

# ET 450

## Vehicle air conditioning



### Learning objectives/experiments

- principle of operation, design and handling of a vehicle air conditioning system
- detection of typical faults and repair of a faulty air conditioning system
  - ▶ simulation of 8 system faults
- typical components of a refrigeration system
- refrigeration circuit as thermodynamic cycle
  - ▶ log p-h diagram
  - ▶ determine the coefficient of performance of the system
  - ▶ determine the compressor pressure ratio

### Description

- **typical vehicle air conditioning system for cooling the vehicle interior**
- **use of components from automotive technology**
- **simulation of eight system faults**

Vehicle air conditioning systems are used to cool down the vehicle interior. They usually work on the basis of the recirculating air principle and aspirate the air to be cooled from the interior. The cold air generated in the air conditioning system is transported by a fan into the vehicle interior.

The refrigeration circuit to generate the cold air in the trainer ET 450 includes a compressor, a condenser with fan and an evaporator as air cooler with three-stage fan and expansion valve.

All system components are typical elements used in vehicle technology. The air cooler with three-stage fan is e.g. equipped with typical air vents for the vehicle interior. This achieves a close proximity to practice.

The trainer operates with the 12VDC supply common in vehicles. Even the ignition lock function has been implemented to switch on the system. An electric motor drives the compressor via a V-belt and a magnetic coupling. The speed of the motor and thus the compressor is variably adjustable by a frequency converter to simulate the drive via the vehicle engine. A swash plate in the compressor controls the displacement as the speed increases.

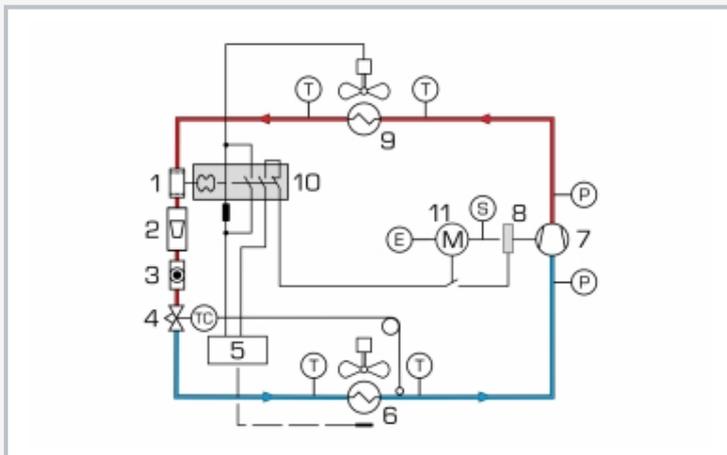
Important characteristic variables, such as pressure, temperature, flow rate and the power consumption of the compressor are displayed. As a particularity eight connectable faults have been installed. The system is particularly suited for the training of motor mechanics.

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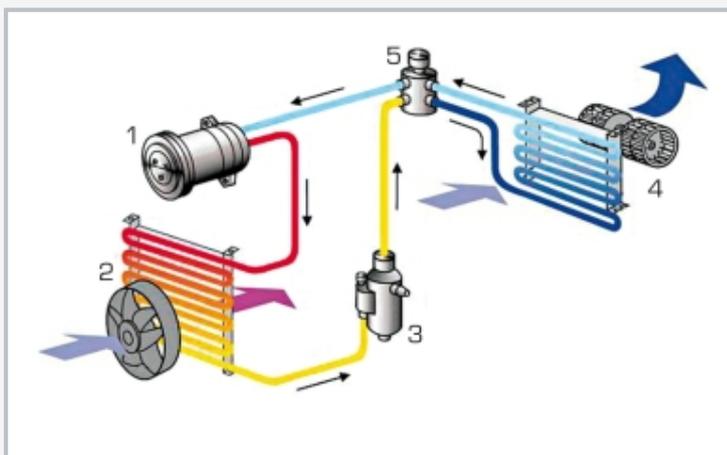
## Vehicle air conditioning



1 box with fault buttons, 2 ignition key, 3 air cooler with three-stage fan, 4 switch cabinet, 5 flow meter, 6 compressor, 7 condenser with fan, 8 electric motor



1 filter/ drier, 2 flow meter, 3 sight glass, 4 expansion valve, 5 switch cabinet, 6 evaporator, 7 compressor, 8 magnetic coupling, 9 condenser, 10 combined pressure switch, 11 motor; red: high pressure, blue: low pressure



Exemplary refrigeration circuit: 1 compressor, 2 condenser with fan, 3 filter/ drier, 4 air cooler with three-stage fan, 5 expansion valve; red: high pressure gaseous, yellow: high pressure liquid; blue: low pressure liquid, light blue: low pressure gaseous

### Specification

- [1] investigation of a typical vehicle air conditioning system for cooling the vehicle interior
- [2] compression refrigeration system with compressor, condenser, filter/ drier, expansion valve and evaporator
- [3] electric motor with variable speed as compressor drive
- [4] condenser with fan
- [5] evaporator as air cooler with three-stage fan
- [6] compressor drive via V-belt and magnetic coupling
- [7] simulation of 8 faults via buttons in the connectable box
- [8] system is switched on via ignition lock
- [9] display of temperatures, pressures (refrigerant), flow rate (refrigerant), pick-up current, speed
- [10] refrigerant R513A, GWP: 631
- [11] air conditioning system voltage supply: 12VDC

### Technical data

#### Electric motor

- rotary current motor
- variable speed via frequency converter: 500...3000min<sup>-1</sup>
- power: 4kW at 3000min<sup>-1</sup>

#### Axial piston compressor

- refrigeration capacity: approx. 3kW at 3000min<sup>-1</sup>

Condenser: capacity: 6,6kW

Evaporator: capacity: 5,3kW

#### Refrigerant

- R513A
- GWP: 631
- filling volume: 800g
- CO<sub>2</sub>-equivalent: 0,5t

#### Measuring ranges

- temperature: 4x -100...100°C
- flow rate: (R513A): 10...95L/h
- pressure: -1...9bar / -1...24bar
- speed: 0...3000min<sup>-1</sup>
- current: 0...10A

400V, 50Hz, 3 phases

400V, 60Hz, 3 phases; 230V, 60Hz, 3 phases

UL/ CSA optional

LxWxH: 1210x800x1520mm

Weight: approx. 185kg

### Scope of delivery

- 1 trainer filled with refrigerant
- 1 set of instructional material