AIR CONDITIONING

CITYSPHERE S

Operating and service instructions

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SPHEROS

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1 INTRODUCTION

This operation and service instructions contains important information to assist trained personnel in the operation and maintenance of the rooftop air-conditioning system.

1.1. Meaning of emphases

WARNINGS, **CAUTIONS** and **NOTES** in this manual have the following meaning:

WARNING

This heading is used to highlight that improper compliance or non-compliance with instructions or procedures may cause injuries or fatal accidents.

IMPORTANT

This heading is used to highlight that improper compliance or non-compliance with instructions or procedures may cause damage to components.

NOTE

This heading is used to draw specific attention to information.

1.2. Additional applicable documentation

Installation instructions for the rooftop air-conditioning system Citysphere S

1.3. General safety regulations

Non-compliance with the installation manual and its included notes will lead to liability exclusion by Spheros. The same applies to unskilled repairs or repairs not using original spare parts.
Electrical wiring and operating elements of the air conditioning system must be arranged in the vehicle in such a way that their correct functioning cannot be impaired under normal operating conditions.

Safety instructions for maintenance

If faults develop in the refrigerant circuit, the system must be tested and repaired by an authorized specialist repair shop according to the rules. Under no circumstances may refrigerant be discharged into the atmosphere.
Never heat refrigerant cylinders with a naked flame. Liquid refrigerant must never be allowed to come into contact with body parts. The safety data sheet must be observed.Always wear protective clothing and goggles when handling refrigerant.

WARNING

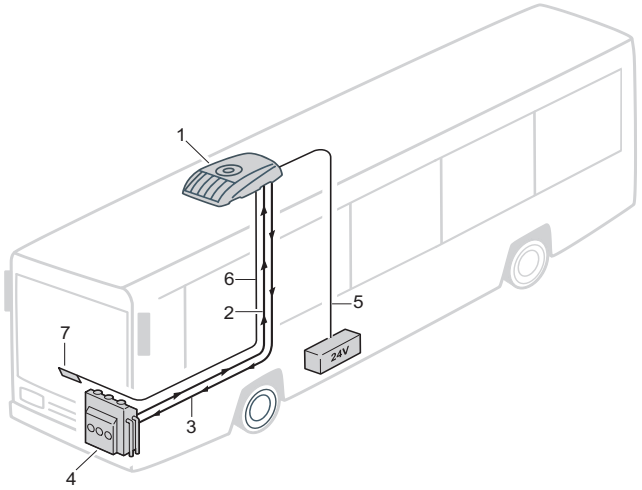
Do not perform soldering or welding directly on components of the closed refrigerant circuit or in its vicinity. The heating will cause a rise in the circuit pressure. There is a danger of explosion.
Before performing any work allow the system to cool down completely. Risk of injury due to burns on the condenser, compressor and refrigerant hoses.
Installation, maintenance and repair work must be carried out by duly qualified personnel. Such work may only be undertaken with the engine off and the power supply switched off.
The battery must be disconnected before starting the work.
Do not wear metal jewellery (bracelets, watches, necklaces, rings) when working on the air conditioning system.

1.4. Certification

The electro-magnetic compatibility (EMC) has been checked.
The standards of the ECE Regulation R10 Rev. 05 are complied.

2 GENERAL DESCRIPTION

The rooftop air-conditioning system is designed for the cooling / air conditioning of the driver seat in city buses. For that the evapurator in the frontbox is used.



1 Citysphere S
2 Line evaporator (frontbox) - compressor
3 Line drier - evaporator (frontbox)
4 Frontbox
5 Power supply cable
6 Cable control panel - rooftop unit
7 Control panel

Fig. 2.1

2.1. Components

The rooftop air-conditioning unit is shown in Fig. 2.2.

1 - Hood (external contour element)
2 - Baseplate as the load-bearing structural element
3 - Condenser
4 - Compressor
5 - Condenser fan
6 - Pressure switch
7 - Collector/Drier/Filter for refrigerant
8 - Filling port HP
9 - Filling port LP
10 - Drain holes
11 - Recessed grips and surfaces for lifting appliances, respectively.

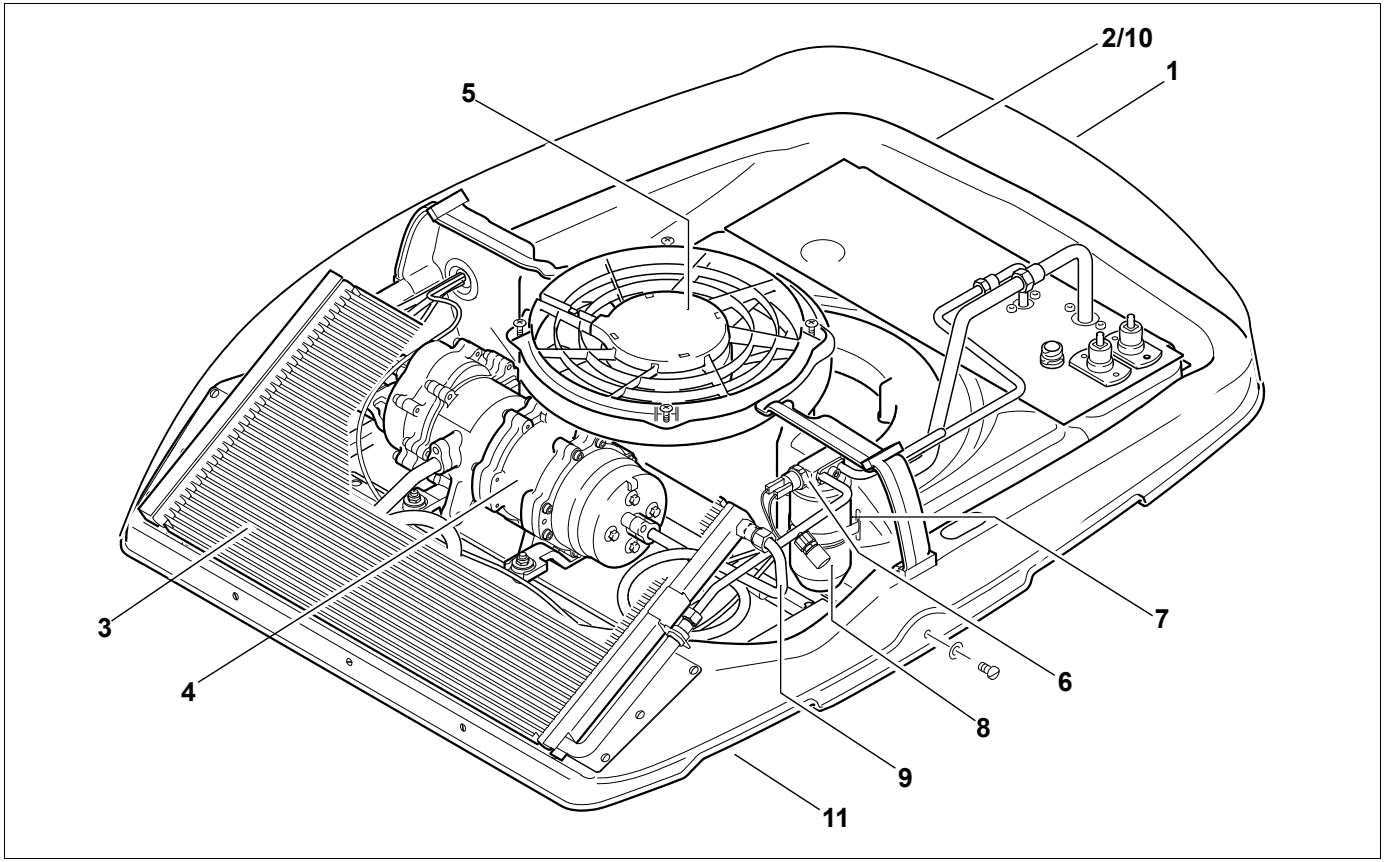


Fig. 2.2 Citysphere S

2.2. Electrical system

The hook-up of the unit shall be accomplished according to the circuit diagram (see Installation Instruction). The electronic system of the compressor motor includes a soft-start function to prevent current peaks in the vehicle electrical system. In addition, the electric motor is switched off automatically in the event of overloads (due to possible system damages). Restarting is effected by repeatedly switching on the system.

2.3. Principle of operation of the air conditioning system

Once air conditioning mode is selected on the control panel, the unit starts operation. The compressor with integrated electric motor runs up. It compresses the refrigerant gas and delivers it to the condenser where

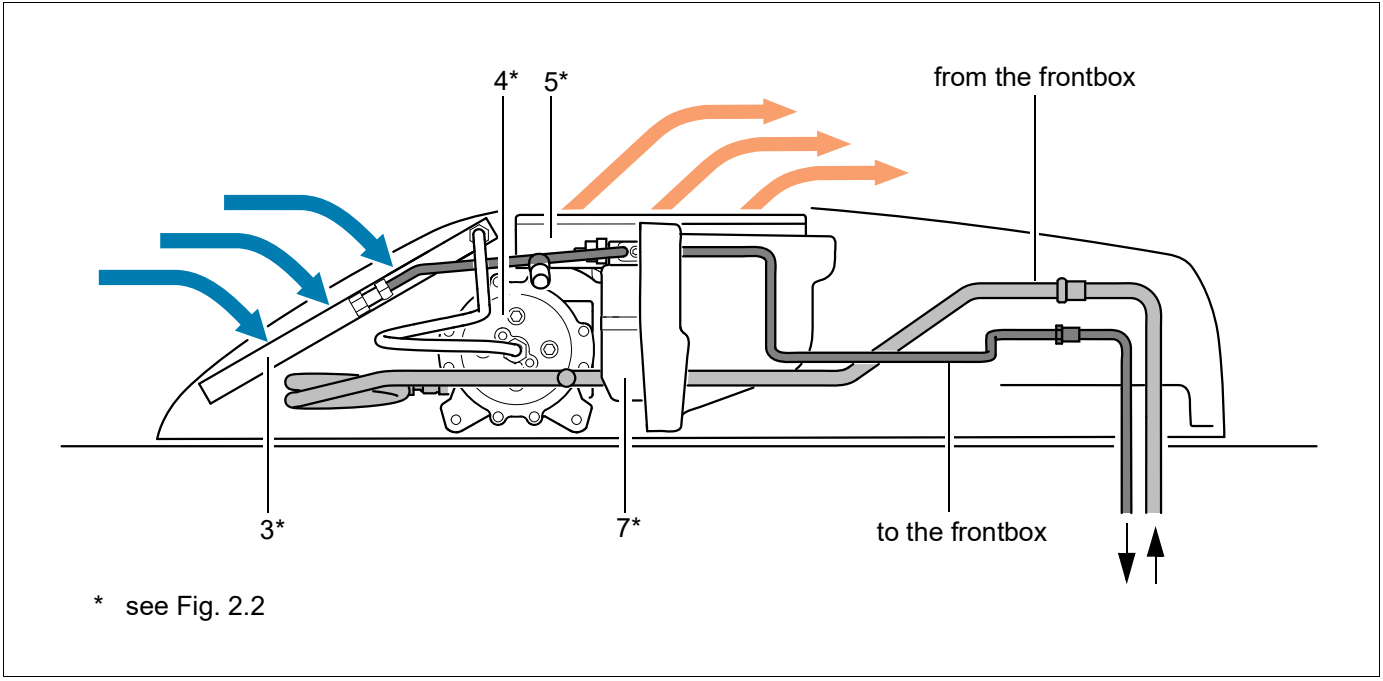


Fig. 2.3 Air conditioning mode of the unit

it condenses and gives off heat.
The resultant condensation heat is transferred to the outside air flowing through the condenser. In this process the axial fan maintains a sufficient ventilation even when the vehicle is stationary. The liquid refrigerant flows through the receiver-drier to the expansion valve at the frontbox of the vehicle, where it expands as a result of the controlled pressure drop and then reverts to the gaseous state in the evaporator. Warm air is drawn in by the evaporator fan, cooled in the evaporator, dried and then fed through air outlets in the instrument panel into the passenger compartment. Resulting condensation water is discharged via drains.
During operation, the refrigerant circuit is monitored by the pressure switch. This switch may switch off the compressor if required.

2.4. Design, purpose and principle of operation of the assemblies

Condenser
The condenser (3, Fig. 2.2) consists of aluminium flat pipes and fins interconnected to form a large heat exchanger surface.
It cools the hot refrigerant gas so that the latter liquefies and undercools. And transfers the condensation heat to the outside air flowing through it via the fins, at the same time.

Receiver-drier
The receiver-drier (7, Fig. 2.2) is an expansion and storage reservoir for refrigerant. Its lower part contains a granulated desiccant, which extracts and chemically binds small amounts of water from the refrigerant. In addition it filters out particles of dirt from the refrigerant circuit which otherwise could lead to faults.

Thermostatic expansion valve (at the frontbox)
The thermostatic expansion valve with outer pressure compensation regulates the flow of refrigerant to the evaporator in accordance with the need for refrigerant resp. the temperature in the evaporator. The thermostatic expansion valve represents the control element between high and low-pressure part of the refrigerant circuit.

Evaporator (in the frontbox)
The evaporator consists of copper pipes and aluminium fins interconnected to form a large heat exchanger surface. The refrigerant flowing through the pipe from the expansion valve changes from the liquid to the gaseous state and superheats. The required evaporation heat is extracted from the cabin air flowing through the fins and is transmitted through the pipe to the refrigerant. The air dries as it cools and condensation water is drained overboard.

Pressure switch
The pressure switch (6, Fig. 2.2) includes a high-pressure and a low-pressure switch. It measures the pressure in the high-pressure part of the refrigerant circuit and switches off both the electric motor and the compressor if the pressure is too low (e.g. due to loss of refrigerant) or too high (e.g. due to overheating in the condenser).

Condenser fan
The axial fan (5, Fig. 2.2) comprises a brushless DC motor, a fan wheel, a housing and a protective grille. Once the air conditioning system is switched on, the fan will be activated by the control system via pin 3 (yellow wire) and will supply the condenser with the required outside air (no speed regulation - On/Off only).

Compressor
The compressor (4, Fig. 2.2) comprises a semi-hermetic housing with integrated scroll compressor, brushless DC motor, and electronics. Once the air conditioning system is switched on, the compressor will be activated via pin 1 of the compressor's cable harness. When in operation, it compresses the refrigerant to the required condensation pressure. The integrated electric motor includes a soft-start function to prevent current peaks being transmitted to the on-board supply, a voltage monitoring (16 V to 32 V), an overload protection, and a temperature monitoring of electronics (to 93°C). If the limits are

exceeded, the compressor is switched off. Restarting is effected by repeatedly switching on the system.

NOTE

The function of the compressor is blocked, if there is no power supply from the on-board power system at pin 3 of the compressor's cable harness (safety chain pressure switch).

3 TECHNICAL DATA

3.1. Air conditioning system

Designation	Citysphere S
Dimensions (rooftop air-conditioning unit)	
Length x width x height	1200 mm x 860 mm x 250 mm
Weight	ca. 37 kg
Operating voltage (acc. to vehicle's electr. system)	24 V DC
Current consumption Total current consumption – Compressor motor – Condenser fan	 65 A (max.) 55 A 10 A
Switching points, low-pressure switch	
– On – Off	2.1 ± 0.3 bar 2.0 ± 0.2 bar
Switching points, high-pressure switch	
– Off – On	26.5 ± 2 bar 20 ± 2 bar
Rated power at temperature inside 25°C and at temperature outside 29°C	 3.8 kW
Refrigerant	R134a, 1100g (already prefilled)

3.2. Electrical fuses

Protected components	Fuse Letter symbol	Fuse ratings
Condenser fan	F1	15A
Compressor	F5	60A

3.3. Compressor Scroll 036cc

Lubricating oil for refrigerating compressors (type / quantity)	POE RL68H / 220 ml
Speed (const. speed via ON-signal)	2800 U/min

NOTE

For wiring diagram, refer to Installation Instructions.

4 STARTUP

4.1. Safety instructions

The safety instructions in chapter 1.3 must be observed.

WARNING

The system may only be started when the hood has been fitted. Risk of injury due to the fan.

4.2. Operator instructions

IMPORTANT

The air conditioning system can only be put into operation with the vehicle engine running.

5 MAINTENANCE

5.1. Safety instructions

The safety instructions and regulations in chapter 1.3 must be observed.

5.2. General

a) All work on the refrigerant circuit may only be carried out by qualified personnel from duly authorized specialist repair shops.
b) For maintenance work on the refrigerant circuit special equipment, tools and accessories are required and must be used.
c) Like all parts of the vehicle, the air conditioning system is subject to constant stresses. The specified maintenance work must be carried out regularly in order to ensure trouble free operation of the system and avoid damage to the components.
d) Proper handling of the system and a complete record of all the required scheduled maintenance are essential for acceptance of possible warranty claims concerning damaged components subject to maintenance.
e) To prevent moving parts in the refrigerant circuit from seizing up due to resinification of the oil, the air conditioning system must be switched on for approx. 10 minutes at least once per month when it is not in regular use. Requirement:
(Minimum outside temperature > 12 °C or heated hall)

5.3. Maintenance and service

a) Regardless of the following schedule, all screw connections securing the rooftop air-conditioning system must be checked within four weeks of using the system for the first time in order to ensure that they are secure.
b) Even if the air conditioning system is not operated, individual components are subject to wear due to normal ageing or stress due to vehicle operation. All checks listed in the maintenance and servicing plan must therefore be performed regardless of the system operating hours.
c) Even if hose connections do not leak, refrigerant may be lost regardless of operating hours. However, a leak must be assumed to exist somewhere in the system if relatively large quantities of refrigerant are lost.
d) Slight contamination of evaporator and condenser fins is removed with compressed air applied against normal direction of airflow. Major contamination or greasy deposits must first be removed with soapy water or a suitable cleaning solvent (not aggressive for copper or aluminium) before cleaning with compressed air or a water jet.
e) The receiver-drier must be replaced principally whenever work has been performed on the refrigerant circuit.
f) The drain holes for rain water in the baseplate must be unobstructed.

IMPORTANT

Under no circumstances may refrigerant be discharged into the atmosphere.

5.4. Maintenance and service checklist

System component	Maintenance tasks	Frequency		
		m	6m	a
Refrigerant circuit				
– Connections	Test for leaks with leak tester			X
– Condenser	Check condition of fins (must be cleaned if soiled)		X	
– Condensation water drain	Check openings and clean if necessary		X	
– rooftop air-conditioning unit	Check overall condition and secure attachment of connections			X
Compressor				
– Compressor	Check for abnormal noises during operation		X	
– supports	Check condition and function			X
– elec. connections	Check for signs of oxydation			X
Electrical connections				
– Power supply wires	Check for unobjectionable condition		X	
– Connectors	Check for unobjectionable condition and secure attachment		X	

Abbreviations: m – monthly, a – yearly (a – every six months if operated throughout the year)

5.5. Inspections before repair

In order to avoid unnecessary disassembly or duplication of work, the overall condition of the airconditioning system must be checked before starting any repairs.

Visual inspection

a) Outer condition of rooftop air conditioning unit:
- Hood without cracks and no damage to paint finish
- Air inlets and outlets clean and undamaged
- Attachment points secure and without corrosion
- Wiring connections serviceable
- Openings in metal undamaged

b) Condition of compressor
- Hose connections undamaged and secure
- Attachment parts / screws secure
- Electrical connection undamaged

5.6. Troubleshooting

5.6.1. General

a) A systematic approach is advisable for troubleshooting. Appropriate action must be undertaken as described below for faults of a general nature or when normal conditions are not obtained during the pressure test.

b) Certain faults can only be located and remedied by skilled personnel using special tools.

5.6.2. Cause of faults in the electrical system

The individual circuits must be systematically checked with the aid of the circuit diagram (see Installation Instructions) and the fault localized. Above all plug connections, switches, relays, etc., should be checked for continuity.

The following possibilities must always be checked and excluded as a possible cause of the malfunction:

– Defective fuses
– Corrosion of plug contacts
– Loose contact in plug connectors
– Wrong crimping on connector
– Corrosion on wiring and fuses
– Corrosion on battery poles

5.6.3. Cause of faults in the air conditioning system

– defective evaporator or condenser fan
– contaminated or clogged air filter, soiled evaporator or condenser fins
– shortage of refrigerant in the system

If the system is deactivated continuously, we recommend that it be checked by an authorized workshop.

5.6.4. Dealing with problems in the refrigerant circuit

If faults develop in the refrigerant circuit, the system must be tested and repaired by an authorized specialist repair shop according to the rules. Refrigerant must never be discharged into the atmosphere.

5.6.5. Cause of faults making it impossible to reach the required states during pressure tests

Divergences from the required state during pressure tests (chapter 6.8) may be due to the following causes. These causes must be checked, the trouble located and defective components repaired or replaced.

High pressure gauge reading too high

– Condenser air flow restricted
– Too much refrigerant
–

High pressure gauge reading too low

– Not enough refrigerant
– Compressor speed too low
– Compressor defective

Low pressure gauge reading too high

– Expansion valve defective
– Compressor speed too low
– Compressor defective

Low pressure gauge reading too low

– Intake or delivery line restricted, e.g. by kinks
– Expansion valve defective
– Not enough refrigerant
– Evaporator air flow restricted
– Collector/drier clogged

5.7. Repairs

IMPORTANT

Under no circumstances may refrigerant be discharged into the atmosphere.

NOTE

The safety precautions and regulations contained in chapter 1.3 and 6.2 must be observed.

a) Always use genuine spare parts or standard parts for repairs.
b) The system's original condition must always be restored when performing repairs.
c) Before opening / disassembling components in the refrigerant circuit, the refrigerant must be drained into the recycling station provided and disposed of properly or reused.
d) After completing repairs on the refrigerant circuit, the system must be
   – evacuated,
   – filled with refrigerant on the high pressure side (with the system at rest)

5.8. Post-repair procedures and testing

5.8.1. Check refrigerant pressures

General

As a rule, every air conditioning system filled with refrigerant is a pressurized system. The pressure is the same throughout the system circuit and depends on ambient temperature.

During operation of the system, the working pressure on the intake side differs from that on the delivery side of the compressor. The pressures differ and are influenced by the compressor operating speed, the temperature inside the vehicle, the outside air temperature and relative humidity. Abnormal working pressures indicate that there is a fault in the system.

The working pressure should be tested with an on-board power supply of 24-26 V and at air temperatures between 17°C and max. 35°C. The hood must be fitted for the pressure test since the air pressure of the heat exchangers has a decisive influence on whether or not the operating pressure is reached.

The following approx. values must be obtained:

Outside air temperature =Indoor temperature	Low pressure gauge	High pressure gauge
17°C	2.7 ± 0.2 bar	8.4 ± 2 bar
20°C	2.9 ± 0.2 bar	9.0 ± 2 bar
25°C	3.3 ± 0.2 bar	10.3 ± 2 bar
30°C	4.1 ± 0.2 bar	11.4 ± 2 bar
35°C	4.7 ± 0.2 bar	12.8 ± 2 bar

If different pressure values are obtained, an authorized repair shop must be consulted to investigate the reasons.
When the pressure test is complete, disconnect the pressure gauges and refit the sealing caps.

5.8.2. Visual inspection

The system must be inspected visually as described in chapter 6.5 when the repairs are complete.

6 WARRANTY CLAIMS PROCESSING

In the event that a warranty claim arises, contact your local distributor.

1 MAINTENANCE AND SAFETY INFORMATION

1. Installation of the system must be performed according to the installation and service instructions.

2. If the height of the vehicle specified in the vehicle licensing documents is exceeded by the installation of the rooftop air-conditioning system, theinstallation must be legalized by an acceptance inspection according to §19 StVZO (German Road Traffic Licensing Regulations).

3. In case of a refrigerating circuit malfunction the system must be checked by an authorized repair shop and repaired properly. By no means must refrigerant be drained to free atmosphere.

4. Installation, maintenance and repairs as well as any other work on the refrigerating circuit must be performed by skilled personnel and authorized repair shops with the engine off and the electrical power supply switched off. When working on the electrical wiring the battery must be disconnected.

5. When handling refrigerant protective clothing and goggles must be worn.

6. Regardless of the operating hours of the system a loss of refrigerant is possible even with no leaks in the system. Considerable loss of refrigerant in short time intervals are however an indication for a leak in the system.

7. For servicing and repairs of the refrigerating circuit the special operating materials, special tools and accessories detailed in the installation and servicing instructions manual must be used.

8. Like all components of the vehicle also the air-conditioning system is exposed to continuous stress. In order to ensure system serviceability and avoid damage of components, the scheduled maintenance tasks must be carried out.

9. Proper handling of the system and a complete record of the completion of scheduled maintenance is a basic requirement for the acceptance of possible warranty claims on components subject to maintenance.

10. Regardless of the timetable in the installation and service instructions, within 4 weeks of first operation of the rooftop air-conditioning system all attachments and coolant line connections must be checked for security.

11. Even with the air-conditioning system not in use, components may wear due to normal ageing or stress caused by vehicle operation. Therefore all scheduled maintenance and servicing tasks detailed in the installation and service instructions must be performed regardless of the system operating hours.

12. Work on the refrigerating circuit always requires the replacement of the collector/drier.

13. It must always be ensured that the quantity of refrigerating oil in the system is at the level specified in the installation and service instructions.

14. Cleaning of slightly contaminated condenser and evaporator fins is performed with pressurized air blown against the normal direction of air flow. Heavy contamination or greasy film must first be removed with soapy water or a suitable cleaning solvent (non-aggressive for copper or aluminum) and subsequently cleaned with pressurized air or water jet.

IMPORTANT

Excessive water jet or air pressure might cause damage.

15. When exposing the air-conditioning system to direct water jet during vehicle cleaning or when running the vehicle through a car wash, be aware of the overall height of the vehicle including the rooftop air-conditioning system.

16. Non-compliance with the installation and service instructions and the information contained therein will void the Spheros warranty. The same applies to unskilled repairs or repairs not using original spare parts.

2 GENERAL

The driver‘s place electrical air condition system can only be operated when the engine is running.

The air-conditioning system is ready for operation only when filled with the refrigerant and refrigerating oil quantities specified in the installation and servicing instructions manual.

Once the climatization function at the driver's place is turned on, the compressor and the condenser fan will start. The selection of the air outlet temperature and the fan speed level is done on the control panel at the frontbox. It is important to ensure that the fan speed has at least level 2 or 50%.

3 OPERATION

The operation is done via the control panel of the frontbox for the driver place depending on vehicle.

4 TROUBLESHOOTING

In case of a malfunction check the fuses and the electrical connections for proper condition and security.

4.1. Air-conditioning system malfunction

Possible causes:

- defective evaporator or condenser fan
- contaminated or clogged air filter, condenser or evaporator fins
- loss of refrigerant, system level too low

In case of a continuous deactivation, the system must be check by an authorized repair shop.

4.2. Refrigerating circuit malfunction

In case of refrigerating circuit malfunction the system must be checked by an authorized repair shop and repaired properly. By no means must refrigerant be drained to free atmosphere.

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