EN

AIRTRONIC / AIRTRONIC M

Technical description, installation, operation and maintenance instructions.

AIRTRONIC	Order no.
AIRTRONIC D2, 12 V	25 2069 05
AIRTRONIC D2, 24 V	25 2070 05

AIRTRONIC M	Order no.
AIRTRONIC D4, 12 V	25 2113 05
AIRTRONIC D4, 24 V	25 2114 05
AIRTRONIC B4, 12 V	20 1812 05

Air heater for diesel and petrol operating independently of the engine.

Eberspächer
A world of comfort

20 2900 81 01 03 0I
08.2016

1 Introduction

Chapter	Title	Contents	Page
1	Introduction	• Pictures Symbols and Text Structures	3
		• Concept of this Manual	3
		• Heater Warnings	4
		• General Safety Instructions	5
2	Product Information	• Airtronic 2 / 4 Introduction	6
		• Technical Data	7
		• Dimensions	11
3	Heater Selection & System Design	• Heater Selection Factors	13
		• Heat Loss Factors	14
		• Heat Calculation with examples (simple and exact)	16
		• Heater and Component Rating Guide	37
		• Duct / Component Rating Calculation	40
4	Installation Procedures	• Heater Installation Factors and Procedure	48
		• Heater Location and Mounting	48
		• Ducting System Installation and Layout examples	51
		• Fuel System Installation	55
		• Fuel Supply	58
		• Exhaust/Intake Connections	59
		• Electrical Connections.	60
		• Control Options	61
5	Operation & functions	• Heater Operation	65
		• Heater Regulation, Functional and Operational Chart	66
		• Safety Feature	68
6	Circuit Diagrams	• Schematic *AIRTRONIC* 2/4	69
		• Schematic Control Options	70
7	Maintenance, Troubleshooting & Repairs	• Periodic Maintenance	72
		• Basic Troubleshooting	72
		• Self Diagnostic Tools	72
		• Fault Codes and Repair Methods	79
		• Reasons for Carboning	87
		• Fuel Quantity Test	88
		• Sensor and Control Values	89
		• Assambly / Disassambly Procedure	91
8	Parts List	• *AIRTRONIC* D2/D4	
		- Heater Parts Diagram	94
		- Heater Parts List	95
		- Accessory Parts Diagram	96
		- Accessory Parts List	97
		- Ducting / Components Diagram	99
		- Ducting / Components Parts List	100
9	Service	• Warranty, Certification and Disposal	103
		• Contact us	103

1 Introduction

CONCEPT OF THIS MANUAL

PICTURE SYMBOLS AND TEXT STRUCTURES

DANGER: Indicates that serious injury or death may result if specific guidelines are not followed.

CAUTION: Indicates that personal injury or damage to equipment may be possible if particular guidelines are not followed.

WARNING: Indicates an important heater related information that may cause personal injury, heater failures and maintenance costs.

PLEASE NOTE! Indicates general heater related notes, clarifications and precautions, which can be very useful for technician, installer, or owner.

A term like " it is recommended" or similar indicates a preferred or suggested information on specific topic that can be beneficial for installation, operation and repair of heating systems in in standard application only.
Such recommendations may or may not be applicable to any non standard applications like specialty or dangerous goods.

(•) A dot indicates a list, which is started with heading; (-) If indented dash follows a "dot", this list is a sub section of the black dot; (*) An asterisk symbol describes a further note on its associated title, statement or data.

FOREWORD

- This document is applicable to heaters listed on the title page, to the exclusion of all liability claims, and aims to support registered dealers, service technicians and end users in North America. This does not replace documentation produced by J. Eberspächer.
- Eberspaecher North America takes regular steps to ensure that any content, illustrations and technical data in its manuals are correct; however, errors do occur, and Eberspaecher North America reserves right to correct any such errors, and disclaims any direct or indirect liability resulting therefrom.
- Eberspaecher North America is not liable for any negligence and incompetence from dealers, installers and owners thereby causing heater or any related system failures and do reserves rights to nullify the warranty under such conditions.
- Any parametric information related to the heating system (like technical data, illustration, table, calculation and graph) in this manual is available to provide a supplementary technical guidance for installers and dealers.
  It does not, however, replace or supersedes any application specific local rules and regulations for heating and ventilation system in automobiles.
- For the sample heat calculation purpose, some values (like dimensions, ACH, R, k etc. values) are provided in the manual as a supplementary reference material only. It is, however, necessary to acquire all required data (dimensions, ACH, R, k etc.) specific to your vehicle type and application to ascertain exact heater size. Contact nearby automotive specialist or Eberspaecher dealer.
- The installation instructions and standards described in this document are NOT APPLICABLE TO MARINE INSTALLATIONS. Please consult a certified Eberspaecher North Ameria Marine dealer for marine installation.
- There may be some design changes in any OEM installed Eberspaecher heater; therefore it is recommended to service the heater only at OEM approved dealer.
- This documentation must be considered merely as a supplementary guideline for warranty or related matters; In such cases, a user or dealer must read an official warranty documentation for further information related to the recognized heater troubleshooting steps and claim procedure.

For further information, please visit:
http://www.eberspaecher-na.com/warranty/warranty.html

CONCEPT OF THIS MANUAL

This manual aims to support the dealer/user during the installation, operation and repair of Airtronic 2/4 heaters as well as to provide the part list of the heater and accessories.
For quick and easy access, the Airtronic 2/4 manual is divided in to 9 chapters wherein each chapter provides information on specific topic as listed below:

1 INTRODUCTION
Here you will find important information related to concept and structure of the manual as well as safety instructions.

2 PRODUCT INFORMATION
Here you will find brief information about the heater, its technical data and dimensions.

3 HEATER SELECTION AND SYSTEM DESIGN
Here you will find through information about heater sizing process, and (duct/component) systems design.

4 INSTALLATION PROCEDURES
Here you will find important information and instructions referring to installation of the heater system.

5 OPERATION AND FUNCTION
Here you will find information about the operation and function of the heater.

6 CIRCUIT DIAGRAMS
This section contains wiring diagrams for the heaters, control options and their harnesses.

7 MAINTENANCE / TROUBLESHOOTING / REPAIRS
This section contains information on possible faults and malfunctions, troubleshooting, maintenance and the service hotline.

8 PARTS LIST
Here you will find the service parts diagrams, parts lists and related descriptions.

9 SERVICE
This section contains information on Certification, Types and Disposal.

1 Introduction

HEATER WARNINGS

⚠ WARNING TO INSTALLER
- Correct installation of this heater is necessary to ensure safe and proper operation.
- Read and understand this manual before attempting to install a heater.

⚠ DANGER! - EXPLOSION HAZARD
- Heater must be turned off while performing welding or filling up the gas tank.
- Do not install heater in enclosed areas where flammable and/or compressed fluid grain, coal or wood may be present.
- Exhaust flue is extremely hot; therefore avoid directing it towards the fuel tank or flammable material (4" away from the fuel tank).
- Failure to follow these specific instructions may lead to extreme conditions which includes a serious injury or possible death.

⚠ DANGER! - FIRE HAZARD
- Install heater so it will maintain a minimum distance of 2" from any combustible or heat sensitive material.
- Install the exhaust system so it will maintain a minimum distance of 2" from any combustible or heat sensitive material.
- Ensure that the fuel system is intact and there are no leaks.
- Ensure extra measures are taken to prevent a fire hazard (fire extinguishers or smoke detectors) in the dangerous goods or passenger compartment.
- If the installation compartment of the heater is treated as stowage area with full of clothings, gas cartridges, fire extinguishers, spray or oil cans; there are chances of fire or explosion hazard. Such must be avoided as much as possible.
- Installation of the fuel lines under the exit locations of buses, RVs and specialty vehicles is not recommended.
- Failure to follow these instructions could cause fire resulting in serious o fatal injury.

⚠ DANGER! - ASPHYXIATION HAZARD
- Route the heater exhaust so that exhaust fumes can not enter any passenger compartments.
- Ensure an air tight seal is maintained between the heater and mounting surface and at any exhaust connection points.
- Check that heating air supply is taken from an area where poisonous gases will not be present.
- If running exhaust components through an enclosed compartment, ensure that it is vented to outside.
- Extra measures must be taken to detect the level of Carbon monoxide and dioxide in passenger compartment.
- Failure to follow these instructions could cause oxygen depletion resulting in serious injury or death.

⚠ DANGER! - ELECTRICAL HAZARD
- Improper procedure for connections to the battery and other electrical equipment leads to severe electrical shock and burns; use extra care while handling the electrical system.
- Ensure that any part of the body or heating system is not wet, while working on the electrical equipment to prevent unwanted events i.e. short circuit, electrical shock and fire hazard.
- To prevent overload on heater's negative wire, it is important to ground both heater and battery to the vehicle chassis.
- Disconnect the heater connections to the battery while performing any electrical work or welding on the vehicle.
- Insert fuse on the main harness of the heater only after the whole installation is completed.
- Vehicles carrying passengers and dangerous goods may require additional safety feature; therefore, use master switch on main wire to prevent heater from running under emergency.
  (Never use master switch to control the heater, which could cause catastrophic failure).
- Failure to follow these instructions could cause heater failures, electrical shocks and severe burns.

⚠ CAUTION! OVERHEAT HAZARD (AIR HEATERS)
- The air heating system requires a duct network free of excessive bends, contaminations or blockages to prevent overheating.
- While operating at high altitudes (>1500 m) without pressure sensor, there are chances of frequent heater overheating.
- Excessive heat (>150°C) from the heater during its overheating situation could be hazardous to vehicles or passenger; such factors must be accounted during system design and duct layout.
- Additional safety must be ensured by following application specific local regulations for vehicle HVAC systems.
- Failure to follow these instructions could cause personal injury or heater failures.

⚠ WARNING! OPERATION WITH BIO-DIESEL
- AIRTRONIC D2
  The diesel heater is not approved for 100% Bio-Diesel. Mixtures up to 10% bio fuel (FAME) may be used.

- AIRTRONIC M (D4)
  The diesel heater is approved for up to 100% Bio-Diesel according to the following conditions:
  – Bio-Diesel (FAME) according to Standard CAS NO. 67784-80-9 (or similar) in free flowing state (reduced at temperature below 0°C (32°F);
  – Operation of heater with mixtures greater than 10% is restricted during periods of temperatures below 0°C (32°F).
  – Apply a frequent preventative inspection and repair schedule on heaters operating with bio diesel (mixture>10%).
  – Heater must be run for 30min on high heat with regular diesel fuel once every 500h if mixtures above 20% are used;
  – Vent hole must be cleaned every 500h (twice a heating season assuming 1000h of operation annually);
  – Atomizing Screen must be replaced every 500h (twice a heating season assuming 1000h of operation annually).

⚠ WARNING! - HEATING AT HIGH ALTITUDES
- Up to 1500 meters (4920') - unrestricted heating operation is possible.
  Above 1500 meters (4920') up to 4000 meters (13120') - heating operation is in principle possible for short periods, e.g. when crossing a mountain pass or during a brief stop. In cases of extended stays, the fuel supply at the fuel metering pump has to be adapted to high altitude conditions.

- The following high altitude kits are available:

  – P/N: 20 2900 70 00 07 - 12V or 24V (Contains high altitude compensator, no extra fuel pump needed - only for 12/24V Airtronic 2/4 with "non H- kit" type ECU.

  – P/N 22 1000 33 22 00 - High Altitude Sensor for 12V Airtronic 2/4 heaters with "H-kit" type ECU.

    P/N: 24 0222 00 00 00 - 12V only (Contains high altitude fuel pump)
  – Only one kit from the listed above is needed.

- Heater operations at high altitude (>4,000 metres) is not possible.

- Direct questions to Eberspaecher North America (Espar Products, Inc.):
  Canada & U.S.A. 1-800-387-4800

1 Introduction

GENERAL SAFETY INSTRUCTIONS

SAFETY

In addition to heater warnings and notes, it is mandatory to follow general safety instructions and procedures while handling the heating system.
List of some required tools and protective equipments are given below:

REQUIRED TOOLS AND PROTECTIVE EQUIPMENT

Mechanical tools:	Electrical tools:	Other tools:	Protective Equipment:
Screw driver set, Plier sets, Standard/metric wrenches and sockets, Torque drive set, Standard drill, Bit set and hole saws, Vice grips, Clamps and clips, Utility knife, Hose and fuel line cutters, Teflon tape, Brass glow plug brush, Small hammer and light duty, Filler gauge, Paper clips, Pencils and markers, Measurement cylinder (10 ml) Measurement tools, Glow pin tool Glow pin screen tool Thermal insulating seal Hole Saw kit Bubble level gauge Manometer other tools as required.	Multimeter, Thermometer, Tachometer, Battery power source (DC), Wire cutter, Wire stripper and crimper, Terminal remover tool (AMP), Electrical grease and tap, Extra wires, Alligator clips test lead and Temporary jumper cable (small). Air flow meter Exhaust gas analyzer Data logger	Thermal sealant for duct and exhaust (as per vehicle manufactures), Diesel, Kerosene, Lock ties and dry rag.	Safety shoes, Safety glasses, Safety hand glows, Ear protection (if required). Any additional protection Requirement from company or dealer.

⚠ WARNING! GENERAL SAFETY INSTRUCTIONS

- Heating systems can be hot; therefore, use appropriate measures before carry out their installations or repair.
- During the glow pin test, the glow pin can become red hot, which could create severe burn to the operator if improperly handled.
- Fuel is explosive material and its system must be handled according to the manufacturer guidelines only.
- Never keep the heating systems ON while performing the welding in the shop or fueling at the gas station.
- Apply appropriate measures to protect the heater from corrosion, contamination and overheat.
- Regardless of the season, run the heater at least once in a month for period of minimum 15 mins to burn away any residue in combustion chamber, minimize contamination in the Blower fan, and prevent unexpected component failures.
- Usage of kerosene must be limited to 30 mins and only after the repair, which, however, can not replace the required repair for excessive carboning issue. At high altitudes and under cold conditions, pre-mixing diesel with kerosene to some limit is allowed; please see fuel section of this manual.
- Frequent overheat conditions could affect heater components i.e. Gaskets, sensors, duct system, ECU and blower fan; therefore it must be promptly rectified to reduce further maintenance costs.
- Ensure that statutory regulations regarding accident prevention as well as work shop H&S standards are followed.

PLEASE NOTE!

- Under the new warranty program “EW Plus”, use of EDiTH diagnosis is recommended to reduce the application processing time and other possible costs.
- Inadequate size of the heater could lead to undesired temperature in the compartment; Eberspaecher NA recommends to account all factors required for heater selection and system design.
- Heater system failures due to incorrect installation, improper handling, or abusive usage could immediately nullify the heater warranty.
- Eberspaecher NA has a strict policy against use of any non-genuine or unauthorized parts in the heater.
  Such actions could immediately nullify the parts warranty.
- Improper installation and repair could lead to further faults or failures and down time for which Eberspaecher North America is not liable and warranty could effectively become null and void.
- For any difficult repair or customized installation including on RV and specialty vehicles, contact nearby Eberspaecher certified dealer.
- The heater manual provides general guidelines for safe installation, operation and repair under normal conditions; if anything out of the ordinary; usage of due diligence is expected or contact near by certified dealer.
- The periodic heater maintenance is the responsibility of the owner and is not covered under Eberspaecher North America (ESPAR) warranty.
- OEM type heating installations are different from after market, therefore contact vehicle manufacturer or dealer for technical support .

2 Product information

EBERSPAECHER'S *AIRTRONIC* BUNK HEATERS

With growing demand for energy efficient systems and green technologies, the automotive market has been increasingly inclined towards new innovations in vehicle systems that could reduce the overall fuel consumption and cost. For such reasons, the demand for cutting edge no-idle technologies has increased.

The Airtronic 2/4 is quality engineered by J.Eberpsacher as a low cost, highly efficient and durable means to provide heat to the vehicle compartment or cargo. It can be operated as an independent heater as a no idle system or an integrated part of climate control systems. Depending on the heat output, the Airtronic heaters are categorized as small (Airtronic) and medium (Airtronic M):

12V / 24V	Airtronic	D2:	2 KW / 7,500 BTU / hr
12V / 24V	Airtronic M	B4/D4:	4 KW / 13,600 BTU / hr

The Airtronic 2/4 is ideal for comfort space heating of trucks, cars, off-road equipment, small trucks and boats featuring an efficient heat regulation, controlled energy consumption and convenient installation. With high power to weight ratio, easy serviceability, and high durability, the overall operational and maintenance cost of the heater is very low. In addition, the heater is compatible with any diagnostic device from Eberspaecher to provide the fault codes for easy troubleshooting.

The Airtronic 2/4 can be operated from the vehicle cab by a thermostat, digital controller or on/off switch. It is controlled by the controller and regulated by the ECU in various stages (boost-high-medium-low-stand by) in order to maintain desired temperature. A flame sensor, temperature regulating sensor and overheat sensor are among the multi layered safety features which makes the Airtronic 2/4 a safe and dependable heating system.

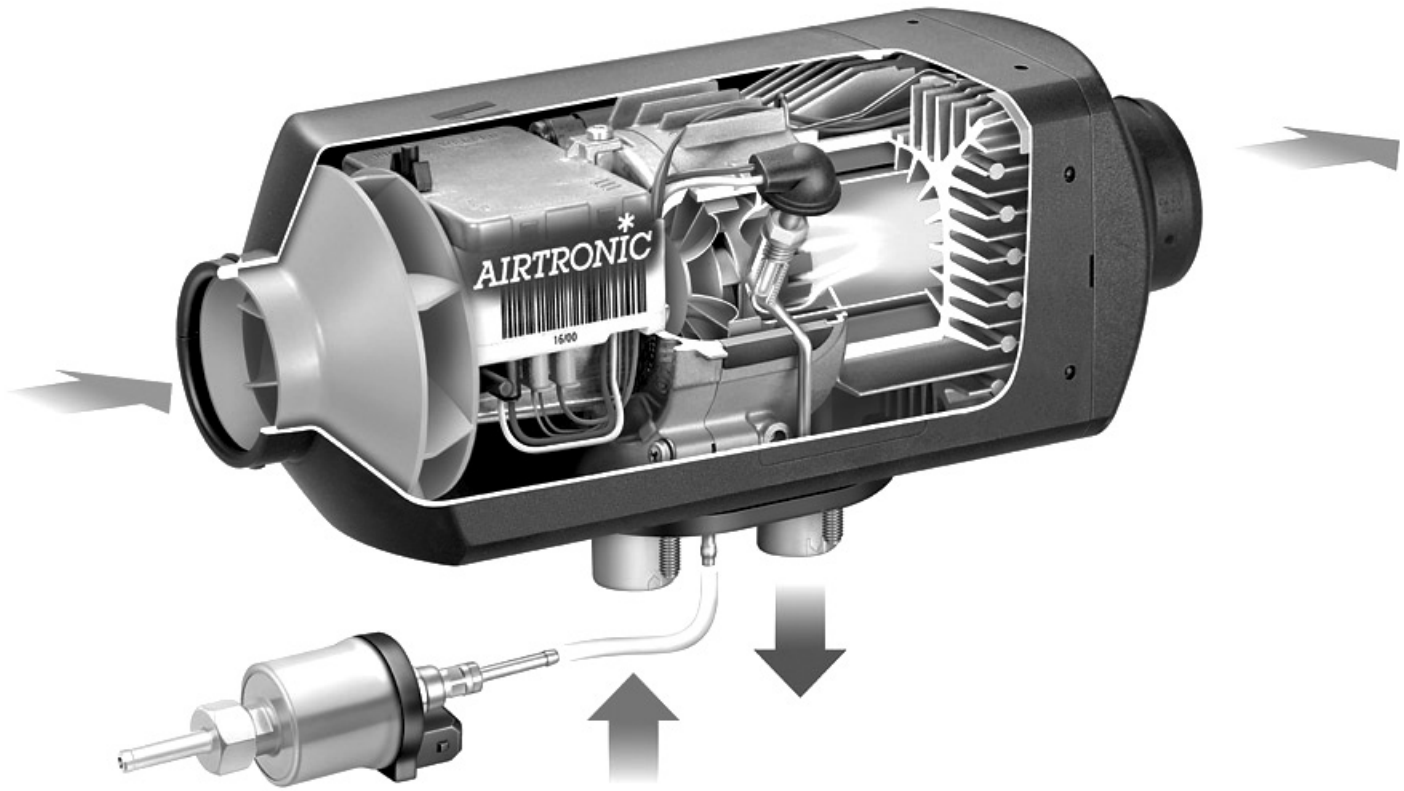
NON PERMITTED APPLICATIONS:

- Long term Continuous operation at high altitude is not permitted.
- Not compatible for space heating of:
  - — Residential rooms, and garages
  - — Weekend homes, and hunting huts
  - — Fuel depot, Wood depot, Grain depot
- House boats etc.
- Aircrafts (high altitude) etc.
- Large Passenger Vehicles (more than 9 seats)

AIRTRONIC M 2/4 HEATER MARKINGS

- Technical designation:

  B D 2 / 4 M
  B: Benzine (gasoline)
  D: Diesel
  2: 2KW Heat output
  4: 4KW Heat output
  M: Medium Type Space heater (B/D 4 only)



For illustration purpose only

2 Product information

TECHNICAL DATA

HEATER	*AIRTRONIC* D2	*AIRTRONIC* D4	*AIRTRONIC* B4
Heat Output (±10%)	7,500 BTU/hr Boost (2.2 kW) 6,150 BTU/hr High (1.8 kW) 4,100 BTU/hr Medium (1.2 kW) 2,900 BTU/hr Low (0.85 kW)	13,650 BTU/hr Boost (4.0 kW) 10,200 BTU/hr High (3.0 kW) 6,800 BTU/hr Medium (2.0 kW) 3,500 BTU/hr Low (1.0 kW)	12,950 BTU/hr Boost (3.8 kW) 10,910 BTU/hr High (3.2 kW) 7,160 BTU/hr Medium (2.1 kW) 4,430 BTU/hr Boost (1.3 kW)
Current at 12v (±10%)	8.3 amps - Start 2.8 amps - Boost 1.8 amps - High 1.0 amps - Medium 0.7 amps - Low 0.4 amps - Stand by	8.3 amps - Start 3.3 amps - Boost 2.0 amps - High 1.1 amps - Medium 0.6 amps - Low 0.4 amps - Stand by	8.3 amps - Start 3.3 amps - Boost 2.4 amps - High 1.3 amps - Medium 0.8 amps - Low 0.4 amps - Stand by
Current at 24v (±10%)	4.2 amps - Start 1.4 amps - Boost 0.92 amps - High 0.5 amps - Medium 0.3 amps - Low 0.2 amps - Stand by	4.2 amps - Start 1.7 amps - Boost 1.0 amps - High 0.5 amps - Medium 0.3 amps - Low 0.2 amps - Stand by	(No 24V version available)
Fuel Consumption (±10%)	Gal/hr Litre/hr Hz Boost 0.07 0.28 3.7 High 0.06 0.23 3.1 Medium 0.04 0.15 2.0 Low 0.03 0.10 1.3	Gal/hr Litre/hr Hz Boost 0.13 0.51 6.8 High 0.10 0.38 5.0 Medium 0.07 0.25 3.3 Low 0.03 0.11 1.7	Gal/hr Litre/hr Hz Boost 0.14 0.54 7.0 High 0.12 0.46 5.9 Medium 0.08 0.29 3.7 Low 0.05 0.18 2.3
Air Flow (±10%) Airtronic 2 with hood Ø 60 Airtronic 4 with hood Ø 90	Flow rate RPM Boost 48 cfm 4800 High 40 cfm 4000 Medium 27 cfm 2800 Low 19 cfm 2000 Stand by 6 cfm 600	Flow rate RPM Boost 85 cfm 4400 High 69 cfm 3500 Medium 50 cfm 2600 Low 30 cfm 1600 Stand by 11 cfm 600	Flow rate RPM Boost 85 cfm 4400 High 74 cfm 3800 Medium 55 cfm 2800 Low 43 cfm 2220 Stand by 11 cfm 600
Operating Voltage Range	10.5 - 16 vdc at 12 vdc 21 - 32 vdc at 24 vdc	10.5 - 16 vdc at 12 vdc 21 - 32 vdc at 24 vdc	10.5 - 16 vdc at 12 vdc 21 - 32 vdc at 24 vdc
Overheat Temperature Shutdown (±10%)	248°F (120°C)	302°F (150°C)	302°F (150°C)
Flame Sensor Shut Down AD2 / AD4 /BD4	536°F (280°C)	554°F (290°C)	554°F (290°C)
Ambient Operating Temperature	-40°F to 158°F (-40°C to 70°C)	-40°F to 158°F (-40°C to 70°C)	-40°F to 122°F (-40°C to 50°C)
Weight	5.9 lbs. (2.7 kg)	9.9 lbs. (4.5 kg)	9.9 lbs. (4.5 kg)
Fuel Quality	DIN EN 590		DIN EN 228
Interference Suppression	Interference suppression class 5 to DIN EN 55 025		
Ventilation Mode	possible		
Emission	CO 0.1 Vol. % (Maximum)	CO2 7.5 - 12.5%	Smoke spot No. <4 (Bacharach)
All technical data ± 10%			

PLEASE NOTE!

The heater control unit is equipped with a low voltage cutout to prevent vehicle battery drain and a high voltage cutout to protect heaterelectrical parts.

PLEASE NOTE!

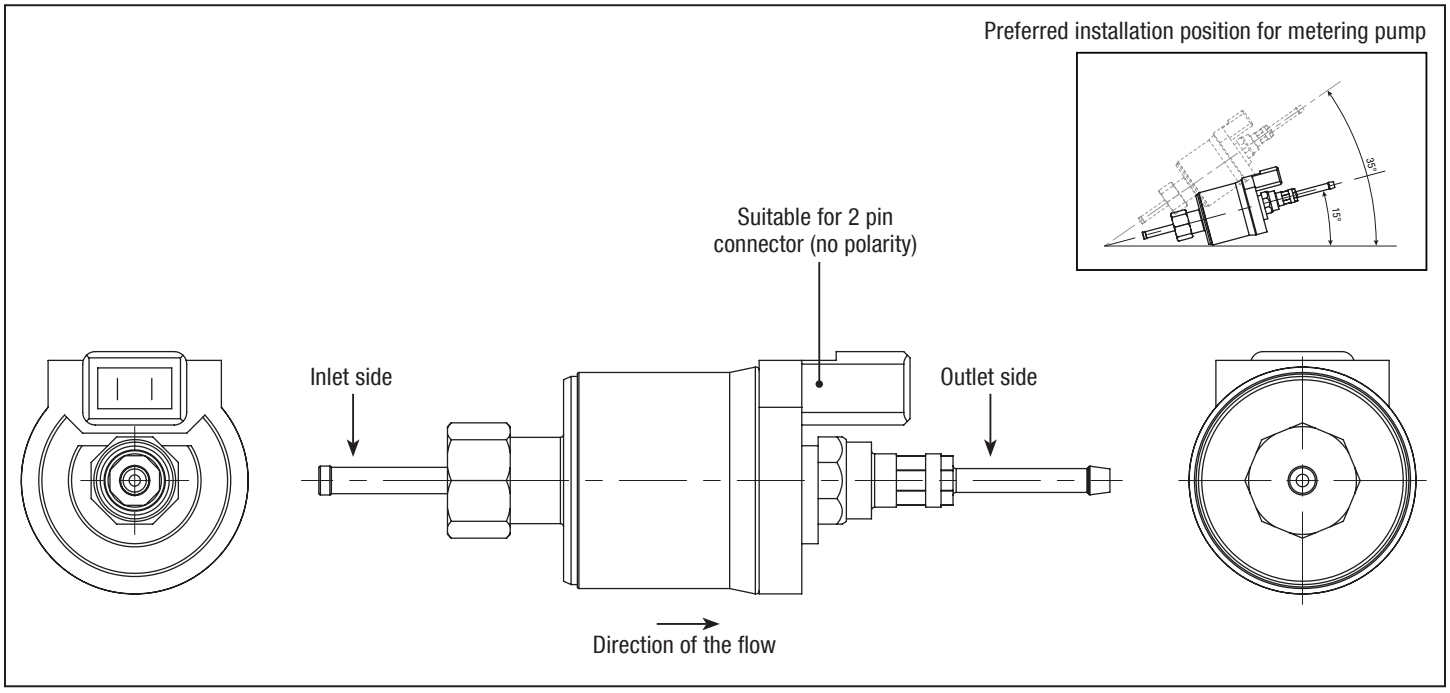
The terms “Boost” and “Power” are used interchangeably throughout this manual. The terms refer to the highest level of heat output.

2 Product information

TECHNICAL DATA

TECHNICAL DATA - FUEL METERING PUMP - (B/D5WS/SC only)		
Heater Voltage	12V	24V
Pump Operating Voltage (⎓)	12V	24V
Operating Current (High mode) (⎓)	1.25 A (12V) and 0.65A (24V) at 20°C	
Pump Type	Positive Displacement type - In line piston pump (axial flow)	
Pump Capacity	0.54 l/h +/- 10% @ 7 Hz (on testing stand)*	
Fuel Delivered	Gasoline DIN 51600 and DIN 228 / Diesel DIN EN 590	
Solenoid Resistance	10 Ω (12V) and 36 Ω (24V) at 20°C	
Installation Position	15° to 35° (Recommended)	
Weight	0.20 Kg (avg.)	
Operating Temperature	-40° C to +80° C (diesel fuel) / -40° C to +20°C (Gasoline fuel)	

* For FMP frequency during operation, see technical data for the heater
The technical data can vary depending on the installation and operating condition as well as types of the heater.



For illustration purpose only

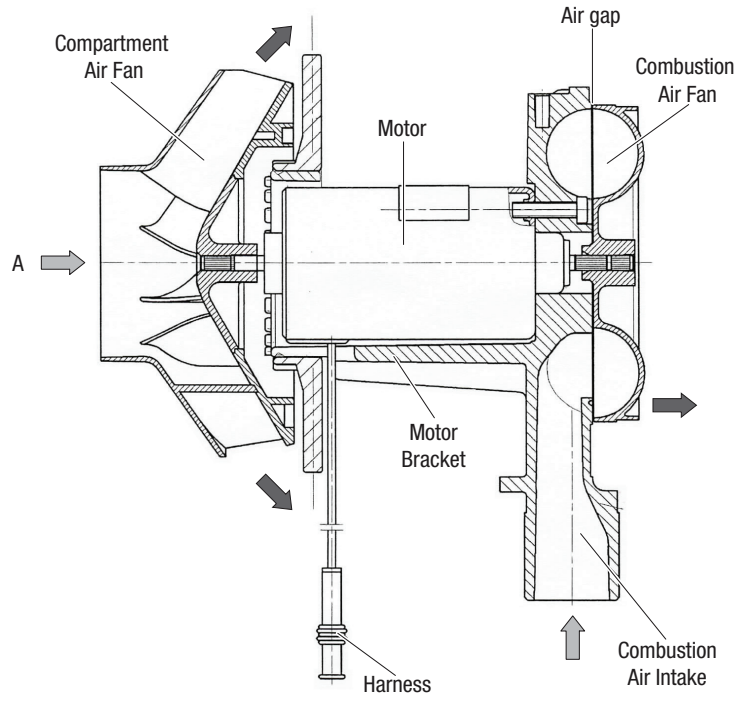
2 Product information

TECHNICAL DATA

TECHNICAL DATA - BLOWER MOTOR - 12/24V Airtronic 2/4		
Heater voltage (DC)	**12 V**	**24 V**
Operating Voltage* (DC) - High Mode	8.2 V*	16.4 V*
Normal Operating Current (at Operating voltage in Power Mode)	3.5 A	1.7 A
Maximum operating Current	6.5 A	3.2 A
Blower Configuration Type	Direct driven, dual impeller, Single stage blower assembly	
Compartment Air fan	In line Centrifugal (mixed & enclosed blades)	
Compartment Air fan (flow rate at Operating voltage in Power Mode)	D2: 48 cfm	D4: 85 cfm
Combustion air fan	Side Channel (straight & radial blades)	
Combustion air fan (flow rate at Operating voltage in Power Mode)	D2: 2.6 cfm	D4: 4.1 cfm
Motor type	PMDC (brushed)	
Clearance between combustion air fan and bracket	D2: 0.35 mm +/- 0.02	D4: 0.30 mm +/- 0.02
Direction of rotation	Bi-directional (Anti-clockwise for the heater from view point “A”)	
Operating Speed (at Operating Voltage in Power Mode)	D2: 4800 RPM +/- 100 (avg.)	D4: 4400 RPM +/- 100 (avg.)
Normal Operating Temperature Range	-15 °C to 50 °C	
Maximum Operating Temperature Range	-40 °C to 70 °C	
Gross Motor weight	D2: 0.632 Kgs	D4: 0.830 Kgs

*To troubleshoot the blower motor, apply testing voltage as provided in fault 032 on page 81.The technical data can vary depending on the installation and operating condition as well as type of the heater. (All technical data +/- 10%).

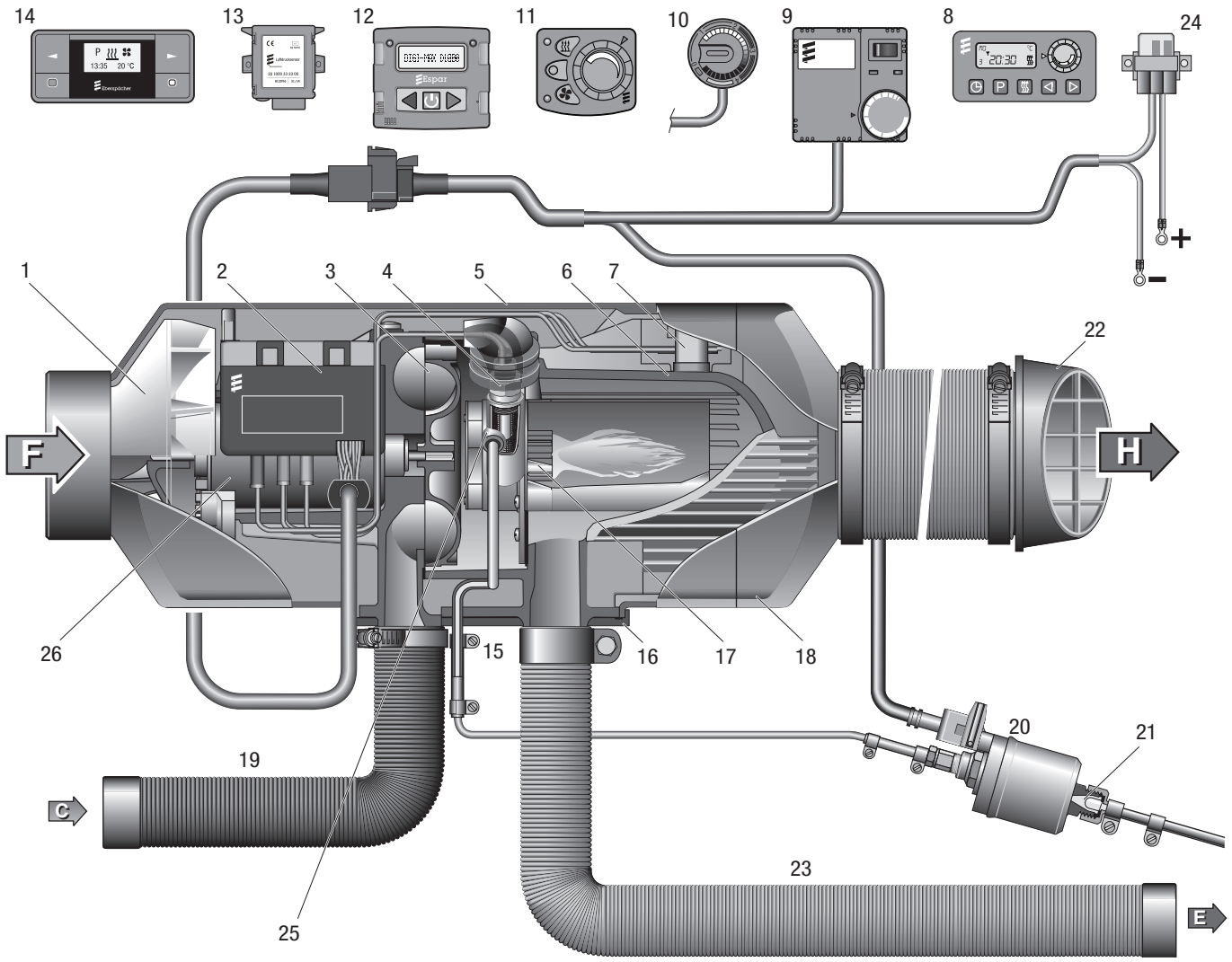
Blower Motor Assembly



For illustration purpose only

2 Product information

AIRTRONIC / AIRTRONIC M



For illustration purpose only

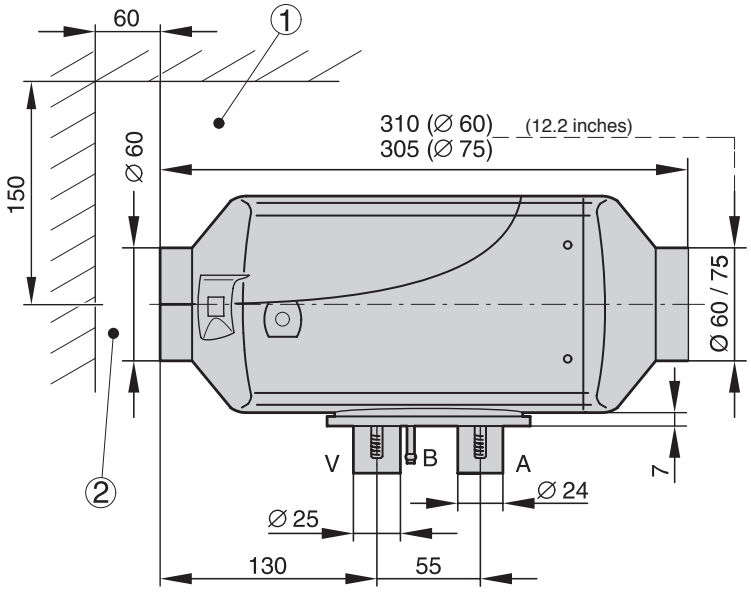
1 Hot Air Blower Wheel
2 ECU
3 Combustion Air Blower Wheel
4 Glow Pin
5 Cover
6 Heat Exchanger
7 Overheat/Flame sensor
8 7 Day Timer with Thermostat (optional)
9 Operating Unit (Thermostat)
10 Operating Unit (Rheostat)
11 Mini Controller
12 Digi Max
13 High Altitude Sensor
14 EasyStart Timer

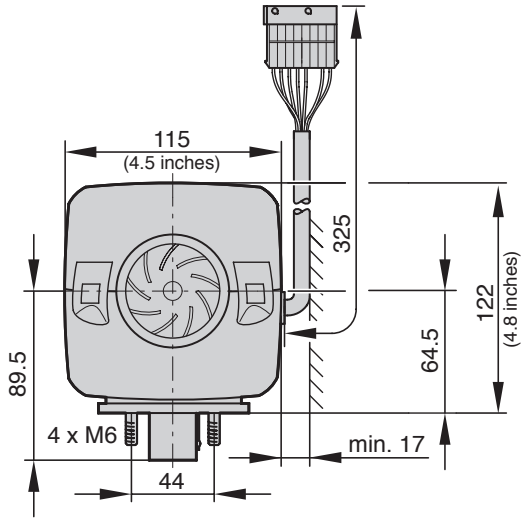
15 Fuel Connection
16 Flange Seal
17 Combustion Chamber (Burner)
18 Hot Air Outlet Hood
19 Combustion Air Intake Hose
20 Fuel Metering Pump
21 Fuel Filter built into FMP
22 Hot Air Output Deflector
23 Flexible Exhaust Pipe
24 Main Fuse: -
AIRTRONIC 12 V - 20 A Fuse
AIRTRONIC 24 V - 10 A Fuse
25 Vent Hole
26 Blower Motor

C = Combustion Air
D = Fuel Intake from Tank
E = Exhaust
F = Fresh Air Intake
H = Hot Air Output

HEATER DIMENSIONS

Principal Dimensions *AIRTRONIC* D2

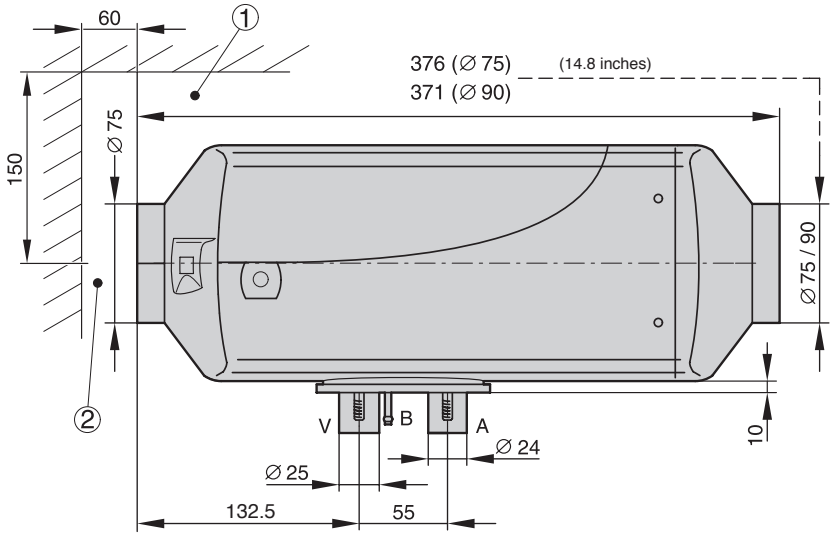


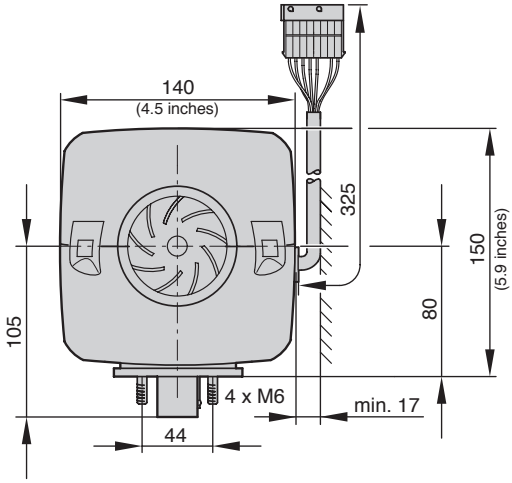


* All measurements in millimeters 25.4 mm = 1”

① Minimum installation distance (clearance) to open the lid and to dismount the glow pin and the control unit.
② Minimum installation distance (clearance) to take in heating air.

Principal Dimensions *AIRTRONIC* D4





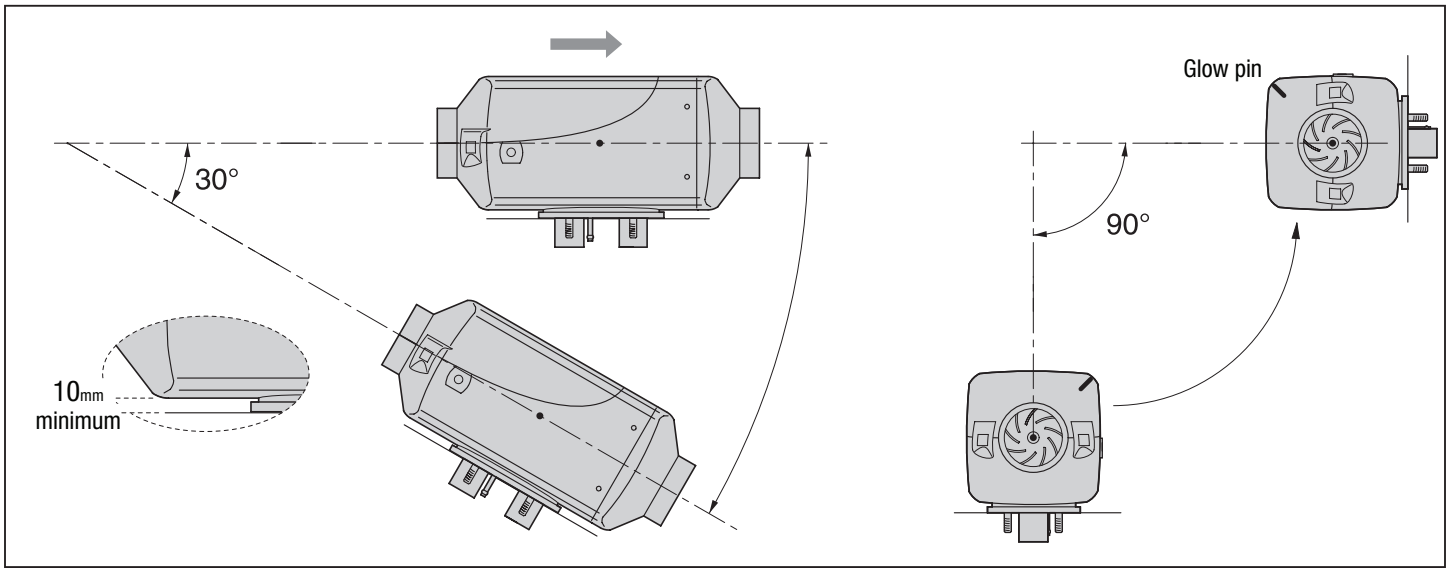
2 Product information

POSSIBLE INSTALLATION POSITIONS

The heater is preferably installed in the normal position as shown in the drawing.
Depending on the installation conditions, the heater can be tilted by max. 30° (flow direction to the bottom) or turned by max. 90° around its own longitudinal axis (exhaust connection horizontal, glow plug points upwards!).

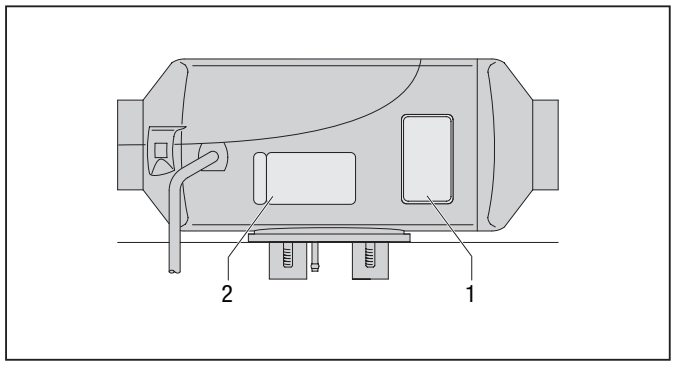
In the heating mode, the heater can deviate from the shown normal or maximum installation positions by up to +15° in all directions because of a slanting position of the vehicle, without any impaired functions.

PLEASE NOTE! Mounting angles of the Airtronic D2/4 heaters as shown in the image must be strictly adhered otherwise it may create an unexpected fuel leakage, odor, operating problems or premature component failures (glow pin).



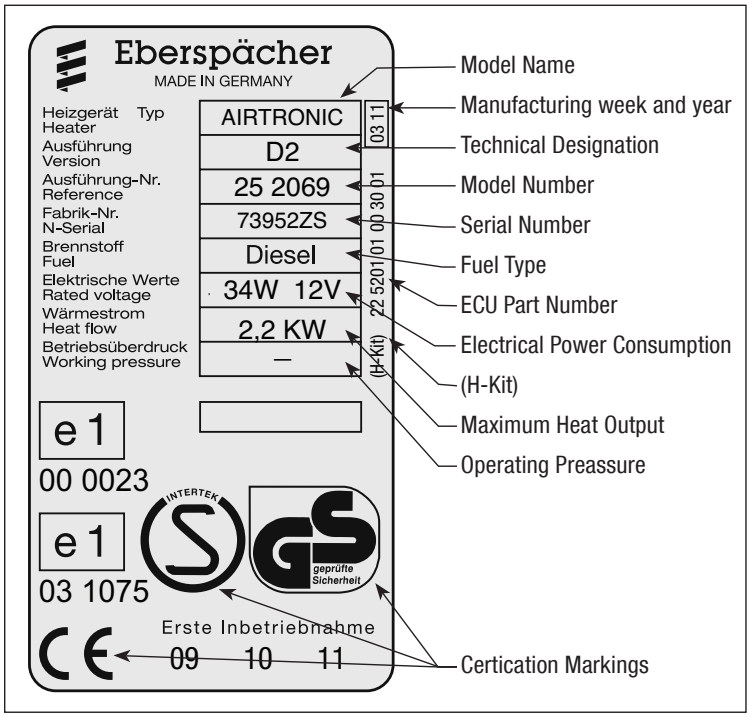
NAMEPLATE

The nameplate is fastened at the side or to the front of the heater.
It includes: name of the heater, part number and serial number.
The “H-kit” is written on the name plate that suggests the compatibility of the heater for digital communication with high altitude sensor, and latest controllers i.e. easy start timer, easy start call.



1 Original nameplate
2 2nd nameplate (duplicate)

PLEASE NOTE! It is important to install a secondary nameplate at easily accessible locations like on the Side window (driver).



For illustration purpose only

3 Heater Selection & System Design

HEATER SELECTION

It is very important to install a properly sized heater to achieve optimal system integrity, efficiency and safety. This manual would provide a general guidlines for the heater selection (Airtronic 2 or 4) based on overall heat requirement and application. However, it is highly recommended to consult with a nearby Eberspaecher dealer for further evaluation of additional system requirement and installation constraints for specific vehicle. In addition, the heater selection and installation for applications like recreational or specialty vehicles as well as cargo trailers carrying dangerous goods may need to comply with local regulations.
The balloon chart as shown here describes key factors affecting the air heater selection.

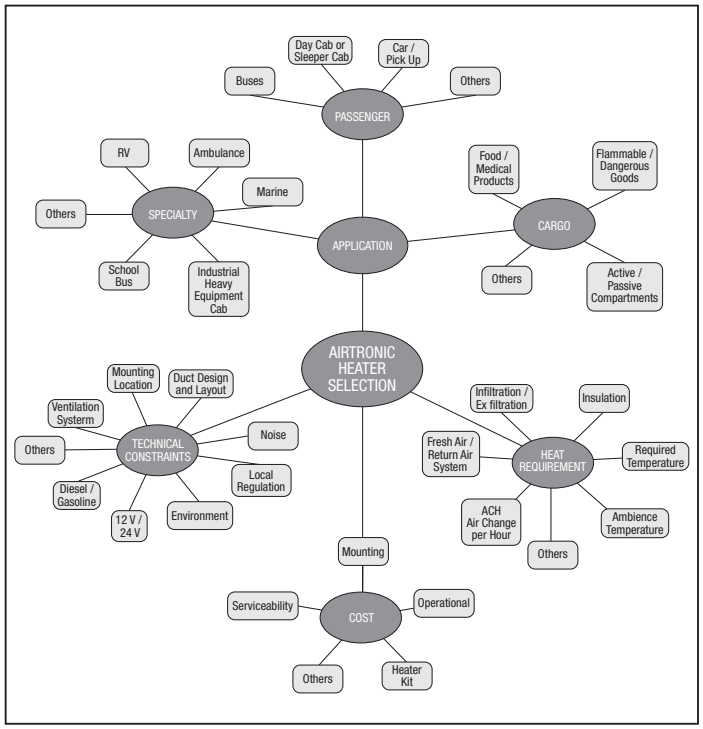
The size of the heater largely depends on the heat requirement in the vehicle, which can be found by referring a heater selection chart or performing a heat calculation. For generic applications, a heater selection chart is mostly sufficient to size the heater. However, sometimes applications like specialty or dangerous goods must be thoroughly analyzed according to various technical constraints; therefore, it is mandatory to carryout a (simple or exact) heat calculation to calculate overall heat requirement.

THE HEATER SELECTION CHART

PLEASE NOTE!

- The heater selection chart only describes a rough estimation regarding size of the heater for basic applications only. In practice, heat loss factors can vary depending on the application and vehicle type.
- Do not use a heater selection chart, if the vehicle compartment is non insulated (sheet metal, glass, or plywood).
- The heater selection chart does not include operating conditions of the heater at high altitudes (>1500 m).
- Any ventilation requirement in passenger vehicles is not covered in the heater selection chart; therefore a heat calculation is recommended.

KEY FACTORS AFFECTING AIR HEATER SELECTION



For illustration purpose only

HEATER SELECTION CHART — AIRTRONIC D2 & D4									
Airtronic D2	Cab Heat	△	△	△	△	△	△	△	△
	Cargo Heat	△	△	○	○	○	○	○	○
Airtronic D4	Cab Heat	□	□	□△	□△	□△	□△	□△	□△
	Cargo* Heat	□*	□*	△*	△*	△	○	○	○
		Class One	Class Two	Class Three	Class Four	Class Five	Class Six	Class Seven	Class Eight

Heater Compatibility

△ = Vehicle with Insulated compartment (Closed cell polyurethane foam)

□ = Vehicle with regular compartment

* = Passenger Compartment (For RV's and buses)*

○ = Not suitable.

3 Heater Selection & System Design

HEAT TRANSFER

Heat transfer is an exchange of thermal energy between physical systems. The rate of heat transfer is dependent on the temperature of the systems and the properties of the intervening medium through which the heat is transferred. Such energy transfer can occur in three ways: **radiation, conduction, and convection**.
At steady state condition, if applied heat to the body changes its temperature, then such process is called as sensible heat transfer. On the contrary, a latent heat transfer is when applied heat to the body converts its physical state between solid, liquid and gaseous without increasing the temperature.
In the heating system, to increase the interior air temperature and compensate an unwanted heat transfer through the surface areas are called as the sensible heat load. On the other hand, the moisture content in the hot interior air has a latent heat, which is frequently required to be exhausted outside the compartment in order to maintain a constant humidity level, called as a latent heat load.

PLEASE NOTE! The latent heat load in the heating system is very small in comparison to the sensible heat load; therefore it is not required to be accounted in the heat requirement calculation for sizing the heater. However, an additional multiplication factor: 1.2 is added in the heat calculations if the heat losses through latent heat, duct loss or door movements need to be accounted.

HEAT LOSS IN THE HEATING SYSTEM

During winter periods, there are various ways through which an undesirable heat transfer can be possible, which reduces the cab temperature and affects the overall performance of the heating system. Such unwanted heat transfer, therefore termed as the heat loss in the heating system. Some of the key heat loss factors are necesary for the heat calculation, which are briefly discussed here.

HEAT LOSS FACTORS

- CONDUCTION: Heat by conduction takes place when two materials, medias or objects are in direct contact, and the temperature of one is higher than the temperature of the other. The temperature tends to equalize; thus the heat conduction consists of a transfer of kinetic energy from the warmer medium to the cooler one. The heat loss through the surface area of the vehicle is an example of conductive heat transfer.

- CONVECTION: occurs when the motion of a fluid carries thermal energy from a warmer region to a cooler region. In vehicles, the main heat loss through the convection is when the heat is applied to the cold air in the compartment to increase its temperature up to the desired value. In heating systems, a convective heating load can be relatively higher due to possibilities of fresh air systems, air leakage, or compartment ventilation. On the other hand, convection can be beneficial sometimes when a convective currents tend to raise a warm air upwards or bring cold air downwards and equalize the interior temperature uniformly.

- RADIATION: It is the emission or transmission of energy in the form of electromagnetic waves or particles through space or a material medium. The radiated energy from the sun or any other source absorbed by the vehicle body increases internal temperature also called as heat gain through radiation.
  The heat gain in the cab from the radiation of the sun is not counted as they do occur in the day while the lowest ambient temperature majorly happens in the night. Similarly, the radiative energies from other heat sources like passengers, light bulbs or microwaves generate comparatively nominal heat gain; therefore, they are not accounted in the heat calculations as well.

- AIR LEAKAGE: It is an unnecessary loss of heat due to infilteration or exfilteration of air through structural gaps, cracks and holes, which are usually found in the vehicles. Depending on the wind direction, vehicle speed, and location of the heater, the pressure in the compartment fluctuates; therefore, a variable degree of the air leakage through the process of infilteration and exfilteration that takes place in the low pressure and high pressure regions of the compartment respectively. To quantify the amount of air leakage, a highly complex set of experiments and lengthy analytical calculations are required, which is outside the scope of this manual. Therefore, to simplify the heat loss calculation, a standard value of the air leakage quanity is estimated (ACH = 2) in terms of air change per hour factor while vehicle is enclosed and in parking mode.
  Please note that the air leakage rate can be significantly higher when windows or doors are open or vehicle is in motion.
  Further information related to the air leakage is also available in Air change section. The image 3 describes the air leakage phenomenon in a cargo compartment of a vehicle with return air heating system.
  - INFILTRATION: is a type of air leakage, which is an unintentional and uncontrolled entry of outdoor air into an enclosed space. Infiltration occurs through cracks in the vehicle envelope due to pressure differences between inside and outside. The outdoor air entering through open doors and windows is considered infiltration although the purpose of opening the door or window might be ventilation. Infiltration occurs mainly in winter when the air outside is colder and heavier than the air inside. Please note: The infilteration heat loss through opening and closing of doors/windows are discussed separately, see page 16.
  - EXFILTRATION: refers to an unwanted flow of indoor air from an enclosed compartment space to the outdoor through structural gaps. For example, it is observed that the air leakage through ex-filtration increases with higher pressure build up from the fresh air heating system in an enclosed and non ventilated compartment. Conversely, exfiltration also takes place from the negative pressure region of the slipstream generated by the vehicle while in motion.

- HEATER SYSTEMS:

  - FRESH AIR SYSTEM: The heater receives cold air from outside through an intake duct and provides a hot air via its outlet duct in the compartment. It is usually meant to control the air quality and moisture level when the interior air is possibly exposed to toxic fumes, carbon dioxide and high humidity. Such systems should be mainly installed in specialty or passenger vehicles and cargo containers of flammable/dangerous goods transportation. Such system may also require a separate ventilation (exhaust) to remove excess air pressure to minimize exfiltration and reduce ballooning effect in vehicle compartment as shown in the image 3. It must be noted that due to constant extraction of the outside air from the intake, the exchanged cold air is required tobe heated. Therefore, such system trends to have higher energy consumption.

    PLEASE NOTE!
    - It is mandatory to ensure that the fresh air must never be received where any chances of exhaust fumes, road spray or rain water ingress are possible (while vehicle at standstill or in motion).
    - An external air sensor is required to regulate the heater and it must be placed inside the compartment where maximum heat is desired.
    - The air change (ACH) value for the fresh air heating system is depending on the heater throughput and compartment volume.
    - The ventilation (exhaust) system is not provided by Eberspacher NA and must be installed separately, if necessary.

$$ACH_{(Fresh\ Air,\ ventilated)} = \frac{\text{Heater throughput (per hour)}}{\text{Vechicle compartment volume (ft}^3\text{)}}$$

— RETURN AIR SYSTEMS*: For small size vehicles like sleeper cabs, the return air system is desired where the interior air can be constantly reheated during the heater operation. Due to consistent energy conservation through a recirculation of the compartment air, such heating systems normally have high efficiency and durability. However, the quality of air can degrade due to accumulation of unnecessary fumes, humidity and carbon dioxide. Some amount of air quality may be improved by the existence of air leakage in the vehicle compartment. However, If the priority is to maintain the best air quality especially in some mid/large passenger vehicles or cargo containers, then a separate means of air exchange like a forced air or natural ventilation system may require (for example: vehicle's integrated HVAC system or separately installed ventilation system).
Further information related to air exchange in the return air system can also be found in ventilation and ACH.
*Also called as: Recirculated Air System.

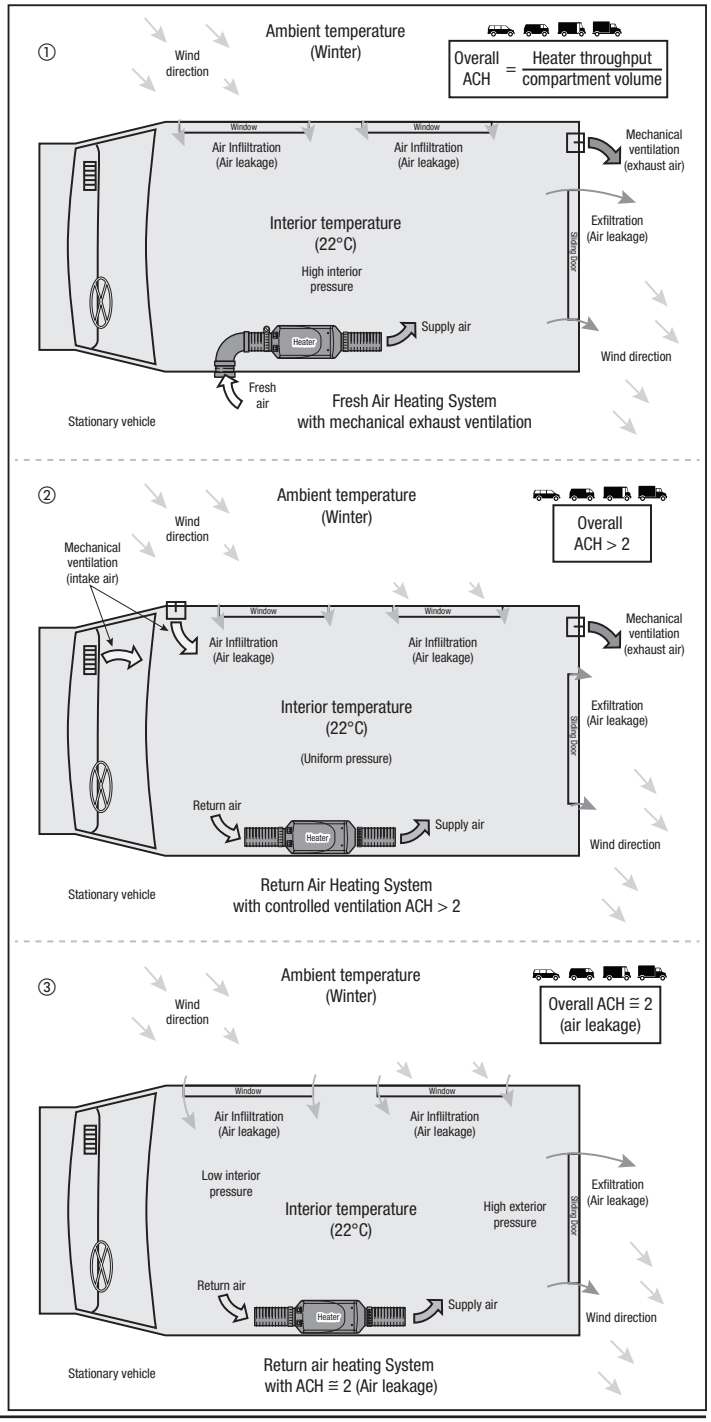
- VENTILATION: it is an artificially controlled process of changing or replacing air in any given space to maintain a high indoor air quality (i.e. to control temperature, replenish oxygen, or remove moisture, odors, smoke, heat, dust, airborne bacteria, and carbon dioxide). In vehicle compartment, the ventilation system is also responsible for replenishing and exhausting air in equal quantity to maintain constant static pressure to minimize the air leakage (infiltration and exfiltration) while vehicle in motion or at standstill. The quantity of ventilation is carefully measured based on number of passengers (CO_2), adverse particulate matter, and moisture content in vehicles using various standard calculation methods used in HVAC.
The air can be either ventilated (intake and exhaust) or only exahusted through a strategically placed mechanical or natural vents on the vehicle walls. The mechanical vent has a bower to provide minimum air flow at intake and exhaust ports to maintain a constant ACH (air change/hour) in as shown in the image 2.
On the other hand, properly sized air vents at intake and outlet provides sufficient air circulation throughout the compartment.
  1) Most of small/medium size vehicles (up to 2 passengers) do not require additional ventilation system as the air leakage can provide sufficient ventilation in the compartment, see image 3.
  2) In return air heating system, some mid sized vehicles carrying passengers (>2) or dangerous goods may need a supplementary ventilation system to maintain necessary air quality as shown in image 2.
  3) In fresh air mode, the only goal of ventilation system is to exhaust the air from compartment via a mechanical/natural type outlet vent since the intake air from outside is provided by the fresh air heating system, see image 1.
  Further information related to the ventilation requirement is available in the ACH section below.

PLEASE NOTE! While a ventilation is an important aspect of climate control in vehicle compartment; it is, however, subject to user's own preferences for its selection and installation; Therefore, excludes Eberspacher NA from any possible direct or indirect liability for physical or personal damages therefrom.

- AIR CHANGE PER HOUR (ACH): It is the measure of total air exchange per hour through the compartment either by an air leakage or by a separate ventilation system. It is denoted by a numerical number in terms of a quantity of air tobe exchanged or exhausted in an hour. The higher air change number, the more air exchange takes place per hour.
As discussed earlier, all vehicles have enough structural gaps to allow minimum air leakage equivalent to ACH 2 for sufficient ventilation through an enclosed compartment of a stationary vehicle. Such air leakage value is suitable for small cabs of vehicles carrying passengers up to 2.
For mid size vehicle carrying passengers (>2) or dangerous goods, a necessity of additional air ventilation arises as the amount or air leakage through existing structural gaps can not maintain required air quality.
In this case, supplementary ventilation from the vehicle's blower system (OEM or separately installed) can be converted in to the ACH value using a simple equation:

$$ACH_{(Recirculated,\ ventilated)} = \frac{\text{Ventilation Airflow / hr (mechanical fan)}}{\text{compartment volume (ft}^3\text{)}}$$

PLEASE NOTE! that the amount of required ventilation (cfm) is empirical in nature and defined (on a standstill vehicle) through a series of analytical calculations and tests using numerous parameters as discussed earlier in the ventilation section. For sufficient air quality for passengers, provide minimum fresh air ventilation: 10-15 cfm/person in the compartment.



3 Heater Selection & System Design

- MATERIALS OF THE VEHICLE SURFACE AREA
  As discussed earlier, a conductive heat loss occurs through the surface area of the vehicle compartment depending on the type of material and thickness of the surface area and temperature gradient.
  To improve system performance and minimize the heat loss, it is highly recommended to use insulating materials in the compartment interiors.
  Manytimes, having and appropriate insulation in the interior can drastically reduce the heater size, as well as decrease the installation and operational cost.
  To simplify the selection process of the insulation material, many manufacturers provide key parameters related to thermal performance of an insulation selection like dimensions, R or k value, moisture effects, cold or hot temperature performance, etc. For further information related to insulation materials, please see page 18-20.

- HEAT LOSS THROUGH WINDOWS AND GLASS SURFACES
  In vehicles, large surface areas (windshield/windows) are covered by tempered or laminated glass through which a huge amount of heat loss can be possible. For example, applications like off road equipment or crane with see through cab can have excessive heat loss via glass structure.
  Therefore, it is imperative to never ignore them in the heat calculations as a negligible factor; nonetheless always use exact technical parameters of such surface area in calculations.
  It is recommended to contact the manufacturer to find appropriate NFRC/ASHRAE approved U or R value of the windshield/side windows.
  For sample heat calculation purpose, the heat transfer coefficient for 1/4 inch laminated/tempered glass is estimated at 0.88 BTU/hr ft^2 °F or 5 W/m^2 °K in this manual.

- HEAT LOSS THROUGH THE DOOR MOVEMENT
  Opening and closing of the door makes interior and exterior air to exchange (air leakage), which ultimately lowers the compartment temperature.
  Such heat losses through frequent door movements mainly occur in transit, passenger or utility vehicles operating in an urban area. The exact amount of heat loss can be very hard to determine since it varies a lot depending on the size and type of the door, time duration and frequency of doors moments, as well as the amount of wind speed and pressure difference between inside and outside the compartment. Therefore, it is recommended to contact vehicle specialist or compartment builder for additional information. For the heat calculation purpose, a simple multiplication factor of 1.2 is considered that can mostly compensate the heat losses through door movements, latent heat loads and duct loss.

- HEAT LOSS THROUGH THE DUCT
  Sometimes in mid size specialty, passenger or cargo vehicles, if a section of duct network is placed outside the heated space, then the heat transfers through a duct wall in such parts of the network can be called as heat loss through the duct. In such cases, it is recommended that the duct exterior is covered with thermal insulation materials to minimize the heat loss through duct wall. If it is not possible, then apply a multiplying factor of 1.2 during the heat calculation to compensate heat losses through duct walls, latent heat, and door movement.

HEAT REQUIREMENT CALCULATION

As discussed earlier, a precise analysis of the necessary heating output should be carried out in the interest of economically and ecologically appropriate heating of vehicle and cargo compartments.

Generally, a simpler version of heat calculation is suffice for the most vehicles. Nevertheless for some specialty, passenger vehicles or cargo compartments, it is highly recommended to find the overall heat requirement using exact heat calculation after a complete evaluation of the application, possible design constraints, operational conditions and statutory regulations.

- SIMPLE CALCULATION OF HEAT REQUIREMENT

1 COMPARTMENT VOLUME: **m^3 or (ft^3)***

$$V_{Compartment} = L \times H \times W$$

2 TEMPERATURE DIFFERENCE: **°C or (°F)***

$$\Delta T = T_{Ambient} - T_{Desired}$$

3 INSULATION MATERIAL: **RSI or [(US) R]*** (see table below)

GOOD INSULATION	Closed sandwhich construction where insulation material (US) R > 6* i.e. closed cell is used.
MEDIUM INSULATION	Regular Vehicle cabs, or containers in simple construction with R > 3 is used. - insulation material.
LOW INSULATION	minimum insulated or hardwood compartments (3 > (US) R > 1).

* For American units only.

PLEASE NOTE!

- In SI units, the R value is sometimes named as RSI.
- To determine heat requirement using simple calculation, It is necessary to have minimum insulation (US) R > 1) in the compartment.
- Use Precise calculation to find the heat requirement for non insulated compartments (like metallic or glass structure).

4 SELECT THE HEAT REQUIREMENT RATE FOR RETURN/FRESH AIR MODE FROM THE TABLE:

$$\Delta Q_{(Heat\ requirement\ rate)} : W / m^3\ (BTU / hr\ ft^3)$$

PLEASE NOTE!

- The table showing the heat requirement rate is determined based on the 30°C (ΔT). Any changes in the ΔT value will linearly change its heat requirement rate value.

5 CALCULATE THE HEAT REQUIREMENT:

W or **(BTU / hr)** for fresh or Return air mode by:

$$Q_{heat\ requirement} = \Delta Q_{Heat\ requirement\ rate} \times V_{Compartment}$$

3 Heater Selection & System Design

HEAT REQUIREMENT CALCULATION... Continuation

HEAT REQUIREMENT RATE

Compartment Insulation °K·m²/W [hr·ft²·°F/Btu]	Good RSI > 1.06 [(US) R > 6]	Medium RSI > 0.53 [(US) R > 3]	Poor 0.53 > RSI > 0.18 [3 > (US) R > 1]
Temperature Difference	30°C [54°F]	30°C [54°F]	30°C [54°F]
Required heating out put W/m³ [Btu / hr · ft³] (Return Air Heating System)	125 - 200 [12.05 - 19.30]	200 - 275 [19.30 - 26.55]	275 - 375 [26.55 - 36.25]
Required heating out put W/m³ [Btu / hr ·ft³] (Fresh Air Heating System)	150 - 240 [14.50 - 23.20]	240 - 330 [23.20 - 31.90]	330 - 450 [31.90 - 43.50]

PLEASE NOTE!

For some applications (like specialty or passenger vehicles), it is necessary to include additional factors (like ventilation system); therefore, it is mandatory to size the heater using precise calculation only.

EXAMPLE:

APPLICATION:	Cargo Compartment
TYPE OF VEHICLE:	Mid Size Truck
INTENDED USE:	Space heat
COMPARTMENT DIMENSIONS :	4.4 x 2 x 2 m
AMBIENT TEMPERATURE:	- 10 °C
DESIRED TEMPERATURE:	20 °C
VENTILATION:	None
INSULATION TYPE:	Polyurethane (RSI = 1.10)
INSULATION QUALITY:	Good
UNITS:	Metric

- TEMPERATURE DIFERENCE (ΔT) = $T_{Required}$ - $T_{Ambient}$
  = 20 °C - -10 °C
  = 30 °C

- VOLUME OF THE COMPARTMENT

$V_{Compartment}$ = L x W x H
= 4.4 x 2 x 2
= 17.6 m^3

- HEAT REQUIREMENT RATE (ΔQ)

$\Delta Q_{(Heat\ requirement\ rate)}$ = (select value from good insulation in the table)

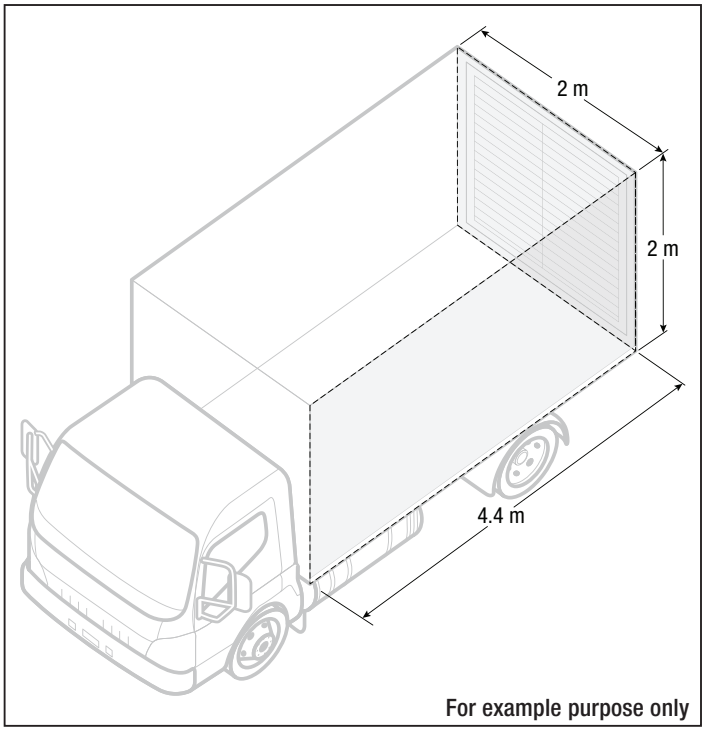
$\Delta Q_{(Heat\ requirement\ rate)}$ = 125 W/m³ (@ Return air mode)
$\Delta Q_{(Heat\ requirement\ rate)}$ = 150 W/m³ (@ Fresh air mode)

- HEAT REQUIREMENT

$Q_{(Heat\ requirement)}$ = $\Delta Q_{(Heat\ requirement\ rate)}$ x $V_{Compartment}$

$Q_{(Heat\ requirement)}$ = 125 x 17.6
= **2200 W** (@ Return air mode)

$Q_{(Heat\ requirement)}$ = 150 x 17.6
= **2640 W** (@ Fresh air mode)



For example purpose only

HEATER SELECTION (GOOD INSULATION)	Air heater in recirculating air mode	Air heater in fresh air mode
Heat demand	2200 W	2640 W
Suitable heater	Airtronic (D2)	Airtronic (D4)
Number of heaters	1	1
Total power	2200	4000

3 Heater Selection & System Design

EXACT CALCULATION OF HEAT REQUIREMENT

The following data are needed for exact calculation of the heat demand:

- TEMPERATURE DIFFERENCE (ΔT):

RANGE OF APPLICATION	OUTSIDE TEMPERATURE (avg.)	DESIRED INTERIOR TEMPERATURE (avg.)	TEMPERATURE DIFFERENTIAL	PRIMARY PURPOSE OF THE HEATING SYSTEM
Cargo compartment (medical,food, beverages, control & paint)	-15°C	10°C	25°C	Frost monitor, climate control
Passenger compartment (RV, buses, cars, truck cabs, specialty vehicles)	-15°C	22°C	37°C	Supplementary Space heating, Climate control

In heat calculation, it is the temperature difference between ambient temperature and desired temperature in the compartment. It is recommended to establish necessary value of interior temperature depending on the application.

PLEASE NOTE! the required temperature must be measured at the location in the compartment where a maximum heat is required. Some values of required temperatures as shown in the table above can be used in general cases.

- COMPARTMENT VOLUME (V):
  The volume (m^3 or ft^3) is calculated using:

  $$V = L \times W \times H$$

  (dimensions of the vehicle / cargo space in [m] or [ft.])

- SURFACT AREA [A] OF THE VEHICLE/CARGO COMPARTMENT:
  The surface area (m^2 or ft^2) is calculated using:

  $$A = 2 (L \times W + L \times H + W \times H)$$

  Above formula is used when the surface area is covered by insulation material with same heat transfer coeficient rating U, otherwise area of each surfaces are required to be calculated separately.

- THERMAL CONDUCTIVITY:

  $$k = W/m\ °K \quad \text{or} \quad Btu / hr\ ft\ °F$$

  The ability of a material to transfer the heat in its steady state is called as its thermal conductivity or k-factor. It is the function of the heat transfer per unit of time (dQ/dt or heat flow Q) and temperature gradient (ΔT/t) through Area A (the area through which the heat is flowing perpendicularly).

  It is measured in metric units: **W / m°K** or in american units: **Btu / hr ft°F**

- HEAT TRANSFER RESISTANCE:

  $$R = m^2\ °K / W \quad \text{or} \quad hr\ ft^2\ °F / Btu$$

  It is a measure of a resistance to the heat transfer per a unit area and temperature gradient while passing through a material with certain thickness, also called as R value of a material. When the material thickness (t) is divided by its (k) thermal conductivity (t/k), then the heat transfer resistance of that material can be found (R).

  $$R = t / k$$

For the most insulation material selection, the heat transfer resistance value (R) provides key information related to the thermal performance of any material. Like thermal conductivity, the heat transfer resistance can be found in metric units: **m^2 °K / W** or in american units: **hr ft^2 °F / Btu**.
Normally, all insulation materials are rated with resistance values (R) at standard thickness (in or m) depending on the manufacturer.
The R value can be improved by increasing the thickness of the insulating material in the vehicle compartment. If a surface area is made of composite materials or laminated sheets like FRP, then the overall R value can be found by adding resistance values of all material in series using equations:

$$R' = R_1 + R_2 + R_3...$$
or
$$R' = R_1 + t_2 / k_2 + t_3 / k_3 + R_4 + t_5 / k_5...$$

In metric system, the R value is also called as RSI.
The conversion factor for RSI and R (US) is:

1 RSI = R value (American) x 0.176
1 R value (American) = RSI x 5.678

- OVERALL HEAT TRANSFER COEFFICIENT:

  $$U = W / m^2\ °K \text{ or } Btu / hr\ ft^2\ °F$$

  As the name implies, it is the overall rate of the heat being transfered in a uni directional motion through a single material or laminated sheet in their study state condition. It is a reciprocal value of the overall heat transfer resistance R' and can be found using one of these equations:

  $$U = 1 / R' \text{ or } 1 / R_1 + R_2 + R_3...$$
  or
  $$1 / R_1 + t_2 / k_2 + t_3 / k_3 + R_4 + t_5 / k_5...$$

  The overall heat transfer coefficient (U) is one of the most important multiplying factors for the heat requirement calculation. Like R values, many manufacturers, especially windows and doors, provide U values of the materials as a thermal performance indicator.

  The U values is measured in metric units: **W / m^2 °K** or in american units: **Btu / hr ft^2 °F**.

  The conversion formula for USI and U (US) is:

  1 USI = U value (American) x 5.678
  1 U value (American) = USI x 0.176

THERMAL PROPERTIES OF MATERIALS (STRUCTURAL AND INSULATING)

	METAL	k - VALUE	
		Btu / hr ft °F	W/m °K
1	Aluminum (pure)	118.50	205
2	Aluminum (alloy)	86.71	150
3	Iron	34	60
4	Steel (mild)	23.16	45.26
5	Steel (carbon)	31.21	54
6	Steel (stainless)	9	15
7	Steel (crome)	23.12	40
8	Copper	223.12	386

	METAL	k - VALUE	
		Btu / hr ft °F	W/m °K
9	Bronze	30	51.90
10	Brass	63.60	111
11	Zinc	67	115
12	Tin	37	64
13	Magnesium	90.20	156
14	Nickel	52.40	90.60
15	Platinum	41.40	71.60
16	Titanum	33.20	57.40

	WOOD	k - VALUE		R - VALUE	
		Btu / hr ft °F	W/m °K	hr ft² °F / Btu (1 inch)	m² °K / W (25.4 mm)
1	Hard wood	0.086	0.15	0.96	0.169
	Mahogany	0.080	0.14	1.03	0.181
	Oak, Birch, Maple	0.086	0.15	0.96	0.169
2	Soft Wood	0.075	0.13	1.11	0.195
	Pine, Fir, Redwood	0.080	0.14	1.03	0.181
3	Plywood	0.069	0.12	1.2	0.211
4	Sterling, OSB	0.075	0.13	1.11	0.195
5	Hard board	0.063	0.11	1.31	0.230
6	Fiber board	0.080	0.14	1.03	0.181
7	Chip board	0.086	0.15	0.96	0.169
8	Card board	0.120	0.20	0.72	0.127

	INSULATING MATERIAL	k - VALUE		R - VALUE	
		Btu / hr ft °F	W/m °K	hr ft² °F / Btu (1 inch)	m² °K / W (25.4 mm)
1	Exp. Polystyrene Board, mold				
	(XPS)	0.0173	0.030	4.77	0.84
	(EPS)	0.020	0.036	3.97	0.70
2	Exp. Polyurethane				
	(board, rigid panels)	0.011 - 0.013	0.019 -0.023	7.55 - 6.25	1.33 - 1.10
	(spray foam)	0.011 - 0.014	0.020 - 0.025	7.21 - 5.74	1.27 - 1.01
3	Polyisocyanurate				
	(board, rigid panels)	0.011- 0.013	0.020 - 0.023	7.21 - 6.25	1.27 - 1.1
	(spray foam)	0.011 - 0.017	0.020 - 0.030	7.21 - 4.77	1.27 - 0.84
4	Polythene	0.23	0.4	0.34	0.06
5	PTFE (teflon)	0.14	0.24	0.6	0.106
6	Exp. PVC	0.020	0.035	4.09	0.72
7	Fiber Glass				
	(batts, rigid panels)	0.021	0.037	3.86	0.68
	(loose fill, wool)	0.022	0.038	3.75	0.66
	(GRP)	0.012	0.21	0.68	0.120
8	Mineral Wool / fibers	0.022	0.039	3.69	0.65
9	Air				
	(Inside film)			0.63	0.11
	(Outside film)			0.17	0.03
	(Still air in cavity or air gap)			0.97	0.17

	GLASS MATERIAL	U - VALUE	
		Btu / hr ft² °F.	W / m² °K
1	Laminated / Tempered (6 mm)	0.88	5

PLEASE NOTE!

Values provided in aforementioned table may be used in heat calculations for general applications only. However, the thermal parameters for each material may vary depending on its type and quality as well as the manufacturer. It is recommended to acquire exact values for insulating materials used in the vehicle, so precise quantity of the heat requirement can be calculated.

3 Heater Selection & System Design

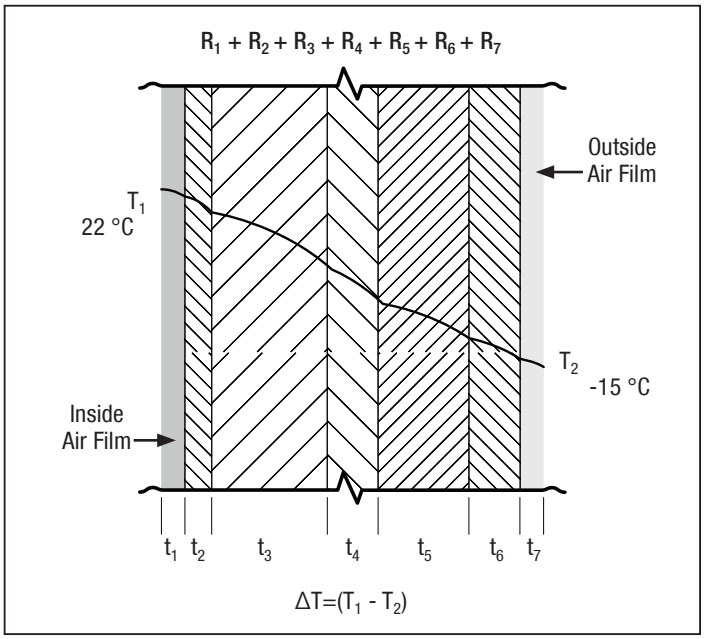
- HEAT LOSS IN SERIES AND PARALLEL
  When the heat is transfered through a number of dissimilar materials and each with different dimensions, thermal resistance values (R) or thermal conductivity values (k), then additional consideration is needed as whether the heat is going to be lost or transfered through materials in series or parallel.

  — HEAT LOSS THROUGH MATERIALS IN SERIES: When the surface area of the vehicle is made of composite or laminated materials joined together in series as shown in the image, then each of their thermal resistances (R1, R2, R3..) values are required to be added to find overall thermal resistance (R'). Similarly, If a different thermal specifications in terms of their thermal conductivity values (k) and thermal resistance values (R) are available for each layer of the composite panels, then the overall thermal resistance (R') can be found through:

$$R' = R_1 + {}^{t_2}/_{k_2} + R_3 + R_4 + R_5 + {}^{t_6}/_{k_6} + R_7$$

$$U = {}^{1}/_{R'}$$

  The reciprocal of overall thermal resistance (1/R') is the overall thermal coefficient U.

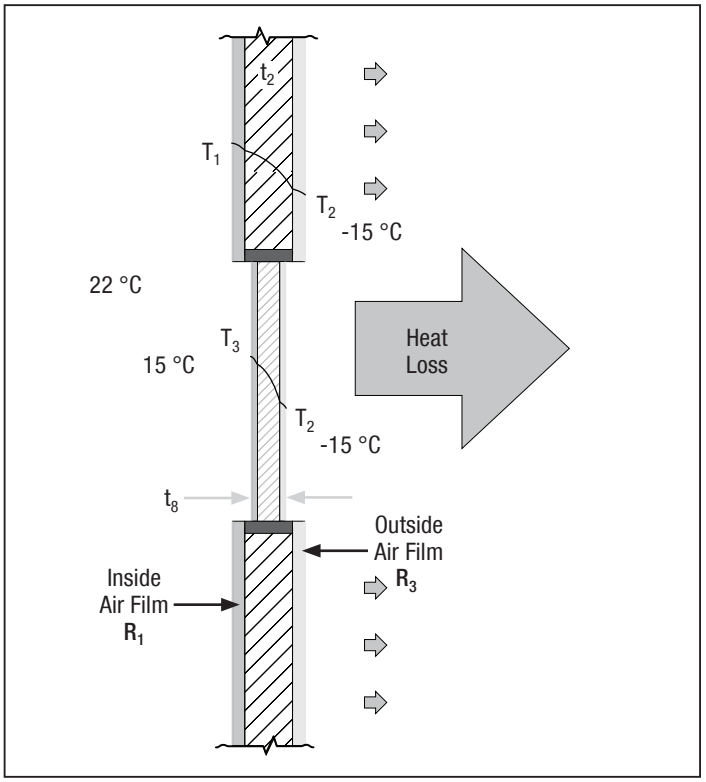


For illustration purpose only

  — HEAT LOSS THROUGH MATERIALS IN PARALLEL AND THERMAL BRIDGING:

  When a surface area of vehicle has two or more unlike materials located in parallel, for example: an insulated wall with glass window or door as shown in the figure, then the heat transfer rate between insulated wall and glass window or door can be different.
  Since a glass window has very low thermal resistance in comparison with an insulated wall, the heat loss/tranfers through windows are relatively large, such phenomenon is also called as thermal bridging. To simplify the heat calculation, the heat transfer coefficient (U) is calculated for both material separately using their independent heat resistance values (R).

  PLEASE NOTE!
  The heat loss through a thermal bridging must be rectified using various insulation or weather stripping procedures available in the automobile industry.



$$R'_{(\text{insulated surface})} = R_1 + R_2 + R_3$$
$$U'_{(\text{insulated surface})} = 1/R'_{(\text{insulated surface})}$$

$$R'_{(\text{glass surface})} = R_1 + t_8 / k_{(\text{glass surface})} + R_3$$
$$U'_{(\text{glass surface})} = 1/R'_{(\text{glass surface})}$$

- AIR FILMS
  It consist layers of of static air on each side of a vehicle envelope or volumes of entraped air within vehicle structures. They can contribute substantially to the insulating capabilities of some structural assemblies. Furthermore, air films play a vital role in reducing heat transfer through noninsulated surface area like glass or metal.
  The R-value of the air film is based on variables like outside air, inside air, wind-speed, and air density. It is important to select appropriate R-value of the air film for heat calculation.

For sample heat calculation, the R-value for the air film is:

Inside air*: 0.63 (R), or 0.11 (R)
Outside air*: 0.17 (RSI), or 0.03 (RSI)

* The R-value is for the air film under the normal wind condition only.

U =	Overall Heat Transfer Coefficient	W/m^2 °C	or	BTU / hr ft^2 °F
R =	Heat Transfer Resistance Coefficient	m^2 °C/W	or	hr ft^2 °F/BTU
R' =	Overall Heat Transfer Coefficient	m^2 °C/W	or	hr ft^2 °F/BTU
k =	Specific Thermal Conductivity	W/m °C	or	BTU / hr ft °F
t =	Thickness of the insulating material	m / mm	or	ft / inch

SPECIFIC HEAT CAPACITY

The specific heat capacity of a substance is the heat energy needed to raise the temperature of 1 kg (1 lb) of the material by 1 °K (1°F).

C_{air} = Specific air heat capacity – 1 [KJ / kg K]

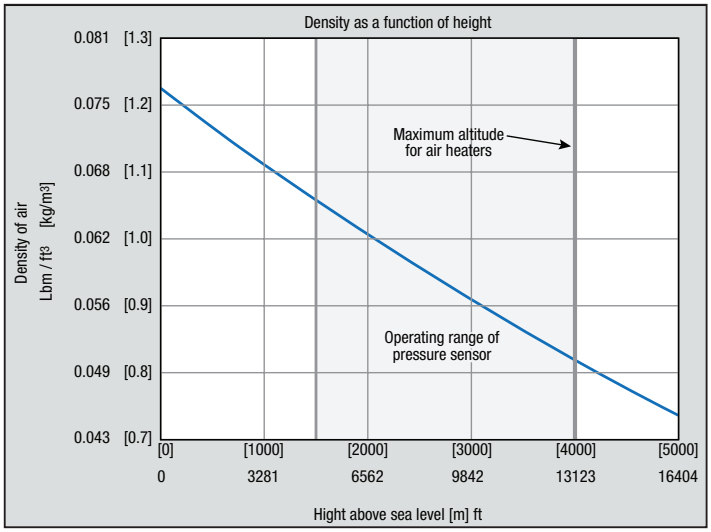
Similarly in heating systems, the amount of heat required to raise the interior temperature up to the desired value is directly depending on the specific heat capacity of the air. For heat calculation purpose, the specific heat capacity of the air at constant pressure is:

0.24 BTU / hr lb °F (american) or 1000 Jules / kg °K (metric).

PLEASE NOTE! The value of specific heat capacity of the dry air at constant pressure remains stable regardless of the temperature and pressure.

ρ_{air} = dense air [kg / m^3] corresponding to 1.2 kg / m^3 at 25 °C sea level

- AIR DENSITY:
  It is an intrinsic property of the air that describes its mass per unit volume (The symbol used for density is **ρ**). The density of air inherently an independent of the earth's gravity; however, its value varies with changes in temperature, pressure and humidity. In other words, as the temperature increases, the density of the air decreases; or, as pressure increases, or density of the air increases, vice versa.
  In heating system, the overall mass of air in the compartment is needed for the heat calculation, which can be found be using density of air and volume of the compartment.
  In addition, air density value must be selected according to the normal operating altitude of the heater.
  The graph shows the relation between air density value, altitude and temperature.



PLEASE NOTE! The compressibility effect of air can change its density as well; however not accounted in the heat calculation.

PLEASE NOTE! The lower air density at high altitude operation alters the air/fuel ratio of the heater (λ <1), which is compensated by air pressure sensor by reducing the fuel input and eventually the heater output by 9% / 1000 m. Further information related to effects of air density can be found in high altitude factor and air pressure sensor topics.

- AIR CHANGE PER HOUR:
  As mentioned in earlier ACH section, it is used to determine the overall air exchange rate through the compartment via either air leakage or controlled ventilation system. For air leakage, the ACH value is 2, while for fresh air, it is determined based on the heater throughput and compartment volume. In return air mode, the ACH value (if required) is based on the ventilation rate (cfm) and compartment volume.

  Sufficient ventilation in the compartment is recommended; however it is up to the user to select appropriate (ACH) rate and type of the ventilation.

- MULTIPLICATION FACTOR:
  For heat loss through duct walls, latent heat and door movements in mid size passenger vehicles, or cargo containers, apply a multiplication factor of 1.2 on the total required heat value. It must be noted that the heat loss may be larger if the door movement frequency is very high or large network of duct channels are exposed to outside atmosphere.

- HIGH ALTITUDE FACTOR:
  Due to changes in air pressure, the heat output of the heater may vary according to its operating altitude. Normally, the heater is within its acceptable range when it operates up to 1500 meter altitude. Any higher altitude will cause operating difficulties in the heater and requirement of the pressure sensor/compensator arises. Between 1500 to 4000 m, the pressure sensor adjusts the heater output at the rate of 9% /1000 meter. In other words, between 1500 to 4000 m, the pressure sensor adjusts the heat output of the airtronic D2 and D4 by 200 W/1000 m and 360 W/1000 m respectively. It is, therefore, necessary to account any possible changes in the heater output during heat calculation according to the average operational altitude of the heater.

  PLEASE NOTE! Always calculate the heater size according to its normal altitudes during its operating life. In addition, the high altitude sensor/ compensator must be connected to the heater system if the operating altitude is higher than 1500 meter.

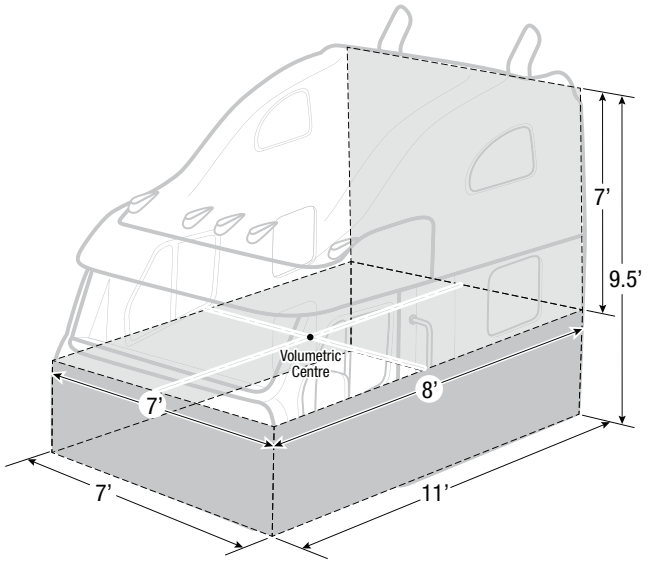
  It is not recommended to use the heater at altitudes higher than 4000 meters from sea level.

EQUATION FOR CALCULATING THE HEAT REQUIREMENT:

$A'_{\text{(total surface area)}}$	=	$A_1 + A_2 + A_3 + A_4 + A_5 + A_6$
$A_{\text{(structural/Insulated area)}}$	=	$A_{\text{(total surface area)}} - [A_{\text{(total glass area)}} + A_{\text{(doors)}}]$
$V_{\text{(compartment volume)}}$	=	L x W x H
R'	=	t / k or $(t_1 / k_1 + R_2 + t_3 / k_3 + R_4...)$
U'	=	$1/R' = [1 / (R + t_1 / k_1 + R_2 + t_2 / k_2...)]$
Q_t'	=	$Q°_{\text{loss surface area}} + Q°_{\text{overall air loss}}$
$Q°_{\text{(loss) surface area}}$	=	U x A x ΔT
$Q°_{\text{surface area}}$	=	$Q_{\text{wall}} + Q_{\text{glass surfaces}} + Q_{\text{door}} + Q_{\text{floor}} + Q_{\text{roof}}$
$Q_{\text{loss air}}$	=	$m° \times C_{\text{air}} \times \Delta T / 3600$ (SI units)
$Q_{\text{loss air}}$	=	$m° \times C_{\text{air}} \times \Delta T°$ (imperial units)
$Q°_{\text{Overall loss air}}$	=	$Q_{\text{loss air}} \times ACH_{\text{fresh air}}$
m°	=	$V°_{\text{compartment}} \times \rho_{\text{air}}$
$V°_{\text{compartment}}$	=	V/1 (1 = 1 h)
$ACH_{\text{fresh air}}$	=	$q_{\text{heater}} / V°_{\text{compartment}}$
$ACH_{\text{ventilation}}$	=	$q_{\text{mechanical fan}} / V°_{\text{compartment}}$
Q°	=	Overall heat requirement (KW or Btu / hr)
U'	=	Overall heat transfer coefficient
R	=	Heat transfer resistance
R'	=	Overall Heat transfer resistant
k	=	Thermal conductivity
A'	=	total surface area
ΔT	=	Temperature difference
C_{air}	=	Specific heat capacity
m_{air}	=	air mass flow
q_{heater}	=	heater throughput
$q_{\text{mechanical fan}}$	=	ventilation fan throughput
$V_{\text{compartment}}$	=	compartment volume
ACH	=	Air change per hour
ρ_{air}	=	air density
1.2	=	multiplication factor: (duct, door and latent heat loss)
t	=	thickness of material (structural or insulated)

EXACT HEAT CALCULATION

1) EXAMPLE CALCULATION:	
APPLICATION:	Pick ups / Day cab / Sleeper type class 8 truck cab
TYPE OF VECHICLE:	Sleeper truck cab (high roof),
COMPARTMENT DIMENSIONS:	8 x 7 x 7 ft (max. usable space measured at volumetric center)
INSULATION TYPE:	Closed Cell Polyurethane: R - Value = 6.2 / inch
GLASS TYPE:	Laminated / Tempered (windshield / Side windows)
AIR FILM:	$R_{(inside\ air\ film)} = 0.63$, $R_{(outside\ air\ film)} = 0.17$,
PRIMARY USAGE:	temporary space heat in the sleeper cab (night time)
HEATING SYSTEM:	Return or Fresh Air,
VEHICLE CONDITION:	Enclosed, In parking (ACH value changes with speed)
NUMBER OF PASSENGERS:	2, Average
NORMAL OPERATING ALTITUDE:	Sea level,
AIR DENSITY (ρ_{air}):	0.075 lbm / ft³ (Sea level)
SPECIFIC HEAT CAPACITY (C_{air}):	0.240 BTU / hr lbm °F
AMBIENT TEMPERATURE (WINTER):	7 °F (Night)
VENTILATION: * For optional purposes only	For non ventilated compartment - Air leakage (ACH = 2 @ return air mode) For Ventilated compartment* - Exhaust vent (ACH = heater throughput @ fresh air mode)*
POSSIBLE HEAT GAIN:	Negligible (appliances and passengers)
DOOR MOVEMENT (HEATER ON):	Negligible
LATENT HEAT LOAD:	Negligible
PLANNED DUCT LAYOUT:	Inside compartment
UNITS:	American



For example purpose only

EXACT HEAT CALCULATION... Continuation

- VOLUMETRIC HEIGHT (h) = 0.77 x H
  = 0.77 x 9.5 = 7.0 *ft* (Approx.)

- TEMPERATURE DIFERENCE (ΔT) = $T_{Required} - T_{Ambient}$
  = 72 °F - 7 °F
  = 65 °F

SURFACE AREA AND COMPARTMENT VOLUME

- INSULATED SURFACE AREA

$A_{Insulated\ Surface} = A_{Total\ Surface} - A_{Glass\ Surface}$
= 322 - 20
= 320 ft^2

- TOTAL SURFACE AREA

$A_{Total\ Surface} = 2(L \times W + L \times H + W \times H)$
$= 2(8 \times 7 + 8 \times 7 + 7 \times 7)$
$= 2(56 + 56 + 49)$
= 322 ft^2

- GLASS SURFACE AREA

$A_{Glass\ Surface}$ = 20 ft^2

- VOLUME OF THE COMPARTMENT

$V_{Compartment} = L \times W \times H$
$= 8 \times 7 \times 7$
= 392 ft^3

R - VALUE

- INSULATED SURFACE

$R_{Polyurethane}$ = 6.2 (per inch)
$R_1 = t \times R_{(Polyurethane)}$
$= 1 \times 6.2$
= 6.2 $ft^2\ °F\ hr / BTU$

$R_{Outside\ Air\ Film}$ = 0.17
$R_{Inside\ Air\ Film}$ = 0.63

$R'_{Total} = R_1 + R_{Inside\ Air\ Film} + R_{Outside\ Air\ Film}$
$= 6.2 + 0.63 + 0.17$
= 7 $ft^2\ °F\ hr/BTU$

U - VALUE

- INSULATED SURFACE

$U'_1 = 1 / R'_{Total}$
$= 1 / 7$
= 0.14 $BTU / hr\ ft^2\ °F$

- GLASS SURFACE

U'_2 = 0.88 $BTU / hr\ ft^2\ °F$

HEAT LOSS THROUGH SURFACE AREA

- HEAT LOSS - INSULATED AREA

$Q°_{Loss\ Insulated\ Surface} = U'_1 \times A_{Insulated\ Surface} \times \Delta T$
$= 0.14 \times 302 \times 65$
= 2748 *Btu / hr*

- HEAT LOSS - GLASS AREA

$Q°_{Loss\ Glass\ Surface} = U'_2 \times A_{Glass\ Surface} \times \Delta T$
$= 0.88 \times 20 \times 65$
= 1144 *Btu / hr*

- TOTAL HEAT LOSS - SURFACE AREA

$Q°_{Surface\ Area} = Q_{Loss\ (Insulated)} + Q_{Loss\ (Glass)}$
$= 2748 + 1144$
= 3892 BTU / hr

EXACT HEAT CALCULATION... Continuation

- HEAT LOSS THROUGH AIR

$Q°_{\text{Compartment Air}} = m°_{\text{air}} \times C_{\text{air}} \times \Delta T$
$= 29.4 \times 0.240 \times 65$
$= 458.64$ *Btu / hr*

- MASS OF COMPARTMENT AIR

$m°_{\text{air}} = V°_{\text{compartment}} \times \rho_{\text{air}}$
$= 392 \times 0.075$
$= 29.4$ *lb*

HEAT LOSS THROUGH VENTILATION

- RECIRCULATED HEATING SYSTEM

$ACH_{\text{(Recirculated, non ventilated)}} = 2$ (Air leakage)
$Q°_{\text{Air (recirculated, non ventilated)}} = 458.64 \times 2$
$= 917.28$ *Btu / hr*

* Airtronic D2 with 60 mm hood
** Optional heating system (Sample purpose only)

- FRESH AIR HEATING SYSTEM**

$ACH_{\text{(Fresh air, ventilated)}} = \frac{\text{Air Flow / hr (Airtronic D2) 48cfm*}}{V°_{\text{compartment}}} = \frac{2887.5}{392} = 7.36$

$Q°_{\text{Air (fresh air, ventilated)}} = 458.64 \times 7.36$ (@ Airtronic D2 throughput)
$= 3375.59$ *Btu / hr*

CALCULATION OF THE TOTAL HEAT REQUIREMENT

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE

$Q°_{\text{Total (recirculated)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (recirculated, non ventilated)}}$
$= 3892 + 917.28$
$= 4809.28$ Btu / hr

- FRESH AIR HEATING SYSTEM**

$Q°_{\text{Total (fresh air)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (fresh air, ventilated)}}$
$= 3892 + 3375.59$
$= 7267.59$ Btu / hr

HEATER SELECTION	Air heater in recirculating air mode (Non Ventilated: Air Leakage)	Air heater in Fresh air mode ** (Ventilation: Heater Throughput)
Heat demand	4809.28 Btu / hr	7267.59 Btu / hr
Suitable heater	Airtronic (D2)	Airtronic (D2)
Number of heaters	1	1
Total power	7500 Btu / hr	7500 Btu / hr

** Optional heating air mode (For sample purpose only)

HEAT CALCULATION: ASSUMPTION AND EXCLUSION

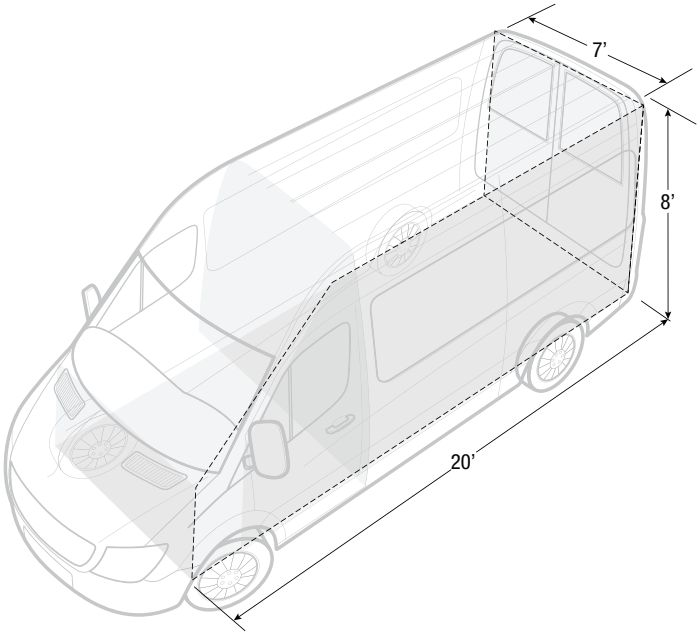
- INSULATION: Any parameters related to structural type, dimensions and insulation (R- value) are roughly estimated for the example purpose only. In addition, the thermal values of the sheet metal body, surface barriers (vapors, sound, thermal) and flooring carpet are excluded in the calculation.
- OPERATING CONDITIONS: The calculation assumes average winter temperature in the night. The heat gain through radiation (from sunlight, engine, passengers or any appliance) is not included.
- HEATING MODES: Both return air and fresh air heating modes are assumed and calculated separately.
  In return air mode, the air is sufficiently ventilated by the air leakage. However, if it is required, then additional air is supplemented by a separate ventilation system.
- VEHICLES MODE: Enclosed compartment, stationary vehicle.
- HIGH ALTITUDE OPERATION: The calculation assumes the heater operation at sea level.

  PLEASE NOTE! The operating altitude is determined by the location at which maximum amount of the heater operation will take place.
  Adjust air density according to the operating altitude in the heat calculation. The specific heat capacity of the air at constant pressure remains similar within the maximum operating altitude of the heater.
- MULTIPLYING FACTOR: Not required.
- HEATER SELECTION: The heater size is based on the final value of the heat calculation. Never select an air heater with the heat output lower than minimum required heat (final value).

3 Heater Selection & System Design

EXACT HEAT CALCULATION... Continuation

2) EXAMPLE CALCULATION:	
APPLICATION:	Camper or Passenger type Van
TYPE OF VECHICLE:	Mega roof Sprinter Type (app.),
COMPARTMENT DIMENSIONS:	20 x 7 x 8 (approx.) (L x W x H)
INSULATION TYPE:	Polyurethane spray foam (R) 6.5 / inch, Foil faced polyisocyanurate rigid panel (R) 6.8 / inch (Floor)
GLASS TYPE:	Laminated/Tempered (windshield / Side windows)
AIR FILM:	$R_{(inside\ air\ film)} = 0.63$, $R_{(outside\ air\ film)} = 0.17$,
PRIMARY USAGE:	Space heating and Climate control (day & night)
HEATING SYSTEM:	Return or Fresh Air,
VEHICLE CONDITION:	Enclosed, In parking (ACH value changes with speed)
NUMBER OF PASSENGERS:	4, Average
NORMAL OPERATING ALTITUDE:	Sea level, Average
AIR DENSITY (ρ_{air})	0.075 lbm / ft^3 (Sea level)
SPECIFIC HEAT CAPACITY (C_{air})	0.240 BTU / hr lbm °F
AMBIENT TEMPERATURE (WINTER):	0 °F (Night)
VENTILATION: * For optional purposes only	For non ventilated compartment - Air leakage (ACH = 2 @ return air mode) For Ventilated compartment* - Mechanical fan (40 CFM to 60 CFM @ return air mode)* For Ventilated compartment* - Exhaust vent (ACH = heater throughput @ fresh air mode)*
POSSIBLE HEAT GAIN:	Minor, Variable (appliances and passengers)
DOOR MOVEMENT (HEATER ON):	Minor
LATENT HEAT LOAD:	Considerable while ventilation is ON (Not accounted)
PLANNED DUCT LAYOUT:	Inside compartment
UNITS:	American



For example purpose only

EXACT HEAT CALCULATION... Continuation

- TEMPERATURE DIFERENCE (ΔT) = $T_{Required} - T_{Ambient}$
  = 72 °F - 0 °F
  = 72 °F

SURFACE AREA AND COMPARTMENT VOLUME

- INSULATED SURFACE AREA (ROOF)

$A_{Insulated\ Surface\ (Roof)} = (L \times W)$
= 20 x 7
= 140 ft^2

- INSULATED SURFACE AREA (FLOOR)

$A_{Insulated\ Surface\ (Floor)} = (L \times W)$
= 20 x 7
= 140 ft^2

- INSULATED SURFACE AREA (WALLS)

$A_{Insulated\ Surface\ (Walls)} = A_{Total\ Surface\ (Walls)} - (A_{Glass\ Surface} + A_{Door\ Surface})$
= 432 - (42 + 9)
= 381 ft^2

- TOTAL SURFACE AREA (WALLS)

$A_{Total\ Surface\ (Walls)} = 2(L \times H + W \times H)$
= 2 (20 x 8 + 7 x 8)
= 2 (216)
= 432 ft^2

- GLASS SURFACE AREA

$A_{Glass\ Surface}$ = 42 ft^2

- DOOR SURFACE AREA

$A_{Door\ Surface}$ = 9 ft^2

- VOLUME OF THE COMPARTMENT

$V_{Compartment} = L \times W \times H$
= 20 x 7 x 8
= 1120 ft^3

R - VALUE

- AIR FILM

$R_{Outside\ Air\ Film}$ = 0.17
$R_{Inside\ Air\ Film}$ = 0.63

- INSULATED SURFACE (WALLS)

$R_{Polyurethane\ Foam}$ = 6.5 (per inch)
$R_1 = t \times R_{(Polyurethane)}$ = 1.5 x 6.5 = 9.75 ft^2 °F hr / BTU

$R_{Plywood}$ = 1.4 (per inch)
$R_2 = t \times R_{(plywood)}$ = 0.25 x 1.2 = 0.3 ft^2 °F hr / BTU

$R_{Sheet\ metal}$ = Negligible

$R'_{Total\ (Walls)} = R_{Outside\ Air\ Film} + R_1 + R_2 + R_{Inside\ Air\ Film}$
= 0.17 +9.75 + 0.3 + 0.63
= 10.85 ft^2 °F hr/BTU

- **U** - VALUE (WALLS)

$U'_{(Walls)} = 1 / R'_{Total\ (Walls)}$
= 1 / 10.85
= 0.091 BTU / hr ft^2 °F

- GLASS SURFACE

$U'_{(Glass)}$ = 0.88 BTU / hr ft^2 °F

- INSULATED SURFACE (ROOF)

$R_{Polyurethane\ Foam}$ = 6.5 (per inch)
$R_1 = t \times R_{(Polyurethane)}$ = 1.5 x 6.5 = 9.75 ft^2 °F hr / BTU

$R_{Plywood}$ = 1.4 (per inch)
$R_2 = t \times R_{(plywood)}$ = 0.25 x 1.2 = 0.3 ft^2 °F hr / BTU

$R_{Sheet\ metal}$ = Negligible

$R'_{Total\ (Roof)} = R_{Outside\ Air\ Film} + R_1 + R_2 + R_{Inside\ Air\ Film}$
= 0.17 +9.75 + 0.3 + 0.63
= 10.85 ft^2 °F hr/BTU

- **U** - VALUE (ROOF)

$U'_{(Roof)} = 1 / R'_{Total}$
= 1 / 10.85
= 0.091 BTU / hr ft^2 °F

EXACT HEAT CALCULATION... Continuation

R - VALUE CONTINUATION

- INSULATED SURFACE (FLOOR)

$R_{Polyisocyanurate}$ = 6.8 (per inch)

R_1 = t x $R_{(polyisocyanurate)}$ = 1.5 x 6.8 = 10.2 *ft² °F hr / BTU*

$R_{Plywood}$ = 1.2 (per inch)

R_2 = t x $R_{(Plywood)}$ = 0.25 x 1.2 = 0.3 *ft² °F hr / BTU*

$R_{Sheet\ metal}$ = Negligible

$R'_{Total\ (Floor)} = R_{Outside\ Air\ Film} + R_1 + R_2 + R_{Inside\ Air\ Film}$

= 0.17 +10.2 + 0.3 + 0.63

= 11.3 *ft² °F hr/BTU*

- U - VALUE (FLOOR)

$U'_{(Floor)}$ = 1 / $R'_{Total\ (Walls)}$

= 1 / 11.3

= 0.08 *BTU / hr ft² °F*

- INSULATED SURFACE (DOOR)

$R_{Polyurethane\ Foam}$ = 6.5 (per inch)

R_1 = t x $R_{(Polyurethane\ foam)}$ = 1 x 6.5 = 6.5 *ft² °F hr / BTU*

$R_{Sheet\ metal}$ = Negligible

$R'_{Total\ (Door)} = R_{Outside\ Air\ Film} + R_1 + R_{Inside\ Air\ Film}$

= 0.17 + 6.5 + 0.63

= 7.3 *ft² °F hr/BTU*

- U - VALUE (DOOR)

$U'_{(Door)}$ = 1 / $R'_{Total\ (Door)}$

= 1 / 7.3

= 0.13 *BTU / hr ft² °F*

HEAT LOSS THROUGH SURFACE AREA

- HEAT LOSS - INSULATED AREA (WALLS)

$Q°_{Loss\ Insulated\ Surface\ (Walls)} = U'_{Walls} \times A_{Walls} \times \Delta T$

= 0.09 x 381 x 72

= 2468.68 *Btu / hr*

- HEAT LOSS - GLASS AREA

$Q°_{Loss\ Glass\ Surface} = U'_{Glass} \times A_{Glass\ Surface} \times \Delta T$

= 0.88 x 42 x 72

= 2661.1 *Btu / hr*

- HEAT LOSS - INSULATED AREA (ROOF)

$Q°_{Loss\ Insulated\ Surface\ (Roof)} = U'_{Roof} \times A_{Roof} \times \Delta T$

= 0.09 x 140 x 72

= 907.2 *Btu / hr*

- HEAT LOSS - INSULATED AREA (FLOOR)

$Q°_{Loss\ Insulated\ Surface\ (Floor)} = U'_{Floor} \times A_{Floor} \times \Delta T$

= 0.08 x 140 x 72

= 847.04 *Btu / hr*

- HEAT LOSS - INSULATED AREA (DOOR)

$Q°_{Loss\ Door\ Surface} = U'_{Door} \times A_{Door} \times \Delta T$

= 0.13 x 9 x 72

= 84.24 *Btu / hr*

- TOTAL HEAT LOSS - SURFACE AREA

$Q°_{Surface\ Area} = Q_{Walls} + Q_{Floor} + Q_{Roof} + Q_{Glass} + Q_{Door}$

= 2468.68 + 847.04 + 907.2 + 2661.1 + 84.24

= 6970.1 BTU / hr

- HEAT LOSS THROUGH AIR

$Q°_{Compartment\ Air} = m°_{air} \times C_{air} \times \Delta T$

= 84 x 0.240 x 72

= 1451.5 *Btu / hr*

- MASS OF COMPARTMENT AIR

$m°_{air} = V°_{compartment} \times \rho_{air}$

= 1120 x 0.075

= 84 *lb*

HEAT LOSS THROUGH VENTILATION

- RECIRCULATED HEATING SYSTEM

$ACH_{(Recirculated,\ non\ ventilated)}$ = 2 (Air leakage)

$Q°_{Air\ (recirculated,\ non\ ventilated)}$ = 1451.5 x 2

= 2903.4 *Btu / hr*

- FRESH AIR HEATING SYSTEM**

$ACH_{(Fresh\ air,\ ventilated)} = \frac{\text{Air Flow / hr (Airtronic D4*)}}{V°_{compartment}} = \frac{5100}{1120} = 4.55$

$Q°_{Air(Fresh\ air,\ Ventilated)}$ = 1451.5 x 4.55 (@ Airtronic D4* throughput)

= 6604.41 *Btu / hr*

* with 90 diameter hood

** optional heating system (sample purpose only)

- RECIRCULATED HEATING SYSTEM**

$ACH_{(Recirculated,\ ventilated)} = \frac{\text{Minimum Airflow / hr (mechanical fan @ 40 cfm)}}{V°_{Compartment}}$

$= \frac{2400}{1120} = 2.14$

$Q_{Air\ (Recirculated,\ with\ ventilation)}$ =1451.52 x 2.14 = 3106.25 *Btu / hr*

- RECIRCULATED HEATING SYSTEM**

$ACH_{(Recirculated,\ ventilated)} = \frac{\text{Maximum Airflow / hr (mechanical fan @ 60 cfm)}}{V°_{Compartment}}$

$= \frac{3600}{1120} = 3.21$

$Q_{Air\ (Recirculated,\ with\ ventilation)}$ = 1451.52 x 3.21 = 4659.37 *Btu / hr*

EXACT HEAT CALCULATION... Continuation

CALCULATION OF THE TOTAL HEAT REQUIREMENT

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (AIR LAEKAGE)

$Q°_{\text{Total (recirculated)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (recirculated, non ventilated)}}$
$= 6970.1 + 2903.40$
$= \mathbf{9873.5\ Btu / hr}$

- FRESH AIR HEATING SYSTEM

$Q°_{\text{Total (fresh air)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (fresh air, ventilated)}}$
$= 6970.1 + 6606.41$
$= \mathbf{13576.51\ Btu / hr}$

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (MECHANICAL VENTILATION)

$Q°_{\text{Total (recirculated)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (recirculated @ 2.14 ACH)}}$
$= 6970.1 + 3106.25$
$= \mathbf{10076.6\ Btu / hr}$

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (MECHANICAL VENTILATION)

$Q°_{\text{Total (recirculated)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (recirculated @ 3.21 ACH)}}$
$= 6970.1 + 4659.37$
$= \mathbf{11629.47\ Btu / hr}$

HEATER SELECTION

	Air heater in recirculating air mode (Non Ventilated: Air leakage)	Air heater in recirculating air mode** (Ventilation: 2.14 ACH @ 40 cfm)	Air heater in recirculating air mode** (Ventilation: 3.21 ACH @ 60 cfm)	fresh air mode** (Ventilation: Heater throughput)
Heat demand	9873.5 Btu / hr	10076.6 Btu / hr	11629.47 Btu / hr	13576.51 Btu / hr
Suitable heater	Airtronic (D4)	Airtronic (D4)	Airtronic (D4)	Airtronic (D4)
Number of heaters	1	1	1	1
Total power	13600 Btu / hr	13600 Btu / hr	13600 Btu / hr	13600 Btu / hr

** Optional heating air mode (for sample purpose only)

HEAT CALCULATION: ASSUMPTION AND EXCLUSION

- INSULATION: Any parameters related to structural dimensions and insulation (R- value) are roughly estimated for the example purpose only. In addition, the thermal values of the sheet metal body, surface barriers (vapors, sound, thermal) and flooring carpet are excluded in the calculation.
- OPERATING CONDITIONS: The calculation assumes average temperature in the night.
  The heat gain through passengers, engine, cab appliances, or sun rediation in the day is not included.
- HEATING MODES: Both return air and fresh air heating modes are assumed and calculated separately.
  In return air mode, the air is sufficiently ventilated by the air leakage. However, if it is required, then additional air is supplemented by a separate ventilation system.
- VEHICLES MODE: The heat calculation is considered assuming the vehicle is enclosed and in parking mode.
- HIGH ALTITUDE OPERATION: The calculation assumes the heater operation at sea level altitude.

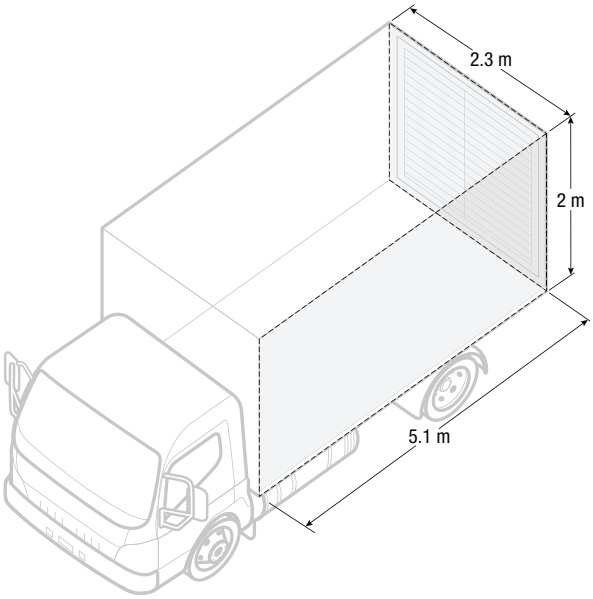
PLEASE NOTE! The operating altitude is determined by the location at which maximum amount of the heater operation will take place.
Adjust air density according to the operating altitude in the heat calculation. The specific heat capacity of the air at constant pressure remains similar within the maximum operating altitude of the heater.

- MULTIPLYING FACTOR: Heat losses from Latent heat load, door movements, duct loss is not accounted in the heat calculation. However, if required, then a multiplication factor: 1.2 (x Q total) may be generally sufficient for most applications.
- HEATER SELECTION: The selected heater is based on the final value of the heat calculation. Never select an air heater with the heat output lower than minimum required heat (final value).

3 Heater Selection & System Design

EXACT HEAT CALCULATION... Continuation

3) EXAMPLE CALCULATION:	
APPLICATION:	Cargo compartment (Mid size truck or Van)
TYPE OF VECHICLE:	Mid size truck (Cargo: Wooden furniture and matress)
COMPARTMENT DIMENSIONS:	5.1 x 2.3 x 2 (approx.) (L x W x H)
INSULATION TYPE (k value):	FRP @ Walls & Roof (0.036); Hardwood @ floor (0.15); Plywood sliding @ Door (0.12)
GLASS TYPE:	Not applicable
AIR FILM:	$R_{(inside\ air\ film)} = 0.11$, $R_{(outside\ air\ film)} = 0.03$
PRIMARY USAGE:	Humidity control and space heating
HEATING SYSTEM:	Return or Fresh Air,
VEHICLE CONDITION:	Enclosed, In parking (ACH value changes with speed)
NUMBER OF PASSENGERS:	None
NORMAL OPERATING ALTITUDE:	2500 mts (From sea level)
AIR DENSITY (ρ_{air}):	0.9 kg / m^3 (@ 2500 mts altitude)
SPECIFIC HEAT CAPACITY (C_{air}):	1000 J / kg °K
AMBIENT TEMPERATURE (WINTER):	-15 °C (Night)
REQUIRED TEMPERATURE:	15 °C
VENTILATION: * For optional purposes only	For non ventilated compartment - Air leakage (ACH = 2 @ return air mode) For Ventilated compartment* - Mechanical fan (70 m^3/hr to 185 m^3/hr @ return air mode)* For Ventilated compartment* - Exhaust vent (ACH = heater throughput @ fresh air mode)*
POSSIBLE HEAT GAIN:	Negligible
DOOR MOVEMENT (HEATER ON):	Considerable (Variable frequency)
LATENT HEAT LOAD:	Considerable (while in fresh air or return air and ventialtion on)
PLANNED DUCT LAYOUT:	Inside compartment
UNITS:	Metric



For example purpose only

EXACT HEAT CALCULATION... Continuation

- TEMPERATURE DIFERENCE (ΔT) = $T_{Required}$ - $T_{Ambient}$
  = 15 °C - -15 °C
  = 30 °C

SURFACE AREA AND COMPARTMENT VOLUME

- INSULATED SURFACE AREA (ROOF)

$A_{Insulated\ Surface\ (Roof)}$ = (L x W)
= 5.1 x 2.3
= 11.73 m^2

- INSULATED SURFACE AREA (FLOOR)

$A_{Insulated\ Surface\ (Floor)}$ = (L x W)
= 5.1 x 2.3
= 11.73 m^2

- INSULATED SURFACE AREA (WALLS)

$A_{Insulated\ Surface\ (Walls)}$ = 2 (L x H) + W x H
= 2 (5.1 x 2) + 2.3 x 2
= 25 m^2

- GLASS SURFACE AREA

$A_{Glass\ Surface}$ = Not applicable

- DOOR SURFACE AREA

$A_{Door\ Surface}$ = (H x W)
= 2 x 2.3
= 4.6 m^2

- VOLUME OF THE COMPARTMENT

$V_{Compartment}$ = L x W x H
= 5.1 x 2.3 x 2
= 23.46 m^3

R - VALUE

- AIR FILM

$R_{Inside\ Air\ Film}$ = 0.11
$R_{Outside\ Air\ Film}$ = 0.03

- INSULATED SURFACE (WALLS)

k_{FRP} = 0.036
R_1 = $t_{(Walls)}$ / $k_{(FRP)}$ = 0.038 / 0.036 = 1.05 °K m^2 / W

$R'_{Total\ (Walls)}$ = $R_{Inside\ Air\ Film} + R_1 + R_{Outside\ Air\ Film}$
= 0.11 + 1.05 + 0.03
= 1.19 °K m^2 / W

- U - VALUE (WALLS)

$U'_{(Walls)}$ = 1 / $R'_{Total\ (Walls)}$
= 1 / 1.19
= 0.84 W / m^2 °K

- INSULATED SURFACE (ROOF)

k_{FRP} = 0.036
R_1 = $t_{(Roof)}$ / $k_{(FRP)}$ = 0.25 / 0.036 = 0.69 °K m^2 / W

$R'_{Total\ (Roof)}$ = $R_{Inside\ Air\ Film} + R_1 + R_{Outside\ Air\ Film}$
= 0.11 + 0.69 + 0.03
= 0.84 °K m^2 / W

- U - VALUE (ROOF)

$U'_{(Roof)}$ = 1 / R'_{Total}
= 1 / 0.84
= 1.20 W / m^2 °K

- INSULATED SURFACE (FLOOR)

$k_{Hardwood}$ = 0.094
R_1 = $t_{(Floor)}$ / $k_{(Hardwood)}$ = 0.050 / 0.15 = 0.33 °K m^2 / W

$R'_{Total\ (Foor)}$ = $R_{Inside\ Air\ Film} + R_1 + R_{Outside\ Air\ Film}$
= 0.11 + 0.33 + 0.03
= 0.47 °K m^2 / W

- U - VALUE (FLOOR)

$U'_{(Foor)}$ = 1 / $R'_{Total\ (Foor)}$
= 1 / 0.47
= 2.12 W / m^2 °K

- INSULATED SURFACE (DOOR)

$k_{Plywood}$ = 0.12
R_1 = $t_{(Door)}$ / $k_{(Plywood)}$ = 0.025 / 0.12 = 0.20 °K m^2 / W

$R'_{Total\ (Door)}$ = $R_{Inside\ Air\ Film} + R_1 + R_{Outside\ Air\ Film}$
= 0.11 + 0.20 + 0.03
= 0.34 °K m^2 / W

- U - VALUE (DOOR)

$U'_{(Door)}$ = 1 / $R'_{Total\ (Door)}$
= 1 / 0.34
= 2.94 W / m^2 °K

3 Heater Selection & System Design

EXACT HEAT CALCULATION... Continuation

HEAT LOSS THROUGH SURFACE AREA

- HEAT LOSS - INSULATED AREA (WALLS)

$Q°_{\text{Loss Insulated Surface (Walls)}} = U'_{\text{Walls}} \times A_{\text{Walls}} \times \Delta T$
$= 0.84 \times 25 \times 30$
$= 630\ W$

- HEAT LOSS - INSULATED AREA (FLOOR)

$Q°_{\text{Loss Insulated Surface (Floor)}} = U'_{\text{Floor}} \times A_{\text{Floor}} \times \Delta T$
$= 2.12 \times 11.73 \times 30$
$= 746.02\ W$

- HEAT LOSS - INSULATED AREA (DOOR)

$Q°_{\text{Loss Door Surface}} = U'_{\text{Door}} \times A_{\text{Door}} \times \Delta T$
$= 2.94 \times 4.6 \times 30$
$= 405.72\ W$

- HEAT LOSS - INSULATED AREA (ROOF)

$Q°_{\text{Loss Insulated Surface (Roof)}} = U'_{\text{Roof}} \times A_{\text{Roof}} \times \Delta T$
$= 1.20 \times 11.73 \times 30$
$= 422.28\ W$

- TOTAL HEAT LOSS - SURFACE AREA

$Q°_{\text{Surface Area}} = Q_{\text{Walls}} + Q_{\text{Floor}} + Q_{\text{Roof}} + Q_{\text{Door}}$
$= 630 + 746.02 + 422.28 + 405.72$
$= 2204.02\ W$

- HEAT LOSS THROUGH AIR

$Q°_{\text{Compartment Air}} = m°_{\text{air}} \times C_{\text{air}} \times \Delta T$
$= \frac{21.11 \times 1000 \times 30}{3600}$
$= 175.95\ W$

- MASS OF COMPARTMENT AIR

$m°_{\text{air}} = V°_{\text{compartment}} \times \rho_{\text{air}}$
$= 23.46 \times 0.9$
$= 21.11\ Kg/hr$

HEAT LOSS THROUGH VENTILATION

- RECIRCULATED HEATING SYSTEM

$ACH_{\text{(recirculated, non ventilated)}} = 2$ (Air leakage)
$Q°_{\text{Air (recirculated, non ventilated)}} = 175.95 \times 2$
$= 351.9\ W$

- FRESH AIR HEATING SYSTEM**

$ACH_{\text{(fresh air, ventilated)}} = \frac{\text{Air Flow / hr (Airtronic D4*)}}{V°_{\text{compartment}}} = \frac{142.30}{23.46} = 6.06$

$Q°_{\text{Air (fresh air ventilated)}} = 175.95 \times 6.06$ (@ Airtronic D4* throughput)
$= 1066.25\ W$

* with 90 diameter hood @ 85 cfm
** optional heating system (sample purpose only)

- RECIRCULATED HEATING SYSTEM**

$ACH_{\text{(recirculated, ventilated)}} = \frac{\text{Minimum Airflow / hr (mechanical fan @ 70 m}^3\text{/hr)}}{V°_{\text{Compartment}}}$

$= \frac{70}{23.6} = 3$

$Q_{\text{Air (Recirculated, with ventilation)}} = 175.95 \times 3 = 525.85\ W$

- RECIRCULATED HEATING SYSTEM**

$ACH_{\text{(recirculated, ventilated)}} = \frac{\text{Maximum Airflow / hr (mechanical fan @ 185 m}^3\text{/hr)}}{V°_{\text{Compartment}}}$

$= \frac{185}{23.6} = 7$

$Q_{\text{Air (Recirculated, with ventilation)}} = 175.95 \times 7 = 1231.65\ W$

CALCULATION OF THE TOTAL HEAT REQUIREMENT

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (AIR LEKAGE)

$Q°_{\text{Total (recirculated)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (recirculated, non ventilated)}}$
$= 2204.02 + 351.9$
$= 2555.92\ W$

- FRESH AIR HEATING SYSTEM

$Q°_{\text{Total (fresh air)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (fresh air, ventilated)}}$
$= 2204.02 + 1066.25$
$= 3270.27\ W$

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (MECHANICAL VENTILATION)

$Q°_{\text{Total (recirculated)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (recirculated @ 3ACH)}}$
$= 2204.02 + 527.85$
$= 2731.87\ W$

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (MECHANICAL VENTILATION)

$Q°_{\text{Total (Recirculated air)}} = Q°_{\text{Total (surface area)}} + Q°_{\text{Air (recirculated @ 7ACH)}}$
$= 2204.02 + 1231.65$
$= 3435.85\ W$

EXACT HEAT CALCULATION... Continuation

TOTAL HEAT REQUIREMENT
(Compensating factor for door movement: 1.2)

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (AIR LAEKAGE)

$Q°_{Total\ (recirculated)}$ = $Q°_{Total\ (recirculated,\ non\ ventilated)}$ x 1.2
= 2555.92 x 1.2
= **3067.10 W**

- FRESH AIR HEATING SYSTEM

$Q°_{Total\ (fresh\ air)}$ = $Q°_{Total\ (fresh\ air,\ ventilated)}$ x 1.2
= 3270.27 x 1.2
= **3924.32 W**

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (MECHANICAL VENTILATION @ ACH 3)

$Q°_{Total\ (recirculating)}$ = $Q°_{Total\ (recirculating,\ ventilated)}$ x 1.2
= 2731.87 x 1.2
= **3278.24 W**

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (MECHANICAL VENTILATION @ ACH 7)

$Q°_{Total\ (recirculating)}$ = $Q°_{Total\ (recirculating,\ ventilated)}$ x 1.2
= 3435.85 x 1.2
= **4123.02 W**

HEATER SELECTION

	Air heater in recirculating air mode (Non Ventilated: Air leakage)	Air heater in recirculating air mode** (Ventilation: 3 ACH @ 70 m³/hr)	Air heater in recirculating air mode** (Ventilation: 7 ACH @ 185 m³/hr)	fresh air mode** (Ventilation: Heater throughput)
Heat demand	**3067.10 W**	**3278.24 W**	**4213.02 W**	**3924.32 W**
Suitable heater	**Airtronic (D4)**	**Airtronic (D4)**	**Airtronic (D5)**	**Airtronic (D5)**
Number of heaters	1	1	1	1
Total power (@ 2500 m)	3640 W	3640 W	4550 W	4550 W
Total power (@ Sea level)	4000 W	4000 W	5000 W	5000 W

** Optional heating air mode (for sample purpose only)

HEAT CALCULATION: ASSUMPTION AND EXCLUSION

- INSULATION: Any parameters related to structural dimensions and insulation (R- value) are roughly estimated for the example purpose only.
  In addition, the thermal values of the sheet metal body, surface barriers (vapors, sound, thermal) and flooring carpet are excluded in the calculation.
- OPERATING CONDITIONS: The calculation assumes average temperature in the night.
- HEATING MODES: Both return air and fresh air heating modes are assumed and calculated separately.
  In return air mode, the air is sufficiently ventilated by the air leakage. However, if it is required, then additional air is supplemented by a separate ventilation system. For heat calculations, a rendom 3-7 ACH value is considered.
- VEHICLES MODE: The vehicle is assumed to have an enclosed compartment and in motion (increase in air-leakage is not accounted).
- HIGH ALTITUDE OPERATION: The calculation assumes the heater operation at 2500 altitude from sea level. The pressure sensor starts reducing the heater output by 9% from 1500 meters up to maximum 4000 meters.

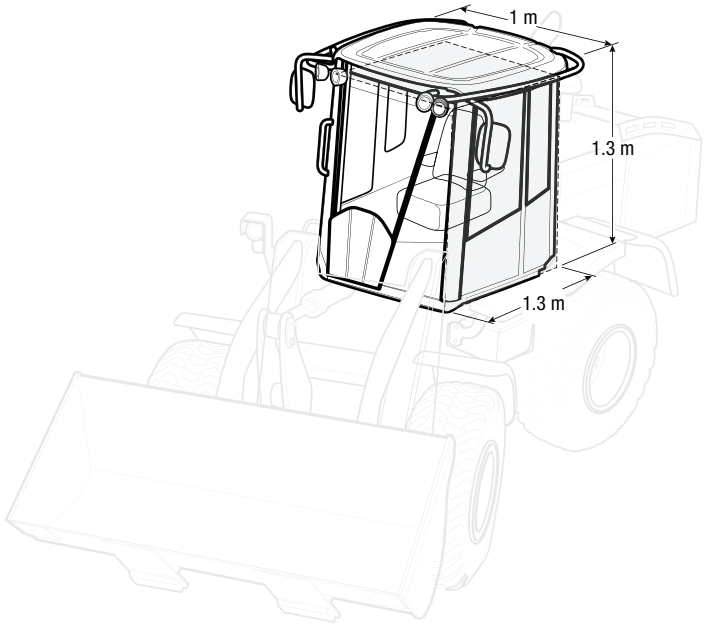
PLEASE NOTE! The operating altitude is determined by the location at which maximum amount of the heater operation will take place.
Adjust air density according to the operating altitude in the heat calculation. The specific heat capacity of the air at constant pressure remains similar within the maximum operating altitude of the heater.

- MULTIPLYING FACTOR: Due to considerable amount of door movements, a compensating multiplication factor: 1.2 (x $Q_{loss\ total}$) for losses from latent loads, door movements or duct loss is considered.
- HEATER SELECTION: The heater size is based on the final value of the heat calculation. Never select an air heater with the heat output lower than minimum required heat (final value).

3 Heater Selection & System Design

EXACT HEAT CALCULATION... Continuation

4) EXAMPLE CALCULATION:	
APPLICATION:	Speciality (Off road equipment/crane)
TYPE OF VECHICLE:	Wheel loader or Crane cab
COMPARTMENT DIMENSIONS:	1.3 x 1 x 1.3 (approx.) (L x W x H)
INSULATION TYPE:	Minimal (Wall: Glass, floor and roof: steel)
GLASS TYPE:	Tempered
AIR FILM:	$R_{(inside\ air\ film)} = 0.11$, $R_{(outside\ air\ film)} = 0.03$
PRIMARY USAGE:	Humidity control and space heating
HEATING SYSTEM:	Return or Fresh Air
VEHICLE CONDITION:	Enclosed (In parking or at slow speed)
NUMBER OF PASSENGERS:	1
NORMAL OPERATING ALTITUDE:	Sea level
AIR DENSITY (ρ_{air}):	1.3 kg / m^3 (@ sea level)
SPECIFIC HEAT CAPACITY (C_{air}):	1000 J / kg °K
WINTER TEMPERATURE:	-20 °C (Night)
REQUIRED TEMPERATURE:	20 °C
VENTILATION: * For optional purposes only	For non ventilated compartment - Air leakage (ACH = 2 @ return air mode) For Ventilated compartment* - Exhaust vent (ACH = heater throughput @ fresh air mode)*
POSSIBLE HEAT GAIN:	Negligible
DOOR MOVEMENT (HEATER ON):	Variable frequency (Not accounted)
LATENT HEAT LOAD:	Negligible
PLANNED DUCT LAYOUT:	Inside compartment
UNITS:	Metric



For example purpose only

EXACT HEAT CALCULATION... Continuation

- TEMPERATURE DIFFERENCE ( ) = $T_{Required}$ - $T_{Ambient}$
  = 20 °C - -20 °C
  = 40 °C

SURFACE AREA AND COMPARTMENT VOLUME

- GLASS SURFACE AREA (WALLS)

$A_{Insulated\ Surface\ (Glass)}$ = 2 (L x H + W x H)
= 2 (1.3 x 1.3 + 1 x 1.3)
= 6 m^2

- STEEL SURFACE AREA (ROOF AND FLOOR)

$A_{Insulated\ Surface\ (Roof\ \&\ Floor)}$ = 2 (L x W)
= 2 (1.3 x 1)
= 2.6 m^2

- VOLUME OF THE COMPARTMENT

$V_{Compartment}$ = L x W x H
= 1.3 x 1 x 1.3
= 1.7 m^3

R - VALUE

- AIR FILM

$R_{Inside\ Air\ Film}$ = 0.11
$R_{Outside\ Air\ Film}$ = 0.03

- U - VALUE: GLASS SURFACE (WALLS)

$U'_{(Walls)\ 6\ mm\ Glass}$ = 5 $W / m^2\ °K$

- STEEL SURFACE (ROOF AND FLOOR)

k_{Steel} = 54
R_1 = $t_{(Roof)} / k_{(Carbon\ steel)}$ = 0.008 x 54 = 0.000148 $°K\ m^2 / W$

$R'_{Total\ (Roof\ \&\ Floor)}$ = $R_{Inside\ Air\ Film} + R_1 + R_{Outside\ Air\ Film}$
= 0.11 + 0.000148 + 0.03
= 0.140 $°K\ m^2 / W$

- U - VALUE (ROOF & FLOOR)

$U'_{(Roof\ \&\ Floor)}$ = 1 / $R'_{Total\ (Roof\ \&\ Floor)}$
= 1 / 0.140
= 7.13 $W / m^2\ °K$

HEAT LOSS THROUGH SURFACE AREA

- HEAT LOSS - GLASS AREA (WALLS)

$Q°_{Loss\ Glass\ Surface\ (Walls)}$ = U'_{Walls} x A_{Walls} x ΔT
= 5 x 6 x 40
= 1200 W

- HEAT LOSS - SURFACE AREA (FLOOR & ROOF)

$Q°_{Loss\ Surface\ (Floor\ \&\ roof)}$ = $U'_{Floor\ \&\ Roof}$ x $A_{Floor\ \&\ Roof}$ x ΔT
= 7.1 x 2.6 x 40
= 741.52 W

- TOTAL HEAT LOSS - SURFACE AREA

$Q°_{Surface\ Area}$ = $Q_{Glass\ Walls} + Q_{Floor\ \&\ Roof}$
= 1200 + 741.52
= **1941.52 W**

- HEAT LOSS THROUGH AIR

$Q°_{Compartment\ Air}$ = $m°_{air}$ x C_{air} x ΔT
= $\frac{2.21 \times 1000 \times 40}{3600}$
= 24.55 W

- MASS OF COMPARTMENT AIR

$m°_{air}$ = $V°_{compartment}$ x ρ_{air}
= 1.7 x 1.3
= 2.21 Kg / hr

3 Heater Selection & System Design

EXACT HEAT CALCULATION... Continuation

HEAT LOSS THROUGH VENTILATION

- RECIRCULATED HEATING SYSTEM

$ACH_{(recirculated,\ non\ ventilated)} = 2$ (Air leakage)

$Q°_{Air\ (recirculated,\ non\ ventilated)} = 24.55 \times 2$

$= 49.11\ W$

* with 90 diameter hood @ 85 cfm

- FRESH AIR HEATING SYSTEM

$$ACH_{(fresh\ air,\ ventilated)} = \frac{\text{Air Flow / hr (Airtronic D4*)}}{V°_{compartment}} = \frac{142.30}{2.6} = 54.73$$

$Q°_{Air\ (fresh\ air,\ ventilated)} = 24.55 \times 54.73$ (@ Airtronic D4 throughput)

$= 1343.62\ W$

CALCULATION OF THE TOTAL HEAT REQUIREMENT

- AIR HEATER IN RETURN AIR / RECIRCULATING MODE (AIR LEKAGE)

$Q°_{Total\ (recirculated)} = Q°_{Total\ (surface\ area)} + Q°_{Air\ (recirculated,\ non\ ventilated)}$

$= 1941.52 + 49.11$

$= \mathbf{1990.63\ W}$

- FRESH AIR HEATING SYSTEM

$Q°_{Total\ (recirculated,\ fresh\ air,\ ventilated)} = Q°_{Total\ (surface\ area)} + Q°_{Air\ (fresh\ air,\ ventilated)}$

$= 1941.52 + 1343.62$

$= \mathbf{3285.41\ W}$

HEATER SELECTION

	Air heater in recirculating air mode (Non Ventilated: Air leakage)	Air heater in fresh air mode **(Ventilation: Heater throughput)
Heat demand	**1990.63 W**	**3285.41 W**
Suitable heater	**Airtronic (D2)**	**Airtronic (D4)**
Number of heaters	1	1
Total power	2200	4000

** Optional heating air mode (For sample purpose only)

HEAT CALCULATION: ASSUMPTION AND EXCLUSION

- Any parameters related to structural dimensions and insulation (R- value) are roughly estimated for the example purpose only.
  In addition, the thermal values of the sheet metal body, surface barriers (vapors, sound, thermal) and flooring carpet are excluded in the calculation.
- OPERATING CONDITIONS: The calculation assumes average temperature in the night. The heat gain through passengers, hydraulic engine, cab appliances, or sun radiation in the day is not included.
- HEATING MODES: Both return air and fresh air heating modes are assumed and calculated separately.
  In return air mode, the air is sufficiently ventilated by the air leakage.
  However, if it is required, then additional air is supplemented by a separate ventilation system.
- VEHICLES MODE: The heat calculation is considered assuming the vehicle is enclosed and slow motion.
- HIGH ALTITUDE OPERATION: The calculation assumes the heater operation at sea level.

  PLEASE NOTE! The operating altitude is determined by the location at which maximum amount of the heater operation will take place.
  Adjust air density according to the operating altitude in the heat calculation. The specific heat capacity of the air at constant pressure remains similar within the maximum operating altitude of the heater.
- MULTIPLYING FACTOR: Due to considerable amount of door movements, a compensating multiplication factor: 1.2 (x $Q_{loss\ total}$) for losses from latent loads, door movements or duct loss maybe considered
- HEATER SELECTION: The heater size is based on the final value of the heat calculation. Never select an air heater with the heat output lower than minimum required heat (final value).

HEATER AND COMPONENT RATING

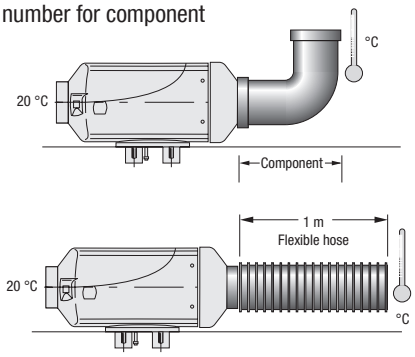
- GUIDE NUMBER

  Depending on the heat output, air mass flow rate and physical size; the maximum operating temperature for the heater may vary. To maintain the temperature below maximum level, the heater and duct components are required to provide a sufficient air throughput against the system pressure. Therefore, general instructions regarding guide numbers ("Component/Duct rating") and its calculation procedure are provided to access whether the system of the planned duct design will allow sufficient airflow to maintain the outlet temperature within acceptable level or not.

0 = No increase in temperature at heater overheat sensor

1 = Increase of air temperature by component equivalent to 1 meter flexible pipe

_ = No Guide number for component



Guide Number (duct/component rating) =

$$\frac{\text{Heating air temperature increase by the component}}{\text{Heating air temperature increase by 1 meter flexible duct/pipe.}}$$

— The guide number is a numerical value that describes the rating of duct, component or the complete system.

— Each heater is rated with their own rating ("heater rating") depending on their design, and diameter of the installed hood at its outlet.
Combined guide numbers/ratings of all connected ducts and components ("system rating") must not be greater than the heater rating, or the heater may trigger an overheat fault due to very high temperature at overheat or flame sensor.

— The overall duct/component (system) rating can be reduced by increasing the duct diameter, changing the duct layout from one channel to multi channel or removing some of the duct components like elbows and joints.

- DUCT: It is a network of small channels through which the heating air is transported to different compartments of the vehicle.
  While ducts can be made from hard materials like a welded metal or PVC; the airtronic heating system mainly requires a flexible pipe type duct.
  It is made of a laminated sheet of aluminium, paper and plastic for an excellent flexibility and heat resistance.

  — A flexible duct is recommended to install on the horizontal surface like floor or on the wall (using a wall bracket.).

  — Mounting of a flexible duct on the wall or roof through P clamps should be avoided.

  — A maximum allowable duct length for any heater is calculated using its duct rating and duct size.

  — Double the diameter of the duct can reduce its rating by 1/4.

  — The smoother the duct surface is, the better the air flow inside the duct would be and duct ratings of the smoother surfaces like PVC or metal pipes is half that of flexible pipes of similar size and length.

  — Any duct for the heating system should be capable of withstanding 150 °C(300 °F) or higher during the overheat condition of the heater.

- DUCT SIZE: In heating system, the quantity of supplied air through a duct can vary depending on the duct size (diameter) and its friction loss per unit length (roughness factor). A smaller duct size allows a lesser quantity of air due to higher friction loss (dynamic head) from increased.
  Such may affect the internal temperature of the heater or trigger the overheat sensor. Therefore, it is recommended to select an appropriate duct size according to the system rating, altitude and type of heater.

  — For complex installation, it is necessary to use larger duct size.

  — To minimize overheating issues at high altitudes, always install the heater with larger duct size.
  — Increase the duct size, if there are many components or 90° bends in the network.

- SYSTEM COMPONENTS: The duct system includes all necessary components to the serve the purpose of a duct connection, air flow direction and its regulation. They are an essential part of the duct layout and need to be accounted during the duct system design as each component generates a flow resistance based on its geometric shape and size.

  — A guide number or component rating is assigned to each components based on their specific friction loss.
  Components creating large guide numbers beyond the heater capacity could be the main cause of a frequent heater overheating issues. Therefore, it is extremely important to account ratings of all components in the ducting system so the overall sum total of the duct system rating can never be higher than heater rating.

  — Like the hot air duct, all components connecting the heater system must be able to withstand high temperatures (> 150 °C) during overheating condition.

  — There are two main types of the components available:
  Flow control type and **directional control type**.

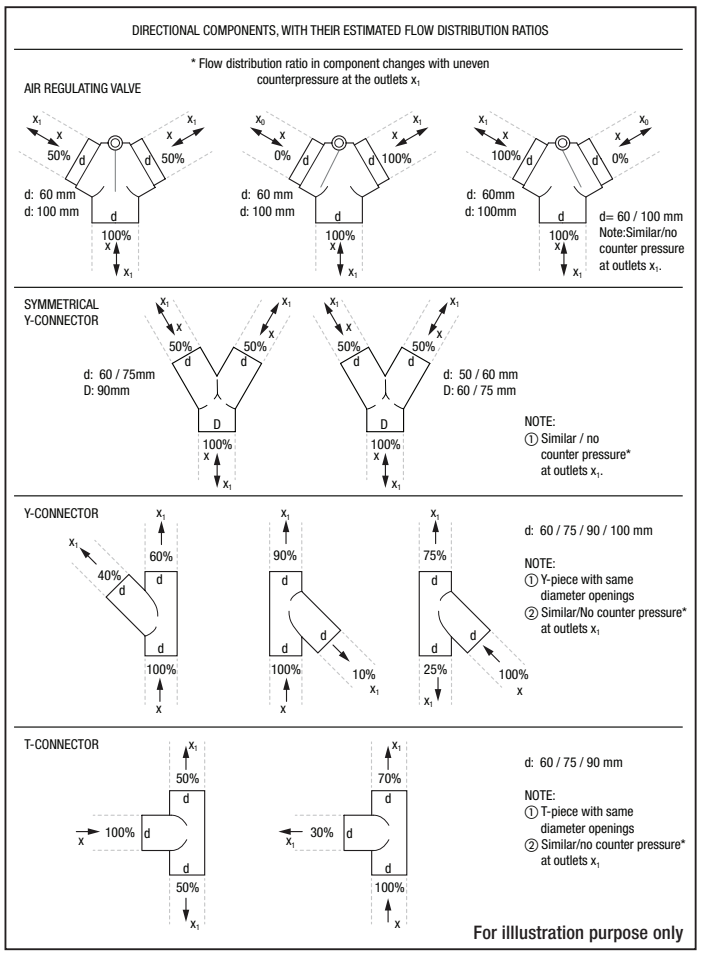
  a) **Flow control type :** As the name implies, the flow control component acts like a regulator type vent that controls the quantity of the airflow and mainly used for heat regulation.

  b) **Directional control type:** A component (like Y-joint or elbow) guides and distributes the air in required direction and mainly used for heat distribution.
  Some of the main directional components with their estimated flow destribution ratios are shown in the image on the next page.

  PLEASE NOTE! To minimize any unwanted maintenance due to component failure in the heating system, it is mandatory to install Eberpaecher duct and component parts only.

3 Heater Selection & System Design

HEATER AND COMPONENT RATING GUIDE... Continuation



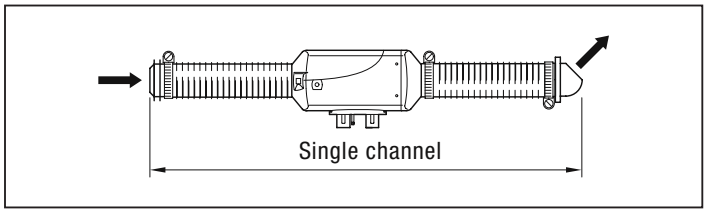
• DUCT SYSTEM DESIGN

As discussed earlier, any duct system must have a heater, duct and connecting components. But depending on their arrangement in network, the design of the duct system is categorized in two main sections:

1 Single duct design.
2 Multi duct design.

— SINGLE DUCT DESIGN:

It is a simple duct network, which consists of a single duct for receiving the return/fresh air to the heater inlet and delivering the heated air from the heater outlet to the compartment. While designing such layout, always connect duct with open outlets only; In addition, any additional channels with closable vents are not cosidered during duct rating calcuations.
If a duct is connected only at the heater outlet, such design is still called as single duct design. For additional information for calculating a duct/component rating of the single duct system, please see page 39-46.



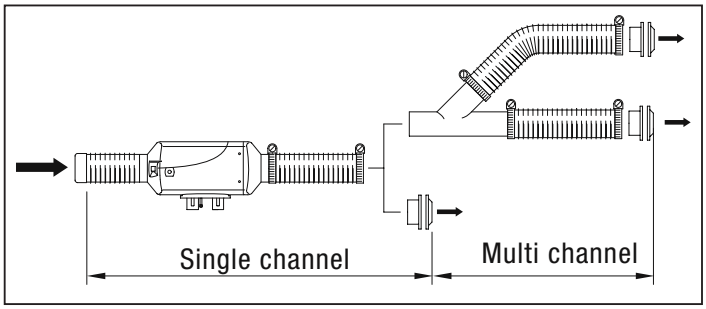
PLEASE NOTE!

Majority of vehicles with small cabs like sleeper class trucks would only require a universal type airtronic D2/4 kits, which has a simple version of selected kit components suitable for designing a single channel duct system.

See the product catalogue for kits part numbers. For custom installations, please refer to the single duct design side of duct/component rating selection table.

— MULTI DUCT DESIGN:

Some applications like cargo, passenger vehicle or RV type installations may require a multiple duct design to provide uniform heat distribution throughout the compartment. This type of design generally has a single channel duct from the heater branching into multiple channels using various joints. Sometimes, there can be a multi branch ducts installed at the both sides of the heater. To select the duct/component ratings, the single duct design must be considered up the first branch, then they fall in multichannel duct design as shown in the figure. For additional information for calculating a duct/component rating of the Multi duct system, please see page 39-46.



- If a regulator or closable type outlet is used in multi duct design, one of the duct branches must have an open outlet at all the time as shown in image.
- The open outlet should be installed on the main trunk of the multi channel duct, which also tends to be the longest branch of the duct network.
- When designing a duct system, only consider ratings of ducts or components that are connected to a channel with open outlet.
  In other words, a branch that has closable outlet must not be taken in to account.
- When placing the two similar ducts in parallel, the system rating of each duct is reduce to 1/4 of the same duct in a single channel layout as described in below example.
- To provide equal proportionated air flow at each duct outlet, connect smaller diameter ducts for shorter branches or use a closable or regulated type outlets.

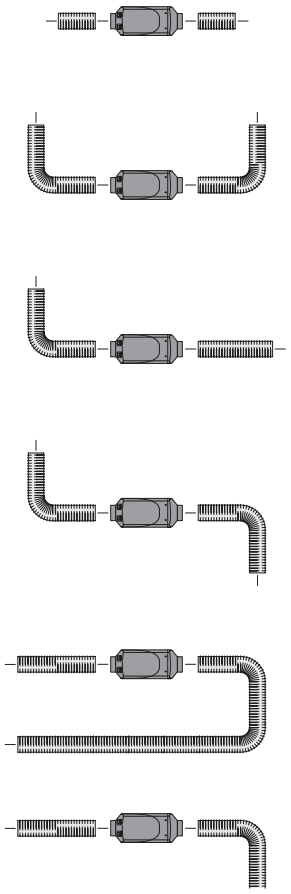
ADDITIONAL GUIDELINES: DUCT SYSTEM DESIGN AND INSTALLATION

- Regardless of the type and plan of the system design (single or multi duct), the heating system must maintain its throughput above minimum to prevent possible overheating issues.
- For high altitude operations, it is necessary to increase the duct diameter and avoid any high restriction components (i.e. 90° spherical hood).
- Regardless of duct length or size, the temperature difference between inlet and outlet of the heater must remain within 110°C (at 20°C intake air temperature). Any higher and the heater may start operating nearer to the overheat threshold.
- Avoid having more than three 90° bends in a single channel duct system.
- The duct system must be designed so that the inlet air temperature at the heater must never be higher than 25°C. Any higher and heater may experience overheating issues.
- A long duct at the inlet may reduce the air flow and create overheating situations. If a long duct (> 2 m) is required at the inlet, then improve the design by converting the duct system in to multi channel at inlet.
- In fresh air heating system, it is mandatory to ensure that the exhaust is far from the location of access port for inlet air.
- It is prohibited to account any existing ducts in the vehicle (OEM) in duct rating calculation.
- The duct system must include grills or vents at all inlets and outlets to prevent any objects entering into the heating system.
- Refer any application specific local regulations that may affect the heating system and duct layout.
- Sometimes, a cargo or passenger vehicle has limited space on the floor for duct, then the duct must be laid out on the wall or ceiling using appropriate duct holding brackets.
- It must be noted that the heater is the most efficient at the shortest duct length; therefore, any additional inclusion of duct length or components with large ratings would only reduce the heater throughput.
- It is mandatory to evaluate the location of a fresh air intake grill as it must not be affected by the road spray, exhaust fumes, or ram air pressure. Normally, the fresh air intake grill should be placed at the middle of the sidewall.
- Always add a grill or vent at inlet and outlet while designing the duct layout to prevent any large object entering in to the heater system.
- For large vehicles carrying passengers and dangerous goods, an extra care must be required for maintaining quality of air using appropriate ventilation system as well as installing additional safety measures like flame and smoke detectors etc.
- For passenger vehicles or RVs, it is recommended to insert an air silencer in the inlet duct system to reduce noise from the blower motor of the heater.
- It is mandatory to keep the system rating of the planned duct layout must be well within the heater ratings.
  Also, design a duct layout in such a way that the minimum quantity of duct bends is required.

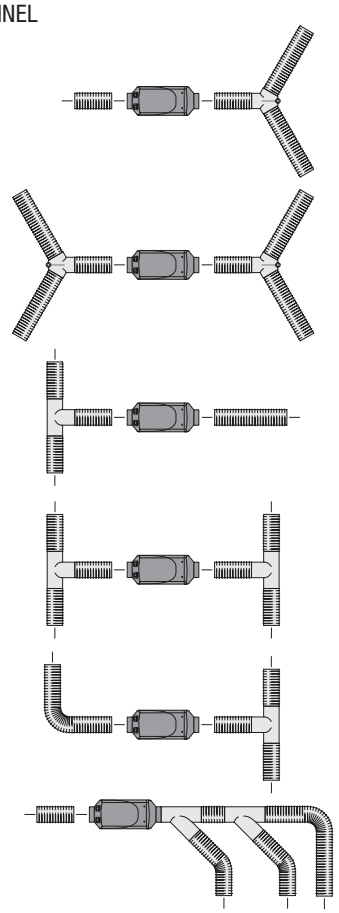
COMMON SHAPES OF THE DUCT LAYOUT:

For illlustration purpose only

SINGLE CHANNEL



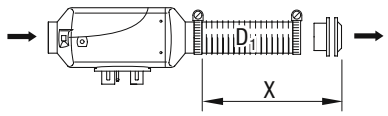
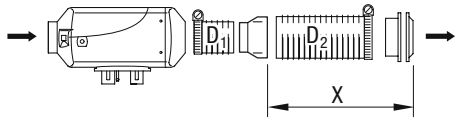
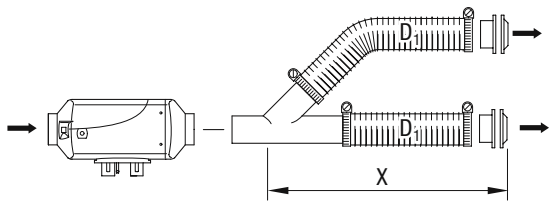
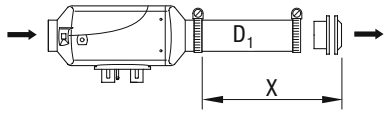
MULTI CHANNEL



3 Heater Selection & System Design

HEATER AND COMPONENT RATING GUIDE... Continuation

RULE OF THUMB: DUCT RATING

	D_1: 50 ø (flexible duct) Rating: 1.0 (Duct line: X)	Single channel duct (X) with normal duct rating.
	Double the cross section D_1: 50 ø to D2: 75 ø (flexible duct) Rating: 0.25 (Duct line: X)	Double the cross section or two identical components running parallel = 1/4 of the rating.
	Two identical ducts running parallel D_1: 50 ø (flexible duct) Rating: 0.25 (Duct lines: X)	
	D_1: 50 ø (smooth or welded duct) Rating: 0.5 (Duct line: X)	The component rating of smooth welded pipe is only half that of flexible pipe of equal diameter; in other words, double the lenght of pipe.

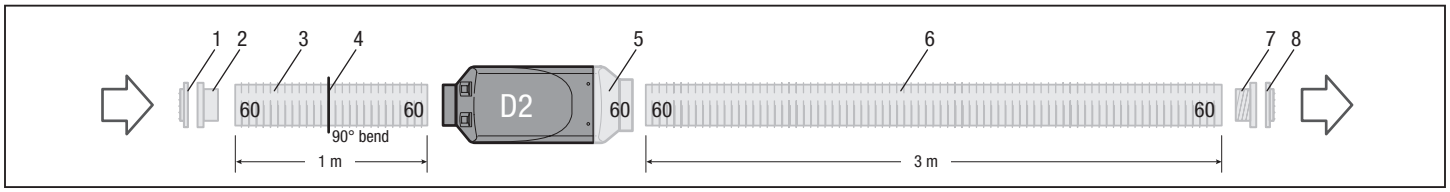
EXAMPLES OF DUCT/COMPONENT RATING CALCULATION

Once the required heat is found and appropriate heater is selected thereafter, the next step is to plan a duct layout and select components according to the heater rating and mounting location.

EXAMPLE #1 - AIRTRONIC D2 WITH 60 ø SCOOP
Heater rating = 6

ITEM	DESIGNATION	COMPONENT RATING
1	Protective grill 60 ø	0.5
2	Plastic hose fitting 60 ø	0
3	Flexible pipe 60 ø (1 m long)	1.0
4	90 ø Elbow (Broad radius) flexible pipe 60 ø	0.2
5	Reduction hood 60 ø straight	0.0

ITEM	DESIGNATION	COMPONENT RATING
6	Flexible pipe 60 ø (3 m long)	3.0
7	Plastic fitting 60 ø	0.0
8	Flat vent 0° with 60 ø fitting	0.5
	TOTAL DUCT RATING	5.2



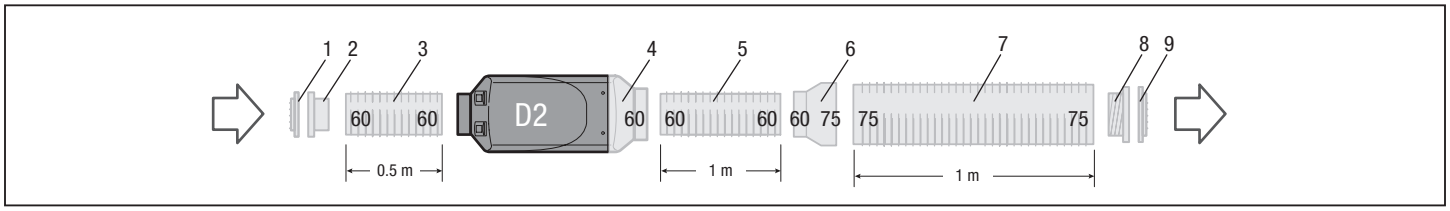
For example purpose only

HEATER AND COMPONENT RATING GUIDE... Continuation

EXAMPLE #2 - AIRTRONIC D2 WITH 60 ø SCOOP
Heater rating = 6

ITEM	DESIGNATION	COMPONENT RATING
1	Protective grill 60 ø	0.5
2	Plastic hose fitting 60 ø	0
3	Flexible pipe 60 ø (0.5 m long)	0.5
4	Reduction hood 60 ø straight	0.0
5	Flexible pipe 60 ø (1 m long)	1.0

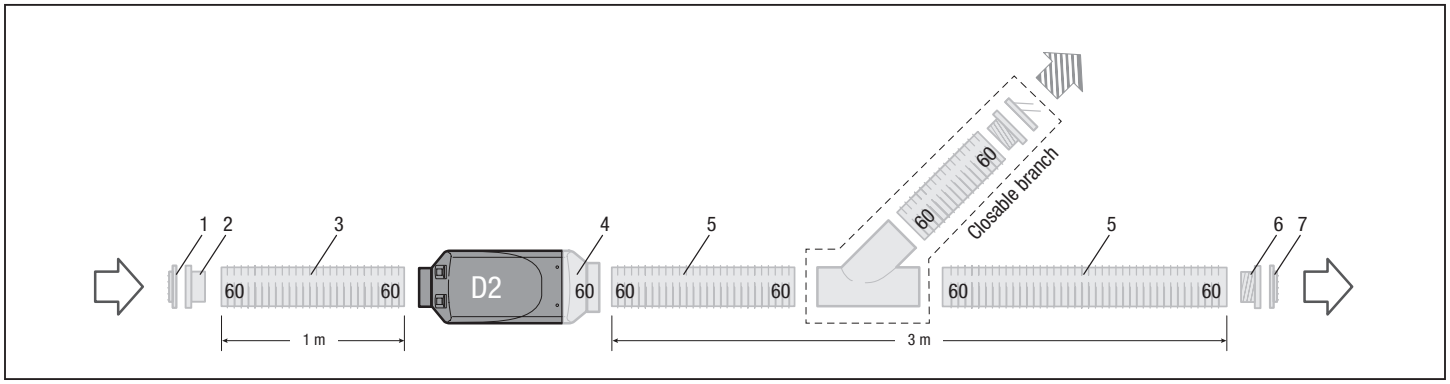
ITEM	DESIGNATION	COMPONENT RATING
6	Adapter 60 ø to 70 ø	3.2
7	Flexible pipe 75 ø (1 m long)	0.25
8	Plastic hose fitting 75 ø	0
9	Flat vent 0° 75 ø	0.125
	TOTAL DUCT RATING	5.575



EXAMPLE #3 - AIRTRONIC D2 WITH 60 ø SCOOP
Heater rating = 6

ITEM	DESIGNATION	COMPONENT RATING
1	Protective grill 60 ø	0.5
2	Plastic hose fitting 60 ø	0
3	Flexible pipe 60 ø (1 m long)	1.0
4	Reduction hood 60 ø straight	0.0

ITEM	DESIGNATION	COMPONENT RATING
5	Flexible pipe 60 ø (3 m Long)	3.0
6	Plastic hose fitting 60 ø	0
7	Flat vent 0° 60 ø	0.5
	TOTAL DUCT RATING	5.0



For example purpose only

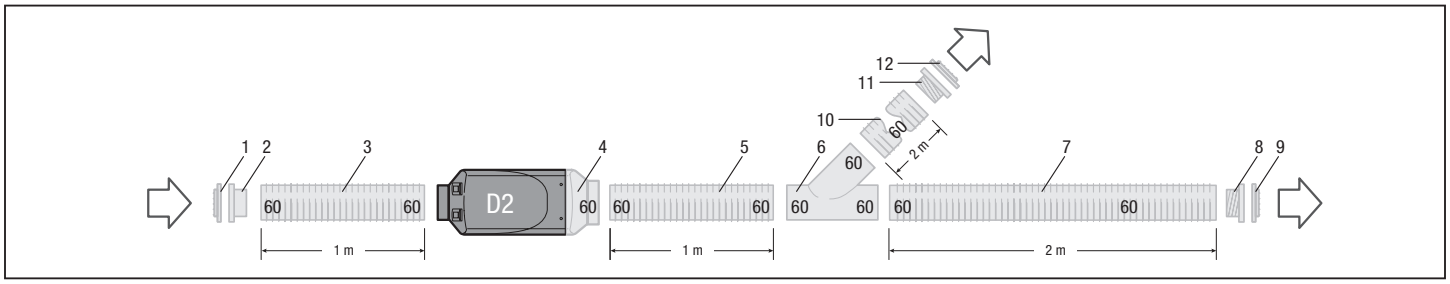
3 Heater Selection & System Design

HEATER AND COMPONENT RATING GUIDE... Continuation

EXAMPLE #4 - AIRTRONIC D2 WITH 60 ø SCOOP
Heater rating = 6

ITEM	DESIGNATION	COMPONENT RATING
1	Protective grill 60 ø	0.5
2	Plastic hose fitting 60 ø	0
3	Flexible pipe 60 ø (1 m long)	1.0
4	Reduction hood 60 ø straight	0.0
5	Flexible pipe 60 ø (1 m long)	1.0
6	45° Y - fitting 60 ø	1.0

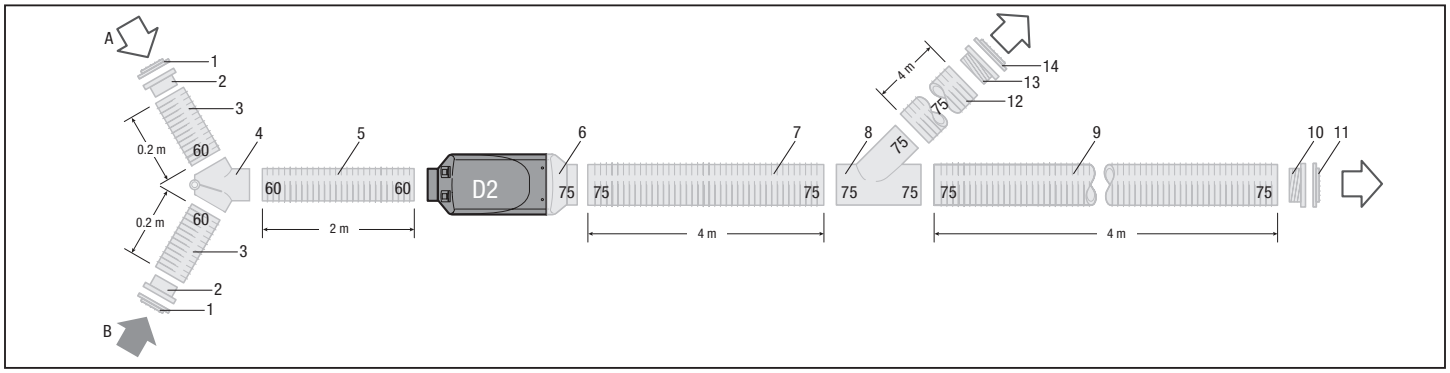
ITEM	DESIGNATION	COMPONENT RATING
7	Flexible pipe 60 ø (2 m long)	0.5
8	Plastic hose fitting 60 ø	0
9	Flat vent 30° 75 ø	0.15
10	Flexible pipe 60 ø (2 m long)	0.5
11	Plastic hose fitting 60 ø	0
12	Flat vent 30° 75 ø	0.15
	TOTAL DUCT RATING	4.8



EXAMPLE #5 - AIRTRONIC D2 WITH 75 ø SCOOP
Heater rating = 12

ITEM	DESIGNATION	COMPONENT RATING
1	Protective grill 60 ø	0.5
2	Plastic hose fitting 60 ø	0
3	Flexible pipe 60 ø (0.2 m long)	0.2
4	Butterfly valve ø 60/60/60 with "right/left" flap position	0.6
5	Flexible pipe 60 ø (2 m long)	2.0
6	Reduction hood 75 ø straight	0.0
7	Flexible pipe 75 ø (4 m long)	4.0

ITEM	DESIGNATION	COMPONENT RATING
8	45° Y - fitting 75 ø	0.6
9	Flexible pipe 75 ø (4 m long)	1.0
10	Plastic hose fitting 75 ø	0
11	Flat vent 0° 75 ø	0.15
12	Flexible pipe 75 ø (4 m long)	1.0
13	Plastic hose fitting 75 ø	0
14	Flat vent 30° 75 ø	0.15
	TOTAL DUCT RATING	10.2



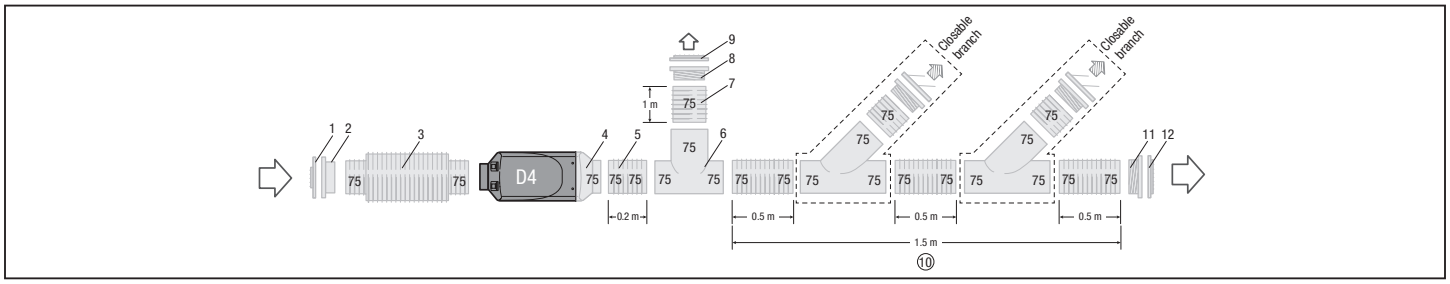
For example purpose only

HEATER AND COMPONENT RATING GUIDE... Continuation

EXAMPLE #6 - AIRTRONIC D4 WITH 75 ø SCOOP
Heater rating = 3

ITEM	DESIGNATION	COMPONENT RATING
1	Protective grill 75 ø	0.4
2	Plastic hose fitting 75 ø	0
3	Intake muffler 75 ø	0.8
4	Reduction hood 75 ø straight	0.0
5	Flexible pipe 75 ø (0.2 m long)	0.2
6	T fitting 75 ø	0.5

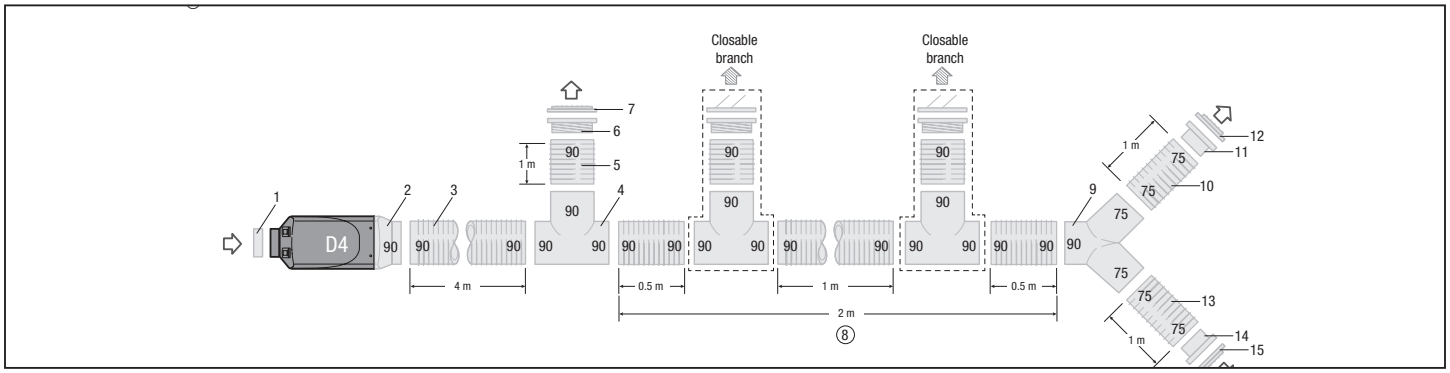
ITEM	DESIGNATION	COMPONENT RATING
7	Flexible pipe 75 ø (1 m long)	0.25
8	Plastic hose fitting 75 ø	0
9	Flat vent 30° 75 ø	0.1
10	Flexible pipe 75 ø (1.5 m long)	0.375
11	Plastic hose fitting 75 ø	0
12	Flat vent 30° 75 ø	0.1
	TOTAL DUCT RATING	2.725



EXAMPLE #7 - AIRTRONIC D4 WITH 90 ø SCOOP
Heater rating = 10

ITEM	DESIGNATION	COMPONENT RATING
1	Grill 75 ø	2.0
2	Reduction hood 90 ø straight	0
3	Flexible pipe 90 ø (4 m long)	4.0
4	T fitting 90 ø	0.6
5	Flexible pipe 90 ø (1 m long)	0.25
6	Plastic hose fitting 90 ø	0
7	Flat vent 0° 90 ø	0.3
8	Flexible pipe 90 ø (2 m long)	0.5

ITEM	DESIGNATION	COMPONENT RATING
9	45° Symetrical Plastic Y-fitting ø 90 / 75 /75	0.9
10	Flexible pipe 75 ø (1 m long)	0.25
11	Plastic hose fitting 75 ø	0
12	Flat vent 30° 75 ø	0.1
13	Flexible pipe 75 ø (1 m long)	0.25
14	Plastic hose fitting 75 ø	0
15	Flat vent 30° 75 ø	0.1
	TOTAL DUCT RATING	9.25



For example purpose only

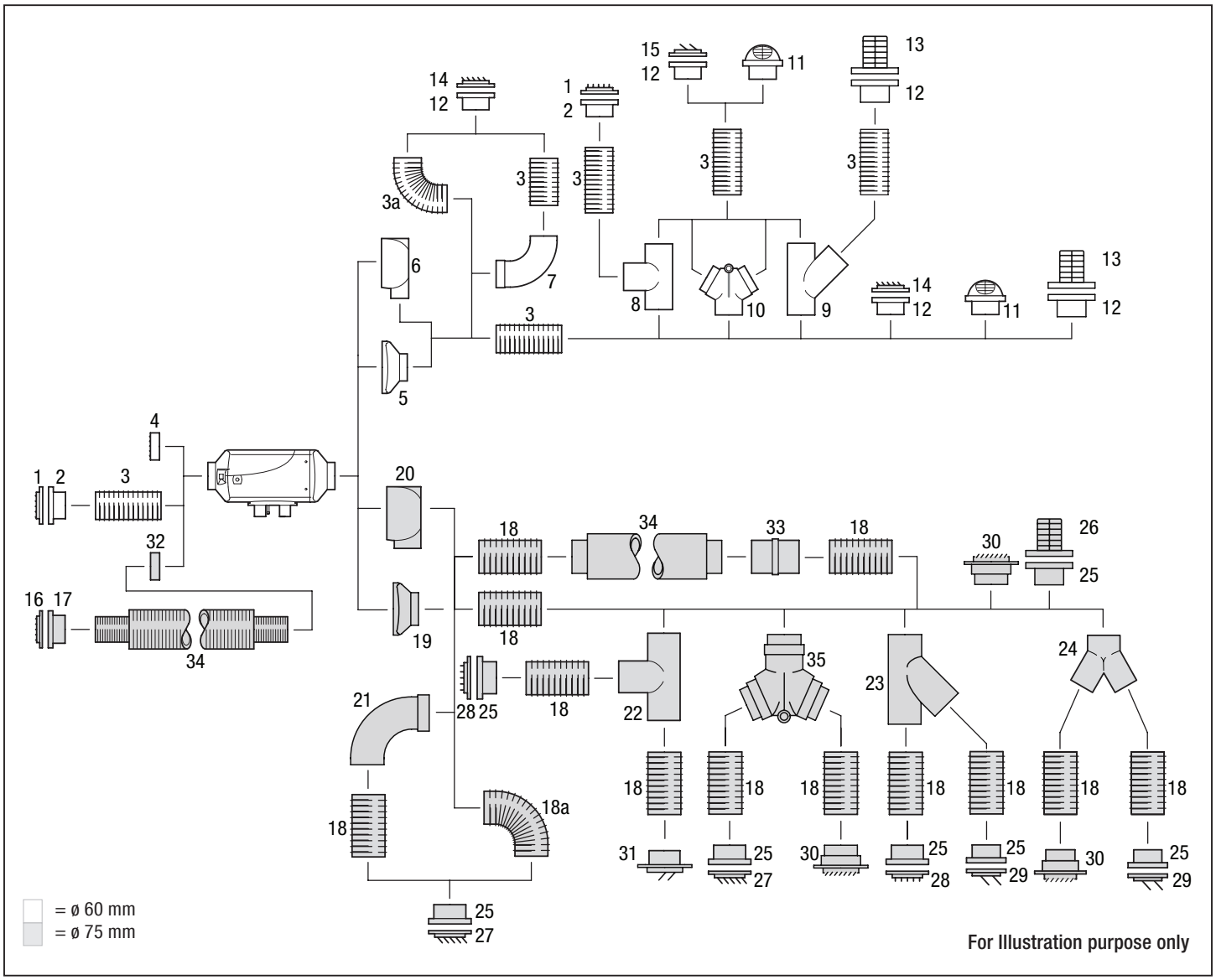
3 Heater Selection & System Design

AIRTRONIC D2 (DUCT / COMPONENT RATING)

AIRTRONIC D2

Heater Rating 6 - applies with a 60 mm dia. outlet hood.
Heater Rating 12 - applies with a 75 mm dia. outlet hood.

The sketch shows how the most important air ducting parts that can be used.
They are not intended as examples of installation.



AIRTRONIC D2

- Never increase the duct rating higher than the heater rating.
- Keep the flexible bends with large bend radius. If possible, avoid unnecessary bends in the duct system.
- Contact near by dealer or Eberspaecher NA for further information regarding duct / component rating.

AIRTRONIC D2 (DUCT / COMPONENT RATING)

	DESIGNATION (measurements in millimeters)	COMPONENT / DUCT RATING		PARTS LIST NUMBER
	AIRTRONIC D2 WITH REDUCTION HOOD 60 DIA. (HEATER RATING 6)	Single duct	Multi duct	(See page 99)
1	Grille (Inlet & Outlet) ø 60	0.4	0.1	1
2	Connecting socket, ø 60	0	0	2
3	Flexible pipe, ø 60 (per metre)	1	0.25	3
3a	90° Bend, flexible pipe, ø 60	0.2	-	3a
4	Protective grille - Heater ø 60	0	-	4
5	Reduction hood, (Straight) ø 60	0	0	5
6	Reduction hood, (Spherical, 90°) ø 60	4.8	-	6
7	90° Bend, plastic elbow, ø 60	4	-	7
8	T-piece, ø 60 x ø 60 x ø 60	1.4	0.25	8
9	Y-piece, 45°, ø 60 x ø 60 x ø 60	-	1	9
10	Butterfly valve with regulating flap, ø 60 x ø 60 x ø 60 (Position “right/left”)	-	0.6	10
11	Outlet grill with connecting piece (rotatable) ø 60	3.2	0.8	11
12	Ducting flange (plastic connecting piece) ø 60	0	0	12
13	Up right vent 90° (rotatable) ø 60	0.8	0.15	13
14	Outlet screen (flat) 30° (rotatable) ø 60	0.5	0.15	14
15	Outlet screen (closeable, rotatable) ø 60	-	-	15
	AIRTRONIC D2 HEATING AIR DUCTING WITH REDUCTION HOOD, ø 75 (HEATER RATING 12)			
16	Grille (Inlet & Outlet) ø 75	0.4	0.1	1
17	Connecting socket, ø 75	0	0	2
18	Flexible pipe, ø 75 (per metre)	1	0.25	3
18a	90° Bend, flexible pipe, ø 75	1.2	-	3a
19	Reduction hood, (Straight) ø 75	0	0	5
20	Reduction hood, (Spherical 90°) ø 75	6	-	6
21	90° Bend, plastic elbow, ø 75	4.5	-	7
22	T-piece, ø 75 x ø 75 x ø 75	-	0.8	8
23	Y-piece, 45°, ø 75 x ø 75 x ø 75	-	0.6	9
24	Y-piece, Symmetrical, ø 75 x ø 60 x ø 60	-	0.8	9.1
25	Ducting flange (plastic connecting piece) ø 75	0	0	12
26	Up right vent 90° (rotatable) ø 75	0.8	0.15	13
27	Outlet screen (flat) 30° (rotatable) ø 75	0.5	0.15	14
28	Outlet screen (flat) 0° (rotatable) ø 75	0.5	0.15	14.1
29	Outlet screen (closeable, rotatable) ø 75	-	-	15
30	Outlet vent with flange (rotatable) ø 75 - ø 100	0.6	0.2	16
31	French vent with flange (closeable) ø 75	-	-	17
32	Adaptor ring (ø 60 to ø 75)	-	-	18
33	Ducting union (straight connector) ø 75	0.5	0.1	19
34	Air silencer (inlet and outlet) ø 75	0.7	-	20
35	Butterfly valve with regulating flap, ø 75 x ø 75 x ø 75 (Position “middle / right, left”)	-	1.2 / 0.6	10

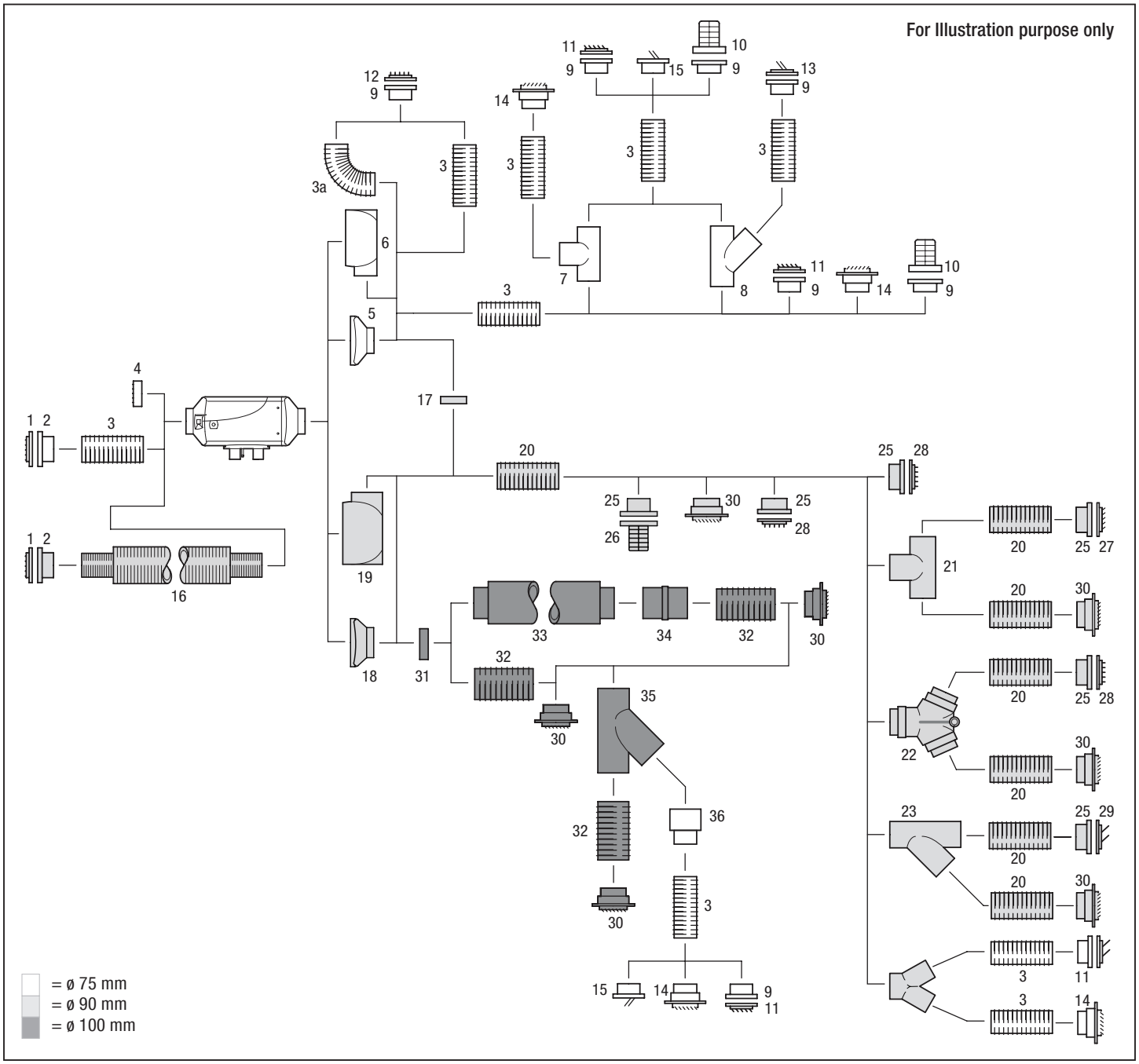
3 Heater Selection & System Design

AIRTRONIC D4 (DUCT / COMPONENT RATING)

AIRTRONIC D4

Heater Rating 3 - applies with a 75 mm dia. outlet hood.
Heater Rating 10 - applies with a 90 mm dia. outlet hood.

The sketch shows how the most important air ducting parts that can be used. They are not intended as examples of installation.



AIRTRONIC D4

- Never increase the duct rating higher than the heater rating.
- Keep the flexible bends with large bend radius. If possible, avoid unnecessary bends in the duct system.
- Contact near by dealer or Eberspaecher NA for further information regarding duct / component rating.

AIRTRONIC D4 (DUCT / COMPONENT RATING)

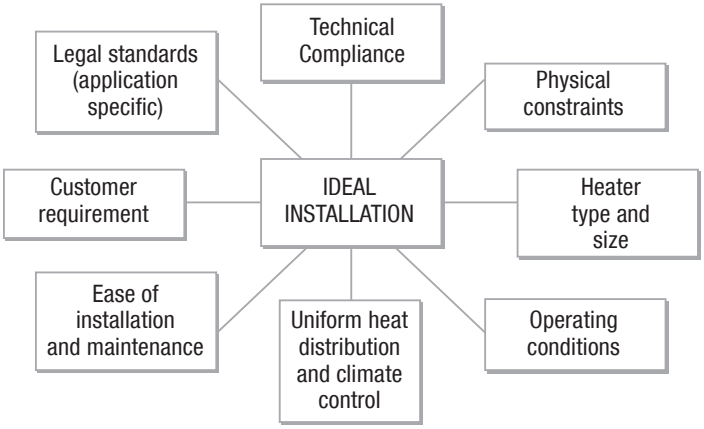
	DESIGNATION (measurements in millimeters)	COMPONENT / DUCT RATING				PARTS LIST NUMBER
	AIRTRONIC D4 HEATING AIR DUCTING WITH REDUCTION HOOD 75 DIA. (HEATER RATING 3)	Single duct ø 75	Single duct ø 90	Multi duct ø 75	Multi duct ø 90	(See page 99)
1	Grille, (inlet & outlet), ø 75	0.4		0.1		1
2	Connecting socket, ø 75	0	-	0	-	2
3	Flexible pipe, ø 75 (per metre)	1	-	0.25	-	3
3a	90° Bend, flexible pipe, ø 75	0.2	-	0	-	3a
4	Protective grille - heater, ø 75	2.0	-	-	-	4
5	Reduction hood, (Streight) ø 75	0	-	-	-	5
6	Reduction hood, (Spherical, 90°) ø 75	2.0	-	-	-	6
7	T-piece, ø 75 x ø 75 x ø 75	-	-	0.5	-	8
8	Y-piece, 45°, ø 75 x ø 75 x ø 75	-	-	0.6	-	9
9	Ducting flange (connecting piece) ø 75	0	-	0	-	12
10	Up right vent 90° (rotatable) ø 75	1.1	-	0.3	-	13
11	Outlet screen (flat, 30°, rotatable) ø 75	0.3	-	0.1	-	14
12	Outlet screen (flat, 0°, rotatable) ø 75	0.3	-	0.1	-	14.1
13	Outlet screen (closable, rotatable) ø 75	-	-	-	-	15
14	Outlet vent with flange (rotatable) ø 75 - ø 100	0.8	-	-	-	16
15	French vent with flange (closable) ø 75	-	-	-	-	17
16	Air silencer ø 75	0.8	-	-	-	20
17	Adapter ring (ø 75 x ø 90)	0.5	-	-	-	18
	AIRTRONIC D4 WITH REDUCTION HOOD, ø 90 (HEATER RATING 10)					
18	Reduction hood (straight) ø 90	0	-	-	-	5
19	Reduction hood (spherical 90°) ø 90	-	5.0	-	-	6
20	Flexible pipe, ø 90 (per metre)	-	1	-	2.5	3
21	T-piece, ø 90 x ø 90 x ø 90	-	0	-	-	8
22	Butterfly valve with regulating flap, ø 90 x ø 90 x ø 90 (Position “middle / right, left”)	-	1.2 / 1.4	-	-	10
23	Y-piece, 45°, ø 90 x ø 90 x ø 90	-	-	-	-	9
24	Y-piece, Symmetrical, ø 90 x ø 75 x ø 75	-	-	-	0.9	9.1
25	Ducting flange (plastic connecting piece) ø 90	-	2.2	-	0.5	12
26	Up right vent 90° (rotatable) ø 90	-	2.4	-	0.6	13
27	Outlet screen (flat) 30° (rotatable) ø 90	-	2.0	-	0.4	14
28	Outlet screen (flat) 0° (rotatable) ø 90	-	1.1	-	0.3	14.1
29	Outlet screen (closable and rotable) ø 90	-	-	-	-	15
30	Outlet vent with flange (rotatable) ø 90 - ø 100	-	2.2	-	0.5	16
31	Adapter ring (ø 90 to ø 100)	-	0	-	-	18
32	Flexible pipe, ø 100 (per metre)	-	0.4	-	-	3
33	Air silencer (inlet and outlet) ø 100	-	0.5	-	-	20
34	Ducting union (connecter) ø 100	-	0.1	-	0.3	19
35	Y-piece, 45° (ø 100 x ø 100 x ø 100)	-	-	-	0.5	9
36	Plastic reducer (for 4-piece & ducting union) (ø 100 to ø 75)	-	3.2	-	0.8	18.2

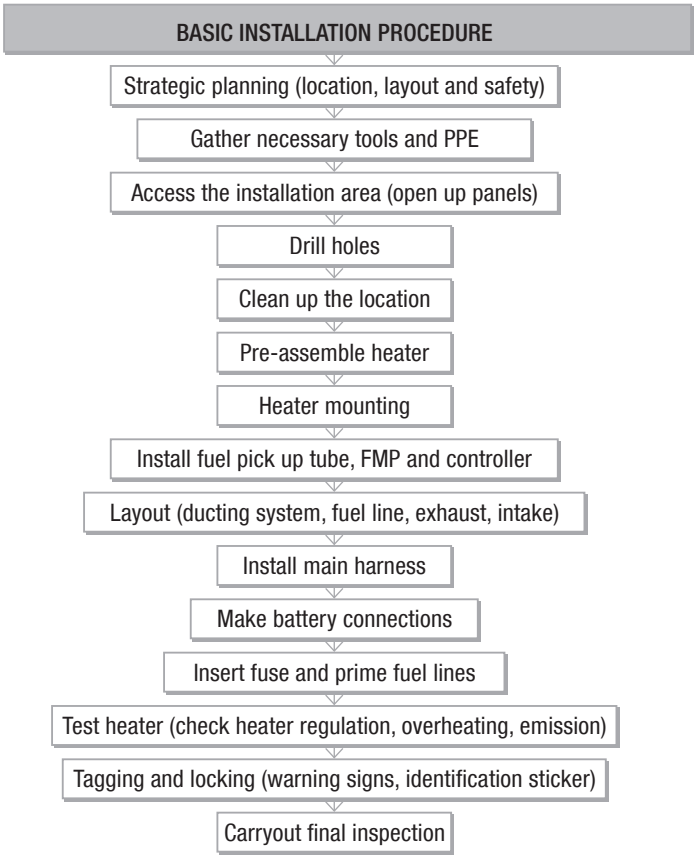
4 Installation Procedures

HEATER INSTALLATION

In addition to the correct size of the air heater, it is imperative to follow its installation and operating instructions for optimal performance.
The type and scope of heater installation can vary with the operating condition, application and vehicle. In addition, an improperly installed heater leads to a frequent maintenance and component failure. Therefore, it is necessary to practice a careful planning with concerning system design, overall safety and installation process.

FACTORS AFFECTING HEATER INSTALLATION





PLEASE NOTE! Above mentioned installation procedure is for general purpose only. Some installation may require additional steps to follow application specific standards.

⚠ WARNING TO INSTALLER

- It is mandatory to use minimum required tools and protective equipment for the safety of installer as well as heating system. Please see page #5.
- Correct installation of this heater is necessary to ensure safe and proper operation.
- Read and understand this manual before attempting to install the heater. Failure to follow all these instructions could cause serious or fatal injury.
  - — Disconnect the vehicle battery before starting any kind of work.
  - — Before working on the heater, switch the engine off and let all hot parts cool down.
  - — The heater must not be operated in closed areas, e.g. a garage or in a multi-storey parkade.
- All appropriate precautions must be taken when arranging the heater to minimize the risk of injuries to people or dama ge property.
- Parts related to the fuel system must not be located in the passenger compartment and at the exit doors of the vehicle. Fuel lines must not be routed on the top of any electrical lines or hot parts.
- Wrong installation could cause physical injury, fire and asphyxiation hazard as well as system failure.
- Installation and repairs by unauthorized and untrained persons, repairs using non-original spare parts and without the technical documents required for installation and repair are dangerous and therefore are not permitted.

PLEASE NOTE! Refer general guidelines for duct system design and installation for additional information, see page 39.

HEATER LOCATION

Depending on the type of vehicle, a suitable location for mounting the heater can vary. Typically, air heaters are mounted inside tool or luggage compartments, or on the wall of the cargo compartment. In rare cases, an airtronic heater may be mounted outside on the exterior structure, but additional measures must be required to protect the heater and enclosure from corrosion, road spray and external activity. The heater may be mounted anywhere inside the vehicle compartment or outside, as long as following conditions are strictly adhered:

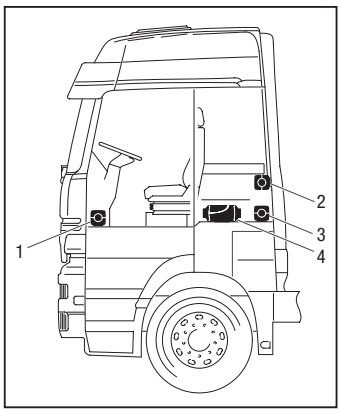
- The heater location should have enough air ventilation as well as sufficient clearance for regular inspection (access the name plate or remove small parts like glow pin or screen)
- The heat from the heater must not be affecting the user, cargo or any equipment in its vicinity and vice versa.
- Combustion air intake, exhaust and fuel inlet must be located outside of the vehicle.
- Heater must be mounted on flat surface of the wall or floor providing an air tight seal between heater and vehicle.
- Heater mounting location outside of the vehicle requires frequent inspection. (Exterior installation is the least recommended for airtronics)
- For dangerous or flammable goods type cargo application, Additional safety measures must be applied on the heater system.
- Heater must never be placed in the compartment full of wood dust, wool, flammable gas, or fuel container.
- Heater must not be affected by vehicle movements, road spray, ram air or slip stream.
- Heater should never be placed in the engine compartment of the vehicle or locations where vibrations and high temperature are normal.
- Heater location must be accounted for appropriate space for duct and wire harness layout.

4 Installation Procedures

HEATER LOCATION

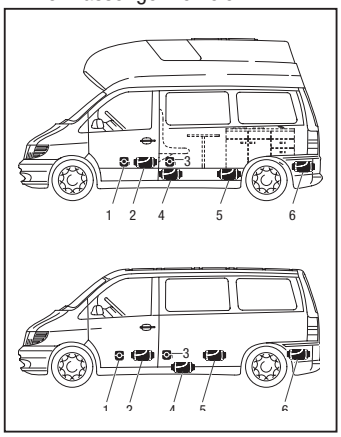
EXAPLES OF HEATER LOCATIONS:

• Truck Cab:



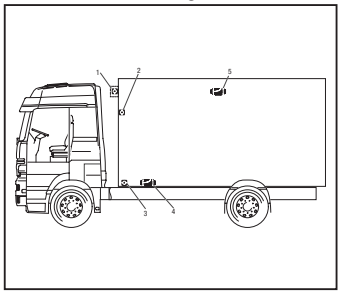
1.Heater in the passenger's foot room
2. Heater on the cab rear wall
3. Heater under the bed
4.Heater under the bed

• RV or Passenger Vehicle:



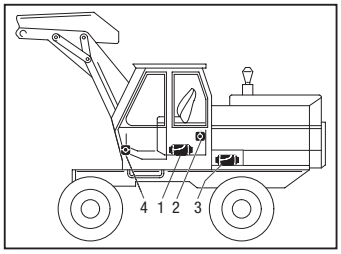
1.Heater in front of the passenger seat
2. Heater between the driver's seat and the passenger seat
3.Heater behind the driver's seat
4. Heater under the vehicle floor
5. Heater in living space
6. Heater in the boot

• Small/midsize Cargo Vehicle;



1.Heater on the front wall (exterior) of the compartment.
2.Heater on the front wall (interior) of the compartment.
3.Heater at the bottom of the front wall (interior) of the compartment.
4.Heater on the floor (interior) at the front side of the compartment.
5. Heater on the side wall (interior) of the compartment.

• Off Road Equipment:



1. Heater in the seat box.
2. Heater on the cab rear wall.
3.Heater in a protective case.
4.Heater in the passenger's foot room.

PLEASE NOTE! The heater mounting locations, as shown here, are for example purpose only, there may be other installation locations depending on the vehicle type

HEATER MOUNTING AND HARDWARE

It is mandatory to install the heater with appropriate mounting components for its safe installation and operation. The mounting and fastening hardware are included in most of the kits.
Apply special attention to the effects of corrosive environment, vibration, and vehicle parts movements while mounting the heater.

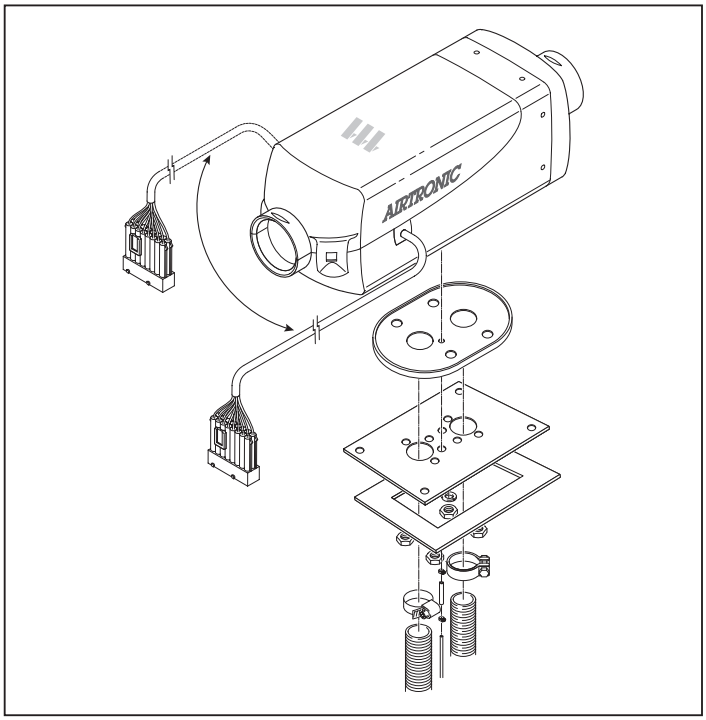
HEATER MOUNTING ON THE FLOOR:

The most suitable way of mounting the heater is to place it horizontally on the compartment floor, so the fuel, intake air and exhaust ports can be placed directly outside of the vehicle body. A separate mounting plate (base plate) is required to provide structural strength and thermal insulation.

BASE PLATE:

When heater is mounted horizontally on the flat surface of the floor, a base plate type mounting bracket must be required for insulation and structural support. The base plate has a self adhesive closed cell foam which acts as a barrier from the exhaust fumes and noise entering inside the compartment. To mount the heater on the base plate, please follow these steps:

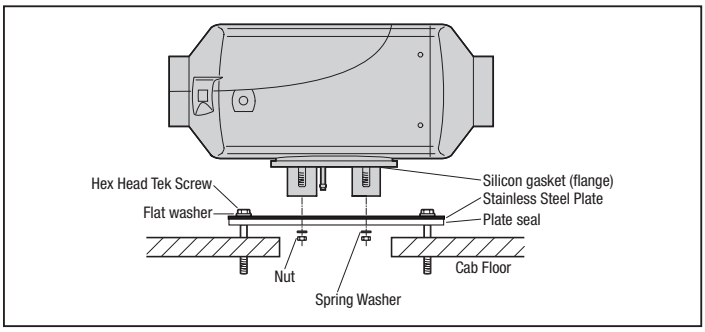
- Choose heater location.
- Cut a 4-½" hole or a rectangular opening 4"x 5" to accommodate mounting plate and seal. Secure mounting plate to vehicle with provided "Tek" screws.
- Mount heater on mounting plate with nuts and spring washers provided.
- If the mounting plate will not be used, the heater flange can be used as a template to mark where the individual components openings should be made. (A diagram of the flange is on the following page.)
- For ease of installation assamble the exhaust, combustion air intake and fuel connections at the base of the heater before mounting the heater. See the fallowing pages for instructions and restrictions on the exhaust, combustion air intake and fuel connections.
- If the sheet metal of the support surface is thinner than 15mm, an additional reinforcement plate will have to be fitted.



For Illustration purpose only

4 Installation Procedures

HEATER MOUNTING AND HARDWARE



HEATER MOUNTING ON THE WALL:
In cargo applications, it is sometimes necessary to mount the heater in such a way so it will not interfere with material handling activity or shipping products. Therefore, the heater mounting location should be close to the ceiling and on the front curbside wall of the compartment. The mounting bracket also called as cargo or angled bracket is required to locate the heater on the wall.

PLEASE NOTE!

- Ensure a sufficient space for layout of the duct (recirculation or fresh air) before installing a cargo heater.
- Since the heater is placed inside the compartment, an extra care is required while installing exhaust, intake and fuel line.
- The exhaust pipe with through hull fitting must be inspected regularly for any leakage or blockages.
- With such installations, it is highly recommended to apply extra measures against fire (i.e. master switch, fire extinguisher, alarm and smoke detector).
- It is recommended to contact nearby dealer for inspection of heating system in cargo compartment.

ANGLED OR CARGO BRACKET:
It is a metal bracket for mounting the heater on a flat surface of the compartment wall. It comes with pre-drilled holes and access ports for intake and exhaust pipes.

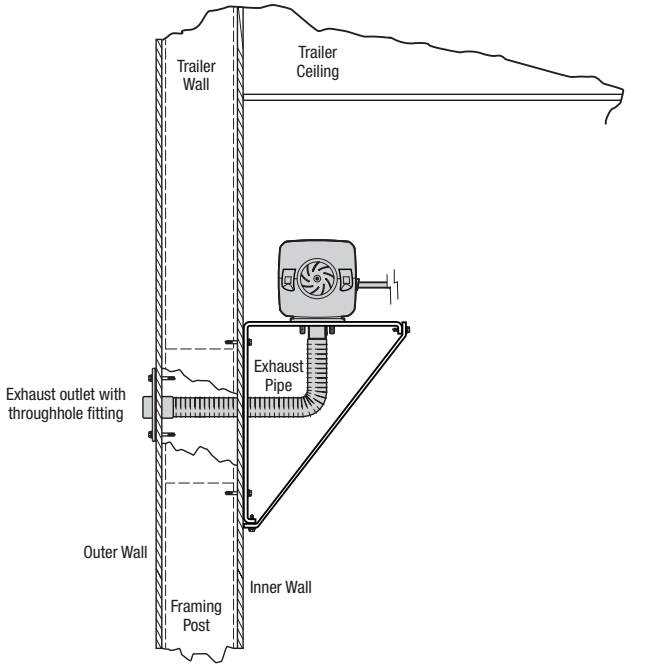
To mount the heater on the wall, refer these guidelines:

1 Identify the location of wall framing posts where bracket is mounted. Ensure that no other parts or electrical lines are available at proposed mounting location.
2 Measure the dimensions, and drill holes on the framing posts according to the footprint of the mounting bracket.
4 Install the bracket using appropriate fastening hardwares. The overall support must be structurally sound to withstand vehicle vibration and heat from the heater.
5 Connect a through hull fitting for exhaust pipe and insulate it with heat resistant sealant .

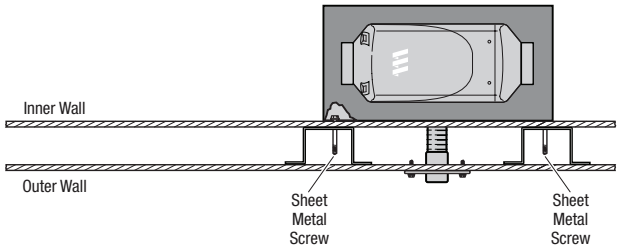
PLEASE NOTE!

When installing a heater in FRP type cargo compartment, use a supplementary bar along with nut and bolt for additional structural support as shown in the image.

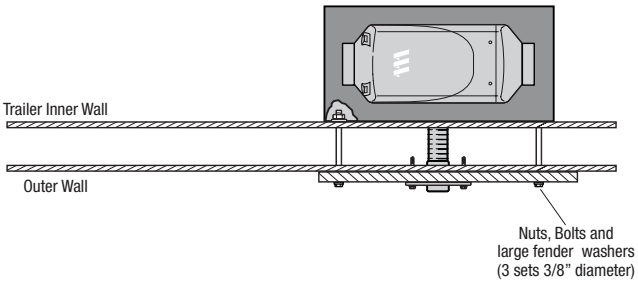
AIRTRONIC 2 / 4 Side View **For Illustration purpose only**



AIRTRONIC 2 / 4 Top View



AIRTRONIC 2 / 4 Top View in a FRP Cargo Compartment



DUCTING SYSTEM INSTALLATION

Normally, installation of duct system is very simple and easy if it is properly designed. However, few installation steps need to be considered as mentioned here:

1) Always use a precise length of the duct during its installation to prevent unwanted bends, misalignment, or physical damage.
2) To avoid physical damage to the ducting system, always use appropriate fasteners and avoid overtightening them.
3) Use a small holding bracket to place the flexbile duct if it is mounted on the wall as shown in image to prevent duct sagging or crushing.
4) Never integrate Eberspaecher heater duct network in to vehcle's HVAC system.
5) Always have a local eberspacher dealer to inspect the duct system layout and installation.

PLEASE NOTE! For most application, it is recommended to purchase a generic kit for aitronic D2/4, which comes with pre cut duct and selected components.

PLEASE NOTE!

Refer general guidelines for duct system design and installation for additional information see page 39.

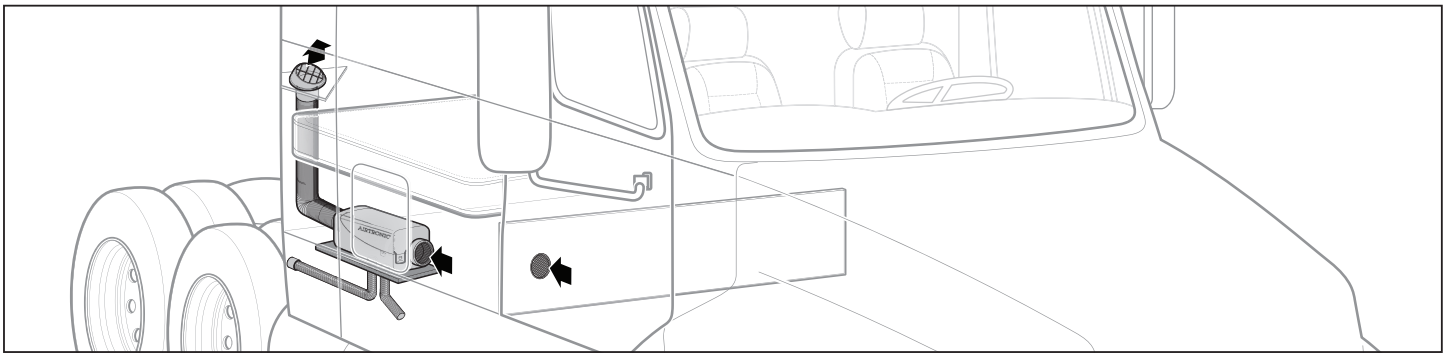
DUCT LAYOUT BASED ON HEATER APPLICATION

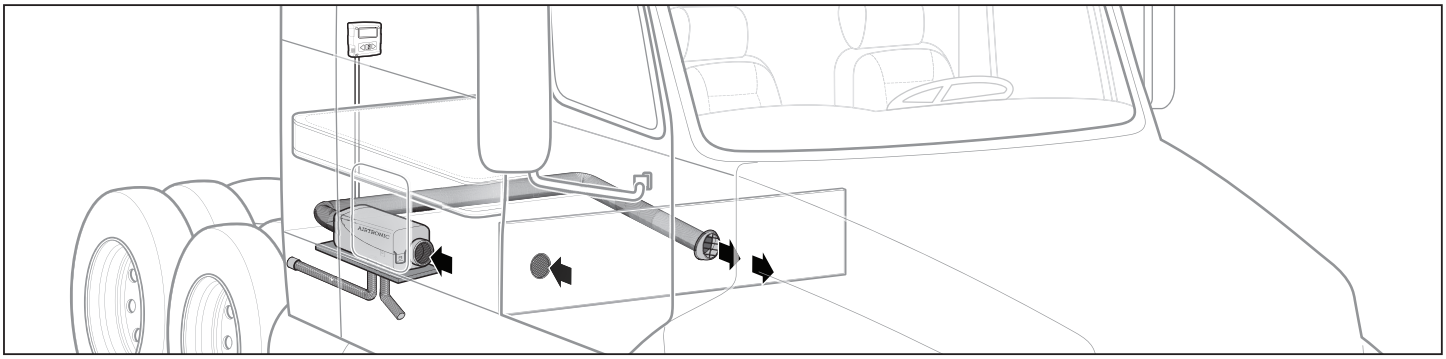
SLEEPER/CAB OVER

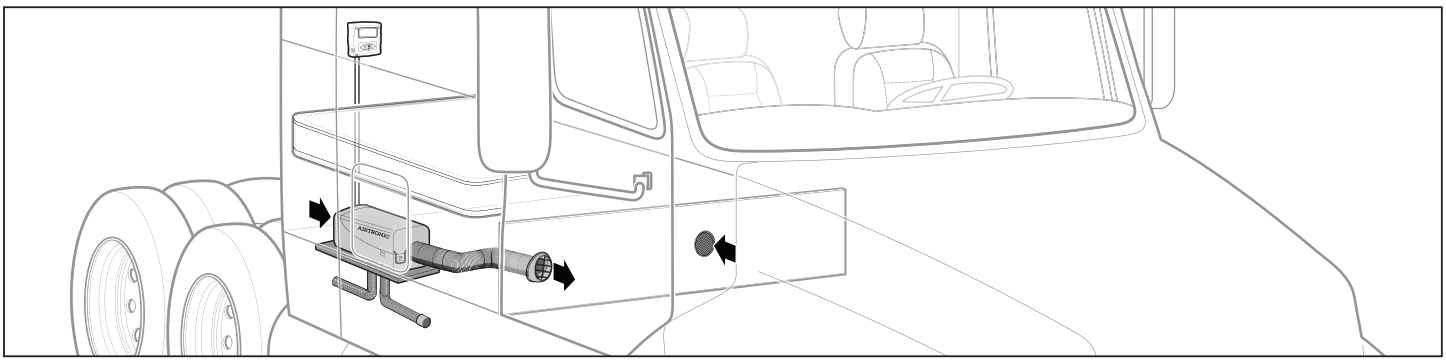
- For such application, a key goal is to use minimum area for the heater mounting and duct layout, so rest of the space can be used for storage or other purposes.
- The heater is normally placed underneath of the sleeper bed or in the tool box compartment. So, the dimensions of the duct layout can vary depending on the location and direction of the heater.
- An airtronic D2 heater with a single channel duct design and return air system is mostly sufficient for such application. Due to space constraints, the design for duct layout may require sharp bends or short duct length.
- A 60 mm flexible duct (approx. 40" long), outlet vent, and clamps are provided with generic Airtronic D2 truck kit for such application, please see product catalogue for additional information.

PLEASE NOTE!

- The heater or any part of its ducting system is hot. It is mandatory to keep storage items away from the heating system.
- Ensure that the hot air from outlet vent is not directed towards a driver, passenger, or heat sensitive material in the compartment.
- In return air heating system, maintain enough space between inlet and outlet vents to prevent short cycling and overheating issues.
- For heater location and mounting, please see pages: 48 - 51.
- For additional guidelines for duct design and installation, see page: 39.







For Illustration purpose only

4 Installation Procedures

DUCT LAYOUT BASED ON HEATER APPLICATION

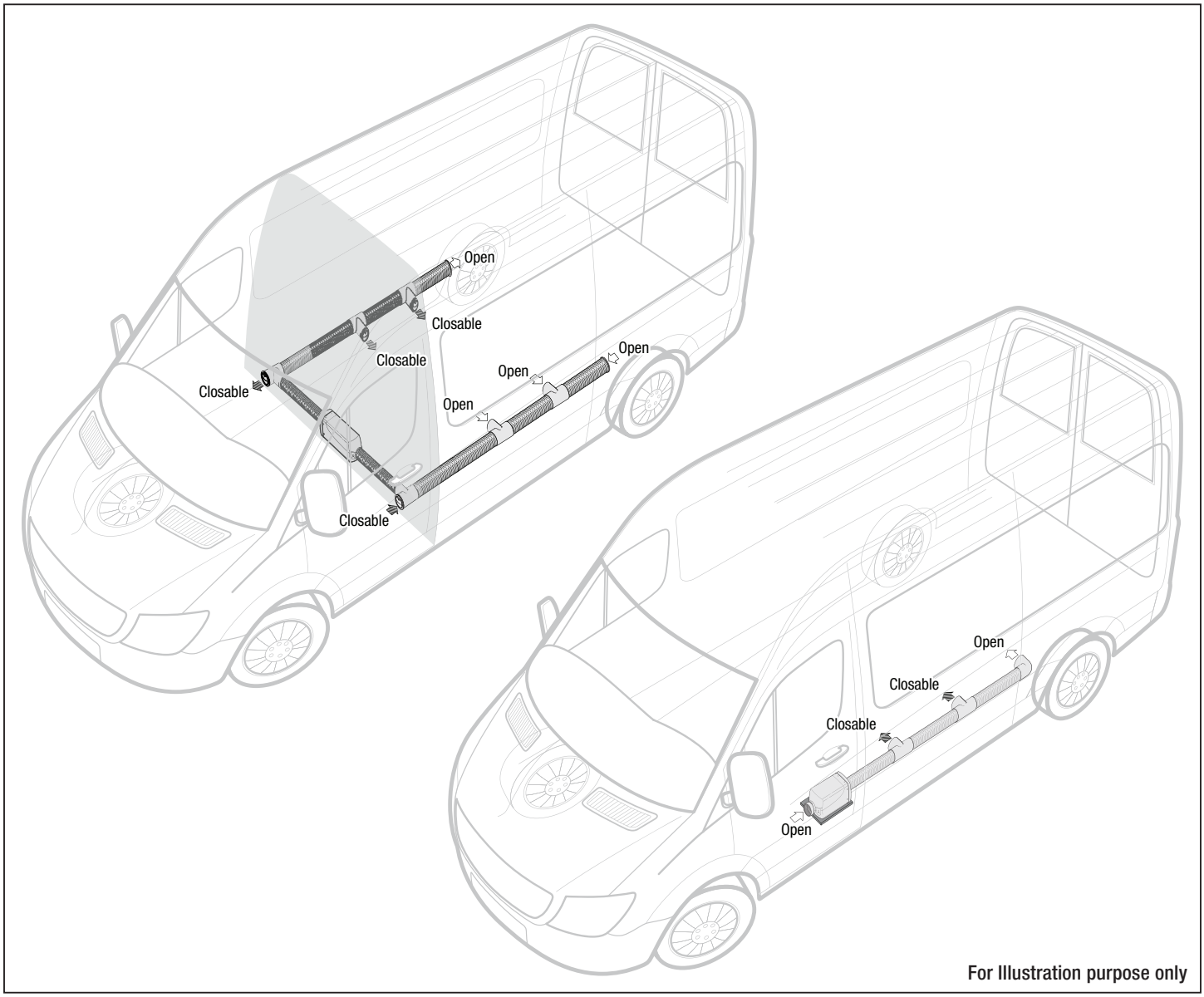
PASSENGER VEHICLES

- For such application, the main goal is uniform heat distribution throughout the compartment to maintain highest quality of the heated air for optimal passenger comfort.
- Depending on the application and number of passengers, additional requirements for fresh air ventilation system may be necessary, but not mandatory.
- Regardless of shapes of the duct layout, such application requires a of multi channel duct system and numerous components.
- Normally, an Airtronic D4 with 90 mm hood is installed if the heat requirement is within limit.
- Make sure all necessary rules and standards for HVAC system for such applications are complied while installing the heating system.

PLEASE NOTE!

- For heater location and mounting, please see pages: 48 - 51.
- For additional guidelines for duct design and installation, see page: 39.

- An air silencer at inlet and/or outlet of the heater reduces blower noise in the compartment.
- Supplementary measures must be taken to ensure the overall safety of the heating system and cargo, like installing the ventilation system, smoke detector, fire alarm system or emergency heater stop system.



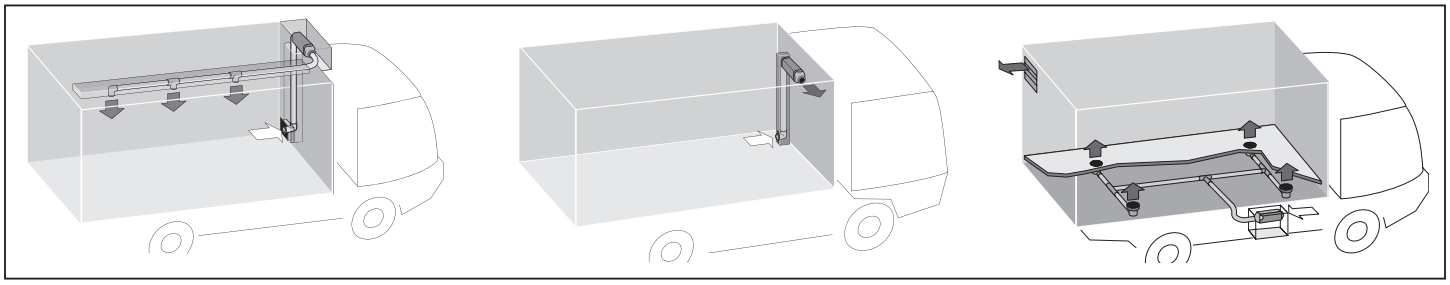
For Illustration purpose only

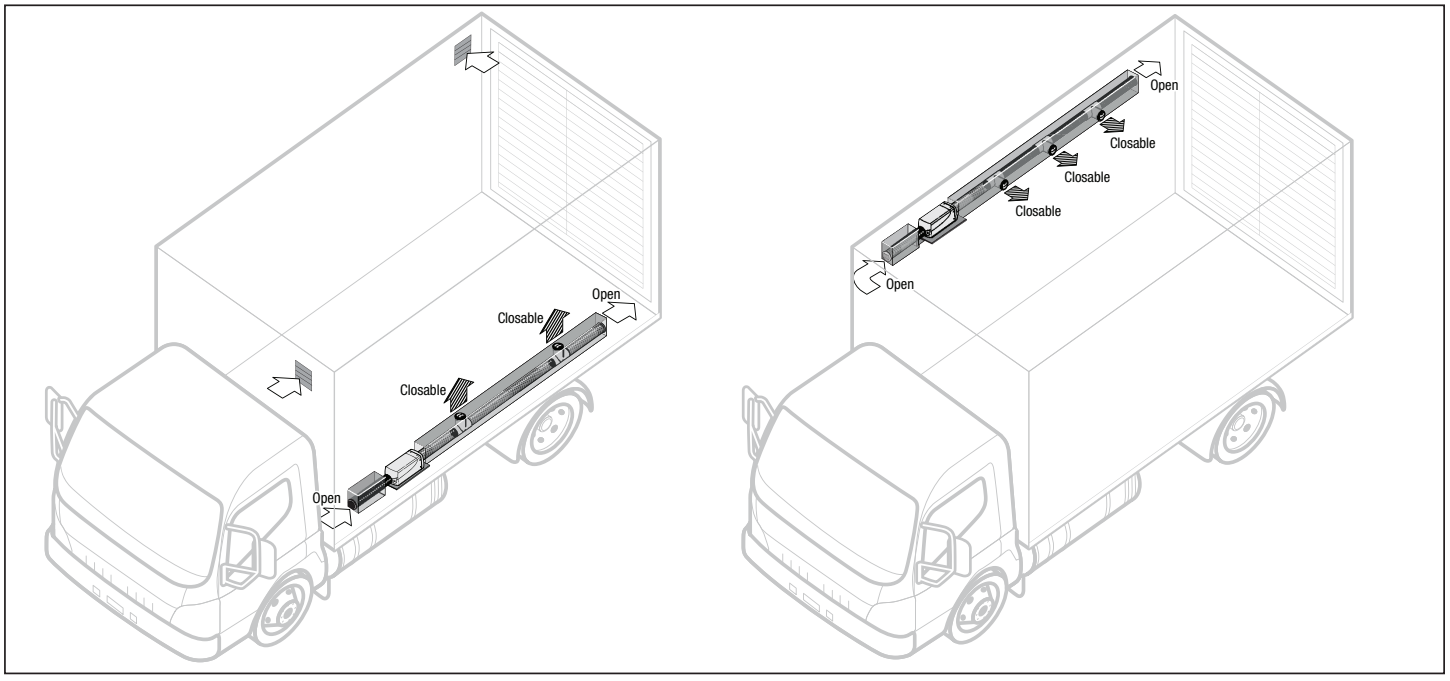
CARGO VEHICLES

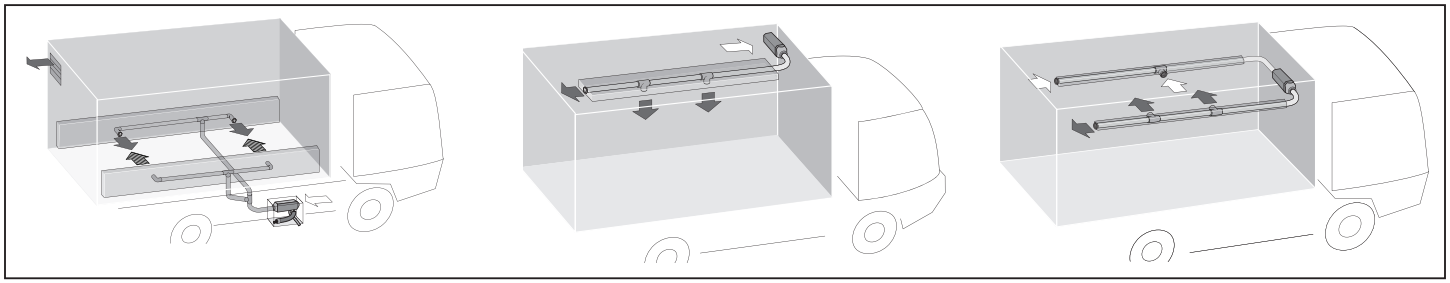
- For such application, the main goal is to install the heating system in such a way so it may not obstruct the cargo space and material handling process, which must be examined prior to the selection of the heater location.
- Mostly, it is necessary to ensure the uniform heat distribution to maintain even temperature throughout the compartment.
- Depending on the application and cargo, additional requirements for fresh air ventilation system may be necessary, but not mandatory.
- Regardless of shapes of the duct layout, such application may require a multi channel duct system and numerous components.
  Sometimes, a single channel duct system must be installed due to space constraints in small cargo compartments.
- Based on the heat requirement and possible duct layout, the heater for such application can be either airtronic D2 (75 mm straight hood) or D4 (90 mm straight hood).
- Make sure all necessary rules and standards for HVAC system for such applications are complied while installing the heating system.

PLEASE NOTE!

- For heater location and mounting for cargo installation, see page: 48 -51.
- For additional guidelines for duct design and installation, see page: 39.







For Illustration purpose only

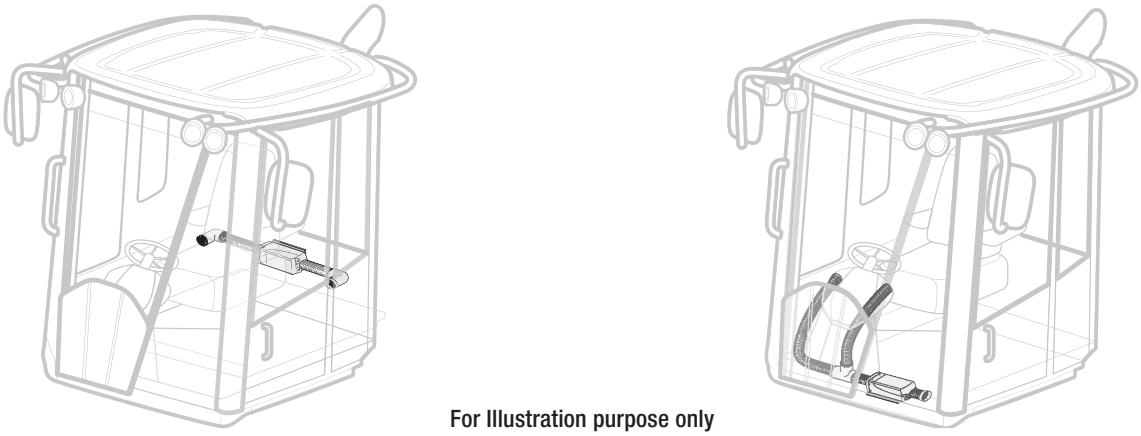
4 Installation Procedures

OFF ROAD EQUIPMENT

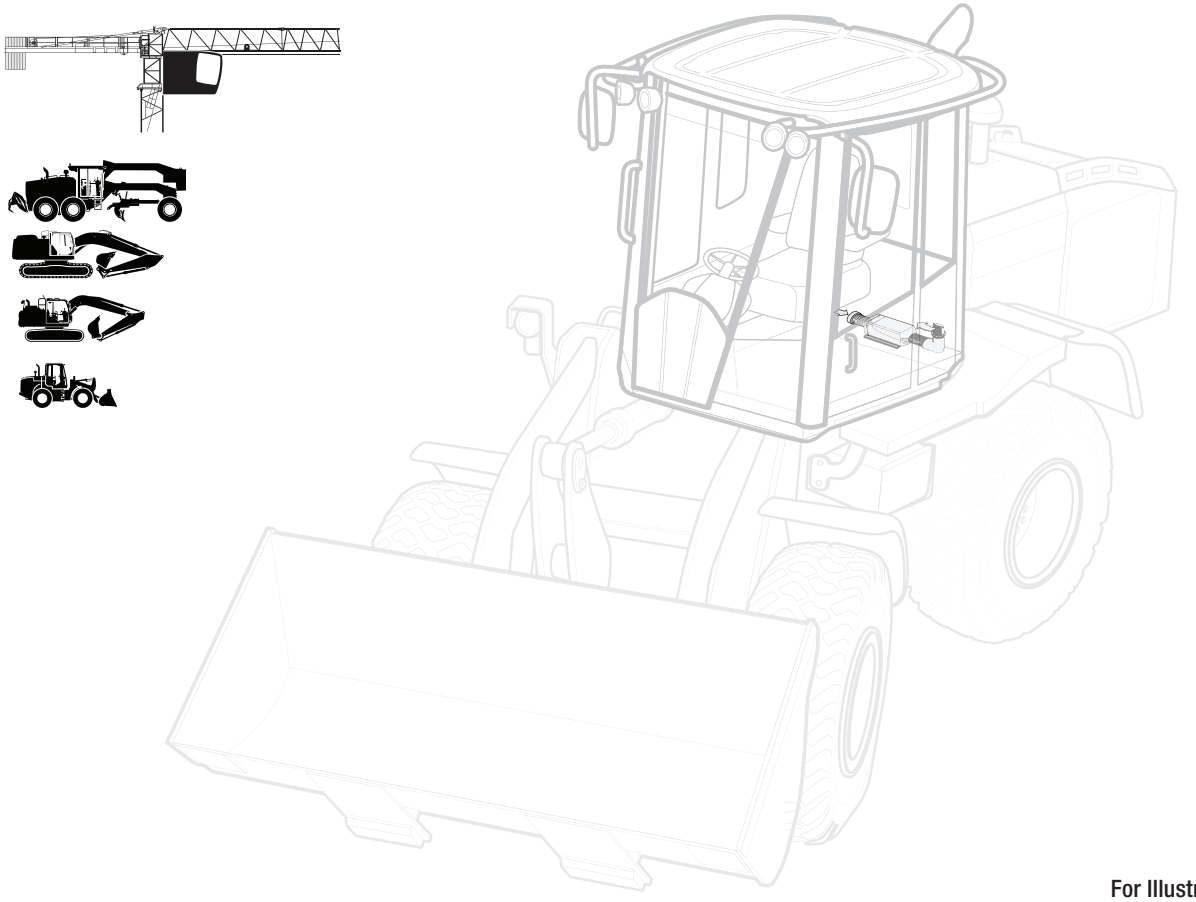
- Regardless of type and application of the off road equipment, the average size of the compartment area is similar to the small cab over truck. Therefore, follow the information for heating system and duct layout available in the sleeper/cab over section, see page 51.

PLEASE NOTE!

- The heating system must be installed in such a way that the mechanical movements of the vehicle or its parts are not affected, or vice versa.
- Additional measures must be taken to protect the heating system from external environment, vibration and flammable material.
- For heater location and mounting for cargo installation, see pages: 48 -51.
- For additional guidelines for duct design and installation, see page: 39.



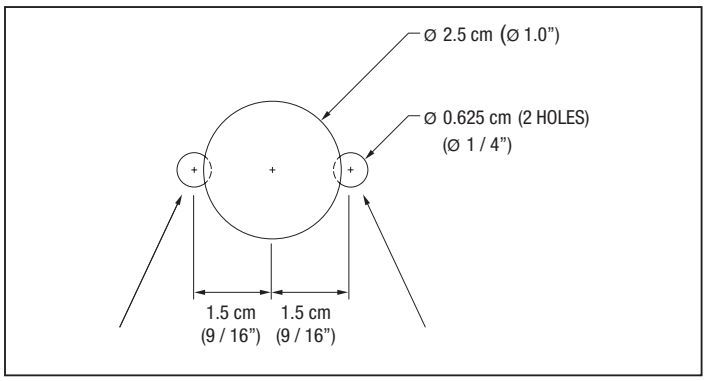
For Illustration purpose only



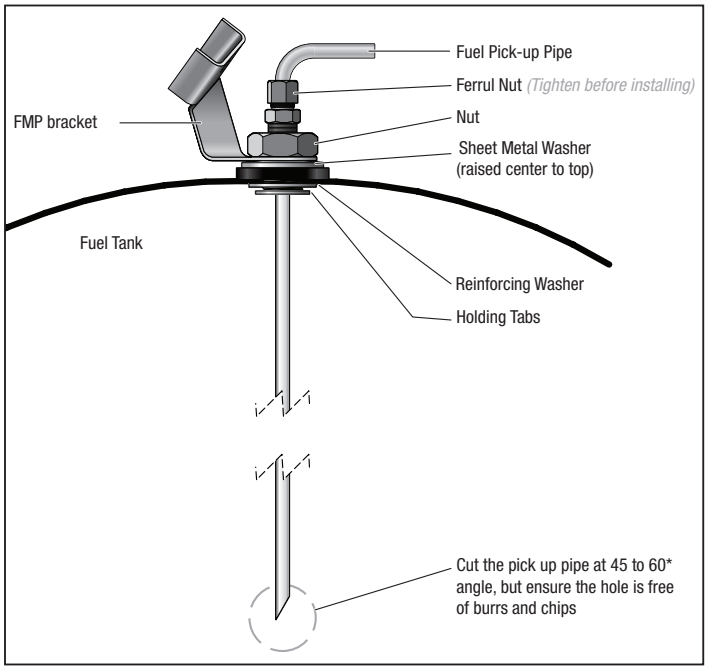
For Illustration purpose only

CUSTOM PICK-UP PIPE WITH 1/4" NTP FITTING - OPTION

- Choose a protected mounting location close to the pump and heater. A spare fuel sender gauge plate provides an ideal mounting location. If one is not available...
- Drill mounting holes in tank to accommodate pick-up pipe as shown.
- Tighten Ferrule nut to pick-up pipe at desired height.
- Cut the fuel pick-up pipe to length. Allow 2-2.5" from bottom of tank.
- Mount the fuel pick-up pipe as shown.
- Lower the fuel pick-up pipe (with reinforcing washer) into the tank using the slot created by the two 0.6cm (1/4") holes.
- Lift the assembly into position through the 2.5cm (1") hole.
- Assemble the rubber washer, metal cup washer and nut.

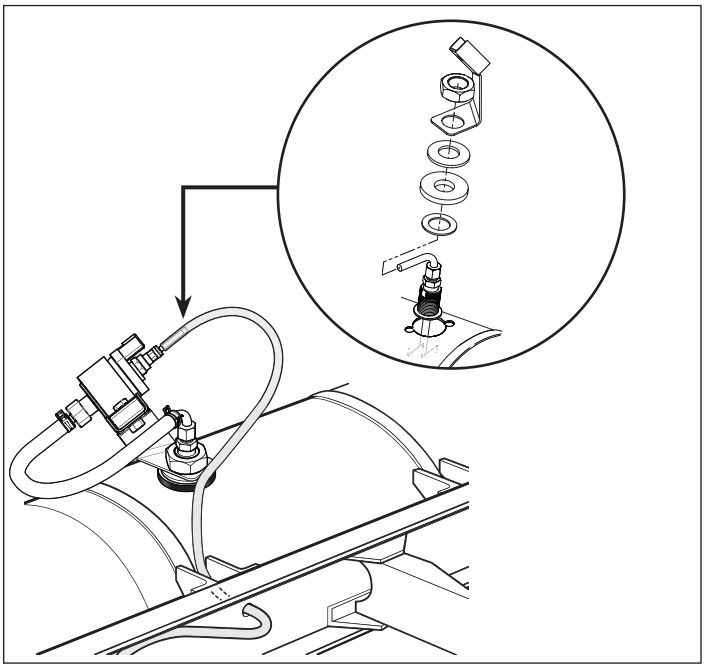


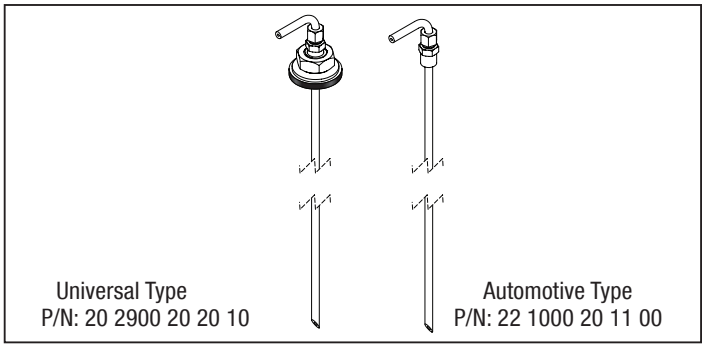
PLEASE NOTE! Drill the two (1/4") holes first.



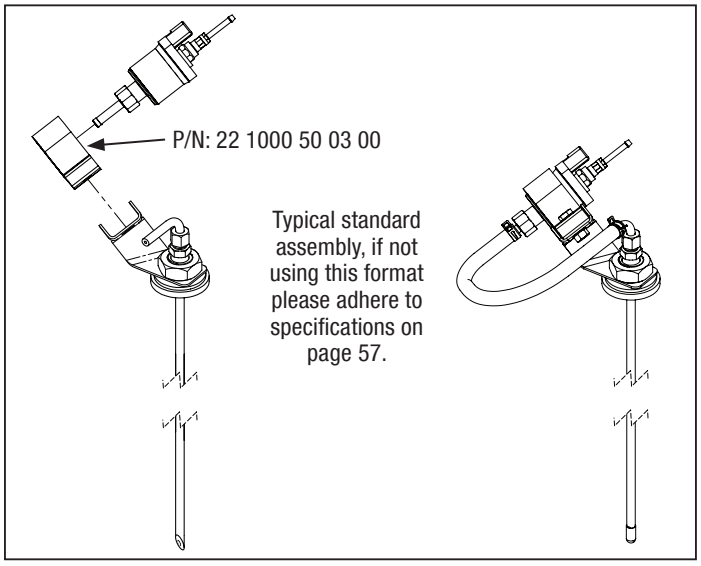
PLEASE NOTE!

- Allow 4" from Fuel Pick-up to tank bottom. Allow only 1" for flat bottom tanks.
- Always install the fuel pick up pipe on the top of the tank
- It is recommended to keep the heater's pick up pipe atleast 25 mm shorter than vehicle stand pipe to access clear fuel.





PLEASE NOTE! Some pick-up pipes can be installed by either drill or NPT.

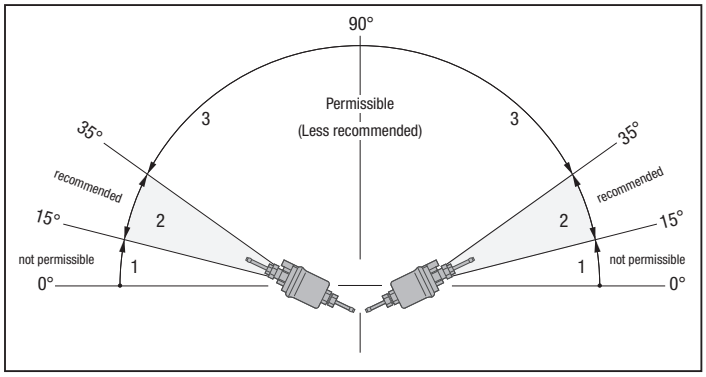


PLEASE NOTE! NPT fittings are available in various sizes (Refer to Eberspaecher's North America Product Catalogue).

4 Installation Procedures

FUEL SYSTEM INSTALLATION

MOUNTING ANGLES OF THE FUEL METERING PUMP (FMP)



PLEASE NOTE!

Improper mounting angle of the heater and FMP could cause unexpected heater faults and component failures; Also, increases the chance of fuel leakage, heater stoppage, or frequent accumulation of carbon in the combustion chamber.

FMP AND PICK UP PIPE MOUNTING HARDWARE

The mounting location of the FMP should be nearer to the fuel pick up pipe. The FMP must be mounted using appropriate mounting bracket and fasteners. To minimize the vibrational noise, it is recommended to use a rubber grommet for FMP.

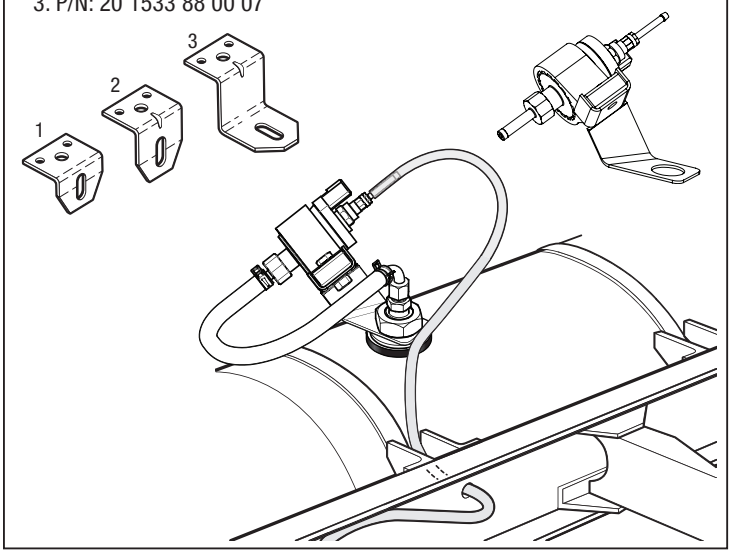
PLEASE NOTE!

Proper mounting angle of the fuel pump is necessary to allow any air or vapor in the fuel lines to pass through the pump rather than cause a blockage.

FMP MOUNTING BRACKET

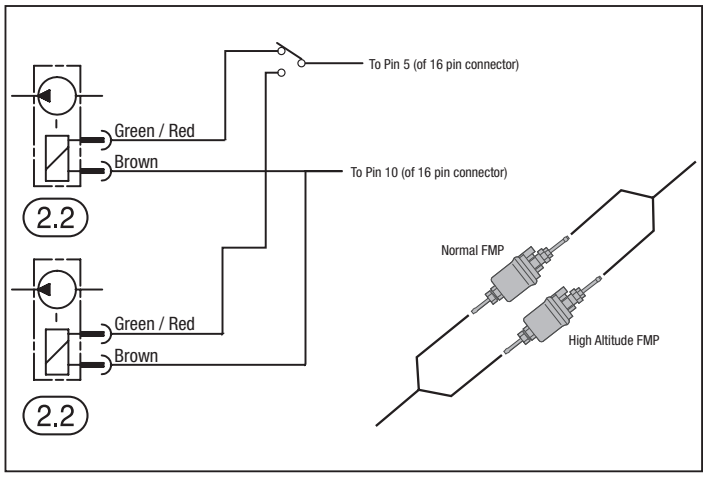
These FMP mounting brackets are used for the pump installation on the locations far from the tank i.e frame rail, vehicle bracket. Please consult the dealer for additional information.

1. P/N: 20 1348 03 00 02
2. P/N: 20 1348 03 00 04
3. P/N: 20 1533 88 00 07



HIGH ALTITUDE FMP

For high altitude operation (1500 to 2750 m), a secondary FMP is required for older airtronic heater (non H-kit only). The main purpose of such pump is to deliver a lesser quantity of fuel than normal FMP. For optimal efficiency, it is necessary to install the high altitude FMP at an angle 15° to 35°. Both pumps are connected in parallel using a changeover switch as shown in the image below. The part number of the high altitude FMP kit is: 24 0222 00 00 00.



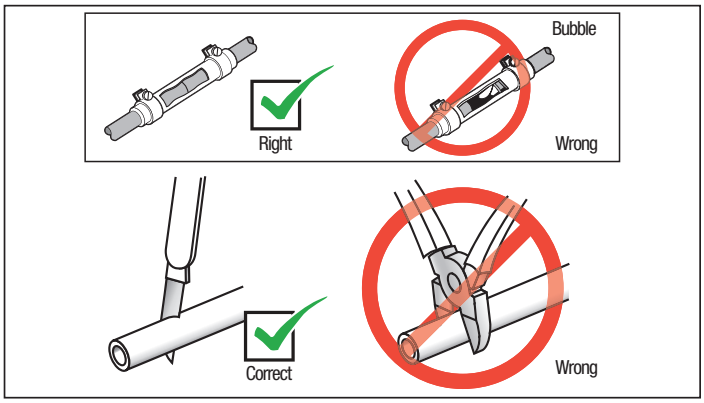
PLEASE NOTE!

- Ensure that both fuel lines have same diameter and length to prevent any flow issue.
- Excessive air bubble in the fuel line will interrupt heater operation. Bleed the air from both fuel lines, if necessary.
- Protect the FMP from heating up more than allowed, do not install near to the exhaust silencer or pipes.
- The fuel output of FMP remains constant regardless of its operational altitude; therefore, avoid running the heater at altitudes higher than 2750 m.

FUEL LINE

- Route fuel lines from the fuel pick-up pipe to the heater.
- Use only fuel lines provided.
- Other sizes or types of fuel lines may inhibit proper fuel flow.
- Make proper butt joints using clamps and connector pieces as shown.
- Use a sharp utility knife to cut plastic fuel lines to avoid fuel line pinching.

PLEASE NOTE! Apply butt joint on the fuel lines connections using an appropriate fuel adapter/hose and clamps.



FUEL SYSTEM INSTALLATION

Based on the design of the heater, the fuel system of the airtronic D2/4 heater is divided into two categories:

- Airtronic D2/4 Fuel system with Rubber fuel lines (hose)
- Airtronic D2/4 Fuel system with Plastic fuel lines (clear/black)

While both types fuel lines are compatible with Airtronic D2/4 heaters, it is recommended to use a plastic fuel line (clear black) to minimize its priming duration. Most of airtronic D2/4 kits is supplied with plastic fuel line along with rubber connectors and adapters.

⚠ WARNING:

- Switch off the vehicle engine before carry out refueling or maintenance work.
- Avoid fuel line installation inside the compartments and underneath of the exit doors.
- Never keep any ignitable material or appliance nearby while working with fuel system.
- It is required to make sure the parts carrying fuel must be protected from any possible heat source in vehicle. Also, dripping or evaporating fuel must never be allowed to collect on the hot parts.
- Do not inhale fuel vapours and avoid any contact with the skin.

⚠ CAUTION:

- Always have appropriate PPE and minimum required tools while installing fuel system.
- Only use sharp knife to cut off fuel hoses and lines, also ensure the interface must not be crushed, also free of burrs.
- Fuel lines must be fastened safely to avoid any damage and/or noise production from vibrations. It is recommended to apply fasteners at every 50 cm. approximately.
- Never fasten or route the fuel lines to the heater or vehicle exhaust system
- Lay out fuel lines under the electrical lines and make sure the motion of vehicle parts while in operation.

PLEASE NOTE!

- Always protect the fuel line from adverse weather conditions like extreme cold temperature. It is recommended to use appropriate fuel grade insulating sleeve to reduce chances of fuel gelling due to wind chill effect.
- If the size of air bubble is larger than 10 mm, then bleed the air, and re-prime the fuel line to prevent frequent heater stoppages (micro air bubble may cause an unstable flame).
- Before commissioning a heater, always prime the fuel line. (FMP test through Switch on component option in EDiTH is good option for priming the heater).

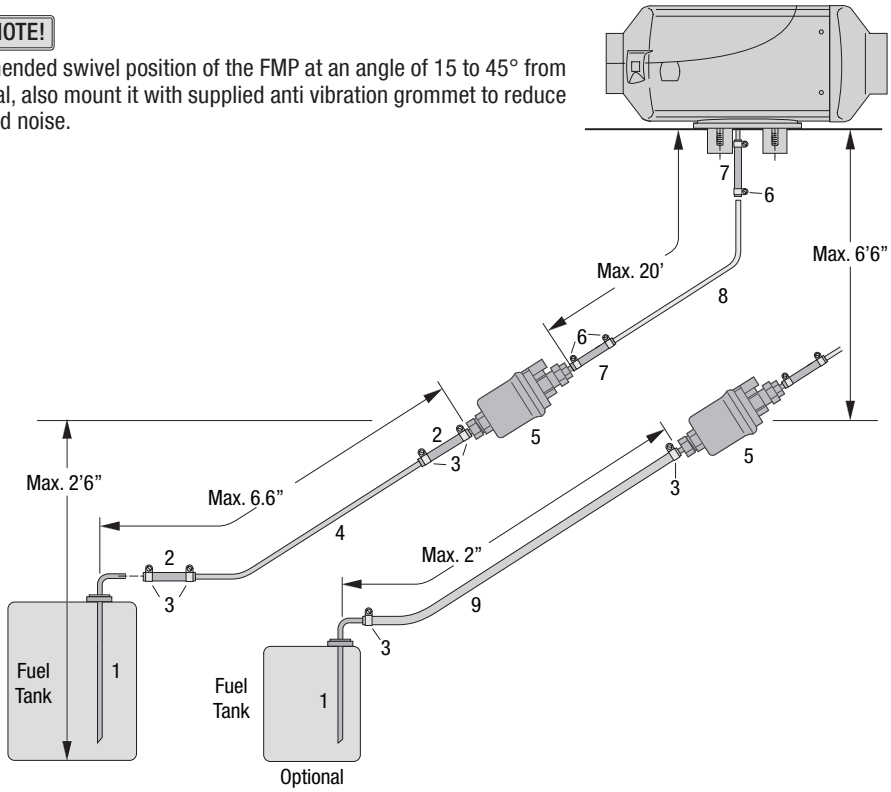
PLEASE NOTE! Please read all necessary information available in this page before carry out fuel line installation.

- Never install the fuel system (airtronic 2/4) beyond the specification provided in the image as shown below.
- Do not tap the heater fuel line to the existing fuel line of the vehicle without inspecting line pressure and fuel availability. If the line pressure is higher than 0.2 to 4 bar max, use a pressure reducer 22 1000 20 08 00 or separate fuel tank 22 1000 20 28 00). Use an additional tank and filter 25 1226 89 00 37, if the pressure values are beyond 4 bar. For further information, please contact Eberspaecher N/A).
  If the distance between the fuel tank to heater is outside specified dimension in image as shown below, then use an auxiliary fuel circulation pump 25 1226 89 83 00 (24V only) and filter 25 1156 20 00 09 to supply the fuel up to the heater fuel line.
- For installations where the fuel tank is located higher than FMP, the maximum recommended height from FMP to the top end of the tank should be no more than 3 meter or 10 ft.
- Make sure that all parts related to the fuel system, are not located in the passenger compartment or exit doors. Fuel lines must not be routed on the top of any electrical lines or hot parts.

PLEASE NOTE!

- Recommended swivel position of the FMP at an angle of 15 to 45° from horizontal, also mount it with supplied anti vibration grommet to reduce unwanted noise.

For Illustration purpose only



1. Fuel Pick-Up Pipe
2. 5.0mm Rubber Connector
3. 11mm Clamp
4. 2.0mm Black Plastic Fuel Line
5. Fuel Metering Pump
6. 9mm Clamp
7. 3.5mm Rubber Connector
8. 1.5mm or 2.0mm White Plastic Fuel Line
9. 5mm Rubber Fuel Line

FUEL SUPPLY

FUEL QUALITY FOR PETROL HEATERS

The heater can run on commercially available fuel as per **DIN EN 228** as used in the vehicle tank.

FUEL QUALITY FOR DIESEL HEATERS

The heater can run on commercially available fuel as per **DIN EN 590**, as used in the vehicle tank.

FUEL FOR SPECIAL CASES

In special cases (above 0 °C), the heater can also run on fuel oil EL or kerosene for short periods only.

FUEL FOR LOW TEMPERATURES

Refineries and fuel service stations automatically adjust the fuel to normal winter temperatures (winter diesel). This means that difficulties are only to be expected for extreme drops in temperature, as also apply to the vehicle engine. Please, refer to the vehicle manual.

If the heater gets fuel from a separate tank, please comply with the following rules:

- For temperatures above 0 °C, any kind of diesel fuel as per **DIN EN 590** can be used.
- If no special diesel fuel is available for low temperatures, then kerosene or petrol should be mixed with the fuel according to the following table:

Temperature	Winterdiesel	Addition
0 °C to – 25 °C	100 %	–
–25 °C to – 40 °C	50 %*	50 % paraffin or petrol

* or 100 % special cold diesel fuel (Arctic diesel)

FUEL WARMER FOR EXTREME COLD CONDITIONS:

The fuel quality varies significantly depending on geographic location, altitude, and local climate. Some fuels are modified with additives, which may or may not affect the heater operation. Overall, it has been seen that the chances of fuel to gel or frost inside the line is higher if improper grade or low quality of the fuel is used. Therefore, by adding a third party fuel/tank warmer may help reduce the effect of winter and minimize the fuel frost or gel inside the lines.

PLEASE NOTE!

- An insulation sleeves compatible with fuel may reduce wind chill effect on the fuel lines.
- Eberspaecher NA is not liable for any direct or indirect results of any third party products.

PLEASE NOTE!

- The ideal diesel fuel for the heater should have no additives, high in 'Cetane rating = 52, low in sulfur* = %Wt 0.005 (10 ppm is ok), Cloud point should be at minimum: -20 °C and Pour point at: -45 °C min, low Flash point rating = 67 and low Carbon residue, on 10% water distillation residue, %Wt <0.001 and must not have Lead (or < 0.005 gram/l). (should be equivalent to the fuel grade DIN 590).
  * The fuel filter (FMP) must be regularly inspected, if the low sulfur diesel is used.

- The Gasoline heaters can also run on motor oil as per **DIN 51600**. (however due to higher content of lead, it is less recommended)

PLEASE NOTE!

- Aviation fuel like JET A may be similar to diesel and kerosene; however it is not recommended. In addition, fuel mixture with used oil is not allowed.

- After refueling with winter diesel or the listed blends, the fuel pipes and the metering pump must be filled with the new fuel by letting the heater run for 15 mins.

- Kerosene can be premixed with diesel during the winter condition or during traveling at high altitudes to reduce the no start event.

- For post maintenance run up, the heater must not be allowed to run on pure kerosene for more than 30 mins.

- Running heater on kerosene can remove soft carbon; however, it will certainly not solve the excessive hard carboning issue, which requires in depth maintenance.

- Improperly stored fuel quality tends to degrade into various layers, which also decreases the overall cetane number of the fuel.

- Running heater on untested fuels (other than listed here) may cause unexpected effects on the heater and not recommended.

- It is important to contact Eberspaecher NA or near by dealer before adding non tested additive for the first time. Some additives MSDS specifically restricts its usage on different materials like copper.

- Eberspaecher North Amercia is not liable for any damage whatsoever caused by use of unspecified fuel.

OPERATION WITH BIODIESEL (PME- FAME)

Airtronic (D2)
The heater is not approved for operation with bio diesel fuel (FAME). However, a regular diesel blended with 10 % bio diesel fuel (FAME) is acceptable.

Airtronic M (D4)
The diesel heater is approved for operation with bio diesel fuel (FAME) according to DIN EN 14 214 or or CAS 67784 -80-9.

PLEASE NOTE! Bio diesel fuel (FAME) according to DIN EN 14 214 or CAS 67784 -80-9

- The flow-ability of the bio diesel reduces at temperature below 0°C.
- At sub zero temperatures, apply additional precautions for blending to reduce viscosity of the fuel.
- Frequent cleaning of combustion chamber (once every 4 months min) and replacement of atomizing screen (every 500 h) is mandatory as the carbon deposits accumulate as a by product during combustion process of bio diesel.
- It is recommended to operate the heater using a regular diesel from separate tank during the maintenance work, to remove any residue from combustion chamber.

OPERATION WITH ETHENOL

Airtronic M (B4)
It is not allowed to operate Gasoline heaters with 100% Ethenol fuel. an ethanol blended Gasoline (E85) fuel is not recommended for B4 airtronic heaters.

⚠ **DANGER - FUEL HANDLING**
Ensure extreme care while handling any type of fuel; Use manufacturer's guidelines for the fuel handling and storage procedures.

4 Installation Procedures

EXHAUST CONNECTION

A flexible exhaust pipe (24 mm ID) is mandatory for safety of the heating system and can be installed with exhaust muffler to reduce the noise level.
A regular heater kit comes with a stainless steel flexible exhaust pipe (40 inch long), end cap and clamp, which can be used for both Airtronic D2/4.

INSTALLATION PROCEDURE:

1 The flexible exhaust pipe must be in between 20 cm to 2 meters max. (including exhaust silencer) with no more than 270° (three 90°) bend (including intake pipe.) For every bend, reduce min. 25 cm length of the intake / exhaust pipe.
2 Connect the exhaust pipe to the exhaust port on the heater and attach with clamp provided.
3 Run exhaust to an open area to the rear or side of the vehicle so that fumes can not build up and enter the passenger compartment or the heater combustion air intake.
4 Install exhaust pipe with a slight slope or drill a small hole in the lowest point to allow water to run out. Any restriction in exhaust will cause operational problems.
5 Route the exhaust pipe from the heater using “p” clamps provided.

PLEASE NOTE!

- Do not point the exhaust pipe against the ram air or in the vehicle’s slip stream.
- Use appropriate heat resistant sleeve and silencer, if require.
- Never direct the exhaust outlet towards the fuel tank or other heat sensitive elements. It is mandatory to keep the exhaust flow atleast 10 cm (4”) away from the fuel tank as shown in image. Also, exhaust pipe should not be within 2” from any nearby heat sensitive material.
- Keep the air intake and exhaust outlets a minimum of 12” apart.
- Exhaust pipe must be fastened safely with recommended clearance of 50 cm to avoid damage from vibrations. Also, ensure that the important functional parts of the vehicle is not impaired.
- Switch off the heater and cool down the exhaust pipe before working with heating system.
- Always follow application specific regulation in addition to the general guidelines for exhaust connections of the heating system.

⚠ DANGER - FIRE HAZARD
Run exhaust so that it cannot be plugged by dirt, water or snow. Ensure the outlet does not face into the vehicle slip stream.

⚠ DANGER - ASPHYXIATION HAZARD
- Route exhaust beyond the skirt of the cab and outside of the frame area.
- Every type of combustion produces high temperatures and toxic gases, which is the reason why the exhaust system must be installed according to the instructions provided.
- Failure to comply with this warning could result in carbon monoxide poisoning.

⚠ DANGER - FIRE HAZARD
The exhaust is hot: keep a minimum of 5cm (2”) clearance from any heat sensitive material.
Route exhaust so that the exhaust fumes cannot enter the passenger compartment.

INTAKE CONNECTION:

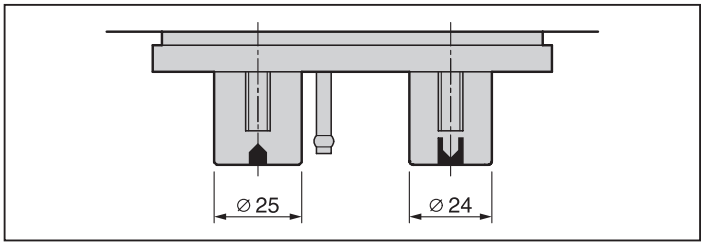
An intake air is used to draw fresh air for combustion purposes in the heater. Normally, a 40” long 25 mm flexible tube (made of paper and plastic) along with end sleeve and fasteners are included with a regular heater kit.

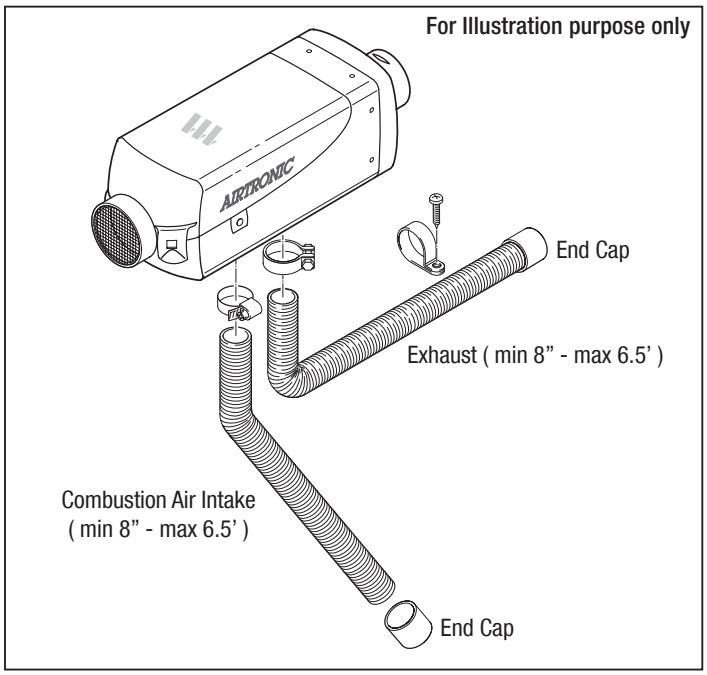
INSTALLATION PROCEDURE:

1 The length of 25 mm intake pipe should be in between 20 cm to 2 meters max., which includes the length of the silencer, additional bends or connections, if there are any.
2 Please ensure that there should be no more than 3 bends or 270° angle from intake to exhaust connection. For every bend, reduce min. 25 cm length of the intake/exhaust pipe.
3 Connect the intake pipe to the intake port and attach with a provided clamp.
4 Lay out the intake pipe away from the exhaust pipe, wheel splash area and slip stream of the vehicle.
5 Ensure that the intake air must not receive dirt or exhaust fumes.
6 Install the intake pipe with a slight slope or drill a small hole in the lowest point to drain the water. Any restriction in the intake will cause operational problems.
7 Route the intake pipe from the heater using “P” clamps.

PLEASE NOTE!

- Do not point the air intake against the ram air or in the vehicle’s slip stream.
- The combustion air intake must not get clogged with dirt or snow.
- Air intake silencer is available to reduce the heater noise level.
- Maximum temperature for intake air should be no more than 25°C; higher inlet temperature changes fuel/air ratio and increases carboning issue.





4 Installation Procedures

ELECTRICAL CONNECTIONS

Main Harness	16 pin connector with 10 terminated wires at 8 terminals (green/red, blue/white (2), red, grey/red, grey, brown, brown/white and yellow (2)). Connect to the heater's 16 pin connector. Main harness branches off to sub harness's described below.
Power Harness	2 core harness (red and brown). Route power harness to batteries, cut to length and terminate. Install 20 amp fuse last (10 amp on 24V). Connect red wire to fuse holder near battery. Connect fuse link wire directly to battery positive post using ring terminal. Connect brown wire directly to battery negative post using ring terminal.
Switch Harness	7 core harness (red, brown/white, yellow, grey, brown, grey/red and blue/white). Route this harness to the control option mounted in the cab. Do not cut this harness, wires have been soldered at ends for convenience of terminating to terminals of the control option. Coil up excess harness and secure in safe location. Connect to control option (refer to switch connection section).
Fuel Metering Pump Harness	2 core harness (green/red and brown). Route this harness from heater to fuel metering pump. Cut to length and connect to fuel metering pump using single terminals and connector provided with kit. **PLEASE NOTE!** Polarity does not matter for FMP connection.
Diagnostic Harness	8 pin connector (red, brown, yellow, blue/white). For diagnostic purposes only.
Temperature Sensor Harness * * only for supplementary remote temperature sensor.	2 core harness (white, brown) Connect white wire to gray wire of the heater and brown to brown/white.

⚠ **CAUTION:** Install power 20 amp fuse only after all electrical connections are complete. (10 amp fuse on 24V.)

PLEASE NOTE!

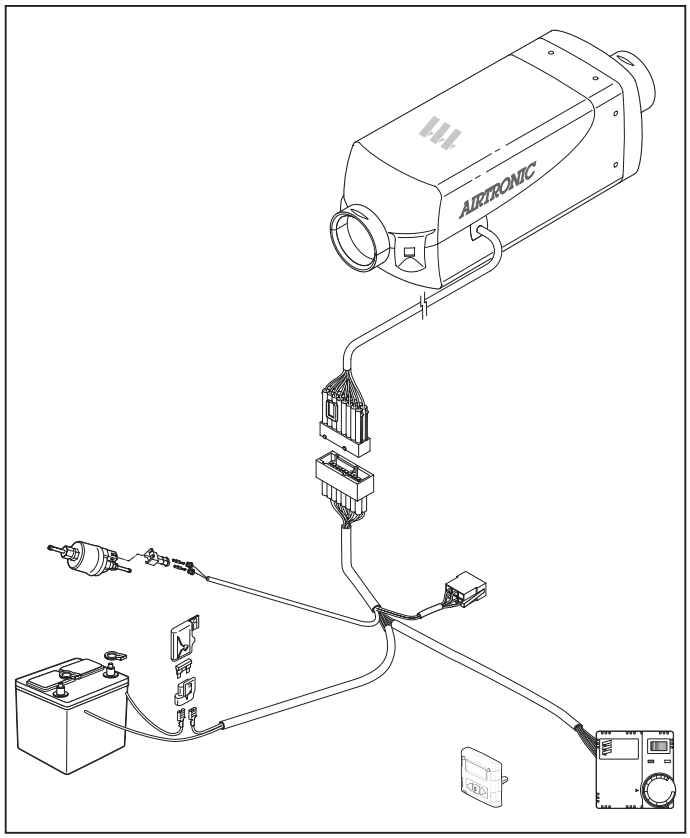
All exposed electrical connections should be coated with protective grease, (petroleum gel, Vaseline, etc.).

PLEASE NOTE!

- The following cable cross sections are to be used between the battery and heater. This ensures that the max. tolerable voltage loss in the cables does not exceed 0.5V for 12V or 1 V for 24V rated voltage.
- Cable cross sections for a cable length of:
  - up to 5 m (plus cable + minus cable) = cable cross section 4 mm²
  - from 5 to 8 m (plus cable + minus cable) = cable cross section 6 mm²
- Wire must be inserted into fuse holder prior to terminating.

PLEASE NOTE!

Negative battery terminal must always be grounded.
If a vehicle is equipped with switch on negative battery wire, install additional 20 A fuse in negative wire of heater's harness. Never run heater or any other vehicle appliances when the battery connection the ground is removed



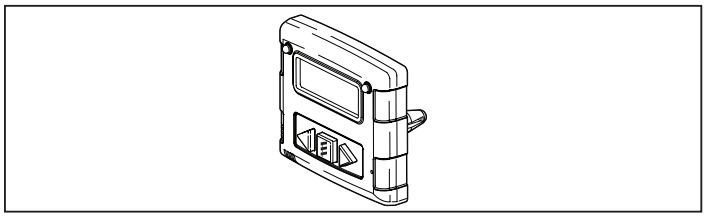
PLEASE NOTE!

All harnesses should be cut to length.
All exposed electrical connections should be coated with protective grease.

CONTROL OPTIONS

There are mainly five types of control options currently available at Eberspacher NA: Digi-Max controller, 7 day timer, Easy start timer, Rheostat and Thermostat. Also additional control options are available for high altitude operation: High altitude sensor, High altitude compensator.

DIGI-MAX CONTROLLER

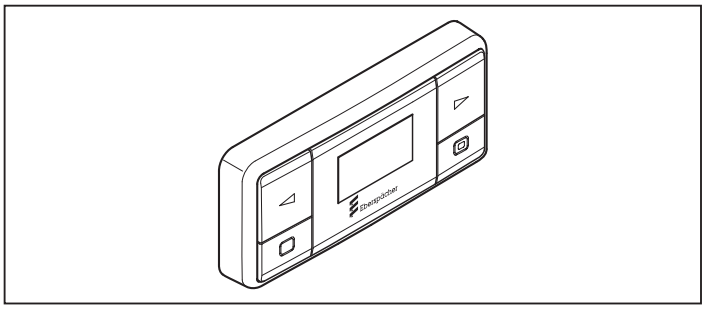


Part number	20 2800 70 1500
Compatibility	Airtronic heaters (including Non H kit)
Voltage	Operating range: 12/24V Maximum range: 10.5 to 31V
Heater Signal	Switch on (Yellow) wire.
Display	3 buttons, Two LED lights, LCD Display (shows real time control parameters, set up options and fault codes).
Feedback	Heater status, fault code and precautionary messages (maintenance required, LVD).
Control Features	Heater ON/OFF, digital set point control, Runtime selection, In built temperature sensor.
Set up Options	LVD, Preventative maintenance schedule, Diagnostic fault code, Run time selection, °C/°F.

PLEASE NOTE!

- The controller must be placed locations in passenger compartment where there is no direct heat from sunlight or appliances. In addition, it must never receive cold air from windows or air gaps; however sufficient ventilation (room temperature) surrounding the controller is necessary.
- Always use Digi-max controller for the fresh air heating system.
- During fault condition, a real time fault is displayed with its associated description. In addition, there are total of 5 stored fault memories, which can be accessed by entering into the set mode of the controller.
- When display shows LVD signal, the heater has stopped its operation due to the controller is sensing the (+) voltage (at yellow wire) below its limit. The LVD values can be changed by entering in to the set up mode. The LVD from Digi-max controller is different from low voltage fault from the heater; In other words, the Digi-max controller stops the heater due to low voltage before ECU does.
- A precautionary message “maintenance required” message comes up every time the counter for the heater operating period has reached to its preset value. It is meant to carryout a preventative inspection and visual check. Such message can be removed by resetting the counter using set up/diagnostic mode.
- When installing a high altitude sensor along with Digi-max controller, it is necessary to use its adapter cable.
- The procedure for accessing a set up /Diagnostic mode of the controller, see page 76.
- For wiring diagram of the Digi-max controller, see page 70.
- The LCD may get sluggish when the interior temperature is below -20 °C; however, it can operate the heater using push buttons up to -40 °C.
- This controller may not suitable for operating in the industrial or mining environment. For such applications, apply additional measures to protect the controller from moisture, dust and vibration..

EASYSTART TIMER (12V* / 24V**)



Part number:	22 1000 34 1500
Compatibility	Airtronic/ Hydronic heaters (H-kit)*
Voltage	Operating range: 12/24V Maximum range: 9 to 32V
Heater Single	JE diagnosis (H-kit): Blue/white* or Switch on (non H kit) : Yellow wire.
Display	4 push buttons, LCD Display (shows real time control parameters, set up options and fault codes), back light.
Feedback	Heater/ventilation status, fault code, program, add on, internal temperature sensor readings.
Control Features	Heater ON/OFF, Heating/Ventilation, digital set point control, Runtime selection, Add on device (multi heater control), Program (3 presets), EN/GE language.
Set up Options	LVD, start/departure time, Diagnostic fault code, Run time selection, °C/°F, after run duration.

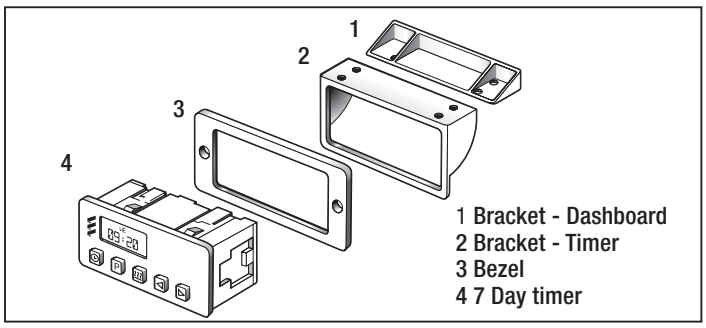
PLEASE NOTE!

- The timer must be placed in passenger compartment where there is no direct heat from sunlight, appliance; however sufficient ventilation (room temperature) surrounding the controller is necessary.
- During fault condition, a real time fault is displayed. In addition, there are total of 5 stored fault memory which can be accessed by entering into the set mode of the controller.
- Using the program feature, It is possible to program for auto start and stop the heater in 3 different sequences (mo-fr/sa-su/mo-su) in a week.
- The Easy start timer is capable of operating two heaters (independently), using its Add on feature. Contact eberspaecher NA for further information.
- The timer is fully compatible with high altitude sensor (a separate adapter cable is not necessary).
- The LCD may get sluggish when the interior temperature is below -20 °C; however, it can operate the heater using push buttons up to -45 °C.
- This controller may be suitable for operating in the industrial or mining environment if additional measures are taken to protect the controller from moisture, dust and vibration.
- The procedure for accessing a service menu of the timer, see page 73.
- For wiring diagram of the easy start timer, see page 70.

4 Installation Procedures

CONTROL OPTIONS... Continuation

7 DAY TIMER (12V / 24V)

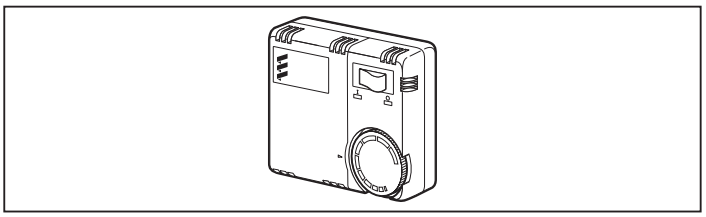


Part number	**22 1000 30 40 00 (kit: 20 2900 70 02 35)**
Compatibility	Airtronic heaters (including non-H kit)*
Voltage	Operating range: 12/24V Maximum range: 10.5 to 30V
Heater Signal	Switch on (non H kit) : Yellow wire, DAT (pulse signal): Violet wire.
Display	5 push buttons, LCD Display (shows real time control parameters, program options and fault codes), back light.
Feedback	Heater status, fault code, program.
Control Features	Heater ON/OFF, digital set point control, Runtime selection, Program (3 presets), Date and time , continuous operation.
Set up Options	Diagnostic fault code, Program settings.

PLEASE NOTE!

- The timer must be placed locations in passenger compartment where there is no direct heat from sunlight, appliance; however, sufficient ventilation (room temperature) surrounding the controller is necessary.
- A separate sensor (external) can be used to display interior temperature. (not for the heater)
- During fault condition, a real time fault is displayed. In addition, there are a total of 5 stored fault memories, which can be accessed by using a procedure available in page no 72.
- Using the settings menu, It is possible to program for auto start and stop the heater in 3 different times (mo-su) in a week.
- The LCD may get sluggish when the interior temperature is below -20°C; however, it can operate the heater using push buttons up to -45°C.
- This controller may be suitable for operating in the industrial or mining environment if additional measures are taken to protect the controller from moisture, dust and vibration.
- For wiring diagram of the 7 day timer, see page 70.

THERMOSTAT



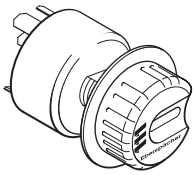
THERMOSTAT

Part number	**5670097 (12V), 5670096 (24V)**
Compatibility	Airtronic heaters (including Non H kit)
Voltage	Operating range: 12V/24V (see part numbers)
Heater Signal	Switch on (Yellow) wire
Display	1 switch, Two LED lights, Knob (temperature set point)
Feedback	LED (red light for heating)
Control Features	Heater ON/OFF, analogue set point control, In built temperature sensor.
Set up Options	None

PLEASE NOTE!

- The controller must be placed locations in passenger compartment where there is no direct heat from sunlight, appliance, or passenger exhalation. In addition, it must never receive cold air from windows or air gaps; however sufficient ventilation (room temperature) surrounding the controller is necessary.
- Always use thermostat for the fresh air heating system. On the contrary, always use external temperature sensor for the heating system in cargo compartment.
- Thermostat provide a blink codes through its LEDs but not compatible with Airtronic D2 / 4 heater.
- The thermostat can operate the heater in extreme cold conditions up to -45°C, as well as industrial or mining environment.
- For wiring diagram of the thermostat , see page 70.

RHEOSTAT



Part number	**25 1895 71 00 00 (12V), 25 1896 71 00 00 (24V)**
Compatibility	Airtronic heaters (including Non H kit)
Voltage Operating range:	12V/24V (see part numbers)
Heater Signal	Switch on (Yellow) wire.
Display	one LED lights, Knob (temperature set point)
Control Features	Heater ON/OFF, analogue set point control.
Set up Options	None

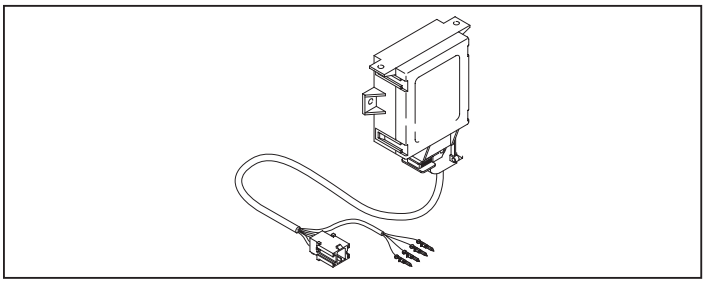
CONTROL OPTIONS... Continuation

RHEOSTAT

PLEASE NOTE!

- A separate temperature sensor is required to operate the heater. It is not suitable for fresh air heating system.
- Thermostat provide a blink codes through its LEDs but not compatible with Airtronic D2/4 heater.
- The thermostat can operate the heater in extreme cold conditions up to -45°C, as well as industrial or mining environment.
- For wiring diagram of the rheostat , see page 70.

HIGH ALTITUDE SENSOR

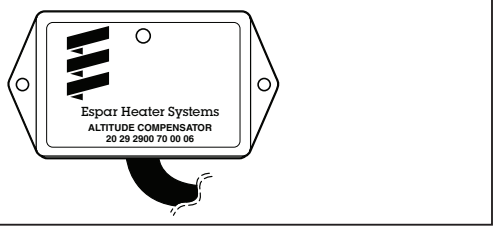


Part number	22 1000 33 22 00
Compatibility	Heater: Airtronic / Hydronic (H-kit) Controller: Easy start timer, 7 day timer and Digi-max controller (with adapter cable)
Voltage	Operating range: 12V/24V (see part numbers) Maximum range: 8V/32V
Operating Altitude	4000 m (max.)
Measuring Range	650 hPa to 1150 hPa
Adjustment Rate	9% per 1000 m (between 1500 to 4000 m)
Operating temperature	-40°C to + 85°C
Communication	JE diagnosis (blue/white wire)
Feedback	EDiTH
Control Features	In built Pressure sensor (digital)

PLEASE NOTE!

- The pressure sensor must be placed near to the controller (in compartment) where there is no direct heat from sunlight, appliance. In addition,the air pressure it senses must never be artificial in nature like ram air, slip stream or HVAC blower pressure; however sufficient ventilation (room temperature) surrounding the controller is necessary.
- Avoid its installation locations where accumulation of condensed water or moist air is possible. Also it must not be installed in air tight packaging or container.
- To test the pressure sensor, connect a branch (in which a blue/white wire comes from pin 10 of high altitude connector) to the EDITH and start up its functional check. If the “lowest atmospheric air pressure” display > 0 hPa, the air pressure is correctly connected. (for Digi-max controller, please contact nearby dealer or Eberspaecher NA)
- A separate adapter cable is required for connecting high altitude sensor to the digimax controller or 7 day timer. Please see on page 71, the block diagram which shows its connections to heater, different controller and diagnostic software.
- For High altitude sensor fault codes and description, see page 84.

HIGH ALTITUDE COMPENSATOR



Part number	20 2900 70 00 07
Compatibility (heater)	Airtronic/ Hydronic (non H-kit)
Voltage	Operating range: 12V/24V (see part numbers) Maximum range: 7.5V/35V
Operating Altitude	3000 m (max.)
Measuring Range	700 hPa to 1150 hPa
Adjustment Rate	9-10% per 1000 m (between 0 to 3000 m)
Operating temperature	-40°C to +85°C
Communication	Yellow wire from heater (Green wires to FMP)
Feedback	LED (mounted on the unit)
Control Features	In built Pressure sensor (digital)

PLEASE NOTE!

- The pressure sensor must be placed near to the controller (in compartment) where there is no direct heat from sunlight, appliance, or passenger exhalation. In addition, the air pressure it senses must never be artificial in nature like ram air, slip stream or HVAC blower pressure; however sufficient ventilation (room temperature) surrounding the controller is necessary.
- Avoid its installation locations where accumulation of condensed water or moist air is possible. Also it must not be installed in air tight packaging or container.
- To test the pressure sensor, connect the sensor according to the wiring diagram provided on page 71 and start up the heater.
  Once FMP starts, measure the frequency or fuel output.
- Use the diagnostic pigtail on the main harness to power the compensator, if possible. Also, Ensure that right FMP wires (input and output) are selected.

4 Notes:

5 Operation and function

PRE-START PROCEDURES

Upon completion of installation, prepare the heater as follows:
- Inspect the heater, controller and FMP mounting and connections.
- Check the ducting system for any post installation damages or blockages.
- Inspect the fuel lines, exhaust and intake pipe connections.
- Check the battery connections and insert the fuse in the main harness.
- Measure the voltage readings at different connectors in power and control harness.
- Make sure there is sufficient fuel in the line, if not, then expect multiple attempts of heater start ups due to fuel priming.

SWITCH ON

- Switch the heater on by pressing ON/OFF button on Digi-max, Thermostat or selecting heat symbol in 7 Day Timer and EasyStart timer. For Rheostat, turn the knob for heater start up.
- A feed back signal for heater ON/OFF is provided by the controller/timer (heat symbol in display, or LED light ON).
- Depending on the heat requirement, ensure appropriate level of set point and run time values using controller switch, or knob.
- The set point value can be selected within the range of 8°C to 35°C depending on the type of controller/timer.
- During operation, the ECU also requires an input value of real time temperature in the cab through a temperature sensor. It must be noted that if the external temperature sensor is not used, the ECU reads the intake air temperature from its internal sensor.

START UP

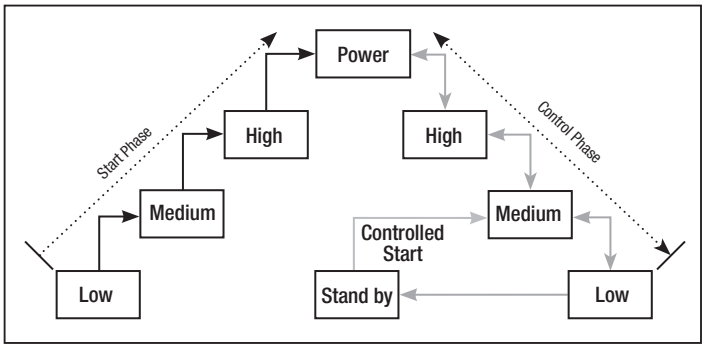
On start up, indicator light illuminates or heat symbol shows in display and following sequence takes place:
1 Control unit does a systems check (flame sensor, overheat sensor, glow pin, motors, temperature sensor and FMP connection checks , ECU circuit).
2 Glow pin is energized and starts pre heating the combustion chamber and Blower fan starts at LOW speed.
3 After approximately 60-65 seconds, the fuel pump delivers the fuel.
4 While passing through the glow pin screen, the fuel breaks into fine particulates and atomized instantaneously. Later, the localized heat intensity from the glow pin vaporizes the atomized fuel. Some of the partially vaporized fuel may remain in the liner (porous interior part of combustion chamber) for further vaporization.
5 When an incoming air (through a tiny vent hole) combines with a fraction of vaporized fuel in the glow pin chamber, the first spark or fuel/air ignition takes place during the start up process. Eventually, the ignited fuel/air mixture starts cascading in to a stable flame in the combustion chamber. The Size and temperature of the flame depends on the combustion process and fuel/air mixture.
6 Once flame sensor detects a flame the glow pin is switched off after 60 seconds for airtronic D2 (or after 90 seconds for Airtronic D/B 4). During operation, the temperature from combustion chamber auto ignites the fuel/air mixture, which maintains a stable and self sustained flame.
An improper fuel/air mixture or lack of temperature in the combustion chamber interrupts the autoignition process and creates extreme fluctuations in flame (or cuts off the flame).
7 Now, Airtronic D2 and D/B 4 heaters reach at standard operation (BOOST/POWER mode) after 60 and 120 minutes of glow pin shut down respectively.
8 The heater starts regulating its heat output according to the values provided by temperature sensor and set point. The larger the difference between their values, the higher the heat output.

PLEASE NOTE!
- The liner inside the flame tube's annular chamber absorbs and holds finely automatized fuel during its vaporization process for a smooth combustion. In other words, the purpose of the liner is to act as a sponge and dampen fluctuations of the fuel pluses, which reduces the overall combustion noise and vibration.
- If the heater fails to start the first time it will automatically attempt a second start. If unsuccessful, the heater will shut down completely.
- During start up, only the blower motor starts up as a Cold Blower mode if the ECU detects excessive temperature due to residual heat in the heat exchanger. Once the heat exchanger temperature lowers down to normal level, the heater initiates its regular start up procedure.

RUNNING

Once ignition is successful, the following operations take place:
- When switched on, heater always starts in boost then it goes in regulating mode.
- The temperature is monitored constantly at the heater's process air inlet or external sensor.
- This temperature is compared to the set temperature on the adjusting dial (Digi-Max controller/Thermostat...)
- The heater cycles through Boost, High, Medium and Low heat modes to maintain the desired temperature.
- If the desired temperature is exceeded while the heater is operating in low heat mode, the heater will switch into "standby" mode.
- The heater will re-start in medium mode once heat is required again.

AIRTRONIC 2-4 CONTROL STAGES



PLEASE NOTE!
- If the heater should shut down due to flame cut out while in running mode, it will automatically attempt one restart. If successful, it will continue to run. If not, it will shut down completely with a cool-down cycle.
- During operation, the heater continually senses the input voltage from the batteries. If the input voltage drops to approximately 10.5 volts (21 V) or rises above 16 volts (30 V) the heater will automatically shut down with a cool-down cycle, and display a fault code when using a multifunction timer.

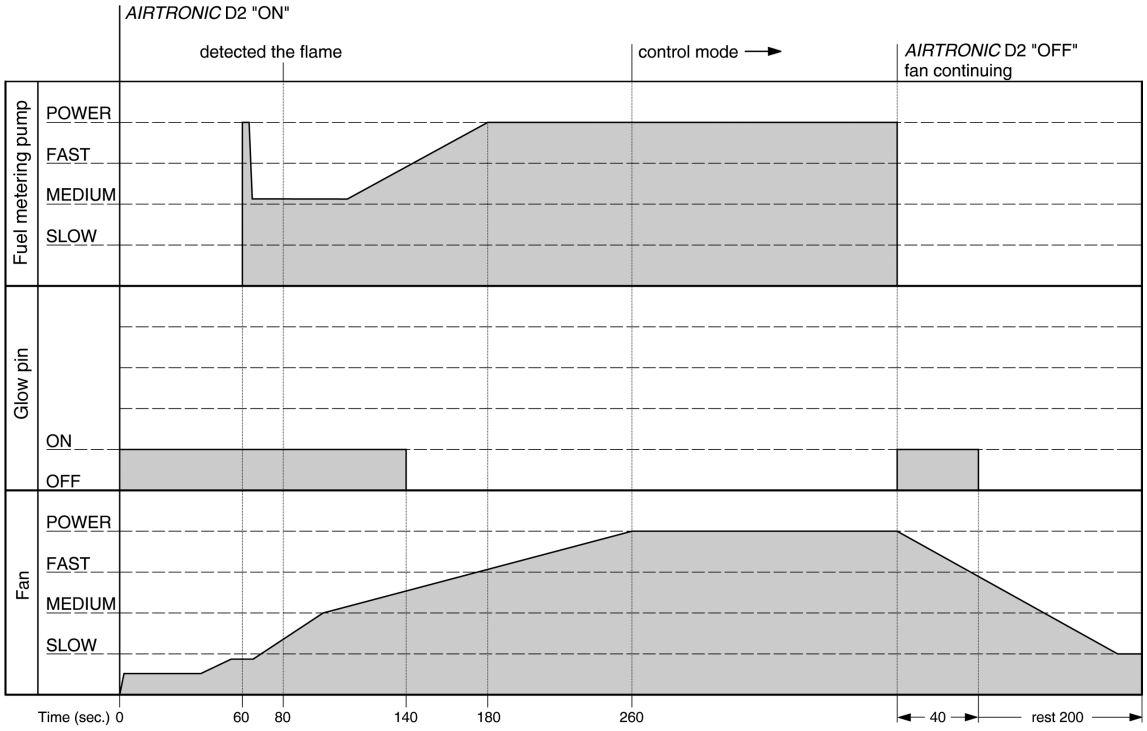
SHUT DOWN
- Once switched off manually, the heater begins a controlled cool down cycle.
- Indicating light(s) on switch will go off.
- Fuel pump stops delivering fuel.
- The glow pin is re-energized for a 40 second after-glow to burn off any combustion residue.
- The blower continues to run for 4 minutes and automatically switches off.

⚠ WARINING
The heater must be switched off while any fuel tank on the vehicle is being filled. The heater must not be operated in garages or enclosed areas.

5 Operation and function

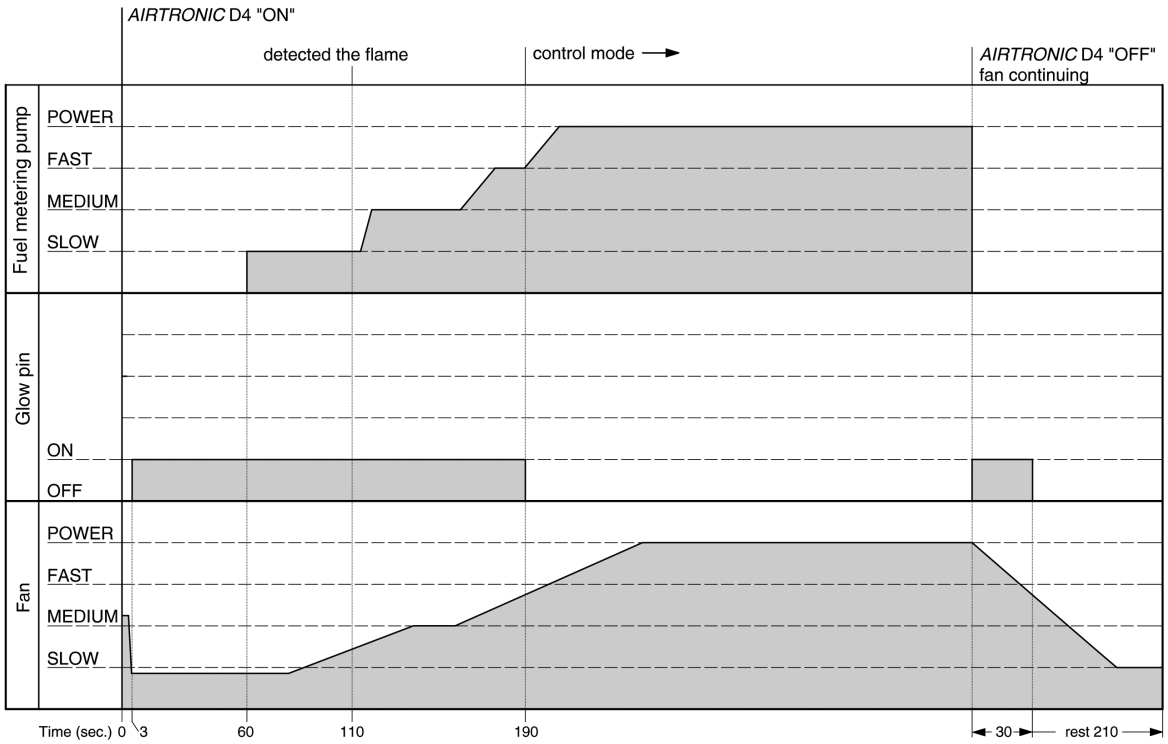
HEATER REGULATION

FUNCTION DIAGRAM *AIRTRONIC* D2 *



* Timing may vary depending on version of ECU.

FUNCTION DIAGRAM *AIRTRONIC* D4 *



* Timing may vary depending on version of ECU.

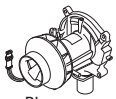
HYSTERESIS VALUE: **AIRTRONIC D2**

26°C				
25°C				Low --> Switch off (+4 K)
24°C				
23°C			Medium --> Low (+2 K)	
22°C		High --> Medium (+1 K)		
	Power --> High (< 21°C)			
21°C	ΔT = 3,5 K	ΔT = 3,5 K	ΔT = 3 K	ΔT = 4,5 K
20°C				Switch off --> Medium (-0,5 K)
19°C			Low --> Medium (-1 K)	
18°C		Medium --> High (-2,5 K)		
17°C	High --> Power (-3,5 K)			

HYSTERESIS VALUE: **AIRTRONIC D4**

26°C				
25°C				Low --> Switch off (+5 K)
24°C				
23°C			Medium --> Low (+2 K)	
		High --> Medium (+1 K)		
22°C	Power --> High (< 21°C)			
21°C	ΔT = 3,0 K	ΔT = 3 K	ΔT = 3 K	ΔT = 5,5 K
20°C				Switch off --> Medium (-0,5 K)
19°C			Low --> Medium (-1 K)	
18°C		Medium --> High (D4 -2 K)		
17°C	High --> Power (-3,0 K)			

OPERATIONAL CHART*
NORMAL OPERATION

	STARTING PHASE					RUNNING PHASE		SHUT DOWN PHASE		
Operating Mode	System Check	Pre-heat	Ignition Attempt	Pre-heat 2nd. Attempt	Ignition Attempt 2nd. Attempt	Boost on start, Medium on restart	Controlled Heating	After Glow	Cool Down	Stand by
 Blower	Off [a]	On	On	On	On	On	On	On [c]	On	On, If iddling without external temperature sensor.
 Glow Pin	Off	On	On	On	On	Off	Off	ON if stopped Off if stand by mode	Off	Off
 Fuel Pump	Off	Off	On	Off	On	On	On	Off	Off	Off
	1- 3 sec. [a]	60 sec. [d]	Up to 90 sec.	120 sec. If Required	Up to 90 sec.	Time dependent on heat exchanger temperature	Continual Operation until switched off by operator or temperature control	40 sec.	4 min.	

PLEASE NOTE! During controlled heating cycle, if desired heat level is exceeded the heater will switch into standby mode. Heater will automatically restart once heat is again required

* The timing shown is for the latest Airtronic D2 during normal operation. The timing does not account for ECU timing variances, or special situations. Timing for other Airtronic heaters will vary. When timing is viewed on EDiTH software, timing will be different because of communication delay between computer and the heater or specifics of particular heater models.

** Off if external temperature sensor is connected

5 Operation and function

SAFETY FEATURE

The control unit, temperature sensor, overheat sensor and flame sensor continually monitor heater functions and will shut down the heater in case of a malfunction.

- The control unit ensures electrical circuits (fuel pump, combustion air blower etc.) are complete prior to starting the heater.
- If the heater fails to ignite within 90 seconds of the fuel pump being started, the starting procedure will be repeated. If the heater again fails to ignite after 90 seconds of fuel being pumped, a “no start safety shutdown” follows. (Fault #52 and performs a shut down cycle for 4 min.)
- If the heater flames out during operation, the heater automatically attempts to restart. If the heater fails to ignite within 90 seconds of fuel delivery, or ignites but goes off again within 15 minutes, the heater will turn off the fuel pump and complete a cool down cycle for 4 mis and display a F052 code. After troubleshooting the problem, the heater can be started again by switching the heater off and then back on again.
- The heater does not start up when ECU detects an open circuit at glow pin and fuel metering pump.
- If the combined (overheat and flame) sensors are failed or the electric lead is interrupted, the heater initiates a short start up process before switching off again. In the mean time, an ECU generates a fault codes according to the nature of failure.
- The speed of a fan is continuously monitored during the heater operation. If the fan does not start up or if the speed deviates by more than 10% (operating speed of a particular mode), then the heater is switched off after 30 seconds.

PLEASE NOTE!

- Repetitive flame cut out conditions prompt ECU to generate a lock out fault code, which must be deleted by diagnostic capable device/controller before restarting the heater.
- During overheat condition, the extreme temperature exerted by combined sensor (flame and overheat) triggers ECU to generate a fault. In addition, the fuel supply is interrupted and heater is switched off. Once the cause of overheating is eliminated, the heater can be restarted by switching it off and on again. Please note that repetitive overheat conditions prompt ECU to generate a lock out fault code which must be deleted by diagnostic capable device/controller before restarting the heater.
- If at any time the voltage drops below 10.5V (21 V)for 20 seconds, or rises above 16.0V (30 V) for 20 seconds the heater will shut down and display the associated Fault Code.

VENTILATION MODE

This is an optional mode for activating only blower motor to provide ventilated air in compartment, also to draw a fresh air or recirculated air in ventilation mode is depending on the duct layout. Some controllers/thermostats have a separate ventilation option through which this mode is activated. To initiate a ventilation mode manually, activate a changeover switch for “heating/ventilating” before turning on the heater. To do so, place a switch between gray/red and brown/white wire, which can close the circuit so a ventilation mode is activated. Please note that the duration of ventilation mode (number of hours) is counted in the heater operating hours for the warranty purpose.

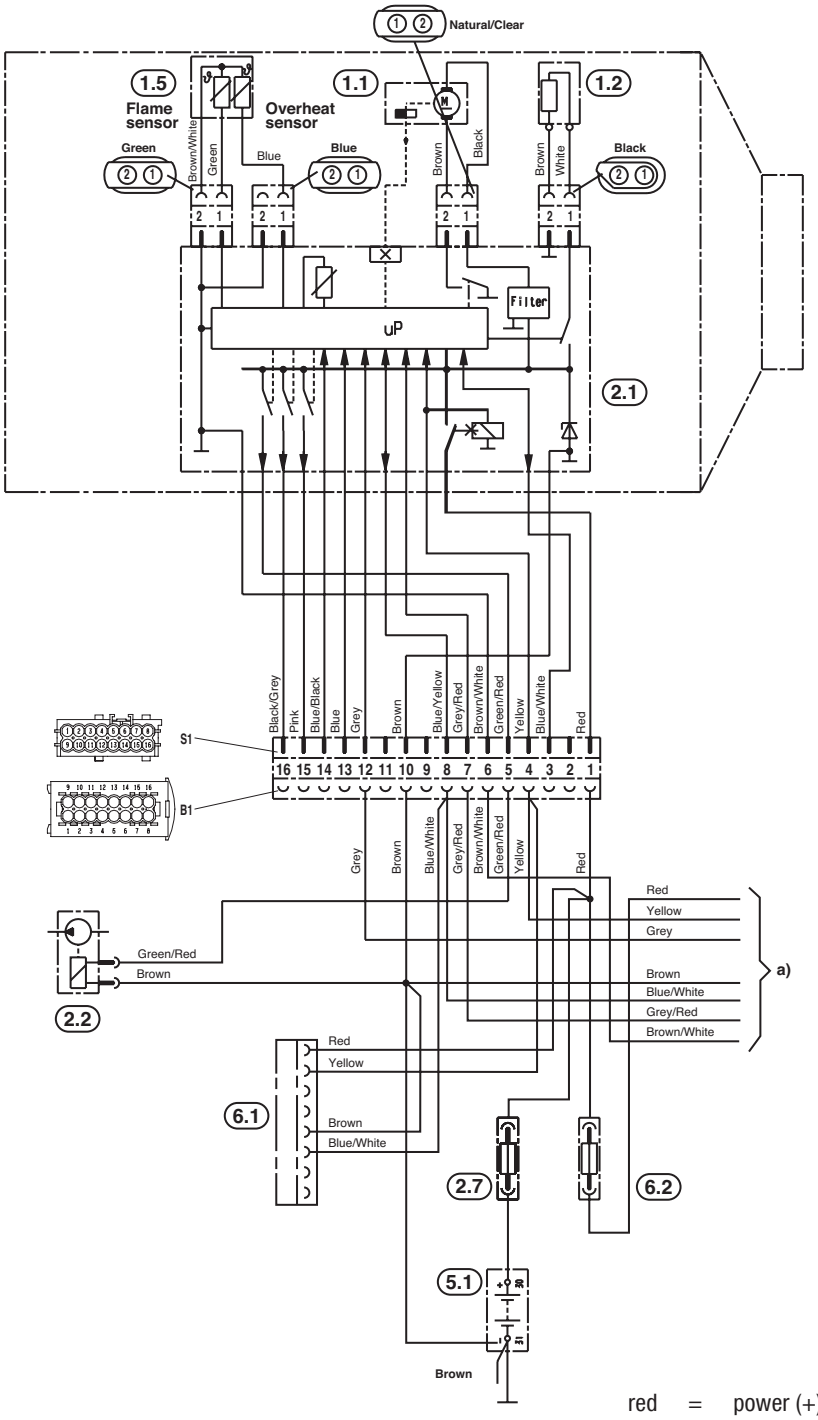
HEATING AT HIGH ALTITUDES

When using the heater at high altitudes, please note:

- Heating at altitudes up to 1500 m: – Unlimited heating possible.
- Heating at altitudes over 1500 m to 4000 m: – Heating is possible for short periods at this altitude (e.g. driving over a mountain pass or taking a break in a journey). During longer stays, e.g. winter camping, the fuel supply must be adjusted to the altitude. This can be done by installing an air pressure sensor, P/N 22 1000 33 22 00 or compensator: 20 2900 70 00 07.
- Heaters suitable for high altitudes are labeled with “H-Kit” on the side nameplate.
- The pressure sensor/compensator adjusts fuel frequency that reduces the overall heater output at the rate of 8-10%/1000 meters of altitude increase.

6 Circuit Diagram

SCHEMATIC *AIRTRONIC* 2 / 4



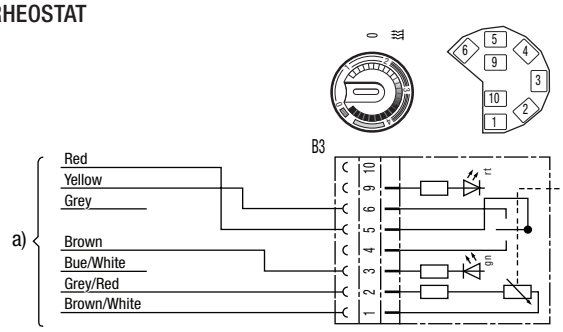
1.1 Blower Motor
1.2 Glow Pin
1.5 Overheat and Flame sensor
2.1 Control Unit
2.2 Fuel Metering Pump
2.7 Main Fuse 12Volt - 20 amp / 24 volt - 10 amp (Fuse for heater)
5.1 Battery
6.1 Diagnostic Pigtail (for connection to Fault code retrieval device)
6.2 5 amp switch fuse - on certain models only (Fuse for mini)

red	=	power (+)
yellow	=	switch
brown	=	ground (-)
grey	=	temperature sensor on thermostat
grey/red	=	temperature setting
blue	=	diagnostic from heater
blue/white	=	diagnostic from heater
brown/white	=	ground
black	=	to vehicle ignition accessories for continuous operation of heater on 7 day timer

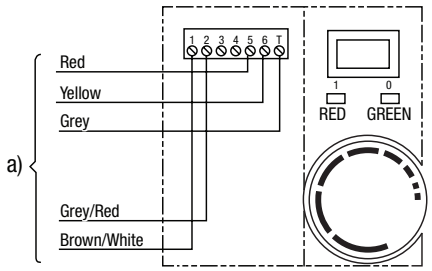
6 Circuit Diagram

SCHEMATIC *AIRTRONIC* D2 / *AIRTRONIC* D4

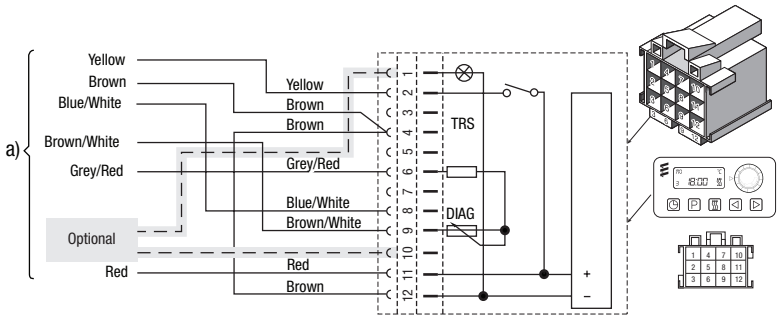
RHEOSTAT



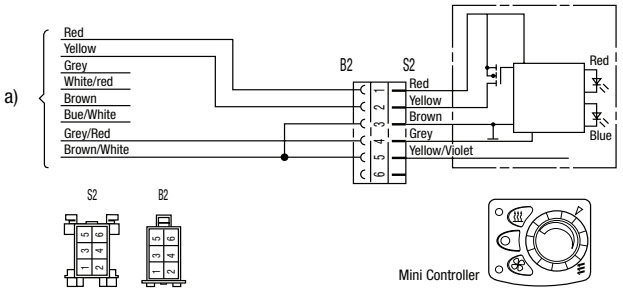
THERMOSTAT



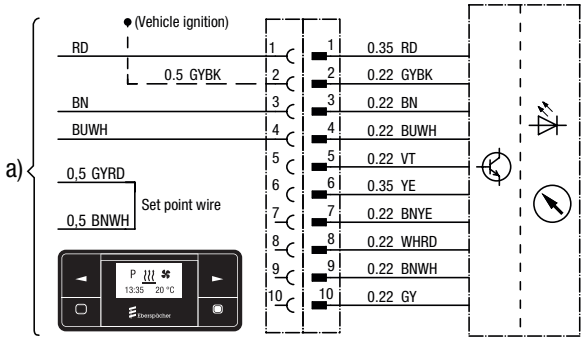
7 DAY TIMER



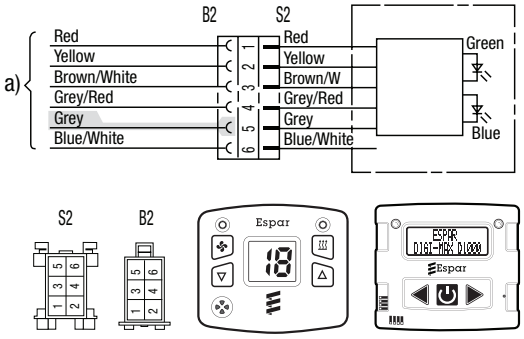
MINI-CONTROLLER



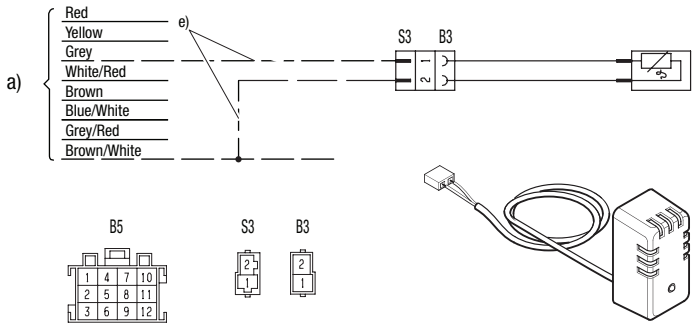
EASYSTART TIMER



DIGI-MAX CONTROLLER

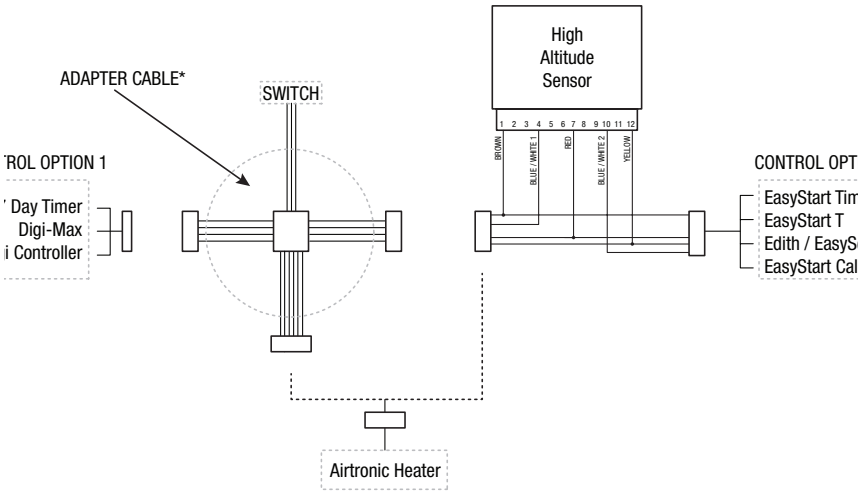


EXTERNAL TEMPERATURE SENSOR



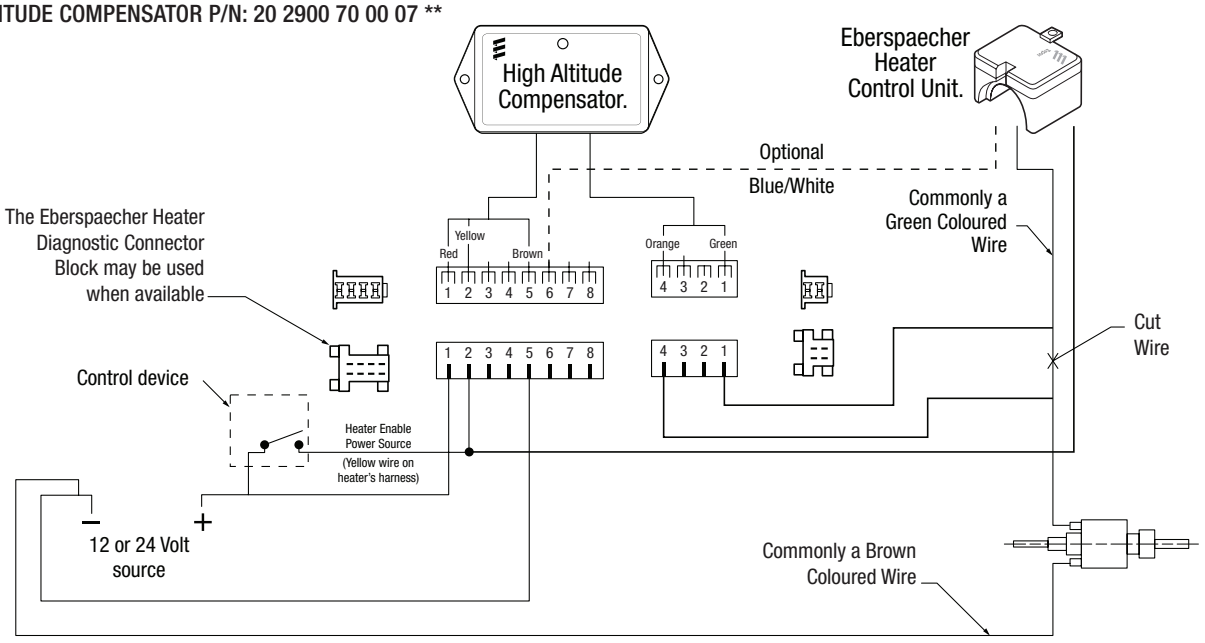
6 Circuit Diagram

HIGH ALTITUDE SENSOR - P/N: 22 1000 33 22 00



* Adapter cable is used for control option 1 only
If control option 2 is used, connect heater directly to the High Altitude Sensor (left side branch)

HIGH ALTITUDE COMPENSATOR P/N: 20 2900 70 00 07 **



** For non H-Kit heaters only

7 Maintenance / Troubleshooting / Repair

RECOMMENDED PERIODIC MAINTENANCE

- Use the fuel suitable for the climate (see engine manufacturers recommendations).
  Blending used engine oil with diesel fuel is NOT permitted.
- Maintain your batteries and all electrical connections in good condition. With insufficient power the heater will not start.
- Visual check of electrical lines and connections for any damage or corrosion.
- Check the battery voltage. Low and high voltage cutouts will shut the heater down automatically.
- Check and if necessary replace fuel filter inserts in FMP.
- Visual check of all fuel lines for leaks.
- Check the glow pin and replace if necessary
- Replace the screen, filters and gaskets at least once a year
- Inspect blower motor for any visible signs of damage
- Inspect the duct system, and make sure there is no contamination, dust or blockages.
- Check the intake and exhaust pipe for blockage,
- Run your heater at least once a month during the year (for a minimum of 15 minutes).

⚠ WARNING - SAFETY:
Before performing the troubleshooting and repair on the heater, always have minimum required tools and protective equipments as provided on page 4.

TROUBLESHOOTING

BASIC TROUBLESHOOTING

In the event of failure there are several items which should be checked first before any major troubleshooting is done. It is recommended to carry out a visual inspection or perform steps as described in a troubleshooting check list if diagnostic tools are not used.

Visual inspection:

- Circuit breakers and fuses.
- Electrical lines and connections.
- For interference in combustion air and exhaust pipes.
- Check the fuel in the tank.
- Battery voltage (> 10.5V/> 21V).
- Check On/off signal wires (yellow, blue/white wire)
- Carry out visual inspection of the duct system.

Troubleshooting Check list:

What happens when the heater is switched on and...

Heater does not ignite

1 Blower motor does not run
  Check: - Fuse in power harness.
  - Power to control unit.
  - Power to and from switch.
  - Electrical connections.

2 Blower motor runs approximately 20 seconds and then shuts off
  Check: - Ensure voltage at control unit remains above 12V (or 24V) during start up with glow pin circuit on.

3 Blower motor runs/fuel metering pump starts and then shuts down after two start up attempts
  Check: - Ventilation hole and glow pin screen.
  - Fuel lines and fuel filter.
  - Fuel quantity. Pg. 88
  - Combustion air or exhaust tube blockage.

4 Blower motor runs/no fuel metering pump
  Check: - For electrical pulses at fuel metering pump.
  - If pump is frozen.
  - Blocked fuel line.

Heater ignites

1 Shuts down at random
  Check: - Possible overheat.
  - Control unit input voltage.

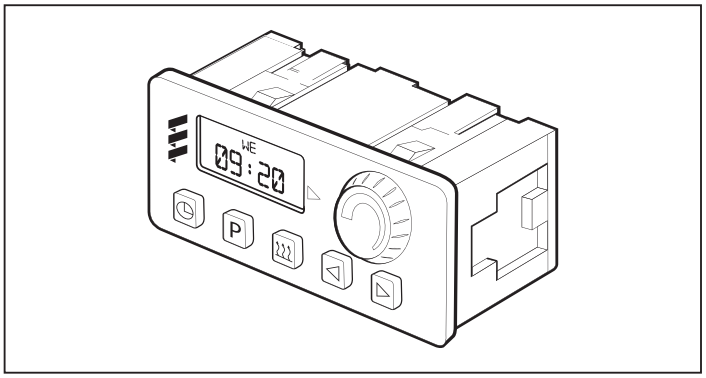
2 Heater smokes and carbons up
  Check: - Exhaust pipe blocked.
  - Combustion air intake blocked.
  - Exhaust entering combustion air intake pipe.
  - Short cycling, rapid on/off operation.
  - Fuel system.
  - Fuel metering pump position and quantity.
  - Motor rpm.

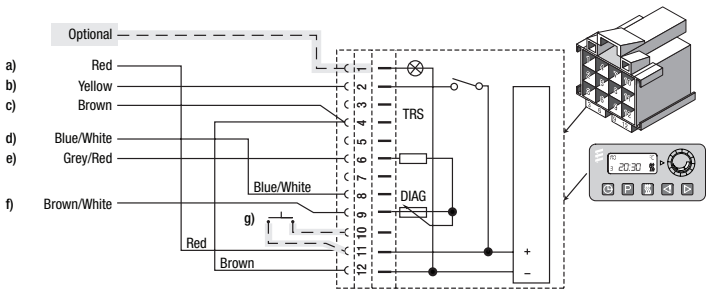
SELF DIAGNOSTICS

The heater is equipped with self diagnostic capability. You can retrieve information on the heaters last 5 faults using the Eberspaecher's diagnostic tools, i.e. EasyScan, 7 Day Timer, EDiTH, EasyStart timer. For diagnostic tool connections, see the image on page 77.

DIAGNOSTIC TOOLS

1. 7 DAY TIMER (12 V / 24 V) - P/N: 20 2900 70 02 35





a) Power from battery “+”.
b) Switch control to heater.
c) Power from battery “-”.
d) Diagnostic from heater
e) Set point wire.
f) Ground reference point (controller) “-”.
g) Temporary switch with jumper cable placed in betwen terminal #10 and #11 to retrieve the stored faults and unlock the ECU.

UNLOCKING CONTROL UNITS AND ERASING FAULT MEMORY

PLEASE NOTE!

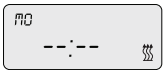
The vehicle ignition signal can be provided at pin #10 of 7 Day timer; however, installations with no vehicle ignition connection require a small jumper cable and switch to be placed in between pin #11 (red wire) and pin #10, for diagnostic purposes.

RETRIEVING THE STORED FAULT CODES

1. Press the key. The heater is switched on. The current fault code is now displayed (Example: AF:50).
2. Press the key and hold it down and press the key P within two seconds.
3. The stored fault codes (maximum of 5) can now be retrieved using the arrow keys and . (Example: F1:50, F2:52, F3:52, F4:54, F5:52).

DELETING THE STORED FAULT CODES

1. Turn on the vehicle ignition to activate timer display (or close the jumper cable circuit) and restart the timer by pressing .
2. The most recent fault code (i.e. F15 or F50) is now displayed.
3. Press the key and hold it down then press the key P within two seconds. The timer is now in the retrieval mode.
4. Turn off the ignition (or open the jumper cable circuit).
5. Press the key and hold it down and press the key P within two seconds and hold it down.
6. While holding down P keys, turn ignition on (or close the jumper cable circuit) and wait until the following display appears:



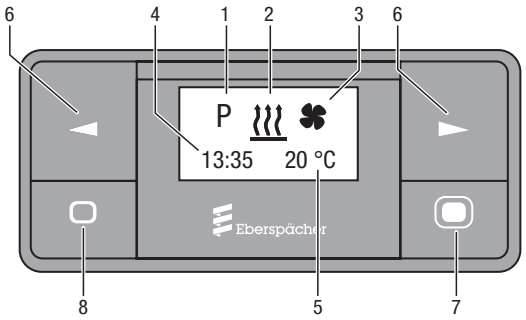
7. Press the key to turn the heater OFF.
8. Press the key to turn the heater ON.
9. Repeat step three. The following display appears:

10. The control unit lock is cancelled after three seconds and the heater starts.

PLEASE NOTE!

Fault code F-50 (ECU lock out) is only triggered when the heater is subjected to repetitive shut downs because of flame cut-off or over heating issues.

2. EASYSTAR TIMER - P/N: 22 1000 34 15 00

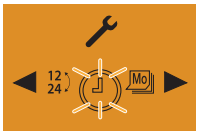


1 Program symbol
2 Heat symbol
3 Fan symbol
4 Current time
5 Temperature (Optional)
6 Menu selection button
7 Enter / “ON”
8 Exit / “OFF”

STEPS TO UNLOCK THE ECU

- Use the buttons ◄ ► to select the setting symbol in the Menu bar and confirm by pressing the button. The Setting Menu is used to set current time, weekday and local time format selecting , and symbols respectively, then confirm them by pressing the button.

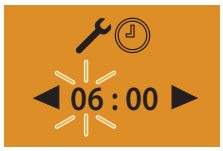
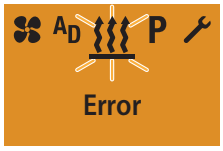
- Service/Workshop Menu
  The service/Workshop menu is a part of SETTINGS MENU , and can be accessed by pressing for more than 5 seconds while the EasyStar timer screen looks like the image below.



In the Service/ Workshop menu, a number of different parameters of the EasyStart timer can be changed via item selection between 1.1 to 14.6.

The Diagnostic Fault Codes can be found in the menu item # 1.1 of Service/ Workshop Menu.

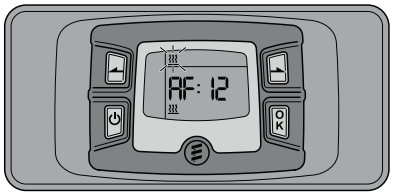
DIAGNOSTIC TOOLS... Continuation

EASYSTART FAULT DISPLAYS	DESCRIPTION	REMEDY / WORKSHOP
	• Automatic detection is active. • The timer has been disconnected from the voltage and reconnected.	Wait until the automatic detection has ended, then set the time and weekday.
	• The timer has been disconnected from the voltage and reconnected. • The automatic detection has ended.	Set the time (hours and minutes) and the weekday. Then the Start display appears.
	• No communication. • It means heater can not be recognized by EasyStart timer (please see the manual) • EasyStart timer can only diagnose 12V (Not 24V) Hydronics D5 heaters with current generation ECUs (H-Kit type).	• Check and if necessary renew the heater fuse. • Check the voltage supply. • Check the wiring.
	• 1st heater fault.	Perform the heater diagnosis. • Access service/workshop menu via settings and select service function #1.1.1 to display current fault and #1.2.1 to display fault memory F1 - F5. • 1.2.1: read out memory fault 1 to 5 by selecting the function using ▭ and pressing ◄ ► buttons. • 1.3.1: Select the delete → function by pressing the ▭ button, the DEL display (appears flashing), press the ▭ to confirm. “no diag” is displayed if no diagnostics cable is connected.
	• 2nd heater fault.	Perform the heater diagnosis. • Access service/Workshop menu via settings and select service function #1.1.2 to display current fault and #1.2.2 to display fault memory F1 - F5. • 1.2.2: read out memory fault 1 to 5 by selecting the function using ▭ and pressing ◄ ► buttons. • 1.3.2: Select the delete → function by pressing the ▭ button, the DEL display (appears flashing), press the ▭ to confirm. “no diag” is displayed if no diagnostics cable is connected.
	• Voltage too low.	• Charge the battery. • Check the heater’s power supply.
	• Temperature sensor is defective.	Check and if necessary renew the temperature sensor.

DIAGNOSTIC TOOLS... Continuation

3. DIAGNOSTIC UNIT - 12V / 24V

The diagnostic unit is solely used to read out, display and delete faults stored in all types of AIRTRONIC D2/D4 heater's electronic control boxes. The electronic control box can store up to 5 faults.
Please refer to user manual at http://www.eberspaecher-na.com/download-center.html. (Diagnostic Unit P/N: 20 2900 70 50 60, the AIRTRONIC 2/4 adapter cable P/N: 22 1000 31 8600)



- backwards control button
- forwards control button
- activation button
- confirmation button

PERFORM THE DIAGNOSIS

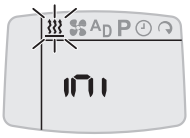
AIRTRONIC
- Disconnect the plug-in connection in the "Heater / Cable harness" cable loom.
- Connect the adapter cable to the "Heater" cable loom and to the cable harness.
- Select the heating/ventilation modes using changeover switch (if there is any).
- Plug the 6-pin connectors of Diagnostic Unit in to similar connector at adapter cable and turn ON the heater.
- Switch the ignition and parking switch ON before starting up the diagnostics on OEM heater.

AUTOMATIC DETECTION

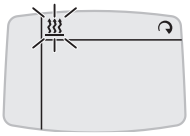
Five seconds after the dia gnostic unit has been connected to the heater using the adapter cable, the automatic detection starts to determine the type of heater to which the dia gnostic unit is connected.

PLEASE NOTE!
- Before starting diagnosis, ensure the set point value is adjusted at maximum temperature at controller.
- During the automatic detection process, some heaters are briefly activated by controller.

Display until the automatic detection is completed.



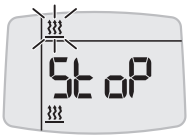
Display
- If an air heater has been detected



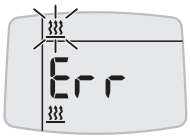
Confirm flashing symbol with OK

possible displays:

- if no errors/faults exist
  further action –> display fault memory, delete fault memory.



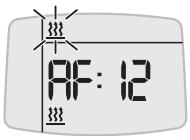
- If errors/faults exist
  further actions –> display current fault and fault memory, delete fault memory.



DISPLAY CURRENT FAULT IN FAULT MEMORY

Simultaneously press and

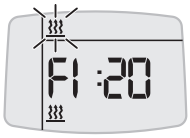
Display: e.g. AF : 12



DISPLAY FAULT MEMORY F1 – F5

press or

Display: e.g. F1 : 20

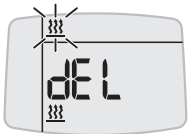


DELETE THE FAULT MEMORY AND AS A RESULT, AT THE SAME TIME CANCEL THE CONTROL BOX LOCK

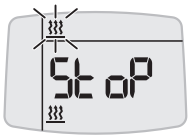
Current fault or fault F1 – F5

confirm with OK.

Confirm display dEL again with OK.



The fault memory is deleted and the control box is unlocked.



QUIT DIAGNOSIS
Switch off heater

Press OK, the heater is switched off.

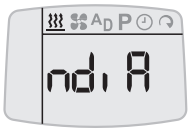
PERFORM THE DIAGNOSIS AGAIN

Press , the display is activated.

For further procedure, see left-hand column.

UNABLE TO PERFORM THE DIAGNOSIS
Automatic detection was unsuccessful

Display if the automatic detection was not successfully completed.

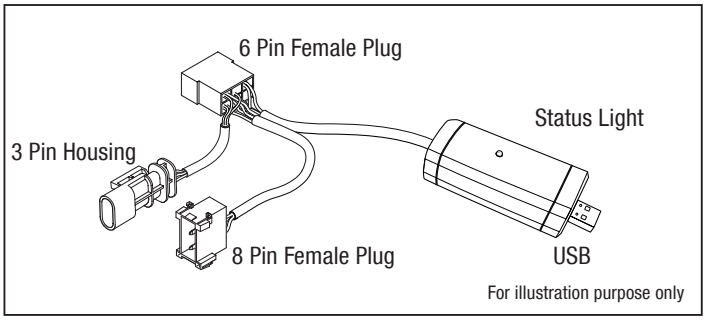


Possible causes:
- bl/ws diagnostic cable not connected
- bl/ws diagnostic cable is defective
  –> check for continuity, short circuit and damage.
- Heater was not detected.

7 Maintenance / Troubleshooting / Repair

DIAGNOSTIC TOOLS... Continuation

4. EUDT - P/N: 20 2800 70 12 00



Eberspaecher is proud to announce a smaller and lighter version of the current ISO adapter. This computer based diagnostic tool gives you more detailed and real time information using EDiTH diagnostic platform for troubleshooting air heaters.
You have an option to save and send the recorded EDiTH file through e-mail.

TOOLS NEEDED TO DIAGNOSE HEATER

- A PC Desktop or Laptop with 32 or 64 bit Windows OS (XP, Vista, Win 7) EDiTH Software Current version of software is EDiTH S4V1-F, please update your software: http://www.eberspaecher-na.com/download-center.html.
- EUDT.
- Adapter cables (part number: 22 1000 31 86 00).
- USB Extension.

PROCEDURE FOR SOFTWARE AND DRIVER DOWNLOAD

Install EDiTH software on PC. Follow the prompts that appear, save it at appropriate location and set up the EDiTH program. A short cut key for EDiTH appears on the desktop.

Connect the New Eberspaecher Diagnostic Tool to unused USB on the PC, and connect the necessary adaptor for the Airtronic heater to be diagnosed.
To operate EUDT hardware, use a link below for driver installation. Please ensure to select appropriate operating system (32/64 bit) before downloading and extracting the zip folder for the driver. Open Device manger and search for the new hardware and driver location in computer.

PLEASE NOTE! Most of the current computers with WIN 7 or 8 automatically downloads drivers through Internet compatible with newly detected hardware; however, some are restricted by lack of administrator rights. For computers with Win XP, please download the driver manually at: http://www.ftdichip.com/Drivers/VCP.htm and install it.

Now you are ready to diagnose the heater, see information above for EDiTH Software.
OPERATION

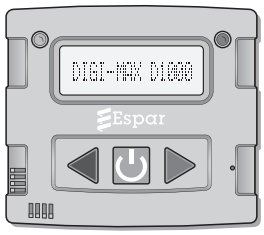
Connect EUDT with computer as well as heater using adapter cable, then click on quick link for EDiTH in desktop.

Select appropriate COM PORT, and click heat symbol in EDiTH

Choose heater type and model or perform automatic detection. Then, select one of the options of heater test: General Data, Functional Check, and Switch On Component. For further information regarding operating process and testing procedure using EDiTH software, please see page 77.

PLEASE NOTE! Some older airtronic heaters do not have all three options for heater testing.

5. DIGI-MAX CONTROLLER (D 1000) - P/N: 20 2800 70 15 00



- Right button
- Left button
- Sensor
- Green LED – Heater enabled
- ON/OFF Key
- Service / Maintenance button
- Red LED – Heater requires attention

To retrieve or delete fault codes, it is necessary to access the Set up/Diagnostic mode of the controller using following steps:

1) Press and hold left button (blue) meanwhile press and release the reset button (Service / Maintnance button) inside the hole using sharp object like paper clip.

2) Keep holding the left button until two LEDs start to blinking and turn RED.

3) Controller start checking the firmware, memory test and diagnostic line, if ok then displays “Memory test OK and diagnostic line OK” (if not, then shows “ Check diagnostic line” message. Check the blue/white wire or replace controller). Now, Controller enters into diagnostic/set up mode.

4) The first menu requests “ Diagnose now?”, select “Yes” to access fault codes and erase them.

PLEASE NOTE!

- The pin hole is located at the right side bottom corner of the controller.
- When fault is detected, the Green LED turns in Red.
- The LVD is triggered and LED is turned in to RED when the voltage stays below pre programmed value for 10 mins. (For LVD, controller monitors voltage at yellow wire).
- A precautionary message “maintenance required” is displayed once the operating hours has completed its set hours, which means the heater is required a visual check and inspection. Such message can be deleted by resetting the operating hours in the set up/diagnostic mode.
- Pressing the diagnostic button alone or restarting the controller does not reset its setting to defaults.

DIAGNOSTIC TOOLS... Continuation

6. * ISO ADAPTER KIT (EDiTH)

This plug and play type computer aided diagnostic tool, which uses EDiTH software (S4V1-F), is compatible with most versions of Windows OS, including windows 7. This tool allows user to access general data of the heater, delete the fault codes as well as run functional check to see all test data in numerical and graphical version. In addition, it can be used to test different heater components separately.

ACTIVATING EDITH DIAGNOSTIC TESTS:

1 Double click the EDiTH shortcut on the desktop to launch the EDiTH program.
2 Click on the “Select Heater” icon from the navigation menu displayed.
3 Select the heater type from the groups listed in the far left column (example: Airtronic /M/L.)
4 Click and select the correct heater model number and the correct ECU version or click and run the “Automatic detection”cycle.
5 Select the diagnostic test to be activated in the far right column.
6 Click on “Start test” button.
7 Select available options depending on type of the heater i.e. General Data, Functional Test, Switch on Component. In functional check, The first step is to select a set point control via EDiTH or controller. If the heater controll is given to EDiTH, feed a set point value in a small box at top left corner in computer screen.

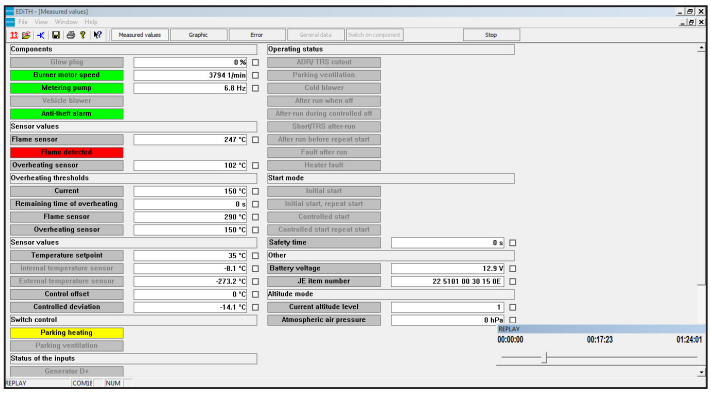
PLEASE NOTE!

- During the functional check, the box for external temperature sensor appears green when the ECU is receiving temperature value from external sources (remote temperature sensor or controller).

8 To delete the fault code, just click on the “error” and then “delete”.
9 Once tests are completed, the EDiTH file can be saved in the computer; click “save” and select appropriate location.
10 The saved tests can be replayed at later time and transfered via email for warranty purposes.

PLEASE NOTE!

- Before commissioning the EDiTH test, Selection of appropriate COM PORT is critical for proper data communication via USB.
- When connected, the green LED on the ISO adapter conforms a 12/24V power supply and the amber LED (flickering light) indicates an active diagnostic link. A constantly lit red LED may indicate a communication failure between the heater and computer.
- The latest version EDiTH software can be downloaded from the technical site of the Eberspaecher website.



For Illustration purpose only

7. EASYSCAN - P/N: 22 1550 89 00 00

EasyScan is the latest diagnostic tool from Eberspaecher NA, which is replacing the current version ISO adapter kit (EDiTH S4V1-F). This computer based tool supports all currently available 12 and 24V airtronic and hydronic heaters with H-kit ECUs. The EasyScan software requires windows 7 or later version of 32 or 64 bit OS on the computer (1GHz min) processor speed, 3 GB RAM, and USB port). It allows user to diagnose the heater using broad scope of control function and features:

1. ADVANTAGES (FUNCTIONS)

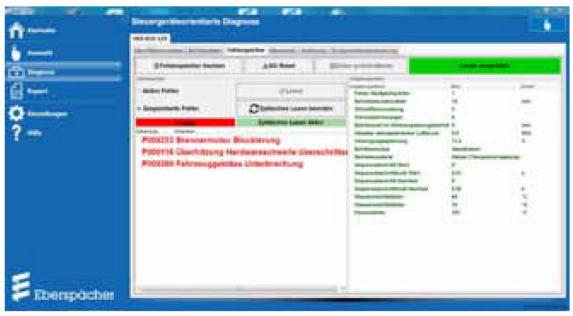
- Future-proof as a result of compatibility with widely used standards in the automotive industry (OBD).
- New, modern, user-friendly user interface.
- Comprehensive evaluation of current operating status.
- Automatic creation of a usage profile.
- Error analysis of devices and components.
- Error code display with ambient conditions.
- Function check of a vehicle application.
- Heating system commissioning support.
- Integrated results log at the end of commissioning and for diagnostic processes.
- Existing heater adapters are still applicable.
- Reliable software for the user.
- Option of direct link to the Eberspaecher Partner Portal.

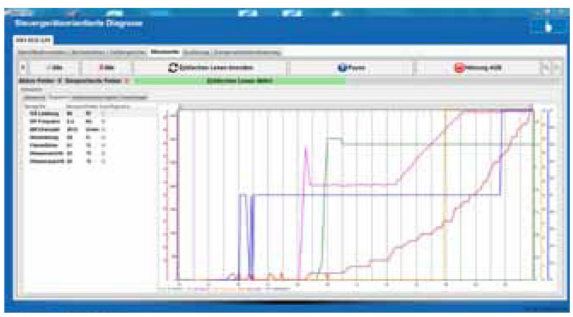
2. FURTHER FEATURES

- Additional languages to those already defined are available upon request.
- P C software is downloaded via the Partner Portal.
- Software can also be installed and updated locally from data media.
- Automatic update check every time software is used.
- Delivery content includes VCI, USB cable + Y-adapter cable (Connection for current heaters as well as future applications)

PLEASE NOTE!

For installation and operation purpose, it is important to read the EasyScan manual available at http://www.eberspaecher-na.com/download-center.htm

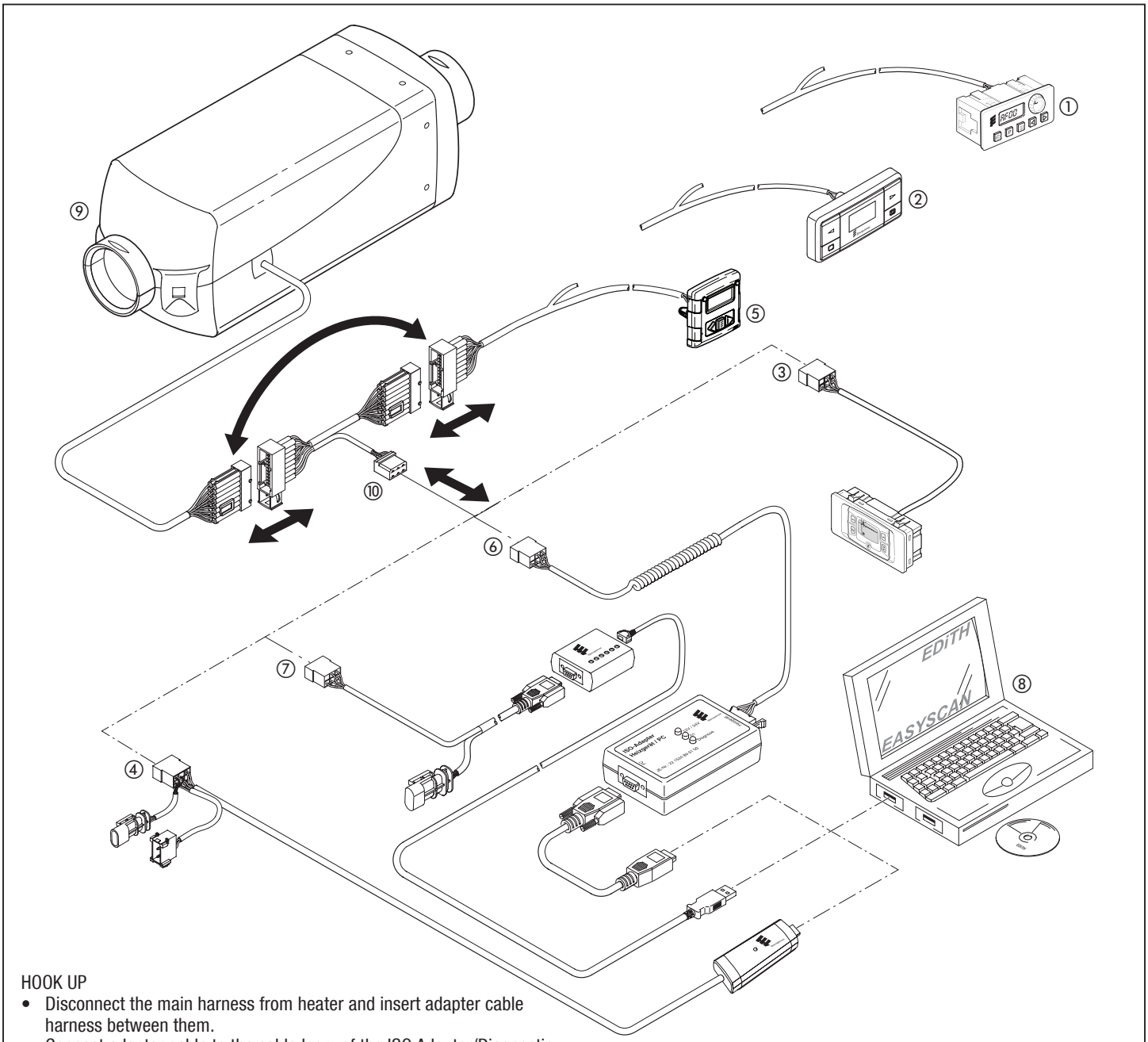




7 Maintenance / Troubleshooting / Repair

DIAGNOSTIC TOOLS... Continuation

DIAGNOSTIC TOOL CONNECTIONS



HOOK UP

- Disconnect the main harness from heater and insert adapter cable harness between them.
- Connect adapter cable to the cable loom of the ISO Adapter/Diagnostic unit/Eberspaecher Universal Diagnostic Tool, EasyScan hardware.

For Illustration purpose only

① 7 Day Timer - P/N: 22 1000 30 40 00
② EasyStart Timer - P/N: 22 1000 34 15 00
③ Diagnostic Unit - P/N: 20 2900 70 50 60
④ EUDT - P/N: 20 2800 70 12 00
⑤ Digi-Max Controller - P/N: 20 2800 70 15 00
⑥ ISO Adapter Kit - P/N: 22 1541 89 00 00
⑦ EasyScan - P/N: 22 1550 89 00 00
⑧ Edith/Easy Scan Software
⑨ Airtronic Heater
⑩ “Y” Shaped test adapter cable for Airtronic D2/D4/D5 - P/N: 22 1000 31 86 00

FAULT CODES

FAULT CODE	FAULT DESCRIPTION	CAUSES / REPAIR
000	Normal Operation	— — —
004	⚠ WARNING: Short circuit in control box - output signal for Blower (Fresh air ventilation)	Short circuit or Loose connection at single wire (terminal) for fresh air ventilation (Note: Function normally not used in North America) • Check for short circuit between pin 16 (B1) and appropriate relay • If there is no short (or no wire attached at terminal), test ECU* and replace if necessary. • To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts, then replace the original ECU. For extra information, see page #84.
005	⚠ WARNING: Short circuit in control box - output for security system (car alarm)	Short circuit or Loose connection at single wire (terminal) for vehicle security system (Note: Function normally not used in North America) • Check for short circuit between pin 15 (B1) and appropriate relay or security system input • If there is no short (or no wire attached at terminal) , test ECU* and replace if necessary. • To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts, then replace the original ECU. For extra information, see page #84.
006	⚠ WARNING: Inexplicable atmospheric altitude information (for H-kit only).	The ECU has received improper information from Altitude sensor • Check the connection and installation location of the sensor • Carry out a diagnostic of Altitude sensor using EDiTH, replace if necessary • To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts, then replace the original ECU. For extra information, see page #84.
009	ADR - Shutdown	Heater shutdown was triggered by a supplementary safety feature for dangerous goods vehicle: ADR signal (Note: Function normally not used in North America) • Check if there is a signal at pin 13 (S1) changed from (+) to (-) or detection of (+) signal at pin 24 (S1) • If above does not resolve problem, then test ECU*. Or if necessary, replace it. • To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts, then replace the original ECU. For extra information, see page #84.
010	Over-voltage - Shutdown	Over voltage (>16V or 32V*) at ECU for minimum of 20 seconds without interruption - Heater is not allowed to run. • Check the voltage between terminals 1 (RED) and 10 (BROWN) at connector (B1). If voltage is >16V or 32V*, check the battery, electrical leads and vehicle charging system. *24V heater only.
011	Under Voltage - Shutdown	Under voltage (<10.2V or 20.4V* at ECU for minimum of 20 seconds without interruption - Heater is not allowed to run. • Check the voltage between terminals 1 (RED) and 10 (BROWN) at connector (B1). • If voltage is <10.5V or 21V*, check the battery, electrical leads and vehicle charging system. (Or start the heater after shutting down high load appliances) * for 24V heaters only. • Measure value and battery voltage should be similar. In case of voltage drop, check fuses, harness, and battery connections for corrosion, loose connections or damage.
012	Overheat sensor - Overheating Shutdown ⚠ WARNING: Risk of physical injury and burns.	The outlet air temperature at overheat sensor is greater than 120°C (AD2) and 150°C (B/D4). PLEASE NOTE! The overheat sensor mainly triggers this fault when the hot air flow is severely blocked at the heater outlet. Blocked air in the heat exchanger is heated increasing its temperature beyond overheat threshold. • Check the duct system, make sure they are within permissible range of system rating (duct and component) according to the rating of connected heater. Remove bends or components with large guide number, if possible. • Check the duct system for any blockages (overheat sensor triggers as the air temperature reaches at 140 to 170°C threshold range that is measured at 300 mm distance from outlet of the heater). Make sure the hot air is not short circuiting back in to the heater inlet. • Make sure the operational altitude of the heater and see if the pressure sensor working or not. (Pressure sensor is mandatory for heaters operating at high altitudes for longer periods) • Carryout fuel quantity test to measure the fuel input, see page (make sure to use the quality to the fuel as specified on page 88) • Measure the resistance value (see page 89) for combination sensor (overheating and flame) at a room temperature. If higher, replace it. Make sure it is properly mounted on the heat exchanger. • If everything seems ok, then test the ECU by swapping it from similar Airtronic D2/4 heater (or replace the ECU, if necessary). For extra information, see page #84.

FAULT CODES... Continuation

FAULT CODE	FAULT DESCRIPTION	CAUSES / REPAIR
013	Flame sensor - Overheating shutdown ⚠ WARNING: Risk of physical injury and burns.	Flame sensor signals temperature at heat exchanger is greater than 280 °C (D2) and 290 °C (B/D4). PLEASE NOTE! The flame sensor mainly triggers this fault when the mass air flow is severely blocked (> 25% app.) at the heater inlet. Due to lack of air in the heater, the heat exchanger. exerts most of the heat from combustion chamber so its temperature may increase beyond flame sensor threshold. Such issue may also arise at high altitudes (low air density) if the heater is not connected with pressure sensor. • Measure the resistance (see page 89) of the Combination sensor (Flame) at room temperature (20°C). Replace if it is out of specified range (see page 91) • Carry out additional troubleshooting steps as provided in Fault 12.
014	Overheating - Shutdown (difference evaluation) ⚠ WARNING: Risk of physical injury and burns.	Temperature difference between the flame sensor and overheat sensor is too high PLEASE NOTE! The main causes of such fault is the high altitude operation without pressure sensor, improper installation of sensors (up side down position of the combo sensor), and damaged or failed sensors. • Inspect the combo sensors (overheat and flame sensor) installation and check their resistance values, replace if necessary (sensor values are available on page 89). • Carry out additional troubleshooting steps as provided in Fault code 12.
015	Too many overheats - Heater lock out ⚠ WARNING: Risk of physical injury and burns	Heater is overheated repetitively (code 12 or 14), and ECU is probably locked out for safety reasons. Repetitive overheats are mainly caused by lack of airflow, blocked air duct, defective sensors. • Unlock the ECU using one of the diagnostic units, see diagnostic procedure on page 72. • Carry out troubleshooting steps as provided in Fault 12.
017	Overheat (ECU) - Shutdown ⚠ WARNING: Risk of physical injury and burns	Temperature threshold is exceeded and ECU failed to recognize a fault 012/013. ECU has trigged lock out procedure. PLEASE NOTE! Fault 017 converts in to Fault 015 if the heater is restarted. • Carry out troubleshooting steps as provided in fault 012, 015.
018	Glow plug - Start energy too low	Glow pin energy too low at the start • Carry out troubleshooting steps as provided in Fault 020, 021.
019	Glow plug - Ignition energy too low	The operating energy of the glow pin is too low at during ignition process • Carry out troubleshooting steps as provided in Fault 020, 021.
020	Glow pin - Interruption ⚠ WARNING: Risk of electrical shock, physical injury and burns.	Resistance of the glow pin is out of range(open circuit). To remove a glow pin, please refer the Disassembly/assembly of the heater on page 91. • Carry out a visual inspection of the glow pin and harness for any damage or deformation. • Check the Glow pin resistance at room temperature (20*C) - 12V airtronic 2/4 heater : 0.42 Ω - 0.7 Ω - 24V airtronic 2/4 heater : 1.2 Ω - 2.0 Ω • Measure the current draw of the glow pin in installed condition (disconnect the connector from the controller and apply voltage from separate DC power source and measure the current intensity after 40 seconds) - 12V airtronic 2/4 heater : Apply 8.5 V : 9A (+/- 1.5) - 24V airtronic 2/4 heater : Apply 18.5 V : 4A (+/- 0.5) If the test value is OK, then check the harness for continuity. If not, then replace the glow pin. • If all tests are OK, then test the ECU* or replace it if necessary. PLEASE NOTE! • The glow pin is irreparably damaged if the voltage values are exceeded for current draw test. Such test is recommended for dealers only. • Necessary precautions must be taken to prevent electrical shock, or burns. • Ensure the DC power source has adequate short circuit resistance * To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts without fault, only then replace the original ECU. For extra information, see page #84.

FAULT CODES... Continuation

FAULT CODE	FAULT DESCRIPTION	CAUSES / REPAIR
021	Glow pin - Overload ⚠ WARNING: Risk of electrical shock, physical injury and burns.	• Resistance value of the glow pin is out of range (short circuit). To remove a glow pin, please refer the disassembly/assembly of the heater on page 91. • Check glow pin and electrical leads for continuity, replace if necessary. • Remove the glow pin and start the heater, if code 020 appears then replace the glow pin, if code 021 still appears then inspect the electrical connections or replace the ECU if necessary. • Carry out troubleshooting procedure as provided in Fault 020.
022	Glow plug - Short circuit down stream of +Ub or transistor error	Short circuit at (+) output signal or transistor error • Check the glow pin harness for connections, if OK then test ECU • Also, carry out troubleshooting steps as provided in Fault 020, 021
025	Diagnostic wire - Short circuit	Short circuit at diagnostic line to (+) battery voltage PLEASE NOTE! Fault code can not be displayed until it has been corrected. • Carry out inspection of the diagnostic cable for connections, damages, and continuity if OK then test ECU • heater is connected with incompatible diagnostic device. • Improper function from diagnostic device
031	Blower motor - Open circuit (interruption) ⚠ WARNING: Risk of electrical shock and physical injury.	Open circuit or high resistance at blower motor connection: • Check the lead and connector to the blower motor for continuity, replace the motor if necessary • If the motor is OK, then check the ECU, replace* if necessary. * To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts without fault, only then replace the original ECU. For extra information, see page #84. • Additional troubleshooting procedure, please measure current draw and speed of the blower motor as described in fault 32
032	Blower motor - Short Circuit (overload) ⚠ WARNING: Risk of electrical shock and physical injury.	Overload at the blower motor due to jammed impeller (due to frost, salt, carbon or improper alignment); fix the jam or replace the motor if necessary. To remove blower motor, please refer the Disassembly/assembly of the heater on page 93. • Remove the blower connection from ECU, and start the heater. If fault 31 (open circuit) appears, then carry out blower testing procedure. Or if, fault 32 (short circuit) persists, then test ECU* or replace it if necessary. • Measure the current draw and speed of blower motor at testing voltage: **Testing Voltage:** - For 12V Airtronic 2/4 heater : Apply 10 V - For 24V Airtronic 2/4 heater : Apply 18 V **Current Draw:** - If the current intensity is > 6.5 A, replace the blower motor - If the current intensity is < 6.5 A, check the connections, and test ECU or replace it if necessary. **Airtronic 2: Blower speed** - If measured speed is < 5000 rpm (+/- 25%), then replace the blower motor. - If measured speed is > 5000 rpm (+/- 25%), then test the ECU or replace it, if necessary. **Airtronic 4: Blower speed** - If measured speed is < 4400 rpm (+/- 25%), then replace the blower motor - If measured speed is > 4400 rpm (+/- 25%), then test the ECU or replace it, if necessary. • Measure the air gap between combustion air intake wheel cast iron base using feeler gauge: if gap is **Airtronic 2:** 0.35 mm+/-0.02, replace the blower motor assembly if necessary. **Airtronic 4:** 0.30 mm+/-0.02, replace the blower motor assembly if necessary. • Due to excessive ice built up or heavy carbon particulates at the outlet of combustion fan could increase the resistance and eventually overload the motor. Therefore, sometimes by simply cleaning the surface area of the blower motor could also help removing the fault. • For excessive speed fluctuations: Carry out blower motor inspection. Check the magnet on the blower fan or hull sensor on the ECU. • If everything seem OK, then test ECU* or replace it if necessary. PLEASE NOTE! • Operating voltage and test voltage of the blower motor are different. • Use non contact tachometer for speed measurements • The blower motor is irreparably damaged if the testing voltage values are exceeded. • Necessary precautions must be taken to prevent electrical shock, or burns. • Ensure the DC power source has adequate short circuit resistance * To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts without fault, only then replace the original ECU. For extra information, see page #84.

FAULT CODES... Continuation

FAULT CODE	FAULT DESCRIPTION	CAUSES / REPAIR
033	Blower motor - speed outside tolerance or short circuit after negative ⚠ WARNING: Risk of electrical shock and physical injury.	Overload at the blower motor due to jammed impeller (due to frost, salt, carbon or improper alignment); fix the jam or replace the motor if necessary. To remove blower motor, please refer the Disassembly/assembly of the heater on page 93. If speed deviation > 10% from operating value for longer than 30 seconds, then ECU triggers the fault. • High torque required by stiff or jammed blower fan leads to overload at the motor and current draw increases beyond range; therefore, sometimes ECU registers code 032 because of similar root causes. • To test the blower motor, follow troubleshooting procedure as provided in fault 031.
034	Blower output signal - Short circuit after battery voltage or transistor error	Signal issue due to defective transistor in ECU or short circuit after negative cable • Check the blower harness and connections • If everything seems OK, then test ECU* or replace it if necessary
047	Fuel Metering Pump - (Overload) Short Circuit	The Fuel metering pump resistance value is out of the range (Low resistance); Remove the FMP and carry out test. • Disconnect the FMP, if ECU gives fault 048, then check the FMP resistance, or replace if necessary; if the fault 047 persists, then check the wire harness, connector and ECU. • To test FMP, follow troubleshooting procedure as provided in fault 048
048	Fuel metering pump - (Interruption) Open Circuit	The Fuel metering pump resistance value is out of the range (high resistance); Remove the FMP and carry out test. • Measure FMP resistance at room temperature for 12V heaters: 9.5 (+/- 0.5) Ω; for 24V heaters: 36 (+/- 1.8) Ω, replace if necessary. • Check the supply lead, connector and wire harness, replace if necessary. • If everything seems OK, then test ECU* or replace it if necessary
048	Metering Pump - Short circuit to battery voltage	Short circuit to the battery voltage or signal issue from ECU. • Carry out inspection of FMP wire harness for connections and continuity • If everything seems OK, then test the ECU or replace it if necessary.
050	Too many failed start attempts - Operating Lock out	Too many start attempts (maximum 255) or overheats triggered ECU to lock the heater, under which heater would not start unless any active and stored faults are deleted. • Use one of the diagnostic tools mentioned on page 72 and follow the procedure to retrieve the fault and Unlock the ECU.
051	Faulty flame recognition - at start up	At start, if the resistance value of the flame sensor is detected > 1274 Ω (>70°C), then the start attempt is delayed and blower is activated for cool down (cold blower) for 15 mins. If the resistance value (temperature) does not fall below aforementioned value within 15 mins, the ECU triggers the heater shut down with fault 051. If the temperature decrease within acceptable level, the heater will proceed with normal start up procedure. • Check the resistance of the flame sensor at room temperature. (the test values are available on page 89) • If everything seems OK, then test ECU* or replace it if necessary
052	Flame Cut Out - (Safety time exceeded) at start up	Flame is not detected within required time during start up. Number of failed start attempts could lock the ECU under fault 50. • Check the intake and exhaust systems for blockages by dirt, salt, condensation. (maintain the total 90° bends from intake to exhaust pip no more than 3 or 270°) • Measure fuel quantity test (see page 88)* and check pump angle (15 to 35°).Check the fuel line for air bubbles or contaminants. For fuel quantity test procedure, please refer (see page 88). • At high altitudes >1500 m, connect high altitude sensor for proper heater operation (stabilize the fuel/air ratio). • Remove carbon, dirt or foreign particles from combustion chamber and run the heater using kerosene for 30 mins. max thereafter. • Check the flame sensor value at room temperature (see page 89). • For fresh installation and first time heater start up require fuel priming which could cause 52. • Check the air gap between the blower motor fan and cast iron housing, see fault 032. • Check the Glow pin resistance and replace the glow pin screen, also clean the vent hole (a small channel connecting to the blower air inlet to the flame chamber) • Check the flame chamber and replace if its shape is elongated due to thermal stresses. • Replace the ECU*, if necessary. For further information on carboning issue, please see page 87. Also, for disassembly/assembly of the heater, please see page 91.

FAULT CODES... Continuation

FAULT CODE	FAULT DESCRIPTION	CAUSES / REPAIR
053 054 055 056	Flame cutout in the “POWER” control stage “HIGH” control stage “MEDIUM” control stage “LOW” control stage	The heater has ignited (flame detected) and signals flame cutout during operational stages. • For troubleshooting, see fault 052.
057	Flame Cutout - Start up (H-kit heaters only)	Heater has extinguished during start up prior to power mode. • Check the combustion air and exhaust pipe • Measure if sufficient fuel is provided. Carry out fuel quantity test. • Follow steps provided in fault 052
060	External temperature sensor - Interruption (open circuit)	External temperature sensor detects a value beyond its range (high resistance R> 3K Ω = open circuit); Remove temperature sensor (For removal procedure of the temperature sensor, please see page 92) and check connections. • Measure the sensor at room temperature see test value on page 89, and replace if necessary. • If everything seems OK, then test ECU* or replace it if necessary.
061	Short circuit - external	Temperature sensor detects a value beyond its range (low resistance, R< 800 Ω = short circuit); Remove the sensor (please see procedure on page 92) and check the connections. • Remove the Temperature sensor from connection and turn on the heater, if code 060 appears then check the sensor resistance or replace it if necessary; if code 061 persists, then check the connections, and ECU, replace if necessary. • If everything seems OK, then test ECU* or replace it if necessary.
062	Set point control - Open circuit (interruption)	ECU detects the temperature set point value is out of range (> 3 K Ω) and determines open circuit. Under such condition, the heater will operate in High mode only. • Activate the controller (digimax, easy start timer. etc) prior to start up diagnosis through Functional check (EDiTH) • Measure resistance between pin 6 and 7 at B1 (thermostat and rheostat only) see test value on page .. . The set point value for mini controller, digimax controller, Easy start timer can be tested using the functional test (EDiTH) • Carry out inspection of the set point wires (Grey/red and brown/white) for any visible damage. • If everything seems OK, then test the ECU or replace it if necessary.
063	Set point control - Short circuit (Overload)	ECU detects the temperature set point value is out of range (<800 ohms) and determines short circuit. Under such condition, the heater starts in the ventilation mode, and only blower motor will function. • Disconnect the set point wire from the controller, and restart the heater. If the heater starts with fault 062 and operates in High mode, then test the controller. If fault 063 reappears, then carry out inspection of the set point control wire (Grey/red and brown/white) and test the ECU, replace it if necessary. • Measure resistance between pin 6 and 7 at B1 (thermostat and rheostat only) see test value on page 89. The set point value for mini controller, digimax controller, Easy start timer can be tested using the functional test (EDiTH) • If everything seems OK, then test the ECU or replace it if necessary.
064	Flame sensor - Open circuit	The Flame sensor detects a value beyond its range (high resistance R> 3 K Ω = open circuit); Remove flame sensor (For removal procedure of the temperature sensor, please page 92) and check connections. • Measure the sensor at room temperature (see test value on page 47) and replace if necessary. • If everything seems OK, then test the ECU or replace it if necessary.
065	Flame Sensor- Short circuit (overload)	The Flame sensor detects a value beyond its range (low resistance, R< 500 Ω = short circuit); Remove the sensor (please see procedure on page 92) and check the connections. • Remove the Flame sensor from connection and turn on the heater, if code 064 appears then check the sensor resistance or replace it if necessary; if code 065 persists, then check the connections, and test the ECU, replace if necessary.
071	Overheat sensor - Open circuit	The Overheat sensor detects a value beyond its range (high resistance R> 1600 Ω = open circuit); Remove overheat sensor (For removal procedure of the temperature sensor, please see page 92) and check connections. • Measure the sensor at room temperature see test value on page 89, and replace if necessary. • If everything seems OK, then test the ECU or replace it if necessary.

FAULT CODES... Continuation

FAULT CODE	FAULT DESCRIPTION	CAUSES / REPAIR
072	Short circuit - Overheat sensor	The Overheat sensor detects a value beyond its range (low resistance, R< 95 Ω = short circuit); Remove the sensor (please see procedure on page 92) and check the connections. • Remove the Overheat sensor from connection and turn on the heater, if code 071 appears then check the sensor resistance or replace it if necessary; if code 072 reappears, then check the connections, and test the ECU, replace if necessary.
072	ECU - Defect - Overheat threshold detection error	Overheating threshold value is not detected by ECU • Inspect combo sensors for damage • If everything seems OK, then test the ECU or replace it if necessary.
090	ECU - Defect (internal fault)	• Disconnect the power source from the heater for 10 seconds and reconnect, then test heater again. • Test the ECU or replace it if necessary.
091	External interference voltage	Error in controller from interference voltage from vehicle network possible causes: poor batteries, poor battery charges, other interference sources; eliminate interference voltages**. ** Disconnect the heater from power for 10 seconds by disconnecting the 8 pin connector at the heater or pull main harness fuse, then reconnect and test it again. If the problem persists test the heater using an external power source other than the vehicle(known good battery only) These faults are common to a bad power supply, attached changer or dead cell in a battery.
092 093 094 095 096 097 098	ECU - Defect (ROM error) ECU - Defect (internal) ECU - Defect (EEPROM error) ECU - Defect (Internal) ECU - Defect (Internal temperature sensor) ECU - Defect (Internal) ECU - Defect (Internal)	• Disconnect the power source from the heater for 10 seconds and reconnect, then test heater again. • test the ECU or replace it if necessary. • To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts without fault, only then replace the original ECU. For extra information, see page #84. PLEASE NOTE! For fault 096, The heater can operate with external temperature sensor.
099	Too many resets in sequence - Transistor error in ECU	A short term voltage drops from power source due to any reason (< 5V for 12V and < 7 V for 24V heater); possible causes: low batteries, charges, other sources of interference, eliminate interference voltages. Internal faults detected in microprocessor/memory. Internal failure. Replace control unit.

*** To test ECU, swap it with newer ECU from similar heater and restart the heater. If heater starts without fault, only then replace the original ECU. Before replacing the original ECU, reconform its bad condition (wrong fault codes, inactivity, wrong status) by retesting it on the same heater; if the secondary test result is consintant (bad ECU), then replace the original ECU.**

PLEASE NOTE! For codes starting with 9x (e.g.91,93), try to put a good known working battery. Be sure to have the engine off and any equipment as well. Try to restart heater and check for any codes. This has to be done before/prior replacing the ECU.
All fault codes and description are only applicable for new style ECU.

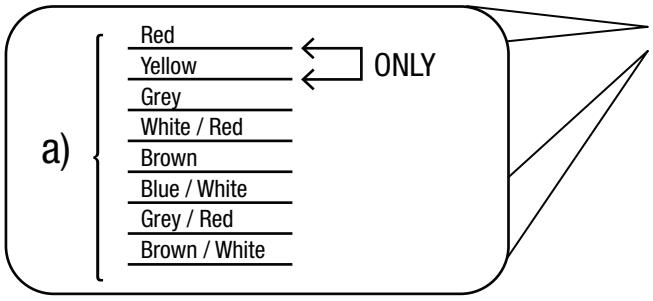
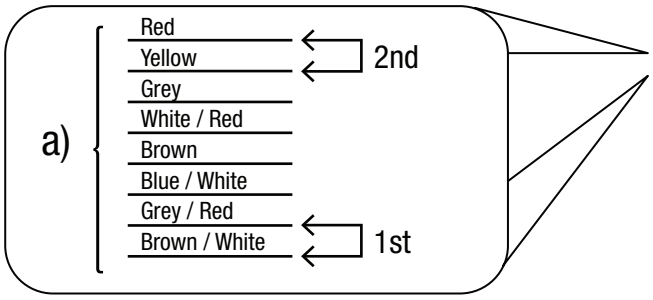
⚠ WARNING - SAFETY:
Before performing the diagnostic and repair on the heater, always have minimum required tools and protective equipments as provided on page 5.

AIR PRESSURE /HIGH ALTITUDE SENSOR FAULT CODE DISPLAY

FAULT CODE	FAULT DESCRIPTION	COMMENTS / REMEDIAL ACTION
00	No faults —	
11	Communication loss	Interruption of the diagnostics cable between the control box (heater) and the air pressure sensor • Check wiring and plug-in connections.
12	No altitude adjustment	Control box (heater) does not support altitude operation with the air pressure sensor. • Use a control box (heater) which supports altitude adjustment
13	Air pressure sensor fault	The air pressure sensor is defective • Replace the air pressure sensor

TROUBLESHOOTING FOR AIRTRONIC 2/4/ HEATERS

"NO START" AND "HEATER STOPS" CONDITIONS
USE THESE RECOMMENDATIONS IN CONJUNCTION WITH FAULT CODE LIST

#	DESCRIPTION OF THE PROBLEM	POSSIBLE REASON AND METHOD OF REPAIR*
1	Absolutely nothing happens when the heater is turned on  	1. Check voltage on heater's harness on the heater's side (pin # 1 and 10 on Airtronic connector). Turn the heater ON and make sure that the voltage is still OK. Repair harness and connections if necessary. 2. If the voltage is OK, then disconnect wall or dashboard controller and try to start the heater by connecting together red and yellow wires on control branch of the heater's harness. Make sure that you have +12 or +24 volts on the red wire on the control branch. 3. If the voltage is OK but the heater still does not start even if red and yellow wires are connected to each other, then the most likely ECU is locked, bad, or one of the startup self tests failed. Use one of diagnostic tools to retrieve fault codes from heater's memory and unlock ECU if it is locked. Follow heater's manual for the fault codes description and repair methods. Computerized diagnostic is advised for all kinds if troubleshooting of Airtronic heaters. 4. If you troubleshoot your own heater and diagnostic tools are unavailable, the following information may help (please note that the features below are determined by software in heater's ECU and may be different in some revisions of heaters): In the event that a heater is not locked out, but simply fails one of the start up tests. The heater will not run in 'Heat' mode, but may however run in 'Vent' mode. If the Mini-controller or Digi – controller is not available, vent mode can be accessed by 'jumping' the grey/red wire to the brown/white wire, then 'jumping' the red wire to yellow wire (order is important). If blower starts up and runs, then ECU is not locked. Otherwise, it may or may not be locked. If heater is able to start in ventilation mode, but can not run in heating mode: - check FMP for open or short circuit; - check roll-over or impact switch for open circuit (if installed); - check Glow pin for open or short circuit; - check overheat sensor for open circuit; If heater does not work in either heat and vent modes: - check flame sensor for open or short circuit; - check overheat sensor for short circuit; * Resistance values for the glow pin, sensors and fuel pump are listed in maintenance/Troubleshooting. Resistance of the fuel pump must be measured at the 16 pin connector with disconnected heater (pins 5 and 10).
2	Being turned on, heater turns blower a few times, FMP and ECU's relay may click one time but heater would not make an attempt to start.	1. Bad electrical connections. Check voltage like described in case #1. 2. Start-up self test failed. Retrieve fault codes from heater's memory using Diagnostic tool or EDiTH, refer to the heater's manual for the description and repair methods.
3	Heater switches into shut-down phase 20-25 seconds after being turned on (the most likely, fault code 11 found in memory).	Check voltage on heater's harness on the heater's side (pins 1 and 10 on Airtronic connector). Turn the heater ON and make sure that the voltage is still OK. Repair harness and connections if necessary.
4	Being turned on, heater just blows cold air for up to 15 minutes and never performs a start attempt. (Code 051 recorded after 15 minutes).	1. Was "Ventilation" button pressed instead of "Heat"? 2. Replace combo Sensor. 3. Test and replace ECU if necessary.
5	Heater makes two attempts to start with no success and then stops completely. No smoke comes from the exhaust pipe, some white smoke can be seen between the exhaust pipe and heat exchanger.	1. Check if exhaust pipe is not plugged with ice. Reroute it if this is the case for not having it to be U-shaped. 2. Check combustion air intake pipe. If the exhaust and combustion air intake pipes are OK, see case #6 below.

FAULT CODES... Continuation

RECOMMENDED TROUBLESHOOTING STEPS FOR HYDRONIC 4/5 HEATERS
("No Start" and "Heater Stops" conditions) Use these recommendations in conjunction with Fault Code List.

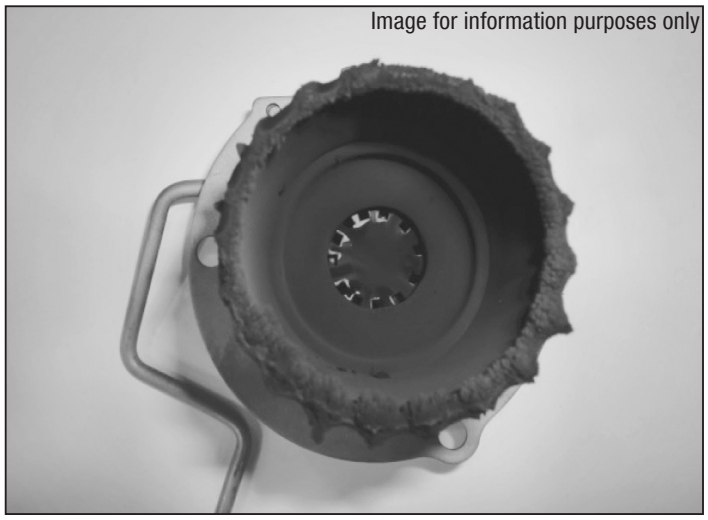
#	DESCRIPTION OF THE PROBLEM	POSSIBLE REASON AND METHOD OF REPAIR*
6	Heater makes two attempts to ignate then stops. Both times no fuel output from the FMP.	1 Check the fuel line, see if the fuel is frozen or blocked 2 If the fuel is OK, then check the FMP, measure its resistance. See if it is not jammed due to internal contamination or ice built up. (use fuel controller if FMP is jammed in low temperatures) see page 88.
7	Heater makes two attempts to start, may smoke for a while and then it stops.	1 Do the fuel quantity check as described in manual, if the amount of fuel is insufficient, than check the fuel pick-up pipe, fuel lines and connections, fuel filter on the pump, replace the filter or pump if necessary. 2 Check the glow pin, clean ventilation hole above the screen in the glow pin chamber and replace atomizing screen. 3 If necessary, take the heater apart, clean combustion tube (including it's all air ways) and the heat exchanger. If internal combustion chamber area is badly carboned or has a ceramic-like build up behind the rin g wall, replace the flame tube. Refer to instructions for cleaning heater with kerosene, which sometimes helps to avoid taking the heater apart for cleaning.
8	Heater makes two attempts to start, then stops. Both times it sounds like the ignition takes place and then combustion process stops together with the fuel metering pump. Usually no bad smoke comes from the exhaust pipe just like when the heater starts normally.	1 The heater ignited but the flame was not detected. Check and replace combo sensor, if needed. 2 Check if voltage on heater drops velow 10.5 V while starting. 3 Replace ECU if combo sensor was good.
9	Heater ignites normally, goes into boost mode, then switches to stand-by mode, blower is slowly spinning but the heater never restarts. No fault code recorded.	1 Using EDiTH, check setpoint for temperature and current air temperature. Replace part which works improperly. Swap wall controller for test if do not have EDiTH; 2 If wall controller OK, install external temperature sensor or replace ECU.
10	Heater ignites normally, but often stops (codes 52 - 56 found in memory)	1 Check fuel lines for gaps in connections inside connection pieces. 2 If the heater stops only when the vehicle is in motion, reroute combustion air intake and exhaust pipes, or bend their ends toward to the rear of the vehicle.
11	Ground wire burned out.	1 Vehicle's starter was turned on or short circuit happened in vehicle's power circuits while vehicle's power switch in the ground battery wire was turned off. Fix the wire or replace ECU. 2 High load appliance is turned on while the batter ground is disconnected and the heater negative wire is overloaded. Check the heater harness, and reattach the battery with ground.

*To avoid inefficient expenses, it is strongly recommended to have the heater diagnosed by specialist before replacing expensive parts.
WARNING

⚠ WARNING - SAFETY:
Do not skip trouble shooting steps replacing ECU before all oth er tests are done.
99% of repaired heaters do not need a new ECU.

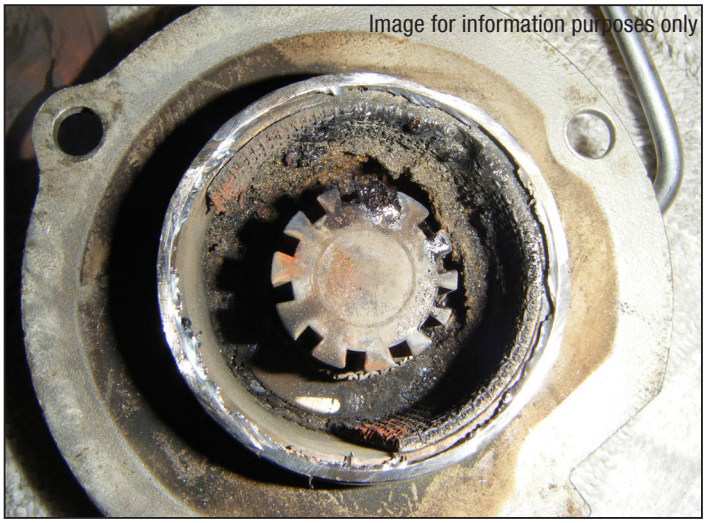
EXAMPLES / CAUSES OF CARBONING

Carbon is a term used to classify debris in the burner chamber. What you may visually see may not be carbon but still needs to be addressed properly to resolve the root cause of the issue. This is just a guide to the more common things you may encounter.



1 AIR FUEL MIXTURE

- If the air fuel mixture is off it can cause a black soot in the burner chamber and can also be identified by looking through the heater exhaust port.
  - — Improper angle of fuel pump.
  - — Wrong fuel pump used.
  - — Fuel pump out of calibration, perform fuel quantity test found on page 88.
  - — Restriction in the flame chamber air slots, and vent holes as well as in the intake and exhaust pipes.
  - — Debris ingested into the combustion air intake fan impeller.
  - — Improper length or too many bends of intake and exhaust tube. Combined maximum of 13' and 270° of bends.
  - — Heater operation at high altitudes without fuel adjustment from altitude sensor.



2 NON-FUEL RELATED BUILDUP

- If all the steps have been covered under the section outlining code 52 and the chamber is clean looking the issue may be in the fuel or chemicals ingested by the intake tube.
  - — If the heater intake tube is in a location to pick up road debris like water, salt and sand, it can build up in the burner matting/liner and activates galvanic corrosion internally.
  - — Additives are OK to use but if the concentration is in excess of the manufactures recommendations, it can build up in the burner porous liner.
  - — Oil related products like ATF or used oil will cause premature chamber failure.
  - — Thicker fuel also brakes into various density layers, which leads to either low quantity fuel or thin sludge in to the heating system. This practice will not be tolerated by the heater. If oil must be used it is recommended to operate your Eberspaecher heater from a separate fuel source.

- Presence of contaminants like sodium, sulfur, or lead in the fuel or/ and intake air during the combustion process could create some amount of high temperature oxidation, vanadium corrosion and sulfidation in the flame chamber, which could reduce its mechanical and thermal integrity, also durability. Therefore, to minimize such unwanted effects, usage of recommended grade fuel and proper heater installation must be ensured.

3 SHORT CYCLING OF HEATER

If the heater is allowed to short cycle it may cause a build-up of Creosote. Minimum runtime on a heater should be 15 minutes.

- Sizing of the heater is important: If it is sized too large or cycled off at too low of a coolant temperature could lead to premature burner chamber failures.
- Electrical connection issues: If the signal wire is sporadic, it will turn the heater on and off.
- Abrupt loss of main power: Can cause burner chamber failure due to loss of its cool down cycle – never use the Master Disconnect Switch to cut heater power.
- Improper duct system: Hot air from the heater outlet returning back into inlet do to improper duct layout.
- Temperature sensor: Uneven readings from temperature sensor due to improper location or defective sensor/harness.

FUEL QUANTITY TEST

The fuel Quantity should be tested if the heater has difficulty starting or maintaining a flame, using graduated cylinder part # 5520004 10ml.

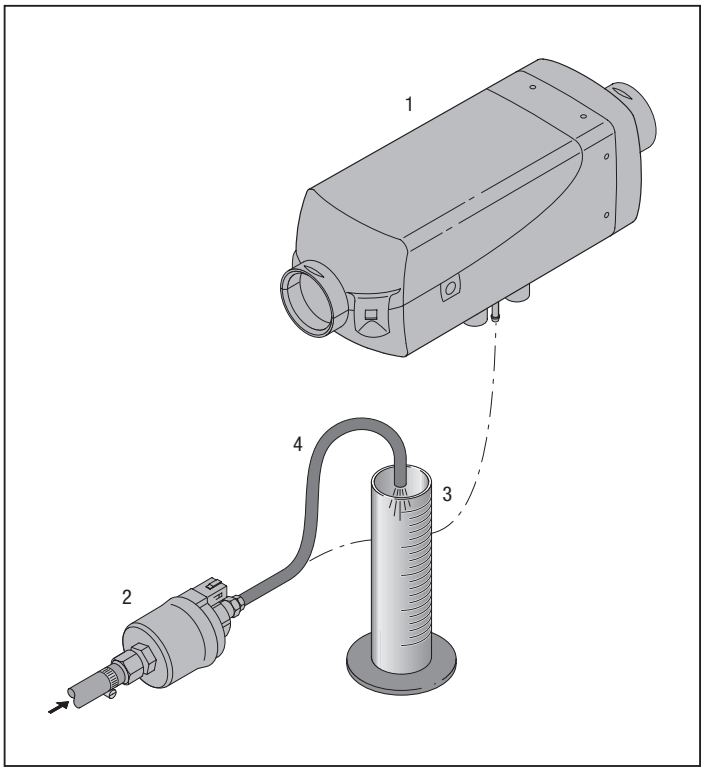
PLEASE NOTE! Measure the fuel quantity when the battery is sufficiently charged. During the test, applied voltage must be within 11to13V for 12V (or 22 to 25V for 24V heater).

PREPARATION

- Detach the fuel line from the AIRTRONIC.
- Insert the fuel line into a graduated cylinder 10ml.
- Switch the AIRTRONIC on. Once the FMP comes on allow the fuel system to bleed air out for approximately 60 seconds.
- Switch the AIRTRONIC off and empty the graduated cylinder.

MEASUREMENT

- Switch the AIRTRONIC on.
- The fuel is pumped approx. 60 seconds after switching on.
- Hold the fuel line in the graduated cylinder level with the glow pin while fuel is being delivered.
- The pump will stop automatically after delivering fuel for 90 seconds (105 seconds for AIRTRONIC 4).
- Once fuel pump stops, switch off the heater.

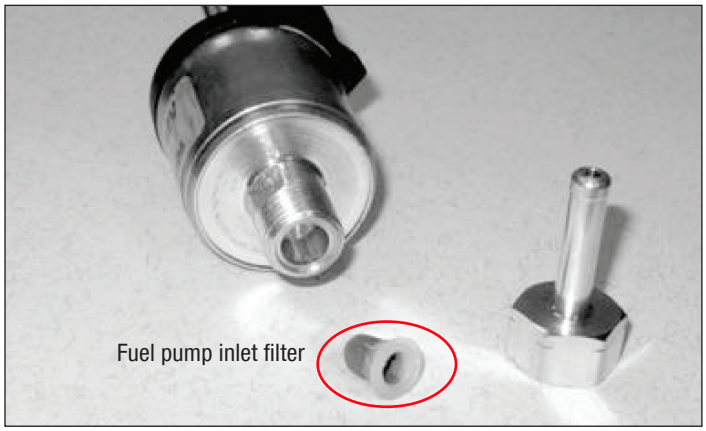


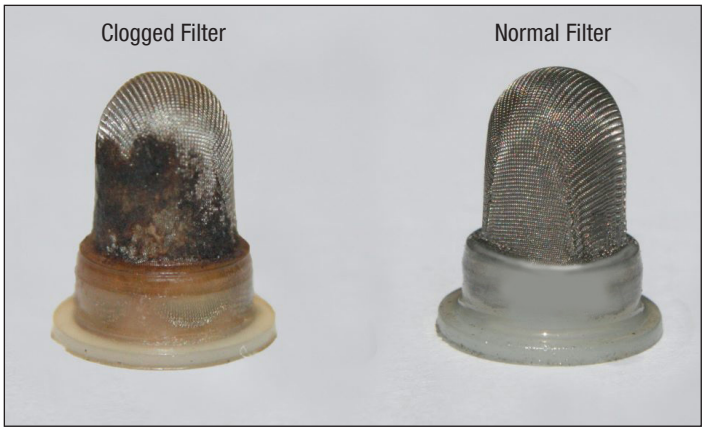
EVALUATION

← DIESEL		GASOLINE →	
Airtronic D2	**Airtronic D4**	**Airtronic B4**	
3.5 ml / 90 seconds	5.0 ml / 105 seconds	6.8 ml / 105 seconds	**Min**
4.3 ml / 90 seconds	6.0 ml / 105 seconds	7.6 ml / 105 seconds	**Max**

If measured quantity of fuel is over or under the nominal value, the metering pump must be replaced or fuel restriction eliminated i.e. clogged fuel filter.

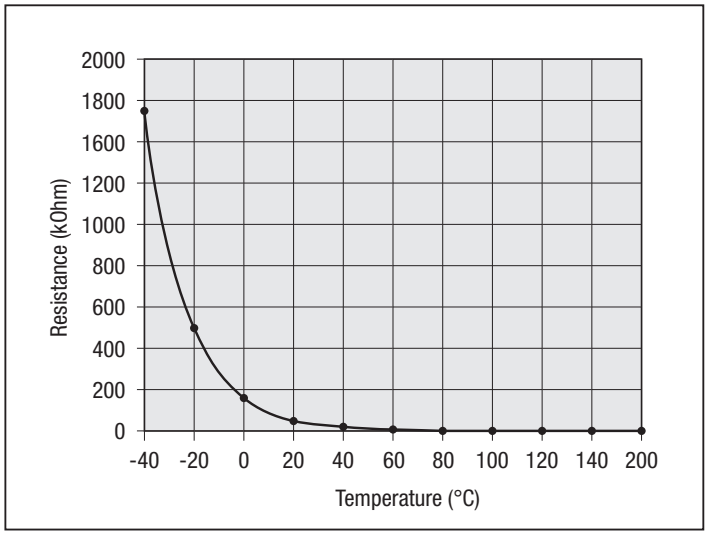
FUEL PUMP FILTER INSPECTION



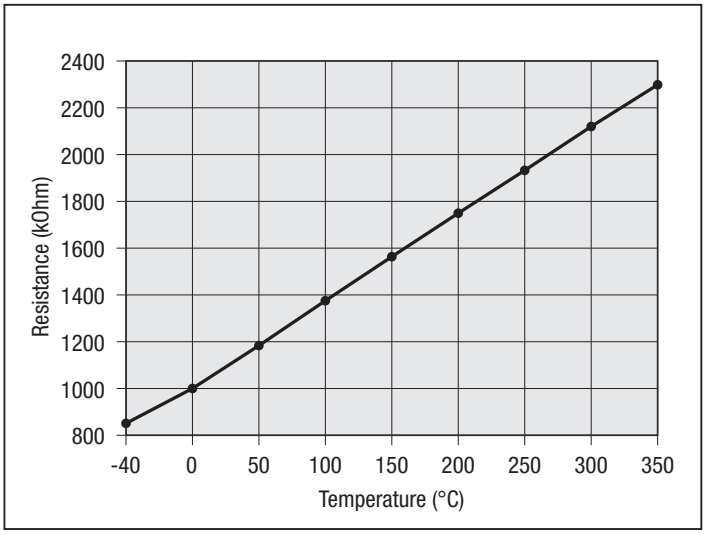


PLEASE NOTE!
Fuel pump inlet filter – clean or replace annually, more frequently if fuel contamination is noticed.

VALUES FOR OVERHEAT SENSOR



VALUES FOR FLAME SENSOR



VALUES FOR EXTERNAL TEMPERATURE SENSOR

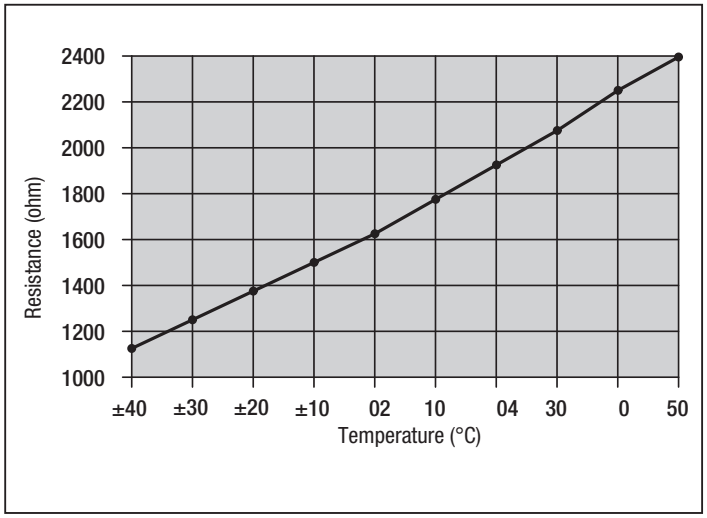


TABLE VALUES FOR OVERHEAT SENSOR

Temperature °C (F°)		Resistance kΩ	
		min.	max.
-40	(-40)	1597.0	1913.0
-20	(-4)	458.80	533.40
0	(32)	154.70	175.50
20	(68)	59.30	65.84
40	(104)	25.02	28.04
60	(140)	11.56	13.16
80	(176)	5.782	6.678
100	(212)	3.095	3.623
120	(248)	1.757	2.081
140	(284)	1.050	1.256
160	(320)	0.6654	0.792
180	(356)	0.4253	0.5187
200	(392)	0.2857	0.3513

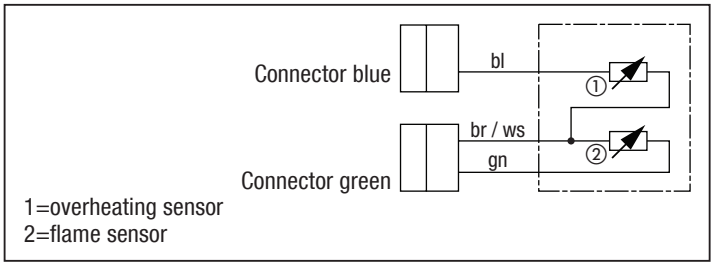


TABLE VALUES FOR FLAME SENSOR

Temperature °C (F°)		Resistance Ω	
		min.	max.
-40	(-40)	825.9	859.6
-20	(-4)	803.2	940.0
0	(32)	980.0	1020.0
20	(68)	1056.4	1099.5
40	(104)	1132.3	1178.5
60	(140)	1207.8	1257.1
80	(176)	1282.8	1335.1
100	(212)	1357.4	1412.8
120	(248)	1431.5	1489.9
140	(284)	1505.1	1566.6
160	(320)	1578.3	1642.8

TABLE VALUES FOR EXTERNAL TEMPERATURE SENSOR

Temperature °C (F°)		Resistance Ω	
		min.	max.
0	(32)	1600	1660
5	(41)	1670	1730
10	(50)	1745	1800
15	(59)	1820	1870
20	(68)	1895	1950
25	(77)	1970	2030
30	(86)	2050	2110
35	(95)	2130	2190
40	(104)	2210	2280
45	(113)	2295	2370

7 Maintenance / Troubleshooting / Repair

CONTROL VALUES

MOTOR SPEED

Test speed for the blower heater		
AIRTRONIC 2 12 volt heater	5000 rpm ±25 %	at U=10.0 volt
AIRTRONIC 2 24 volt heater	5000 rpm ±25 %	at U=18.0 volt
AIRTRONIC 4 12 volt heater	4400 rpm ±25 %	at U=10.0 volt
AIRTRONIC 4 24 volt heater	4400 rpm ±25 %	at U=18.5 volt

⚠ WARINING
Never apply full battery voltage to the blower motor.

PLEASE NOTE!

The testing voltage for the blower motor is different from its nominal operating voltage.

CONTROL STAGE 2 / 4

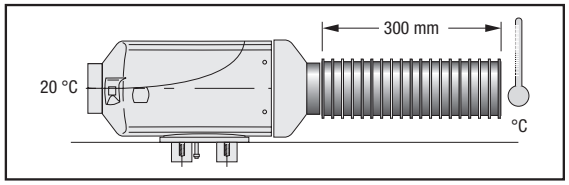
	AIRTRONIC 2	AIRTRONIC 4
• Power	4800 U/min ± 140 rpm	4400 U/min ± 130 rpm
• Fast	4000 U/min ± 120 rpm	3500 U/min ± 100 rpm
• Medium	2800 U/min ± 80 rpm	2600 U/min ± 80 rpm
• Slow	2000 U/min ± 60 rpm	1600 U/min ± 50 rpm
• Adjustment (Stand - by) - with internal temperature sensor. - with external temperature sensor.	 600 U/min ± 20 rpm 0 rpm	 600 U/min ± 20 rpm 0 rpm
• Ventilation	4800 U/min ± 140 rpm	4400 U/min ± 100 rpm

RESISTANCE VALUES AT ROOM TEMPERATURE

Component	*AIRTRONIC* - 12 V	*AIRTRONIC* - 24 V	Overheat ~60K Ω at room temp
Glow pin	0.42 - 0.7 Ω	1.2 - 2.0 Ω	Flame sensor ~1.0K Ω at room temp
Fuel metering pump	9.5 ± 0.5 Ω	36 ± 1.8 Ω	
Operator control unit			
Set value potentiometer Low setting High setting	(May slightly vary for different controller models) 1720 - 1780 Ω 2096 - 2240 Ω		

MAXIMUM TEMPERATURE RANGE DURING THE OVERHEAT CONDITION

AIRTRONIC 2 / 4
140°C - 170°C
(284°F - 338°F)
measured in the control stage “power” and at
a clearance of 300 mm from the hot air outlet



EXHAUST VALUE

	AIRTRONIC 2 / 4
CO_2 value	7.5 - 12.5 Vol. %
CO value	0.1 Vol. % (Maximum)
Smoke spot number	< 4 (as per Bacharach)
EGT*	425°C avg (Power mode)

*EGT reading can vary largely depending upon the installation, inlet temperature, fuel/air mixture and mode of the heater.

ASSEMBLY/DISASSEMBLY AND REPAIR INSTRUCTIONS

PLEASE NOTE!

- The cover must always be removed from the *AIRTRONIC* for all repair stages. You may have to wait for the device to cool down.
- Remove power from the heater prior to any disassembly by unplugging main connection or removing main fuse.
  If gasket was removed during disassembly, replace it when reassembling. Clean all parts before reassembly and check for any signs of damage, replace where necessary.

⚠ WARNING - SAFETY

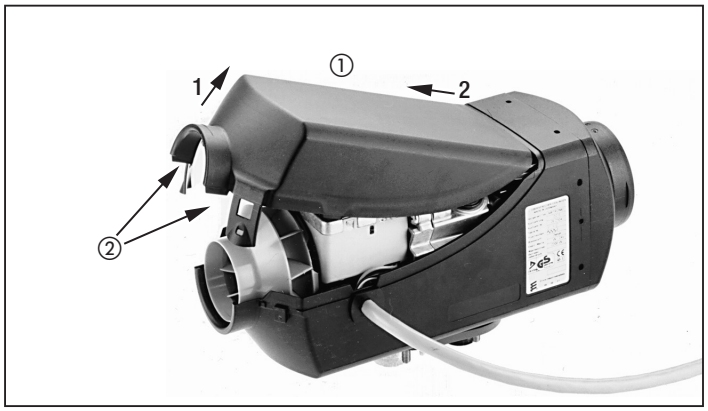
Before carry out any maintenance and repair on the heater, ensure minimum required tools and protective equipment are available as specified on page 5.

Step 1. Airtronic Cover

1 Unlock both seal plates, lift the cover and pull it to the front.
2 Inspect the top cover for any signs of thermal stress or mechanical damage (wear marks from blower fan, or cracks), Replace if necessary. (please see page 94 for part number)

PLEASE NOTE!

Depending on the heater type and installation, the main cable from ECU can exit from the left or right of the heater shell.



Cover ①
Seal Plates ②

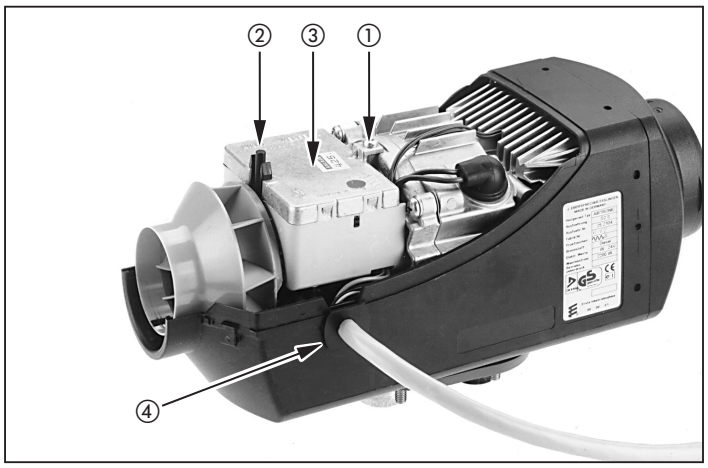
Step 2. ECU

- Remove the Airtronic cover

1 Remove the fastening screw, squeeze retaining brackets and and lift the ECU.
2 Unplug connectors for blower fan and sensors
3 Remove the bushing (lower part) from the bottom cover.
4 Inspect the ECU for any signs of corrosion, electrical burns, or thermal stress, as well as damages at harness, temperature sensor or hull sensor.

PLEASE NOTE!

When reassembling the ECU, ensure that the lines are correctly clipped in the holder of the ECU, and that the connectors are plugged into the ECU (noninterchangeable).



Fastening screw ①
Retaining brackets ②
ECU ③
Bushing ④

Step 3. Glow pin and Screen

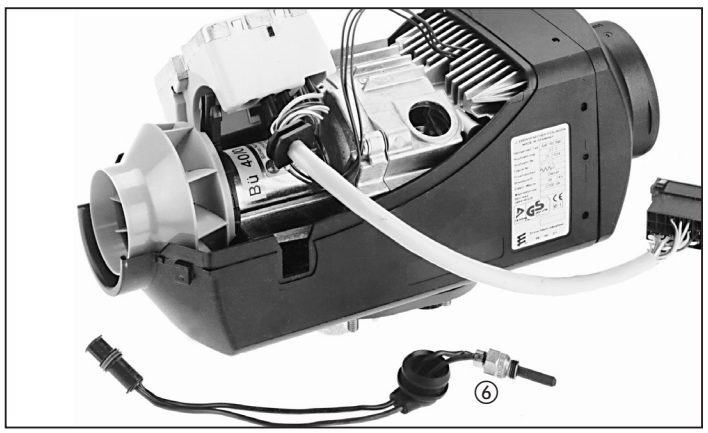
- Remove the Airtronic Cover and ECU

Glow pin:

1 Ensure the connector for glow pin cable is disconnected from the ECU
2 Remove the rubber grommet and use a special tool to unscrew the glow pin. Use extreme care while removing glow pin. (Tightening torque of the glow pin: 6 +0.5 Nm (50 in. lb)
3 Inspect the glow pin for any thermal or mechanical stress. Measure its resistance value and amperage draw. (page 90). Replace if necessary.

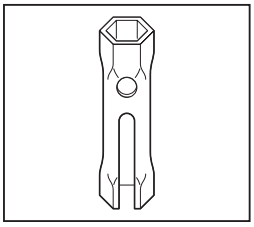
PLEASE NOTE!

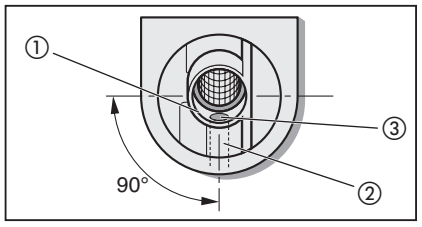
- For part numbers of glow pin and tools, please see page 94.
- Ensure the position of the screen and check its condition, replace if the surface is covered with carbon.
- It is recommended to always replace the atomizing screen along with the glow pin.



ATOMIZING SCREEN:

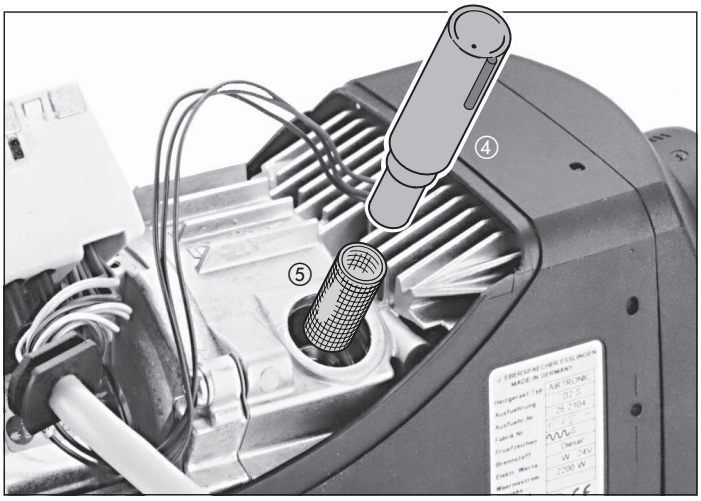
1 Pull the screen out using pointed (needle) pliers or blow it out using compressed air. If necessary, carefully pierce with a wire. Ensure extreme care while removing the screen (Use the PPE for eye protection).
2 Inspect the screen for excessive carbon, deformation or cracks. Replace it if necessary.
3 Use a special tool for the atomizing screen installation purpose as shown in the image. Ensure the location of the screen while pushing it in the glow pin chamber. (The new style screen is shorter and has no reference for location; however ensure the special tool is completely seated when installing screen.





PLEASE NOTE!

- Clean up the vent holes in the glow pin chamber using cleaning brush as shown in the page 96. Excessive carbon in the glow pin chamber describes improper operation of the heater due to uneven fuel/air ratio or ignition issue.



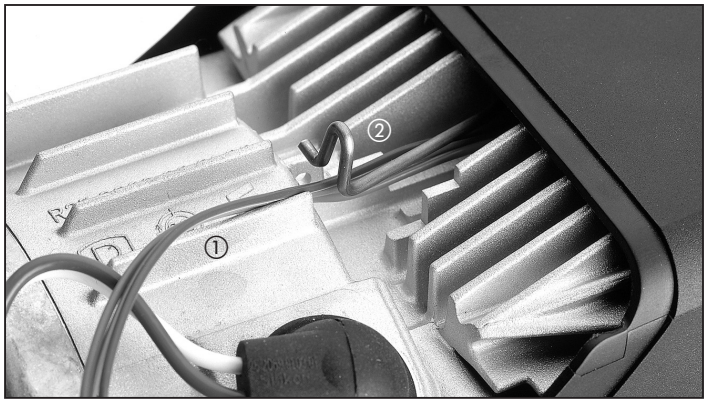
① Screen
② Bore (Ø 2.7 mm) for glow pin ventilation
③ Vent Hole (Must be cleaned with wire)
Allow riveted section to be placed in such a way as to not block the vent more.
④ Special tool
⑤ Position of recess
⑥ Glow pin with harness

Step 4. Overheat sensor and Flame (combo) sensor

Removal:

- Remove the Airtronic cover, and ECU

1 Ensure all connectors for combo sensor cable are disconnected from ECU
2 Unlock the clip from sensor and remove it.
3 Carry out visual inspection for any thermal, electrical or mechanical damage. Measure resistance values of combo sensor using steps and values provided on page no.

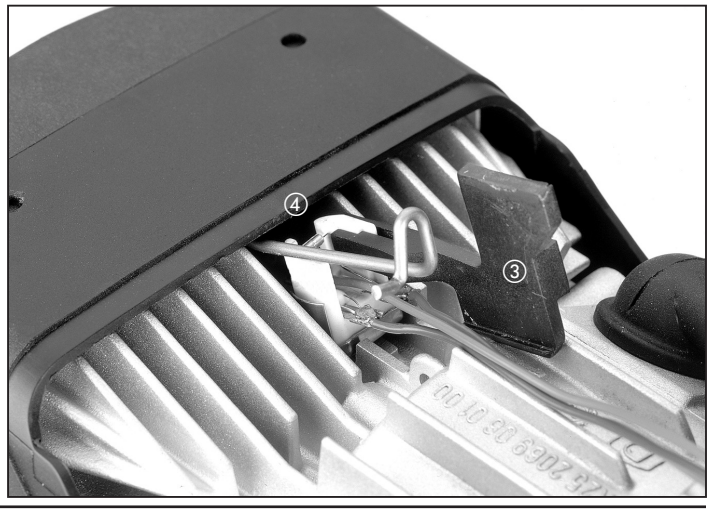


Installation:

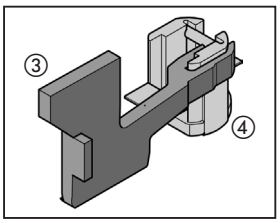
1 For Airtronic D2, use a special tool for installation of combo sensor ensuring its location and orientation as shown in the image. For part number of combo sensor and tool, please see page
2 For Airtronic D4, the installation location for sensor is easily accessible; therefore, special tool is not necessary. Ensure the sensor mounting position and orientation as shown in the image.
3 After positioning the sensors on its sit, lock them carefully by a clip. If necessary, use appropriate tool for visual inspection.
4 route the cable harness along the clip eyelet to the control unit and connect.

PLEASE NOTE!

- Ensure that the sensor is not placed upside down: otherwise unexpected heater operation or frequent overheating is possible. (it is also called as improper installation for warranty purpose)
- Make sure the connectors are seated properly on the ECU.



① Cable harness for overheat/flame sensor
② clip
③ Special tool - only for *AIRTRONIC* D2
④ Overheat sensor / flame sensor



Step 5. Blower motor

- Remove Airtronic cover, and the ECU

1 Remove flange seal and pull the heater out from its cover (bottom part).
2 Remove 4 fastening screws and pull blower section out from heat exchanger section
3 Perform blower motor visual inspection, Check for any thermal, electrical or mechanical damage. Check the condition and location of the magnet located behind the combustion air fan. Test the fan for its free rotation.
4 Test the blower using values and steps provided on page # 81, replace if necessary.
5 Replace the gasket during the blower repair or replacement.

PLEASE NOTE!

- Tightening torque for fastening screws is 4 +.5 N m (35 in.lb)
- Replace the gasket during the blower repair or replacement.
- Wear marks on the compartment fan describes improper installation or abuse. Also, the availability of shoot inside the combustion fan shows possible blockages in the flame chamber or exhaust pipe.

Step 6. Heat exchanger

- Remove the Airtronic cover, ECU and blower motor

1 The heat exchanger is removed along with blower motor.
2 Carry out visual inspection of the heat exchanger (check for any signs of cracks, micro fracture, burn marks, and shoot).
3 It is mandatory to replace the heat exchanger every 10 years regardless of its condition.

Step 7: Flame (combustion) chamber

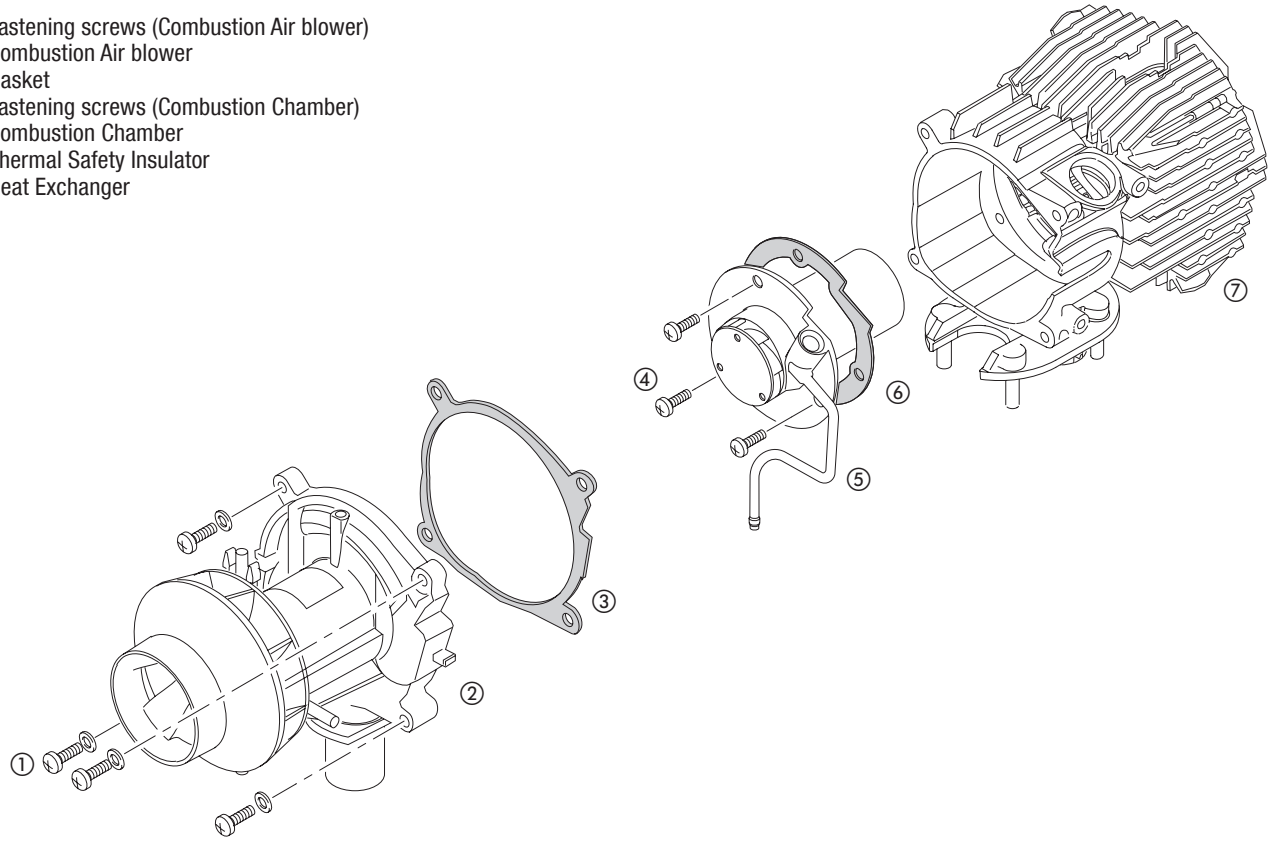
- Remove Airtronic cover, ECU, blower motor to access the heat exchanger section

1 For Airtronic 2 : Remove 3 fastening screws and pull out the flame chamber to the front
2 For Airtronic 4 : Remove 4 fastening screws and pull out the flame chamber to the front
3 Remove the thermal safety insulator (seal) from combustion chamber
4 Carry out visual inspection for any signs of thermal or mechanical stress, corrosion, or shoot. Remove any type of contamination from the heat exchanger as well as combustion chamber from its interior areas and unblock the air slots and holes using dry rug and light brush.

PLEASE NOTE!

- The tightening torque of the fixing screw is 5 +.5 Nm (44 in.lb)
- It is mandatory to replace the thermal safety insulator (seal) during combustion chamber repair or replacement.
- It is sometimes necessary to replace the combustion chamber, if a heavy contamination has found in the interior portion. It is necessary to find the underlaying cause behind such issue.

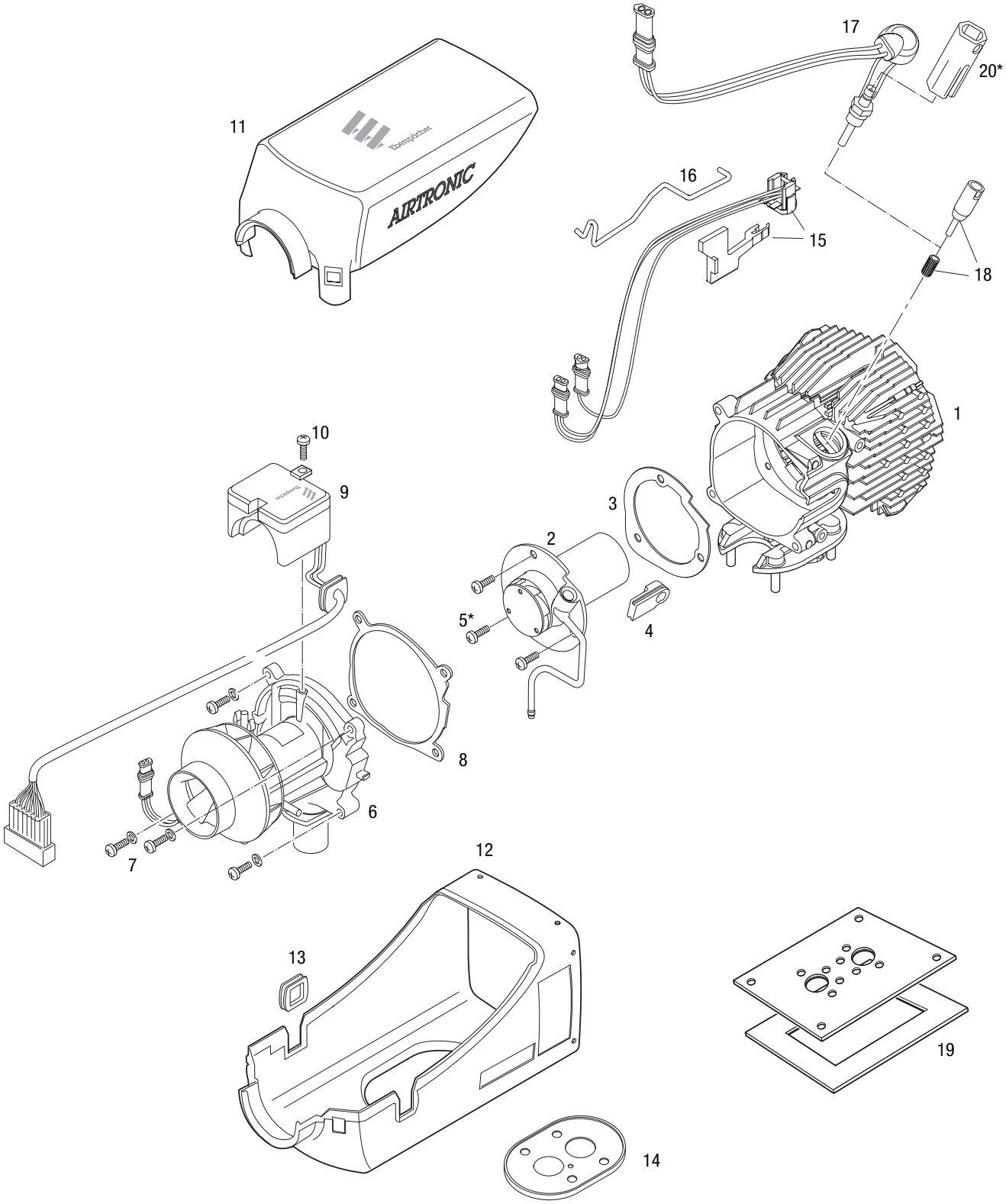
① Fastening screws (Combustion Air blower)
② Combustion Air blower
③ Gasket
④ Fastening screws (Combustion Chamber)
⑤ Combustion Chamber
⑥ Thermal Safety Insulator
⑦ Heat Exchanger



PLEASE NOTE! Holes in heat exchanger that fasten the burner tube are not tapped. When fastening a burner to a new heat exchanger it is recommended to use new screws.

8 Heater Parts

AIRTRONIC D2 / /D3 / B /D4
SERVICE PARTS DIAGRAM



For Illustration purpose only

AIRTRONIC D2 / B / D4

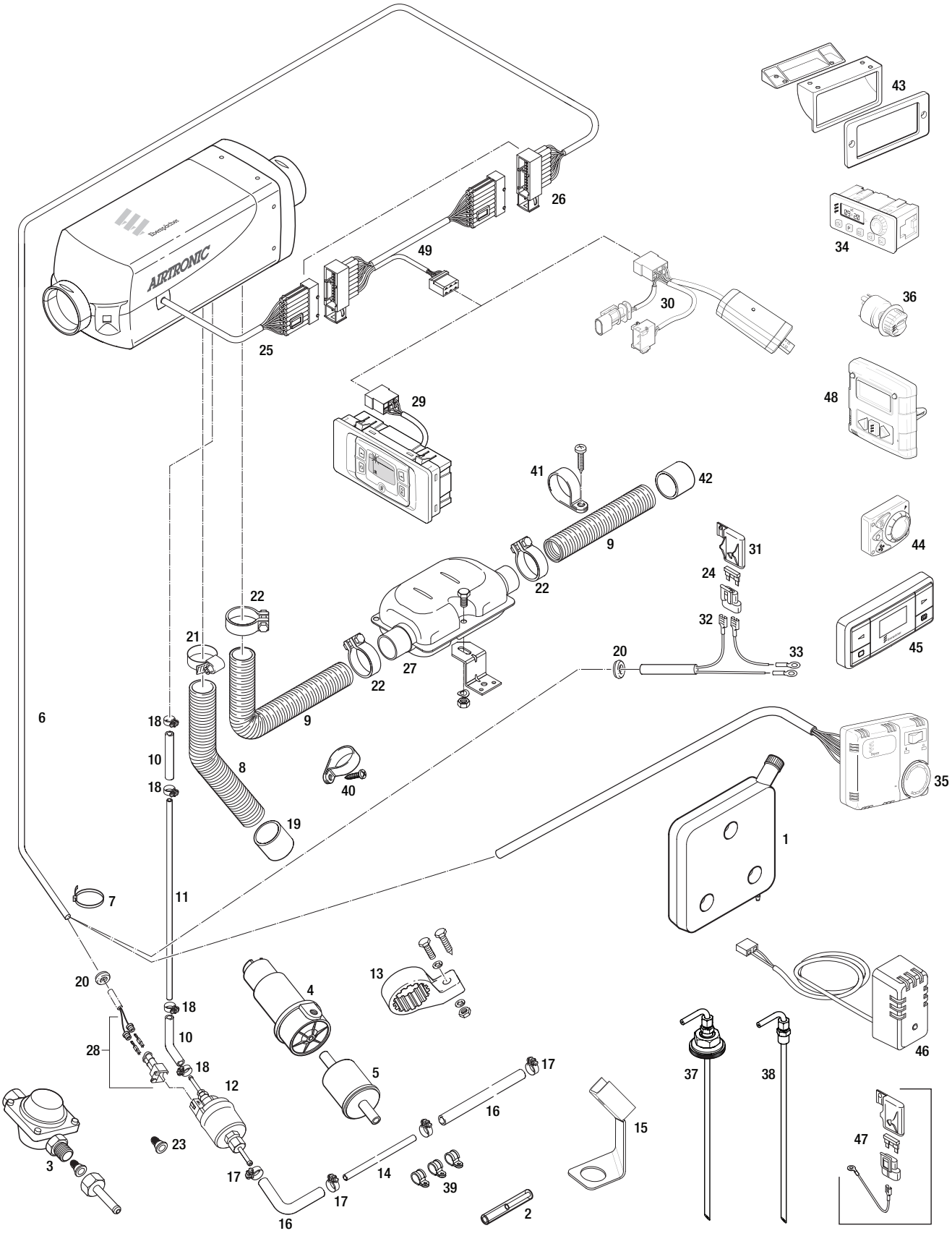
DESCRIPTION & PART #'S

Ref. No.	Description		Part Number	Model # 20 1812 05 12V	25 2069 05 12V	25 2070 05 24V	25 2326 05 12V	25 2113 05 12V	25 2114 05 24V	25 2144 05 12V	25 2327 05 12V
1	Heat exchanger		25 2069 06 01 00		•	•	•				
			25 2113 06 01 00	•				•	•	•	•
2	Burner		25 2069 10 01 00		•	•	•				
			25 2113 10 01 00					•	•	•	•
			20 1812 10 01 00	•							
3	Thermal insulator for burner		25 2069 06 00 01		•	•	•				
			25 2113 06 00 01	•				•	•	•	•
4	Grommet		25 2069 06 00 02	•	•	•	•	•	•	•	•
5	Fillister head bolt, M 5 x 12 (3 required)		103 10 348		•	•	•				
	Fillister head bolt, M 5 x 12 (4 required)		103 10 348	•				•	•	•	•
6	Blower motor	12V	25 2069 99 20 00		•		•				
		24V	25 2070 99 20 00			•					
		12V	25 2113 99 20 00	•				•			
		24V	25 2114 99 20 00						•		
		12V	25 2144 99 20 00							•	•
7	Fillister head bolt, M 5 x 25	Locally available hardware		•	•	•	•	•	•	•	•
8	Gasket, blower		25 2069 01 00 03		•	•	•				
			25 2113 01 00 03	•				•	•	•	•
9	Control unit	24V	22 5102 00 30 01			•					
	(For OEM ECU's Please contact your dealer directly)	12V	22 5101 00 30 05					•			
		24V	22 5102 00 30 03						•		
		12V	22 5101 00 30 06							•	
		12V	22 5101 00 30 01				•				
		12V	22 5101 00 30 14								•
		Hella 12V	22 5101 00 30 01		•						
		Hella 12V	22 5101 00 30 05					•			
			22 5101 00 30 15	•							
10	Fillister head bolt, M 4 x 10		103 10 349	•	•	•	•	•	•	•	•
11	Upper casing		25 2069 01 06 00		•	•	•				
			25 2113 01 00 01	•				•	•	•	•
12	Lower casing		25 2069 01 01 00		•	•	•				
			25 2113 01 01 00	•				•	•	•	•
13	Grommet		25 2069 01 00 01	•	•	•	•	•	•	•	•
14	Flange seal		25 2069 01 00 02	•	•	•	•	•	•	•	•
15	Overheat sensor / Flame sensor with tool		25 2069 01 02 00	•	•	•	•	•	•	•	•
16	Clip		25 2069 01 02 02		•	•	•				
			25 2113 01 02 02	•				•	•	•	•
17	Glow pin with socket wrench	12V	25 2069 01 13 00	•	•		•	•		•	•
		24V	25 2070 01 11 00			•			•		
18	Glow pin screen with tool		25 2069 10 01 02	•	•	•	•	•	•	•	•
19	Mounting plate with hardware and seal		5540001	•	•	•	•	•	•	•	•
20	Glow pin wrench *		25 2069 01 03 03	•	•	•	•	•	•	•	•

* This tool is designed for occasional usage. If heavy use is anticipated, more appropriate tools are available from tool manufacturers.
Recommended: Snap-On Flare nut socket 12mm Stock # FRXM12

8 Heater Parts

AIRTRONIC D2 / D3 / B / D4
PARTS LIST DIAGRAM



For Illustration purpose only

AIRTRONIC D2 / B / D4

DESCRIPTION & PART #'S

Ref. No.	Description		Part Number	Model # 20 1812 05 12V	25 2069 05 12V	25 2070 05 24V	25 2113 05 12V	25 2114 05 24V
1	Plastic fuel tank (10L or 2.6 gal - blue)		22 1000 20 28 00	•			•	•
2	Fuel line adapter	ø 3.5 -5 mm	25 1888 80 01 02	•			•	•
3	Pressure reducer		22 1000 20 08 00	•			•	•
4	Auxiliary fuel pump 24 V		25 1226 89 83 00	•			•	•
5	Plastic fuel filter (in front of auxiliary pump)	ø 60	25 1156 20 00 09	•			•	•
6	Main harness		20 2900 70 03 91	•	•	•	•	•
	Short harness		20 2900 70 02 05	•	•	•	•	•
7	Cable ties (197mm)		5590003	•	•	•	•	•
8	Air intake (1 meter)	ø 25 mm	360 00 006	•	•	•	•	•
9	Flexible exhaust (1 meter)	ø 24 mm	25 1774 80 02 00	•	•	•	•	•
10	Fuel hose - rubber 3.5 mm		360 75 300	•	•	•	•	•
11	Plastic fuel line 1.5 mm		890 31 118	•	•	•	•	•
12	Fuel metering pump	12V	22 4519 01 00 00	•	•		•	
		24V	22 4518 01 00 00			•		•
13	FMP holder for noise reduction		22 1000 50 03 00	•	•	•	•	•
14	Plastic fuel line - black	2 mm	890 31 125	•	•	•	•	•
15	Angle bracket		20 2900 40 0104	•	•	•	•	•
16	Fuel hose - rubber 5 mm		360 75 350	•	•	•	•	•
17	Clamp	11 mm	10 2068 01 10 98	•	•	•	•	•
18	Clamp	9 mm	10 2068 00 90 98	•	•	•	•	•
19	End sleeve with cross bar - 25mm plastic		25 1729 89 00 02	•	•	•	•	•
20	Grommet		20 1280 09 01 03	•	•	•	•	•
21	Intake hose clamp	ø 20-32	10 2066 02 00 32	•	•	•	•	•
22	26-28mm exhaust clamp w/nut	26 mm	152 61 102	•	•	•	•	•
23	Integrated fuel filter		20 1312 00 00 06	•	•	•	•	•
24	Blade fuse	20 amp	5670055	•	•		•	•
		10 amp	5670056			•		•
25	Housing set male D2/4 air htr		22 1000 31 80 00	•	•	•	•	•
26	Housing - Kit female		22 1000 31 81 00	•	•	•	•	•
* 27	Exhaust muffler 24mm		25 1864 81 01 00	•	•	•	•	•
28	Connectors for fuel metering pump - Kit		22 1000 31 87 00	•	•	•	•	•
29	Fault code retrieval device		20 2900 70 50 60	•	•	•	•	•
30	Eberspaecher Universal Diagnostic Tool (EUDT)		20 2800 70 12 00	•	•	•	•	•
		ø 75	25 1482 89 00 05	•	•	•	•	•
31	Fuse holder with terminals		5670051	•	•	•	•	•
32	Terminals		5670199	•	•	•	•	•
33	3/8' Ring terminals 10-12 AWG		5670178	•	•	•	•	•
* 34	7 day timer		22 1000 30 40 00	•	•	•	•	•
35	Thermostat	12V	5670097	•	•		•	
		24V	5670096			•		•
* 36	Rheostat Switch	12V	25 1895 71 00 00	•	•		•	
		24V	25 1896 71 00 00			•		•
37	Standard fuel pick up pipe	2 mm	20 2900 20 20 10	•	•	•	•	•
* 38	Fuel pick up pipe (Compression fitting type)	2 mm	20 2900 20 20 42	•	•	•	•	•

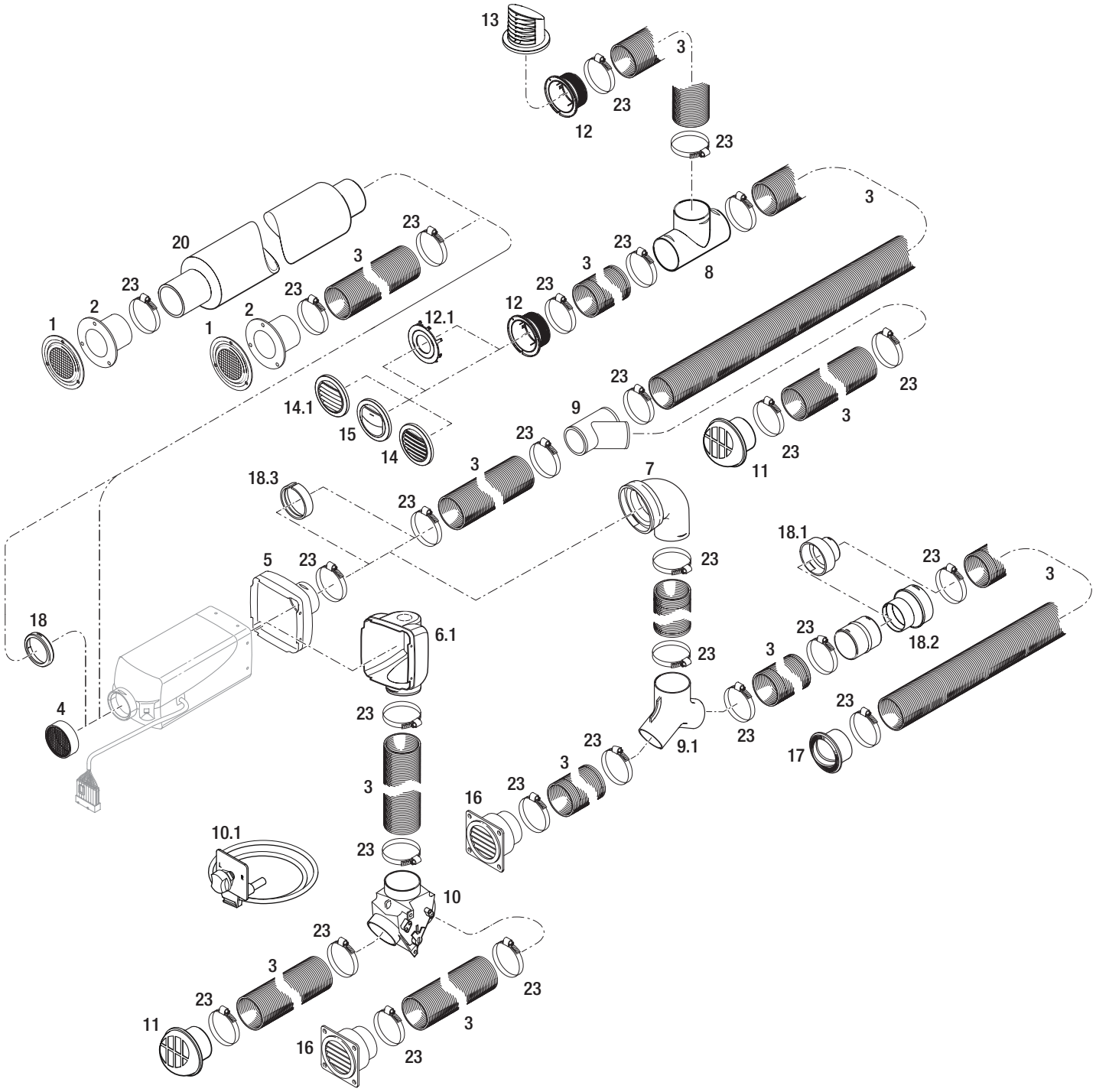
AIRTRONIC D2 / B / D4

DESCRIPTION & PART #'S

Ref. No.	Description		Part Number	Model # 20 1812 05 12V	25 2069 05 12V	25 2070 05 24V	25 2113 05 12V	25 2114 05 24V
* 38a	Compression fittings	1/4" NPT	20 2900 20 20 44	•	•	•	•	•
		3/8" NPT	5520002	•	•	•	•	•
		1/2" NPT	5520006	•	•	•	•	•
39	P-clamp w/Lining	10 mm	152 00 139	•	•	•	•	•
40	P-clamp	25 mm	152 10 048	•	•	•	•	•
41	P-clamp	28 mm	152 09 010	•	•	•	•	•
42	End-sleeve 24 mm		25 1482 80 00 01	•	•	•	•	•
43	Bezel kit for 7 day timer		25 1482 70 01 00	•	•	•	•	•
44	Mini Controller		22 1000 32 07 00	•	•	•	•	•
45	EasyStart Timer		22 1000 34 15 00	•	•	•	•	•
46	Ext Temp Sensor		25 1774 89 03 00	•	•	•	•	•
47	Fuse link power harness		20 2900 70 51 08	•	•	•	•	•
48	Digi-Max Controller		20 2800 70 15 00	•	•	•	•	•

* = indicates optional features

AIRTRONIC 2 / 4
DUCTING COMPONENTS DIAGRAM



For Illustration purpose only

AIRTRONIC 2 / 4 - DUCTING COMPONENTS PARTS LIST

DESCRIPTION & PART #'S

Ref. No.	Description		Part Number	Model # AIRTRONIC 2	Model # AIRTRONIC 4
1	Grill (Inlet & Outlet)	60 mm (2.4")	22 1000 01 00 01	•	•
		90 mm (3.5")	20 1465 89 05 00	•	•
		140 mm (5.25")	25 1729 89 00 05	•	•
		Nickel Plated Open Screen, 140 mm (5.25")	25 1226 89 05 00	•	•
2	Ducting Flange (Connecting Socket)	for Duct Size 50 mm (2")	20 1575 80 08 01	•	•
		for Duct Size 60 mm (2.4")	20 1577 89 06 01	•	•
		for Duct Size 90 mm (3.5")	20 1297 00 00 01	•	•
		for Duct Size 100 mm (4")	25 1226 89 00 40	•	•
3	Flexible Air Hose (aluminum, paper, plastic)	di = 60mm (2.4")	10 2114 31 00 00	•	•
3a		di = 75mm (3.0")	10 2114 34 00 00	•	•
		di = 90mm (3.5")	10 2114 37 00 00	•	•
3a	Flexible Hose	di = 75 mm or 3.0"	5550007	•	•
3.1		di = 100 mm or 4.0"	5550008	•	•
4	Protective Grill (Heater)	d = 60 mm (2.4")	25 1688 80 06 00	•	
		d = 75 mm (3")	25 1552 05 01 00	•	•
		d = 90 mm (3.5")	25 1729 80 00 01		•
5	Straight Air Outlet Hood	d = 60 mm (2.4")	22 1000 01 00 16	•	
		d = 75 mm (3.0")	22 1000 01 00 17	•	
		d = 75 mm (3.0")	22 1000 01 00 18		•
		d = 90 mm (3.5")	22 1000 01 00 19		•
6.1	Ball-shaped scoop	di = 60 mm Outlet	22 1000 01 00 20	•	
		di = 75 mm Outlet	22 1000 01 00 22		•
		di = 90 mm Outlet	22 1000 01 00 23		•
7	90° Bend,	di = 60 mm	25 1688 89 00 01	•	
	Plastic Elbow	di = 75 mm	25 1482 89 00 05		•
8	Plastic "T" Piece	d = 60 mm (2.4")	25 1688 89 00 02	•	
		d = 75 mm (3.0")	22 1000 01 00 27	•	•
		d = 90 mm (3.5")	22 1000 01 00 26		•
9	45° Plastic "Y" Connector	d = 75 mm or 3", L = 175 mm	25 1226 89 00 44	•	•
		d = 100 mm or 4", L = 230 mm	25 1226 89 00 45		•
		d = 60 mm or 2.4", L = 145 mm	25 1774 89 00 05	•	
		d = 90 mm or 3.5", L = 180 mm	22 1000 01 00 21	•	•

AIRTRONIC 2 / 4 - DUCTING COMPONENTS PARTS LIST

DESCRIPTION & PART #'S

Ref. No.	Description		Part Number	Model # AIRTRONIC 2	Model # AIRTRONIC 4
9.1	Symmetrical "Y" Piece	Plastic, D = 60 mm, d =50 mm	25 1688 89 00 03	•	
		Metal, D = 75 mm, d =50 mm	25 1482 80 08 00	•	•
		Plastic, D = 75 mm, d =60 mm	22 1000 01 00 82	•	•
		Plastic, D = 90 mm, d =60 mm	22 1000 01 00 83	•	•
		Plastic, D = 90 mm, d =75 mm	22 1000 01 00 84		•
10	Butterfly Valve with regulating flap	60 mm	330 00 174	•	
	(Requires operating cable)	90 mm	330 00 175		•
10.1	Operating Cable for Butterfly Valve		22 1000 01 03 00	•	•
11	Outlet Grill with Connecting Piece	d = 60 mm or 2.4"	20 2800 50 02 00	•	•
12	Ducting Flange (Plastic connecting piece)	ø 60 mm, black	22 1000 01 00 35	•	•
	For vents, Items: 11, 12, 13 and 14	ø 75 mm, black	22 1000 01 00 36	•	•
		ø 90 mm, black	22 1000 01 00 37	•	•
12.1	Air Control Element (2 position)				
		* for fitting, order no. 22 1000 01 00 35 - Plastic, ø 60 mm	22 1000 01 00 79	•	•
		** for fitting, order no. 22 1000 01 00 36 - Plastic, ø 75 mm	22 1000 01 00 80	•	•
		*** for fitting, order no. 22 1000 01 00 37 - Plastic, ø 90 mm	22 1000 01 00 81	•	•
13	90° Upright Vent				
	(Rotatable)	Suitable for ø 50/60 mm fitting, black)	22 1000 01 00 64	•	•
		Suitable for ø 75/90 mm fitting, black)	22 1000 01 00 68	•	•
14	30° Outlet Screen (Flat)	Suitable for ø 50/60 mm fitting, black)	22 1000 01 00 44	•	•
	(Rotatable)	Suitable for ø 75/90 mm fitting, black)	22 1000 01 00 52	•	•
14.1	0° Outlet Screen (Flat) (For 75/90mm flange)	Suitable for 75/90 mm fitting, black)	22 1000 01 00 48	•	•
15	Outlet Screen Closable (Rotatable)	Suitable for ø 50/60 mm fitting, black)	22 1000 01 00 72	•	•
	see Ducting Flange (Plastic) for fitting	Suitable for ø 75/90 mm fitting, black)	22 1000 01 00 76	•	•
16	Outlet Vent with Flange	d1 = 90, d2 = 100 mm or 3.5-4")	20 1609 80 09 00		•
	(Rotatable)	d1 = 75, d2 = 100 mm or 3-4")	22 1050 89 21 00	•	•
17	French Vent with Flange (Closable)	(75 mm or 3" Ducting)	330 31 311	•	•
18	Adapter Ring	di = 60 mm, da = 75 mm	22 1000 01 00 08	•	
		di = 75 mm, da = 90 mm	25 1822 89 00 01	•	•
		di = 90 mm, da= 100 mm	20 1607 80 00 01		•
18.1	Plastic Reducer for "Y" or Ducting Union	di=100 mm (4"), da=75 mm (3"), L=50 mm	25 1226 89 00 47	•	•
		di = 75 mm (3"), da = 60 mm (2.4"), L = 45 mm	25 1226 89 00 50	•	•

AIRTRONIC 2 / 4 - DUCTING COMPONENTS PARTS LIST

DESCRIPTION & PART #'S

Ref. No.	Description		Part Number	Model # AIRTRONIC 2	Model # AIRTRONIC 4
18.2	Plastic Reducer	di = 60 mm, da = 75 mm, L = 40.5 mm	25 1688 89 00 10	•	
18.3	Hood Adapter	(black plastic) di = 90 / 100 mm or 3.5" / 4"	20 1607 80 00 01		•
		d = 100 mm (4")	20 2900 50 20 02		•
19	Ducting Union, straight	d = 60 mm (2.4")	22 1000 01 00 05	•	•
		d = 75 mm (3")	22 1000 01 00 06	•	•
		d = 90 mm (3.5")	22 1000 01 00 24		•
		d = 100 mm (4")	22 1000 01 00 07		•
20	Air Silencer (Inlet & Outlet)	75 mm (3")	25 1226 89 15 00	•	•
		100 mm (4")	25 1226 89 56 00		•
23	Stainless Steel Hose Clamp	46-70 mm (60 mm or 2.4" Ducting)	5550004	•	•
		59-83 mm (75 mm or 3" Ducting)	5550002	•	•
		84-108 mm (100 mm or 4" Ducting)	5550003		•

WARRANTY

The product warranty is a part of the quality service and support for Eberspaecher NA products to ensure customer satisfaction.
Normally, the warranty period for Airtronic 2/4 heater is 2000 hours/2 years (whichever comes first).
Refer warranty manuals :

- Warranty Manual
- Basic Repair Analysis (Airtronic D2/4)
- Diagnostic and Repair manual (Airtronic D2/4)
- Web link: http://www.eberspaecher-na.com/warranty/warranty.html

It is mandatory to use warranty related manual for authorized troubleshooting for warranty claim.

PLEASE NOTE!

- The heater must be installed within 1 year of its purchasing date to be eligible for warranty. Also, It is mandatory to notify the Eberspaecher NA by registering the heater within 30 days of installation.
- The warranty claim must be administered and performed by Eberspaecher NA authorized dealers only.
- Usage of EDiTH/Easy Scan for heater diagnostics reduces additional processing time for warranty.
- Regardless of the type and nature of the fault, the original ECU must be replaced at last. Contact Eberspaecher NA or authorized dealers for additional information.

CERTIFICATION

The high quality of 's products is the key to our success.
To guarantee this quality, we have organised all work processes in the company along the lines of quality management (QM).
Even so, we still pursue a large number of activities for continuous improvement of product quality in order to keep pace with the similarly constantly growing requirements made by our customers.
All the steps necessary for quality assurance are stipulated in international standards.
This quality is to be considered in a total sense.
It affects products, procedures and customer/supplier relationships.
Officially approved public experts assess the system and the corresponding certification company awards a certificate.

Eberspaecher has already qualified for the following standards:

Quality management as per
DIN EN ISO 9001:2000 and ISO/TS 16949:2009

Environment management system as per
DIN EN ISO 14001:2004

HEALTH AND SAFETY

Eberspacher North America gives utmost importance to workplace health and safety and abides by highest standards possible:

Health and Safety
ISO/TS 16949:2009

DISPOSAL

Disposal of materials

Old devices, defect components and packaging material can all be separated and sorted into puregrade factions so that all parts can be disposed of as required in an environment-friendly manner or recycled where applicable.
Electric motors, controllers and sensors (e.g. temperature sensors) are deemed to be “electronic scrap”.

Dismantling the heater

The heater is dismantled according to the repair stages in the current troubleshooting / repair instructions.

Packaging

The packaging of the heater can be kept in case it has to be sent back.

CONTACT US:

Eberspaecher North America (ESPAR)

6099A Vipond Dr., Mississauga
Ontario L5T 2B2
Canada

Phone number: 905-670-0960/800-387-4800
Website: http://www.eberspaecher-na.com/
Technical page: http://www.eberspaecher-na.com/download-center.html
Warranty page: http://www.eberspaecher-na.com/warranty/warranty.html

www.eberspaecher.com

Espar Products, Inc.
(800) 387-4800
(905) 670-0960
(905) 670-0728 Fax
www.eberspaecher-na.com

Eberspächer

20-2900-81-01-03-0I Version 08/2016 Subject to change without notice. Printed in Canada.