User’ guide MT-C7000

Training mock-up

AIR CONDITIONING FOR VEHICLES

Cold production

EXOTEST® EDUCATION

CONTENTS

1. INSTRUCTION MANUAL

Installation and start-up of the MT-C7000 mock-up.

- Press the emergency stop button.
- Connect the 230 V power cable to the mains power socket.
- Move the three switches to the left position.
- Reactivate the emergency stop button, press Push, the electric motor starts turning.
- Then actuate the compressor switch to engage it.

Operational environment

The mock-up must be installed in a clean, dry location, free of dust, water vapour and combustion fumes.

The mock-up must be placed on a horizontal table of sufficient dimensions for the equipment to rest on its 4 feet and remain stable, of sufficient height for the workstation to be within 960 mm and 1225 mm from the floor, for an operator standing position in accordance with ISO 14738.

The equipment requires a lighting level of approx. 400 to 500 Lux. The mock-up can be installed in a Practical Workshop classroom. Operating noise will not exceed 70 dBA.

The mock-up is protected against any errors by future users.

Calibration and servicing of the MT-C7000 mock-up.

Quantity of R134A gas in the equipment: 400 grammes
Quantity of SP10 model oil in the equipment: 150 cc

Servicing frequency:
Poly V belt: change every 2 years, ref: PR 5750.WN PSA,
Hutchinson 6PK728
Hose: change every 3 years
Filter dryer: change every 2 years (PSA ref.: 6453Y5)
Cleaning: use a soft, clean cloth with a window cleaning product.

Number of workstations

The MT-C7000 mock-up is considered as one single workstation.
Equipment users will remain standing throughout the practical work.

Method for removal from service

Press the emergency stop button. Remove the 230 V connection.

Check for the absence of current by reactivating the emergency stop button and pressing the Push button. If the electric motor does not restart, if nothing occurs, there is no residual current.

Press the emergency stop button. Then store the MT-C7000 mock-up in a closed room, clearly marked with 'Equipment Removed from Service'.

Residual hazards

The inner workings are reserved for qualified and authorised persons due to electrical risks.
Trainees will spend the entire period of practical works on the front part of the training mock-up.

DISCONNECT THE 230 V POWER SUPPLY PRIOR TO PERFOMING ANY WORK ON THE MOCK-UP

Only qualified and authorised members of personnel may access the interior of the mock-up.

Transporting the MT-C7000 mock-up

The mock-up must be turned off and tagged-out before transport (see instructions on tagging-out).

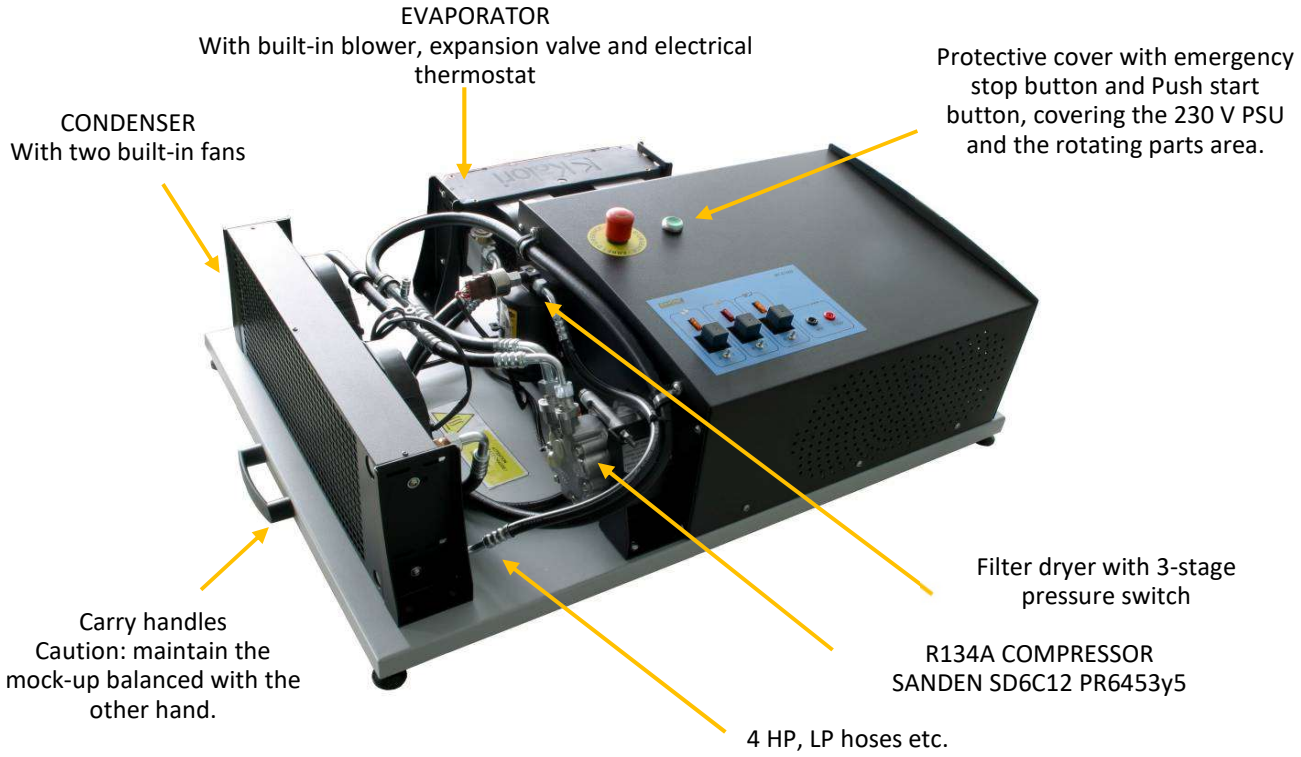
At least two people are required for transport purposes (wearing safety gloves and footwear). Use the carry handles fitted for this purpose.

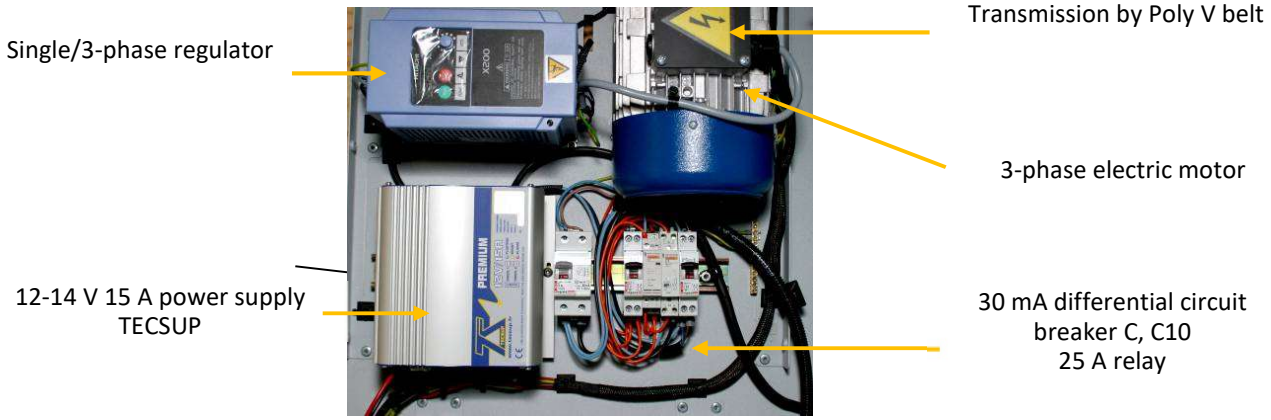
To move the equipment, use a pallet lifter or a transport trolley (the equipment weights approx. 50 kg).

230 V power supply

2. TECHNICAL CHARACTERISTICS OF MOCK-UP

Size: L 1100 x D 700 x H 350 mm, weight approx 60 kg



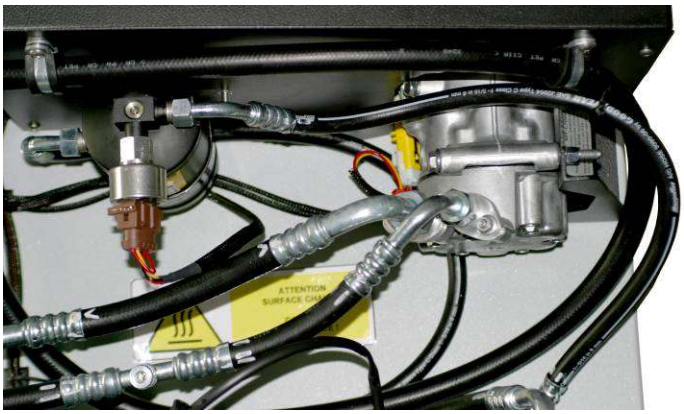


IMPORTANT!

After 3 or 4 emergency stops, the regulator may indicate a fault.
Disconnect the mock-up from the mains power supply, wait for 10 minutes then restart.
Do not touch the regulator buttons

12 V control console

230 V Push start button
Emergency stop button



High Pressure and Low Pressure hydraulic part

Caution: residual risk of burns and freezing in the event of prolonged contact with the hoses.

Access hatch to 230 V part

230 V cable

2.1. Safety rules for application of vacuum or changing a gas part

Operator protection

Wear protective eyewear and safety gloves. Work in a ventilated area.

Do not expose the fluid to heat as it transforms into toxic gas.

In the event of contact with eyes or skin, rinse abundantly with running water (consult medical practitioner for the eyes). In the event of gas inhalation, place the victim in the open air and alert the emergency services if necessary. In the event of fire, there are not contraindications concerning extinction, but toxic gases may be generated (breathing apparatus needed).

Environmental protection

The Montreal protocol declared the stoppage of production of type 12 Chlorofluorocarbons (R12) 1987.

It is imperative to recover all the fluid. If it is not re-used it must be placed in a specific bottle and deposited in an approved recycling centre. If the compressor is scrapped, its oil must be recovered.

Circuit protection

It is imperative to work in a clean area, respect the load and intervention guidelines.

Use the recommended towels and plugs to isolate elements from ambient humidity when they are removed (remember to remove them when reassembling!).

2.2. R134a part

Gas used: R134a, approx. 400 g in quantity.
R134a is a hydrofluorocarbon (HFC) used in domestic, commercial and industrial refrigeration applications and in air conditioning systems, liquid cooling and heat pumps. R134a is the preferred fluid of manufacturers of vehicle and agricultural air conditioning systems.
This fluid may also replace R12 in existing facilities subject to specific procedures.
SANDEN SD6C12 compressor, oscillating plate, 6 cylinders offering a total of 120 cm^3, external control of plate by control duty cycle.
Quantity of SP10 oil in the equipment: 150 cc.
Normal usage pressure in the vehicle air conditioning circuit 12 to 14 bar HP.
Maximum pressure prior to electric cut-off of compressor (via pressure switch): 27 bar see 12 V diagram.
Filter dryer: change every 2 years. Peugeot ref.: 6453Y5
Evaporator volume: 181 cm^3 Condenser volume: 997 cm^3

Hose characteristics

Hose: operating pressure 34.5 bar, temperature from -40 °C to 120°C, SAE J2064.
Rupture pressure of nylon chloroprene hose, single black chlorobutyl polymer braid: diameter M6 and M8 = 172 bar and diameter M10 = 121 bar.
8-point crimp, operating pressure 50 bar produced in factory with special machine.
Change the hoses every 3 years.

IMPORTANT! There is a residual risk of BURNS or FREEZING in the event of prolonged voluntary contact with these zones. This usage is not considered as CORRECT USE OF THE MACHINE.

2.3. Leak tightness part

FRENCH MINISTRY OF ECOLOGY AND SUSTAINABLE DEVELOPMENT

Decree of 7 May 2007 on the verification of leak tightness of elements ensuring the containment of refrigerant fluids used in refrigeration and air conditioning equipment

Article 1 - This decree applies to refrigeration and air conditioning equipment subject to the provisions of paragraph 2 of article 4 of the aforementioned decree of 7 May 2007.

Article 2 - The leak test of refrigeration and air conditioning equipment is performed by passing a manual detector over all points of the equipment presenting a risk of leakage.

If the configuration of the equipment does not enable access to all points that may present a risk of leakage, the accessible points shall be inspected manually and further measurements of the characteristic values of the containment shall be monitored in accordance with standards EN 378-2 and EN 378-3.

The detector and room monitor are suitable for the refrigeration fluid contained in the inspected equipment.

Article 3 - The frequency of leak tests on elements containing refrigerant fluids in refrigeration and air conditioning equipment is as follows:

- once every twelve months if the volume of refrigerant fluid in the equipment exceeds two kilograms.

Article 4 - The detectors used shall enable a sensitivity of at least five grammes per year and the room monitors shall offer a sensitivity of at least ten parts per million. These sensitivity ratings are measured according to EN 14624. They are verified at least once every twelve months to ensure that they do not deviate from the values indicated in the previous paragraph by more than 10 %.

Article 5 - In the event that the leak test is performed using a room monitor:

- only the sensitivity of the equipment will be verified during the inspections indicated in article 2;
- the frequency of inspections for equipment with fluid loads in excess of thirty kilograms is reduced by half in relation to the frequencies defined in article 3.

Article 6 - The results of the leak tests and repairs made or to be made are recorded on the intervention log sheet indicated in article 5 of the aforementioned decree of 7 May 2007. The intervention log sheet shall enable the identification of each circuit and points on the equipment where a leak is detected.

Operators performing leak tests shall affix a removable mark on equipment components requiring repair.

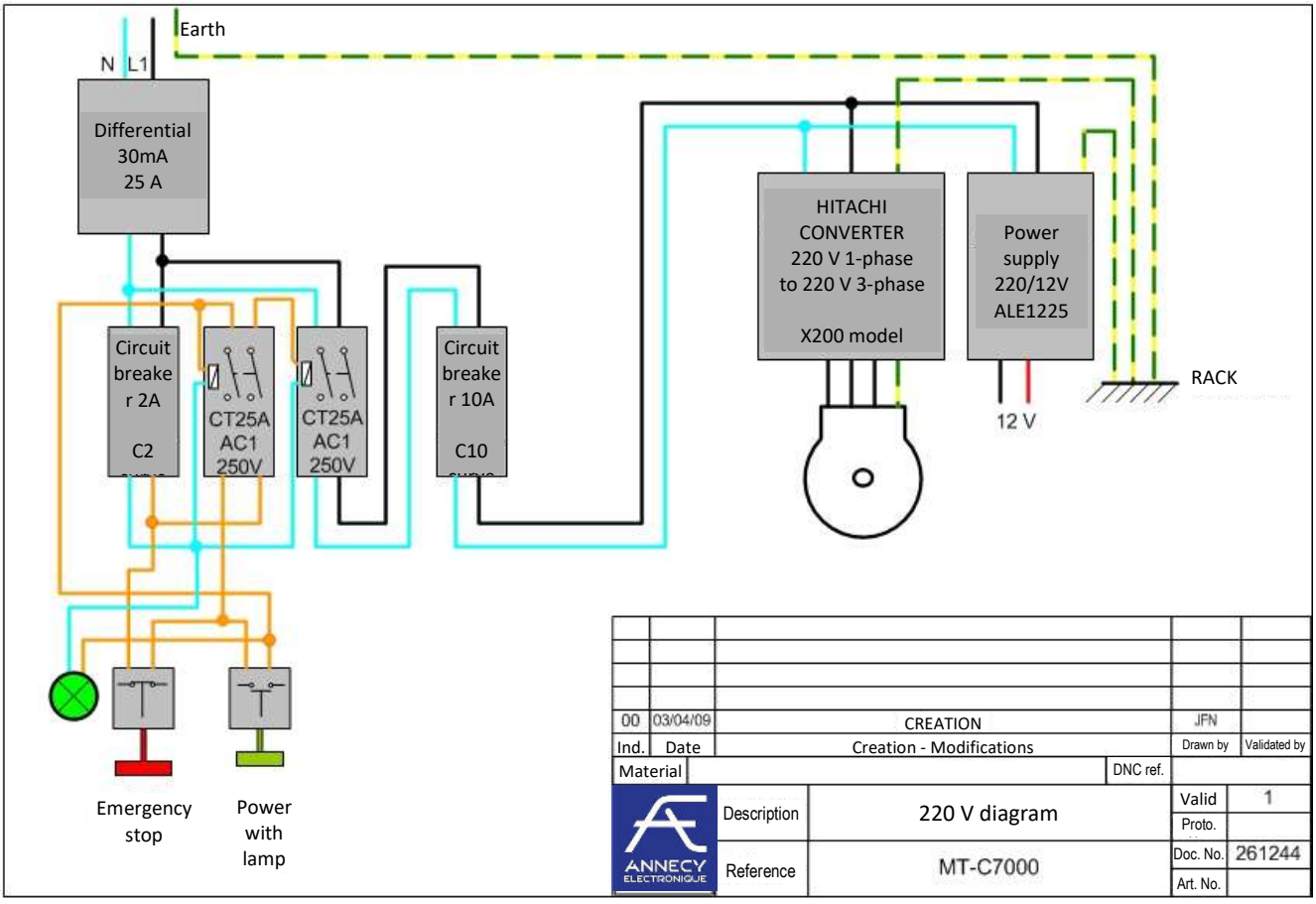
2.4. List of consumables

Vehicle fuses: 5 A, 10 A, 25 A
Vehicle relays: 5-pin, 12 V 40 A
Hose seals:

Reference	Description	Quantity
700.06.100	To connect the high pressure condenser outlet to the expansion valve inlet O-RING SEAL M6 HNBR	4
700.06.101	To connect the high pressure compressor outlet to the condenser inlet + expansion valve and evaporator inlet + compressor flange O-RING SEAL M8 HNBR	5
700.06.102	To connect the low pressure expansion valve outlet to the compressor inlet O-RING SEAL M10 HNBR	2
700.06.103	For compressor low pressure flange O-RING SEAL M12 HNBR	1
700.06.120	For compressor high pressure flange O-RING SEAL HNBR INT 10.7 x 2.5	1
700.06.119	For compressor low pressure flange O-RING SEAL HNBR INT 17 x 2.5	1

Legrand 30 mA differential circuit breaker for general power supply
Legrand 10 A circuit breaker C10 curve for electric motor
Legrand 2 A circuit breaker C2 curve for AU
Legrand CT25A AC1 250 V relay

2.5. 230 V wiring diagram



2.6. 230 V access in mock-up

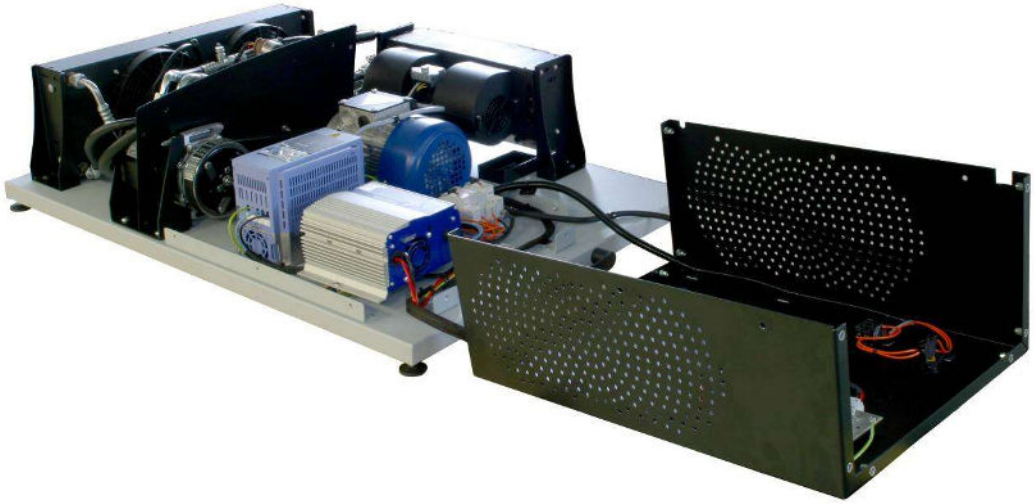
Disconnect the 230 V mains power cable.
Only authorised personnel may open and perform work inside the mock-up.
To open the panel, use a 4 mm hex-head wrench.

Remove this cover
8 screws

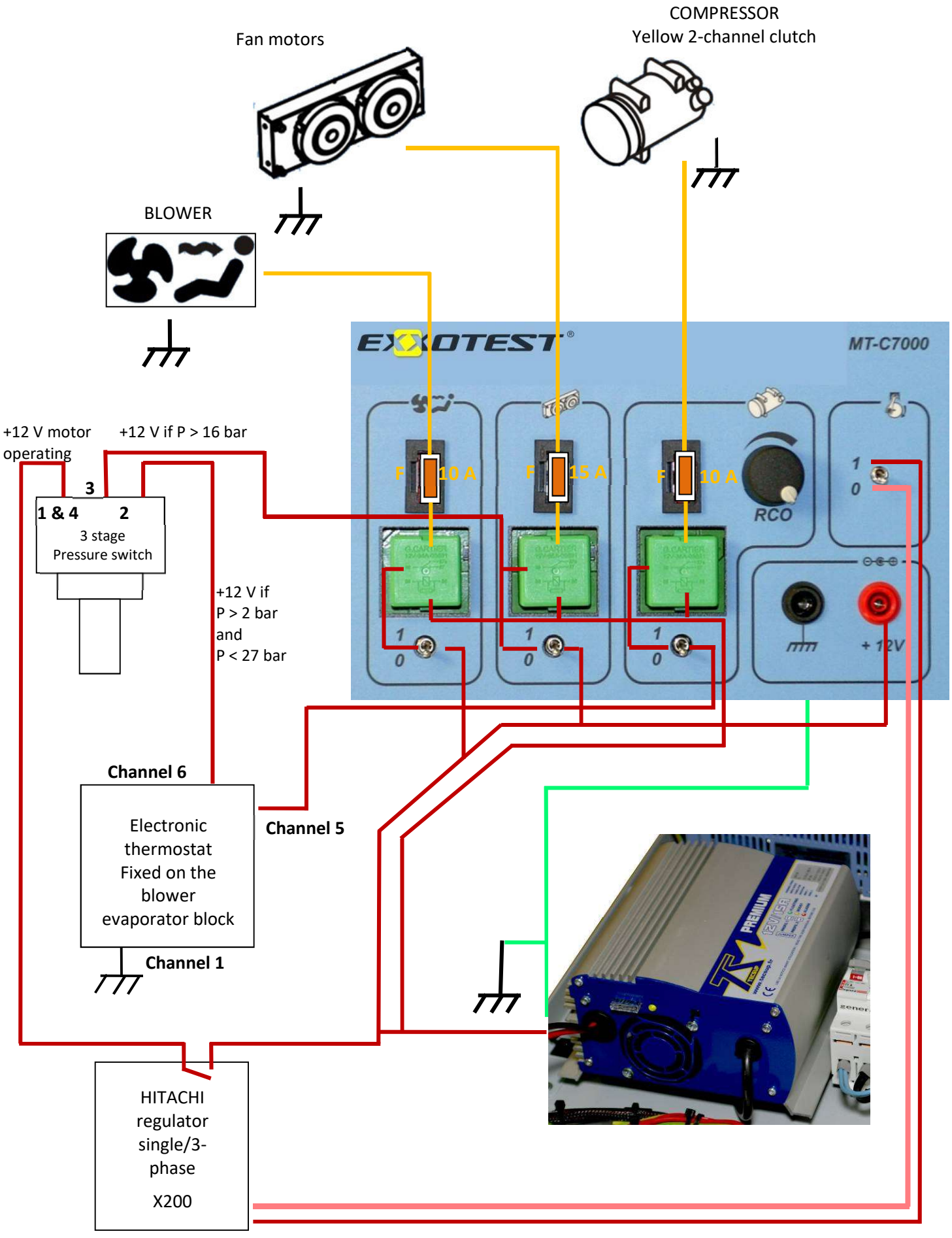
Use the same wrench to open the panel on the other side:
There are 8 screws
but the main cover remains on the mock-up

Remove the 3 screws on each side

And pivot the cover



2.7. 12 V wiring diagram



2.8. TECSUP 12-14 V - 15A power supply user manual

Technical characteristics:

- Extruded anodised aluminium unit; aluminium flanges, epoxy paint
- Tropicalised PCB, stainless steel fastening accessories
- Mains input voltage:
  - universal, i.e. the charger may operate using any voltage between 90 and 260 V AC. Full power available above 115 V, progressive derating below this.
  - 50 - 60 Hz
- Output voltage:
  - U bat +/- 2 %;
  - 1 or 2 independent outlets (according to model)
- Output current: I bat +/- 10 %
- Load curve: 2, selectable using external jumper (open seal, leaktight/AGM/gel batteries)
- Operating temperature: -20 °C to +70 °C.
- Ventilation:
  - natural (no ventilation) for 12 V/15 A and 24 V/08 A versions. Maximum power available from -20 °C to +30 °C then progressive self-limiting up to +70 °C (no cut-off),
  - forced (with variable-speed fan) for 12 V/20 A and 24 V/15 A versions. Maximum power available from -20 °C to +45 °C then progressive self-limiting up to +70 °C (no cut-off).

Safety:

- Electronic protection against:
  - transient short circuits on output;
  - battery discharge to charger;
  - mains over-voltage.
- Fuse protection:
  - internal: overload at mains inlet;
  - external: inversion of polarity.
- Storage temperature: -25°C to +75°C
- Relative humidity: 90%
- Protection rating:
  - IP 43 (12 V/15 A and 24 V/08 A)
  - IP 23 (12 V/20A and 24 V/15A)
- Standards: see CE declaration of conformity

Options:

- Compensation of load voltage according to battery temperature
- Remote display panel
- Specific settings on request.

Transformer insulation: 3500 V 50 Hz between primary and secondary.

Main insulation between primary and Earth. Reinforced insulation between primary and secondary (leak lines are at 8 mm on the copper between the primary and secondary)

4 CE DECLARATION OF CONFORMITY

TECSUP	CE DECLARATION OF CONFORMITY	AQ-030 CE - 97-030

Manufacturer: Address:	**TECSUP** 32, Route des Moulins BP 116 74410 SAINT-JORIOZ	Tel: 22 Fax: 34	+33 (0)4 50 63 96 +33 (0)4 50 68 96

PRODUCT DESCRIPTION

Name:	**PREMIUM** charger
Type:	12 V/15 A - 12 V/20 A • 24 V/08 A – 24 V/15 A
Model:	1 channel, 2 channels

The products identified above are declared as compliant with the stipulations of:

• Council Directive of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (89/336/EEC)

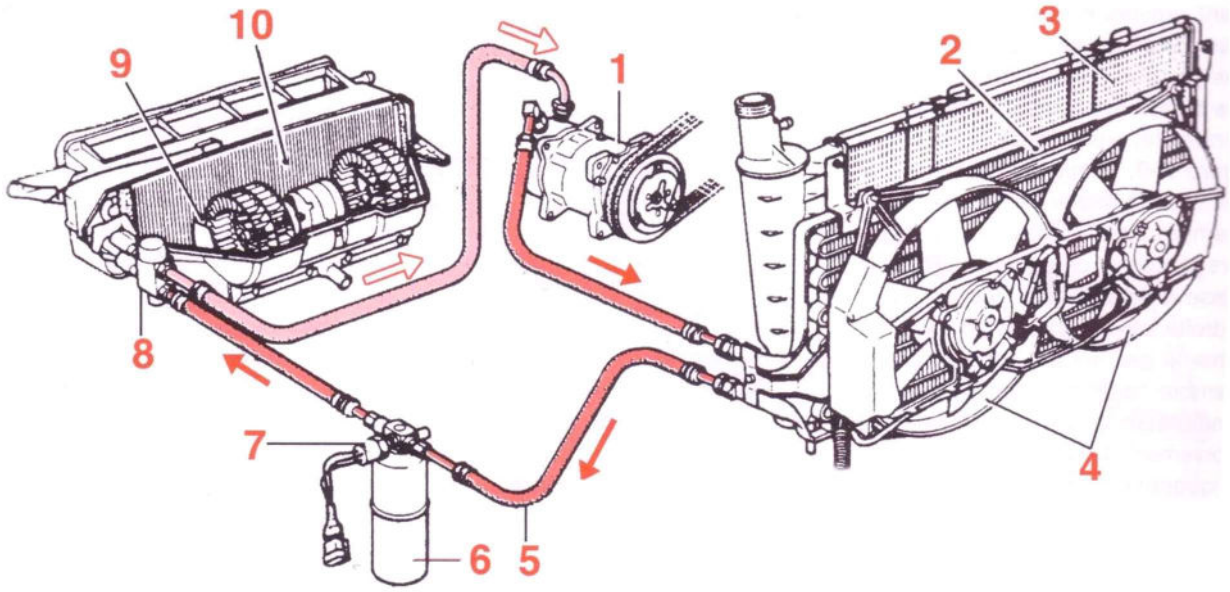
• Council Directive 73/23/EEC of 19 February 1973 amended on 22 July 1993 on the approximation of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits (amended by Directive 93/68/EEC).

This compliance is assumed by reference to the following specifications:
- NF EN 50081-1 / Generic Emission Standards - June 1992,
- NF EN 50082-1 / Generic immunity standard - June 1992,
- NF EN 55022 - class B / Information technology equipment Radio disturbance characteristics. Limits and methods of measurement,
- NF EN 60335-1, NF EN 60335-2-29 / Household and similar electrical appliances. Safety April 1992.

Location:	SAINT-JORIOZ	Date: 09/04/2004
Name of signatory:	Eric COCHETEL, CEO 32, Route des Moulins BP 116, 74410 SAINT-JORIOZ Tel +33 (0)4 50 68 96 22 Fax +33 (0)4 50 68 96 34	

3. AIR CONDITIONING SYSTEM

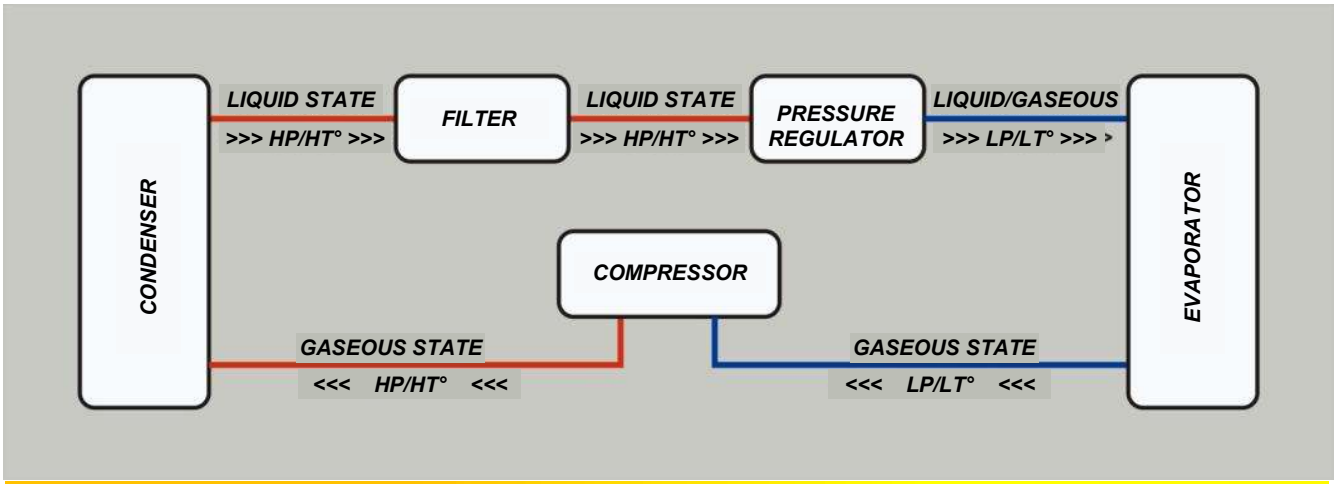
3.1. View of refrigeration circuit components

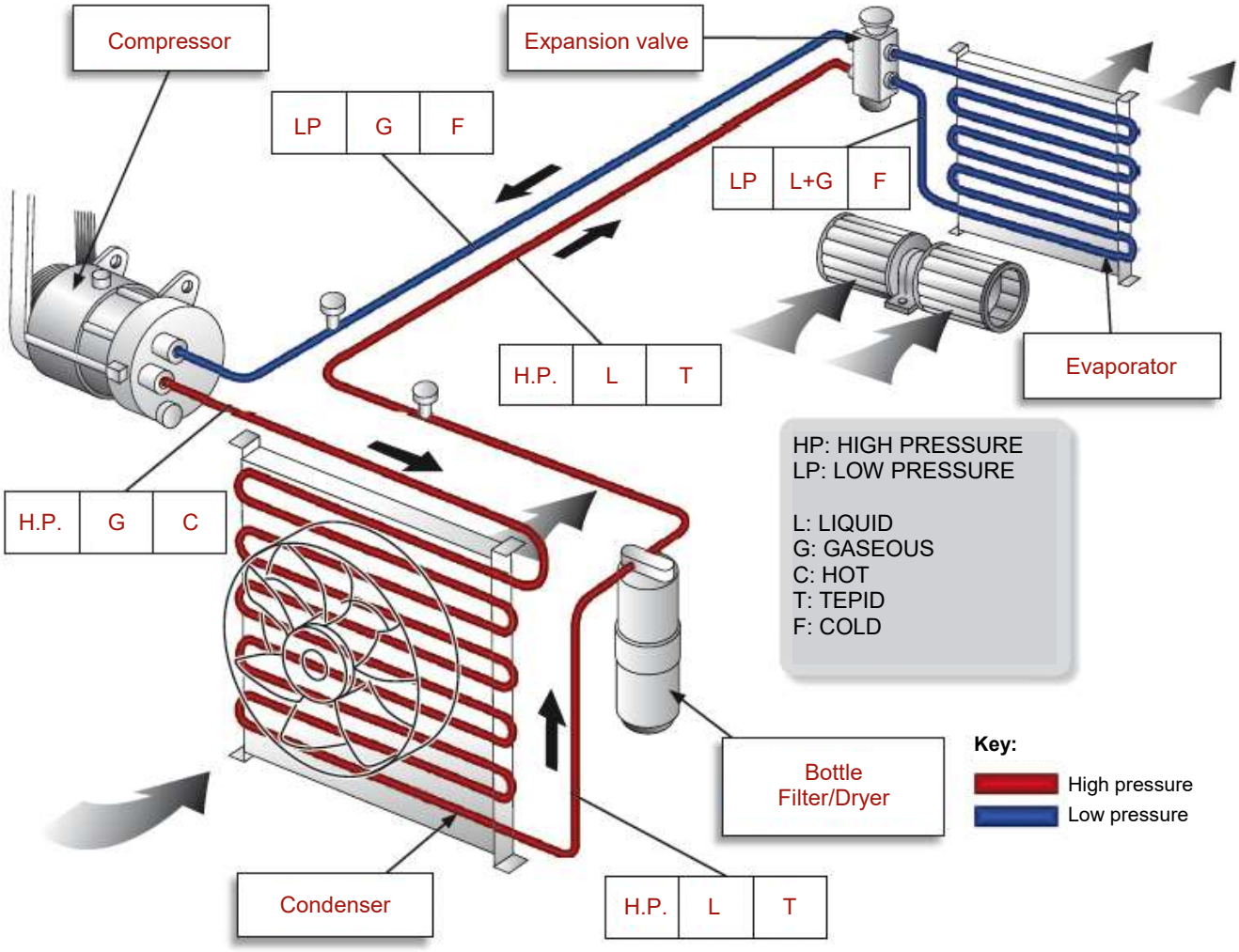


1 - Compressor
2 - Condenser
3 - Motor cooling radiator
4 - Fan unit
5 - Hoses
6 - Dryer bottle
7 - 3-function pressure switch
8 - Expansion valve
9 - Air fan (blower)
10 - Evaporator

3.2. State of refrigerant at each point in the cooling circuit

Point in circuit	State of fluid	Pressure	Temperature
Evaporator outlet or compressor inlet	Vapour	Low	Low
Compressor outlet or condenser inlet	Vapour	High	High
Condenser outlet or expansion valve inlet	Liquid	High	Tepid
Expansion valve outlet or evaporator inlet	Liquid Vapour	Low	Low
Point in circuit	State of fluid	Pressure	Temperature
Evaporator outlet or compressor inlet	Vapour	Low	Low





3.3. Definition and justification of system

A vehicle air conditioning system consists in a range of equipment used to maintain a constant, controlled atmosphere inside the cab (temperature, pressure and humidity).

The result is produced by combining the ventilation, heating and refrigeration functions.

Vehicle air conditioning is a major factor in ensuring the comfort and safety of passengers, by providing:

- better visibility by preventing misting and icing on windows by drying air,
- continued driver vigilance by ensuring a constant temperature and reducing the need for adjustments due to variations in external weather,
- insulation of the cab when the vehicle crosses polluted areas, to protect passengers against odours and gases, ensuring a clean, filtered air supply,
- a sensation of well-being by ensuring the atmosphere remains with each driver's comfort zone at a temperature between 18 and 26 °C, a humidity level between 40 and 60 %, along with an airflow speed between 0.1 and 0.2 m/s.

3.4. Functional analysis

Thermodynamic elements

The quantity of heat is measured in calories or in joules (1 calorie = 4.18 joules).
A calorie is the amount of energy required to warm one gram of air-free water from 14.5 to 15.5 °C at standard atmospheric pressure.

Different material states:
VAPORISATION = ABSORPTION OF HEAT
LIQUEFACTION = RELEASE OF HEAT

Compression of a gas causes: an increase in the pressure and temperature, with release of heat outwards.

Expansion of a gas causes: a reduction in the pressure and temperature, with absorption of heat from the external atmosphere.

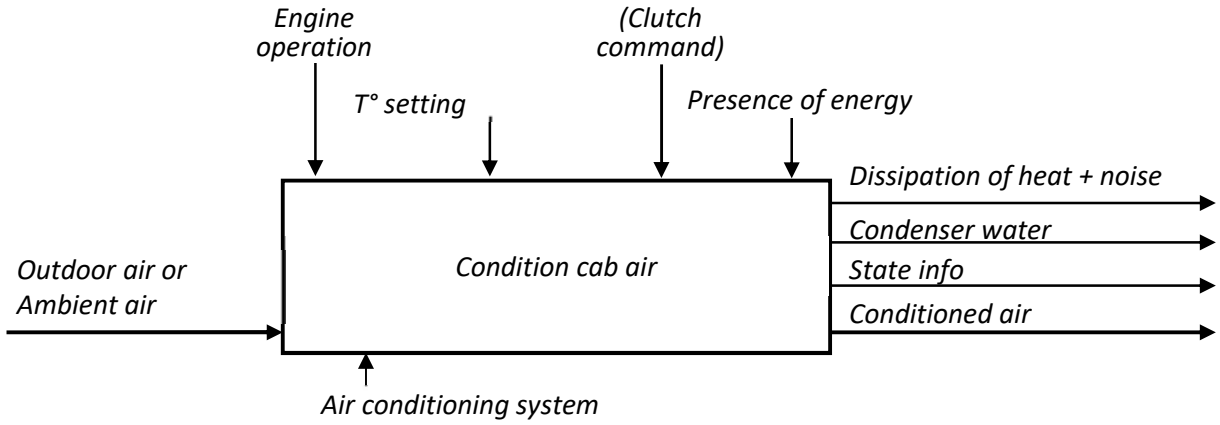
Definition of enthalpy: The enthalpy (H) of a fluid is the quantity of heat expressed in joules per kilogram (J/Kg).

The quantity of heat received by a system which operates at constant pressure is equal to its variation in enthalpy.

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 mbar. On the other hand, water will only boil in a steam cooker at a pressure of 5 bar above a temperature of 151 °C.

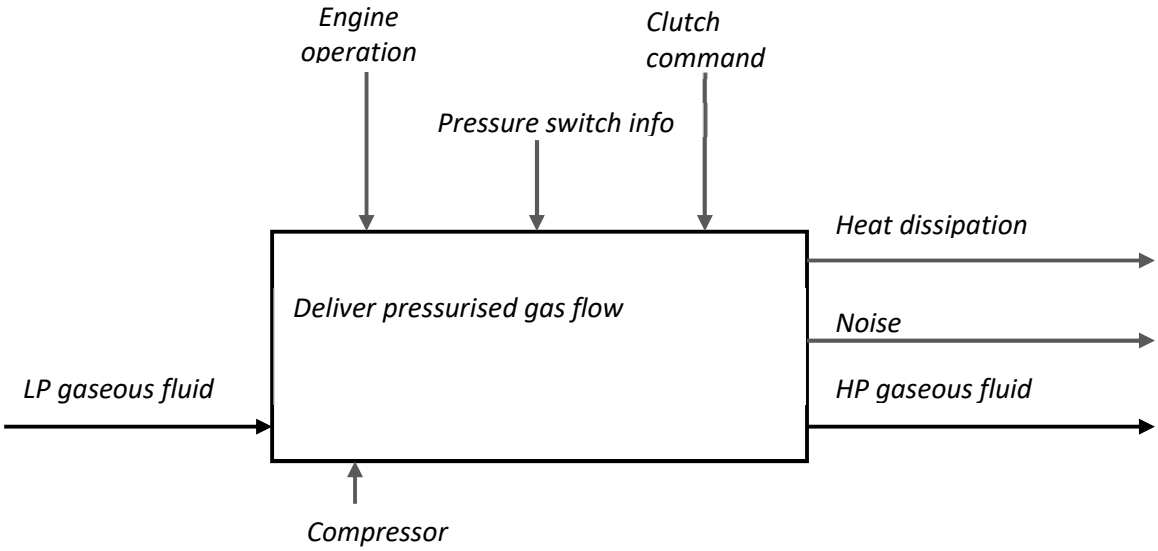
General operation



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 drawing it 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.

General function of the compressor: ensure high pressure refrigerant flow.



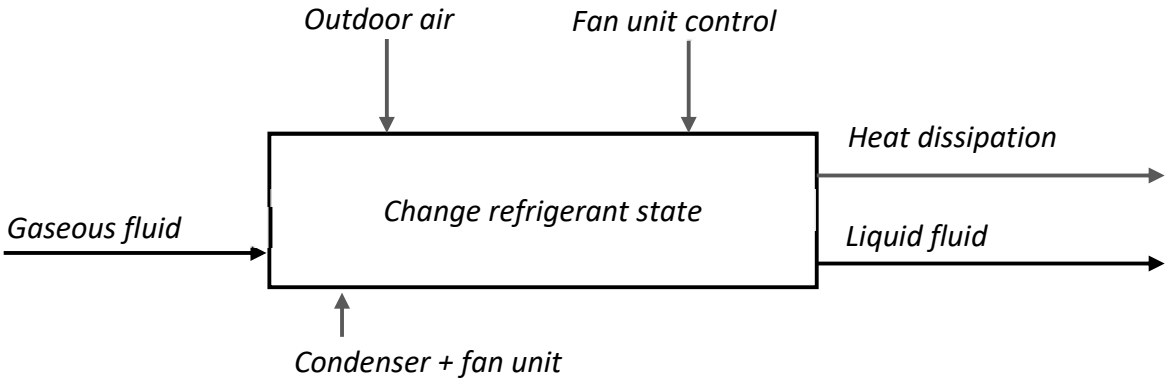
The condenser

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.

Condenser 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.

General function of condenser: condense the superheated vapour (gas) and supercool the fluid (liquid).



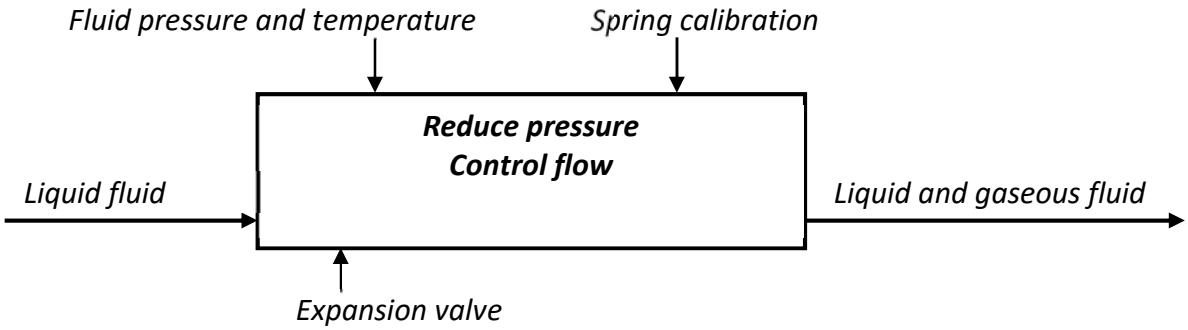
Expansion valve (with built-in thermostat)

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.

General function: reduce the pressure and control the flow of the refrigerant depending on temperature.

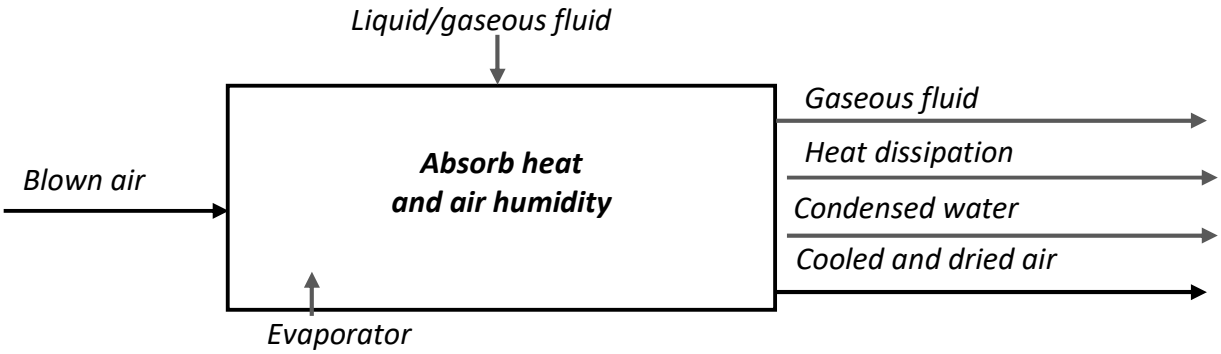


Evaporator

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 ambient outdoor air crosses the evaporator before entering the cab. This air will transfer some of its heat to the refrigerant, ensuring vaporisation. The outdoor air blown into the cab is cooled, dried and free of dust.



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

General function: 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.

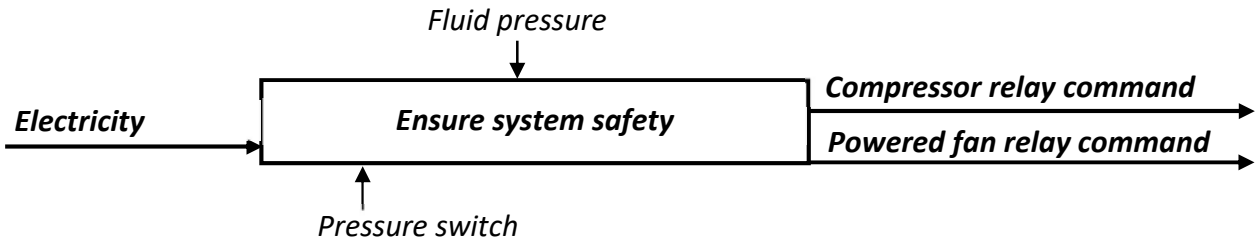
Pressure sensor (pressure switch)

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).

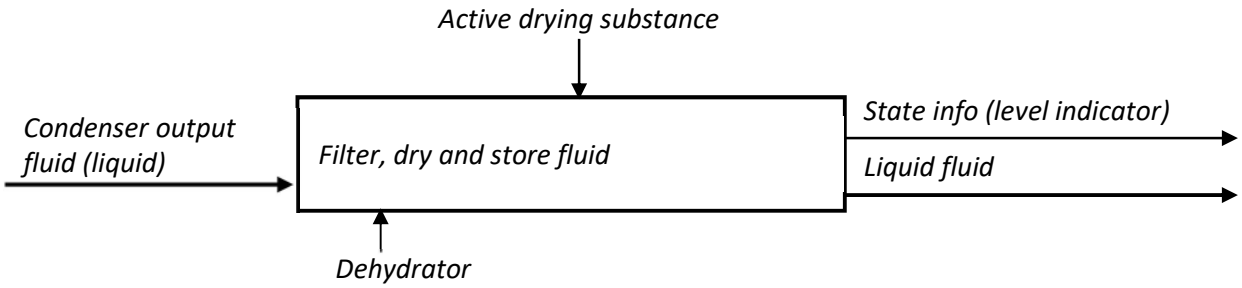
General function: Control the powered fan and clutch command to ensure system safety.



The dehydrator

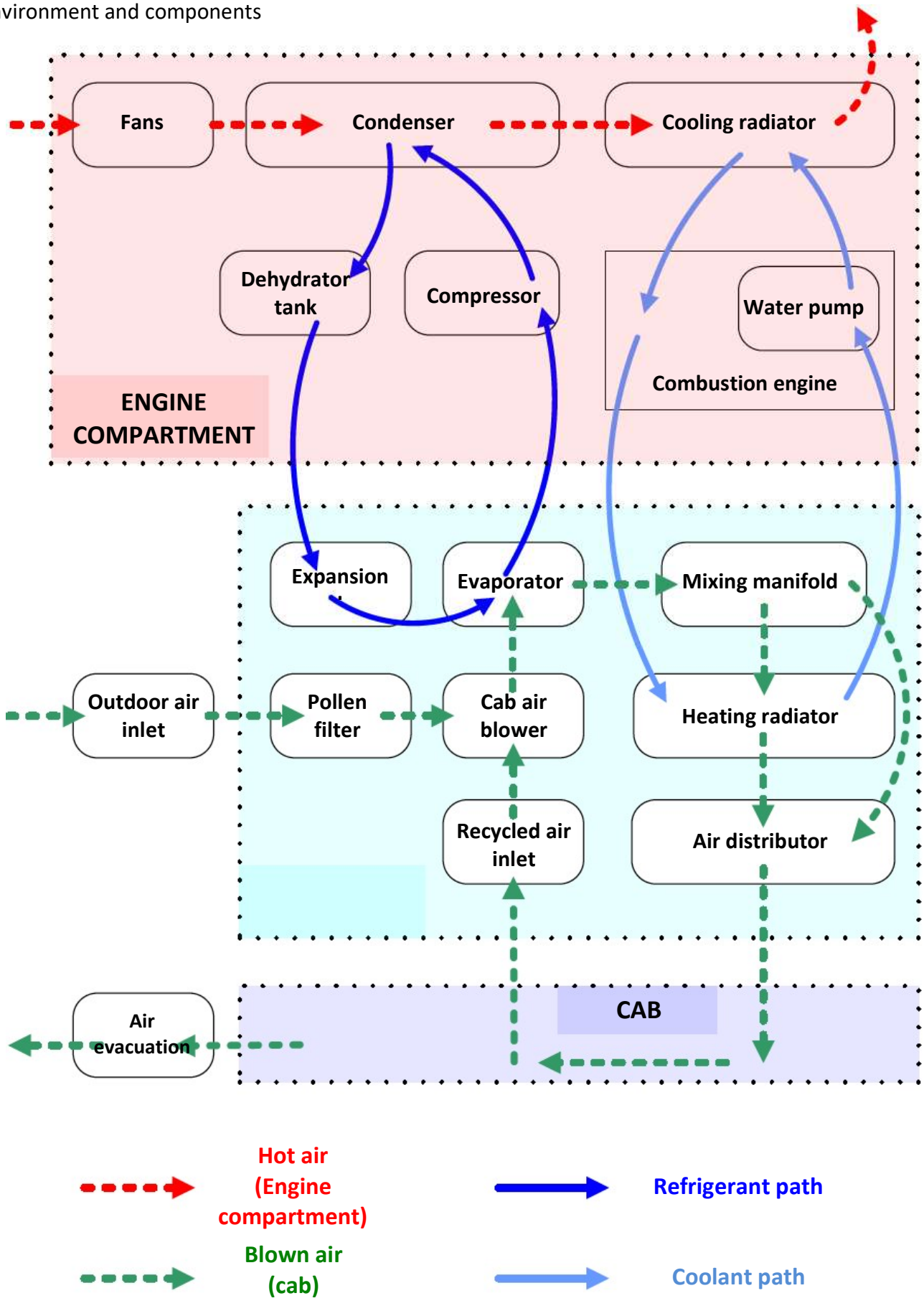
The dehydrator is located at the outlet of the condenser, and is increasingly integrated in the condenser (removable or other). This unit stores, filters and dehydrates the refrigerant.

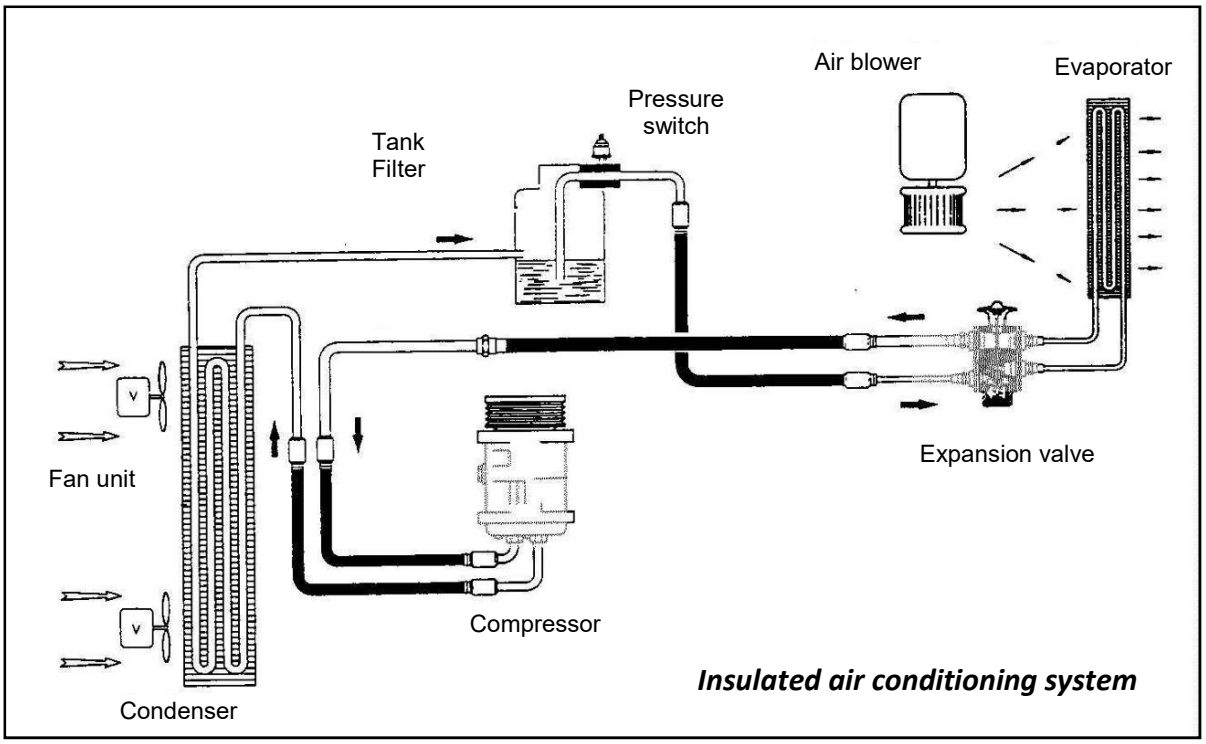
General operation: Create a buffer of fluid, filter circulating fluid, and retain the humidity in the system.



3.5. Operating principle

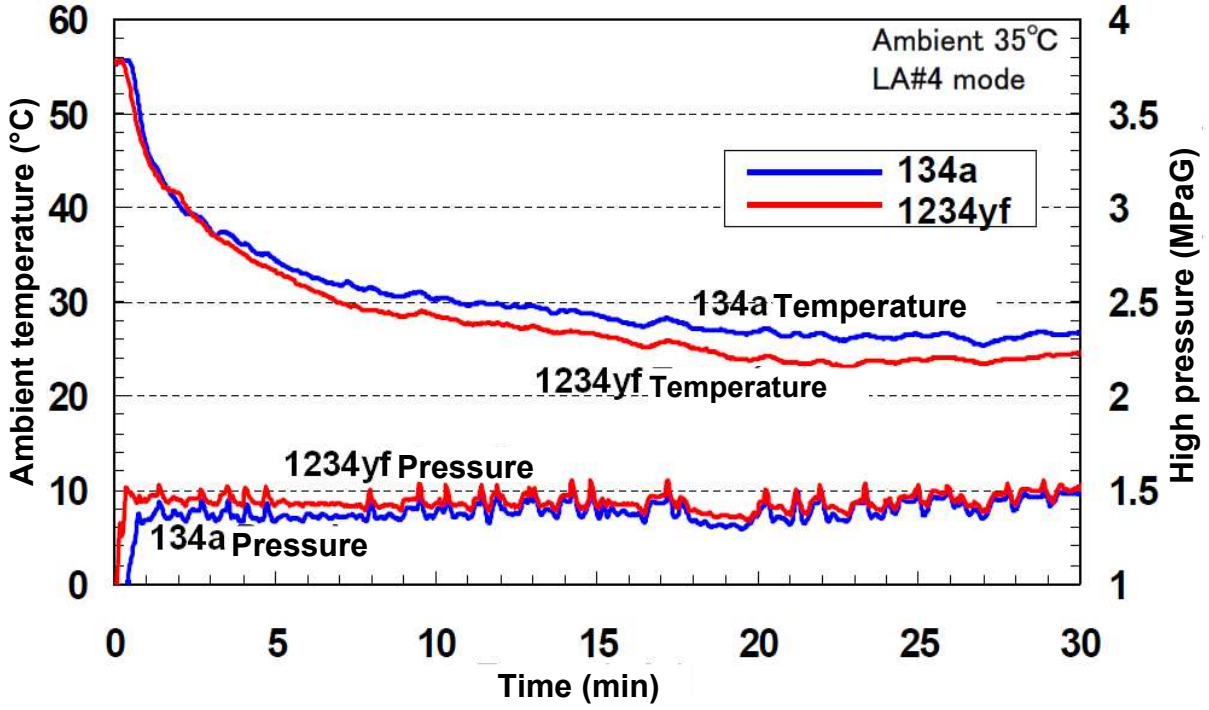
Environment and components





Refrigerant

Since 01 January 2013, new vehicles must be equipped with the new fluid R1234yf. This replaces R134a. The difference between these two fluids does nor entail major modifications to the air conditioning circuit. Furthermore, the PAG oil in R134a circuits is compatible with the R1234yf fluid, which will facilitate operations to replace R134a by R1234yf.



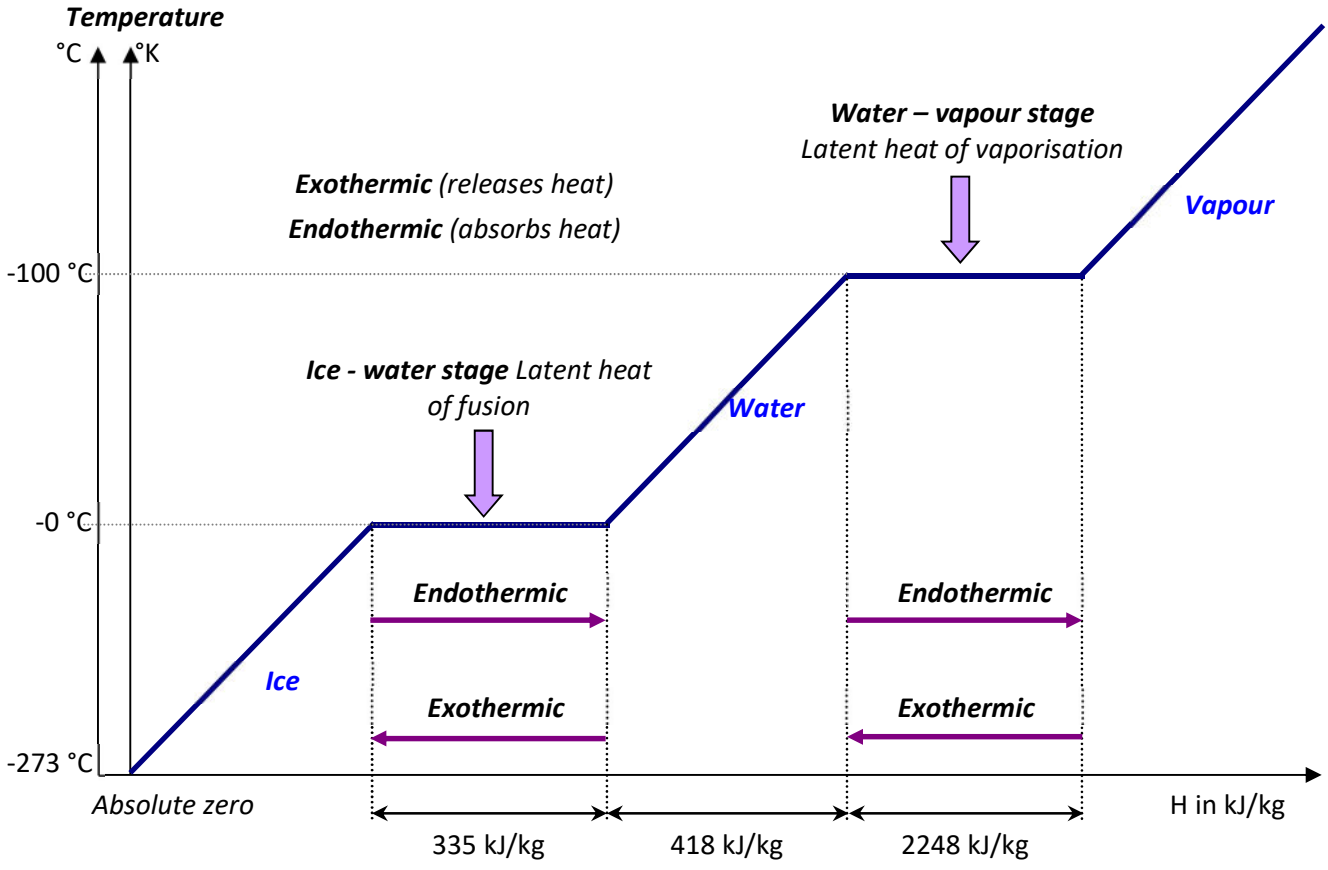
Three types of gas can be found in air conditioning systems. The first known as R12 was abandoned in 1995 and replaced by R134A, which is less toxic. This gas will progressively be replaced by HFO 1234yf.

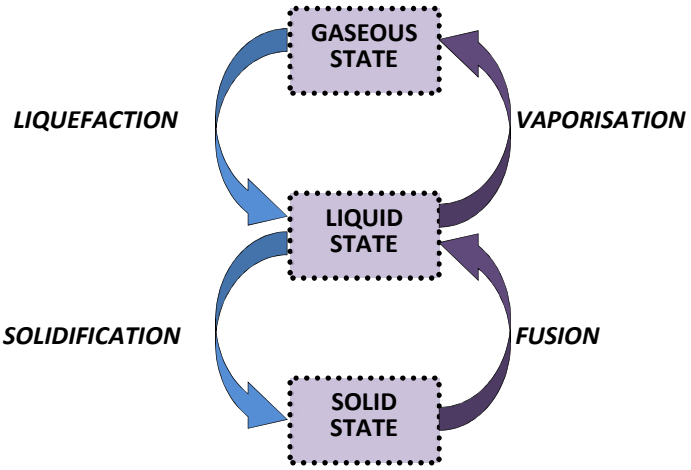
Characteristics of fluids at a pressure of 1013 mbar:

	Unit	R134A	R12	HFO 1234yf
Physical formula		$C_2H_2F_4$ (CF_3-CH_2F)	CCl_2F_2	$C_3H_2F_4$
Chemical name		Tetrafluoroethane	Dichlorodifluoromethane	Hydrofluoroalkane
Atomic mass	$g \cdot mol^{-1}$	102.0	120.9	114
Boiling point at 1013 Mb	°C	-26.5	-29.8	-29.4
Critical temperature	°C	101.1	112	95
Liquid density at 25°C	$kg \cdot m^{-3}$	1203	1310	1094
Vapour pressure at 25°C	kPa	661.9	651.6	677

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 mbar. On the other hand, water will only boil in a steam cooker at a pressure of 5 bar above a temperature of 151°C.

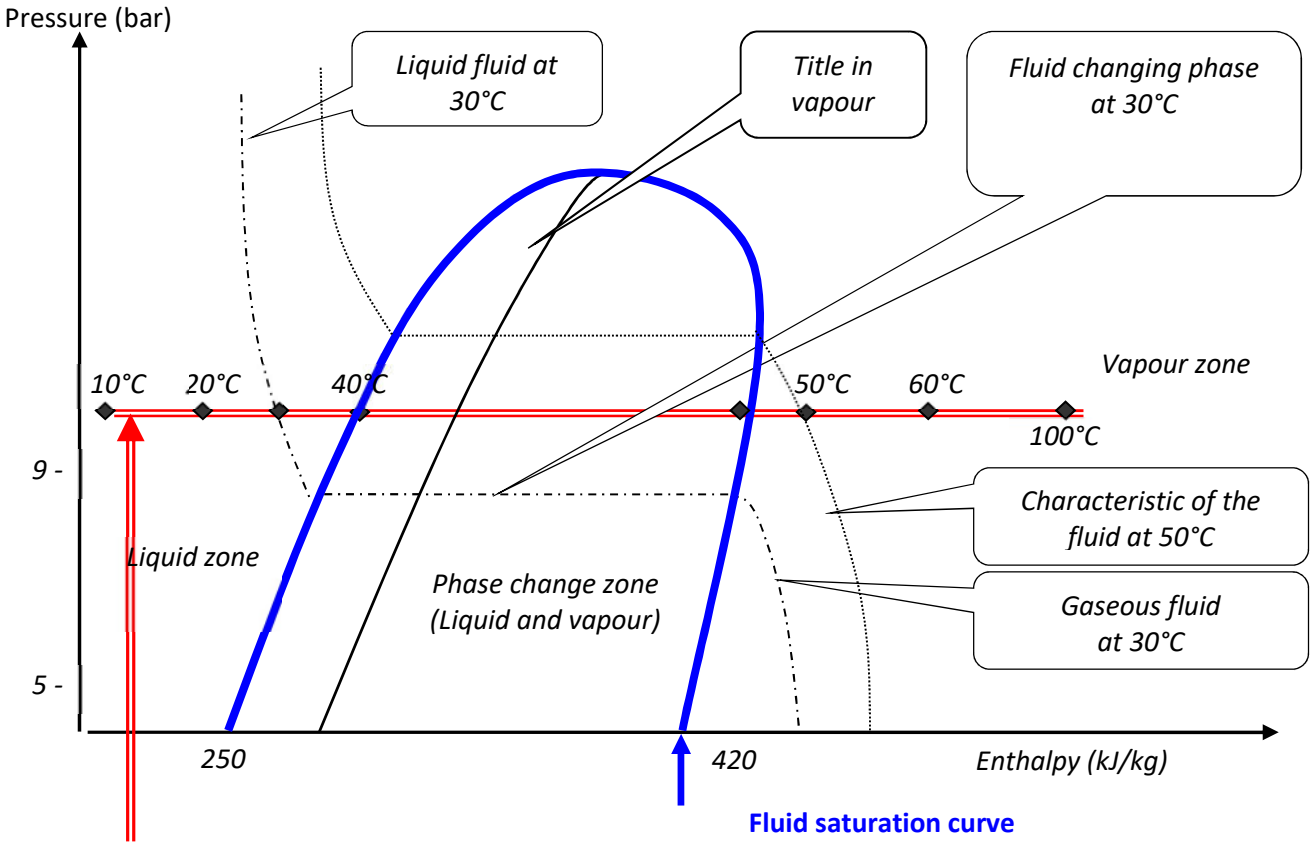




Enthalpy characterises the amount of heat contained in the fluid. The zero point of this scale corresponds to absolute zero. Variations are shown by the double arrows quantifying the additional energy the fluid requires to change temperature or state. Variations in enthalpy occur during the following 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.

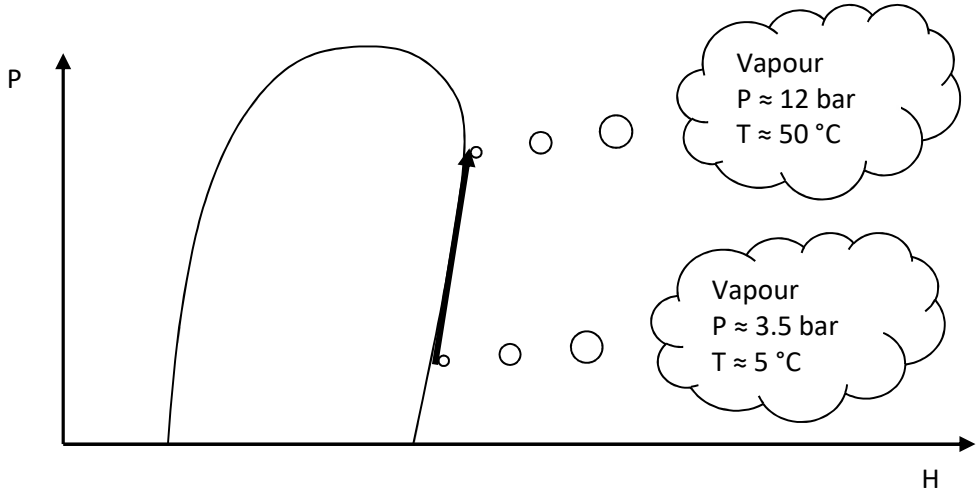


Isobar straight line: quantify the energy required to change the phase or temperature of a mass of fluid.

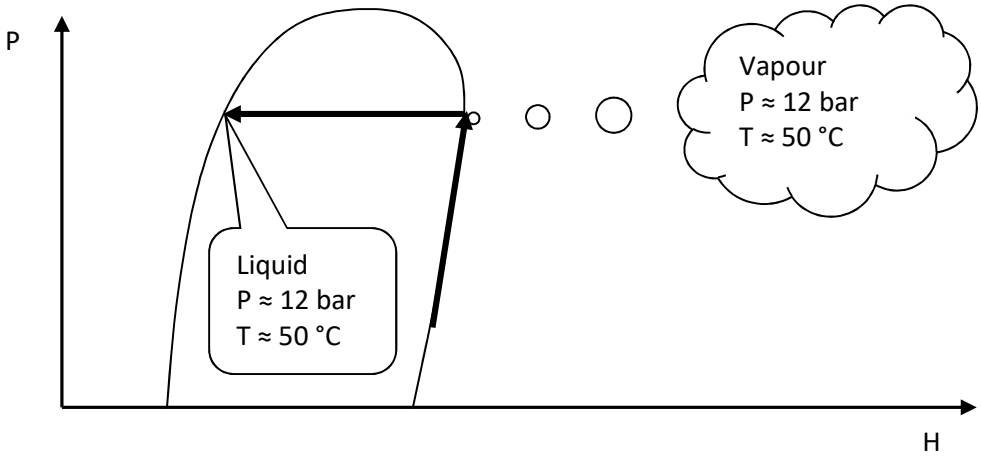
Changes in the characteristics of R134a fluid, the enthalpy diagram:

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

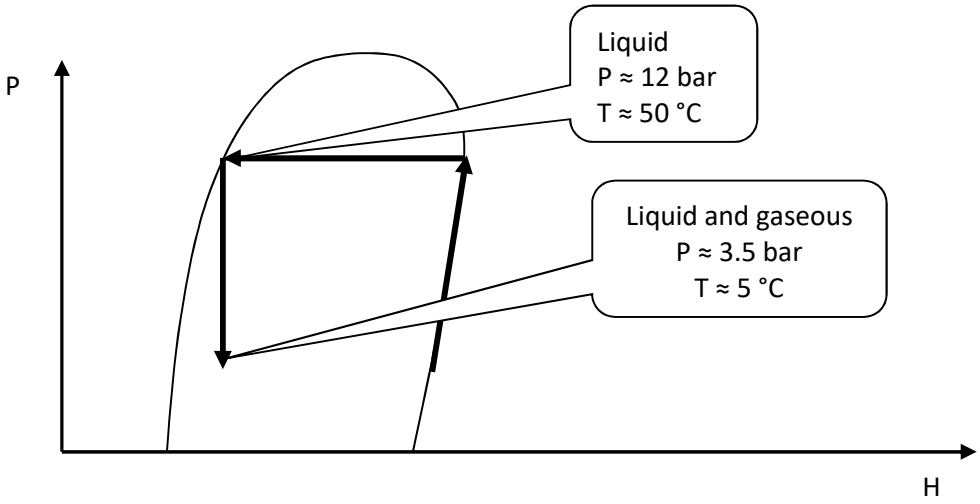
The compressor: The compressor aspirates the saturated vapour and compresses this fluid, which is then discharged to the condenser as high pressure, high temperature vapour.

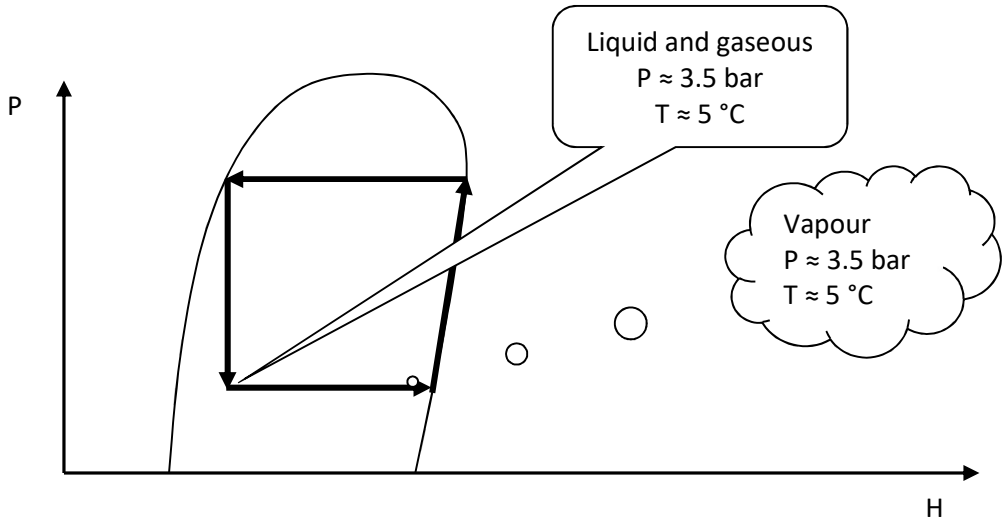


Condenser: The condenser is a heat exchanger. When the vapour enters the condenser, it changes state. The vapour liquefies at constant temperature, reducing its enthalpy, and transferring the heat (absorbed in the evaporator) to the air blown by the fans, until complete liquefaction.



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 blown across the evaporator by the cab fan (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.

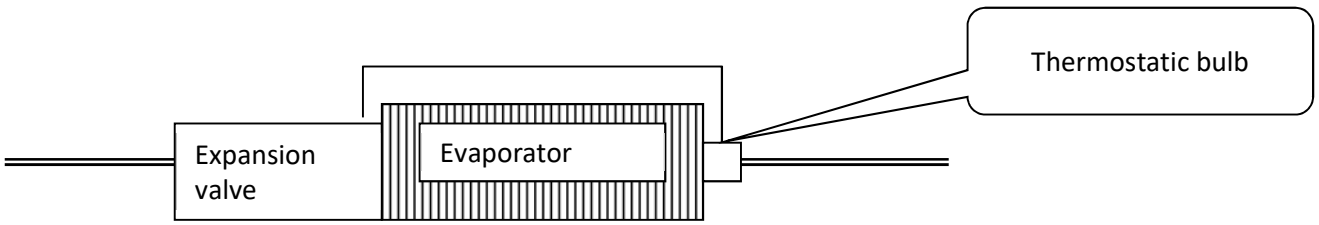
The actual cycle of the R134a fluid

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-capacity 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.



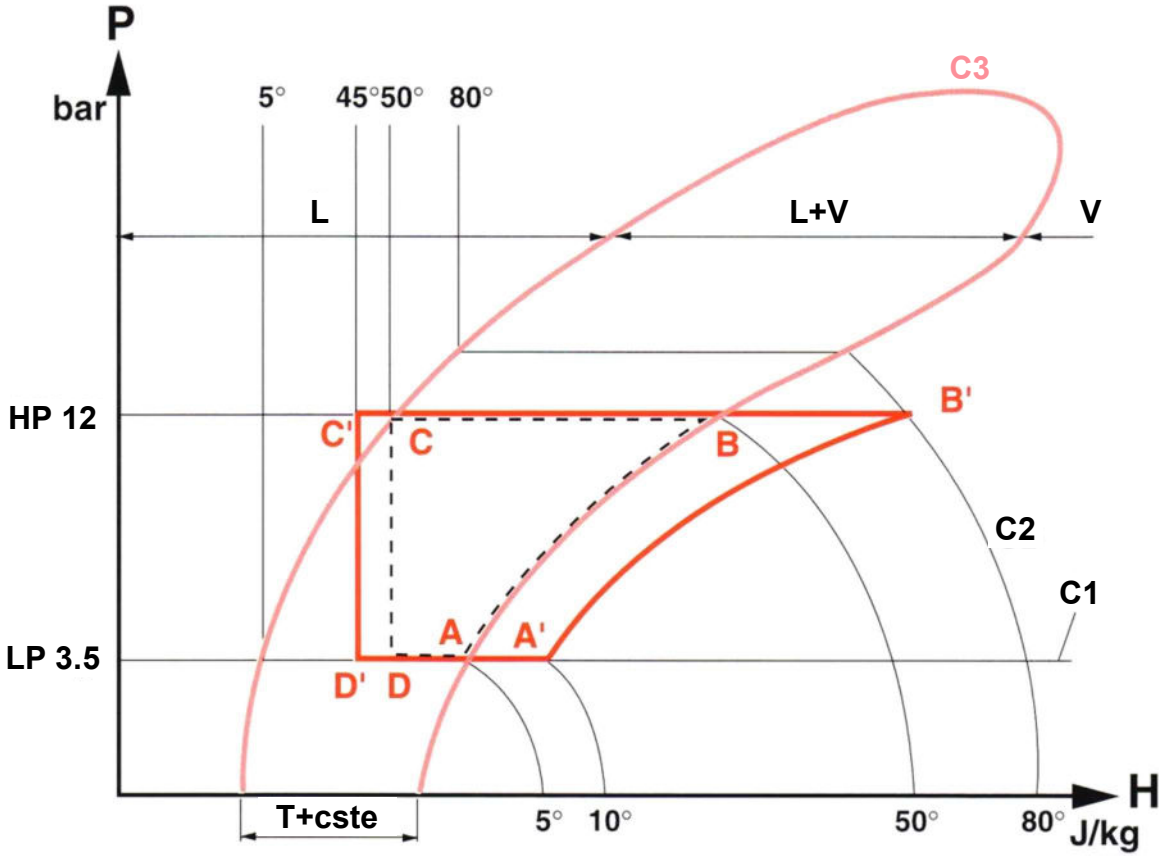
Desuperheating (B'B):

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

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

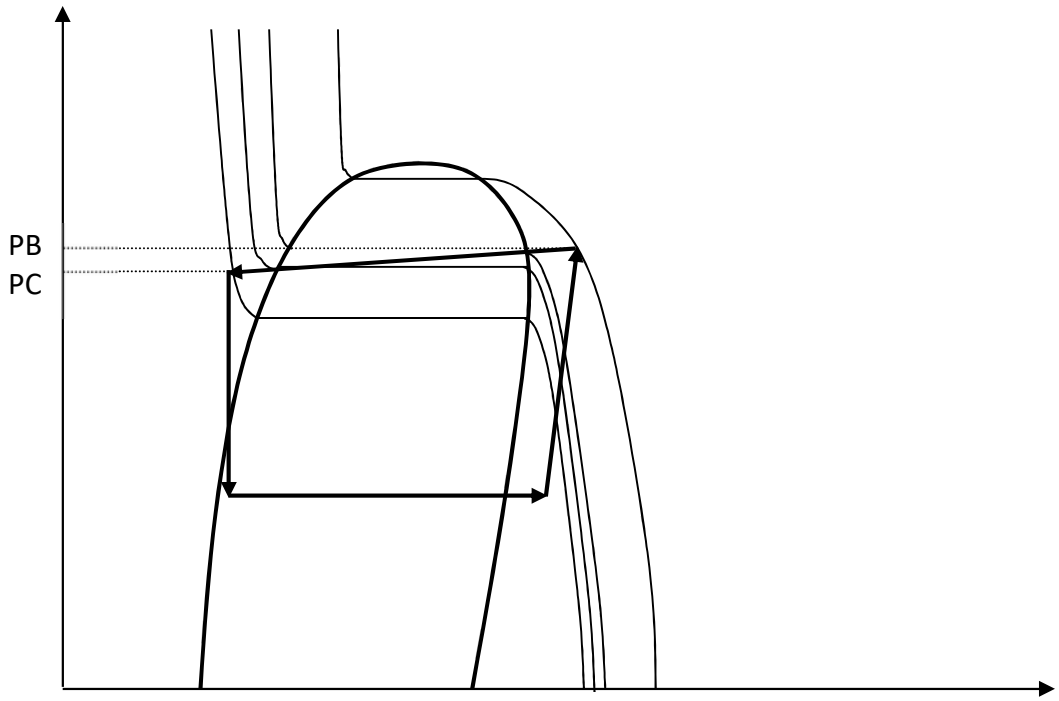
AA': Superheating
B'B: Desuperheating
CC': Subcooling
D'D: Condensation

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

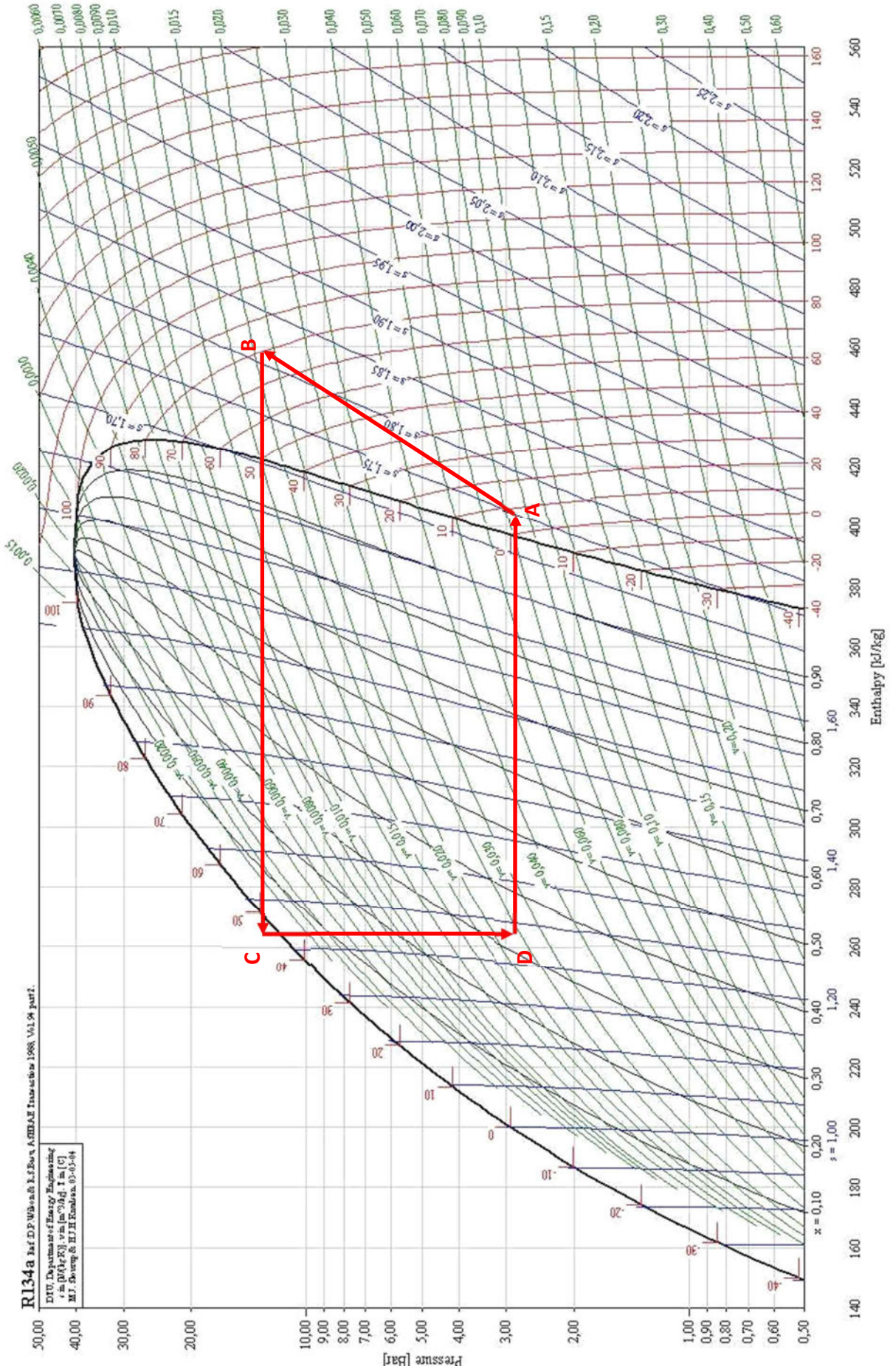
The pressures shown are ***absolute pressures***
(To obtain relative pressure measured at the workshop, ***deduct 1 bar***)

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 flowrate 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.



3.6. 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

4. DESCRIPTION OF THE MT-C7000 MOCK-UP

4.1. Measuring with the mock-up

Mollier diagram on a refrigeration loop with expansion valve.

You will take readings on the MT-C7000 refrigeration mock-up.
Equipment required:

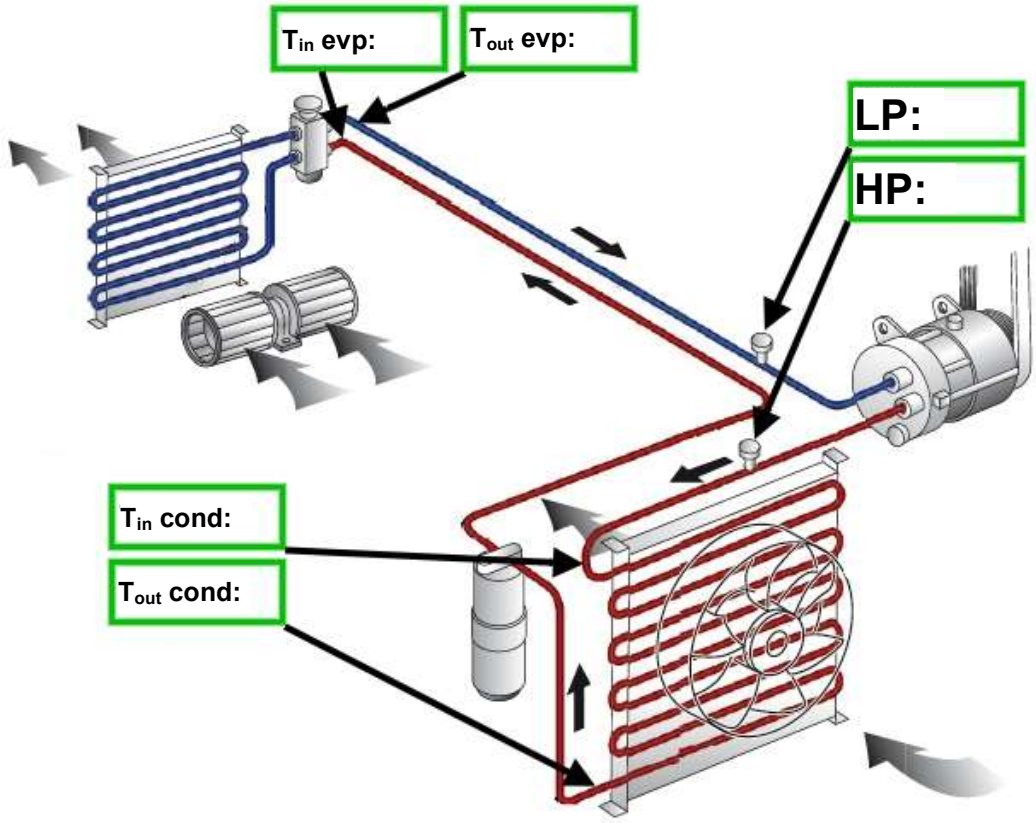
- MT-C7000 mock-up in operating condition
- EXXOCLIM
- Use of protective gloves and eyewear

Step 1:

Connect the EXXOCLIM unit to the mock-up, the 2 pressure connectors to LP and HP, the temperature probe clamps T1 to T4 according to the EXXOCLIM recommendations (Condenser inlet outlet, Evaporator inlet outlet), humidity probe and wireless temperature probe on blown air outlet side.

Step 2:

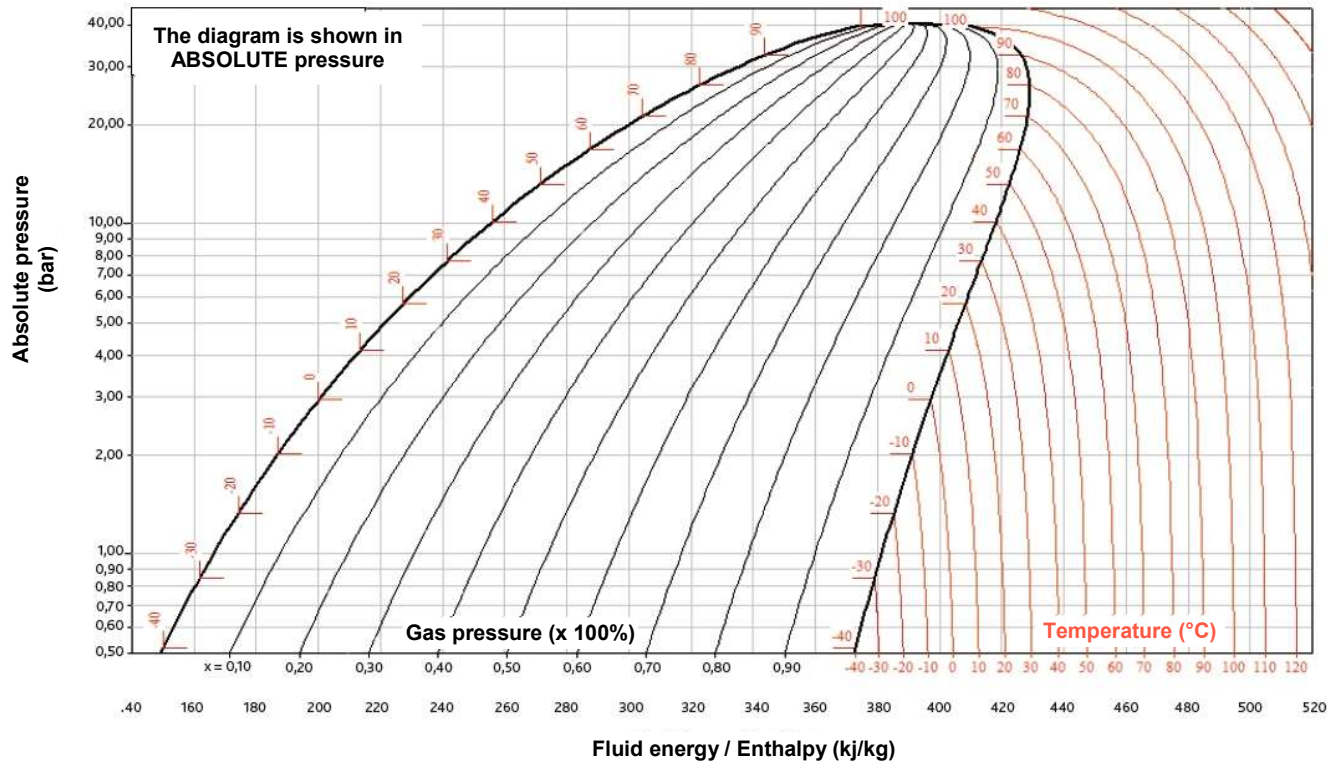
Complete the following boxes:



Log sheet:
Proposed test conditions:
Air conditioning system operating for 5 mins
Air blower operating
Fan unit in OFF position

Readings:

External temperature		
Cold air temperature		
High Pressure		
Condenser inlet temperature		
Condenser outlet temperature		
Low Pressure		
Evaporator inlet temperature		
Evaporator outlet temperature		
Superheating		Normal value between 3 and 10 °C
Desuperheating		
Undercooling		Normal value between 5 and 15°C



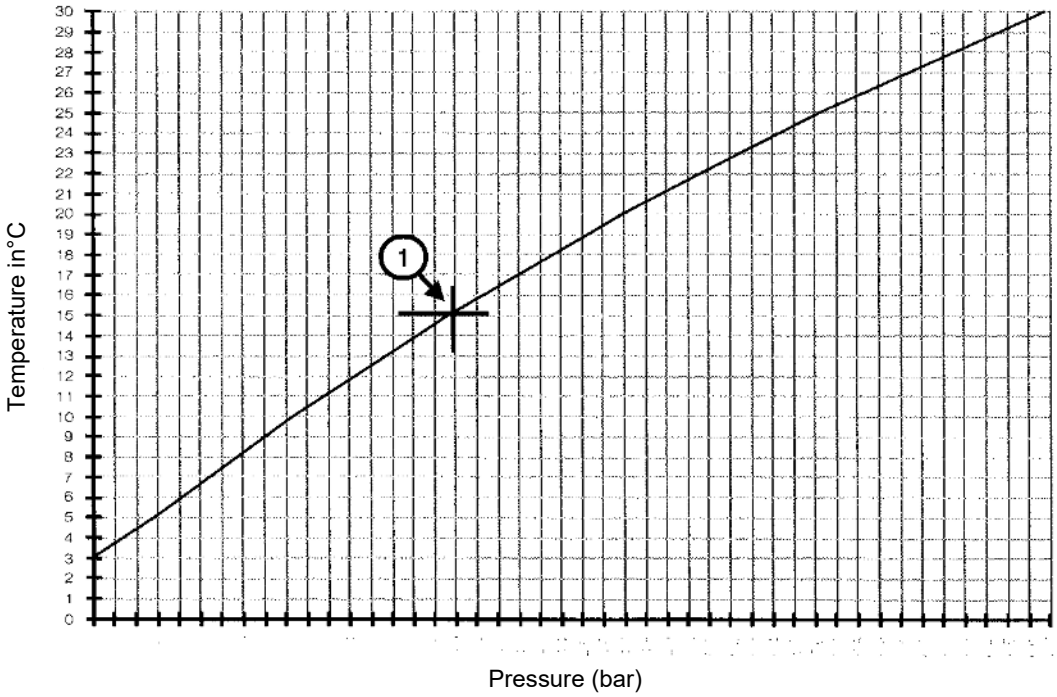
Redo these tests:

- With the Fan unit ON
- With the blower ON and the Fan unit ON
- With the blower ON and the Fan unit OFF

4.2. Diagnostic on the air conditioning system

Fluid load test

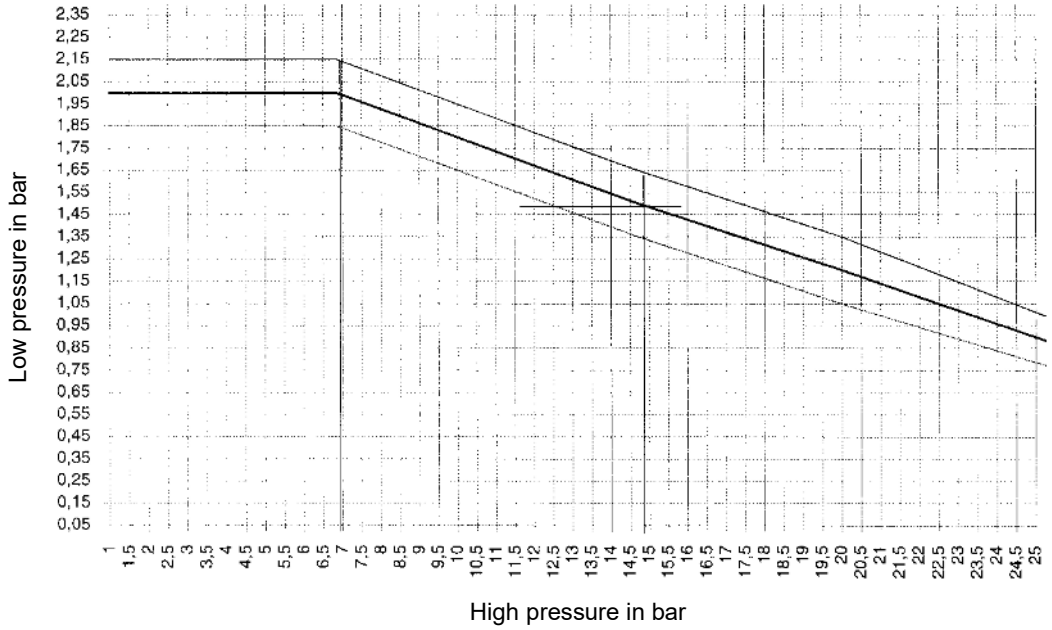
The load curve must be as close as possible to the fluid saturation curve (the operating load) was calculated according to this saturation curve). This information is therefore important in measuring pressure at rest, as the pressure measurement on its own has no relevance.



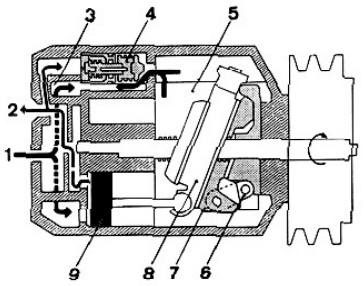
R134a fluid(saturation curve)
Relationship between pressure / temperature

Example: Vehicle parked, engine stopped, ambient temperature 15 °C (in this case the fluid has the same temperature): the pressure on the circuit for a correct load must be 3.9 bar (item 1 on curve above).

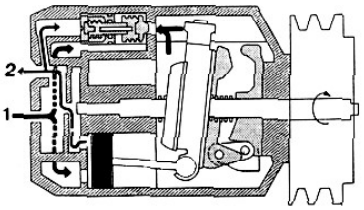
Variable-capacity compressor



The simultaneous measurement of Low and High pressure serves to compute the correct operation of the variable-capacity compressor. The principle of this type of compressor is the automatic adjustment of capacity. This variation in capacity is achieved by altering the length of the piston stroke.



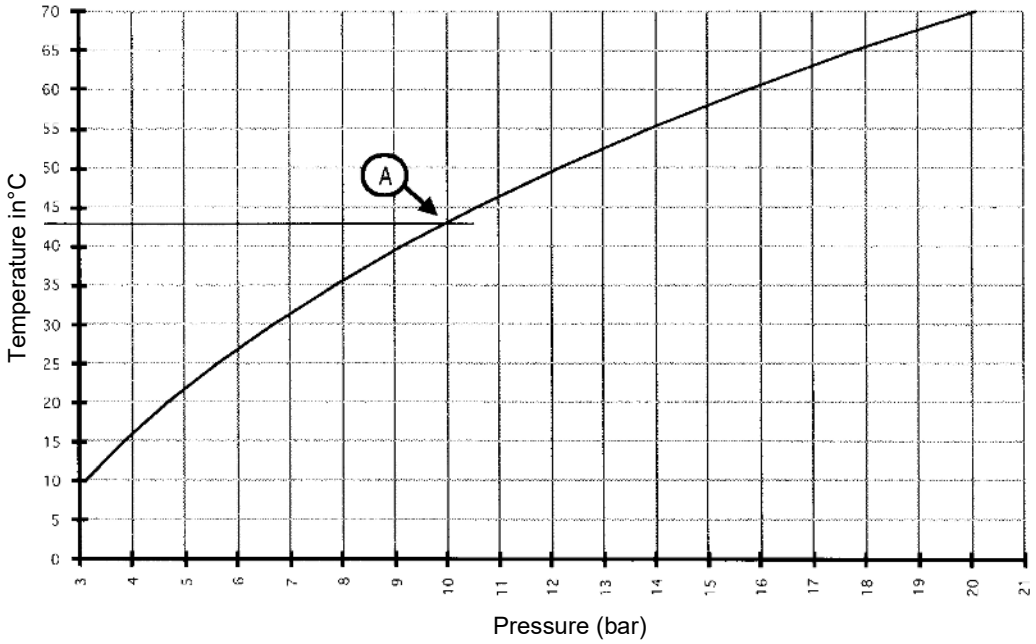
The stroke (C) varies according to the angle of a rotating cam which controls an oscillating plate to which the pistons are fixed.
This change in angle is achieved through permanent control of the pressure differential between the aspiration pressure and the pressure in the compressor body. Regulation of this pressure differential is ensured by a valve with a tare of 2 bar. This valve maintains the evaporator at the limit of freezing point.



To respond to high refrigeration demand, the aspiration pressure exceeds 2 bar, the valve opens. The gaseous fluid enters the aspiration chamber, there is no differential pressure, the piston stroke (C1) is at maximum.
The capacity is maximum, approx. 160 cm^3 (depending on the model).

For a low refrigeration demand, the pressure drops below 2 bar, the valve closes. Pressure rises in the compressor body. The angle of the oscillating plate decreases and the stroke (C2) of the pistons shortens.
The capacity is minimum, approx. 10 cm^3 (depending on the model).

LP aspiration
HP discharge
Aspiration chamber
Regulation valve
Compressor body
Cam pivot
Cam
Oscillating plate
Piston



High Pressure Test (motor operating, compressor engaged)

High pressure circuit test

By measuring the pressure, we can deduce the temperature of the high pressure circuit:
If you read a pressure of 10 bar (item A, curve above), you can deduce that the temperature of the fluid in the high pressure circuit is around 43 °C.

What value should we obtain?

The value varies slightly from one maker to another (depending on the type of control, the ventilation trigger threshold, the condenser used, etc.).

The value of high pressure is not static, it can vary from 8 to 16 bar on a normally-functioning system in good condition. Variations will depend on:

- use of air conditioning
- interior temperature setting
- condenser cooling management
- vehicle speed
- outdoor temperature
- outdoor humidity level

Condenser: important element on the high pressure circuit

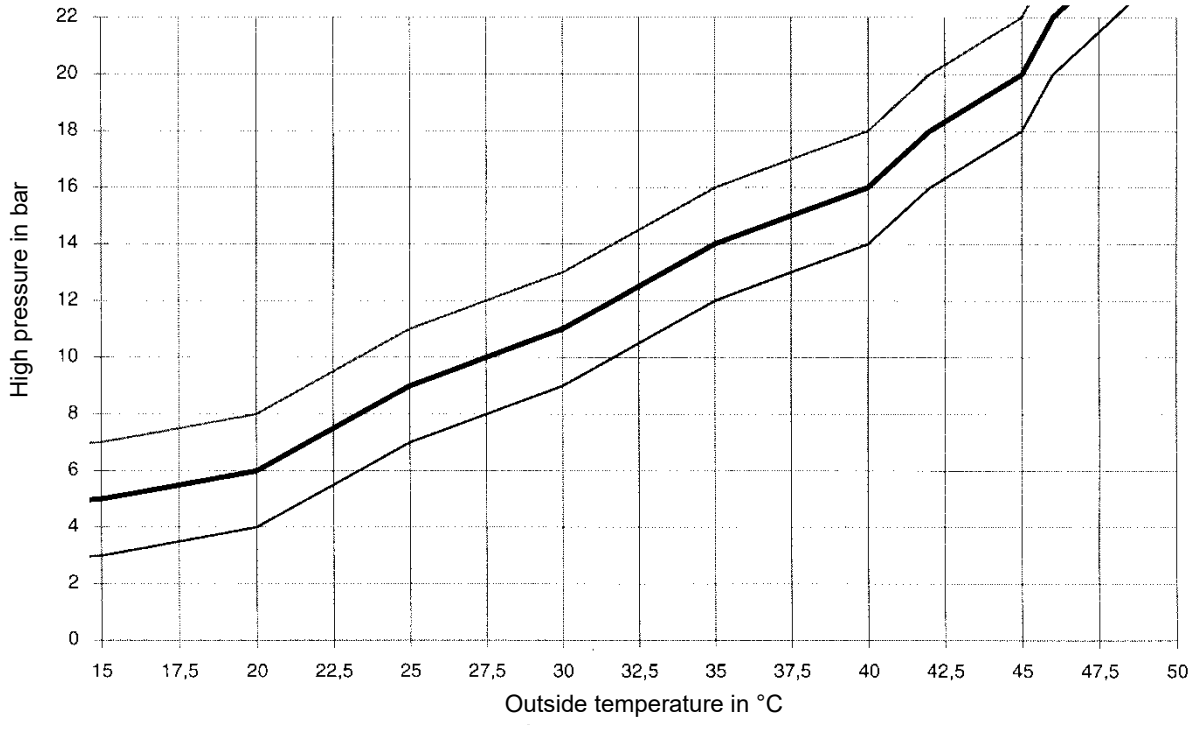
The function of this heat exchanger is to:

- make the fluid which is at 'high temperature' high pressure change from gaseous phase to the liquid phase and bring it to a pressure enabling optimum expansion in the evaporator
- evacuate the calories absorbed during evaporation and compression

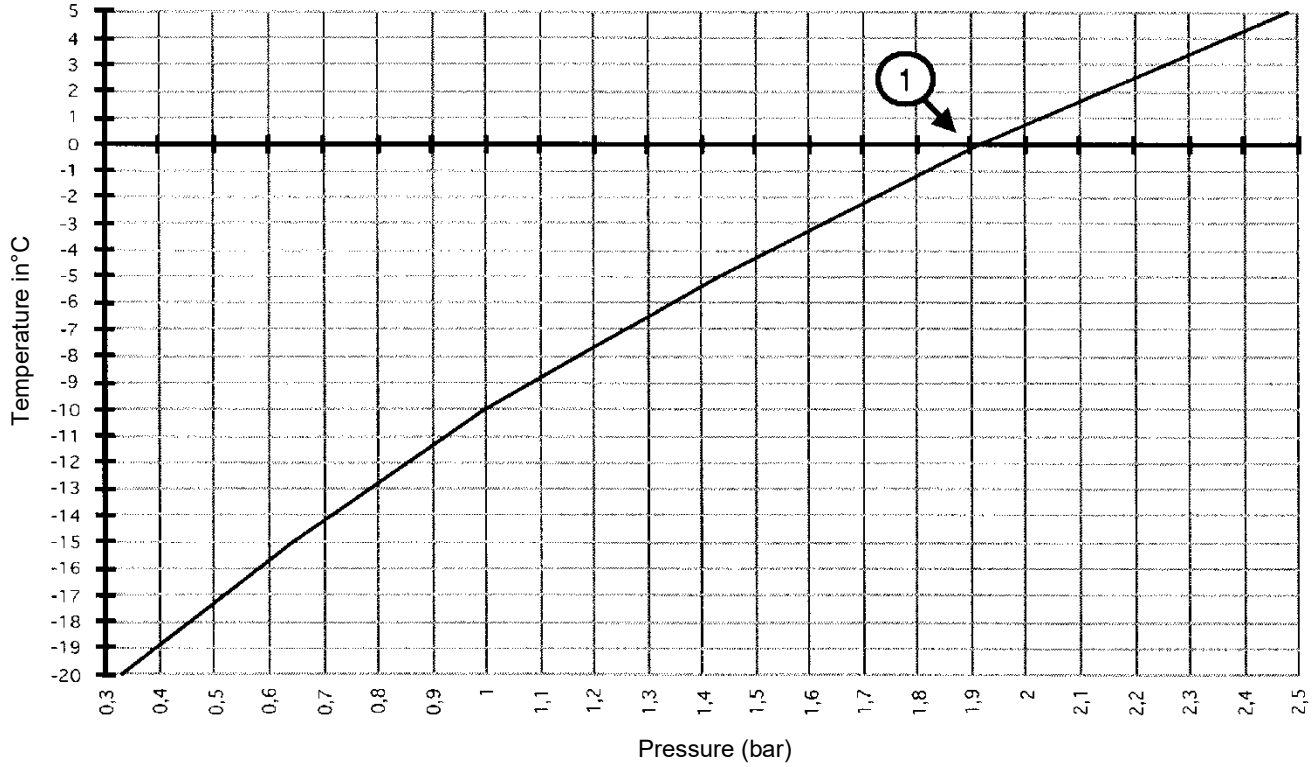
Various fan unit control modes exist to regulate this heat exchange. Two methods used are:

Fast rise to 16 bar on the high pressure circuit. The fan units are activated at half-speed for 10 seconds, then switched to high speed. The pressure drops and at around 10.5 bar, the pressure switch cuts the fan units (Fiat, Lancia, Alfa, etc.).

As soon as the compressor is activated, the fans are restarted at half-speed (slower rise than on HP circuit). The fans go into high speed mode at between 17 and 19 bar. The pressure drops to around 11 bar, the pressure switch cuts high speed mode (Peugeot, Citroën, etc.).



Low pressure circuit test



By measuring the pressure, we can deduce the temperature of the low pressure circuit:
If you read a pressure of 1.9 bar (item 1, curve above), you can deduce that the temperature of the fluid in the low pressure circuit is around 0 °C.

What value should we obtain?

The value varies slightly from one maker to another (depending on the type of control, the ventilation trigger threshold, the condenser used, etc.).

The value of low pressure is not static, it can vary from 1.3 to 2.1 bar on a normally-functioning system in good condition. Variations will depend on:

- use of air conditioning
- interior temperature setting
- condenser cooling management
- air speed (pulser) through the evaporator
- vehicle speed
- outdoor temperature
- outdoor humidity level

Output test

"Refrigerate, ok, but how?" When you leave the sea to lie down on a hot sandy beach, for a few minutes you feel cold as the evaporation of water on our body that removes the calories. The same principle applies to air conditioning.
Evaporator: important element on the low pressure circuit.
This is a heat exchanger whose function is to ensure the full evaporation of the fluid exiting the expansion valve, causing it to change state from liquid phase to gaseous phase.

During evaporation, the fluid is loaded with energy (calories) from the blown air passing through the evaporator (the temperature of the gas aspirated by the compressor increases). The temperature of the blown air in the cab drops: the transfer of heat calories occurs.

But during this event, another important phenomenon occurs on the outside of the evaporator bundle: condensation. In effect the humidity in the 'hot' outdoor air cools rapidly. Cooling causes condensation, therefore extraction of water (which runs off under the vehicle).

The blown air is therefore cold and dried.

Measurements to take to ensure high efficiency of the air conditioning system (the methods are similar for each manufacturer):

Compressor: engaged
Engine speed: stable at around 2000 rpm
Blower speed: maximum
Temperature setting: maximum cold
Air inlet flap: recycle
Distribution flaps: central manifold
Engine hood: closed
Doors: closed

Outdoor temperature	Outdoor humidity %	Temperature of blown air	Note
15/20°C	10	<7°C	This measurement can be taken with the TH600 probe (item A) in the EXXOCLIM measurement kit. The probe should be attached to the outlet of the central manifold.
20/25°C	10/20	<7°C	
25/30°C	20/30	7/8°C	
30/35°C	30/40	9°C	
35/40°C	40/50	9°C	
40/45°C	50/60	10°C	

Values read after 10 min of operation (system stabilised) with a low pressure between 1.4 and 2.1 bar (R134a fluid).

5. USE OF THE EXXOCLIM 3 UNIT

The EXXOCLIM 3 is part of the EXXOTEST range used to perform diagnostics and efficiency tests on air conditioning systems.

Equipment required:

- the EXXOCLIM 3 unit
- The MT-C7000 mock-up or a unit form a vehicle equipped with an air conditioning system using R134a (test performed with a Peugeot 306).

Initial test: vehicle parked for approximately 4 hours, engine stopped, in shade to prevent overheating due to sunshine.

Complete the following table:

Parameters read	Example of data on test vehicle
Outdoor temperature (with TH500 probe)	22°C
Outdoor humidity (with TH500 probe)	65%
Pressure P1 (with CLIM500 sensor)	4.8 bar
Pressure P2 (with CLIM500 sensor)	4.8 bar
Temperature of High Pressure hose (with TH thermocouple)	≈22°C

Second test: vehicle running, engine speed 2000 rpm, windows, doors and hood closed, air conditioning system at maximum cooling setting, flap in recycle position and distribution via central manifolds, compressor engaged, blower speed at maximum setting.

After 10 minutes of operation, complete the following table:

Parameters read	Example of data on test vehicle
Outdoor temperature (with TH500 probe)	22°C
Interior temperature (on output from manifold)	11°C
Outdoor humidity (with TH500 probe)	65%
Interior humidity (with TH500 probe)	48%
Pressure P1 (with CLIM500 sensor)	2 bar
Pressure P2 (with CLIM500 sensor)	9 bar
Temperature of High Pressure hose	
(with TH thermocouple)	37°C

Observations:

With the air conditioning system activated, the cab temperature is pleasant, the humidity level is reduced. The hoses and condenser are hot. Water runs off under the vehicle.

The pressure/temperature relationships between the high pressure and low pressure circuits can be tested against the curves in the CL500 user manual.

Table of relationships between low and high pressures:

	HP too low	HP normal	HP too high
LP too low	Insufficient refrigerant load Choking in High Pressure circuit Presence of humidity in circuit Evaporator clogged	Evaporator blocked or covered with ice. Check the evaporator probe. Clean the evaporator. Expansion valve blocked from opening: replace	Expansion valve blocked from closing: replace Blockage in circuit: check all circuit
LP normal	Internal leak on compressor: replace	Air conditioning circuit ok	Condenser clogged (if load correct) Fan units not activated: check the circuit
LP too high	Expansion valve stuck open Check the evaporator, condenser, fan unit. Internal leak on compressor	Expansion valve blocked open. Check operation of probes	Excessive load Condenser bundle clogged Check the Fan units

Table of observed faults, causes and remedies:

FAULT	CAUSE	REMEDY
Lack of cooling	Evaporator frozen Clutch inoperative Belt slips Parasite air leak Dehydrator tank clogged Expansion valve inoperative High Pressure too high Low Pressure too high Compensator stopped	Check clutch control Apply tension to belt Seal air circuit Change the tank Change the expansion valve See: (cause of high HP) See: (cause of high LP) Clean the circuit and refill
Evaporator frozen	Probe inoperative Evaporator clogged	Change the probe Clean the evaporator bundle
High HP	Condenser clogged Incondensable in the air circuit Aspiration valve blocked Excessive load Insufficient refrigeration	Clean the condenser Redo the load Change the aspiration valve Redo the load Revise the fans
High LP	Expansion valve bulb clogged Excessive load Aspiration valve open	Change the expansion valve Redo the load Change the aspiration valve
Low HP	Refrigerant leak Aspiration valve open Lack of refrigerant Dehydrator tank clogged Expansion valve inoperative Leak on compressor entry Evaporator clogged	Repair Change the aspiration valve Redo the load Change the tank Change the expansion valve Revise the compressor Clean the evaporator bundle

FAULT	CAUSE	REMEDY
Low BP	Incorrect load Compressor pistons worn Compressor leak Defective expansion valve Evaporator clogged	Redo the load Change the compressor Revise the compressor Change the expansion valve Clean the evaporator bundle
Compressor inoperative	Belt broken Clutch broken Defective electrical power supply Piston or rod broken	Change the belt Change or repair the clutch Verify the electrical circuit Change the compressor
Engine overheats	Belt slips Engine out of synch Radiator cap broken Water level too low Condenser clogged Fan operation ineffective Low oil pressure Oil pump broken	Apply tension to belt Revise engine settings Change radiator cap Drain air circuit Clean the condenser bundle Check the fan Fill oil to correct level Change oil pump

DECLARATION OF CONFORMITY

Manufacturer Name: **ANNECY ELECTRONIQUE SAS**

Address 1: **1, rue Callisto - Parc Altaïs**

Address 2: **74650 CHAVANOD**

Address 3: **FRANCE**

represented by the signatory below, declares that the following product

Commercial reference	Description	Brand
MT-C7000	TRAINING MOCK-UP: automatically-controlled vehicle air conditioning	EXXOTEST

is compliant with the requirements of the European Directives relating to EEE design and WEEE management for the EU :

- Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE);
- Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS);
- Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on electromagnetic compatibility.

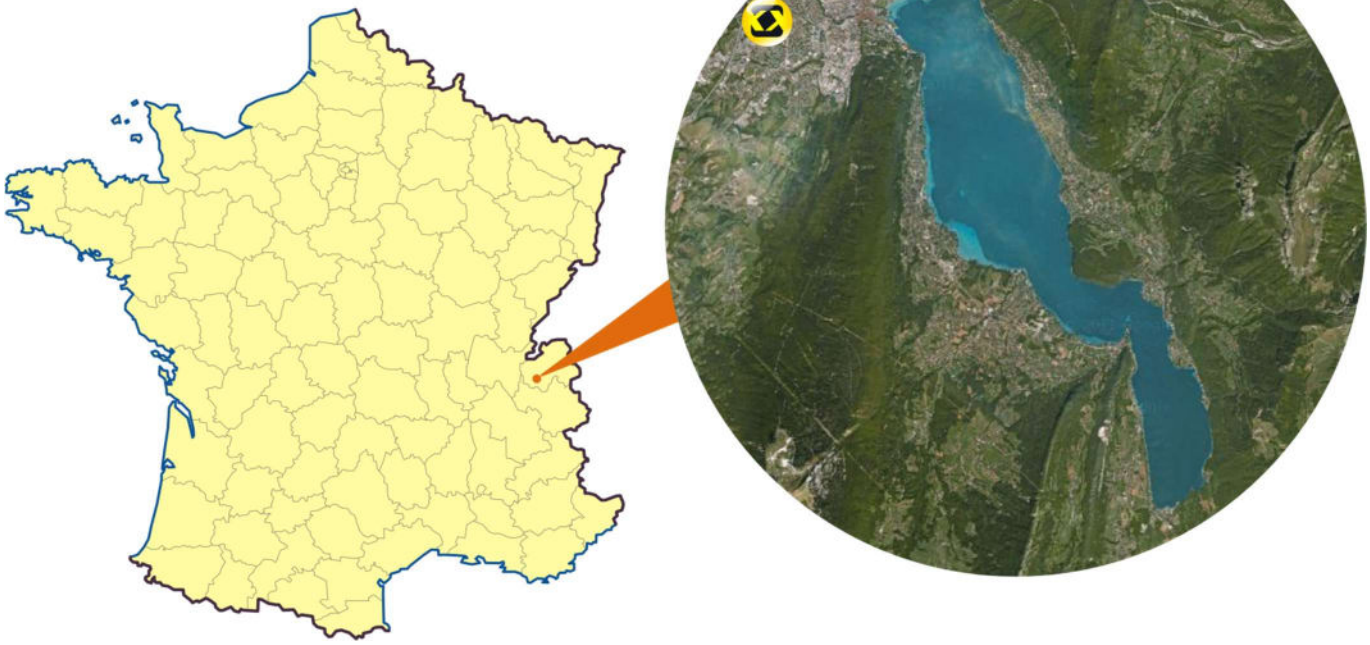
The product has been manufactured in accordance with the requirements of:

- Directive 2006/95/EU of the European Parliament and of the Council of 12 December 2006 on Low Voltage Equipment;
- Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery.

Drawn up in Chavanod on 22/12/2014,

CEO Stéphane SORLIN

Latitude: 45° 53’ 49’’ / Longitude: 6° 4’ 57’’



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