/theo
                                                      rical) must be stored
Tin_chiller         :=#Tin_chiller                    #Tin_chiller        -- Temp
                                                      erature fixed with the chi
                                                      ller
DB_Tout             :=#DB_Tout                        #DB_Tout            -- Indi
                                                      cate the direction in whic
                                                      h the value (measured/theo
                                                      rical) must be stored
m_ref_grams         :=#m_ref_grams                    #m_ref_grams        -- Refi
                                                      rgerant flux calculated in
                                                       g/s
flow_w_lit_min      :=#flow_w_lit_min                 #flow_w_lit_min     -- Wate
                                                      r flux calculated in l/min
T2_deseada          :=#T2deseada                      #T2deseada          -- Desi
                                                      red temperature at point 2
                                                      r, after the heating resis
                                                      tance
m_ref_th            :=#m_ref_th                       #m_ref_th           -- Refr
                                                      igerant flux in kg/s
Qcond_necesitado    :=#Qcond_necesitado               #Qcond_necesitado   -- Heat
                                                       exchanged needed in the c
                                                      ondenser
m_w_th              :=#m_w_th                         #m_w_th             -- Wate
                                                      r flux in kg/s
rend_iso_th         :=#rend_iso_th                    #rend_iso_th        -- Isen
                                                      tropc efficiency computed
                                                      with the second degree equ
                                                      ation
PR                  :=#PR                             #PR                 -- Pres
                                                      sure ratio P2measured/P1 s
                                                      et
rend_vol_th         :=#rend_vol_th                    #rend_vol_th        -- Volu
                                                      metric efficiency computed
                                                        with the second degree e
                                                      quation
DB_P2               :=#DB_P2                          #DB_P2              -- Indi
                                                      cate the direction in whic
                                                      h the value (measured/theo
                                                      rical) must be stored
DB_Tin              :=#DB_Tin                         #DB_Tin             -- Indi
                                                      cate the direction in whic
                                                      h the value (measured/theo
                                                      rical) must be stored
h1                  :=#h3_th                          #h3_th              -- Enth
                                                      alpy at P1_m, x1
h1_th               :=#h1_th                          #h1_th              -- Enth
                                                      alpy at the desired pressu
                                                      re and quality
h3_th               :=#h3_th                          #h3_th              -- Enth
                                                      alpy at P1_m, x1
h2_th               :=#h2_th                          #h2_th              -- Enth
                                                      alpy at point 2, with the
                                                      theoretical values
h3_m                :=#h3_m                           #h3_m               -- Enth
                                                      alpy at point 3
h2_m                :=#h2_m                           #h2_m               -- Enth
                                                      alpy at 2, with  the "meas
                                                      ured"value of T2 (if its i
                                                      mplemented)
T2sat               :=#T2sat                          #T2sat              -- Satu
                                                      ration temperature at pres
                                                      sure P2
```

```
      m_ref_div_rho        :=#m_ref_div_rho                                  #m_ref_div_rho     -- m_re
                                                                              f/rho, displ [m^3/rev]*eff
                                                                              _vol*rps [rev/s]
      DB_P1                :=#DB_P1                                          #DB_P1             -- Indi
                                                                              cate the direction in whic
                                                                              h the value (measured/theo
                                                                              rical) must be stored
      DB_m_w               :=#DB_m_w                                         #DB_m_w            -- Indi
                                                                              cate the direction in whic
                                                                              h the value (measured/theo
                                                                              rical) must be stored
      DB_T2                :=#DB_T2                                          #DB_T2             -- Indi
                                                                              cate the direction in whic
                                                                              h the value (measured/theo
                                                                              rical) must be stored
      Ref_number_11        :=#Ref_number_11                                  #Ref_number_11     -- Refr
                                                                              igerant number, UDT 11
      P1_m_11              :=#P1_m_11                                        #P1_m_11           -- P1_m
                                                                              , UDT 11
      P1_set_11            :=#P1_set_11                                      #P1_set_11         -- P1_s
                                                                              et, UDT 11
      x1_11                :=#x1_11                                          #x1_11             -- x1,
                                                                              UDT 11
      Tout_m_11            :=#Tout_m_11                                      #Tout_m_11         -- Tout
                                                                              _m, UDT 11
      P2_m_11              :=#P2_m_11                                        #P2_m_11           -- P2_m
                                                                              , UDT 11
      delta_T_resistance_11:=#delta_T_resistance_11                          #delta_T_resistance_11 --
                                                                              delta_T_resistance, UDT 11
      m_w_m_11             :=#m_w_m_11                                       #m_w_m_11          -- m_w_
                                                                              m, UDT 11
      m_ref_div_rho_11     :=#m_ref_div_rho_11                               #m_ref_div_rho_11  -- m-re
                                                                              f_div_rho, UDT 11
      T2_m_11              :=#T2_m_11                                        #T2_m_11           -- T2_m
                                                                              , UDT 11
      T1sat_12             :=#T1sat_12                                       #T1sat_12          -- T1_s
                                                                              at,UDT 12
      h1_th_12             :=#h1_th_12                                       #h1_th_12          -- h1_t
                                                                              h, UDT 12
      h1_12                :=#h1_12                                          #h1_12             -- h1,
                                                                              UDT 12
      T2sat_12             :=#T2sat_12                                       #T2sat_12          -- T2sa
                                                                              t, UDT 12
      h2_th_12             :=#h2_th_12                                       #h2_th_12          --  h2_
                                                                              th,UDT 12
      h3_th_12             :=#h3_th_12                                       #h3_th_12          -- h3_t
                                                                              h, UDT 12
      T2desired_12         :=#T2desired_12                                   #T2desired_12      -- T2de
                                                                              sired, UDT 12
      rho_ref_12           :=#rho_ref_12                                     #rho_ref_12        -- rho_
                                                                              ref, UDT 12
      h2_m_12              :=#h2_m_12                                        #h2_m_12           -- h2_m
                                                                              , UDT 12
      h3_m_12              :=#h3_m_12                                        #h3_m_12           -- h3_m
                                                                              , UDT 12
      m_ref_th_12          :=#m_ref_th_12                                    #m_ref_th_12       -- m_re
                                                                              f_th, UDT 12
      m_ref_grams_12       :=#m_ref_grams_12                                 #m_ref_grams_12    -- m_re
                                                                              f_grams, UDT 12
      T1sat                :=#T1sat                                          #T1sat             -- Satu
                                                                              ration temperature at 1, t
                                                                              heoretical value of T1
      T2desired            :=#T2desired                                      #T2desired         -- Desi
                                                                              red temperature after the
                                                                              heating resistance
      rho_ref              :=#rho_ref                                        #rho_ref           -- Refr
                                                                              igerant density (entering
                                                                              of the compressor)


//The variables X_calc-->might not be necesaies if we dont want to store the calculated  values in the DB were
 the measured values are being kept.
```

Segm.: 2 PID Control: Pump, EEV & Resistance
Once that the real and desired values are known (they have been import/export from a database), the control orders must be defined.

```
     CALL  "AUT_Control PID"               FC7
      P3                  :=#DB_P3          #DB_P3             -- Indicate the direction in which the value
                                             (measured/theorical) must be stored
      P1_set              :=#P1_set         #P1_set            -- Set pressured at the operating point 1
      OFF                 :=#OFF            #OFF               -- Indicator of the OFF state of the station
```

```
       m_w_th              :=#m_w_th          #m_w_th            -- Water flux in kg/s
       m_w                 :=#DB_m_w          #DB_m_w            -- Indicate the direction in which the value
                                               (measured/theorical) must be stored
       T2deseada           :=#T2deseada       #T2deseada         -- Desired temperature at point 2r, after th
                                              e heating resistance
       T2                  :=#DB_T2           #DB_T2             -- Indicate the direction in which the value
                                               (measured/theorical) must be stored
       P1                  :=#DB_P1           #DB_P1             -- Indicate the direction in which the value
                                               (measured/theorical) must be stored
       resistance_relay_dir:=#Dir_res         #Dir_res           -- Digital output--> Resistance (x.1)
       Dir_pump            :=#Dir_pump        #Dir_pump          -- Analog output-> PUMP ("2+x"24)
       Dir_EEV             :=#Dir_EEV         #Dir_EEV           -- Analog output--> EEV  ("2+x"28)
       orden_EEV           :=#orden_EEV_int   #orden_EEV_int     -- EEV order, INT
       orden_pump          :=#orden_pump_real #orden_pump_real   -- Pump order, REAL
       orden_pump_int      :=#orden_pump_int  #orden_pump_int    -- Pump order, INT
       orden_EEVreal       :=#orden_EEVreal   #orden_EEVreal     -- EEV order, REAL



//Compressor ON

      UN     #ON_OFF                          #ON_OFF            -- Indicates when the station is ON (-->1),
                                              or OFF (-->0)
      =      #OFF                             #OFF               -- Indicator of the OFF state of the station

      S      #Dir_comp                        #Dir_comp          -- Digital output that controls the compress
                                              or (x.0)
```

FC98 - <offline>

"MAN_SensON/SensOFF->th"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 07/06/2014 10:44:17
Interface: 05/06/2014 12:20:55
Longitud (bloque / código / datos): 00780 00586 00016

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
IN_T2	Int	0.0	Analog INPUT of T2
IN_P1	Int	2.0	Analog INPUT of P1
IN_P2	Int	4.0	Analog INPUT of P2
IN_P3	Int	6.0	Analog INPUT of P3
IN_m_w	Int	8.0	Analog INPUT of m_w
T2_connected	Bool	10.0	0-> sensor not connected, 1--> sensor connected
P1_connected	Bool	10.1	0-> sensor not connected, 1--> sensor connected
P2_connected	Bool	10.2	0-> sensor not connected, 1--> sensor connected
P3_connected	Bool	10.3	0-> sensor not connected, 1--> sensor connected
m_w_connected	Bool	10.4	0-> sensor not connected, 1--> sensor connected
T2_calc	Real	12.0	Theoretical/set/calculated value of the magnitude
P3_calc	Real	16.0	Theoretical/set/calculated value of the magnitude->P2
Mode_manual_automatic	Bool	20.0	When mode is manual->1, UDT8
OUT		0.0	
IN_OUT		0.0	
DB_P1	Real	22.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_P2	Real	26.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_P3	Real	30.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_T2	Real	34.0	Indicate the direction in which the value (measured/theorical) must be stored
DB_m_w	Real	38.0	Indicate the direction in which the value (measured/theorical) must be stored
T2sat	Real	42.0	Saturation temperature at pressure P2
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC98 Meassurement of the sensors/calculate the theoretical values

The meassurements of the sensors will be conditionate and stored. First the sensors that MUST BE CONECTED would be measured.
With this measured values, the theoretial ones can be computed.
Then the progam check wether T1, T2, P3 andm_ref are connected. If they are, it measures their values, otherwise, the thoeretical values calculated are stored.

Segm.: 1 Meassurement of the sensors IMPLEMENTED FOR SURE
The data will be meassured, conditionate and stored. The FC 105 "SCALE" takes an input between the Hi and Lo limits, and transforms it in a biòlar way (-27.648, +27.648) or unipolar(0,+ 27.648), obtaining an output between K1 and K2 (0,27.648)--> unipolar

```
//TEMPERATURE T_OUT

//     U     #Tout_connected
//     SPB   To_M

//PRESSURE 1

      U     #P1_connected                         #P1_connected      -- 0-> sensor not
                                                  connected, 1--> sensor connected
      SPB   M_P1

//PRESSURE 2

C_P2: U     #P2_connected                         #P2_connected      -- 0-> sensor not
                                                  connected, 1--> sensor connected
      SPB   M_P2
      SPA   SEG2



//***************//
// MEASUREMENTS  //
//***************//


//To_M: CALL  "SCALE"                    // Termopar Tout
//       IN     :=#IN_Tout
//       HI_LIM :=3.000000e+001
//       LO_LIM :=5.000000e+000
//       BIPOLAR:=FALSE
//       RET_VAL:=MW0
//       OUT    :=#DB_Tout
//Check the sensor P2
//   SPA   C_P1


M_P1: CALL  "SCALE"           //Presión 1, puesto 1      FC105              -- Scaling Values
       IN     :=#IN_P1                                  #IN_P1             -- Analog INPUT of
                                                         P1
       HI_LIM :=6.000000e+001
       LO_LIM :=1.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_P1                                  #DB_P1             -- Indicate the di
                                                        rection in which the value (measured/
                                                        theorical) must be stored
// Check the sensor P2
      SPA   C_P2


M_P2: CALL  "SCALE"           //Presión 2, puesto 1      FC105              -- Scaling Values
       IN     :=#IN_P2                                  #IN_P2             -- Analog INPUT of
                                                         P2
       HI_LIM :=6.000000e+001
       LO_LIM :=1.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_P2                                  #DB_P2             -- Indicate the di
                                                        rection in which the value (measured/
                                                        theorical) must be stored

      SPA   SEG2
```

Segm.: 2 EXCEL INTERFACE

```
//**WITH THE DATA MEASURED  WE HAVE TO OBTAIN rho_ref....
//SENT
//-->P1measured,P1_set,x1, P2mesaured,delta_T_resistence,T2desired
//--> Tin_chiller, Tout measured, Refrigerant--> Num_ref(0->134a,1->410a,2->407c, 3->22)

//RECEIVE
//--> T1sat, T2 sat
//-->h1_th(P1set,x1),h1(P1,x1), h2_th (P2,T2desired), h3_th (P2, T2sat),
//--> rho_ref, rho_water
```

```
//T1_SAT TIENE QUE SER CALCULADA, SI NO HAY SENSOR EN T1 ENTONCES SE TOMA ESE VALOR COMO REAL

SEG2: NOP   0


      SPA   SEG4
```

Segm.: 3 Check and measured the rest of the sensors
If the rest of the sensors are not connected, the theroretical values calculated above must be stored.

```
//TEMPERATURE 1

//SEG4:// U     #T1_connected
// SPB   T1_M

//If the sensor is not connected, we employ de theoretical value
//NO se si esto debería hacerse.Cuando no haya sensor, nos lo incica el X_conectado
//Si no está conecttado en las parametrizado habrá que poner el valor teórico y el "medido"
//Yque el código emplee para los cálculos uno o otro dependiendo del resultado.

//La gráfica dibuja lo del DB_T1 (medido) si queremos evitar que dibuje el valor teórico cuando no esta conect
ado
//habria que guardar el teórico en otro lado

//   CALL  "Sensor conect/desconect"
//       Sensor_conectado:=#T1_connected
//       Valor_teorico   :=
//       Valor_a_GUARDAR :=

//TEMPERATURE 2

SEG4: NOP   0
      U     #T2_connected                                                    #T2_connected      -- 0-> sensor
                                                                             not connected, 1--> sensor connec
                                                                             ted
      SPB   T2_M

      CALL  "Sensor conect/desconect"                                        FC3
       Sensor_conectado:=#T2_connected                                       #T2_connected      -- 0-> sensor
                                                                             not connected, 1--> sensor connec
                                                                             ted
       Valor_teorico   :=#T2_calc       //T2 sat + delta_T                   #T2_calc           -- Theoretical
                                                                             /set/calculated value of the magn
                                                                             itude
       Valor_a_GUARDAR :=#DB_T2                                              #DB_T2             -- Indicate th
                                                                             e direction in which the value (m
                                                                             easured/theorical) must be stored

//If the sensor T2 is connected, then the value meassured (after the aconditionating processs)
//then, it will be storaged in the UDT1_1.T2
//If not, the corresponding value of T2sat ( saturation temperature at the pressure P2)
//will be considered as valid, and storaged in the UDT

//TEMPERATURE 3

//C_T3: U     #T3_connected
//  SPB   T3_M

//    CALL  "Sensor conect/desconect"
//       Sensor_conectado:=#T3_connected
//       Valor_teorico   :=#T3_calc       //T2sat
//       Valor_a_GUARDAR :=#DB_T3

//If the sensor T3 is connected, then the value meassured (after the aconditionating processs)
//then, it will be storaged in the UDT1_1.T3
//If not, the corresponding value of T2sat ( saturation temperature at the pressure P2=P3)
// will be considered as valid, and storaged in the UDT1_T3

//TEMPERATURE T_IN

//C_Ti: U     #Tin_connected
// SPB   Ti_M

//If the sensor is not connected, we employ de theoretical value

//   CALL  "Sensor conect/desconect"
//       Sensor_conectado:=#Tin_connected
//       Valor_teorico   :=#Tin_chiller
//       Valor_a_GUARDAR :=#DB_Tin


//PRESSURE 3
```

```
C_P3: U     #P3_connected                                              #P3_connected      -- 0-> sensor
                                                                       not connected, 1--> sensor connec
                                                                       ted

      SPB   M_P3

//If the sensor is not connected, we employ the value of P2 MEASSURED

      CALL  "Sensor conect/desconect"                                  FC3
       Sensor_conectado:=#P3_connected                                 #P3_connected      -- 0-> sensor
                                                                       not connected, 1--> sensor connec
                                                                       ted
       Valor_teorico   :=#P3_calc                                      #P3_calc           -- Theoretical
                                                                       /set/calculated value of the magn
                                                                       itude->P2
       Valor_a_GUARDAR :=#DB_P3                                        #DB_P3             -- Indicate th
                                                                       e direction in which the value (m
                                                                       easured/theorical) must be stored


//WATER

C_WF: U     #m_w_connected                                             #m_w_connected     -- 0-> sensor
                                                                       not connected, 1--> sensor connec
                                                                       ted

      SPB   W_M

      SPA   SEG5



//IF THE SENSORS ARE CONNECTED//

//T1_M: CALL  "SCALE"                    // Meassure T1, T1
//        IN     :=#IN_T1
//        HI_LIM :=8.000000e+001
//        LO_LIM :=5.000000e+000
//        BIPOLAR:=FALSE
//        RET_VAL:=MW0
//        OUT    :=#DB_T1
//Go to the comprobation of the sensor T2
//      SPA   C_T2


T2_M: CALL  "SCALE"                    // Measured  T2                 FC105              -- Scaling Val
                                                                       ues
       IN     :=#IN_T2                                                 #IN_T2             -- Analog INPU
                                                                       T of T2
       HI_LIM :=8.000000e+001
       LO_LIM :=5.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_T2                                                 #DB_T2             -- Indicate th
                                                                       e direction in which the value (m
                                                                       easured/theorical) must be stored

//Check the sensor T2
//    SPA   C_T3


//T3_M: CALL  "SCALE"                    // Termopar 1, T3_P1
//        IN     :=#IN_T3
//        HI_LIM :=8.000000e+001
//        LO_LIM :=5.000000e+000
//        BIPOLAR:=FALSE
//        RET_VAL:=MW0
//        OUT    :=#DB_T3

// Check the sensor Tin
//      SPA   C_Ti


//Ti_M: CALL  "SCALE"                    // Termopar 1, Tin_P1
//        IN     :=#IN_Tin
//        HI_LIM :=3.000000e+001
//        LO_LIM :=5.000000e+000
//        BIPOLAR:=FALSE
//        RET_VAL:=MW0
//        OUT    :=#DB_Tin




// Check the sensor P3

      SPA   C_P3


M_P3: CALL  "SCALE"                    //Presión 3, puesto 1           FC105              -- Scaling Val
                                                                       ues
```

```
       IN     :=#IN_P3                                                     #IN_P3            -- Analog INPU
                                                                           T of P3
       HI_LIM :=6.000000e+001
       LO_LIM :=1.000000e+000
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_P3                                                     #DB_P3            -- Indicate th
                                                                           e direction in which the value (m
                                                                           easured/theorical) must be stored
// Check the sensor m_ref
      SPA   C_WF


W_M:  CALL  "SCALE"                    //m_w                               FC105             -- Scaling Val
                                                                           ues
       IN     :=#IN_m_w                                                    #IN_m_w           -- Analog INPU
                                                                           T of m_w
       HI_LIM :=5.500000e+001          //lo máximo son 5 l/min, pongo 5,5 l/min
       LO_LIM :=0.000000e+000          //lo mínimo es 0.25 l/min, pongo 0.0 l/min
       BIPOLAR:=FALSE
       RET_VAL:=MW0
       OUT    :=#DB_m_w                                                    #DB_m_w           -- Indicate th
                                                                           e direction in which the value (m
                                                                           easured/theorical) must be stored

      SPA   SEG5
```

Segm.: 4 EXCEL INTERFACE 2.0
h2, h3, rho_w....with the new measurements of the sensors (in case that they have been connected)their values might change

```
//**WITH THE DATA MEASURED  WE HAVE TO OBTAIN rho_ref....
//SENT
//-->T1 measured, P1measured,P1_set,x1, P2mesaured, T2 measured, P3 measured, T3 measured
//--> Tin_chiller, Tout measured,

//RECEIVE
//-->h1_th,h1, h2,h3,rho_ref, rho_water, Cp_w

SEG5: NOP   0
      SPA   END
```

Segm.: 5 END
END segment

```
END:  NOP   0
```

FC99 - <offline>

"DiagramIntermitences"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 11/06/2014 16:46:08
Interface: 09/06/2014 17:55:42
Longitud (bloque / código / datos): 00186 00078 00002

Nombre	Tipo de datos	Dirección	Comentario
IN		0.0	
intermitencias	Int	0.0	Controls the "movement" of the diagram in WINCC
ON_OFF	Bool	2.0	ON_OFF of the station
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
Reset_end_timer	Bool	0.0	End of the time, reset the timer
RETURN		0.0	
RET_VAL		0.0	

Bloque: FC99 INTERMITENCES

In the HMI (WINCC) the diagram that shows the cycle, the refriigerant flux can be added. In other words, thereis the possibility to create "intermitences" and

make the illusion that the user is actually seing the refrigerant flux.

Segm.: 1 Timer

The timer would set when the variable "intermitencias", that controls the "movement" of the diagram, increase its value.

```
      U     #Reset_end_timer  #Reset_end_timer   -- End of the time, reset the timer
      FR    T     99

      U     #ON_OFF           #ON_OFF            -- ON_OFF of the station
      L     S5T#100MS
      SE    T     99
      U     T     99
      =     #Reset_end_timer  #Reset_end_timer   -- End of the time, reset the timer
      U     #Reset_end_timer  #Reset_end_timer   -- End of the time, reset the timer
      SPB   ADD
      SPA   END

ADD:  L     #intermitencias   #intermitencias    -- Controls the "movement" of the diagram in WINCC
      L     1
      +I
      T     #intermitencias   #intermitencias    -- Controls the "movement" of the diagram in WINCC

      L     #intermitencias   #intermitencias    -- Controls the "movement" of the diagram in WINCC
      L     9
      ==I
      SPB   RSET
      SPA   END

RSET: L     0
      T     #intermitencias   #intermitencias    -- Controls the "movement" of the diagram in WINCC



END:  NOP   0
```

DB10 - <offline> - Declaración

"Puestos1"
DB de datos globales 10
Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 11/06/2014 16:31:09
Interface: 11/06/2014 16:31:09
Longitud (bloque / código / datos): 00862 00402 00000

Bloque: DB10

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	UDT1_1	"Vector_Sensors_&_Quality"		
+64.0	UDT2_1	"ThermodynamicProperties"		
+198.0	UDT3_1	"Control Orders"		
+234.0	UDT4_1	"Sensors&Stations_Actives"		
+244.0	UDT5_1	"Conversions"		
+268.0	UDT6_1	"Aux_Operations"		
+306.0	UDT7_1	"Coeff for the eff, PR"		
+354.0	UDT8_1	"WINCC_var"		
+370.0	UDT9_1	"START/STOP"		
+372.0	UDT10_1	"AlarmSettings"		
+400.0	STOP_ALL	BOOL	FALSE	All the stations must be turned off simustaneously
+400.1	START_ALL	BOOL	FALSE	All the stations must be turned on simustaneuosly
=402.0		END_STRUCT		

DB11 - <offline> - Declaración

"Excel_Interface"
DB de datos globales 11

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 13/06/2014 16:29:03
Interface: 13/06/2014 16:29:03
Longitud (bloque / código / datos): 00224 00086 00000

Bloque: DB11

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	UDT11_1	"Excel_INPUTS"		
+38.0	UDT12_1	"Excel_OUTPUTS"		
=86.0		END_STRUCT		

UDT1 - <offline>

"Vector_Sensors_&_Quality"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 04/06/2014 13:37:42
Interface: 04/06/2014 13:37:42
Longitud (bloque / código / datos): 00000 00000 00000

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	x1	REAL	0.000000e+000	Quality
+4.0	T1_m	REAL	0.000000e+000	Input temperature of the compressors refrigerant
+8.0	T2_m	REAL	0.000000e+000	Input temperature of the condenser
+12.0	T3_m	REAL	0.000000e+000	Output temperature of the condenser
+16.0	Tin_m	REAL	0.000000e+000	Water input temperature
+20.0	Tout_m	REAL	0.000000e+000	Water output temperature
+24.0	P1_m	REAL	0.000000e+000	Input pressure of the compressor
+28.0	P2_m	REAL	0.000000e+000	input pressure of the condenser
+32.0	P3_m	REAL	0.000000e+000	Output pressure of the condenser
+36.0	m_ref_m	REAL	0.000000e+000	Refrigerant flux
+40.0	m_w_m	REAL	0.000000e+000	Water flux
+44.0	P1_set	REAL	0.000000e+000	Pressure desired at point one
+48.0	Tin_chiller	REAL	0.000000e+000	Tin temperature fixed with the chiller
+52.0	Ref_number	INT	0	0->R134A , 1->R410A, 2->R407C, 3->R22
+54.0	c111	INT	0	
+56.0	C12	REAL	0.000000e+000	
+60.0	C13	REAL	0.000000e+000	
=64.0		END_STRUCT		

UDT2 - <offline>

"ThermodynamicProperties"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 13/06/2014 15:11:53
Interface: 30/05/2014 17:17:00
Longitud (bloque / código / datos): 00000 00000 00000

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	Refrigerante	STRING[8]	'R134A'	
+10.0	h1_th	REAL	0.000000e+000	Enthalpy at point 1, according to the desired P1
+14.0	h2s_th	REAL	0.000000e+000	Theoretical enthalpy at the exit of the compressor , if it was isentropic
+18.0	h2c_th	REAL	0.000000e+000	Theoretical enthalpy at the exit of the compressor , no isentropic
+22.0	h2_m	REAL	0.000000e+000	Enthalpy at point 2, with measured data
+26.0	h3_m	REAL	0.000000e+000	Enthalpy at point 3, with measured data
+30.0	T2sat	REAL	0.000000e+000	Saturation temperature for P2
+34.0	T1sat	REAL	0.000000e+000	Theoretical temperatura ata point1, saturation temperature for P1
+38.0	T2c_th	REAL	0.000000e+000	Theoretical temperature at the exit of the compressor
+42.0	T2deseada	REAL	0.000000e+000	Desired temperatura at point 2, T2sat+delta_T_resistance
+46.0	s1	REAL	0.000000e+000	Entropy at point 1
+50.0	rho_ref	REAL	0.000000e+000	Refrigerant density at the entering og the compressor
+54.0	rho_ref_after_res	REAL	0.000000e+000	Refrigerant density after the heating resistance
+58.0	rho_water	REAL	0.000000e+000	Water density
+62.0	Cp_w	REAL	0.000000e+000	Especific heat
+66.0	delta_h_condenser	REAL	0.000000e+000	Difference of enthalpies in the condenser
+70.0	delta_h_res	REAL	0.000000e+000	Difference of enthalpies for the heating resistance
+74.0	delta_Pressure_EEV	REAL	0.000000e+000	Pressure's difference to achieve by the EEV
+78.0	delta_caudal_deseado_rea	REAL	0.000000e+000	Difference between the desired and the real water flux
+82.0	m_ref_th	REAL	0.000000e+000	Theoretical refrigerant flux (kg/s)
+86.0	m_w_th	REAL	0.000000e+000	Theoretical water flux (kg/s)
+90.0	Qcond_necesitado	REAL	0.000000e+000	Heat exchanged in the condenser
+94.0	Qres_necesitado	REAL	0.000000e+000	Heat exchanged by the resistance
+98.0	flow_w_lit_min	REAL	0.000000e+000	Desired water flux (l/min)
+102.0	rend_vol_th	REAL	0.000000e+000	Theorical volumetric efficiency
+106.0	rend_iso_th	REAL	0.000000e+000	Theorical isentropic efficiency
+110.0	rpm	REAL	0.000000e+000	Revolutions per minute
+114.0	displ	REAL	0.000000e+000	Displacement -->CC/rev
+118.0	h1	REAL	0.000000e+000	Enthalpy computed with the data of the sensor in the operating point 1
+122.0	delta_T_resistance	REAL	0.000000e+000	Extra temperature degrees above the sat.T° to be obtained by the resistance
+126.0	h2_th	REAL	0.000000e+000	Enthalpy at point 2, with theoretical data
+130.0	h3_th	REAL	0.000000e+000	Enthalpy at point 2, with theoretical data
=134.0		END_STRUCT		

UDT3 - <offline>

"Control Orders"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 04/06/2014 11:13:21
Interface: 02/06/2014 11:44:22
Longitud (bloque / código / datos): 00000 00000 00000

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	Orden_EEV_int	INT	0	Control signal of the EEV
+2.0	Orden_pump_int	INT	0	Control signal of the water pump
+4.0	Orden_resitance	BOOL	FALSE	Control pulse signal for the heating resitance
+6.0	Man_delta_T_res_int	INT	0	When manual mode is activated it gives the "order" for the resistance
+8.0	Man_delta_P_EEV_int	INT	0	When manual mode is activated it gives the "order" for the EEV
+10.0	Man_WF_pump_int	INT	0	When manual mode is activated it gives the "order" for the pump
+12.0	Man_delta_T_res_real	REAL	0.000000e+000	
+16.0	Man_delta_P_EEV_real	REAL	0.000000e+000	
+20.0	Man_WF_pump_real	REAL	0.000000e+000	
+24.0	C1	REAL	0.000000e+000	
+28.0	C2	REAL	0.000000e+000	
+32.0	C3	REAL	0.000000e+000	
=36.0		END_STRUCT		

UDT4 - <offline>

"Sensors&Stations_Actives"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 04/06/2014 10:02:29
Interface: 04/06/2014 10:02:29
Longitud (bloque / código / datos): 00000 00000 00000

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	Puesto_habilitado	BOOL	FALSE	Indicates if the station is "built", if it can be turned ON
+0.1	T1_conectado	BOOL	FALSE	Indicates the connection state of the sensor T1
+0.2	P1_conectado	BOOL	FALSE	Indicates the connection state of the sensor P1
+0.3	T2_conectado	BOOL	FALSE	Indicates the connection state of the sensor T2
+0.4	P2_conectado	BOOL	FALSE	Indicates the connection state of the sensor P2
+0.5	T3_conectado	BOOL	FALSE	Indicates the connection state of the sensor T3
+0.6	P3_conectado	BOOL	FALSE	Indicates the connection state of the sensor P3
+0.7	Tin_conectado	BOOL	FALSE	Indicates the connection state of the sensor Tin
+1.0	Tout_conectado	BOOL	FALSE	Indicates the connection state of the sensor Tout
+1.1	Qw_conectado	BOOL	FALSE	Indicates the connection state of the sensor Qw
+1.2	Resistance_conectado	BOOL	FALSE	Indicates ifa heating resistance can be uses
+1.3	m_ref_conectado	BOOL	FALSE	Indicates the connection state of the sensor m_ref
+1.4	ON_OFF	BOOL	FALSE	Indicates if the station is ON (ON=1, OFF=0)
+1.5	OFF	BOOL	TRUE	Indicates if the station is OFF(OFF=1, ON=0)
+1.6	AUXI_COMP	BOOL	FALSE	Its an auxiliar variable,in order to make the comparations
+1.7	AUXI_COMP_MANUAL	BOOL	FALSE	Its an auxiliar variable,in order to make the comparations in MANUAL mode
+2.0	c1	REAL	0.000000e+000	
+6.0	c2	INT	0	
+8.0	c3	BOOL	FALSE	
=10.0		END_STRUCT		

UDT5 - <offline>

"Conversions"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 04/06/2014 11:13:05
Interface: 04/06/2014 10:01:57
Longitud (bloque / código / datos): 00000 00000 00000

Propiedades del objeto:
S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	orden_EEVreal	REAL	0.000000e+000	EEV control order
+4.0	orden_pump_real	REAL	0.000000e+000	Pump control order, REAL
+8.0	P1	REAL	0.000000e+000	
+12.0	P2	REAL	0.000000e+000	
+16.0	P3	REAL	0.000000e+000	
+20.0	P4	INT	0	
+22.0	P5	WORD	W#16#0	
=24.0		END_STRUCT		

UDT6 - <offline>

"Aux_Operations"

Nombre: **Familia:**

Autor: **Versión:** 0.1

Versión del bloque: 2

Hora y fecha Código: 13/06/2014 15:13:47

Interface: 04/06/2014 09:59:31

Longitud (bloque / código / datos): 00000 00000 00000

Propiedades del objeto:

S7_language 9(1) Inglés (Estados Unidos) 23/05/2014 13:19:47

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	m_ref_grams	REAL	0.000000e+000	m_ref_th*1000--> [g/s]
+4.0	m_ref_div_rho	REAL	0.000000e+000	Is m_ref/rho--> displ[m^3/rev]*rps[rev/s]*rend_vol
+8.0	AUXI_2	REAL	0.000000e+000	
+12.0	AUXI_3	REAL	0.000000e+000	
+16.0	AUXI_4	REAL	0.000000e+000	
+20.0	AUXI_5	REAL	0.000000e+000	
+24.0	AUXI_6	REAL	0.000000e+000	
+28.0	AUXI_7	REAL	0.000000e+000	
+32.0	AUXI_8	INT	0	
+34.0	AUXI_9	INT	0	
+36.0	AUXI_10	INT	0	
=38.0		END_STRUCT		

UDT7 - <offline>

"Coeff for the eff, PR"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 13/06/2014 15:10:31
Interface: 03/06/2014 11:56:02
Longitud (bloque / código / datos): 00000 00000 00000

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	a_iso	REAL	0.000000e+000	Coefficient "a" of the second degree equation to calculate the isentropic eff.
+4.0	b_iso	REAL	0.000000e+000	Coefficient "b" of the second degree equation to calculate the isentropic eff.
+8.0	c_iso	REAL	0.000000e+000	Coefficient "c" of the second degree equation to calculate the isentropic eff.
+12.0	a_vol	REAL	0.000000e+000	Coefficient "a" of the second degree equation to calculate the volumetric eff.
+16.0	b_vol	REAL	0.000000e+000	Coefficient "b" of the second degree equation to calculate the volumetric eff.
+20.0	c_vol	REAL	0.000000e+000	Coefficient "c" of the second degree equation to calculate the volumetric eff.
+24.0	a1	REAL	0.000000e+000	
+28.0	a2	REAL	0.000000e+000	
+32.0	a3	REAL	0.000000e+000	
+36.0	PR	REAL	0.000000e+000	Pressure ratio P2measured/P1set--> To calculate the efficiencies
+40.0	PRint	INT	0	In manual modePressure ratio P2measured/P1set--> To calculate the efficiencies
+42.0	c1	INT	0	
+44.0	c2	REAL	0.000000e+000	
=48.0		END_STRUCT		

UDT8 - <offline>

"WINCC_var"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 11/06/2014 16:30:58
Interface: 09/06/2014 10:12:07
Longitud (bloque / código / datos): 00000 00000 00000

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	Num_puestos	INT	1	Variable que indica el numero de puestos POSIBLES a indicar como implementados
+2.0	intermitencia	INT	0	It shows the "circulation" od the refrigerant in the WINCC diagram
+4.0	Mode_Automatic_Manual	BOOL	TRUE	It determine wehter the cycle works automatically (1) or in a manual way (0)
+4.1	Manual_compressor	BOOL	FALSE	Test the correct functioning of the compressor in the manual mode
+4.2	Manual_resistance	BOOL	FALSE	Test the correct functioning of the resistance
+4.3	Manual_EEV	BOOL	FALSE	test the correct funtioning of the EEV
+4.4	Manual_Pump	BOOL	FALSE	Test the correct functioning of the pump
+4.5	Mode_manual_automatic	BOOL	FALSE	It determine wehter the cycle works automatically (0) or in a manual way (1)
+4.6	Equipment_button	BOOL	FALSE	Itchanges the color when the quick acces botton of the stations equipment.
+4.7	Setup_button	BOOL	FALSE	Itchanges the color when the quick acces botton of the stations set up.
+5.0	Equip_ref_select_all	BOOL	FALSE	
+5.1	Equip_water_select_all	BOOL	FALSE	
+5.2	b2	BOOL	FALSE	
+5.3	b3	BOOL	FALSE	
+5.4	b4	BOOL	FALSE	
+5.5	b5	BOOL	FALSE	
+5.6	b6	BOOL	FALSE	
+5.7	b7	BOOL	FALSE	
+6.0	C1	BYTE	B#16#0	
+8.0	C2	INT	0	
+10.0	C3	INT	0	
+12.0	c21	REAL	0.000000e+000	
=16.0		END_STRUCT		

UDT9 - <offline>

"START/STOP"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 05/06/2014 17:21:41
Interface: 04/06/2014 09:53:00
Longitud (bloque / código / datos): 00000 00000 00000

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	MAN_button_STOP	BOOL	TRUE	It is the stop order of the sation
+0.1	MAN_button_START	BOOL	FALSE	It is the start order
+0.2	Button_start_all	BOOL	FALSE	Just for the HMI
+0.3	Button_stop_all	BOOL	FALSE	Just for the HMI
+0.4	c12	BOOL	FALSE	
+0.5	c13	BOOL	FALSE	
=2.0		END_STRUCT		

UDT10 - <offline>

"AlarmSettings"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 16/06/2014 10:05:40
Interface: 11/06/2014 16:30:46
Longitud (bloque / código / datos): 00000 00000 00000

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	DeviationP1	REAL	0.000000e+000	Maximum deviation of P1 allowed
+4.0	DeviationT1	REAL	0.000000e+000	Maximum deviation of T1 allowed
+8.0	MaxP2	REAL	0.000000e+000	Maximum value of P2 allowed
+12.0	MaxT2	REAL	0.000000e+000	Maximum value of T2 allowed
+16.0	T1_Low	BOOL	FALSE	Indicates when the temperaute 1 is beyond the minimum valu e
+16.1	T1_High	BOOL	FALSE	Indicates when the temperature 1 is above the maximum valu e
+16.2	T1_Error	BOOL	FALSE	Inticates when an error because of the temperature 1 (lowe r o greater)
+16.3	P1_Low	BOOL	FALSE	Indicates when the pressure 1 is beyond the minimum value
+16.4	P1_High	BOOL	FALSE	Indicates when the pressure 1 is above the maximum value
+16.5	P1_Error	BOOL	FALSE	Indicates when an error because of the pressure 1 (lower o greater)
+16.6	T2_Error	BOOL	FALSE	Indicates when the temperature 2 is greater than the limit , ERROR
+16.7	P2_Error	BOOL	FALSE	Indicates when the pressure 2 is greater than the limit, E RROR
+17.0	Stable	BOOL	FALSE	Indicates when the station has been stabilized-->1
+17.1	Alarm	BOOL	FALSE	The alarm setttings haven't been fulfilled (after been sta bilized) for a X time
+17.2	UDT11_12	BOOL	FALSE	1-->import the data to UDT11, 0--> save the export data in UDT 12
+17.3	a2	BOOL	FALSE	
+17.4	a3	BOOL	FALSE	
+17.5	a4	BOOL	FALSE	
+17.6	a5	BOOL	FALSE	
+17.7	a6	BOOL	FALSE	
+18.0	CI	INT	0	
+20.0	C2	REAL	0.000000e+000	
+24.0	C3	REAL	0.000000e+000	
=28.0		END_STRUCT		

UDT11 - <offline>

"Excel_INPUTS"

Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 13/06/2014 16:23:32
Interface: 13/06/2014 16:23:32
Longitud (bloque / código / datos): 00000 00000 00000

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	Ref_number	INT	0	Is in UDT 1, for the excel interface
+2.0	P1_m	REAL	0.000000e+000	P1_measured, UDT1
+6.0	P1_set	REAL	0.000000e+000	P1 set, UDT 1
+10.0	x1	REAL	0.000000e+000	Quality of the refrigerant, UDT1
+14.0	Tout_m	REAL	0.000000e+000	Otput water temperature, UDT 1
+18.0	P2_m	REAL	0.000000e+000	Pressure after the heating resistance measured, UDT1
+22.0	delta_T_resistance	REAL	0.000000e+000	Delta T over the T2sat temperature to be chieve, UDT 2
+26.0	m_w_m	REAL	0.000000e+000	Water flux measured, UDT 1
+30.0	m_ref_div_rho	REAL	0.000000e+000	Auxiliar variable to calculate the refrigerant flux in the excel, UDT 6
+34.0	T2_m	REAL	0.000000e+000	Temperature after the heating resistance, UDT 1
=38.0		END_STRUCT		

UDT12 - <offline>

"Excel_OUTPUTS"

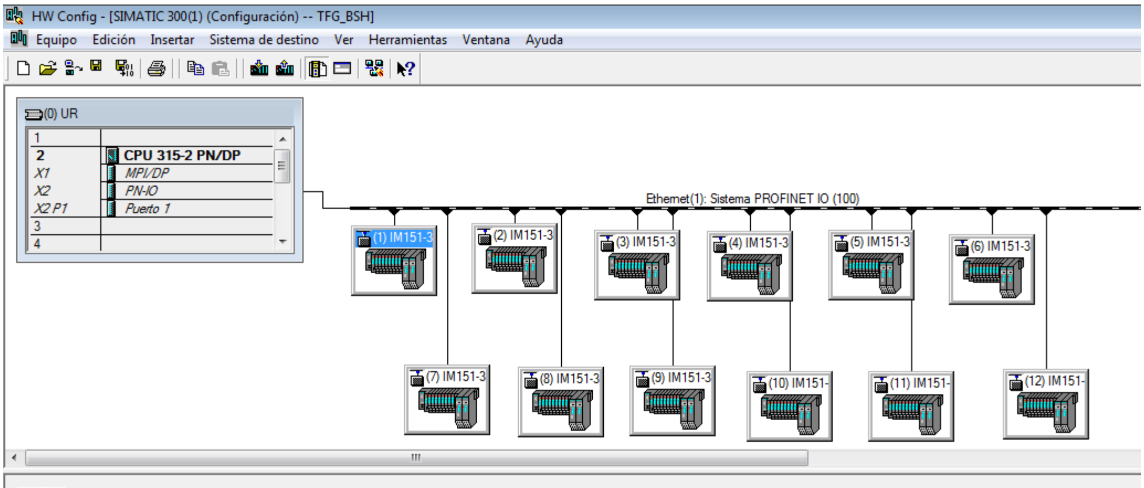
Nombre: **Familia:**
Autor: **Versión:** 0.1
Versión del bloque: 2
Hora y fecha Código: 16/06/2014 10:10:46
Interface: 13/06/2014 16:27:42
Longitud (bloque / código / datos): 00000 00000 00000

Dirección	Nombre	Tipo	Valor inicial	Comentario
0.0		STRUCT		
+0.0	T1sat	REAL	0.000000e+000	Saturation temperature at pressure P1_set, UDT 2
+4.0	h1_th	REAL	0.000000e+000	Enthalpy computed at pressure P1_set, UDT 2
+8.0	h1	REAL	0.000000e+000	Enthalpy computed at pressure P1_m, UDT 1
+12.0	T2sat	REAL	0.000000e+000	Saturation temperature at P2_m, UDT 2
+16.0	h2_th	REAL	0.000000e+000	Enthalpy computed with T2desired, UDT 2
+20.0	h3_th	REAL	0.000000e+000	Enthalpy computed with P1_set, is h1_th, UDT 2
+24.0	T2desired	REAL	0.000000e+000	Desired temperature after the resistance--> T2sat+delta_T, UDT 2
+28.0	rho_ref	REAL	0.000000e+000	Refrigerant density at the entering of the compressor UDT 1
+32.0	h2_m	REAL	0.000000e+000	Enthalpy computed with T2_m, UDT 2
+36.0	h3_m	REAL	0.000000e+000	Enthalpy equal to h1, UDT 2
+40.0	m_ref_th	REAL	0.000000e+000	Theoretical refrigernt flux [kg/s], UDT 2
+44.0	m_ref_grams	REAL	0.000000e+000	Theoretical refrigerant flux [g/s], UDT 6
=48.0		END_STRUCT		

34 HARDWARE & PLC- HMI CONNECTION

In STEP 7 de hardware connection of the twelve future stations, and their external modules, have been implemented. It was also needed to define the networks of the PLC, ET200 and the HMI to determine their interaction.

34.1 HARDWARE



Slot	Módulo ...	Referencia	Dirección E	Dirección S	Dirección de diagnóstico	Comentario
0	IM151-3PN	6ES7 151-3AA10-0AB0			2043*	
1	PM-E DC24..48V	6ES7 138-4CA50-0AB0			2037*	Alimentación ET200S
2	2AI TC HF	6ES7 134-4NB00-0AB0	300...303			Termopar 2 entradas
3	2AI TC HF	6ES7 134-4NB00-0AB0	304...307			Termopar 2 entradas
4	2AI TC HF	6ES7 134-4NB00-0AB0	308...311			Termopar 2 entradas
5	2AI I 2WIRE ST	6ES7 134-4GB00-0AB0	312...315			2 entradas corriente
6	2AI I 2WIRE ST	6ES7 134-4GB00-0AB0	316...319			2 entradas corriente
7	2AI I 2WIRE ST	6ES7 134-4GB00-0AB0	320...323			2 entradas corriente
8	2AO U ST	6ES7 135-4FB00-0AB0		324...327		2 salidas tensión
9	2AO I ST	6ES7 135-4GB01-0AB0		328...331		2 salidas corriente
10	2DO DC24V/0,5	6ES7 132-4BB01-0AA0		1.0...1.1		2 salidas 24 V/0,5 A, hay que poner un relé
11						

Figure 55- Hardware connection, 12 stations

34.2 PLC-HMI CONNECTION

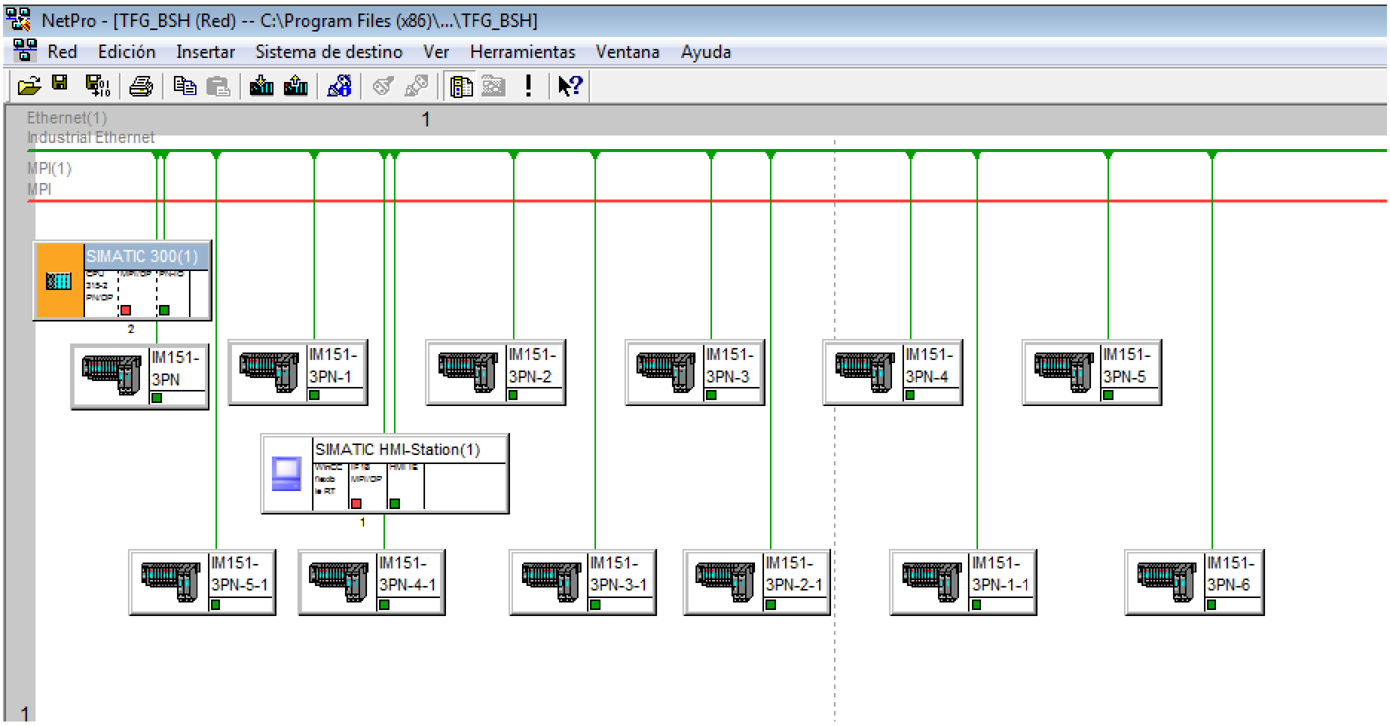


Figure 56- PLC,HMI and remotes connection

Each component has its own IP address, belonging to the same network:

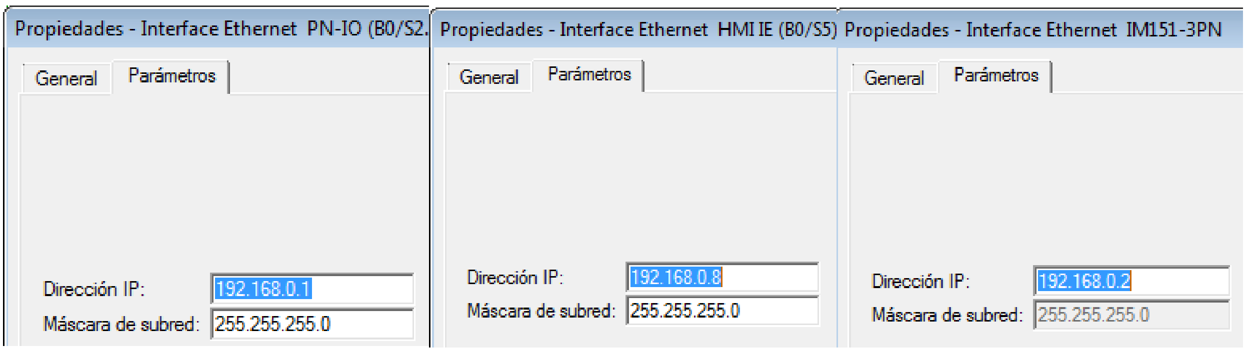


Figure 57- IP adress of the CPU, the HMI and the first station

ANNEX VIII: UNCERTAINTIES

1 EES CODE

```
R$='R134a'

m_ref=disp*rpm*eta_v*rho[1]
m_ref=0,007238 [kg/s]

disp=8,1/10^6  [m3]

rpm=2900/60  [rev/s]

eta_v=0,90


v[1]=1/rho[1]

P[1]=4                              "uncertainty that comes from 1 measures"


P_2rm=25
T_2rm=70
h[2]=enthalpy(R$;P=P_2rm;T=T_2rm)  "uncertainty that comes from 2 measures"



Q_cond=m_water*Cp(Water;T=23;P=1,013)*(T_wo-T_wi)  "uncertainty that comes from 3 measures"

T_wo=25
T_wi=24,50
m_water=8/60  [kg/s]

Q_cond=m_ref*(h_2rm-h[3])  "calculation of h[3]"

h[1]=h[3]
x[1]=quality(R$;v=v[1];P=P[1])
h[1]=enthalpy(R$;P=P[1];v=v[1])


u_x=0,009623/0,95*100
```

2 RESULT

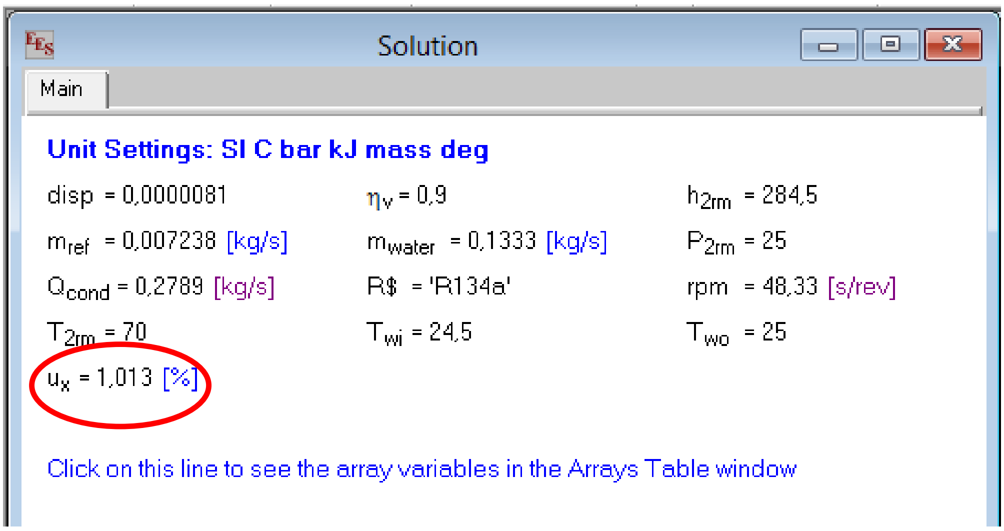


Figure 58- Uncertainties

As it is shown, the quality of the refrigerant at the entrance of the compressor, would be guarantee with a 1,013% of accuracy.

1 PUMP

USE AND MAINTENANCE INSTRUCTION MANUAL
TO BE KEPT BY THE USER

1. INTRODUCTION

Follow the instructions contained in this manual to obtain the best performance and the proper operation of the electropump.
For any further information, please contact your nearest authorized dealer.

The following symbols have been used in the handbook:

ATTENTION	**Risk of damage to the pump or plant**
⚠	**Risk of damage to persons or property**
⚡	**Electrical hazards**

2. INDEX

3. IDENTIFICATION DATA

3.1. MANUFACTURER

EBARA PUMPS EUROPE S.p.A.
Factory management:
Via Pacinotti, 32 - 36040 BRENDOLA (VI) ITALIA
Telephone: Tel. +39 0444 706811 - Fax: +39 0444/405811

Registered office:
Via Campo Sportivo, 30 - 38023 CLES (TN) ITALIA
Telephone: Tel. +39 0463 660411 - Fax: +39 0463/422782

4. WARRANTY AND TECHNICAL ASSISTANCE

Failure to comply with the indications supplied in this instruction book and/or any intervention on the unit not performed by our assistance centres, will make the warranty null and void and relieve the manufacturer from any liability in case of accidents to persons or damage to property and/or the unit itself.

5. GENERAL SAFETY PRECAUTIONS

Before operating the electropump, the user should know how to perform all operations described in this manual and apply them every time during the use or maintenance of the electropump.

The user must strictly observe the safety regulations in force in his country; he must also take into account the electropump features (see "data label"). The user must never carry out operations or interventions, which are not accepted in this manual, on his own initiative.

This device is not intended for use by persons (including children) with reduced physical, sensory and mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of this device by a person responsible for their safety.

During the repair or maintenance interventions of the electropump, take off the power supply, thus preventing the accidental starting that could cause damage to persons and/or property.

Any maintenance, installation or moving operations performed on the electropump with the electric system energized, can cause serious accidents or death to persons.

Do not start the unit when barefoot ,or worse, in water and with wet hands.

5.1. INTENDED USE

The circulating pumps E*go* (ER) -/40, E*go* (ER) -/60, and E*go* (ER) -/80 are designed for forced circulation of the fluid in central heating systems. They differ from standard fixed speed pumps by having the option of continuous adjustment of the pump operation to the actual needs of the system. This feature gives both great electrical and thermal saving together with reduced noise level in the installation. In order to guarantee a regular operating of the pump, a fluid which is appropriate for a central heating system, such as pure water or a solution of pure water and antifreeze, must be provided. The water must meet water quality standards, such as VDI 2035. Use the electropumps according to their specification.

5.2 NOT INTENDED USE

All uses not specifically mentioned in 5.1 are generally banned; in particular, the fluid must not contain aggressive or explosive additives, mixtures of mineral oils and/or solid or fibrous particles. The pump should not be used for pumping flammable or explosive media, or in an explosive atmosphere. To avoid formation of condensation in the pump, fluid temperature must be higher or equal to the ambient temperature.

6. TECHNICAL AND BUILDING FEATURES

6.1 TECHNICAL DATA

Supply voltage: 230V, 50Hz
Protection class: IP44
Insulation class: H

Motor protection: the pump is provided with a draining labyrinth inside the electromotor casting; do not insulate the pump as this can cause serious damage.

	E*go* (ER) -/40		E*go* (ER) -/60		E*go* (ER) -/80	
Speed/ pressure curve	Regulated mode [W]	Unregulated mode [W]	Regulated mode [W]	Unregulated mode [W]	Regulated mode [W]	Unregulated mode [W]
I	5-25	8	7-50	16	10-75	25
II	7-25	17	10-50	34	12-75	50
III	10-25	25	12-50	50	15-75	75

GB

6.2 LIMITS OF USE
The allowed maximum pressure in the system is 1 MPa (10 bar).
The minimum pressure at suction shall be:
- 0.05 bar for medium at 50°C
- 0.40 bar for medium at 80°C

Relative humidity of the air: max 95%

WORKING TEMPERATURE	
Water (medium)	Ambient Temperature
5-95°C	0-40°C
Working outside of recommended conditions can shorten life time and nullify the warranty.	

7. INSTALLATION, DISMANTLING AND TRANSPORT
7.1 GENERAL ARRANGEMENT FOR INSTALLATION
- The pump must be mounted with electromotor shaft in horizontal position (fig. 3.1). Allowed and forbidden positions are shown in fig. 3.2
- The arrow on pump plate shows direction of medium flow
- If there is not enough space for electric connection, control box can be rotated by 90° (allowed positions are shown in fig. 3.3): rotate the motor as shown in fig. 3.4, 3.5 and 3.6. Before rotating the motor, the pump must be emptied of fluid.

7.2 DISMANTLING
In order to handle and dismantle the electropump you should:
a) Take off the power supply.
b) Lift the electropump with suitable means according to its weight and dimensions

7.4. TRANSPORT
The electropump is packed in a carton or, depending on its weight and dimensions, it is fixed on a wooden pallet; however, transport does not present many difficulties.
In any case, check the total weight imprinted on the box.

8. ELECTRICAL CONNECTION
8.1. PROTECTIVE DEVICES
- ALL THE CONNECTIONS MUST BE EXECUTED ACCORDING TO THE LAW BY A QUALIFIED TECHNICIAN.
- ALL THE ELECTRICAL MASSES MUST BE CONNECTED TO THE EARTH OF THE PLANT ACCORDING TO THE ELECTRICAL STANDARDS IN FORCE IN YOUR COUNTRY: THE INSTALLER SHALL BE THE SOLE RESPONSIBLE FOR IT.
- FOR THE THREE-PHASE AND SINGLE-PHASE TYPES, WE RECOMMEND INSTALLING A HIGH SENSITIVE DIFFERENTIAL SWITCH (0.03 A).

After installing the unit check again the feeding cable following the CABLE CONNECTION instructions and connect it to the control panel (1) that must be fitted, according to the actual rules, with:

- An omnipolar device for switching-off/separation of the net (minimum opening contacts 3 mm).
- A protection against short circuits (Am fuse) and magnetothermics, rated in compliance with the current plate.
- Possible devices against: lack of phases, electric dissipations, lack of water, atmospheric discharges and functioning-failure indicators.

IMPORTANT: ALL THE ELECTRIC MASSES MUST BE CONNECTED TO THE EARTH OF THE PLANT.

8.2. CABLE CONNECTION
- Connect the mains supply cable to the connector present inside the terminal box, as shown on fig. 3.7
- The electrical connection of the pump to the mains (230V, 50 Hz) must be carried out with suitable standardised connecting cord
- When connecting the mains cable ensure it never comes in contact with the casing of the device, due to the high temperatures of the casing.

Electrical connection of ER module (for E*go* ER versions)
- The signal conductor for control signal 0-10 V should be led through a small gland along the hydraulic housing on the electric fuse box. The conductor should be temperature resistant at a temperature of >85°C. The polarity of the signal conductor is not relevant. See fig. 3.7

9. USE AND RUNNING
- Before the startup, the pump must be filled with fluid and vented (fig. 3.8)
- Pumps E*go* (ER) -/40, -/60 and -/80 do not need to be manually vented, as this occurs automatically when the hydraulic system is being ventilated during the start-up. The air in the pump generates noise. After a short working period noise should disappear.
- For a proper functioning, a minimum pressure at suction must be guaranteed (see LIMIT OF USE)

During its running, it is normal for the pump to heat up, or to be heated by the pumped fluid - to prevent from risk of burns, it should therefore not be touched!

- The permitted operating area around the pump is determined by the diagram in these instructions.

10. SETTING AND OPERATION
10.1 OPERATION MODES
- Pump settings can be changed with the button on electric box top. It is possible to choose between the following operating modes:
  a) **"Proportional differential pressure" (∆pv – *regulated mode*):** in this mode the button pulsates and the duration of the pulse interval shortens along with the flow decreasing.

b) **"Fixed speed" (*unregulated mode*):** in this mode the setting button does not pulse, but remains constantly illuminated.

- Each mode enables a choice between three different preset curves at "proportional differential pressure" and three curves at "fixed speed". The button lights up with the colour that indicates the selected level. The sequence is "blue-green-yellow": the blue indicates the lowest speed/differential pressure curve, the yellow the maximum speed/differential pressure curve

How to set different operating curves and how to switch between the 2 modes

- If the pump is operating at proportional differential pressure (regulated mode – recognizable by the pulsating button), a short pressing of the button will change the operating curve according to a.m. sequence (blue-green-yellow).
- In order to switch from the "regulated mode" to the "fixed speed" (unregulated mode) it is necessary to press the setting button for at least 5 seconds: in this way the button will remain constantly lit (thus indicating the fixed speed mode has been set) and the current speed curve set will be according to the colour selected before long pressing the button. Shortly pressing the setting button will set the pump back to "proportional differential pressure" mode. In order to change the speed curve (in "fixed speed" operation) it is therefore necessary to select the requested curve while in "regulated mode" and after that to switch to the "fixed speed mode" by long pressing the setting button.

NOTE: the hydraulic response in the regulated mode is proportionate to the flow. The set head for single chosen level has an inclination angle of 50% (see table below).

10.2 PUMPS E*go* ER-/40, 60, 80 – CONTROL BY ANALOG SIGNAL

The E*go* ER -/40, 60, 80 are equipped with an additional module that allows
controlling the pump with an analogue signal 0 -10 V.

"Unregulated mode" (fixed speed)

- The curve is determined by the value of the controlling signal. This mode is set by pressing and holding the button on the primary circuit for 5 seconds (the light is on). If the value of the controlling signal is lower than 1 V, the pump enters in a stand-by mode. See diagram at the end of this manual.

"Regolated mode" (proportional differential pressure)

- The pressure curve of the pump is determined by the value of the controlling signal. If the value of the controlling signal is lower than 1 V, the pump enters in a stand-by mode. See diagram at the end of this manual.

External control works only if the input resistance is < 10kΩ. In this case, the input voltage must be considered. If the input resistance is > 50 kΩ, the pump will operate as a standard version without external control.

GB

11. MAINTENANCE AND REPAIR

Often control the plant trying to eliminate the disturbing causes such as sand, lime, etc. Keep efficient the parts exposed to damages (valves, filters, detectors and protections). For interventions always call qualified technicians.
In case of long rests provide to often start the electropump.
Any replacement of the feeding cable as well as all other maintenance operations must be performed only by the assistance centre.

12. DEMOLITION

When demolishing the electropumps, follow strictly the regulations in force in your country.
The user is responsible for disposing the equipment by delivering it to a collecting point for recycling and disposal of electrical equipment.
For further information about the collecting points of equipment, contact your local authority for waste disposal, or the shop where you purchased your product.

13. TECHNICAL DOCUMENTATION ATTACHED

Installation diagram.

14. TROUBLESHOOTING

DESCRIPTION OF THE ERROR	POSSIBLE CAUSES	PROPOSED SOLUTION
INDICATOR LIGHT IS OFF, PUMP IS NOT WORKING	No voltage applied	Check electric installation and fuses
INDICATOR LIGHT IS PERMANENTLY ON	The unregulated mode may have been selected	Select regulated mode
INDICATOR LIGHT CHANGES COLOUR	The pump is blocked	Clean the pump
NOISES COMING FROM THE PUMP/THE HYDRAULIC SYSTEM	The pump or the system are not properly vented	Vent the hydraulic system
FLOW RATE TOO LOW	The selected setting is too low	Select a higher curve

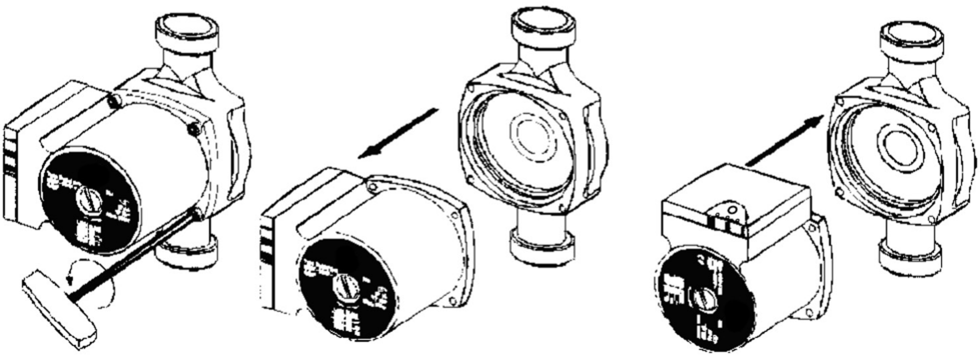
15. DECLARATION OF CONFORMITY

The company EBARA PUMPS EUROPE S.p.A. declares under its own responsibility that its E*go* products are in conformity:
2006/42/EC (MD), 2004/108/EC (EMC),
2006/95/EC (LVD), EN 809,
EN 60 335-1, EN 60 335-2-51,
EN 61000-6-3, EN 61000-6-1

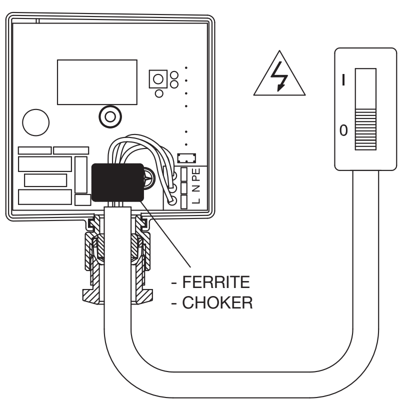
Mr. SHU NAGATA
Managing Director
Date: Jan. 30, 2013

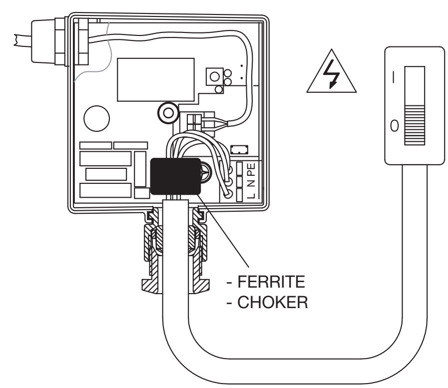
EBARA Pumps Europe S.p.A.
Via Pacinotti, 32 - 36040 Brendola (Vicenza) - Italy
Tel. +39 0444 706811 - Fax +39 0444 405811
www.ebaraeurope.com

3.4 3.5 3.6

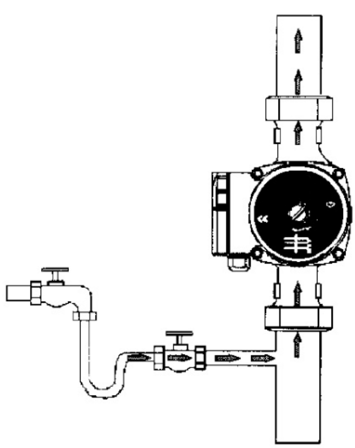


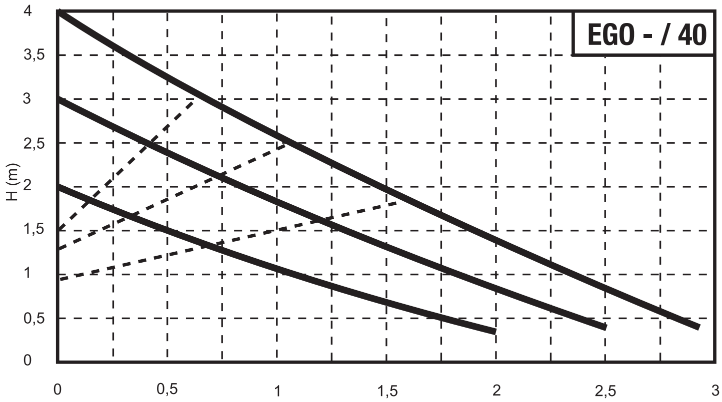
3.7

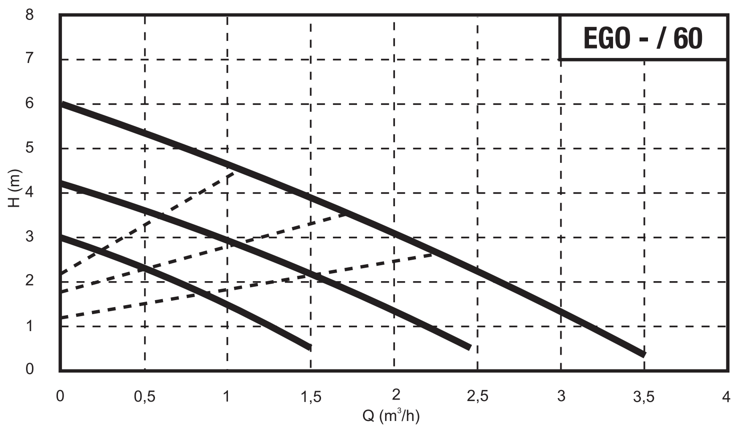


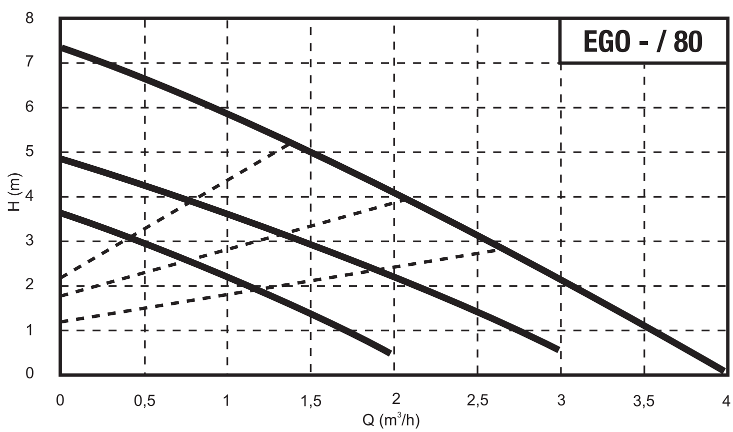


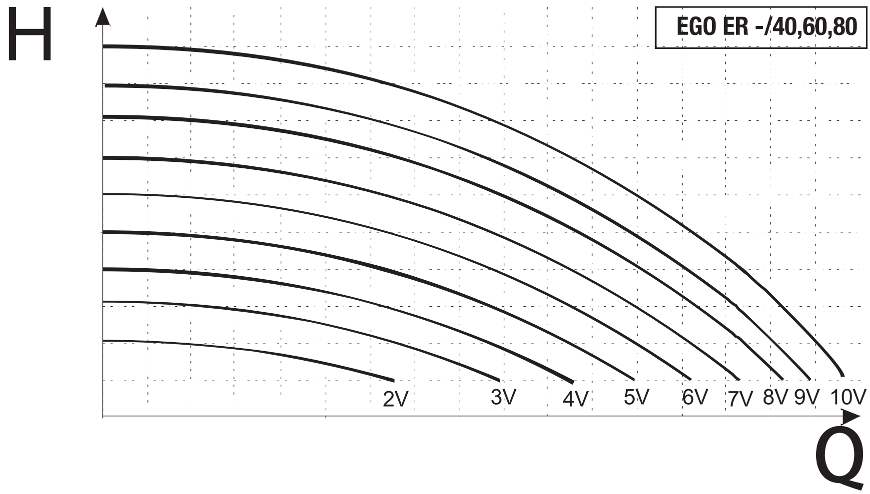
3.8

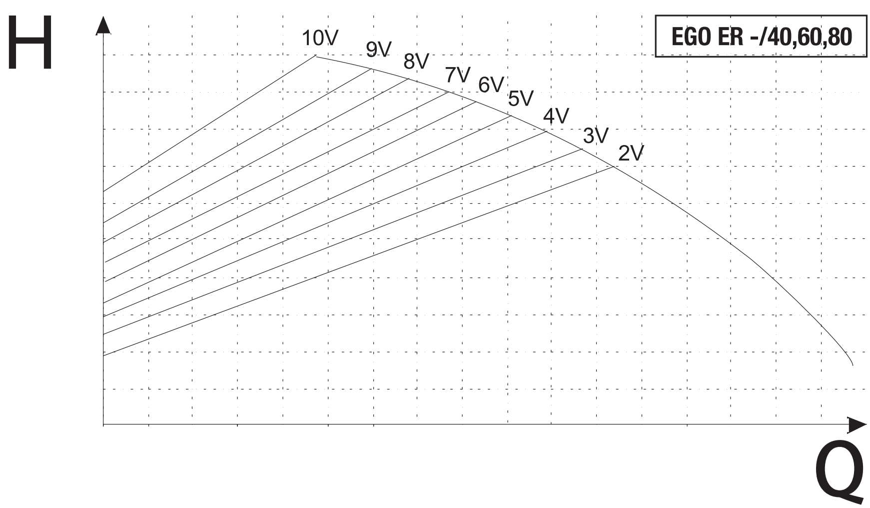



EGO - / 40
H (m)
4
3,5
3
2,5
2
1,5
1
0,5
0
0
0,5
1
1,5
2
2,5
3


EGO - / 60
H (m)
8
7
6
5
4
3
2
1
0
0
0,5
1
1,5
2
2,5
3
3,5
4
Q (m³/h)


EGO - / 80
H (m)
8
7
6
5
4
3
2
1
0
0
0,5
1
1,5
2
2,5
3
3,5
4
Q (m³/h)


H
EGO ER -/40,60,80
2V
3V
4V
5V
6V
7V
8V
9V
10V
Q


H
EGO ER -/40,60,80
10V
9V
8V
7V
6V
5V
4V
3V
2V
Q

2 WATER FLUX

1 Advertencia preliminar

1.1 Símbolos utilizados

▶ Requerimiento de operación

> Reacción, resultado

[...] Referencia a teclas, botones o indicadores

→ Referencia cruzada

! Nota importante
El incumplimiento de estas indicaciones puede acarrear funcionamientos erróneos o averías.

2 Indicaciones de seguridad

- Lea este documento antes de poner en marcha el dispositivo. Asegúrese de que el producto es apto para su aplicación sin ningún tipo de restricciones.
- El uso indebido o no conforme a lo estipulado puede provocar fallos de funcionamiento en el dispositivo o consecuencias no deseadas en su aplicación. Por este motivo, el montaje, la conexión eléctrica, la puesta en marcha, el manejo y el mantenimiento del dispositivo solo pueden ser llevados a cabo por personal cualificado, autorizado además por el responsable de la instalación.
- Compruebe en todas las aplicaciones la compatibilidad de los materiales del producto (→ 12 Datos técnicos) con los fluidos que se van a medir.

Para el ámbito de validez cULus:

El aparato debe recibir el suministro de tensión de una fuente de alimentación con separación galvánica que disponga en la parte secundaria de un fusible con homologación UL y una corriente nominal máxima de

a) 5 A con tensiones de 0...20 Vrms (0...28.3 Vp) o

b) 100/Vp con tensiones de 20...30 Vrms (28.3...42.4 Vp)

3 Utilización correcta

El equipo supervisa fluidos líquidos.
Registra 3 variables del proceso: cantidad de caudal, volumen de consumo, temperatura del fluido.

Campo de aplicación

Fluidos líquidos conductores con las siguientes características:

- Conductividad: ≥ 20 µS/cm
- Viscosidad: < 70 mm^2/s a 40°C

4 Función

4.1 Procesamiento de las señales de medición

- El equipo muestra los valores actuales del proceso en una pantalla.
- Genera 2 señales de salida en función de los parámetros.

OUT1: 3 posibilidades de selección .... Parametrización
Señal de conmutación para el valor límite de cantidad de caudal .... (→ 9.2.1)
o secuencia de impulsos para el contador de caudal............................... (→ 9.3.1)
o señal de conmutación para el contador con preselección..................... (→ 9.3.2)

ES

OUT2: 4 posibilidades de selección
Señal de conmutación para el valor límite de cantidad de caudal .... (→ 9.2.2)
o señal de conmutación para el valor límite de temperatura.................... (→ 9.4.1)
o señal analógica para la cantidad de caudal .... (→ 9.2.3)
o señal analógica para la temperatura .... (→ 9.4.2)

En vez de como salida, OUT2 (pin 2) se puede utilizar como entrada para una señal externa de reseteo:.. (→ 9.3.5)

4.2 Supervisión de caudal

El fluido fluye a través de un campo magnético. Durante este proceso se genera una tensión de señal que es directamente proporcional a la cantidad de caudal.

- Se pueden emitir 2 señales de conmutación para valores límites de caudal (salida 1 y salida 2). Funciones de conmutación → 4.5.
- Se puede emitir una señal analógica proporcional al caudal (4...20 mA o 0...10 V) en la salida 2. Funciones analógicas → 4.6.

Además de la velocidad de caudal, el equipo también registra el sentido del mismo. El sentido positivo de caudal está indicado en el equipo con una flecha ("flow direction" → 5.2).

- Sentido del caudal = “flow direction”: valor de proceso e indicación positivos.
- Caudal en el sentido opuesto a la "flow direction": valor de proceso e indicación negativos.

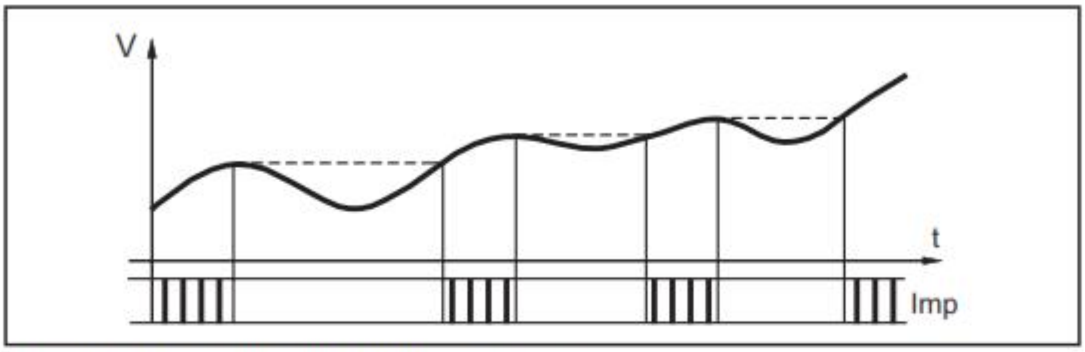
Para la emisión de señales (valores límite y valores analógicos de caudal) se procesan solamente valores de proceso positivos.

4.3 Supervisión de volúmenes de consumo (función totalizador)

El equipo posee un contador de caudal interno, el cual va sumando de forma continua la cantidad de caudal. La suma se corresponde con el volumen de consumo actual desde el último reseteo.

- El contador realiza la suma con signos correctos.

  Caudal correspondiente al sentido de caudal marcado (flecha "flow direction"): el contador suma. Caudal en el sentido opuesto a la marca indicada: el contacto resta.
  Los impulsos contadores solo se emiten en caso de suma ascendente. Tras una substracción (el volumen de consumo disminuye) no se emitirán más impulsos hasta que el volumen de consumo vuelva a exceder el valor máximo actual.



V = cantidad de caudal, Imp = impulsos de salida

- El valor actual del contador se puede mostrar.
- Asimismo se almacena el valor registrado antes del último reseteo. Este valor también puede ser mostrado.

  El contador almacena cada 10 minutos el volumen de consumo sumado. Tras una interrupción de la tensión, este valor estará disponible como valor actual del contador. Si se configura un reseteo temporizado, también se almacenará el tiempo transcurrido del intervalo de reseteo configurado. La posible pérdida de datos puede, por tanto, ser como máximo de 10 minutos.

El contador se puede poner a cero de la siguiente manera:

- Reseteo manual (→ 9.3.3).
- Reseteo automático temporizado (→ 9.3.3).
- Señal externa de entrada en el pin 2 (→ 9.3.5).

4.3.1 Supervisión de volúmenes de consumo con salida por impulsos

La salida 1 emite un impulso contador cada vez que se alcanza el valor configurado en ImPS (→ 9.3.1).

4.3.2 Supervisión de volúmenes de consumo con contador con preselección

Son posibles 2 tipos de supervisión:

- Supervisión de caudal en función del tiempo.
  - Configuraciones: [ImPS] = cantidad x, [ImPR] = [no], [rTO] = tiempo t.
  - Cuando se alcanza la cantidad x durante el tiempo t, la salida 1 conmuta y permanece en este estado hasta que el contador se ponga a cero.
  - Si no se alcanza la cantidad x una vez transcurrido el tiempo t, el contador se pone a cero automáticamente y empieza a contar de nuevo; la salida 1 no conmuta.
- Supervisión del caudal independientemente del tiempo.
  - Configuraciones: [ImPS] = cantidad x, [ImPR] = [na], [rTO] = [OFF].
  - Cuando se alcanza la cantidad x, la salida 1 conmuta y permanece en este estado hasta que el contador se ponga a cero.

ES

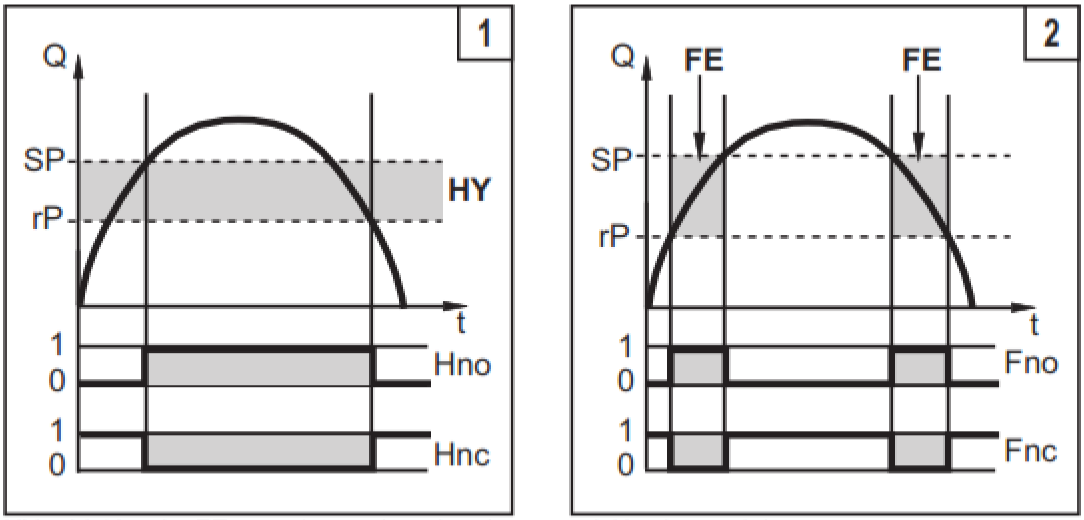
4.4 Supervisión de temperatura

- Se puede emitir en la salida 2 una señal de conmutación para los valores límites de temperatura. Funciones de conmutación → 4.5.
- Se puede emitir en la salida 2 una señal analógica proporcional a la temperatura (4...20 mA o 0...10 V). Funciones analógicas → 4.6.

4.5 Supervisión de caudal o temperatura / función de conmutación

OUTx cambia su estado de conmutación en caso de que los valores superen o estén por debajo de los límites de conmutación configurados (SPx, rPx). Se pueden seleccionar las siguientes funciones de conmutación:

- Función de histéresis / normalmente abierto: [OUx] = [Hno].
- Función de histéresis / normalmente cerrado: [OUx] = [Hnc].
  Primero se fija el punto de conmutación (SPx) y después se configura el punto de desconmutación (rPx) con la diferencia deseada.
- Función de ventana / normalmente abierto: [OUx] = [Fno].
- Función de ventana / normalmente cerrado: [OUx] = [Fnc].
  La extensión de la ventana se configura mediante la diferencia entre el SPx y el rPx. SPx = valor superior, rPx = valor inferior.



HY = histéresis; FE = ventana; ejemplos de supervisión de caudal

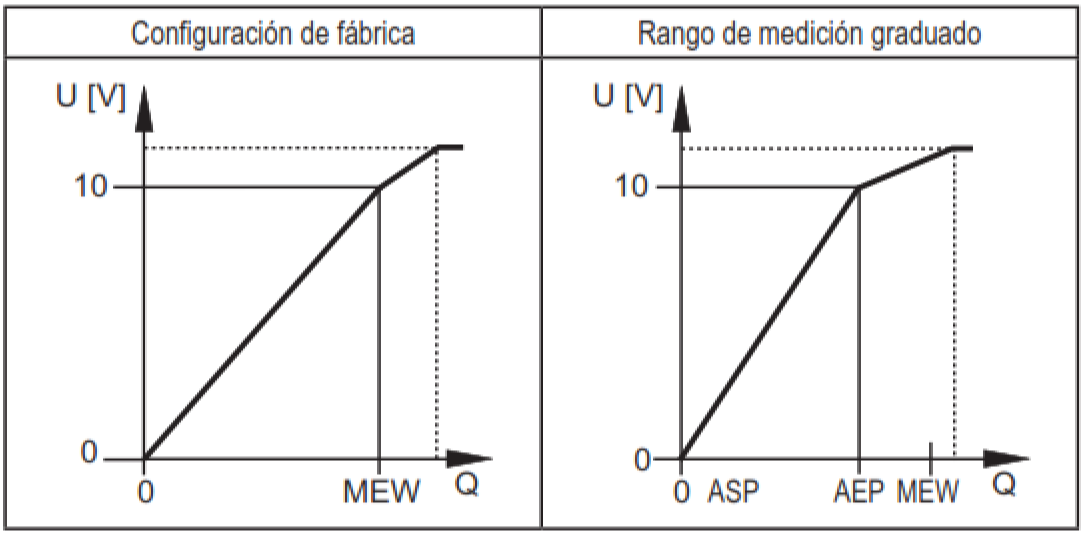
En caso de configuración de la función de ventana, los puntos de conmutación y desconmutación tienen una histéresis de configuración fija del 0,25% del valor límite del rango de medición. Esto hace que se mantenga estable el estado de conmutación de la salida en caso de fluctuaciones muy escasas del caudal.

4.6 Supervisión de caudal o temperatura / función analógica

- El punto inicial analógico [ASP] determina el valor de medición en el cual la señal de salida tiene 4 mA o 0 V.
- El punto final analógico [AEP] determina el valor de medición en el cual la señal de salida tiene 20 mA o 10 V.

Diferencia mínima entre [ASP] y [AEP] = 20% del valor límite del rango de medición.

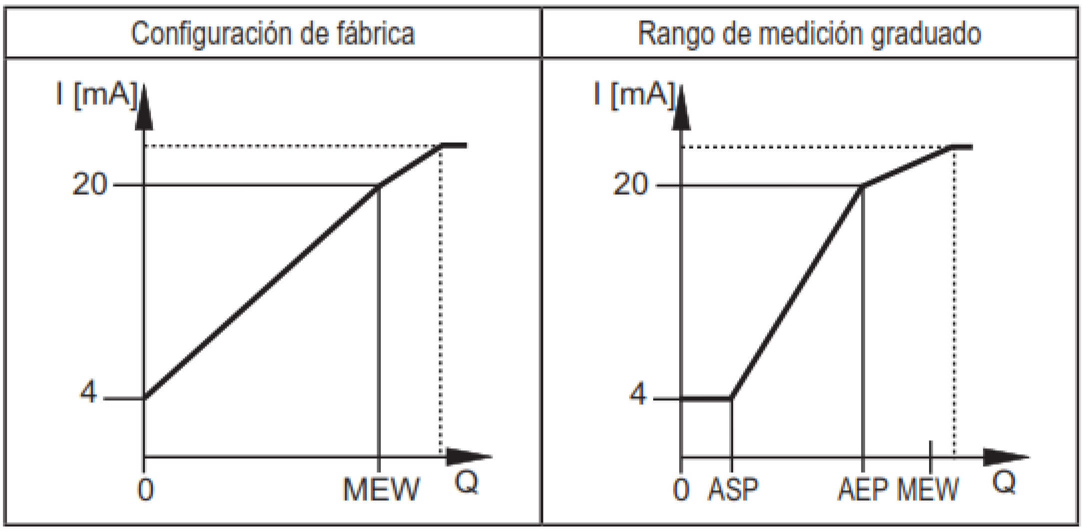
Salida de tensión 0 ... 10 V (ejemplo de supervisión de caudal)



MEW = valor límite del rango de medición
En el rango de medición configurado, la señal de salida se encuentra entre 0 y 10 V.
Además se señaliza lo siguiente:
Caudal por encima del rango de medición: señal de salida > 10 V.

ES

Salida de corriente 4 ... 20 mA (ejemplo de supervisión de caudal)



MEW = valor límite del rango de medición
En el rango de medición configurado, la señal de salida se encuentra entre 4 y 20 mA.
Además se señaliza lo siguiente:
Caudal por encima del rango de medición: señal de salida > 20 mA.

4.7 Tiempo de espera al arranque [dSt]

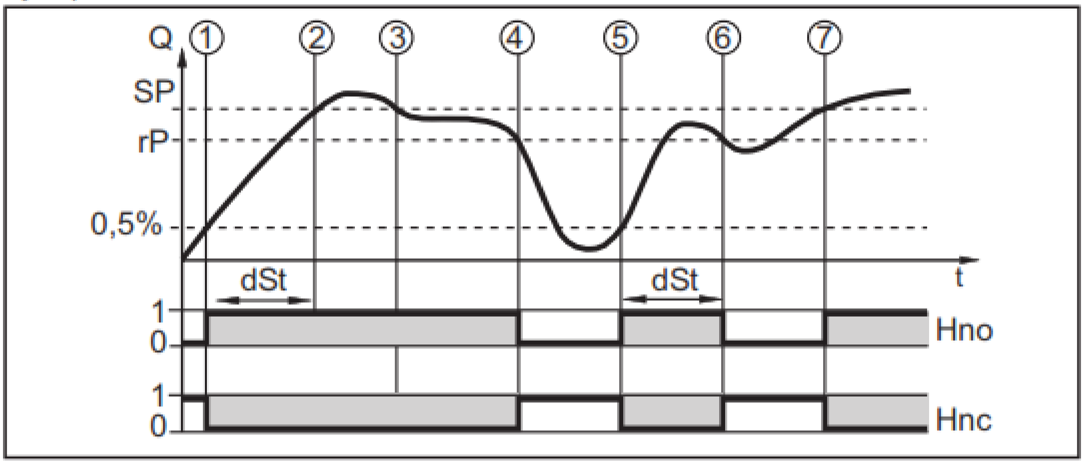
Si el tiempo de espera al arranque está activo ([dSt] > [0]), se aplica lo siguiente: En cuanto la cantidad de caudal supera el 0,5% del valor límite del rango de medición (MEW), tienen lugar los siguientes procesos:

- Se inicia el tiempo de espera al arranque.
- La salida 1 conmuta en función de la programación: se ACTIVA en caso de función NA, se DESACTIVA en caso de función NC.
- La salida 2 conmuta con la evaluación del caudal ([SEL2] = [FLOW]) en función de la programación: se ACTIVA en caso de función NA, se DESACTIVA en caso de función NC.
- [dSt] solo tiene efecto sobre las señales de conmutación para la supervisión de caudal.

Tras el inicio del tiempo de espera al arranque pueden darse los siguientes 3 casos:

- El caudal aumenta rápidamente y alcanza el punto de conmutación / margen de aceptación dentro del dSt -> las salidas permanecen activas.
- El caudal aumenta lentamente y no alcanza el punto de conmutación / margen de aceptación dentro del dSt -> las salidas se restablecen.
- El caudal cae dentro del dSt por debajo de 0,5% → las salidas se restablecen inmediatamente; el dSt finaliza.

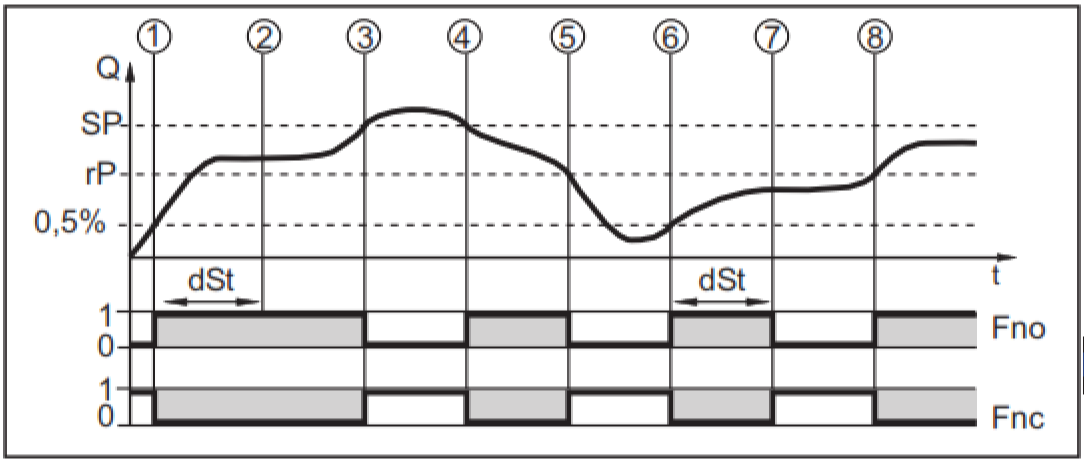
Ejemplo: dSt en la función de histéresis



1	El caudal Q alcanza el 0,5% del MEW → se inicia el dSt, la salida se activa.
2	El dSt ha finalizado, Q ha alcanzado el SP → la salida sigue activa.
3	Q está por debajo del SP, aunque sigue estando por encima del rP → la salida sigue activa.

4	Q está por debajo del rP → la salida se restablece.
5	Q alcanza de nuevo el 0,5% del MEW → se inicia el dSt, la salida se activa.
6	El dSt ha finalizado, Q no ha alcanzado el SP → la salida se restablece.
7	Q alcanza el SP → la salida se activa.

Ejemplo: dSt en la función de ventana



ES

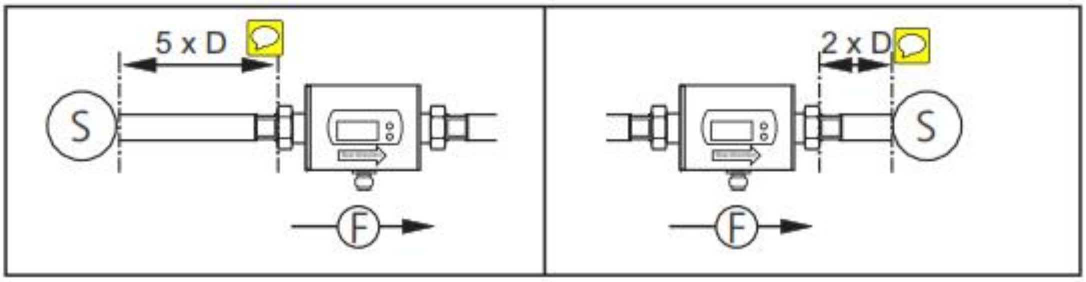
1	El caudal Q alcanza el 0,5% del MEW → se inicia el dSt, la salida se activa.
2	El dSt ha finalizado, Q ha alcanzado el margen de aceptación → la salida sigue activa.
3	Q aumenta por encima del SP (fuera del margen de aceptación) → la salida se restablece.
4	Q vuelve a caer por debajo del SP → la salida se activa otra vez.
5	Q cae por debajo del rP (fuera del margen de aceptación) → la salida se restablece de nuevo.
6	Q alcanza de nuevo el 0,5% del MEW → se inicia el dSt, la salida se activa.
7	El dSt ha finalizado, Q no ha alcanzado el margen de aceptación → la salida se restablece.
8	Q alcanza el margen de aceptación, la salida se activa.

5 Montaje

5.1 Lugar de montaje

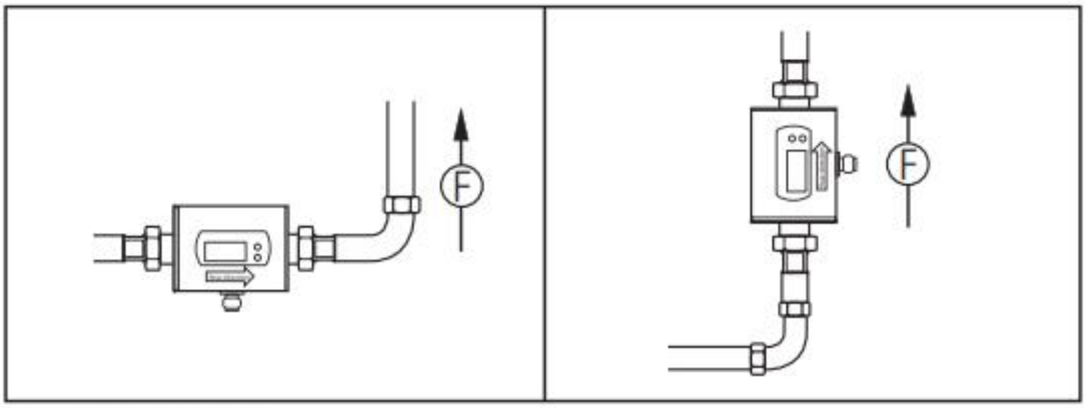
▶ Montar el equipo de tal manera que el tubo de medición esté siempre completamente lleno.

▶ Prever los tramos de entrada y salida. De esta forma se compensan influencias perturbadoras causadas por codos, válvulas, estrechamientos o similares. En concreto se aplica lo siguiente: los sistemas de bloqueo y regulación no deben encontrarse directamente delante del equipo.



S = influencia perturbadora; D = diámetro de la tubería; F = sentido del caudal

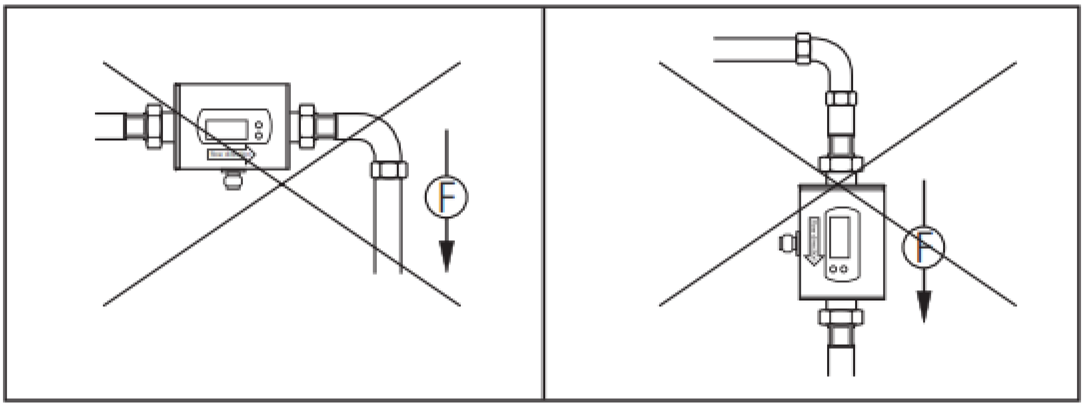
▶ Montar en un tubo ascendente o antes del mismo.



F = sentido del caudal

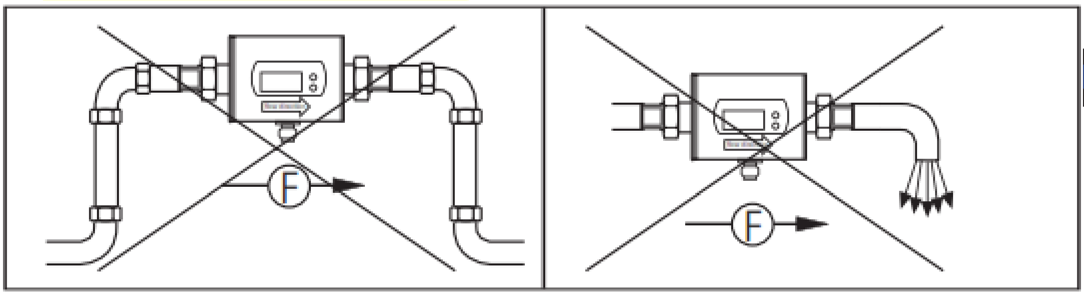
▶ Se deben evitar los siguientes lugares de montaje:

- Justo antes de un tubo descendente.
- En un tubo descendente.



F = sentido del caudal

- En el punto más alto del sistema de tubos.
- Justo antes de un tubo de salida.



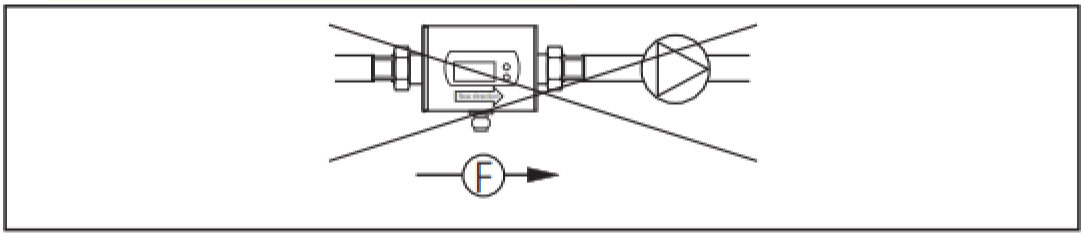
ES

F = sentido del caudal

El equipo se puede montar en cualquier posición, siempre y cuando esté garantizado lo siguiente:

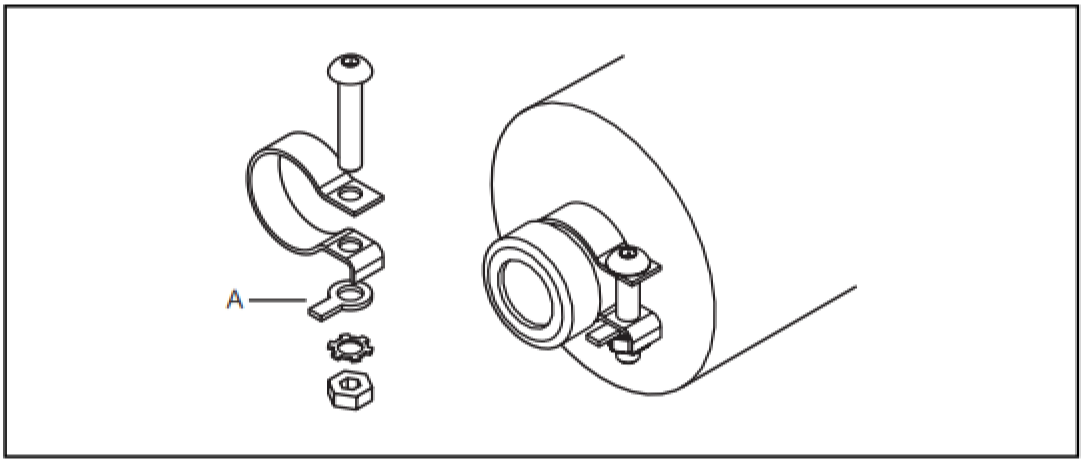
- Queda descartada la formación de burbujas de aire en el sistema de tubos.
- Las tuberías están siempre completamente llenas.

- En la zona de aspiración de una bomba.



F = sentido del caudal

En caso de montaje en un sistema de tubos que no esté puesto a tierra (p.ej. tubos de plástico), el sensor debe conectarse a tierra.

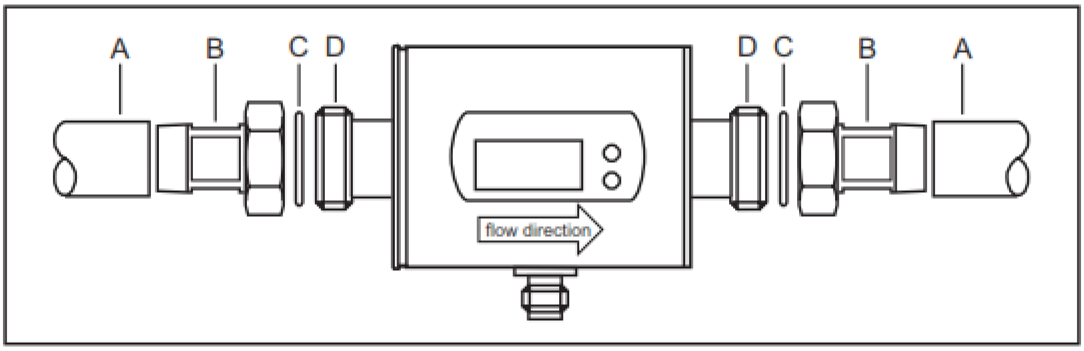


Abrazaderas de puesta a tierra para la conexión G½ disponibles como accesorios (ref. E40196).
A = terminal de cable (no incluido).

5.2 Instalación en la tubería

El equipo se instala en la tubería con ayuda de adaptadores. Estos se piden por separado como accesorios.

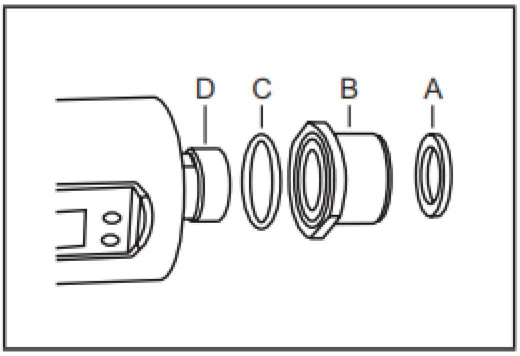
- Referencia E40199: 2 adaptadores para tubería R½ + 2 juntas.



1. Atornillar el adaptador (B) en la tubería (A).
2. Colocar las juntas (C) y montar el equipo en función del sentido del caudal indicado (flow direction).
3. Colocar el adaptador (B) en las conexiones (D) y apretarlo con la mano.
4. Apretar ambos adaptadores en sentido opuesto (par de apriete: 30 Nm).

El equipo también puede utilizarse en racores G¾. Para ello enroscar primero un adaptador G½ - G¾ (B) con junta tórica (C) en ambas conexiones (D) del dispositivo.

Colocar las juntas (A) y montar el equipo en función del sentido de caudal indicado (flow direction).



Estos adaptadores se piden por separado como accesorios.

- Ref. E40189: 2 adaptadores G½ - G¾ + 2 juntas tóricas + 2 juntas.

Después del montaje pueden aparecer burbujas de aire en el sistema que podrían afectar a la medición. Solución:

▶ Aclarar el sistema después del montaje para purgarlo (cantidad de fluido de aclarado > 3 l/min.).

ES

En caso de montaje horizontal se aplica lo siguiente: debido a exigencias constructivas, después de apagar la bomba siempre permanece una pequeña cantidad del fluido en el canal de medición.

5.3 Protección en caso de elevadas temperaturas del fluido

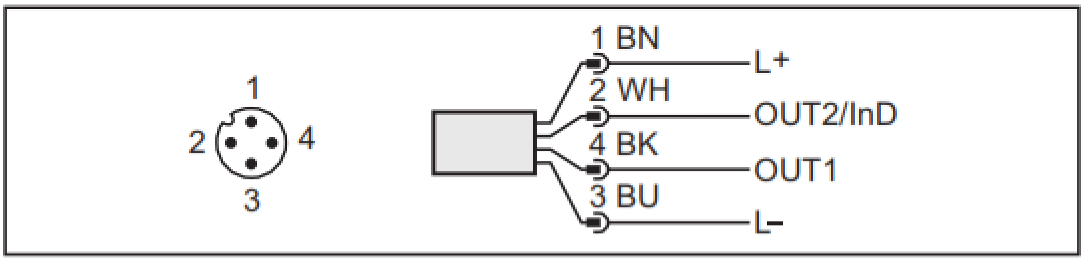
Con temperaturas del fluido superiores a 50ºC, algunas partes de la carcasa pueden calentarse a más de 65ºC.

▶ Proteger la carcasa contra el contacto con sustancias inflamables y contra un contacto involuntario.

6 Conexión eléctrica

El dispositivo sólo puede ser instalado por técnicos electricistas.
Se deben cumplir los reglamentos tanto nacionales como internacionales para el establecimiento de instalaciones electrotécnicas.
Suministro de tensión según EN 50178, MBTS y MBTP.

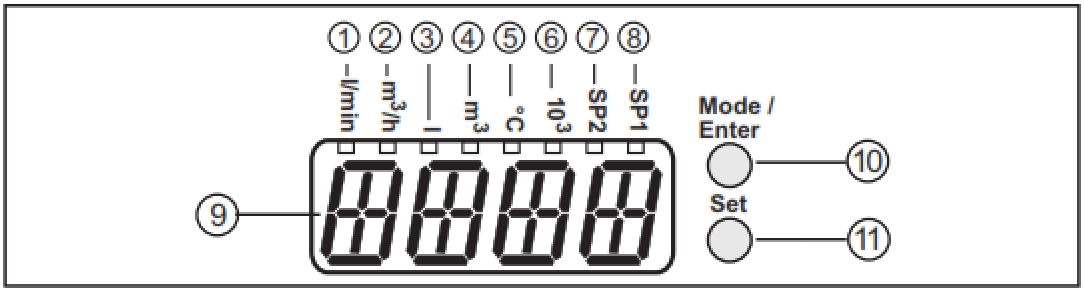
- ▶ Desconectar la tensión de alimentación.
- ▶ Conectar el dispositivo de la siguiente manera:



Pin 1	Ub+
Pin 3	Ub-
Pin 4 (OUT1)	Señal de conmutación: valores límites de caudal. Señal de conmutación: el contador de caudal ha alcanzado el valor de preselección. Impulsos: 1 impulso cada vez que se alcance la cantidad de caudal indicada.
Pin 2 (OUT2/InD)	Señal de conmutación: valores límites de caudal. Señal de conmutación: valores límites de temperatura Señal analógica para caudal. Señal analógica para temperatura. Entrada para la señal "reseteo del contador".

Colores de los hilos para los conectores hembra de ifm:
1 = BN (marrón), 2 = WH (blanco), 3 = BU (azul), 4 = BK (negro)

7 Elementos de manejo y visualización

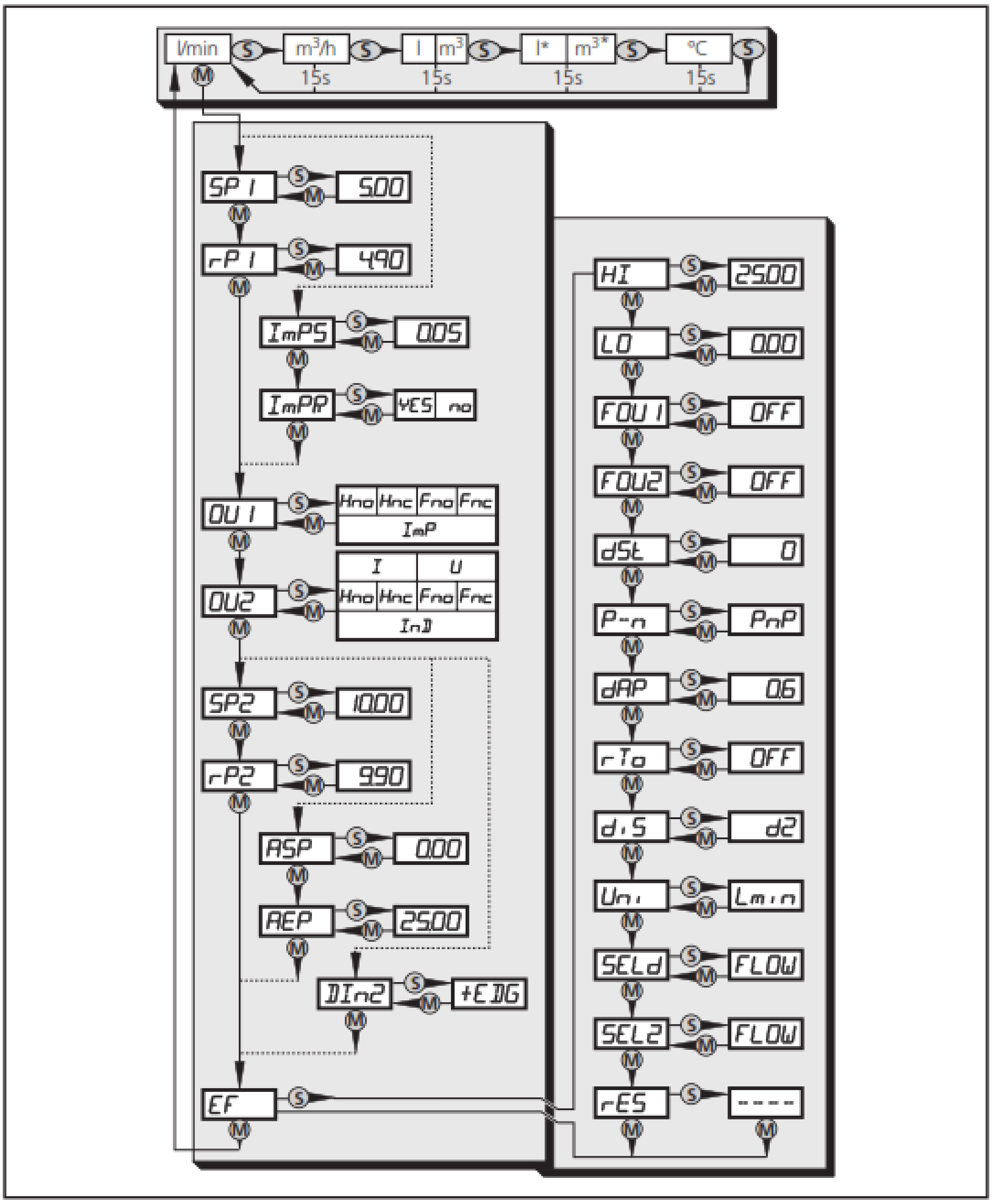


ES

De 1 a 8: LEDs indicadores
- LED 1 = caudal actual en litros/minuto. - LED 2 = caudal actual en metros cúbicos/hora. - LED 3 = volumen de consumo actual desde el último reseteo en litros. - LED 3 parpadeante = volumen de consumo antes del último reseteo en litros. - LED 4 = volumen de consumo actual desde el último reseteo en metros cúbicos. - LED 4 parpadeante = volumen de consumo antes del último reseteo en metros cúbicos. - LEDs 4 y 6 = volumen de consumo actual desde el último reseteo en 10^3 metros cúbicos. - LEDs 4 y 6 parpadeantes = volumen de consumo actual antes del último reseteo en 10^3 metros cúbicos. - LED 5 = temperatura actual del fluido en °C. - LED 7, LED 8 = estado de conmutación de la salida correspondiente.
9: Display alfanumérico de 4 dígitos
- Indicación de la cantidad de caudal actual (en caso de configuración de [SELd] = [FLOW]). - Indicación del valor del contador (en caso de configuración de [SELd] = [TOTL]). - Indicación de la temperatura actual del fluido (en caso de configuración de [SELd] = [TEMP]). - Indicación de los parámetros y de los valores de los parámetros
10: Botón Mode/Enter
- Selección de los parámetros y confirmación de los valores de los parámetros.
11: Botón Set
- Configuración de los valores de los parámetros (de forma continua si se mantiene pulsado el botón; uno por uno si se presiona el botón una sola vez). - Cambio de la unidad de indicación en el modo operativo normal (modo Run).

8 Menú

8.1 Estructura del menú



Ⓜ = [Mode/Enter] / Ⓢ = [Set]
l o m³ = valor actual del contador en l, m³ o 1000 m³
l* o m³* = valor del contador almacenado en l, m³ o 1000 m³

8.2 Explicación del menú

SP1/rP1	Valor límite superior/inferior de caudal.
ImPS	Valor de impulsos.
ImPR	Repetición de impulsos activa (= emisión de impulsos) o no activa (= función del contador con preselección)
OU1	Función de salida para OUT1 (caudal o volumen de consumo): - Señal de conmutación para los valores límites: función de histéresis o función de ventana, respectivamente normalmente abierto o normalmente cerrado. - Impulso o señal de conmutación para el contador de caudal.
OU2	Función de salida para OUT2 (caudal o temperatura): - Señal de conmutación para los valores límites: función de histéresis o función de ventana, respectivamente normalmente abierto o normalmente cerrado. - Señal analógica: 4-20 mA [I] o 0-10 V [U].
	Otra opción: configurar OUT2 (Pin2) como entrada para una señal externa de reseteo; configuración: [OU2] = [InD].
SP2/rP2	Valor límite superior/inferior de caudal o temperatura.
ASP	Valor inicial analógico para caudal o temperatura.
AEP	Valor final analógico para caudal o temperatura.
DIn2	Configuración de la entrada (Pin2) para el reseteo del contador.
EF	Funciones avanzadas / acceso al nivel de menú 2.
HI	Memoria de los valores máximos de caudal.
LO	Memoria de los valores mínimos de caudal.
FOU1	Comportamiento de la salida 1 en caso de un fallo interno.
FOU2	Comportamiento de la salida 2 en caso de un fallo interno.
dSt	Tiempo de espera al arranque (startup delay).
P-n	Lógica de conmutación de las salidas: pnp / npn.
dAP	Amortiguamiento de los valores de medición / constante de amortiguamiento en segundos.
rTo	Reseteo del contador: reseteo manual / temporizado.
diS	Frecuencia de actualización y orientación de la pantalla.
Uni	Unidad de medida estándar para caudal: litros/minuto o metros cúbicos/hora.
SELd	Magnitud de medición estándar de la pantalla: valor de caudal / valor del contador / temperatura del fluido.

ES

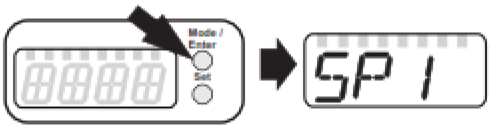
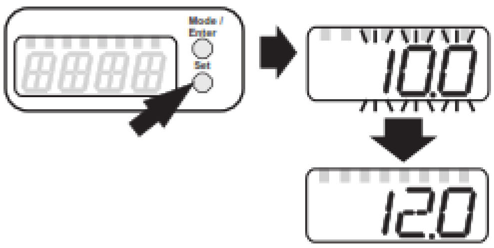
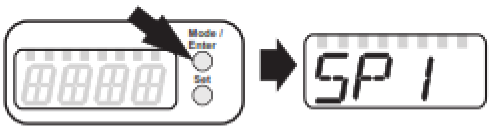
SEL2	Magnitud de medición estándar para la evaluación mediante OUT2: - Señal del valor límite o señal analógica para caudal - Señal del valor límite o señal analógica para temperatura
res	Restablecer las configuraciones de fábrica.

9 Parametrización

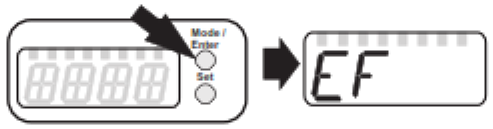
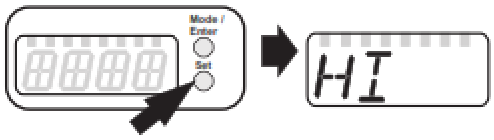
Durante el proceso de parametrización el sensor permanece en el modo operativo. Sigue llevando a cabo sus funciones de supervisión con los parámetros existentes hasta que la parametrización haya concluido.

9.1 Proceso general de parametrización

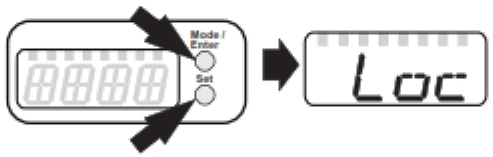
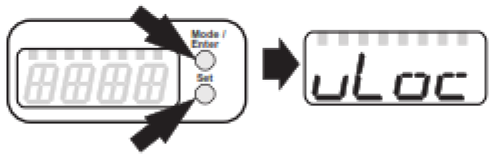
Cada configuración de parámetros requiere seguir 3 pasos:

1	**Seleccionar el parámetro** ▶ Presionar [Mode/Enter] hasta que aparezca el parámetro deseado..	
2	**Configurar el valor del parámetro** ▶ Presionar [Set] y mantenerlo pulsado. > El valor actual de configuración del parámetro parpadea en la pantalla durante 5 s. > Tras 5 s: el valor de configuración se puede modificar (uno por uno si se presiona una vez o de forma continua si se deja pulsado el botón)	
	Los valores numéricos aumentarán de forma continua. Si desea disminuir el valor: pulsar el botón hasta que en la pantalla aparezca el valor máximo de configuración. Tras éste, empieza de nuevo a contar desde el valor mínimo de configuración.	
3	**Confirmar el valor del parámetro** ▶ Presionar brevemente [Mode/Enter]. > El parámetro se muestra de nuevo. El nuevo valor de configuración ha sido memorizado.	
Configurar otros parámetros ▶ Comenzar de nuevo con el paso 1.		
Finalizar la parametrización ▶ Presionar [Mode/Enter] tantas veces como sea necesario hasta que aparezca el valor de medición actual o esperar 15 s. > El dispositivo retorna al modo operativo.		

- Cambio del nivel de menú 1 al nivel de menú 2:

▶ Presionar [Mode/Enter] hasta que aparezca [EF] en la pantalla.	
▶ Presionar brevemente [Set]. > Se muestra el primer parámetro del submenú (en este caso: [HI]).	

- Bloquear / Desbloquear
  El aparato se puede bloquear electrónicamente para evitar un ajuste erróneo no intencionado.

▶ Asegurarse de que el equipo se en- cuentra en el modo operativo normal. ▶ Presionar [Mode/Enter] + [Set] durante 10 s. > [Loc] aparece en la pantalla.	
Durante el funcionamiento: si se intentan modificar los valores de los parámetros, en la pantalla aparecerá brevemente [Loc].	
Para desbloquear el equipo: ▶ Presionar [Mode/Enter] + [Set] durante 10 s. > [uLoc] aparece en la pantalla.	

Estado en el momento de entrega: desbloqueado.

ES

- Timeout:

Si durante la configuración de un parámetro no se pulsa ningún botón durante 15 s, el aparato retorna al modo operativo sin que se produzca ninguna modificación de los valores.

! Con temperaturas del fluido superiores a 50ºC, algunas partes de la carcasa pueden calentarse a más de 65ºC.

En este caso no pulsar los botones con los dedos; en su lugar utilizar un objeto auxiliar (p.ej. un bolígrafo).

9.2 Configuraciones para la supervisión de caudal

9.2.1 Configurar la supervisión del valor límite con OUT1

▶ Seleccionar [OU1] y configurar la función de conmutación: - [Hno] = función de histéresis / normalmente abierto, - [Hnc] = función de histéresis / normalmente cerrado, - [Fno] = función de ventana / normalmente abierto, - [Fnc] = función de ventana / normalmente cerrado. ▶ Seleccionar [SP1] y configurar el valor en el cual la salida tiene que conmutar. ▶ Seleccionar [rP1] y configurar el valor en el cual la salida tiene que ser desactivada.	OU1 SP1 rP1

9.2.2 Configurar la supervisión del valor límite con OUT2

▶ Seleccionar [SEL2] y configurar [FLOW]. ▶ Seleccionar [OU2] y configurar la función de conmutación: - [Hno] = función de histéresis / normalmente abierto, - [Hnc] = función de histéresis / normalmente cerrado, - [Fno] = función de ventana / normalmente abierto, - [Fnc] = función de ventana / normalmente cerrado. ▶ Seleccionar [SP2] y configurar el valor en el cual la salida tiene que conmutar. ▶ Seleccionar [rP2] y configurar el valor en el cual la salida tiene que ser desactivada.	SEL2 OU2 SP2 rP2

9.2.3 Configurar el valor analógico para caudal

▶ Seleccionar [SEL2] y configurar [FLOW]. ▶ Seleccionar [OU2] y configurar la función: - [I] = señal de corriente proporcional al caudal (4…20 mA); - [U] = señal de tensión proporcional al caudal (0…10 V). ▶ Seleccionar [ASP] y configurar el valor con el cual se emitirá el valor mínimo. ▶ Seleccionar [AEP] y configurar el valor con el cual se emitirá el valor máximo.	SEL2 OU2 ASP AEP

9.3 Configuraciones para la supervisión de volúmenes de consumo

9.3.1 Configurar la supervisión de volúmenes mediante emisión de impulsos

▶ Seleccionar [OU1] y configurar [ImP]: ▶ Seleccionar [ImPS] y configurar la cantidad de caudal con la que se emitirá 1 impulso respectivamente (→ 9.7). ▶ Seleccionar [ImPR] y configurar [YES] > La repetición de impulsos está activa. La salida 1 emite un impulso contador cada vez que se alcanza el valor configurado en [ImPS].	OU1 ImPS ImPR

9.3.2 Configurar la supervisión de volúmenes mediante contador con pre-selección

▶ Seleccionar [OU1] y configurar [ImP]. ▶ Seleccionar [ImPR] y configurar [no] > La repetición de impulsos no está activa. La salida se ACTIVA cuando se ha alcanzado el valor configurado en [ImPS]. La salida permanece conmutada hasta que el contador sea puesto a cero. ▶ Seleccionar [ImPS] y configurar la cantidad de caudal hasta que la salida 1 conmute (→ 9.7).	OU1 ImPR ImPS

ES

9.3.3 Configurar el reseteo programado del contador

▶ Seleccionar [rTo] y continuar con a) o b). a) Restablecer el contador manualmente: ▶ Presionar [Set] hasta que aparezca [rES.T] en la pantalla, a continuación presionar brevemente [Mode/Enter]. b) Introducir un valor para el restablecimiento temporizado del contador ▶ Presionar [Set] hasta que se muestre el valor deseado (intervalos de 1 hora hasta 8 semanas), a continuación presionar brevemente [Mode/Enter].	rTo

9.3.4 Desactivar el reseteo del contador

▶ Seleccionar [rTo] y configurar [OFF]. El contador no se restablecerá hasta que se produzca un desbordamiento (= configuración de fábrica).	rTo

9.3.5 Configurar el reseteo del contador mediante una señal externa

▶ Seleccionar [OU2] y elegir [InD]. ▶ Seleccionar [Din2] y configurar la señal de reseteo: - [Hi] = reseteo en caso de señal alta, - [Lo] = reseteo en caso de señal baja, - [+EDG] = reseteo en caso de flanco ascendente, - [-EDG] = reseteo en caso de flanco descendente.	OU2 Din2

9.4 Configuraciones para la supervisión de temperatura

9.4.1 Configurar la supervisión del valor límite con OUT2

▶ Seleccionar [SEL2] y configurar [TEMP]. ▶ Seleccionar [OU2] y configurar la función de conmutación: - [Hno] = función de histéresis / normalmente abierto, - [Hnc] = función de histéresis / normalmente cerrado, - [Fno] = función de ventana / normalmente abierto, - [Fnc] = función de ventana / normalmente cerrado. ▶ Seleccionar [SP2] y configurar el valor en el cual la salida tiene que conmutar. ▶ Seleccionar [rP2] y configurar el valor en el cual la salida tiene que ser desactivada.	SEL2 OU2 SP2 rP2

9.4.2 Configurar el valor analógico para temperatura

▶ Seleccionar [SEL2] y configurar [TEMP]. ▶ Seleccionar [OU2] y configurar la función: - [I] = señal de corriente proporcional a la temperatura (4...20 mA); - [U] = señal de tensión proporcional a la temperatura (0...10 V). ▶ Seleccionar [ASP] y configurar el valor con el cual se emitirá el valor mínimo. ▶ Seleccionar [AEP] y configurar el valor con el cual se emitirá el valor máximo.	SEL2 OU2 ASP AEP

9.5 Configuraciones de usuario (opcionales)

9.5.1 Fijar la unidad de medida estándar para caudal

▶ Seleccionar [Uni] y fijar la unidad de medida: [Lmin] o [m3h]. La configuración solo afecta al valor de caudal. El valor del contador (volumen de consumo) es indicado automáticamente en la unidad de medida (l o m^3) que ofrece la mayor precisión posible.	Uni

9.5.2 Configurar la indicación estándar

▶ Seleccionar [SELd] y fijar la magnitud de medición estándar: - [FLOW] = la pantalla muestra el valor actual de caudal en la unidad de medida estándar. - [TOTL] = la pantalla muestra el valor actual del contador en l, m^3 o 1000 m^3. - [TEMP] = la pantalla muestra la temperatura actual en °C. ▶ Seleccionar [diS] y fijar la frecuencia de actualización y la orientación de la pantalla: - [d1] = actualización del valor de medición cada 500 ms. - [d2] = actualización del valor de medición cada 1000 ms. - [d3] = actualización del valor de medición cada 2000 ms. - [rd1], [rd2], [rd3] = visualización como los d1, d2, d3; pero girado 180°. - [OFF] = el display está apagado en el modo operativo.	SELd diS

9.5.3 Configurar la lógica de conmutación de las salidas

▶ Seleccionar [P-n] y configurar [PnP] o [nPn].	P-n

ES

9.5.4 Configurar el tiempo de espera al arranque

▶ Seleccionar [dSt] y configurar el valor numérico en segundos.	dSt

9.5.5 Configurar el amortiguamiento de los valores de medición

▶ Seleccionar [dAP] y configurar la constante de amortiguamiento en segundos (valor t 63%).	dAP

9.5.6 Configurar la reacción de las salidas ante errores

▶ Seleccionar [FOU1] y fijar un valor: - [On] = la salida 1 se ACTIVA en caso de fallo. - [OFF] = la salida 1 se DESACTIVA en caso de fallo. - [OU] = la salida 1 conmuta según los parámetros configurados independientemente de si se produce un fallo. ▶ Seleccionar [FOU2] y fijar un valor: - [On] = la salida 2 se ACTIVA en caso de fallo, la señal analógica alcanza el valor límite superior. - [OFF] = la salida 2 se DESACTIVA en caso de fallo, la señal analógica alcanza el valor límite inferior. - [OU] = la salida 2 conmuta según los parámetros configurados independientemente de si se produce un fallo. La señal analógica se corresponde con el valor de medición.	FOU1 FOU2

9.6 Funciones de asistencia

9.6.1 Leer los valores mín/máx para caudal

▶ Seleccionar [HI] o [LO], presionar brevemente [Set]. [HI] = valor máximo, [LO] = valor mínimo. Borrar la memoria: ▶ seleccionar [HI] o [LO]. ▶ Presionar [Set] y mantenerlo pulsado hasta que aparezca [----] en la pantalla. ▶ Presionar brevemente [Mode/Enter]. Es recomendable borrar la memoria una vez que el aparato esté operando por primera vez en condiciones normales de funcionamiento.	HI LO

9.6.2 Restablecer todos los parámetros a la configuración de fábrica

▶ Seleccionar [rES]. ▶ Presionar [Set] y mantenerlo pulsado hasta que aparezca [----] en la pantalla. ▶ Presionar brevemente [Mode/Enter]. Los valores de fábrica se encuentran al final de este manual (→ 13 Configuración de fábrica). Es recomendable anotar en esta tabla las configuraciones propias antes de poner el equipo en funcionamiento.	rES

9.7 Configuración del contador con preselección/del valor de impulsos (ImPS)

El equipo dispone de 7 rangos de configuración:

	LED	Indicación	incremento	Valor
1	3	00.01 ... 99.99	0,01 l	0,01...99,99 l
2	3	100.0 ... 999.9	0,1 l	100,0...999,9 l
3	3	1000 ... 9999	1 l	1000...9999 l
4	4	10.00 ... 99.99	0,01 m³	10,00...99,99 m³
5	4	100.0 ... 999.9	0,1 m³	100,0...999,9 m³
6	4	1000 ... 9999	1 m³	1000...9999 m³
7	4 + 6	10.00 ... 30.00	10 m³	10 000...30 000 m³

ES

Proceso de configuración:

- ▶ Seleccionar [OU1] y configurar [ImP] (→ 9.3.2).
- ▶ Presionar [Mode/Enter] hasta que aparezca [ImPS] en la pantalla.
- ▶ Presionar [Set] y mantenerlo pulsado.
- > El valor numérico actual parpadea durante 5 s, a continuación se activará el primero de los 4 dígitos (el dígito parpadea, se puede modificar).
- ▶ Configurar el valor deseado como se indica en la siguiente tabla.
  - ▶ Seleccionar primero el rango de configuración deseado (1, 2, 3 ...).
  - ▶ A continuación introducir el número de izquierda (primer dígito) a derecha (cuarto dígito).
- ▶ Presionar brevemente [Mode/Enter] cuando los 4 dígitos estén configurados.

En cuanto parpadee el primer dígito, se pueden dar 3 posibilidades:

▶ Presionar brevemente [Set] 1 vez en cada caso.	El dígito que parpadea aumenta. Después de 9 sigue 0 - 1 - 2, etc. 81.23 [Set] pulsado 1 vez 91.23 [Set] pulsado 1 vez 01.23 [Set] pulsado 1 vez 11.23

▶ Presionar [Set] y mantenerlo pulsado.	El dígito que parpadea aumenta, después de 9 sigue 0 y el siguiente dígito de la izquierda se activa. 8 1. **8** 3 [Set] pulsado permanentemente 8 1. **9** 3 [Set] se sigue manteniendo pulsado 8 **1.** 0 3
	Si el dígito 1 aumenta de esta manera, la pantalla cambia al siguiente rango de configuración superior (después de 9 sigue 10; el punto decimal se traslada un puesto hacia la derecha o el indicador LED cambia). **8** 1. 2 3 [Set] pulsado permanentemente **9** 1. 2 3 [Set] se sigue manteniendo pulsado **1** 0 1. 2
▶ Esperar 3 s (no pulsar ningún botón).	El siguiente dígito de la derecha parpadea (= se activa). **8** 1 2. 3 Ningún botón pulsado; tras 3 s 8 **1** 2. 3 tras 3 s 8 1 **2.** 3 tras 3 s 8 1 2. **3**
	Si el cuarto dígito parpadea durante 3 s sin ser modificado, el dígito 1 volverá a activarse si tiene un valor > 0. tras 3 s **8** 1 2. 3 Si el dígito 1 tiene el valor "0", la pantalla cambia al siguiente rango de configuración inferior (el punto decimal se traslada un puesto hacia la izquierda o el indicador LED cambia). 0 1 2. **3** tras 3 s 1 2. 3 **0** A continuación: modificar el dígito 4 o esperar 3 s y configurar el dígito 1. tras 3 s **1** 2. 3 0

Marcado en gris (**1**) = dígito parpadeante.

Nota: si se pulsa [Set] continuamente, por la pantalla irán pasando todos los rangos; tras el valor final se comienza de nuevo con el valor inicial. A continuación soltar brevemente [Set] y comenzar de nuevo con la configuración.

10 Funcionamiento

Una vez conectada la tensión de alimentación y pasado el tiempo de retardo a la disponibilidad (aprox. 5 s), el aparato se encuentra en el modo Run (= modo operativo normal). Ejecuta las funciones de evaluación y medición y genera señales de salida correspondientes a los parámetros configurados.

- Indicación de funcionamiento → Capítulo 7 Elementos de manejo y visualización.
- Durante el tiempo de retardo a la disponibilidad, las salidas están conmutadas según se haya programado: se activan con la función N.A. (Hno / Fno) o se desactivan con la función N.C. (Hnc / Fnc)
- Si la salida 2 se configura como salida analógica, la señal de salida tendrá el valor máximo durante el tiempo de retardo a la disponibilidad.

10.1 Lectura de la configuración de los parámetros

▶ Presionar [Mode/Enter] hasta que aparezca el parámetro deseado.

▶ Presionar brevemente [Set].

> El equipo muestra durante aprox. 15 s el valor correspondiente del parámetro. Tras otros 15 s, el dispositivo retorna al modo Run.

ES

10.2 Cambio de la unidad de indicación en el modo Run.

▶ Presionar brevemente [Set] en el modo Run. Cada vez que se pulsa el botón, se pasa a la siguiente unidad de indicación.

> El equipo muestra durante aprox. 15 s el valor de medición actual en la unidad de indicación seleccionada, el LED correspondiente se enciende.

10.3 Indicación de errores

[SC1]	Cortocircuito en OUT1.
[SC2]	Cortocircuito en OUT2.
[SC]	Cortocircuito en ambas salidas.
[OL]	Rango de detección de caudal o temperatura superado; valor de medición entre 120% y 130% del MEW.
[UL]	Rango de detección de caudal o temperatura no alcanzado; valor de medición entre -120% y -130% del MEW.
[Err]	- Equipo defectuoso / fallo de funcionamiento. - Valor de medición superior al 130% del MEW o inferior al -130% del MEW.
[SEnS]	El sensor indica una medición errónea.
[Loc]	Botones de configuración bloqueados, la modificación de parámetros no es posible.

MEW = valor límite del rango de medición

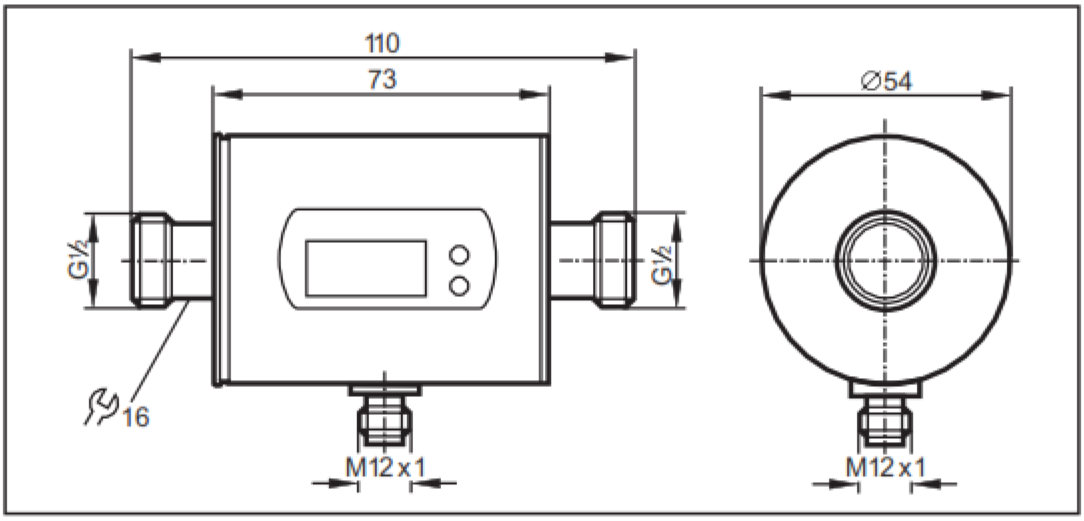
10.4 Condiciones generales de funcionamiento

- Evitar la acumulación de residuos, gas y aire en el sistema de tubos.

! Con temperaturas del fluido superiores a 50ºC, algunas partes de la carcasa pueden calentarse a más de 65ºC.

- En este caso no tocar el equipo.
- Proteger la carcasa contra el contacto con sustancias inflamables y contra un contacto involuntario.
- No pulsar los botones con los dedos; en su lugar utilizar un objeto auxiliar (p. ej. un bolígrafo).

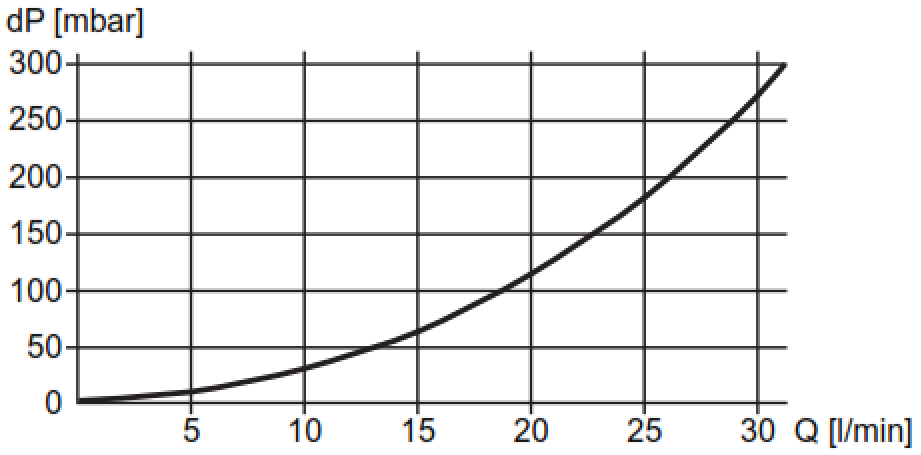
11 Dibujo a escala



Dimensiones en mm

12 Datos técnicos

Campo de aplicación	Fluidos líquidos conductores
Conductividad	≥ 20 µS/cm
Viscosidad	< 70 mm²/s a 40°C
Tensión de alimentación [V]	19...30 DC[1)]
Corriente máxima [mA]	2 x 200
resistente a los cortocircuitos; resistente a inversiones de polaridad / sobrecargas	
Caída de tensión [V]	< 2
Consumo de corriente típ. [mA]	120
Salida analógica	4 ... 20 mA / 0 ... 10 V; Rango de medición graduado
Carga máx. para la salida de corriente [Ω]	500
Carga mínima para la salida de tensión [kΩ]	2
Valor de impulsos	0,01 l...30 000 m³
Duración de los impulsos [s]	mín. 0,01 / máx. 2
Tiempo de retardo a la disponibilidad [s]	5
Supervisión de caudal	
Rango de medición [l/min / m³/h]	0,1...25 / 0,005...1,5
Resolución [l/min / m³/h]	0,05 / 0,005
Margen de indicación [l/min / m³/h]	-30...30 / -1,8...1,8
Tiempo de respuesta [ms]	< 150 (si dAP = 0);
Amortiguamiento de la señal de caudal (dAP) [s]	0,0...5,0
Tiempo de espera al arranque [s]	0...50
Precisión	< ± (2% MW + 0,5% MEW)
Repetibilidad [% MEW]	± 0,2
Pérdida de presión (dP) en función de la cantidad de caudal (Q)	



ES

Supervisión de temperatura
Rango de medición [°C].. -20...80
Tiempo de respuesta [s] .... T09 = 30 (Q > 1 l/min)
Resolución [°C]..0,2
Precisión [°C]..± 2,5 (Q > 1 l/min)

Temperatura ambiente [°C].. -10...60
Temperatura del fluido [°C].. -10...70
Resistencia a la presión [bar] 16
Materiales en contacto con el medio .... inox (1.4404 / 316L); PEEK; FKM
Materiales de la carcasa.. inox (1.4404 / 316L); PBT-GF 20; PC (Makrolon); EPDM/X (Santoprene)
Grado/clase de protección.. IP 67 / III
Resistencia de aislamiento [MΩ] .... > 100 (500 V DC)
Resistencia a choques [g] .... 20 (DIN / IEC 68-2-27, 11ms)
Resistencia a vibraciones [g].. 5 (DIN / IEC 68-2-6, 55 - 2000 Hz)
CEM
IEC 1000/4/2 Descargas electrostáticas: .... 4 / 8 KV
IEC 1000/4/3 Campos electromagnéticos de alta frecuencia radiados:.. 10 V/m
IEC 1000/4/4 Transitorios eléctricos rápidos en ráfagas:..2 KV
IEC 1000/4/5 Impulsos de alta energía u ondas de choque:..0,5 / 1 KV
IEC 1000/4/6 Campos electromagnéticos de alta frecuencia conducidos: .... 10 V

1) según EN50178, MBTS, MBTP;
MW = valor de medición; MEW = valor límite del rango de medición

12.1 Rangos de configuración

FLOW	SP1 / SP2		rP1 / rP2		ASP		AEP		ΔQ
	mín	máx	mín	máx	mín	máx	mín	máx	
l/min	0,25	25,00	0,10	24,90	0,00	20,00	5,00	25,00	0,05
m^3h	0,015	1,500	0,005	1,495	0,000	1,200	0,300	1,500	0,005

TEMP	SP2		rP2		ASP		AEP		ΔT
	mín	máx	mín	máx	mín	máx	mín	máx	
°C	-19,2	80,0	-19,6	79,6	-20,0	60,0	0,0	80,0	0,2

ImPS	mín	máx
	0,01 l	30 000 m^3

(ΔQ, ΔT = incremento)

13 Configuración de fábrica

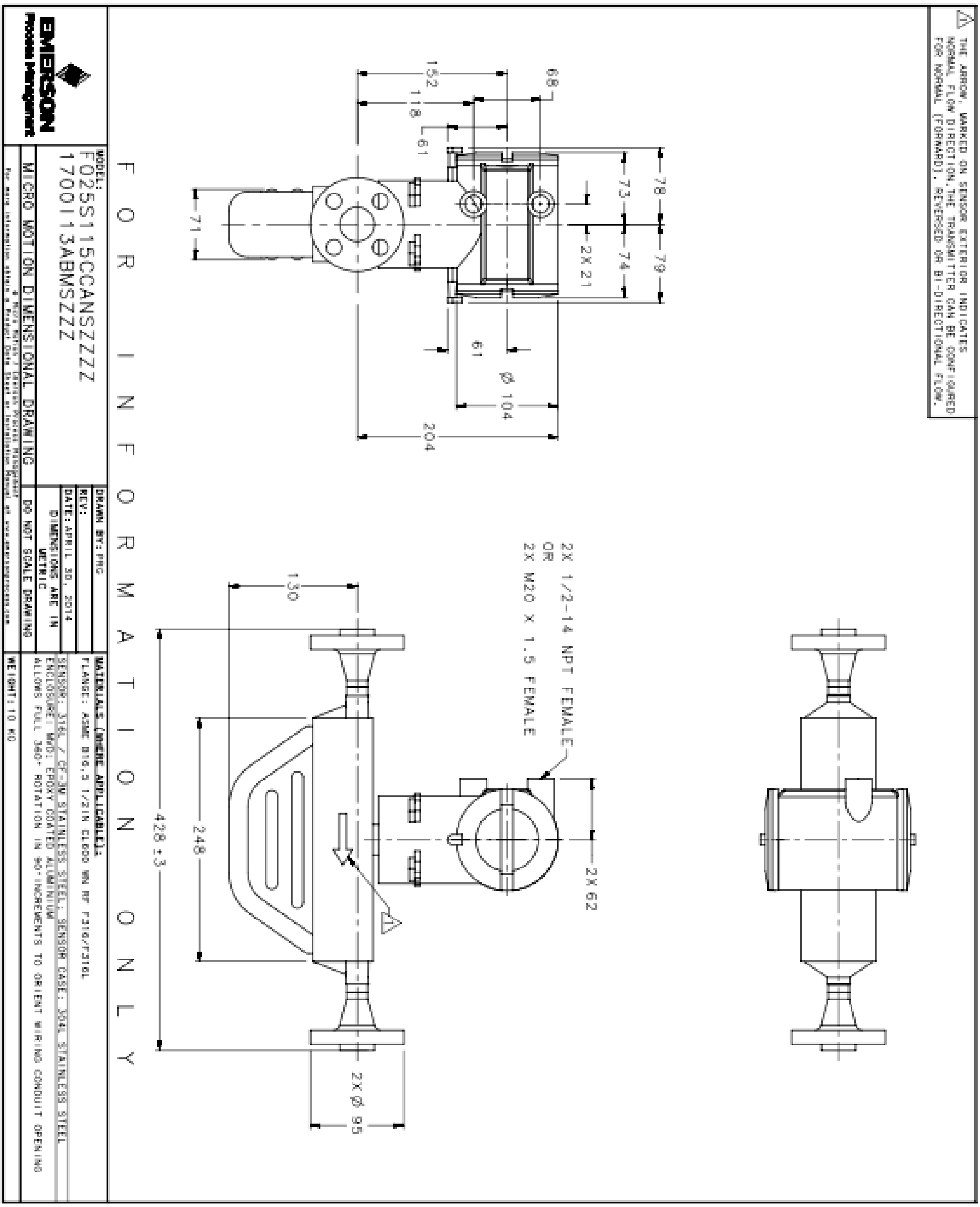
	Configuración de fábrica	Configuración del usuario
SP1	5,00	
rP1	4,90	
ImPS	0,05	
ImPR	YES	
OU1	Hno	
OU2	I	
SP2 (FLOW)	10,00	
rP2 (FLOW)	9,90	
SP2 (TEMP)	20,0	
rP2 (TEMP)	19,6	
ASP (FLOW)	0,00	
AEP (FLOW)	25,00	
ASP (TEMP)	-20,0	
AEP (TEMP)	80,0	
DIn2	+EDG	
FOU1	OFF	
FOU2	OFF	
dSt	0	
P-n	PnP	
dAP	0,6	
rTo	OFF	
diS	d2	
Uni	Lmin	
SELd	FLOW	
SEL2	FLOW	

ES

Datos técnicos y más información en www.ifm.com

	FINAL PROJECT	Date: **19.06.2014** Page: **334**
PROJECT: **“Compressors test live bench under wet compression conditions”**		ANNEX: **2**

3 REFRIGERANT FLUX



JUMO MIDAS S05
OEM pressure transmitter - universal

Type 401010
with terminal box

Type 401010
with M12x1 connector

Applications

- HVAC (Heating, Ventilating and Air Conditioning)
- Refrigeration
- Compressor construction
- Machine and plant engineering
- Packaging industry

Brief description

The JUMO MIDAS S05 pressure transmitter is available with both relative pressure and absolute pressure measurement ranges.
The high-quality stainless steel welded measuring system with no seals ensures the instrument can be used in almost all media, even under harsh conditions. The design offers optimum protection against process medium escaping.
The instrument features a silicon sensor that is able to handle extreme overload, even in the lowest measuring ranges, and is capable of millions of pressure cycles.

Customer benefits

• Economical
A high level of automation (digital compensation and calibration of the sensor assembly) reduces production time and manufacturing costs.
• Process safety
The piezoresistive silicon sensor is highly overload-resistant and long-term stable. The high quality of every pressure transmitter is ensured by the 100% final inspection within the fully automated measuring and calibration system.
• Time-saving, uncomplicated and versatile
There is little work involved in mounting the measuring instrument and electrical installation is simple. Universal: thanks to its modular configuration, it can be used in virtually every application.

Special features

- 1 bar to 100 bar relative pressure, up to 25 bar in absolute pressure as well
- High level of process safety thanks to a welded measuring system with no seals
- Sturdy and maintenance-free measurement technology with extreme overload resistance
- 60% faster device installation with the Quickon fast-connection system
- Sturdy design for a long service life
- Parts in contact with media made of stainless steel

JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14
36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow, Essex CM20 2DY, UK
Phone: +44 1279 635533
Fax: +44 1279 635262
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-5866
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info.us@jumo.net
Internet: www.jumousa.com

Technical data

General information

Reference conditions	DIN 16 086 and EN 60770
Sensor	
Material	Silicon sensor with stainless steel separating diaphragm
Pressure transfer medium	Synthetic oil
Permissible load change	> 10 million
Location	
Mounting position	Any
Calibration position	Device standing upright, process connection on bottom

Measuring range

Relative and absolute pressure	Measuring ranges start at 0 bar.									
Measuring range	1	1.6	2.5	4	6	10	16	25	40	bar
Overload capacity [a]	4	6	10	16	24	40	60	100	100	bar
Bursting pressure	6	10	15	24	36	60	100	150	150	bar
Relative pressure	Measuring ranges start at 0 bar.									
Measuring range	60	100								bar
Overload capacity [a]	180	180								bar
Bursting pressure	250	250								bar
Relative pressure										
Measuring range	-1 – 0	-1 – 0.6	-1 – 1.5	-1 – 3	-1 – 5	-1 – 9	-1 – 15	-1 – 24		bar
Overload capacity [a]	4	6	10	16	24	40	60	100		bar
Bursting pressure	6	10	15	24	36	60	100	150		bar

[a] All pressure transmitters are vacuum-proof

Output

Output signal[a]	
Current	
Output 405	4 – 20 mA, two wires
Voltage	
Output 412	DC 0.5 – 4.5 V, three wires, ratiometric 10 – 90% of the supply voltage
Output 415	DC 0 – 10 V, three wires
Output 418	DC 1 – 5 V, three wires
Output 420	DC 1 – 6 V, three wires
Jump response	
T_{90}	≤5 ms
Burden	
Current	
4 – 20 mA, two wires	$R_i \leq (U_B - 8\text{ V}) / 0.02\text{ A}\ (\Omega)$
Voltage	
DC 0.5 – 4.5 V, three wires	≥ 5 kΩ
DC 1 – 5 V, three wires	≥ 10 kΩ
DC 1 – 6 V, three wires	≥ 10 kΩ
DC 0 – 10 V, three wires	≥ 10 kΩ

[a] Additional outputs are available on request.

JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14
36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow, Essex CM20 2DY, UK
Phone: +44 1279 635533
Fax: +44 1279 635262
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-5866
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info.us@jumo.net
Internet: www.jumousa.com

Mechanical properties

Process connection		
Material		Stainless steel 304[a]
Membrane		
Material		Stainless steel 316L
Enclosure		
Material		Stainless steel 304
Electrical connection		
Material		
Fixed cable,	Electr. connection 11	PBT-GF30, PVC
Quickon,	Electr. connection 23	PBT-GF30
Round plug M12x1,	Electr. connection 36	PBT-GF30, stainless steel 303
Bayonet connector,	Electr. connection 53	PBT-GF30
Terminal box,	Electr. connection 61	PBT-GF30, PA, silicon
Weight		approx. 80 g with process connection 502 (G1/4)

[a] Pressure transmitters with process connection 521 come with an FPM seal.

Ambient conditions

Permissible temperatures		
Electrical connections 36, 53 or 61		
Medium		-40 – +125°C
Environment		-40 – +125°C
Storage		-40 – +125°C
Electrical connection 11		
Medium		-40 – +125°C
Environment		-40 – +100°C
Storage		-40 – +100°C
At ambient temperature -50°C		
Restricted function		Stationary use only, danger of broken cable
Permissible relative humidity		
In operation		100% rel. humidity, incl. condensation on the outer sleeve of the instrument
Storage		90% relative humidity, no condensation
Permissible mechanical loading		
Vibration resistance[a]		20 g, 10 – 2000 Hz
Shock resistance[b]		50 g for 11 ms 100 g for 1 ms
Electromagnetic compatibility		
Interference emission[c]		Class B
Interference immunity[c]		Industrial requirements
Enclosure protection[d]		
Fixed cable,	Electr. connection 11	
Relative pressure measuring ranges		IP66
Absolute pressure measuring ranges		IP67
Quickon,	Electr. connection 23	IP66
M12x1 round plug,	Electr. connection 36	IP66
Bayonet connector,	Electr. connection 53	IP67
Terminal box[e],	Electr. connection 61	IP65

[a] IEC 60068-2-6
[b] IEC 60068-2-27
[c] EN 61326-2-3
[d] EN 60529
[e] Connecting cable diameter is min. 5 mm, max. 7 mm.

JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14
36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow, Essex CM20 2DY, UK
Phone: +44 1279 635533
Fax: +44 1279 635262
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-5866
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info.us@jumo.net
Internet: www.jumousa.com

Accuracy

Relative and absolute pressure	Measuring ranges start at 0 bar.									
Measuring range	1	1.6	2.5	4	6	10	16	25	40	bar
Linearity[a]	**0.3**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.2**	**0.2**	**0.2**	**% of FS**
Accuracy, 20°C[b]	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	% of FS
Accuracy, -20 – +100°C[c]	1.5	1.4	1.3	1.2	1.2	1.0	1.0	1.0	1.0	% of FS
Relative pressure	Measuring ranges start at 0 bar.									
Measuring range	60	100								bar
Linearity[a]	**0.2**	**0.2**								**% of FS**
Accuracy, 20°C[b]	0.5	0.5								% of FS
Accuracy, -20 – +100°C[c]	1.0	1.0								% of FS
Relative pressure										
Measuring range	-1 – 0	-1 – 0.6	-1 – 1.5	-1 – 3	-1 – 5	-1 – 9	-1 – 15	-1 – 24		bar
Linearity[a]	**0.3**	**0.3**	**0.3**	**0.3**	**0.25**	**0.25**	**0.25**	**0.2**		**% of FS**
Accuracy, 20°C[b]	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5		% of FS
Accuracy, -20 – +100°C[c]	1.5	1.5	1.4	1.3	1.3	1.2	1.0	1.0		% of FS
Long-term stability[d]	< 0.2% of FS									

[a] Linearity based on limit point setting
[b] Includes: linearity, hysteresis, repeatability, deviation from initial and full scale values of the measuring range
[c] Includes: linearity, hysteresis, repeatability, deviation from initial and final values of measuring range, thermal effect on initial value of measuring range and span
[d] EN 61298-1

Auxiliary power

Supply voltage U_B[a]				
4 – 20 mA,	two wires,	output 405	DC 8 – 30 V,	nominal power supply DC 24 V
DC 0.5 – 4.5 V,	three wires,	output 412	DC 3 – 5.25 V,	nominal supply voltage DC 5 V, radiometric output 10 – 90% of the supply voltage
DC 0 – 10 V,	three wires,	output 415	DC 11,5 – 30 V,	nominal power supply DC 24 V
DC 1 – 5 V,	three wires,	output 418	DC 8 – 30 V,	nominal power supply DC 24 V
DC 1 – 6 V,	three wires,	output 420	DC 8 – 30 V,	nominal power supply DC 24 V
Power consumption			≤ 25 mA	
Reverse polarity protection			Yes	
Circuit			SELV	

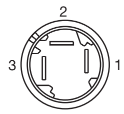
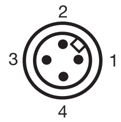
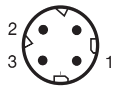
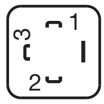
[a] Residual ripple: Peak voltages must **not** exceed or fall below the values specified for the supply voltage!

JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14
36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow, Essex CM20 2DY, UK
Phone: +44 1279 635533
Fax: +44 1279 635262
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-5866
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info.us@jumo.net
Internet: www.jumousa.com

Connection diagram

Connection		**Terminal assignment**[a]				
						
		11 Fixed cable	23 Quickon	36 Round plug, M12x1	53 Bayonet	61 Terminal box
4 – 20 mA, two wires, output 405						
Supply voltage 8 – 30 V DC	UB/S+ 0 V/S-	White Brown	1 3	1 3	1 2	1 2
DC 0.5 – 4.5 V Ratiometric, output 412						
Supply voltage DC 3 – 5.25 V Ratiometric output 10 – 90 % of the supply voltage	UB 0 V/S- S+	White Brown Yellow	1 2 3	1 2 3	1 2 3	1 2 3
DC 0 – 10 V, three wires, output 415						
Supply voltage DC 11.5 – 30 V	UB 0 V/S- S+	White Brown Yellow	1 2 3	1 2 3	1 2 3	1 2 3
DC 1 – 5 V, three wires, output 418 **DC 1 – 6 V, three wires, output 420**						
Supply voltage DC 8 – 30 V	UB 0 V/S- S+	White Brown Yellow	1 2 3	1 2 3	1 2 3	1 2 3

[a] Illustration shows the pressure transmitter connector

Color assignment: Round plug, M12x1					
	1 bn	Brown	4 bk	Black	The color assignment applies **only** to A-coded standard cables!
	2 wh	White	5 gy	Gray	
	3 bu	Blue			

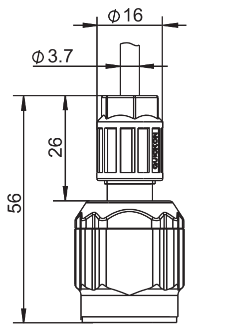
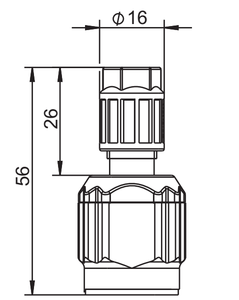
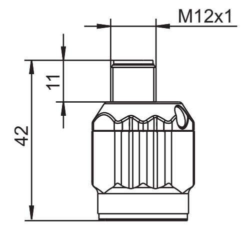
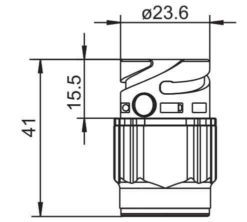
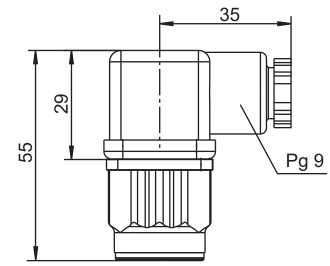
JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14
36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow, Essex CM20 2DY, UK
Phone: +44 1279 635533
Fax: +44 1279 635262
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

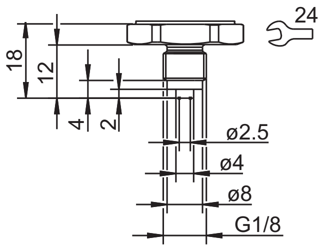
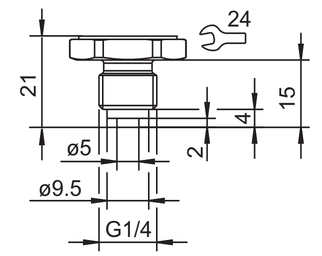
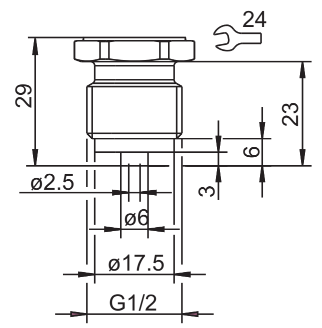
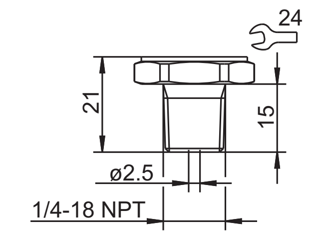
JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-5866
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info.us@jumo.net
Internet: www.jumousa.com

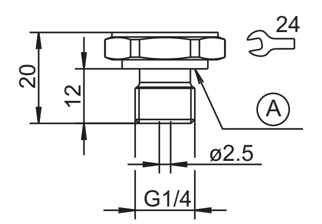
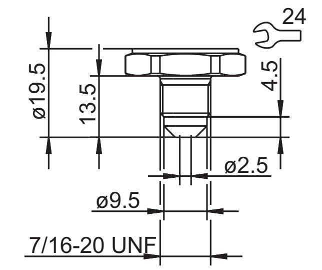
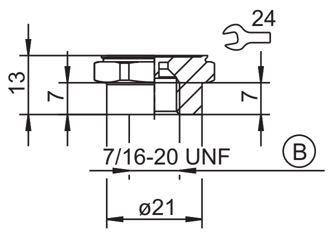
Dimensions

Electrical connection

11 Fixed cable	23 Quickon	36 Round plug, M12x1	53 Bayonet connector	61 Terminal box
				

Process connection

501 G1/8	502 G1/4	504 G1/2	511 1/4 - 18 NPT
			

521 G1/4	562 7/16-20 UNF	563 7/16 UNF inside
		

A = G1/4 profile seal

B = 7/16-20 UNF inside, with valve core depresser

JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14
36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow, Essex CM20 2DY, UK
Phone: +44 1279 635533
Fax: +44 1279 635262
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-5866
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info.us@jumo.net
Internet: www.jumousa.com

Order details

	(1)	**Basic type**	
401010/000		JUMO MIDAS S05 pressure transmitter	
401010/999		JUMO MIDAS S05 pressure transmitter, special design	
	(2)	**Input**	
454		0 – 1 bar relative pressure	
455		0 – 1.6 bar relative pressure	
456		0 – 2.5 bar relative pressure	
457		0 – 4 bar relative pressure	
458		0 – 6 bar relative pressure	
459		0 – 10 bar relative pressure	
460		0 – 16 bar relative pressure	
461		0 – 25 bar relative pressure	
462		0 – 40 bar relative pressure	
463		0 – 60 bar relative pressure	
464		0 – 100 bar relative pressure	
478		-1 – 0 bar relative pressure	
479		-1 – 600 mbar relative pressure	
480		-1 – 1.5 bar relative pressure	
481		-1 – 3 bar relative pressure	
482		-1 – 5 bar relative pressure	
483		-1 – 9 bar relative pressure	
484		-1 – 15 bar relative pressure	
485		-1 – 24 bar relative pressure	
488		0 – 1 bar absolute pressure	
489		0 – 1.6 bar absolute pressure	
490		0 – 2.5 bar absolute pressure	
491		0 – 4 bar absolute pressure	
492		0 – 6 bar absolute pressure	
493		0 – 10 bar absolute pressure	
494		0 – 16 bar absolute pressure	
495		0 – 25 bar absolute pressure	
998		Special measuring range for absolute pressure	
999		Special measuring range for relative pressure	
	(3)	**Output**	
405		4 – 20 mA,	two wires
412		DC 0.5 – 4.5 V,	three wires
415		DC 0 – 10 V,	three wires
418		DC 1 – 5 V,	three wires
420		DC 1 – 6 V,	three wires
	(4)	**Process connection**	
501		G 1/8 to DIN EN 837	
502		G 1/4 to DIN EN 837	
504		G 1/2 to DIN EN 837	
511		1/4-18 NPT to DIN 837	
521		G1/4 to DIN 3852 T11	
562		7/16 - 20 UNF	
563		7/16 - 20 UNF inside, with valve opener	
	(5)	**Process connection material**	
20		CrNi (stainless steel)	
	(6)	**Electrical connection**	
11		Fixed cable [a]	
23		Quickon	
36		Round plug, M12x1	
53		Bayonet instrument connector DIN 72585[b]	
61		Terminal box EN 175301-803, Form A, ex DIN 43650	

JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14
36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow, Essex CM20 2DY, UK
Phone: +44 1279 635533
Fax: +44 1279 635262
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-5866
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info.us@jumo.net
Internet: www.jumousa.com

	(7)	**Extra codes**
000		No extra code
591		Throttle in pressure channel
624		Free of oil and grease
630		Enlarged pressure channel[c]

Notes on the order details

[a] **Electrical connection 11**
Standard: 2 m fixed cable, other lengths available on request

[b] **Electrical connection 53**
Bayonet connector DIN 72585-A1-3.1-Sn/K1

[c] **Extra code 630**
Diameter 6 mm for process connection 501
Diameter 8 mm for process connections 511 and 521

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(7)
Order code		-		-		-		-		-		/		,	...
Sample order	401010/000	-	459	-	405	-	504	-	20	-	61	/	591	,	624

Minimum order quantity for production orders: 5 units
Minimum order quantity for storage orders: 1 unit

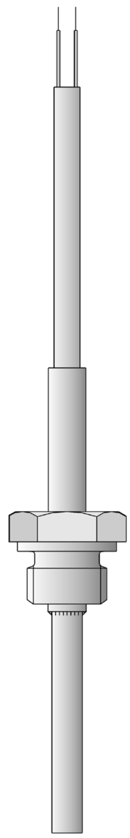
Stock versions

Order code	Description	Part no.
401010/000-456-405-502-20-61/000	0 – 2.5 bar; 4 – 20 mA; G1/4; terminal box	43012486
401010/000-457-405-502-20-61/000	0 – 4 bar; 4 – 20 mA; G1/4; terminal box	00517155
401010/000-458-405-502-20-61/000	0 – 6 bar; 4 – 20 mA; G1/4; terminal box	00517148
401010/000-459-405-502-20-61/000	0 – 10 bar; 4 – 20 mA; G1/4; terminal box	00517139
401010/000-459-405-563-20-61/000	0 – 10 bar; 4 – 20 mA; 7/16-20UNF; terminal box	43012540
401010/000-460-405-502-20-61/000	0 – 16 bar; 4 – 20 mA; G1/4; terminal box	00517133
401010/000-461-405-502-20-61/000	0 – 25 bar; 4 – 20 mA; G1/4; terminal box	00523660
401010/000-483-405-563-20-61/000	-1 – 9 bar; 4 – 20 mA; 7/16 - 20 UNF; terminal box	00531777
401010/000-491-405-502-20-61/000	0 – 4 bar abs.; 4 – 20 mA; G1/4; terminal box	43012517
401010/000-492-405-502-20-61/000	0 – 6 bar abs.; 4 – 20 mA; G1/4; terminal box	00526283

Accessories

Description	Part no.
Cable connector, straight, 4-pin, M12x1, 2m PVC cable	00404585
Cable connector, angled, 4-pin, M12x1, 2m PVC cable	00409334

Screw-in thermocouples with compensating cable



- ■ **for temperatures from -200 to +600°C**
- ■ **available with different thermocouples**
- ■ **as single or twin thermocouple**
- ■ **compensating cable in silicone or with metal braiding**

Screw-in thermocouples are preferred for measuring temperatures in liquids and gases. An important selection criterion is their reliable sealing against both negative and positive pressures. Applications include heating installations, ovens, furnaces and plant engineering.

Depending on the version, the compensating cables are suitable for use in dry and humid areas within a temperature range from -20 to +350°C. The connection of the cable to the protection tube incorporates strain relief and can be provided with a cable protector (option).

Protection tubes in stainles steel protect the measuring insert from chemical influences and mechanical damage.

The measuring insert is fitted with thermocouples to EN 60 584 and DIN 43 710. Versions with two thermocouples are also available.

Technical data

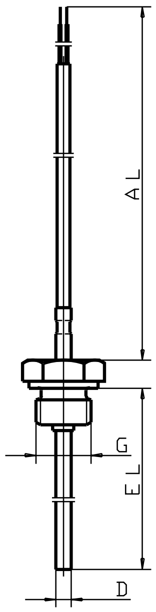
Connection	available with cable ends as: bare wires, ferrules, with receptacles or multipole connector
Compensating cable	silicone, ambient temperature -50 to +180°C metal braiding, ambient temperature -20 to +350°C
Process connection	thread, stainless steel 1.4571
Protection tube	stainless steel 1.4571, 6mm and 8mm dia.
Measuring insert	insulated assembly: 1 x Fe-Con L, DIN 43 710, Cl. 2, operating temperature -200 to +600°C 1 x NiCr-Ni K, EN 60 584, Cl. 2, operating temperature -200 to +600°C 2 x Fe-Con L, DIN 43 710, Cl. 2, operating temperature -200 to +600°C 2 x NiCr-Ni K, EN 60 584, Cl. 2, operating temperature -200 to +600°C
Accessories	pockets, Data Sheet 90.9721

JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14, 36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

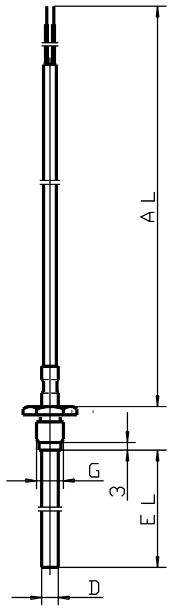
JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow - Essex CM20 2DY, UK
Phone: +44 1279 63 55 33
Fax: +44 1279 63 52 62
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-JUMO
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info@jumo.us
Internet: www.jumo.us

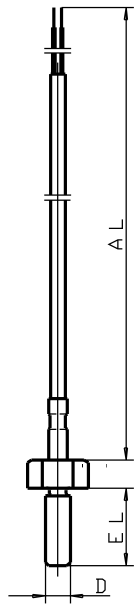
Dimensions



Type 901050/10



Type 901050/20



Type 901050/30

JUMO GmbH & Co. KG
Delivery address: Mackenrodtstraße 14, 36039 Fulda, Germany
Postal address: 36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
E-mail: mail@jumo.net
Internet: www.jumo.net

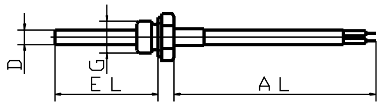
JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow - Essex CM20 2DY, UK
Phone: +44 1279 63 55 33
Fax: +44 1279 63 52 62
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

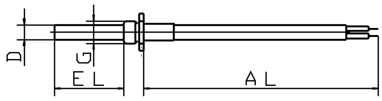
JUMO Process Control, Inc.
8 Technology Boulevard
Canastota, NY 13032, USA
Phone: 315-697-JUMO
1-800-554-JUMO
Fax: 315-697-5867
E-mail: info@jumo.us
Internet: www.jumo.us

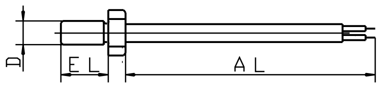
Order details: Screw-in thermocouples with compensating cable

(1) Basic version

			901050/10	Screw-in thermocouple with fixed screw fitting
			901050/20	Screw-in thermocouple with loose screw fitting
			901050/30	Screw-in thermocouple with screw-in protection tube







(2) Operating temperature in °C / compensating cable

x	x		150	-200 to +600°C / metal braiding
x	x	x	380	-50 to +200°C / silicone
x	x	x	390	-50 to +300°C / metal braiding
x	x		402	-50 to +400°C / metal braiding

(3) Measuring insert

x	x	x	1042	1 x Fe-Con L
x	x	x	[illegible]	[illegible]
x	x			
x	x			
x	x			
		x		
	x			
		x		
	x			
x				
	x		137	137mm
x	x		...	please specify in plain text (50mm steps)

FINAL PROJECT	Date: 19.06.2014 Page: 346
PROJECT: "Compressors test live bench under wet compression conditions"	ANNEX: 2

(6) Process connection

x			104	thread 1/2"pipe
x			105	thread 3/4"pipe
x			106	thread 1"pipe
		x	111	thread M 8
	x		114	thread M 10 x 1

(7) Compensating cable end

x	x	x	03	bare cable ends
x	x	x	11	ferrules to DIN 46 228 Part 4 (standard)
x	x	x	13	receptacle 6.3 to DIN 46 247
x	x	x	80	multipole connector (please specify type in plain text)

(8) Compensating cable length AL in mm (500≤ AL ≤500000)

x	x	x	2500	2500mm
x	x	x	...	please specify in plain text (500mm steps)

(9) Extra codes

x	x	x	000	no extra code
x	x	x	309	uninsulated assembly (thermocouple welded to tip)
x	x	x	315	cable protector: coil
x	x	x	316	cable protector: tube

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)	
Order code		-		-		-		-		-		-		-		/		,...
Order example	901050/10	-	150	-	1042	-	6	-	100	-	104	-	11	-	2500	/	000[1]	

1. List extra codes in sequence, separated by commas.

ANNEX X: OFFERS

1 EMERSON

SUMARIO

Item	Cant.	Descripción	Precio unitario (EUR)	Precio total (EUR)	Plazo de entrega (semanas)
1	1	**F025S115CCANSZZZZ** Micro Motion Coriolis F-Series sensor; 1/4-inch; 316L stainless steel	2.774,70	2.774,70	5
1,1	1	**1700I13ABMSZZZ** Micro Motion Coriolis MVD single variable flow transmitter	691,65	691,65	5
2	1	**ASISTENCIA TECNICA MICRO MOTION (Opcional)** *1 día de asistencia en planta para la puesta en servicio del caudalímetro*	680,00	680,00	

Total material (EUR):	**3.466,35**
Transporte (EUR):	**69,33**
Embalaje (EUR):	**INCLUIDO**
Total (EUR):	**3.535,68**

Condiciones particulares

Pedido mínimo	:150,00 € (portes no incluidos)
Precios	:Los precios son fijos durante el período de validez de la oferta.
Plazo de entrega	:Empieza a partir de la fecha de recepción de su pedido oficial en nuestras oficinas. El pedido deberá venir acompañado de toda la documentación técnica y comercial necesaria para su tramitación y suministro sin interrupciones. En caso de recibir un pedido incompleto o incorrecto, el plazo empezará a contar en el momento de la compleción de la información necesaria.
Transporte	:
Condiciones de entrega	: CPT Transporte Pagado Hasta destino peninsular
Validez	: 30/05/14
Forma de pago	:Contado al pedido / Transferencia Los términos de pago ofertados y la aceptación de cualquier pedido resultante de esta oferta están sujetos a la aprobación de nuestro departamento de control de créditos.
Hitos de pago	:En caso de pedidos que incluyan equipos y servicios, los equipos se facturarán a la entrega y los servicios se facturarán una vez completados.
Destino final	:España
Garantías	:A) Estándar: 12 meses desde la puesta en marcha ó 18 meses desde la entrega del material, siendo de aplicación la fecha que se cumple en primer lugar.

	B) Extensión: Por cada 6 meses de ampliación de garantía, se aplicará un 3% del importe total del pedido.
Pedidos	:Solo se aceptarán pedidos oficiales. No se procesarán comunicaciones de intención de pedido o pedidos verbales.
Modificaciones de pedido	:La cancelación de un ítem o el cambio en su especificación pueden ocasionar costes o variaciones en la fecha de entrega que variarán según la envergadura y el momento del cambio y que se notificarán en su caso. Se procesarán las modificaciones una vez recibido el pedido definitivo.
Documentación	:Salvo indicación contraria, la documentación incluida es la documentación estándar de Emerson para los equipos ofertados. En caso de necesitar documentación específica rogamos nos lo comuniquen antes de formalizar su pedido.

Esta oferta está sujeta a las condiciones generales de Emerson Process MANAGEMENT, S.L., y las condiciones particulares indicadas anteriormente.

"La presente oferta, la aceptación de cualquier pedido bajo la misma y el cumplimiento de cualesquiera obligaciones contractuales derivadas de ella estarán sujetos al cumplimiento de cualesquiera normas aplicables en materia de control a la importación y la exportación y su normativa sancionadora, incluidas, en su caso, las normas de los EE.UU. No obstante lo anterior, dichas normas podrán ser modificadas en cada momento, incluyendo durante el procesamiento de un pedido. En el caso de que EMERSON PROCESS MANAGEMENT, SL (la Compañía) no obtenga las licencias, autorizaciones o aprobaciones que sean necesarias o convenientes, aun en el caso de que la falta de obtención se deba a la falta de respuesta de las autoridades administrativas competentes para ello, o en el caso de que dichas licencias, autorizaciones o aprobaciones sean denegadas o revocadas, la Compañía quedará relevada y exonerada de todas sus obligaciones derivadas de cualquier oferta realizada, sin penalización alguna. Del mismo modo, la Compañía quedará relevada y exonerada de todas sus obligaciones sin penalización alguna si existiera algún cambio en las leyes, órdenes u otra normativa aplicable que prohibiera a la Compañía el cumplimiento de cualquier pedido o que, a juicio razonable de la Compañía, le exponga a algún riesgo en aplicación de dichas leyes, órdenes o normativa en caso de cumplimiento del pedido."

"Emerson Process Management SL (La empresa) está comprometida con los estándares más estrictos de conducta ética y comercial y puede requerir la cumplimentación de un cuestionario de diligencia debida (DDQ por sus siglas en inglés). Si se requiere esta cumplimentación, la aceptación de cualquier pedido resultante de esta oferta estará sujeta a la revisión favorable por la empresa del DDQ enviado."

RESUMEN DE EQUIPOS

Item	Cant.	Descripción	
1	1	**F025S115CCANSZZZZ**	
		F025S	Modelo: Micro Motion Coriolis F-Series sensor; 1/4-inch; 316L stainless steel
		115	Conexiones de proceso: 1/2-inch CL600 ASME B16.5 F316/F316L Weld neck flange Raised face
		C	Opciones de estuches: Compact case
		C	Interfase de los electrónicos: For integral mount 1700/2700 transmitter
		A	Conexiones de conductos: No gland
		N	Aprobaciones: Micro Motion Standard / PED compliant
		S	Idioma: Spanish installation manual
		Z	Opción futura 1: Reserved for future use
		Z	Calibration,for liquids only) 0.20% mass flow and 0.002 g/cc density calibration
		Z	Software de aplicación de medidas: No measurement application software
		Z	Opciones de fábrica: Standard product

Item	Cant.	Descripción	
1,1	1	**1700I13ABMSZZZ**	
		1700	Modelo: Micro Motion Coriolis MVD single variable flow transmitter
		I	Montaje: Integral mount transmitter
		1	Alimentación: 18 to 100 VDC and 85 to 265 VAC; self switching
		3	Pantalla: No display
		A	Output (1700): One mA; one frequency; RS485
		B	Conexiones de conductos: 1/2-inch NPT - no gland
		M	Aprobaciones: Micro Motion Standard (no approval)
		S	Idioma: Spanish installation manual and Spanish configuration manual
		Z	Opciones de software 1: Reserved for future use
		Z	Opciones de software 2: No software options 2
		Z	Opciones de fábrica: Standard product
		Tag	**Calibracion**
			0 – 120 g/seg

Item	Cant.	Descripción
2	1	**ASISTENCIA TECNICA MICRO MOTION (Opcional)**

Revisión de la instalación eléctrica y mecánica
Configuración del instrumento según hoja de datos.
Realización del cero y
Pruebas de lazo en señales analógicas

2 EBARA

Fecha: 01/05/2014 **OFERTA Nº.: EEZA - 20140501 30.733**

Referencia:

A continuación le detallamos la oferta solicitada:

Item	Uds.	Descripción	Precio neto unitario	Total neto
1	1	Tipo: BOMBA SIMPLE ROTOR HÚMEDO ELECTRÓNICA Pot. [kw]: 0 r.p.m.[1/min]: 0 Modelo: EGO **EGO 15/40-130** Construida en: HIERRO FUNDIDO Tensión: 1 * 230V VERSION ESPECIAL ER PORTES: 9,90 € EN FRA.	**202,80€**	**202,80 €**

CONDICIONES DE VENTA:

Precios según tarifa vigente.

Forma de pago:	De acuerdo con la ley 15/2010 de lucha contra la morosidad.
Validez de la oferta:	1 mes.
Plazo de entrega:	1 semana laboral aproximadamente.
Impuestos:	No incluidos.
Condiciones de entrega:	Portes pagados hasta pie de obra / su almacén, para importes superiores a 600 €. Descarga a cargo del cliente.
Garantía:	La garantía de los equipos estará supeditada al estricto cumplimiento de los requisitos de funcionamiento reflejados en la Documentación Técnica.
Gastos de almacenaje:	Los gastos de almacenaje son del 2,5% por mes pasados los primeros 15 días. En el caso de retraso, por causas ajenas a EBARA, en la entrega de la mercancía fabricada, se emitirá la factura en el plazo de 15 días desde la fecha de finalización de
Devoluciones:	El comprador dispone de un plazo de 15 días contados a partir de la fecha de recepción de las mercancías, para devolvernos cualquier equipo. En ningún caso se admitirán devoluciones que no hayan sido previamente acordadas con nuestro departamento comercial. En caso de acuerdo, y siempre dentro del plazo anteriormente establecido, el material deberá sernos remitido perfectamente embalado (embalaje original) y a PORTES PAGADOS, indicando datos de su expedición y/o facturación (nº y fecha de albarán, nº de factura, etc.) En todas las devoluciones la mercancía se depreciará un 15% del valor neto facturado, en concepto de participación de nuestros costos de revisión y acondicionamiento.

3 JUMO

En relación a su consulta, nos es grato cotizarles como sigue:

Página.1

Item	Descripción	Cant	Precio	Desc	Total	Plazo
1	Termopar NiCr-Ni tipo "K", con dimensiones de inserción medición en accesorio pos. 2, rosca M10, con 3000 mm longitud de cable de silicona con malla metálica Ref.: 901050/10-380-1043-5,6-29-114-03-3000/31	5,00	61,00		305,00	4 semanas
2	Soporte para tubería de ½”., entrada y salida Ref.: 902442/11-000-104-104-000	5,00	45,00		225,00	10 días laborables
3	Transmisor de presión con rosca de ¼”. Ref.: 401010/000-464-405-502-20-61/000	3,00	144,00		432,00	3/4 semanas

Total: 962,00

En caso de formular pedido, hacer
referencia al número de oferta

Condiciones comerciales

Precio: franco fábrica, sin IVA, sin embalaje
Envío: Portes debidos, envío no incluído en la
la oferta. (Sus medios).
Forma de pago: primer pedido al contado sino
según condiciones habituales
Validez de la oferta: 30 días
Pedido mínimo: € 75,00
La oferta no incluye otros servicios ni presta-
ciones, no recogidas expresamente en la oferta

Oferta válida según nuestras condiciones ge-
nerales de venta y suministro (visibles en
www.jumo.es)

Aun cuando Jumo Control de su apoyo por
escrito o verbalmente, en la selección de sus
productos para la aplicación por el cliente,
es responsabilidad final del comprador com-
probar la idoneidad del producto para la apli-
cación a la que se le destina.
El riesgo de uso es del comprador, a no ser,
Jumo hubiera suscrito un acuerdo explícito
de uso con el comprador

4 IFM

Oferta y compra online
en www.ifm.com

Contacto ifm RUBIO David (DAR)
Teléfono - Fax -
E-mail general: info.es@ifm.com
solo pedidos: eorders.es@ifm.com
asistencia técnica: soporte.es@ifm.com

Copia 1 Pagina 1

Dirección de entrega BSH ELECTRODOMESTICOS
ESPAÑA SA
CRTA.TAFALLA 17
31132 VILLATUERTA
ESPAGNE

Pos	Fecha entrega estimada	Articulo	Cantidad	Precio neto unit. EUR	Total sin IVA EUR
10	22/04/2014	**SM6000** SMR12GGXFRKG/US-100 Caudalímetro magneto-inductivo efector300 5 años Garantía	**1** pcs	304,0000	304,00
20	22/04/2014	**EVC005** ADOAH040MSS0005H04 Conector hembra ecomat400 5 años Garantía	**1** pcs	4,2000	4,20
950	22/04/2014	**PV01** Portes			14,70

Condiciones de entrega : Standard (max.5 dias)- Portes en factura
Transportista : UPS
Condiciones de pago : 75 DIAS NETO
Forma de pago : PAGARE/TALON

Total base imponible : 322,90 EUR
IVA 21,0 % : 67,81 EUR
Total a pagar : 390,71 EUR

Identificación : Ingenieurgemeinschaft fuer Messtechnik Electronic S.L.
Inscrita en el RM Barcelona, Tomo 40787, folio 96, Hoja B-375041, inscripción 1ª
CIF: B64956873

Domiciliación bancaria : Commerzbank AG: IBAN ES68 0159 0002 8056 2380 6978 BIC/Swift COBAESMXBAR

Ver nuestras condiciones de venta en www. ifm.com

Los datos personales facilitados por Usted serán incorporados a un fichero automatizado de ifm electronic con la finalidad de realizar las tareas administrativas/comerciales y de gestión necesarias para el cumplimiento de las obligaciones legales derivadas de la relación mercantil. Usted puede ejercitar los derechos de acceso, rectificación y cancelación legalmente establecidos, mediante comunicación a ifm electronic, en C/Garrotxa 6-8 de El Prat de Llobregat, Barcelona (CP08820).

5 OMEGA

Su N º de pedido	EMAIL RFQ	Enviar por	U P S
Fecha del pedido	8 May 14	Número de cuenta del transportista	-
Fecha de envío	8 May 14	Condiciones de envío	SHIPPING POINT
Comprador	N. MEDINA	N º de IVA	ESA28893550
Agente de ventas	GAIZKA NUNEZ (gnunez@omega.co.uk)	Condiciones	NET 30 DAYS

	Número de pieza	Descripción	Ctd Pedida	Ctd Restante	Precio unitario EUR	Ext EUR
1	CSH-5082000/240V	CARTRIDGE HTR 3/4"X8" 2000W	1	1	56.280	56.280
2	*CARRIAGE-C	UPS ROAD SERVICE	1	1	15.000	15.000
					Subtotal	EUR 71.280
					TOTAL	EUR 71.280

Entrega: En stock.
Oferta válida durante un período de 60 días.

Omega Engineering Limited, One Omega Drive, River Bend Technology Centre, Northbank, Irlam, Manchester M44 5BD. Reino Unido
Teléfono Gratuito: 800 900 532 (Solo desde España), Tel: 911 776 121, Fax: 911 776 122, Email: ventas@es.omega.com

N º de IVA GB 620 0439 89 Company No. 2564017 Todos los bienes son propiedad de Omega Engineering Ltda hasta que se reciba el pago en su totalidad

CÓDIGO	RESUMEN	CANTIDAD	PRECIO	IMPORTE
	CAPÍTULO 01 OPCION 1 - PLC UNICO PARA 6 PUESTOS			
	SUBCAPÍTULO 01.01 PLC S7-315 PARA 6 PUESTOS			
01.01.01	Ud Perfil soporte 480mm SIMATIC S7-300, Perfil soporte longitud =480mm	2,00	28,99	57,98
01.01.02	Ud Unidad central CPU 315-2PN/DP SIMATIC S7-300 CPU 315-2 PN/DP, Módulo central con 384 Kbyte . Memoria principal, Interface 1: MPI/DP 12 MBits/s, Interface 2: Ethernet Profinet, con Switch de 2 Puertos. Requiere Micro memory card.	1,00	2.193,17	2.193,17
01.01.03	Ud Micro Memory Card 512kB SIMATIC S7, Micro Memory Card para S7-300/C7/S7-200 IM 151 CPU, 3,3 V NFlasch, 512 Kbyte	1,00	179,02	179,02
01.01.04	Ud Interfase IM-365 SIMATIC S7-300, interfase IM 365 para conectar un bastidor de ampliación, 2 Módulos + cable 1m. Sin Bus K	1,00	127,27	127,27
01.01.05	Ud Módulo de termopares 6 canales SIMATIC S7-300, Módulo entradas analógicas SM331, canal galvánico AC250V, 6 termopares tipo B, E, J, K, L, N, R, S, T Tensión +/-25MV hasta +/-1V 16 Bits, 50 ms, 1 x 40 polos	5,00	858,89	4.294,45
01.01.06	Ud Módulo de entradas analógicas 8 canales en tensión SIMATIC S7-300, Módulo entradas analógicas SM 331, con aislamiento galvánico, 8 EA, Resolución de 13 Bits, U/I/Resistencia/PT100, NI100, NI1000, LG-NI1000, PTC / KTY, tiempo con versión 66MS, 1 x 40 polos	4,00	406,68	1.626,72
01.01.07	Ud Módulo de salidas analógicas 8 canales tensión/corriente SIMATIC S7-300, Módulo de salidas analógicas SM 332, con separación galvánica, 8 SA, U/I; con diagnóstico, resolución 11/12 Bits, 40 polos, posible conexión y desconexión con bus protector activo	2,00	922,02	1.844,04
01.01.08	Ud Módulo de salidas digitales 16SD 24Vcc SIMATIC S7-300, Módulo de salidas digitales SM 322, con separación galvánica, 16 SD, 24 V DC, 0,5 A, conector 20 polos	1,00	214,20	214,20
01.01.09	Ud Conector frontal 40 polos tornillo SIMATIC S7-300, conector frontal 392 con terminales de tornillo, 40 polos	11,00	35,69	392,59
01.01.10	Ud Conector frontal 20 polos tornillo SIMATIC S7-300, conector frontal para bloques de entrada/salida con terminales de tornillo, 20 polos	1,00	22,55	22,55
01.01.11	Ud Pantalla táctil 9" SIMATIC TP900 Comfort Panel, Windows CE 6.0, Display TFT panorámico de 9 , 12 MB de Memoria de config., configurable con WinCC V11	1,00	1.625,56	1.625,56

TOTAL SUBCAPÍTULO 01.01 PLC S7-315 PARA 6 PUESTOS.. 12.577,55

TOTAL CAPÍTULO 01 OPCION 1 - PLC UNICO PARA 6 PUESTOS 12.577,55

CÓDIGO	RESUMEN	CANTIDAD	PRECIO	IMPORTE
	CAPÍTULO 02 OPCION 2 - PLC CENTRAL + REMOTA POR PUESTO			
	SUBCAPÍTULO 02.01 PLC CENTRAL			
02.01.01	Ud Perfil soporte 160mm SIMATIC S7-300, Perfil soporte longitud =160mm	1,00	18,64	18,64
02.01.02	Ud Unidad central CPU 315-2PN/DP SIMATIC S7-300 CPU 315-2 PN/DP, Módulo central con 384 Kbyte . Memoria principal, Interface 1: MPI/DP 12 MBits/s, Interface 2: Ethernet Profinet, con Switch de 2 Puertos. Requiere Micro memory card.	1,00	2.193,17	2.193,17
02.01.03	Ud Micro Memory Card 512kB SIMATIC S7, Micro Memory Card para S7-300/C7/S7-200 IM 151 CPU, 3,3 V NFlasch, 512 Kbyte	1,00	179,02	179,02
02.01.04	Ud Pantalla táctil 9" SIMATIC TP900 Comfort Panel, Windows CE 6.0, Display TFT panorámico de 9 , 12 MB de Memoria de config., configurable con WinCC V11	1,00	1.625,56	1.625,56
	TOTAL SUBCAPÍTULO 02.01 PLC CENTRAL			4.016,39
	SUBCAPÍTULO 02.02 REMOTA (ET200S) PUESTO 1			
02.02.01	Ud Módulo interfase IM 151 PN para ET200S SIMATIC ET 200, módulo de interfase IM151-3 PN ST para ET 200S, velocidad de transmisión 100MBit/s máximo 63 módulos (potencia, electrónicos, arrancadores de motor), hasta 2 metros de ancho, conexión al bus mediante 2 x RJ45 , incluye módulo terminador de ET	1,00	232,19	232,19
02.02.02	Ud Módulo de potencia PM-E 24Vcc SIMATIC ET 200, 1 módulo de potencia PM-E para ET 200S; DC 24V con diagnóstico	1,00	12,26	12,26
02.02.03	Ud Módulo de terminales para alimentación SIMATIC ET 200, 1 módulo de terminales TM-P15S23-A1 para ET 200S, para módulos de potencia, 15 mm de ancho, bornes de tornillo, 2 x 3 conexiones, con bornas de acceso a AUX1, continuación de AUX1	1,00	6,94	6,94
02.02.04	Ud Módulo electrónico para 2EA termopar SIMATIC ET 200, 1 módulo electrónico para ET 200S, 2EA TC (termopar) HIGH FEATURE, 15mm de ancho, 15bit + signo, con compensación interna de temperatura	3,00	147,77	443,31
02.02.05	Ud Módulo de terminales para termopar SIMATIC ET 200, 1 módulo de terminales TM-E15S24-AT para ET 200S, para módulos electrónicos 2 EA TC HIGH FEATURE, 15 mm de ancho, bornes tornillo, con bornas de acceso a AUX1, continuación de AUX1	3,00	19,01	57,03
02.02.06	Ud Módulo electrónico para 2EA intensidad 2 hilos SIMATIC ET 200, 1 módulo electrónico para ET 200S, 2EA STANDARD I-2DMU, 15mm de ancho, 4 .. 20mA; 13 bit, para transmisores de medida a 2 hilos, tiempo de ciclo 65ms/canal, con LED SF (fallo agrupado)	3,00	118,17	354,51

CÓDIGO	RESUMEN	CANTIDAD	PRECIO	IMPORTE
02.02.07	Ud Módulo electrónico para 2SA tensión SIMATIC ET 200, 1 módulo electrónico para ET 200S, 2 SA U (tensión), 15mm de ancho, +/-10V; 13 bit + signo :, 1..5V; 12 bit, tiempo de ciclo menor de 1 ms, con LED SF (fallo agrupado)	1,00	117,68	117,68
02.02.08	Ud Módulo electrónico para 2SA intensidad SIMATIC ET 200, 1 módulo electrónico para ET 200S, 2 SA I (corriente), 15mm de ancho, +/-20mA; 13 bit + signo, 4 . .20mA; 12 bit, tiempo de ciclo menor de 1 ms, con LED SF (fallo agrupado)	1,00	117,68	117,68
02.02.09	Ud Módulo electrónico para 2SD 24Vcc SIMATIC ET 200, 5 módulos electrónicos para ET 200S, 2 SD STANDARD DC 24V/0,5A, 15mm de ancho, 5 unidades por embalaje	0,20	98,72	19,74
02.02.10	Ud Módulo de terminales SIMATIC ET 200, 5 módulos de terminales TM-E15S24-01 para ET 200S, para módulos electrónicos, 15 mm de ancho, bornes de tornillo, 2 x 4 conexiones, sin bornas de acceso a AUX1, continuación de AUX1, 5 unidades por embalaje	1,20	34,77	41,72

E.T.S. de Ingeniería Industrial,
Informática y de Telecomunicación

Compressors test life bench under wet compression conditions

Grado en Ingeniería
en Tecnologías Industriales

PLANES

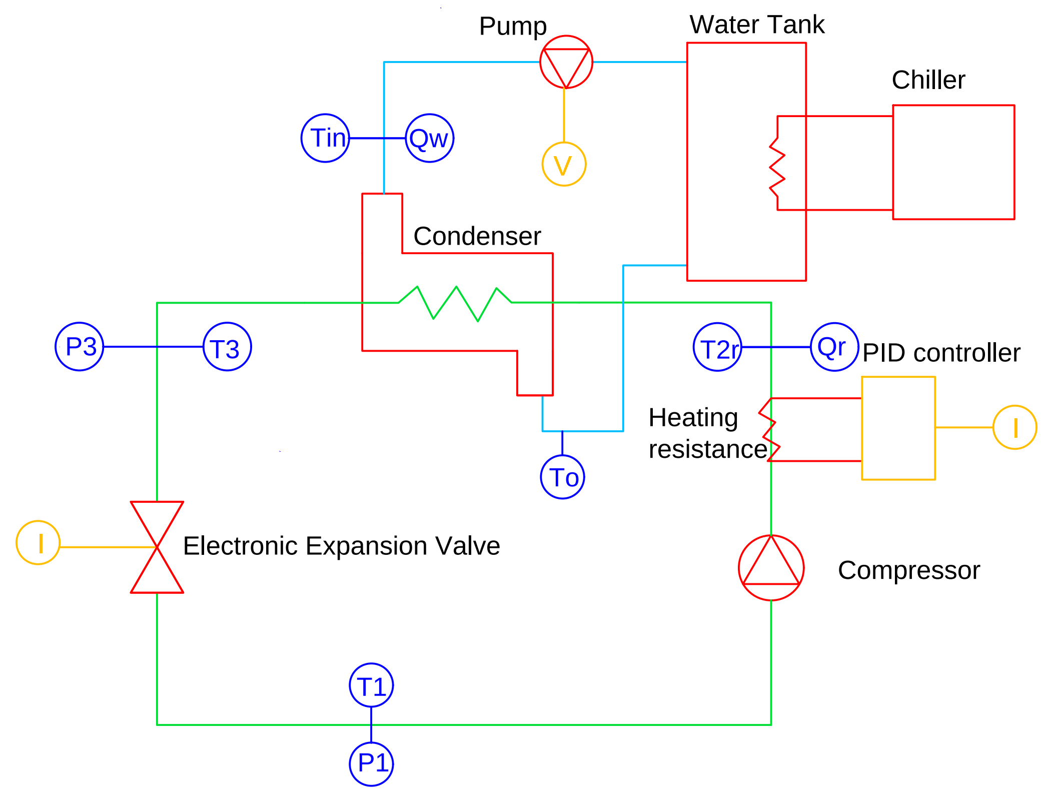
Natalia Medina Cabello

Jose Ignacio Arocena

Pamplona, 26 de Junio del 2014

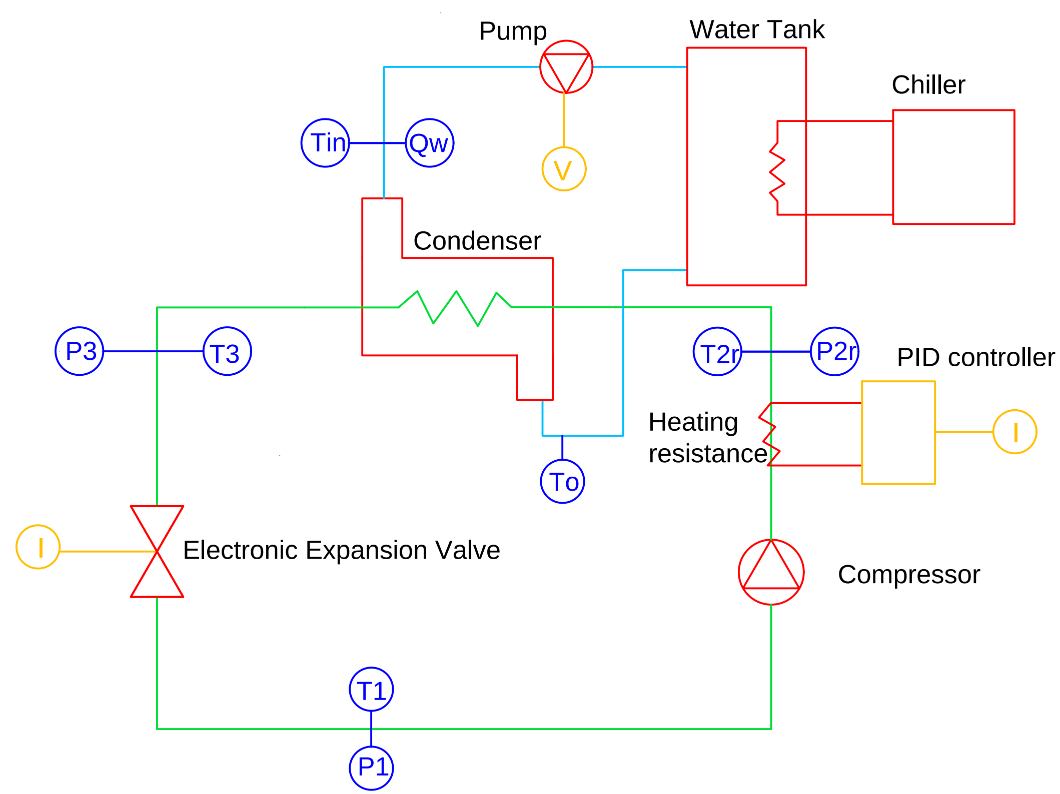
	FINAL PROJECT	Date: **19.06.2014** Page: **1**
PROJECT: **“Compressors test live bench under wet compression conditions”**		PLANES: **3**

PLANE’S INDEX



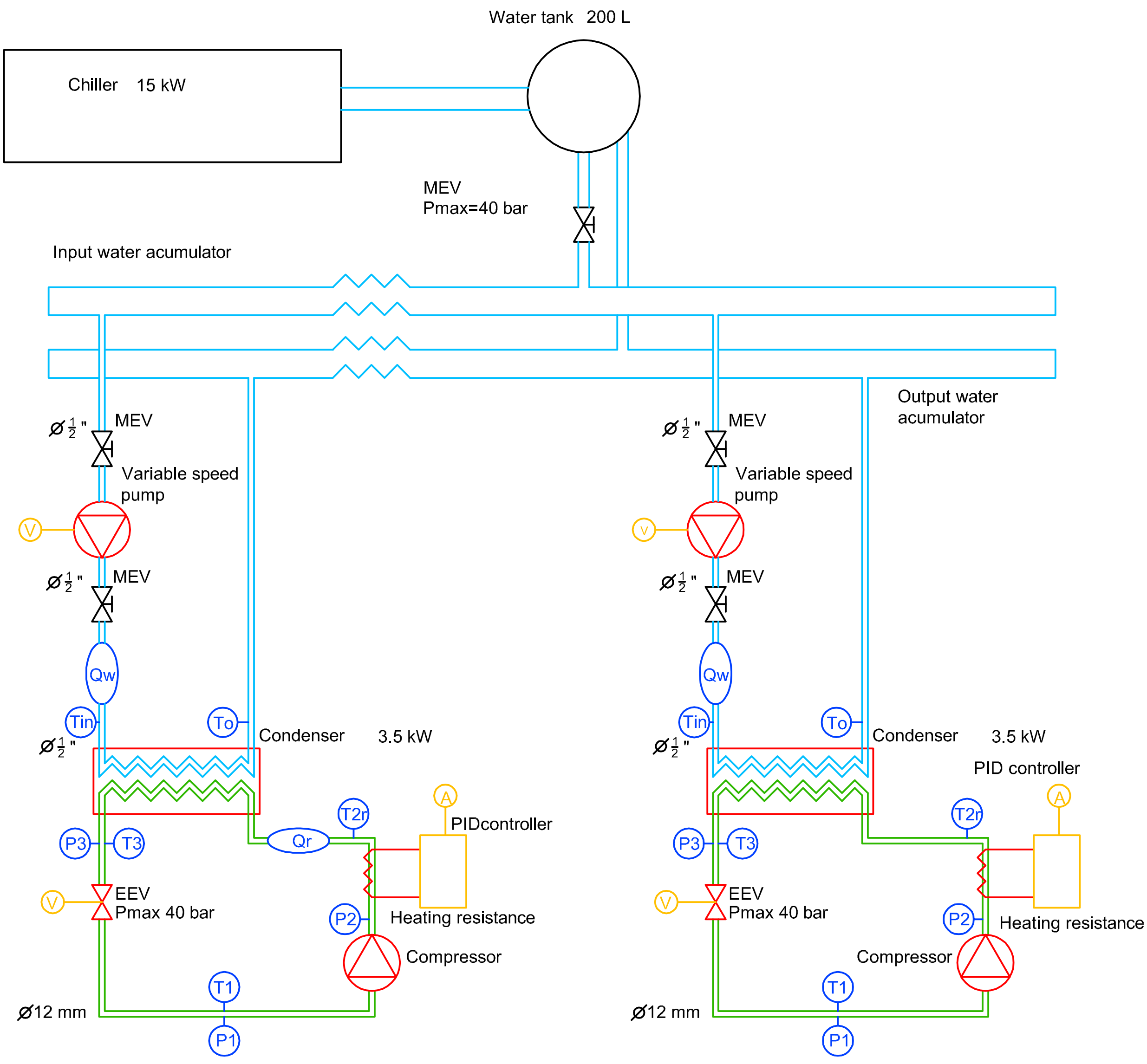
○	Sensors-Inputs
○	Actuators-Outputs
□	Thermodynamic equipment
—	Refrigerant circuit
—	Water circuit

Universidad Publica de Navarra *Nafarroako Unibertsitate Publikoa*	**E.T.S.I.I.T.** **INGENIERO TECNICO INDUSTRIAL E.**	DEPARTMENT: **DEPARTAMENTO DE AUTOMATICA Y CONTROL**
PROJECT: **TEST BENCH**		AUTHOR: **MEDINA CABELLO, NATALIA**
		SIGNATURE:
PLANE: **PID OPTION 1**		DATE: 27/06/2014 · ESCALE: 1 : 100 · Num. PLANE: 1



○	Sensors-Inputs
○	Actuators-Outputs
□	Thermodynamic equipment
—	Refrigerant circuit
—	Water circuit

Universidad Publica de Navarra *Nafarroako Unibertsitate Publikoa*	**E.T.S.I.I.T.** **INGENIERO TECNICO INDUSTRIAL E.**	DEPARTMENT: **DEPARTAMENTO DE AUTOMATICA Y CONTROL**
PROJECT: **TEST BENCH**		AUTHOR : **MEDINA CABELLO, NATALIA**
		SIGNATURE:
PLANE: **PID OPTION 2**		DATE: 27/06/2014 / ESCALE: 1 : 100 / Num. PLANE: 2



LEYEND	Actuators-Output signals
Water circuit	Manual Expansion Valve (MEV)
Refrigerant circuit	Electronic Expansion Valve (EEV)
Thermodynamic equipment	Compressor
Sensors-Input signals	Variable speed pump

Universidad Publica de Navarra

Nafarroako Unibertsitate Publikoa

E.T.S.I.I.T.

INGENIERO TECNICO INDUSTRIAL E.

DEPARTAMENT:

DEPARTAMENTO DE PROYECTOS E ING. RURAL

PROJECT:

TEST BENCH

AUTHOR:

MEDINA CABELLO, NATALIA

SIGNATURE:

PLANE:

DISTRIBUTION

DATE:	ESCALE:	Num. PLANE:
27/06/2014	1 : 25	3