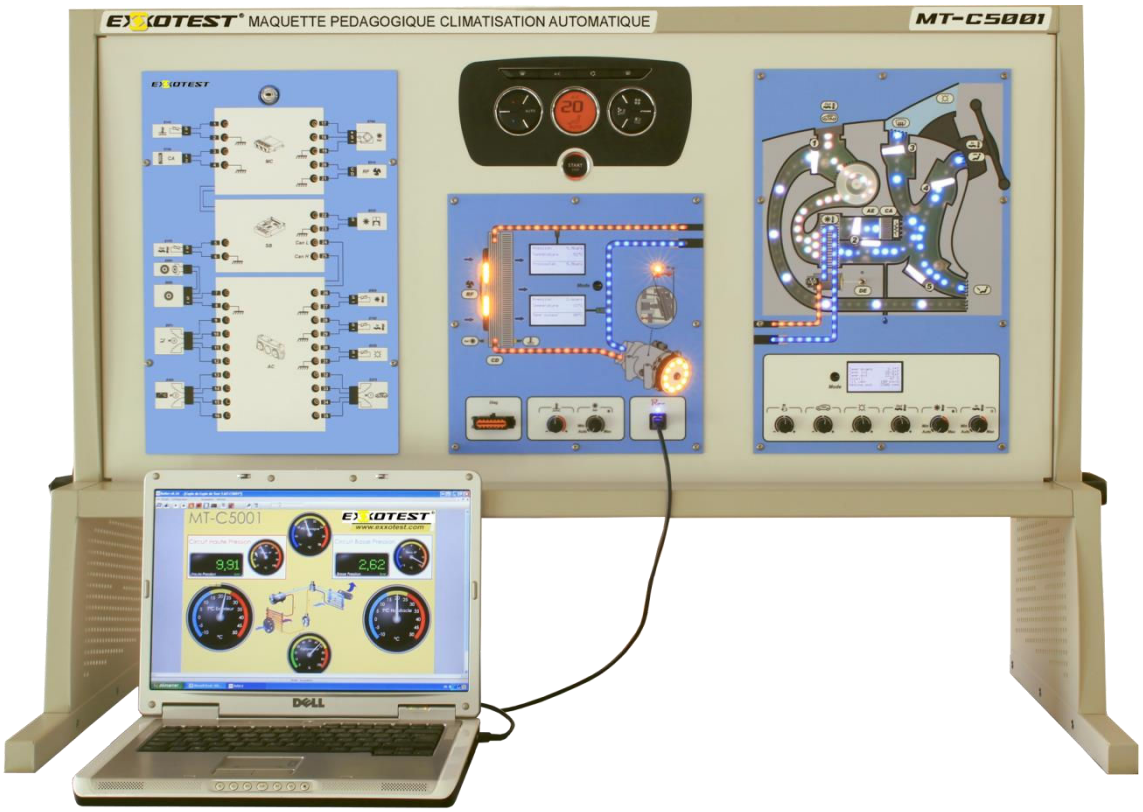
EXXOTEST® EDUCATION

Vehicle training equipment



User's guide MT-C5001
TRAINING MODEL:
Controlled air conditioning for vehicles

CONTENT

1. INSTRUCTION MANUAL

Installation and start-up of the MT-C5001 model.

Connect the model to the 230V mains supply (check that the power switch behind the MT-C5001 model is set to **0**).
After plugging in the power cable, set the power switch on the MT-C5001 model to **1**.

Operational environment

The model must be installed in a clean, dry location, free of dust, water vapour and combustion fumes. The model requires a lighting level of approx. 400 to 500 Lux. The model can be installed in a Practical Workshop classroom. Operating noise will not exceed 70 dBA. The model is protected against any errors by future users.

Calibration and servicing of the MT-C5001 model.

Calibration: Factory settings.
Servicing interval: N/A
Cleaning: Use a soft, clean cloth with a window cleaning product.

Number of workstations.

The MT-C5001 model is considered as one single workstation.

Method for removal from service

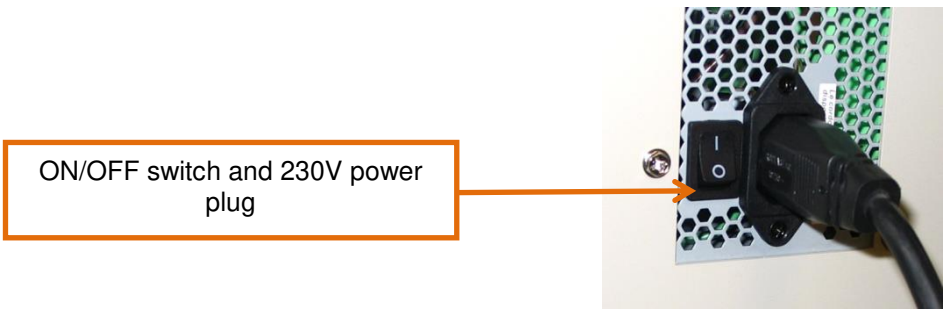
Set the switch to **0**.
Remove the 230V connection.
Then store the MT-C5001 model in a closed room with a front panel marked 'Equipment Removed from Service'.

Only qualified and authorised members of personnel may access the interior of the model!!!

Transporting the MT-C5001 model.

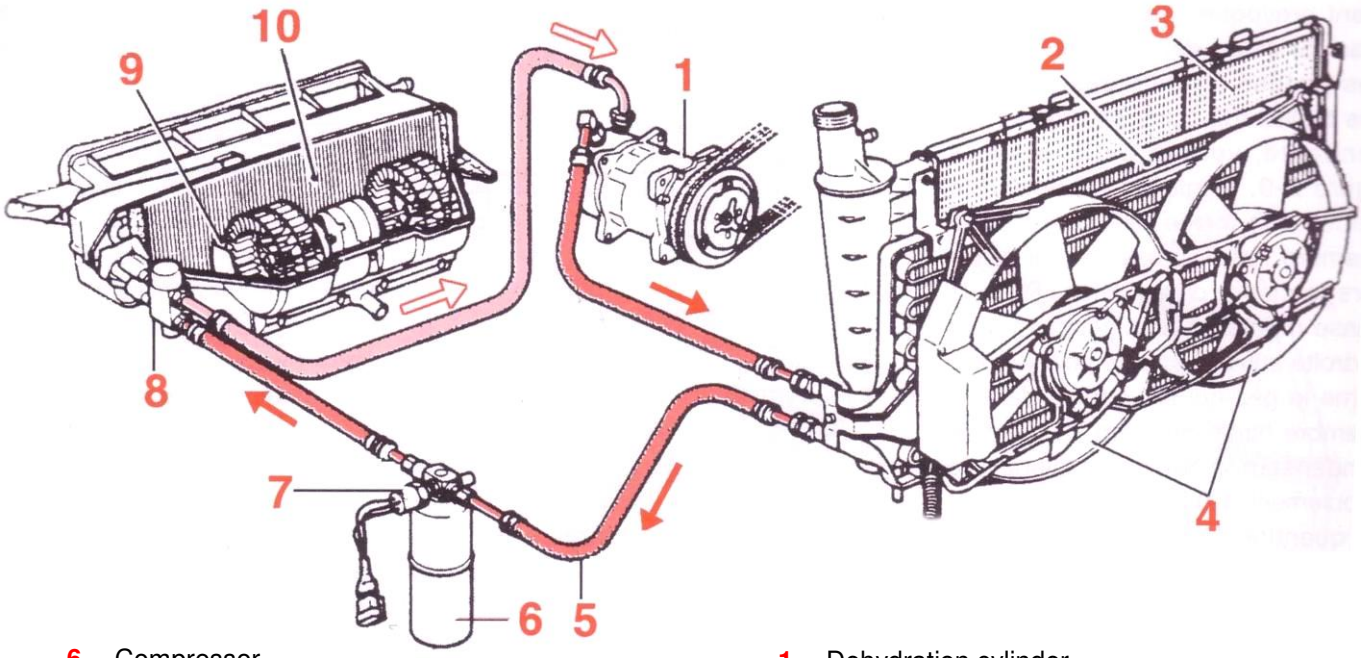
The model must be turned off and removed from service before transport (see "removal from service"). Important: never leave anything on the tablet. At least two people are required for transport purposes. Use the carry handles fitted for this purpose.

230V supply:



2. AIR CONDITIONING SYSTEM

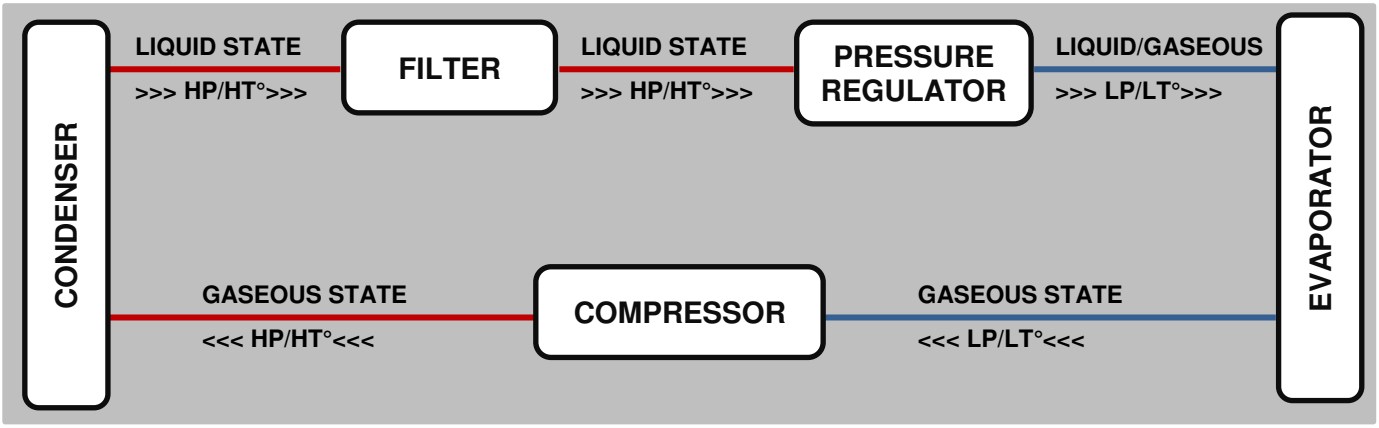
2.1. View of cooling circuit components:



6. Compressor
7. Condenser
8. Engine cooling radiator
9. Powered fan unit
10. Pipes

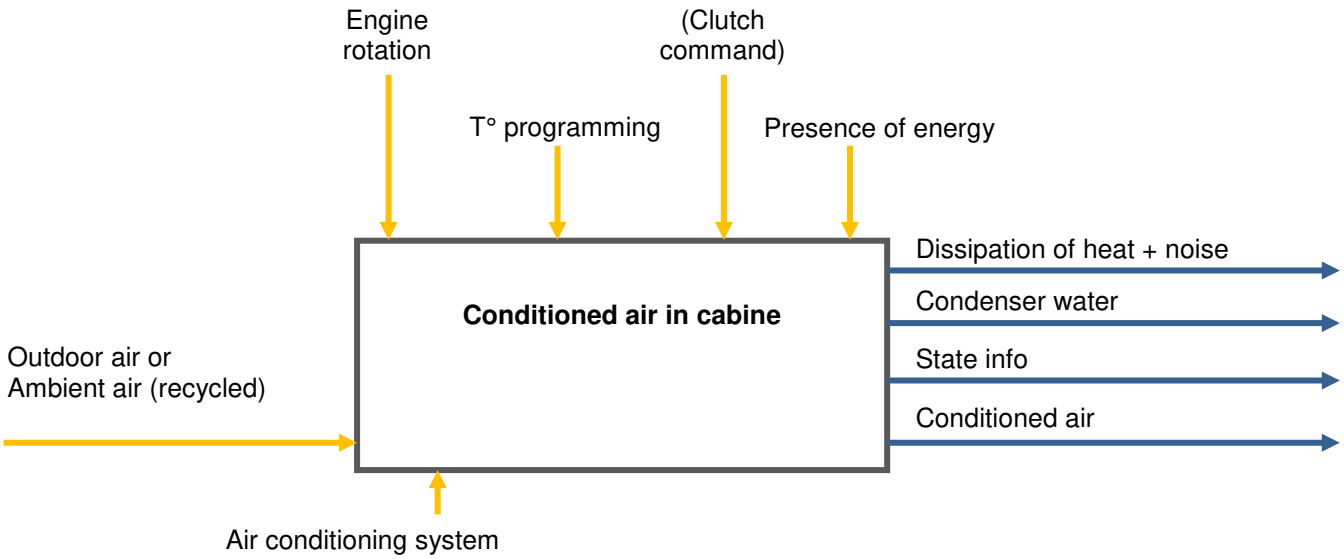
1. Dehydration cylinder
2. Fluid pressure sensor
3. Expansion valve
4. Air fan (pulser)
5. Evaporator

State of refrigerant at each point in the cooling circuit:



2.2. Functional analysis

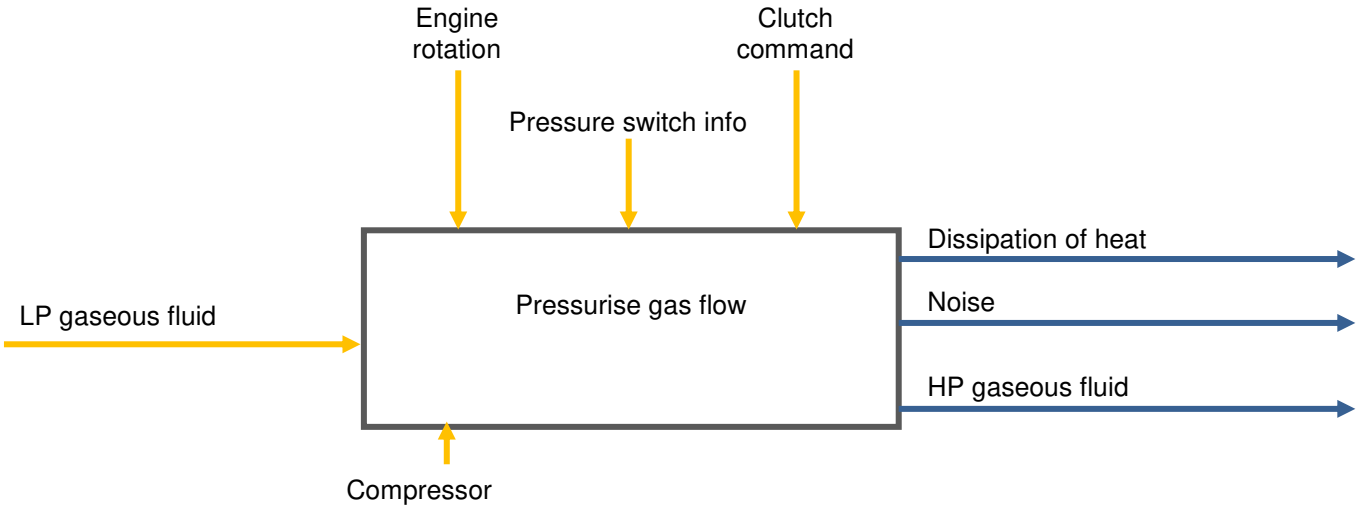
Overall operation



The compressor

The compressor is a pump which transforms the mechanical energy transmitted by the vehicle engine into pressure energy. The compressor starts refrigerant flow by sucking at the evaporator outlet and propelling the fluid into the condenser, after increasing its pressure to optimal operating levels. The compressor only acts on fluid in the dry vapour phase.

Overall operation of the compressor:
Ensure high pressure refrigerant flow.



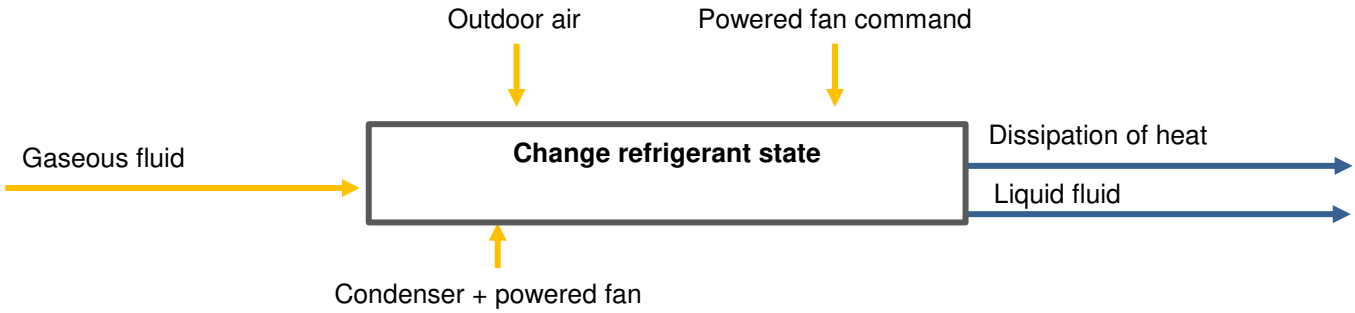
The condenser

The condenser is a heat exchanger. The refrigerant will lose a large amount of heat between the inlet and the outlet, and will condense (liquefy). The refrigerant flows in a network of tubes separated by vanes. The assembly forms a bundle crossed by air flow forced by one or two axial powered fans.

C*ondenser inlet:* the refrigerant leaves the compressor in gaseous form at high pressure and high temperature.

Condenser outlet: the refrigerant is in liquid form at a lower temperature and high pressure.

Overall operation of the condenser:
Condense the superheated vapour (gas) and supercool the fluid (liquid).



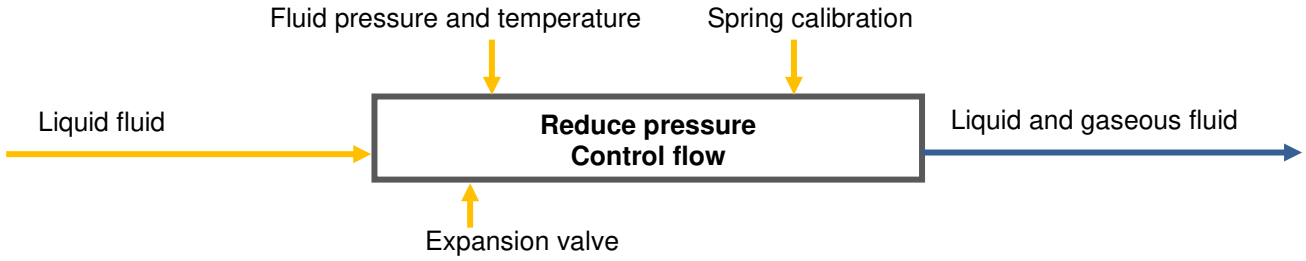
The expansion valve (with built-in thermostat)

The thermostatic expansion valve controls the flow of refrigerant in the evaporator. This flow is controlled on the basis of the temperature of the refrigerant when leaving the evaporator. Therefore, only the amount of fluid required for optimal evaporation is injected.

Expansion valve inlet: The refrigerant is liquid and at high pressure.

Expansion valve outlet: The refrigerant has been vaporised at low pressure, generating cold.

Overall operation:
Reduce the pressure and control the flow of the refrigerant depending on temperature.



The evaporator

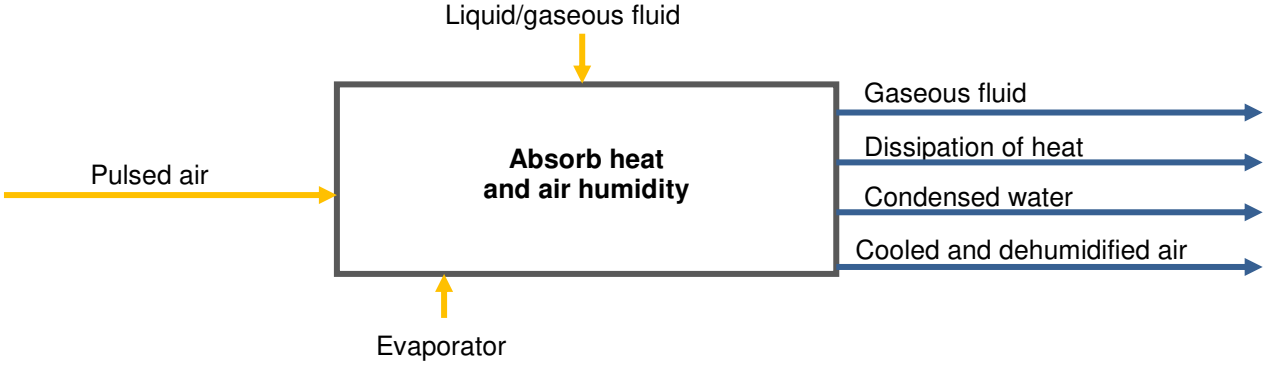
The evaporator is a heat exchanger and is an integral part of the thermostatic expansion valve.

Evaporator inlet: The expanded refrigerant is in liquid/vapour phase and at low pressure.

Inside the evaporator: The outdoor ambient air crosses the evaporator before entering the cab. This air will transfer some of its heat to the refrigerant, ensuring vaporisation. The outdoor air pulsed into the cab is cool, dehumidified and free of dust.

Evaporator outlet: The refrigerant is gaseous and at low pressure.

Overall operation:
Cool the air entering the vehicle cab.



Evacuating condensates

Ambient relative humidity contributes to the comfort ensured by an air conditioning system. The rapid evacuation of humidity, condensed in the evaporator, is therefore essential to avoid icing. This humidity is evacuated under the vehicle.

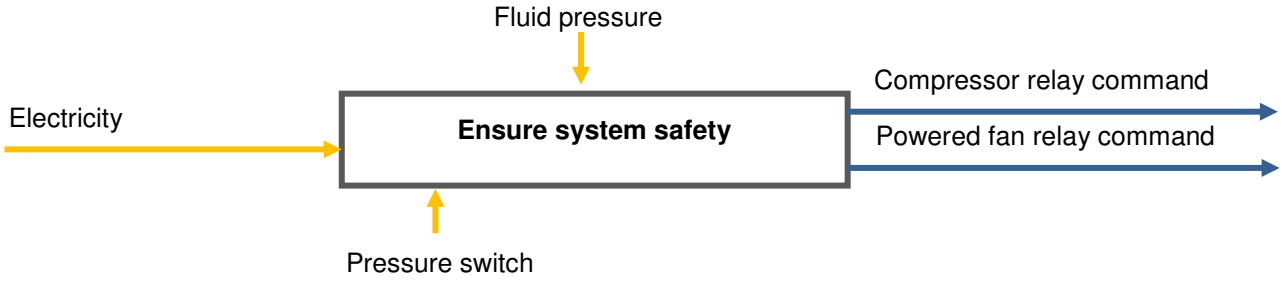
Pressure sensor (pressure switch)

This sensor ensures system safety:

High pressure: the compressor will be deactivated if refrigerant pressure is too high (> 25 bar).

Low pressure: the compressor will be deactivated if refrigerant pressure is too low (< 2.5 bar = leak or no fluid).

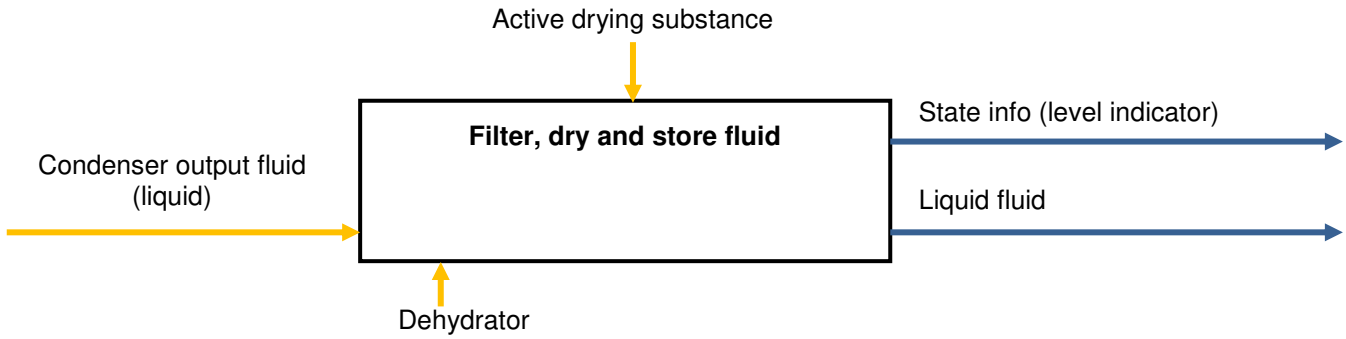
Overall operation:
Control the powered fan and clutch command to ensure system safety.



The dehydrator

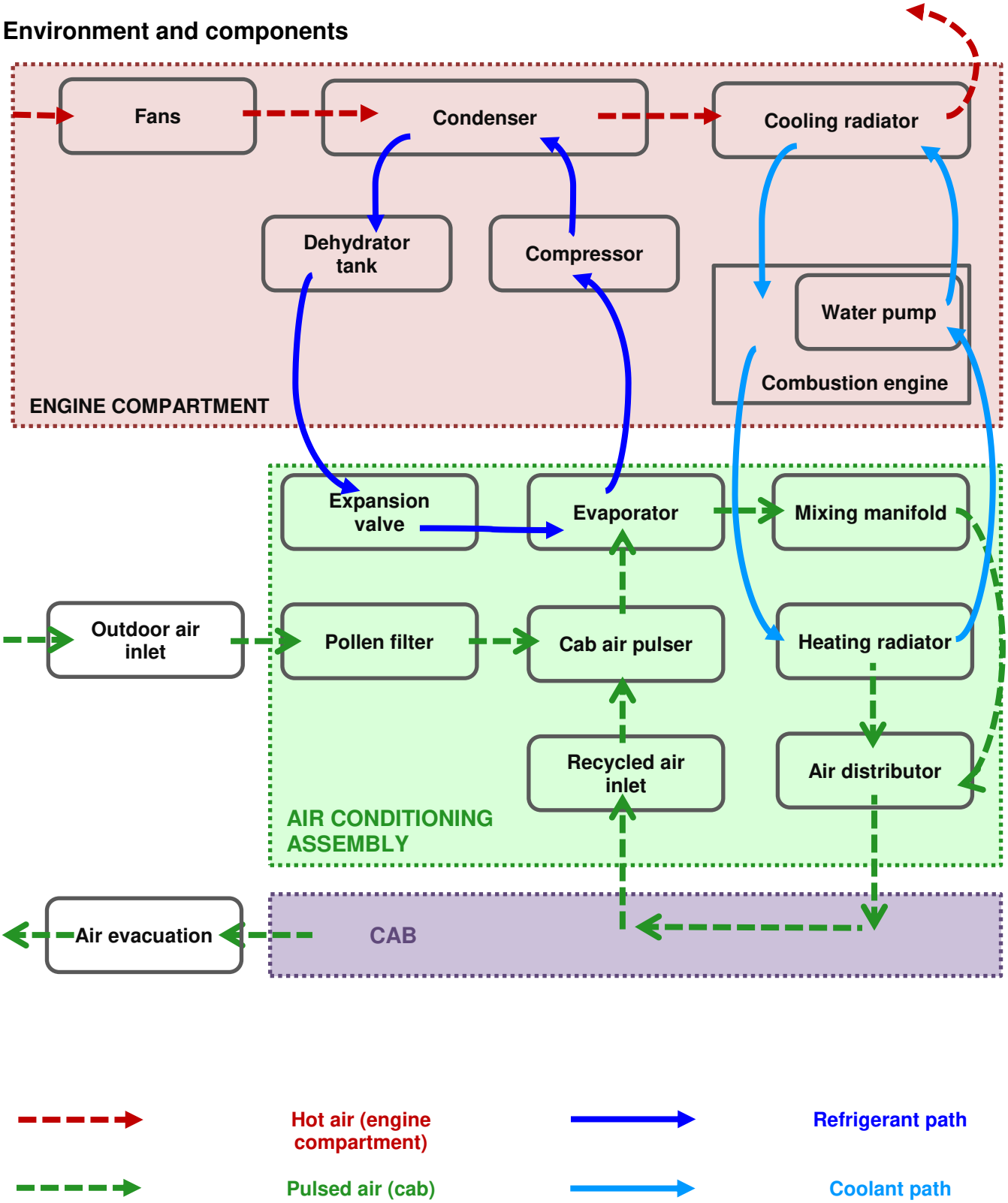
The dehydrator is located at the outlet of the condenser, and is increasingly integrated in the condenser (removable or other). This unit stores, filters and dehydrates the refrigerant.

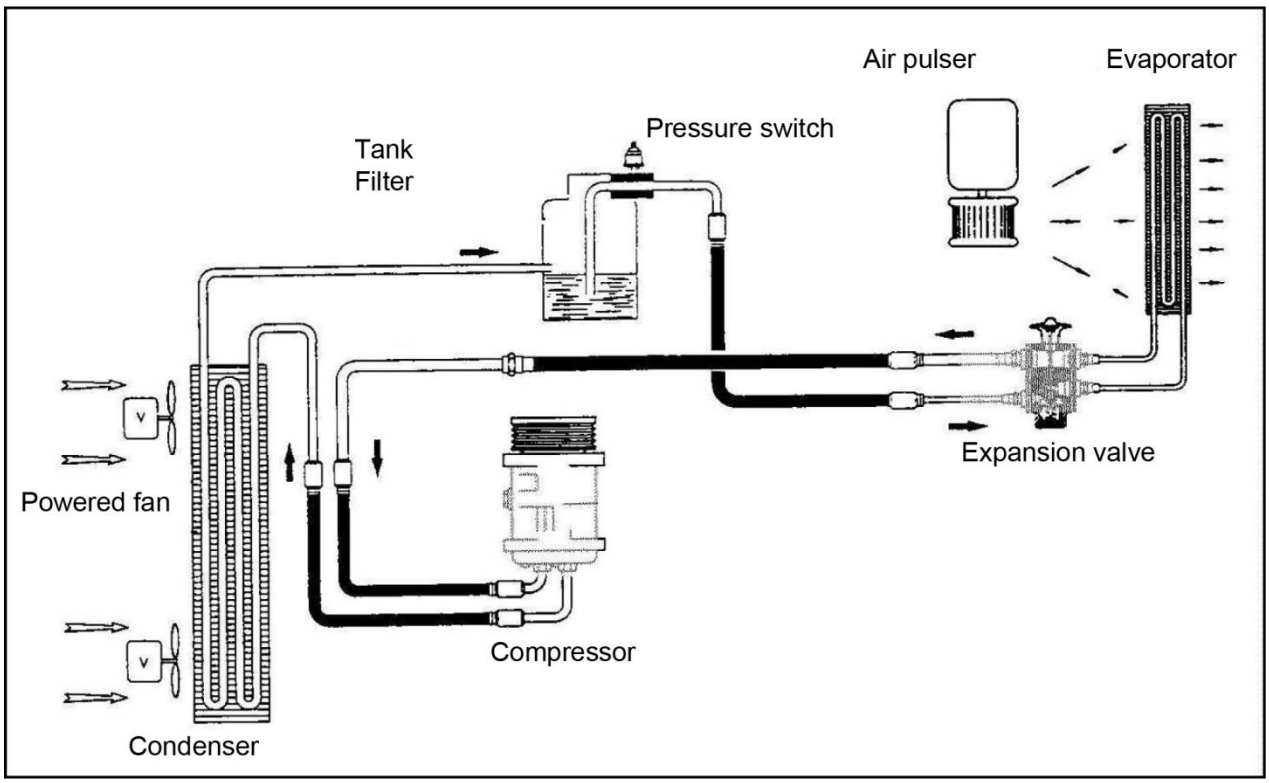
Overall operation:
Create a buffer of fluid, filter circulating fluid, and retain the humidity in the system.



2.3. *Operating principle*

Environment and components





The refrigerant

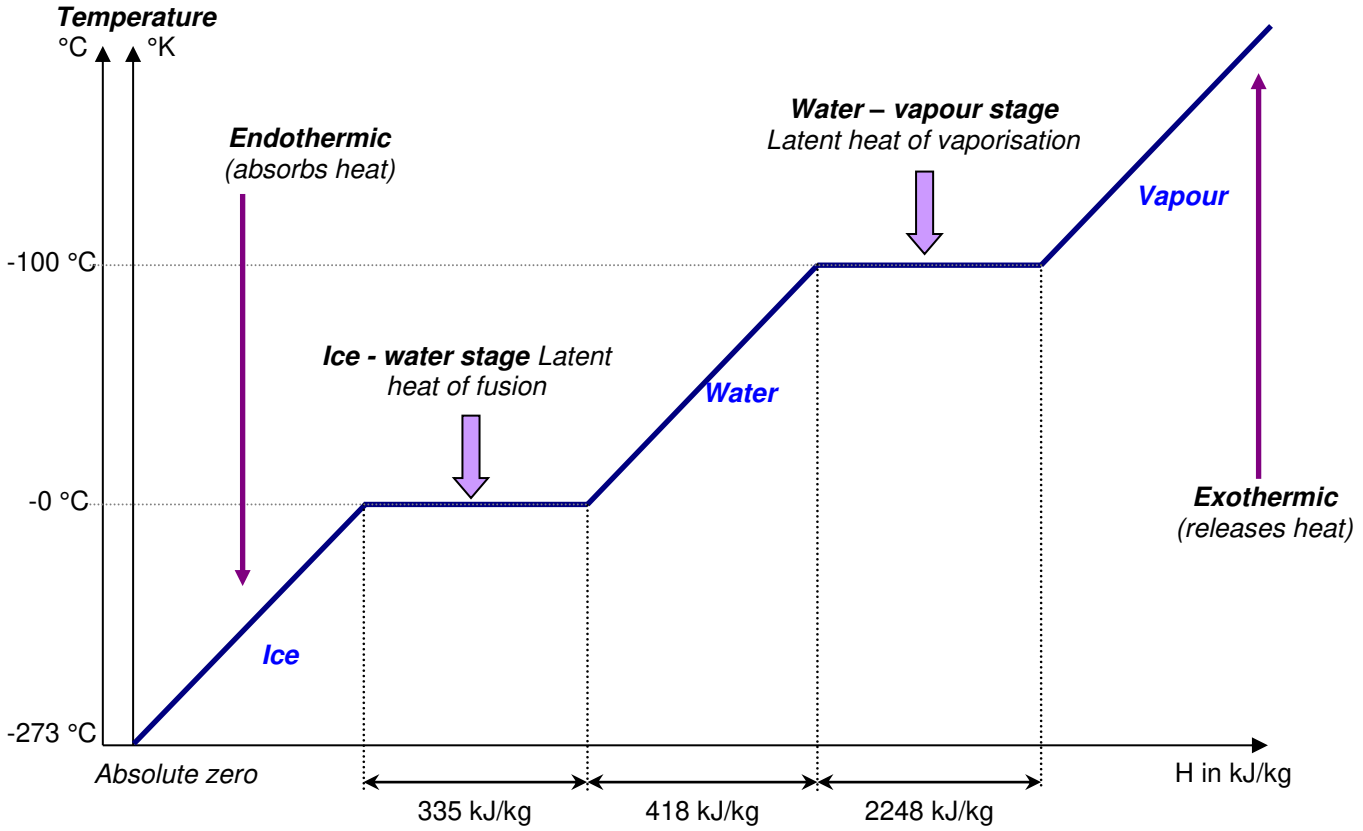
Three types of gas can be found in air conditioning systems. The first known as R12 was abandoned many years ago and replaced by R134A, which is less toxic. This gas will progressively be replaced by HFO 1234yf …

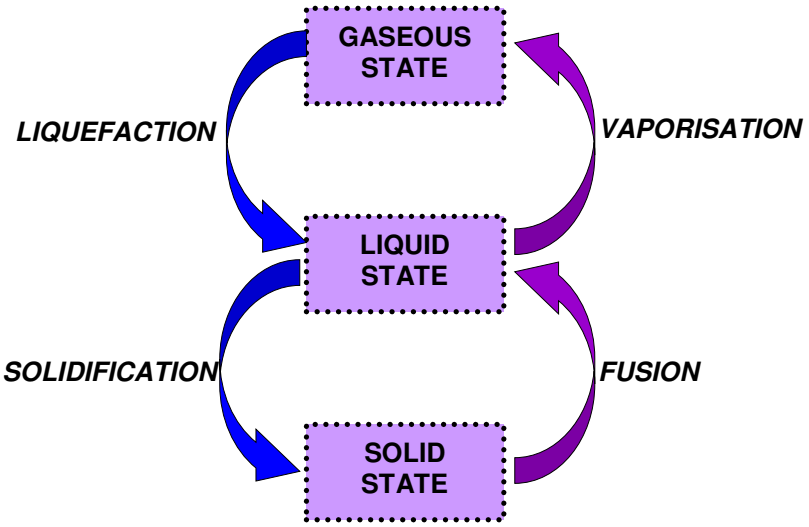
Characteristics of fluids at a pressure of 1013 mbar:

	Unit	R134A	R12
Physical formula		$C_2H_2F_4$ (CF_3-CH_2F)	CCl_2F_2
Chemical name		Tetrafluoroethane	Dichlorodifluoromethane
Atomic mass	$g \cdot mol^{-1}$	102.0	120.9
Boiling point at 1013 Mb	°C	-26.5	-29.8
Freezing point	°C	-101	-158
Critical temperature	°C	101.1	112
Critical pressure	kPa	4056	4115
Critical specific volume	$m^3 \cdot kg^{-1}$	$1.94x10^{-3}$	$1.79x10^{-3}$
Critical density	$kg \cdot m^{-3}$	515.3	558
Liquid density at 25°C	$kg \cdot m^{-3}$	1203	1310
Vapour pressure at 25°C	kPa	661.9	651.6
Saturated vapour density at boiling point	$kg \cdot m^{-3}$	$5.05x10^{-3}$	$6.31x10^{-3}$
Specific heat of the liquid at 25°C	$kJ \cdot kg^{-1}$	0.8577	0.6755
Vaporisation heat (at boiling temperature)	$kJ \cdot kg^{-1}$	217.36	165.25

Study of the changing states of a fluid: water

Values given for a pressure of 1013 mbar. In fact, water could boil at a temperature of 12.7°C if its absolute pressure dropped to 15 mb. On the other hand, water will only boil in a steam cooker at a pressure of 5 bars above a temperature of 151°C.



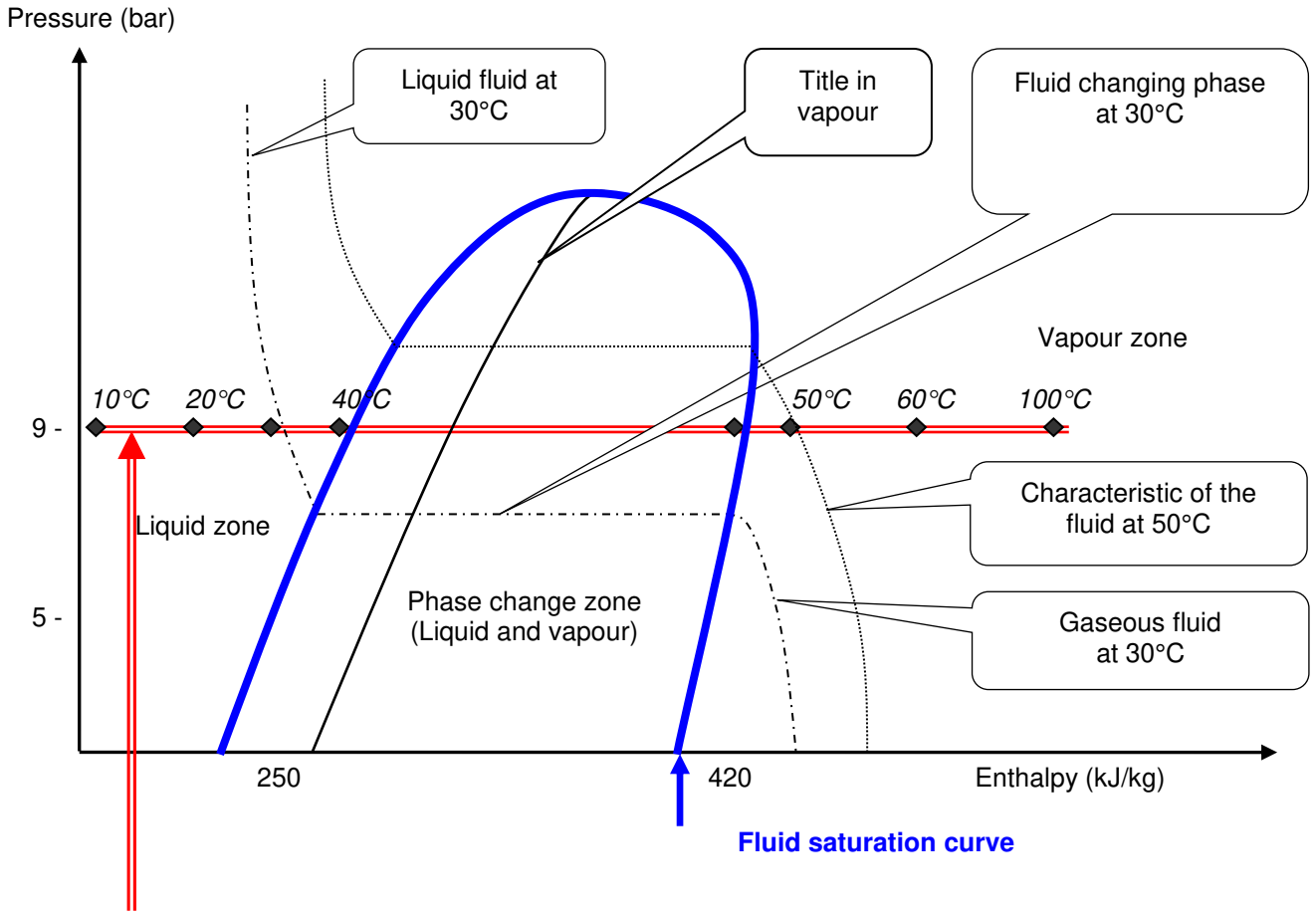


Enthalpy characterises the amount of heat contained in the fluid. The zero point of this scale corresponds to absolute zero. Variations are shown by the double arrows quantifying the additional energy the fluid requires to change temperature or state. Variations in enthalpy occur during the following two transformation phases: *Sensible heat* (variation in fluid temperature due to the contribution of heat) and *latent heat* (change in fluid state due to the contribution of heat).

In a contained environment, variations in enthalpy will lead to changes in fluid state via a horizontal segment (constant pressure) and changes in pressure.

A series of experimental measurements will then track a characteristic of the fluid in question and lead to the determination of its *saturation curve* (defined by horizontal segments), and a network of temperature curves defining the state of the fluid at a given pressure and temperature.

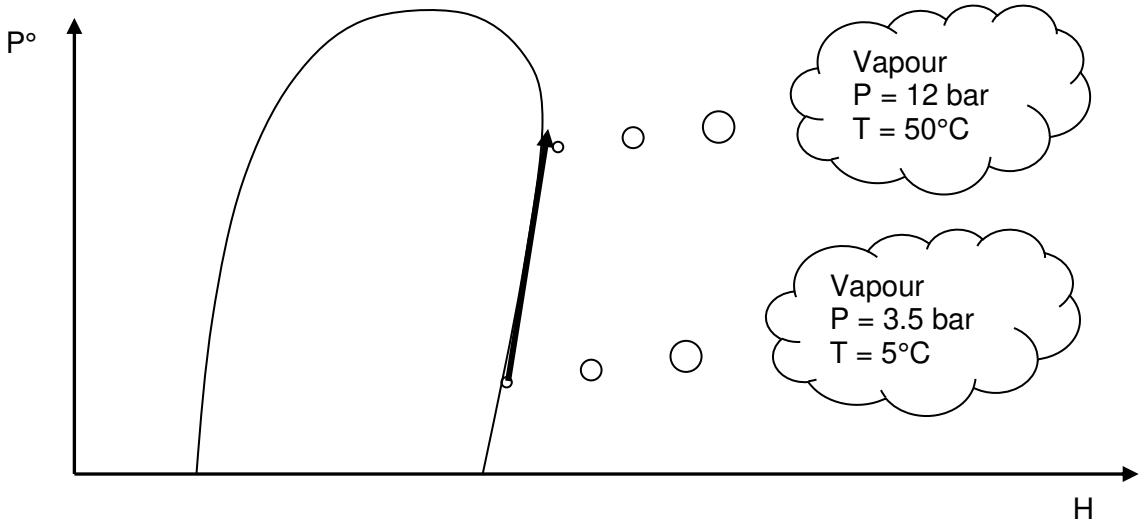
Changes in the characteristics of R134 a fluid, the enthalpy diagram:



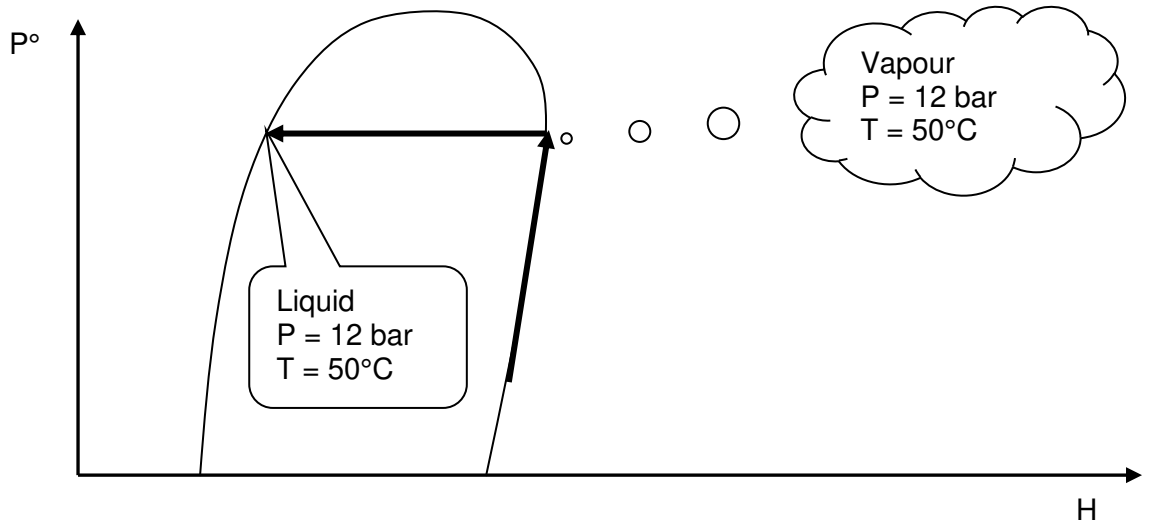
Isobar straight: quantify the energy required to change the phase or temperature of a mass of fluid.

Role of components, theoretical cycle (indication of absolute pressure)

The compressor: The compressor sucks in the saturated vapour and compresses this fluid, which is then discharged to the condenser as high pressure, high temperature, and vapour.

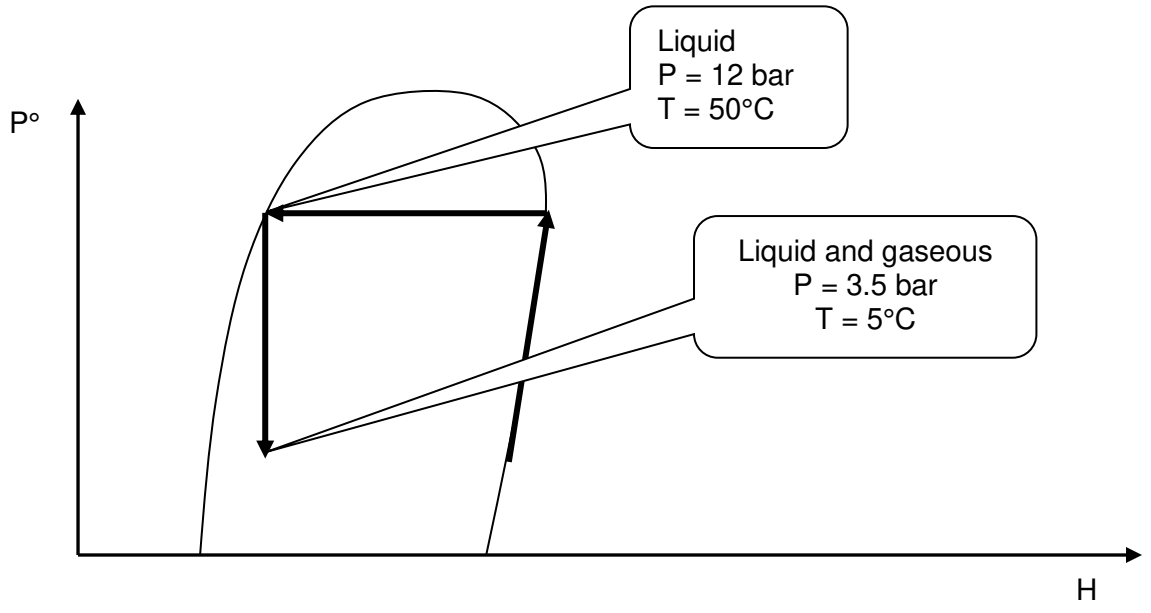


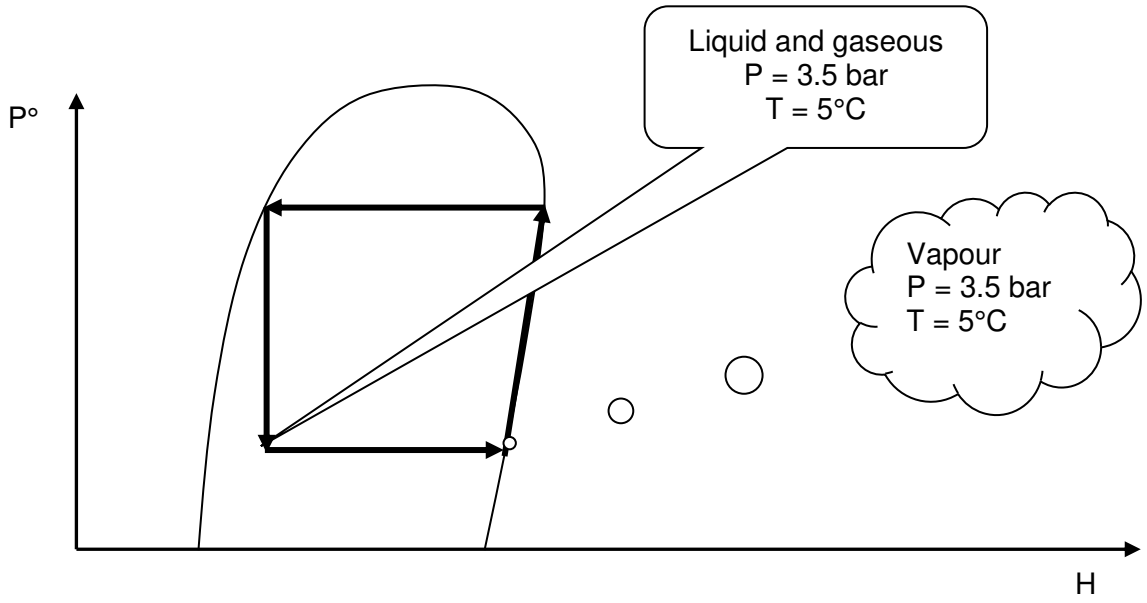
Condenser: The condenser is a heat exchanger. When the vapour enters the condenser, it changes state. The vapour liquefies at constant temperature, reducing its enthalpy, and transferring the heat (absorbed in the evaporator) to the air pulsed by the powered fans, until complete liquefaction.



Thermostatic expansion valve: This device expands the fluid in the evaporator. It adjusts the flow depending on the temperature at the evaporator output, thereby controlling the complete evaporation of the fluid

Evaporator: The evaporator is a heat exchanger. The fluid vaporises at constant temperature, an *endothermic reaction*, absorbing heat from the air pulsed via the evaporator by the cab pulser (this heat is later evacuated in the condenser). The expansion valve controls the fluid flow in order to obtain 100% gaseous fluid at the output.



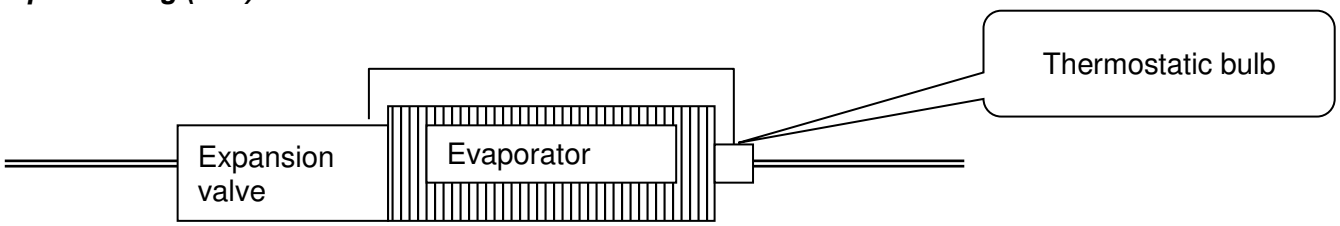


The actual cycle of the R134a fluid

Variations in system operating conditions, temperature variations, pressure losses in the circuit, and variations in compressor flow all render phase change zones unstable. This could prevent the optimal operation of the system and can lead to risks for the compressor (intake of a liquid-gas mixture). To avoid this effect, variable cylinder compressors are used (to improve operating smoothness) and the limits defined above are exceeded.

Phase change limits are exceeded at three points on the diagram:

Superheating (AA'):

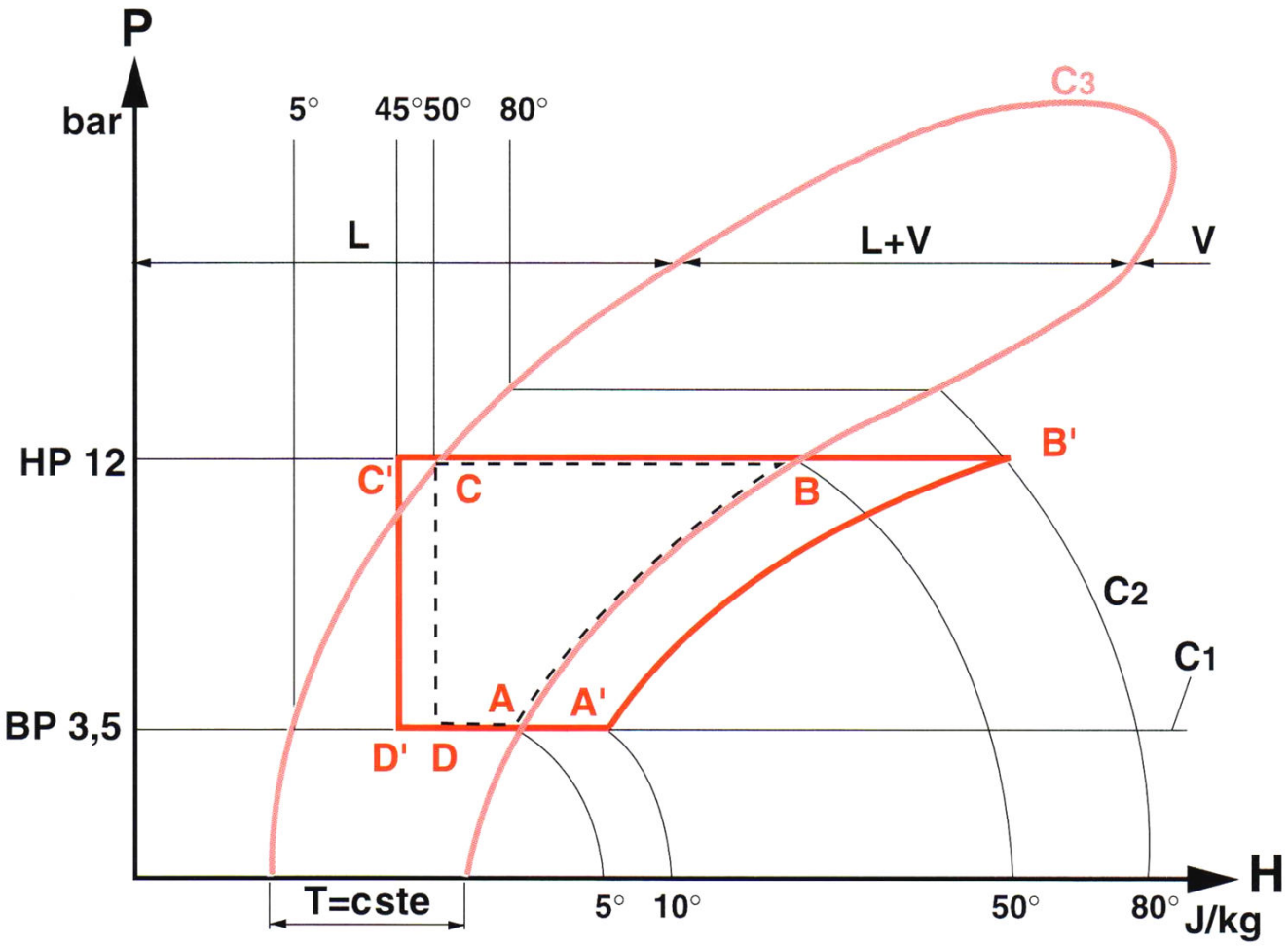


The system is designed to superheat the fluid by 5°C to 10°C at the compressor inlet. This increase in temperature is measured by the thermostatic expansion valve and controls the opening of this valve to ensure that the fluid is 100% gaseous when leaving the evaporator.

Desuperheating (B'B):
The desuperheating phase at the condenser inlet cools the fluid from 80°C to 50°C before the phase change.

Subcooling (CC'):
Finally, sub-cooling from 50°C to 45°C guarantees 100% liquid fluid when leaving the condenser, improving the effectiveness of the system and enabling the installation of the filter - tank with (or without) the liquid indicator.

The following theoretical values and curve are obtained:



ABCD: Theoretical cycle
A'B'C'D': Real cycle
AB or **A'B':** Compression
BC or **B'C':** Condensation
CD or **C'D':** Expansion
DA or **D'A':** Evaporation

AA': Superheating
B'B: DE superheating
CC': Sub cooling
D'D: Condensation

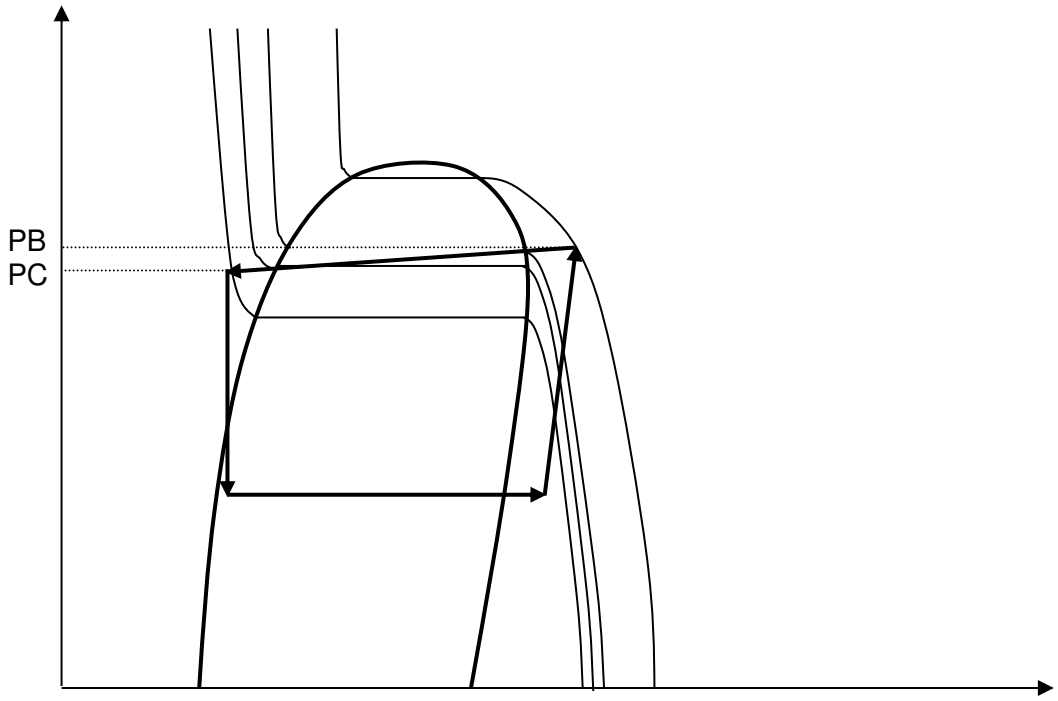
L: Liquid phase
L+V: Liquid + vapor phase
V: Vapour phase
C1: Isobar curve
C2: Isotherm curve
C3: Saturation curve

P: Pressure
H: Enthalpy
HP: High pressure
BP: Low pressure

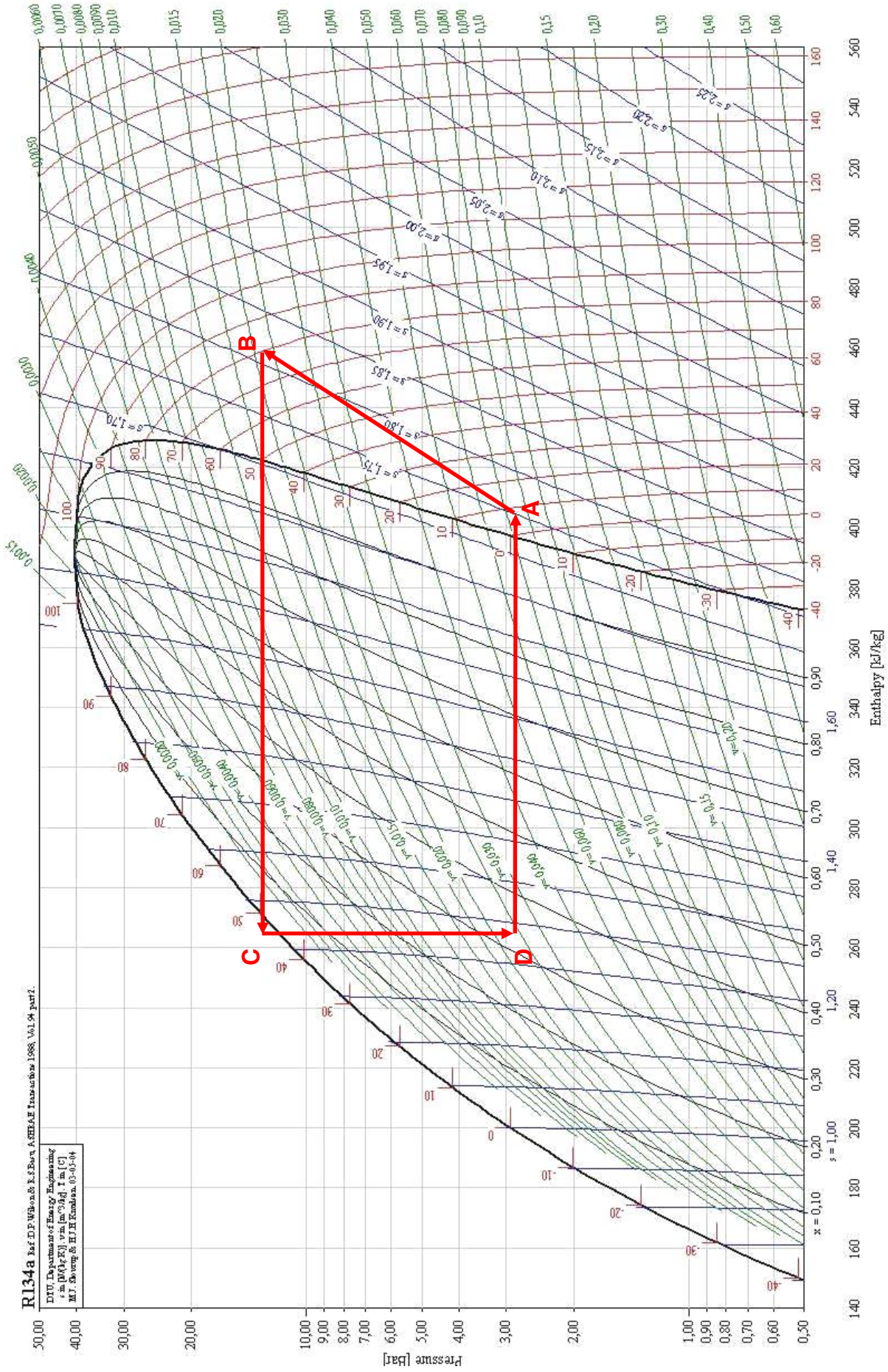
The pressures shown are ***absolute pressures***
(To obtain relative pressure measured at the workshop, ***deduct 1 bar***)

Pressure drops in the air conditioning system

The condenser, pipes, filter, tank and evaporator all create pressure drops due to their section and length. These pressure drops can be quantified as low flow rate and vary with fluid flow rate and phase. When studying this system, it is important to take the pressure lost due to the condenser (PB-PC on the graph) into account in order to match the real diagram as far as possible, as this will limit the action of the expansion valve, and therefore the effectiveness of the system.



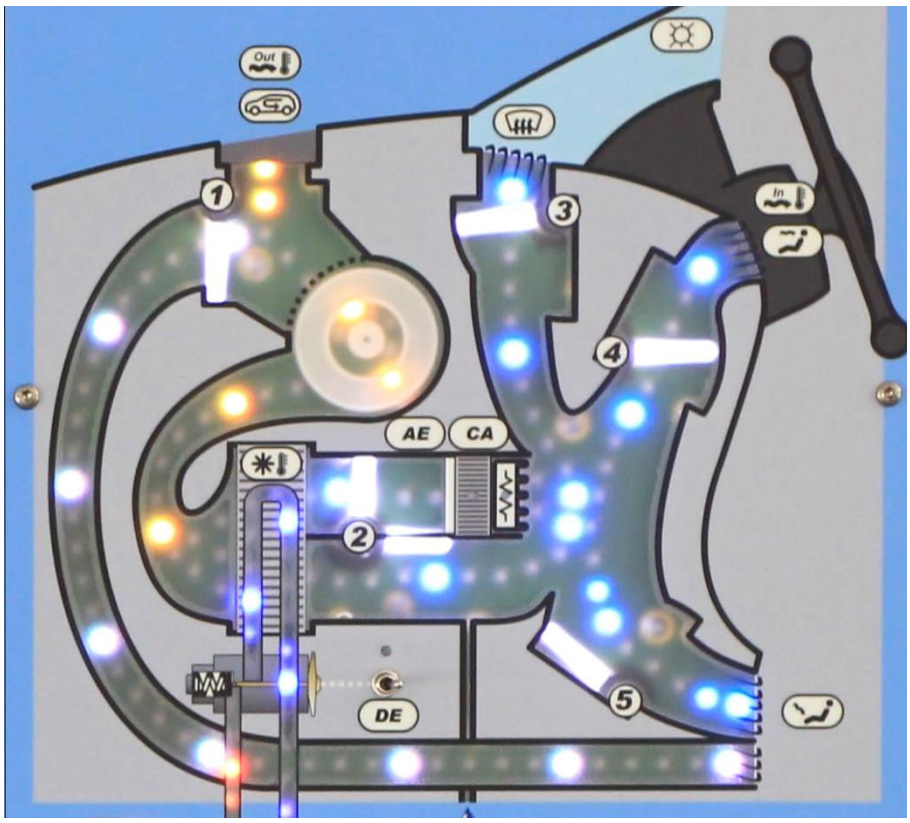
2.4. Mollier diagram with system operating cycle



A = 2.8 bar (absolute) and 8°C / **B** = 14 bar (absolute) and 80°C / **C** = 14 bar (absolute) and 45°C / **D** = 2.8 bar (absolute) and 0°C

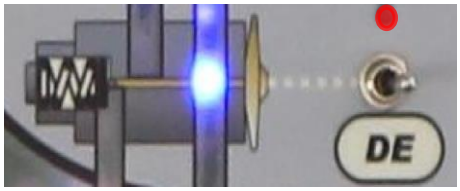
3. DESCRIPTION OF THE MT-C5001 MODEL

3.1. Air unit diagram (cross-section): the vehicle cab



ID	Function
1	Recycling manifold (outdoor air inlet)
2	Mixing manifold (Hot/cold dosing)
3	Upper distribution manifold (windscreen)
4	Central aerators distribution manifold (face)
5	Lower distribution manifold (feet)
AE	Unit heater (cab heating radiator)
CA	Additional heating (resistor)
DE	Expansion valve with LED and failure simulations switch (see operation on next page)

3.2. Simulating mechanical failures for the expansion valve:



The switch next to the expansion valve diagram can be used to simulate the seizure of the valve.

Three positions are possible:

- Middle position, red LED OFF: The expansion valve is operating normally.
- Right-angled switch, red LED ON: expansion valve blocked closed.
- Left-angled switch, red LED ON: expansion valves blocked open.

3.3. Setting potentiometer and parameter display screen:

ID	Function
	Engine speed settings,
	Vehicle speed settings
	Sunlight settings
	Outdoor temperature settings
	Evaporator temperature settings *
	Cab temperature settings *
	Currently inactive (possible changes)

* **Auto** = the value is calculated on the basis of other parameters
from Min. to Max. = value selected by the user

3.4. Automatic air conditioning control panel:

The air conditioning management and start-up commands for the MT-C5001 model are taken from current PSA-brand mass-produced vehicles. The following are taken from driver user manuals:

Model start-up:

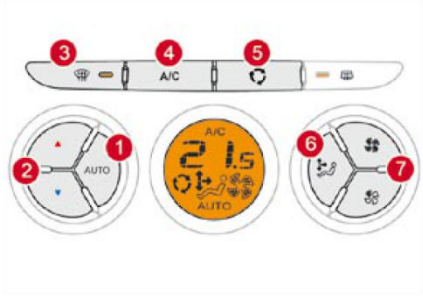
Press “START/ STOP” button

Using the automatic air conditioning controls in the vehicle:

Digital air conditioning

The air conditioning operates when the engine is running, as well as in STOP mode with Stop & Start.

Automatic operation



For your comfort, when the engine is switched off, the settings are retained until the engine is switched on again. To prevent too great a distribution of cold air when the engine is cold, the air flow will only reach its optimum level gradually.

1. Automatic "comfort" programme

AUTO

Press the **"AUTO"** button. The **"AUTO"** symbol is displayed. We recommend that you use this mode. It provides optimised automatic control of all of the following functions: passenger compartment temperature, air flow, air distribution and air intake, in accordance with the comfort value that you have chosen.
This system is designed to operate effectively in all seasons, with the windows closed.

2. Temperature adjustment

The value indicated on the display corresponds to a level of comfort and not to a temperature in degrees Celsius or Fahrenheit.

▲
▼

Press the " " and " " buttons to change this value. A setting around the value **21** enables optimum comfort to be obtained. However, depending on your requirements, a setting between 18 and 24 is usual.

On entering the vehicle, if the interior is very cold or hot, there is no need to change the value displayed in order to reach the required level of comfort. The system corrects the temperature difference automatically and as quickly as possible.

3. Automatic "visibility" programme

The automatic comfort programme may not be sufficient for rapid demisting or defrosting of the windscreen and side windows (humidity, several passengers, ice, etc.).
In this case, select the automatic visibility programme. The button **3** indicator lamp comes on.
The system automatically controls the air conditioning and the flow of air and provides optimum air distribution to the windscreen and side windows. It deactivates air recirculation **5**.
To exit this programme, press button **3** again or **"AUTO"**, the indicator lamp on the button goes off and **"AUTO"** is displayed.

With Stop & Start, when demisting has been activated, the STOP mode is not available.

Manual override

It is possible to adjust one or more functions manually while leaving the other functions in automatic mode.
The **"AUTO"** symbol switches off.
To return to automatic mode, press the **"AUTO"** button.

Switching to manual mode may not be suitable (temperature, humidity, odour, condensation) and does not provide optimum comfort.

For maximum cooling or heating of the cabin, it is possible to go beyond the minimum 14 or maximum 28 values.
Press the blue button **2** until **"LO"** is displayed or the red button **2** until **"HI"** is displayed.

4. Air conditioning on/off

Press this button to switch off the air conditioning.
Stopping the air conditioning may cause some problems (humidity, misting).
Automatic operation of the air conditioning is resumed when the button is pressed again.
The symbol **"A/C"** is displayed.

5. Air intake/Air recirculation

Press this button for recirculation of the interior air. The air recirculation symbol **5** is displayed.

Air recirculation enables the passenger compartment to be isolated from exterior odours and smoke.
Press this button again or press the **"AUTO"** button to resume automatic management of the intake of air. The air recirculation symbol **5** goes off.

Avoid prolonged recirculation of interior air (risk of condensation or deterioration of the air quality).

6. Air distribution adjustment

Pressing this button several times in succession enables the air flow to be directed in turn towards:

- the windscreen and the side windows (demisting or defrosting),
- the windscreen, side windows and air vents,
- the windscreen, the side windows, the air vents and the footwells,
- the windscreen, the side windows and the footwells,
- the footwells,
- the air vents and the footwells,
- the air vents.

7. Air flow adjustment

Press the **"full fan"** button to increase the air flow.

The air flow symbol, the fan, fills progressively according to the value requested.

Press the **"empty fan"** button to decrease the air flow.

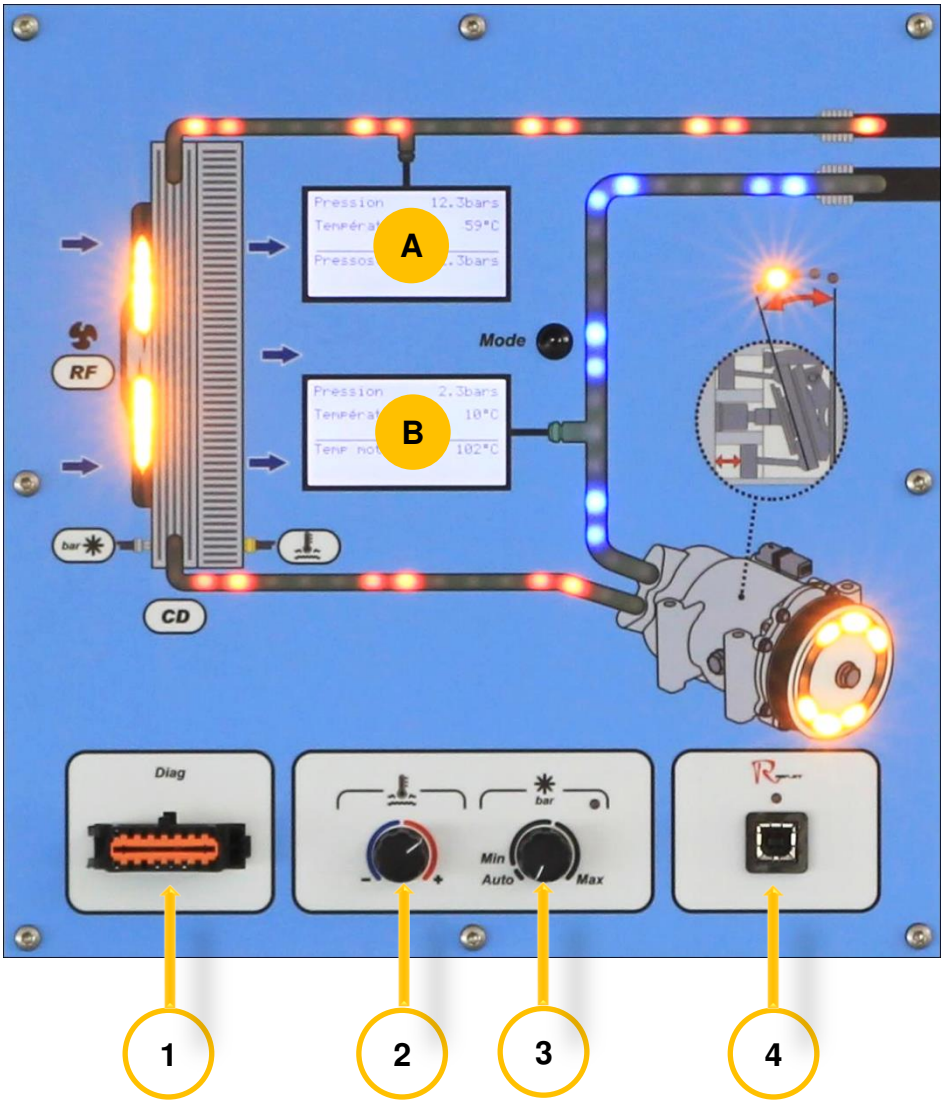
Switching the system off

Press the air flow **"empty fan"** button **7** until the fan symbol disappears.

This action switches off all of the functions of the air conditioning system.
Thermal comfort is no longer controlled.
A slight flow of air resulting from the movement of the vehicle, remains perceptible however.
Pressing the air flow **"full fan"** button **7** or on **"AUTO"** reactivates the system with the values set before it was switched off.

Avoid driving for long periods with the air conditioning switched off (risk of misting and reduction of the air quality in the cabin).

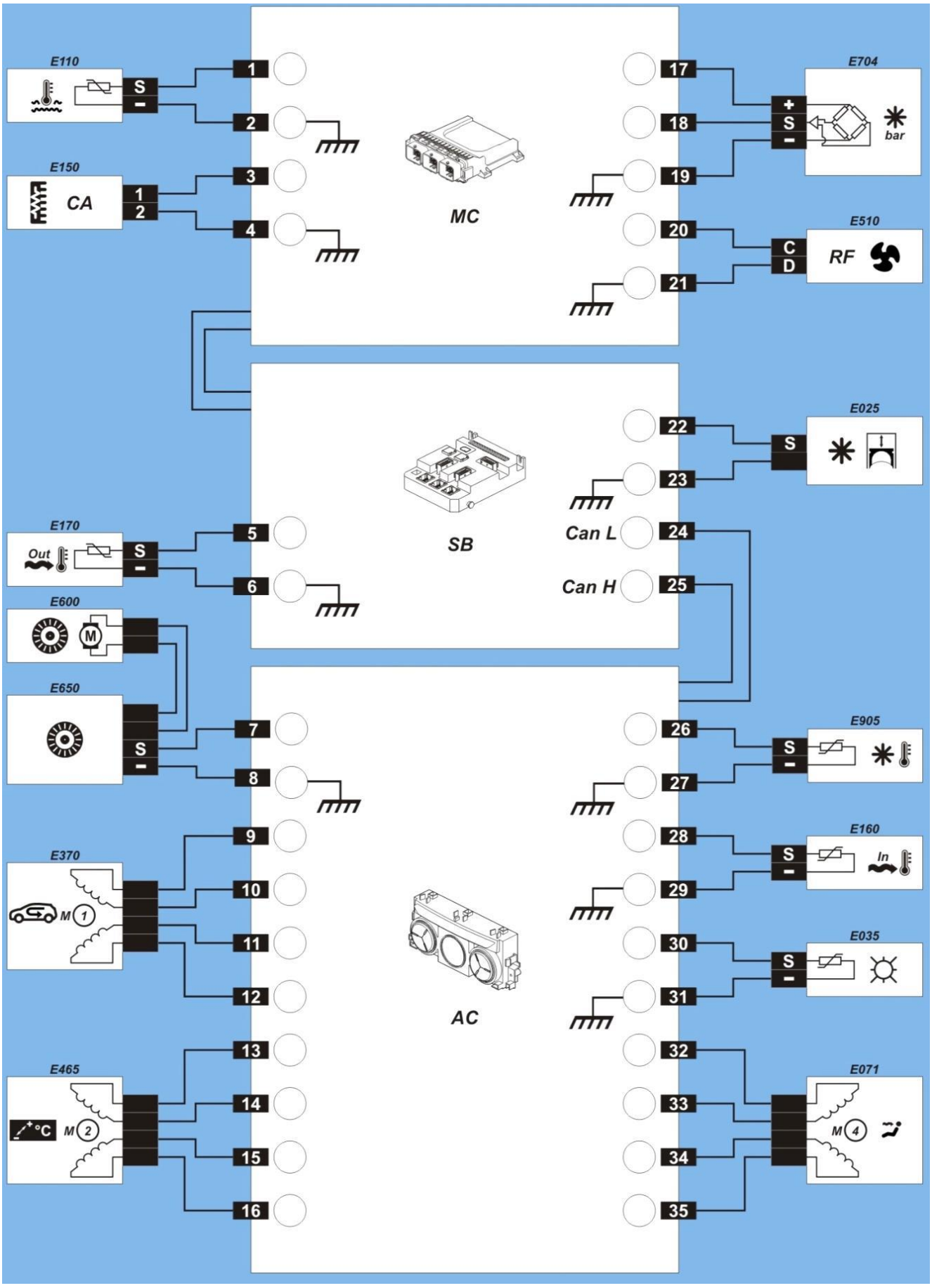
Engine compartment diagram: refrigerant



ID	Function
1	**Standardised diagnostic plug (Diagnostic tool connection)**
2	**Engine water temperature settings potentiometer (display B)**
3	**Adjustment potentiometer of the high refrigerant pressure (display A)** *
4	**USB port (Connection with REFLET software)**
A	**High pressure display: circuit temperature and pressure, sensor info** 
B	**Low pressure display: circuit temperature and pressure, sensor info** 

* Auto = the value is calculated on the basis of other parameters
from Min. to Max. = value selected by the user (sensor failures simulated)

Computer diagram: system management



3.5. Parts lists:

Engine management computer

ID	Function
MC	**"M**otor **C**ontrol" - Engine control
E110	Engine coolant temperature sensor
E150	Additional heating: cab resistor
E704	Refrigerant pressure sensor
E510	Radiator fan control module

Cab computer

ID	Function
SB	**"S**ervitude **B**ox": Cab computer
E170	Outdoor air temperature sensor
E025	Variable cylinder capacity solenoid control valve
Can L	"Can low" thread of the Comfort Can Low Speed network
Can H	"Can high" thread of the Comfort Can High Speed network

Air conditioning computer

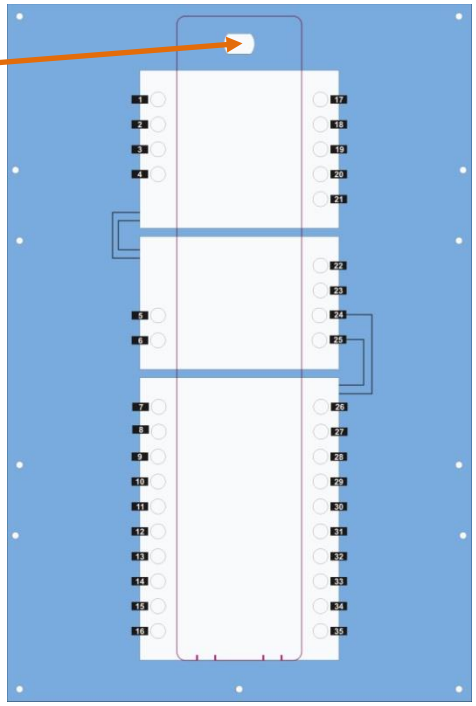
ID	Function
AC	"Air Conditioning" : air conditioning computer
E600	Cab air pulser
E650	Pulser control module
E370	Stepper recycling manifold motor
E465	Stepper mixing manifold motor
E905	Evaporator temperature sensor
E160	Cab temperature sensor
E035	Sunlight sensor
E071	Stepper air distribution manifold motor n°. 4

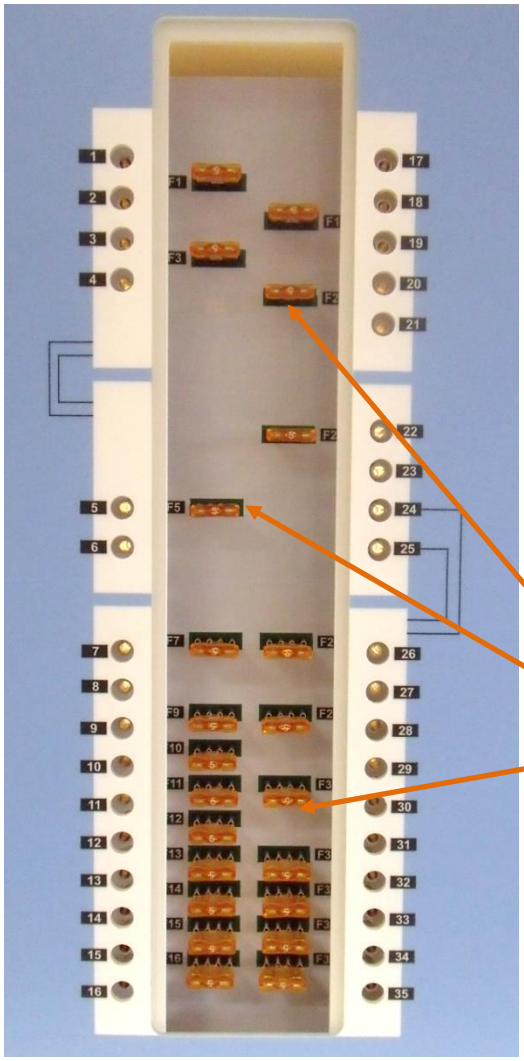
3.6. Summary of computer inlet/outlet terminals:

ID	Function	Signal
1	Engine water temperature sensor signal	Variable voltage, from 3.8 V to 0.2 V
2	Water temperature sensor ground	0 V
3	Additional heating command	0 V or 12 V
4	Additional heating ground	0 V
5	Outdoor temperature sensor signal	Variable voltage, from 3.6 V to 0.8 V
6	Outdoor temperature sensor ground	0 V
7	Cab air pulser command	PWM (12V)
8	Cab air pulser ground	0 V
9	Stepper recycling command motor n°. 1	0 V or 12 V
10	Stepper recycling command motor n°. 1	0 V or 12 V
11	Stepper recycling command motor n°. 1	0 V or 12 V
12	Stepper recycling command motor n°. 1	0 V or 12 V
13	Stepper mixing command motor n°. 2	0 V or 12 V
14	Stepper mixing command motor n°. 2	0 V or 12 V
15	Stepper mixing command motor n°. 2	0 V or 12 V
16	Stepper mixing command motor n°. 2	0 V or 12 V
17	Refrigerant pressure sensor supply	+ 5 V
18	Refrigerant pressure sensor signal	Variable voltage, from 0.6 V to 4.5 V
19	Refrigerant pressure sensor ground	0 V
20	Cooling module command	PWM (12V)
21	Cooling module ground	0 V
22	Variable cylinder capacity solenoid valve command	PWM (12V)
23	Variable cylinder capacity solenoid valve ground	0 V
24	"Can low" line of the CAN Comfort network	Digital
25	"Can high" line of the CAN Comfort network	Digital
26	Evaporator temperature sensor signal	Variable voltage, from 3.4 V to 1.2 V
27	Evaporator temperature sensor ground	0 V
28	Cab temperature sensor signal	Variable voltage, from 4.5 V to 1.3 V
29	Cab temperature sensor ground	0 V
30	Sunlight sensor signal	Variable voltage, from 4.5 V to 0.5 V
31	Sunlight sensor ground	0 V
32	Stepper central distribution motor n°. 4 command	0 V or 12 V
33	Stepper central distribution motor n°. 4 command	0 V or 12 V
34	Stepper central distribution motor n°. 4 command	0 V or 12 V
35	Stepper central distribution motor n°. 4 command	0 V or 12 V

Failure options: fuses, expansion valve

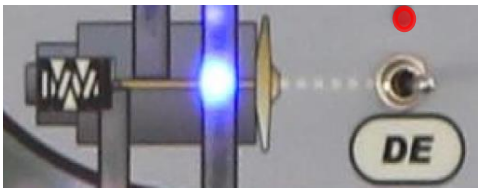
After having released the plate located under the computer diagram, you can remove this plate and access the fuses.





Into the model, a number of fuses associated with the input-output of the computer allows the implementation of fault.

Simulating mechanical failures for the expansion valve



The switch next to the expansion valve diagram can be used to simulate the seizure of the valve.

Three positions are possible:

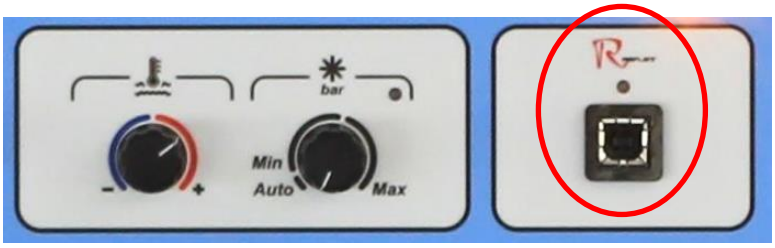
- Middle position, red LED OFF: The expansion valve is operating normally.
- Right-angled switch, red LED ON: expansion valve blocked closed.
- Left-angled switch, red LED ON: expansion valves blocked open.

4. USING THE REFLET SOFTWARE

4.1. Connecting to the computer

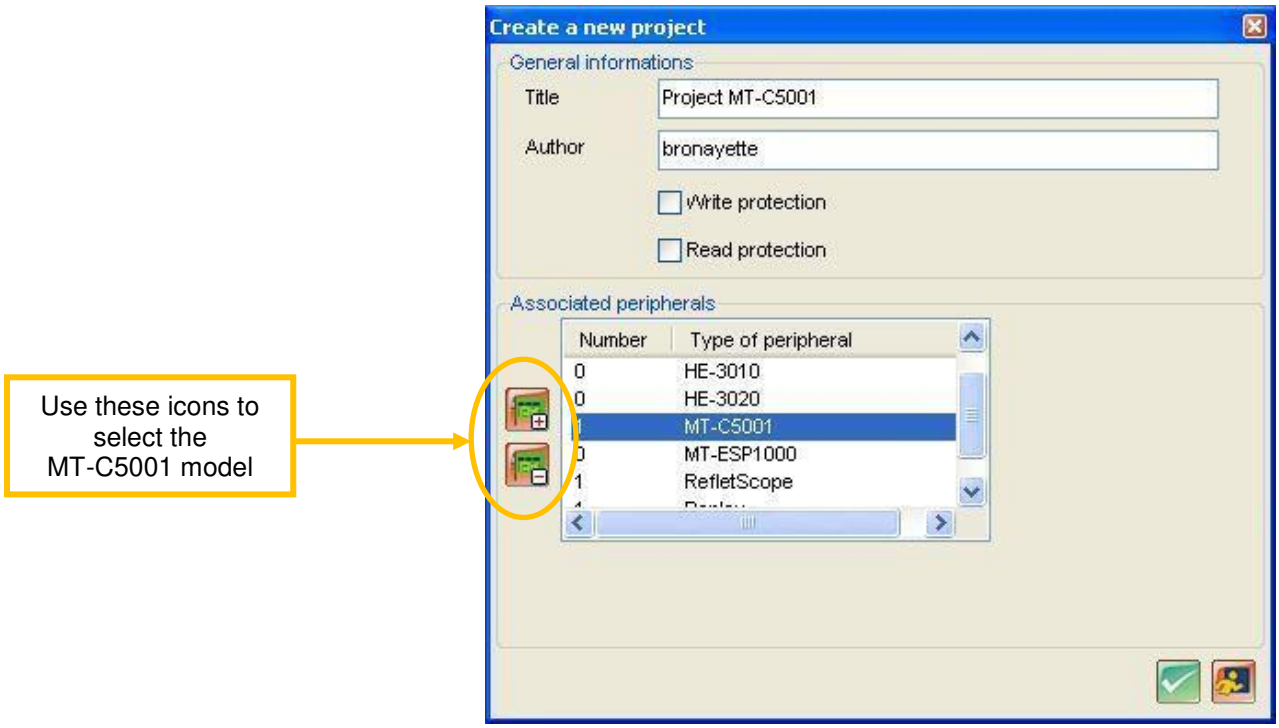
The REFLET acquisition software is provided with the MT-C5001 model. You can use this software to view internal model signals on your PC.

After installing the software and the model driver, simply connect the USB ports using the cable provided:

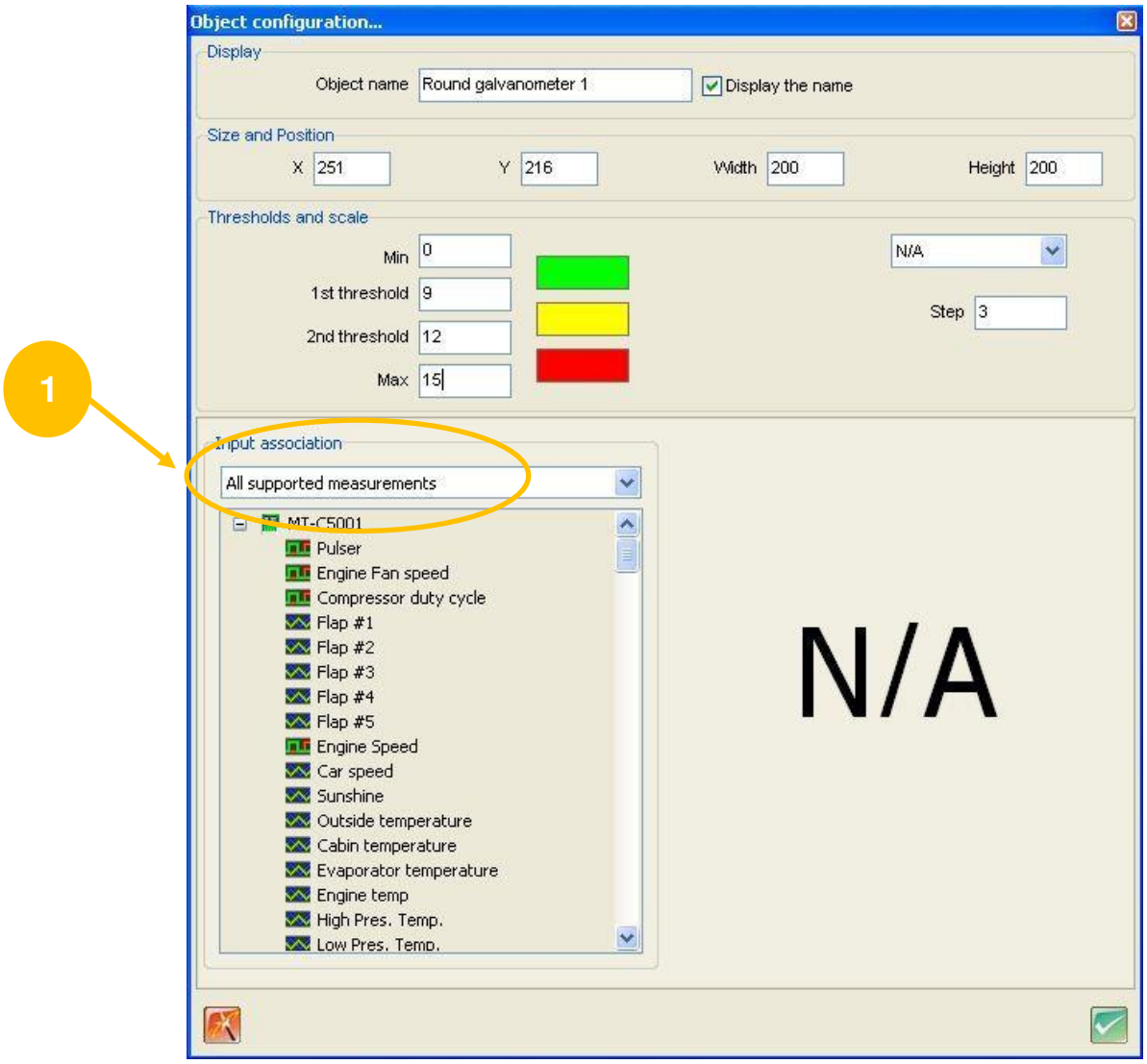


The LED above the USB plug on the model lights up blue when the cable is connected to the computer and flashes when the model is dialoguing with the REFLET software (data exchange).

When creating a new REFLET project, select the model as shown in the window below:



After opening a new project, the following window will open when you select a new measuring tool (e.g. a display):



You must then select "*Defined by the user"* from the Unit and measuring **type section** (ID ***1*** above): you will only be able to access all of the signals proposed by the MT-C5001 model after this selection process.

4.2. List of available signals

- **Controlling air conditioning actuators:**

Pulser; Mixing, distribution and recycling manifolds (No. 1, 2, 3 , 4 and 5); Additional heating; Powered fan unit; Compressor duty cycle; Temperature set point (user input);

- **Sensor data, physical measurements:**

Engine speed; Vehicle speed; Sunlight; Outdoor, indoor, evaporator and engine temperature; High and low R134a fluid pressure; High and low R134a fluid temperature;

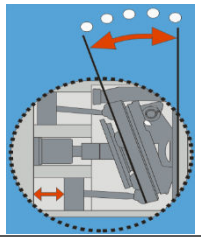
5. USING THE DIAGNOSTIC TOOL

You can connect a diagnostic tool to the model plug. In this case, select a Citroën C3 as "vehicle" (model 2010, type A51), VIN no.: VF700000000000000 and OPR no.: 12222.

After selecting the air conditioning diagnostic, you will be able to access actuator tests, parameters and measurements.

Examples of Citroën software tools:

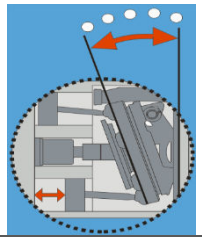
6. PRACTICAL WORKS

TABLE OF READINGS No.					
Parameters defined by the user		**Input**			
		1st test	**2nd test**	**3rd test**	
Engine	Speed				**rpm**
	Temperature				**°C**
Vehicle	Speed				**km/h**
Outdoor	Sunlight				**%**
	Temperature				**°C**
Setpoint (driver input)	Required temperature				**°C**
	Selection				
Parameters simulated by the MT-C5001		**Readings**			
Refrigerant characteristics (R134a)	High Pressure				**bar**
	HP temperature				**°C**
	Low Pressure				**bar**
	LP temperature				**°C**
Compressor cylinder capacity	Position: **4-3-2-1-0** 				
					%
					V
Cab temperature	Indoor temperature				**°C**

Practical works n° 1: Studying the air conditioning system

It is important to observer variations in physical parameters such as the pressure and temperature of the R134a fluid in order to become familiar with the operation of the system and therefore optimise troubleshooting. For that, you could use the table on the previous page to carry out comparative evaluations for the MT-C5001 model.

The interpretations n° 1 proposed below show the variations caused by a rise in outdoor temperature with unchanged operating conditions (engine speed, vehicle speed, etc.).

EVALUATIONS TABLE N° 1				
Parameters defined by the user		**Input**		
		1st	**2nd**	**3rd test**
Engine	Speed	**2000**	**2000**	**2000 rpm**
	Temperature	**85**	**85**	**85 °C**
Vehicle	Speed	**90**	**90**	**90 km/h**
Outdoor	Sunlight	**50**	**50**	**50%**
	Temperature	**25**	**30**	**40 °C**
Setpoint (driver input)	Required temperature	**20**	**20**	**20 °C**
	Selection	**Auto**	**Auto**	**Auto**
Parameters simulated by the MT-C5001		**Readings**		
Refrigerant characteristics (R134a)	High Pressure	**11.6**	**15.1**	**19.2 bar**
	HP temperature	**57**	**67**	**77 °C**
	Low Pressure	**2.4**	**1.8**	**1.6 bar**
	LP temperature	**11**	**5**	**3 °C**
Compressor cylinder capacity	Position: **4-3-2-1-0** 	**3**	**4**	**4**
		69	**78**	**82 %**
		8.4	**9.6**	**10 V**
Cab temperature	Indoor temperature	**20**	**20**	**22 °C**

Questions, analysing readings:

1. *What can be concluded on the variations in high pressure and low pressure for the air conditioning circuit when the outdoor temperature increases and the temperature required in the cab remains unchanged?*

   When outdoor temperature increases, the pressure and temperature of the high-pressure circuit increase, while the pressure and temperature of the low-pressure circuit decrease.

2. *What will occur in the cab in the 3rd configuration?*

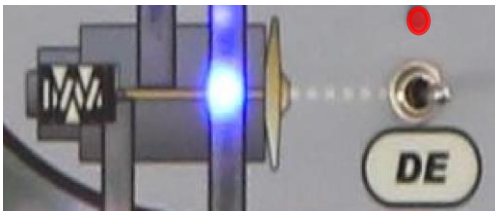
   The temperature difference between the user setpoint (20°C) and outdoor temperature (40°C) is too significant, the setpoint can no longer be achieved.

3. *Is this considered as a system malfunction?*

   No, this is normal operation. An excessive difference between the temperature inside the vehicle and outside can be dangerous for vehicle occupants: thermal shock, risk of fainting, etc. The air conditioning systems are designed to ensure that the difference cannot exceed reasonable values. A maximum difference of 8°C is recommended.

Practical works n° 2: Studying the expansion valve

Fill out a table of evaluations, using the predefined settings and the three switch positions:



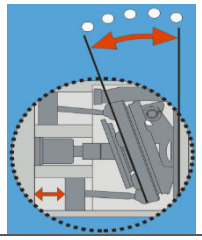
1. Normal operation: vertical switch (LED OUT)
2. Expansion valve blocked open: left switch (LED ON)
3. Expansion valve blocked closed: right switch (LED ON)

Note:
Wait for a few seconds until the values stabilise before filling out the table.

Questions, analysing readings:

1. *What happens if gas expansion is inadequate?*

2. *What happens if gas expansion is excessive?*

EVALUATIONS TABLE N° 2 (Expansion valve)					
Parameters defined by the user			**Input**		
			NORMAL	**OPEN**	**CLOSED**
Engine		Speed	**2000**	**2000**	**2000 rpm**
		Temperature	**85**	**85**	**85 °C**
Vehicle		Speed	**90**	**90**	**90 km/h**
Outdoor		Sunlight	**50**	**50**	**50%**
		Temperature	**30**	**30**	**30°C**
Setpoint (driver input)		Required temperature	**20**	**20**	**20°C**
		Selection	**Auto**	**Auto**	**Auto**
Parameters simulated by the MT-C5001			**Readings**		
Refrigerant characteristics (R134a)  		High Pressure	**14.8**	**8.8**	**10 - 25 bars**
		HP temperature	**66**	**48**	**8 - 0.8 °C**
		Low Pressure	**1.9**	**3.8**	**2.4 - 0.8 bars**
		LP temperature	**7**	**18**	**-8 - +8 °C**
Compressor cylinder capacity	Position: **4-3-2-1-0** 		**3**	**4**	**0 - 4**
			75.6	**100**	**0 - 80%**
			9.25	**11.85**	**0 - 9.5 V**
Cab temperature		Indoor temperature	**20**	**27.6**	**27 - 28 °C**

DECLARATION CE OF CONFORMITY

By means of this declaration of conformity, as defined by the European Directive on Electromagnetic Conformity 2004/108/EC, the company:

ANNECY ELECTRONIQUE S.A.S.
Parc Altaïs – 1, rue Callisto
F-74650 CHAVANOD

Declares that the following product:

Brand	Model	Description
EXXOTEST	**MT-C5001 model**	**TRAINING MODEL: automatically controlled vehicle air conditioning**

I - Has been manufactured in accordance with the requirements of the following European Directives:

- LV Directive 2006/95/EC - 12 December 2006
- Machinery Directive 98/37/EC - 22 June 1998
- EMC Directive 2004/108/EC - 15 December 2004

and satisfies the requirements of the following standard:

- NF EN 61326-1 dated 07/1997 +A1 of 10/1998 +A2 of 09/2001
  Electrical measurement, control and laboratory equipment, EMC-related requirements.

II - Has been manufactured in accordance with the requirements of the European Directives relating to EEE design and WEEE management for the EU. :

- Directive 2002/96/EC dated 27 January 2003 on Waste Electronic and Electrical Equipment (WEEE)
- Directive 2002/95/EC dated 27 January 2003 on the limitations for the use of certain hazardous substances in the construction of Electronic and Electrical Equipment (EEE).

Drawn up in Saint-Jorioz on 12 December 2011.

CEO - Stéphane SORLIN