OXITEC® 5000

O_2 Analyser System
with SME 5 Electronics

Installation & Operating Manual

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ENOTEC GmbH
Process and Environmental
Measuring Technology

DIN EN ISO 9001

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13. BImschV and 17. BImschV

CE

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Introduction

Dear customer,

Thank you for selecting our OXITEC® 5000 as your InSitu Flue Gas Oxygen measuring system.

For many years now, our OXITEC® oxygen analyser systems have been operating in numerous applications with some 1000 units being produced and shipped around the world. ENOTEC are committed to total quality and performance and we have continuously enhanced our products to integrate various additional features and functions. In this package, the electronics uses the very latest Microprocessor Technology, making the SME5 electronics one of the most advanced and up-to-date monitoring units, permitting you to reduce your maintenance & fuel costs, and to achieve increased measuring accuracy with more operational reliability using these new monitoring functions.

In our oxygen measuring probes you will find that the Zirconium Oxide measuring cell is soldered in place using a special process and technique developed by our company. This results in a considerably increased service life compared to "glued or cemented" measuring cells, which have a tendency to leak or crack during operation. The OXITEC® cell is a proven gas-tight design, providing greater measuring accuracy, durability and longer working life.

All ENOTEC instruments are thoroughly tested in the factory and are subject to a strict ISO 9001 Quality Assurance procedure. Therefore, with the correct installation, the operation of the OXITEC®5000 oxygen analyser system is very easy and user friendly and will provide you with many years of operation with perfect measuring results.

Please read this manual carefully and follow the instructions as directed. If you have any questions, or you are unclear about any aspect of the installation or operation, our Service Department, regional sales offices or approved distributors will be pleased to assist. The factory contact points are Tel: +49 2264-45780 or Fax: +49 2264 457831. You may also visit us at our website www.enotec.de or www.enotec.com or contact us by e-mail: info@enotec.de, or enotec.uk@enotec.com within UK, or enotec.inc@enotec.com for North America, or Enotec@singnet.co.sg within Asia.

Marienheide, 20 December 2005
Dipl.-Ing. Fred Gumprecht
Managing Director
ENOTEC GmbH

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1 Instructions for the Operator

1.1 Warranty

E N O T E C

2 Y E A R W A R R A N T Y

ENOTEC warrants that the equipment manufactured and sold by it will, upon shipment, be free of defects in workmanship or material. Should any failure to conform to this warranty become apparent during a period of two years after the date of shipment, ENOTEC shall upon prompt written notice from the purchaser, correct such nonconformity by repair or replacement of the defective part or parts. The purchaser is not entitled to claim any other legal remedies on the basis of this warranty. Please refer to the complete ENOTEC warranty policy for details.

ENOTEC does not warrant equipment supplied by it against normal deterioration. Corrosive gases and solid particles may cause damages and make a repair or a replacement necessary as a consequence of normal wear and tear during the warranty period.

Note: When installing the equipment, the customer must ensure that all necessary supply lines are connected and the operating temperature of the probe is reached. Experience has shown that products installed but not taken into operation may be damaged by the process or by external influence. ENOTEC will not accept any responsibility for such damages.

In the case of combination of ENOTEC products with non-ENOTEC products, which are not approved by ENOTEC, any warranty claim is invalid.

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1.2 Declaration of EC-Conformity

ENOTEC GmbH
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51709 Marienheide/Rodt
Germany

CE Mark - Conformity
to EC Directive Electromagnetic Compatibility 89/336/EEC

We declare that the OXITEC® Oxygen Analyser System as detailed below as well as the type sold by us, is designed and constructed to comply with the relevant basic safety and health requirements of the EC Directive. This declaration becomes invalid if the product is modified without our prior consent.

Identifier:	OXITEC® Oxygen Analyser System
Electronics Type:	OXITEC 5000 - SME 5
Relevant EC-directives:	EC Low-voltage Directive (73/23/EEC) EC Directive Electromagnetic Compatibility (89/336/EEC) EC Directive Product Liability (85/374/EEC)
Applied harmonised generic standards:	EN 50082-2 1995 Resistance to interference EN 55011 Cl.B 1992 Emission
Applied standards and technical specification, in particular:	EN 61000-4-2 ESD EN 61000-4-3 Irradiation E-field EN 61000-4-4 Burst EN 61000-4-6 Inflow EN 61000-3-2 Current Harmonics EN 61000-3-3 Flicker EN 61326-1 Immunity partly
Date / Manufacturer's signature:	20 December 2005 signed Fred Gumprecht
Position:	Managing Director

1.3 Information on the CE-Certification

After having completed and successfully passed EMC-tests, the complete ENOTEC analyser system - consisting of oxygen measuring probe, electronics and special probe cable - has a conformity certificate.
If parts of this system are operated with products not supplied or approved by ENOTEC, the CE-conformity is no longer valid.

Likewise, all warranties are void if the system is operated in a configuration not authorized by ENOTEC!

Note

The enclosed ferrite sleeves must be placed over the terminal leads of the cable (see chapter 7.9 on page 36). The CE-conformity is void if these ferrite sleeves are not fitted!

Note

The ground (Earth) connection must be installed thoroughly using the correct cable of at least 1,5mm² minimum. It is very important that the equipotential bonding is installed correctly.

Please note that some electrical devices (e.g. frequency converter etc.) close to the system can create considerable electrical disturbance and instability. So for normal function of the OXITEC® 5000 system it is important that these devices be installed away from the system and in accordance with the manufacturer's installation notes and guidelines.

Please do not lay the probe cable near power supply cables, or near motors and their cables, as frequency converters control them and this could cause interference effects. If possible, do not cross the cables because this could also cause interference effects. However, if this is unavoidable please make sure that these cables are only crossed at right angles.

1.4 Notes on this Document

This document describes the design, installation, commissioning, operation, maintenance and troubleshooting for the OXITEC® 5000 InSitu analyser system.

Only authorized, qualified personnel may work on this equipment. These personnel must be familiar with all warnings, safety references and maintenance tasks in accordance with this instruction manual. The reliable and safe use of this equipment assumes appropriate transport, professional storage and installation as well as care with operation and maintenance.

1.5 Symbols used in this Document

Important information as well as safety instructions are emphasised by the below-mentioned symbols. Please make sure that all safety advices and warnings are observed at all times.

Note

Points out important information, which should be particularly noted.

Important

Warns of the risk to destroying the system or components or reducing its function.

Warning

Warns of dangers, which emerge by inappropriate handling, and which can result in death, bodily harm and/or substantial property damage.

Warning – Hot Surface

Warns of the danger of burns, which could occur from hot system parts.

2 Intended Use

Note

The OXITEC® 5000 analyser system is a system for measuring the oxygen concentration in flue gases and other non-combustible gases. For reasons of safety and the possibility of accidents, unauthorized conversions and modifications of the system are prohibited.

Warning

The system must not be used to determine the oxygen concentration of combustible gases or in a location where combustible gases are present as the measuring cell temperature of 840°C could present an explosion hazard!

3 Hazardous Area ATEX Certified Options

OXITEC® 5000 Oxygen Analyser Systems are available in an explosion-proof design for Zone-1-installation. The SME5 Electronic Unit is ATEX Certified II 2G EExd IIC T6/IP66. And the KEX500X Probe is ATEX Certified II 2G EExd IIC T3.

4 Safety Instructions for the Operation of OXITEC® 5000 Analyser System

4.1 General Safety Instructions

The OXITEC® 5000 analyser systems may only be operated by authorized trained skilled persons. For reasons of immunity to interference, it must be ensured that the connection between the measuring probe and the electronic unit is only made using the special ENOTEC probe cable and pneumatic tubing.

The O_2 measuring probes supplied by ENOTEC may only be used with an ENOTEC Electronic Unit or with compatible electronics approved by ENOTEC. All probes are operated at 840°C (**Exception:** EExd electronics).

Important

Under no circumstance should the measuring probe be directly connected to the 230V main power supply, as this will immediately destroy the probe heater element!

4.2 Maximum Ambient Temperature

Important

The maximum ambient temperature for the electronic unit is 50°C (122°F) and for the probe terminal box 80°C (176°F). These ambient temperatures may not be exceeded in any circumstances. Please contact ENOTEC for other temperatures.

4.3 Corrosion

The probe may only be used in flue gases whose composition is not critical regarding the corrosive effect on the materials used. Where there is an increased risk of corrosion, regular checks at suitably short intervals are necessary.

4.4 Installation Notes

The probe/protection tube is installed into the wall of a flue gas duct. It may protrude into the combustion system up to the probe flange at maximum.

The connection box must remain outside the hot flue gas duct up to the probe flange. For high temperature applications, the probe is installed into the cool end of the gas cooling tube, outside the duct.

4.5 Safety Hazards

Warning – Hot Surface

During operation, the temperature of the probe filter head and of other parts exposed to flue gas is 150°C - 840°C (302°F - 1472°F). Direct contact with the hot parts when dismantling or maintenance will cause severe burns!

The probe may only be removed with heat-insulated gloves. Before removing the probe, always switch off the supply voltage of the electronic system. After removal, store the probe in save, protected place and wait until it has cooled downs below 35°C (95°F).

5 General System Description

5.1 Measuring Principle

The oxygen analysing system OXITEC® 5000 measures the net concentration of oxygen in the flue gas of combustion processes and other non-combustible gases.

The source voltage Uq (in former times called EMF for “electrical motive force”) is produced by a temperature-stabilised zirconium cell indicating the amount of oxygen concentration. Measurement is made direct and InSitu, i.e. the measuring cell is inside the flue gas duct at the probe end.

The measuring cell consists of a small zirconium-oxide disc about the size of a penny, which is coated with porous layers of platinum on both sides and soldered with a gas-tight seal, into the end of a steel tube cell holder. The temperature of the measuring cell is stabilised by a built-in heater whose temperature is kept constant by a temperature controller. At a constant temperature the mV-output of the cell is calculated as follows:

$$U_q = \frac{RT}{4F} \bullet \ln\left(\frac{P1}{P2}\right) + C_{[mV]}$$

Where:

P1 =	Oxygen partial pressure of the reference gas on the inside of the cell (e.g. Ref. air)
P2 =	Oxygen partial pressure of the process gas on the outside of the cell (Flue gas - O_2)
R =	Gas constant
F =	Faraday’s constant
T =	Absolute temperature = (273 + t °C)
$C_{[mv]}$ =	Cell constant – millivolt
Uq =	Source voltage

The reference gas (Instrument Air) is clean, dry and oil-free air (20.95% by volume O_2).

When different oxygen concentrations occur between the measuring and reference sides of the electrochemical cell, there is a migration of oxygen ions from the higher to the lower partial pressure side. The mV output signal of the cell is inversely logarithmically proportional to the oxygen content of the process gas. With reducing oxygen content in the process gas the mV signal of the measuring cell increases. With air on the process gas side, the ZrO_2-cell generates approx. 0 mV ±5 mV (cell constant) and with 2.1% O_2 approx. +50 mV (slope of the characteristic line or decade voltage).

The water content which exists in any flue gas, has an influence on the actual O_2 concentration, and is taken into account in this wet measuring process. The wet process provides a lower measuring value compared to the dry process, because it refers to the total volume. The difference between both values is in direct proportion to the water content in the flue gas.

5.2 Design of the OXITEC® 5000 Analyser System

Every OXITEC® 5000 analyser system consists of the measuring probe, which detects the oxygen partial pressure direct in the flue gas duct; the electrical connection cable; the pneumatic connection cable and the electronics unit. The following paragraphs explain the individual components in detail.

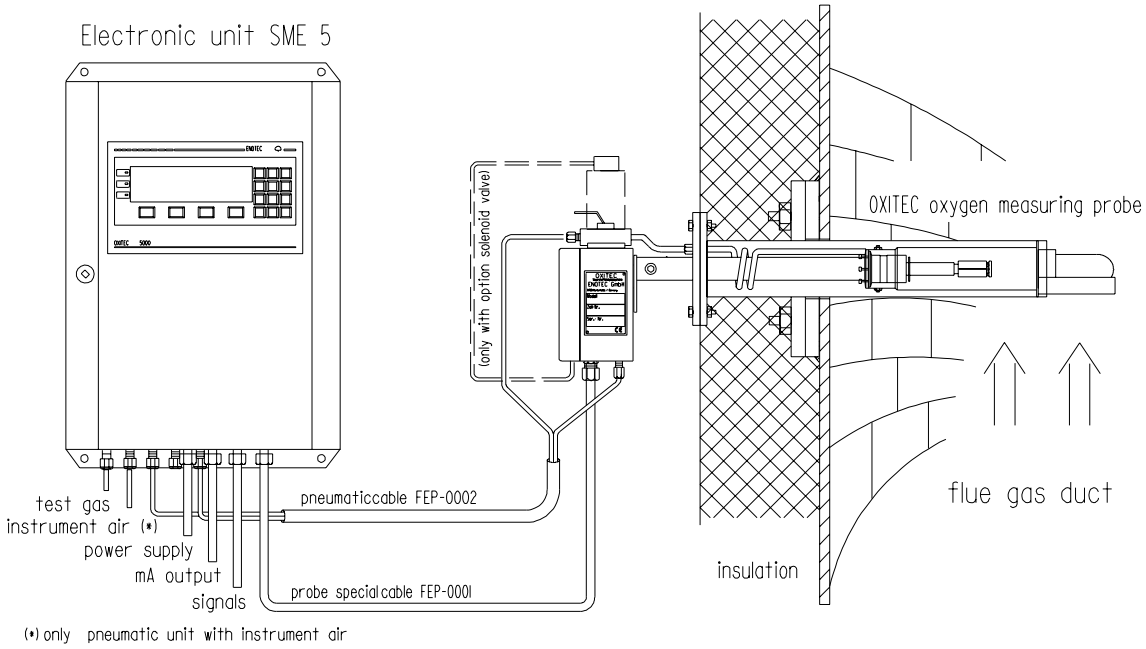


Figure 1 Design of the OXITEC® 5000 analyser system with O_2 probe

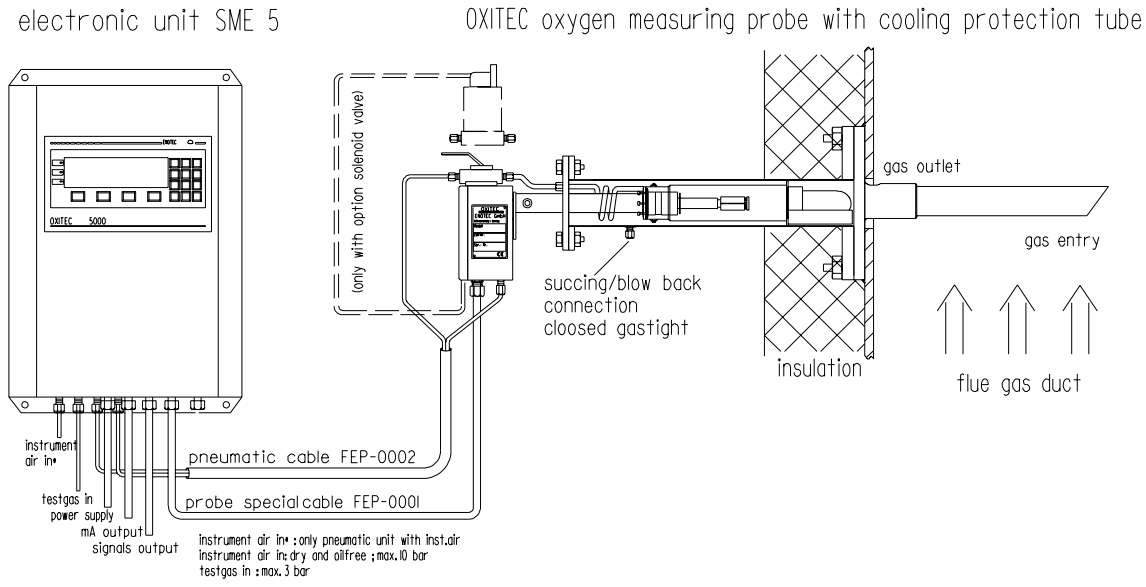


Figure 2 Design of the OXITEC® 5000 analyser system with O_2 probe with cooling protection tube

6 Description of the OXITEC® 5000 System Components

6.1 Design and Function of the Measuring Probe

The probe assembly consists of the connection box (ASK-...); the inner probe assembly part (SIK-...) complete with heater, thermocouple and signal wire; the measuring probe tube (MSR-...) with test gas line; the ZrO_2 measuring cell, the filter head and the protection tube (optional).

The connection box contains the electrical connectors for the measuring cell, the thermocouple, the probe heater, the solenoid valve and additionally the pneumatic connector for the reference air.

The probe tube with flange provides the negative pole and serves as protection for the positive measuring line and the reference gas line to the reference side of the measuring cell.

The filter head has a gas deflector plate referred to as v-shield.

The O_2 measuring cell itself consists of three layers: platinum, zirconium oxide and platinum with the platinum being applied porously. The measuring cell with its 4-hole connection flange and gasket seal can be field replaceable by the customer, if required.

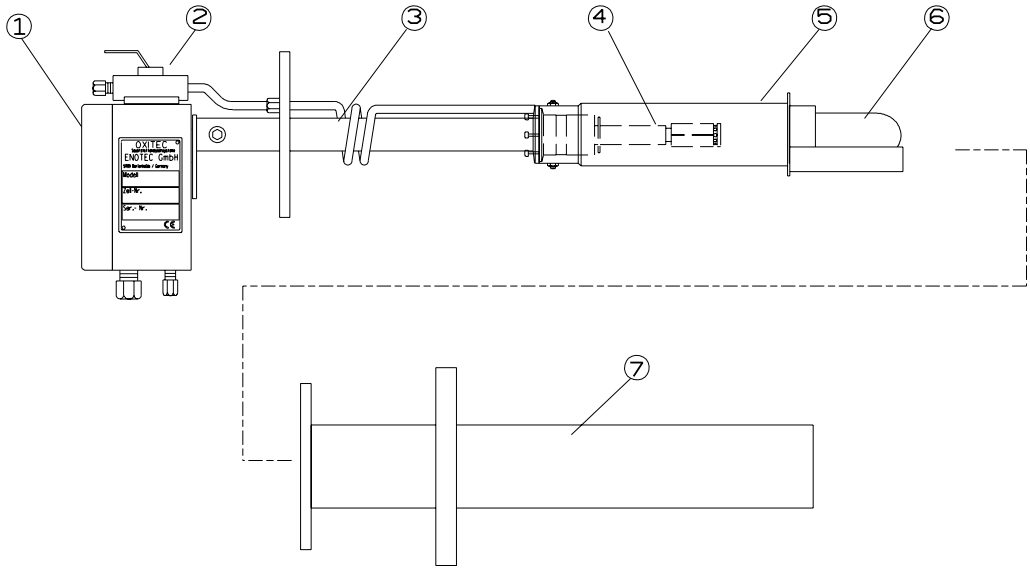


Figure 3 Design of the O_2 measuring probes KES-132x/KES-200x

No.	Name	Part Number
1	Connection box	ASK-0001
2	Test gas valve/ solenoid valve	KES-2000010 and KES-2000020 respectively/ KES-2000030 and KES-2000040 respectively
3	Measuring tube with test gas line	MSR-132X (for KES-1321 and KES-1322) MSR-1323 (for KES-1323) MSR-200X (for KES-200x)
4	Measuring cell	ZO2-0001
5	Filter head	KES-2000x00 x=1: with ceramic filter x=2: with basalt filter etc.
6	Filter	KEF-1321 and KEF-200X respectively (ceramic filter) BAF-200X (basalt filter) SMF-1321 and SMF-200X respectively (sintered metal filter)
7	Protection tube	KES-200000X (for KES-200X) KES-500000X (for KES-500X)

Table 1

The test gas or flue gas flows through to the filter and fills the flue gas side of the filter head. On the probe internal side, reference gas (clean, dry and oil-free instrument air (20.95 percent by volume O_2)) continuously flows through the inner part of the probe to the measuring cell. Because of the two different gases on each side of the measuring cell, a logarithmic mV output occurs (high O_2 concentration in the test gas = low voltage (e.g. 21% ≈ 0 mV); low O_2 concentration in the test gas = high voltage (e.g. 2.1% ≈ 50 mV)). By means of the electronics, this voltage (mV) is converted into a current 4-20 mA (or 0-20 mA) with a maximum load of 500 Ohm. The current output is then directly related to the measured oxygen value and available as an electrically isolated output signal from the terminals (see Figure 4 on page 24 and also Figure 7 on page 27).

The temperature of 840°C required for the O_2 measuring cell, is produced by a heater element installed inside the probe. To keep the temperature constant, it is measured by a Ni-Cr-Ni (type K) thermocouple, and the heater voltage is controlled by the SME 5 electronics unit equipped with a built-in temperature reference point to compensate ambient temperature variations (Cold Junction Compensation).

6.2 Special Probe Cable

Note

Only ENOTEC special cable for the O_2 sensor (FEP-0001) is to be used between the probe and the electronics unit. This special cable contains the conductors for the heater power, as well as all other necessary conductors. This cable must not be longer than 150m. Other cable length must be technically approved by ENOTEC in advance.

All ENOTEC special cable must be treated as a measuring signal line.

Important

The shielding of the special probe cable FEP-0001 must only be connected at one end - in the electronic housing - at the ground wire (PE terminal). In no circumstances should the shield of the special probe cable be also connected at the probe end.

All cables have PUR insulation and can be used in ambient temperatures up to 90°C.

Important

Please do not run the probe cable near power supply cables, or near motors and their cables, as frequency converters control them and could cause interference.
If possible, do not cross the cables because this could also cause interference. However, if this is unavoidable, please make sure that these cables are only crossed at right angles.

6.3 Special Pneumatic Cable

ENOTEC offers a pneumatic cable (tubing) with two tubes - one for the reference air supply to the probe (blue tube, 30 l/h continuously) and the other for the test gas supply (green tube, 150 l/h - 200 l/h) for the calibration of the O_2 sensor with test gas.

If the pneumatic unit uses reference air and test air pumps, instead of instrument air, the pneumatic cable **must not be longer than 50 m**. If longer lengths are required, an additional external pump must be installed upstream, to ensure a test air flow of 150 l/h min. even under the worst conditions.

All cables have PUR insulation and can be used in ambient temperatures up to 90°C.

6.4 Design of the Electronics

As a standard, the electronics unit is supplied in a wall mounting housing, with built-in pneumatic system.

Two different pneumatic systems are available:

- An instrument air version requiring the supply of clean, dry, oil-free instrument air at the point of installation.
- A pump version using the surrounding ambient air for reference air and test air.

In addition to these two versions another variant without pneumatics is available.

To recognize the type of pneumatic version please look at the valve for adjusting test air. (For details see page 79).

Note

To ensure the full functional range of the electronics, one of the above pneumatic units is required.

The housing has bottom entry electrical cable glands, and compression fittings for 6 mm or ¼" tubing, as specified, for the pneumatic lines (see Figure 14 on page 35).

Optionally, the electronic unit SME 5 is also available in a 19" rack version or a weather-resistant glass fibre reinforced plastic housing or in an EExd housing for hazardous areas. In the EExd housing version, the pneumatic unit is mounted in a separate sheet steel field housing which does not require certification since it only contains the pneumatic components.

Flow monitoring of the test and/or reference gas is made electronically inside the electronics unit (only versions with built-in pneumatic unit). No manual control is necessary.

The microprocessor electronics unit possesses a graphic display with background lighting. For operation the electronics unit possesses 4 soft keys and a numeric keyboard. The entire menu structure is laid out in such a way that an intuitive operation is possible.

6.5 Description of Function of the Microprocessor Electronics

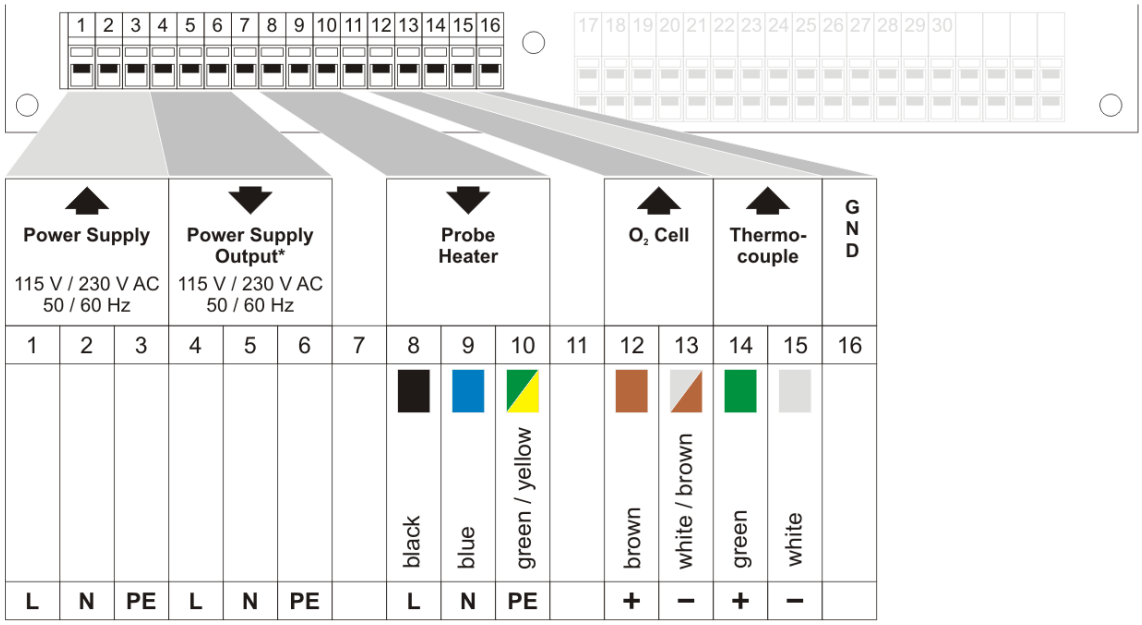
The SME 5 electronics unit is designed for connection to an oxygen measuring probe. The mV signal of the measuring cell is amplified and then converted into a digital signal in the electronics (14 Bit converter). The µ-processor linearises and corrects the signal of the measuring cell according to the Nernst equation. The O_2 value is then displayed as a percent value and has a floating transmitted output, either 0 - 20 mA or 4 - 20 mA - keypad selectable.

As a standard, the electronics unit has two measuring ranges. These measuring ranges can be freely defined in their initial and/or final value (within permissible system-related limits). The second measuring range can be switched remotely (digital input see Figure 4 on page 24) or manually using the keyboard of the electronics. The second measuring range is signalled remotely by a relay contact, and also on the display.

The electronics is completely self-controlled. Any system errors are displayed as clear text with help function information. The ENOTEC user interface permits intuitive operation by means of a self-explanatory menu structure.

The system is multi-lingual; currently the available languages are: German and English. Spanish, Italian and French are in preparation.

6.6 Terminal Connections of the SME5 Electronics in Field Housing



* The output voltage of this contacs (4 ... 6) has always the same level as on the power supply input on contacts 1 ... 3.

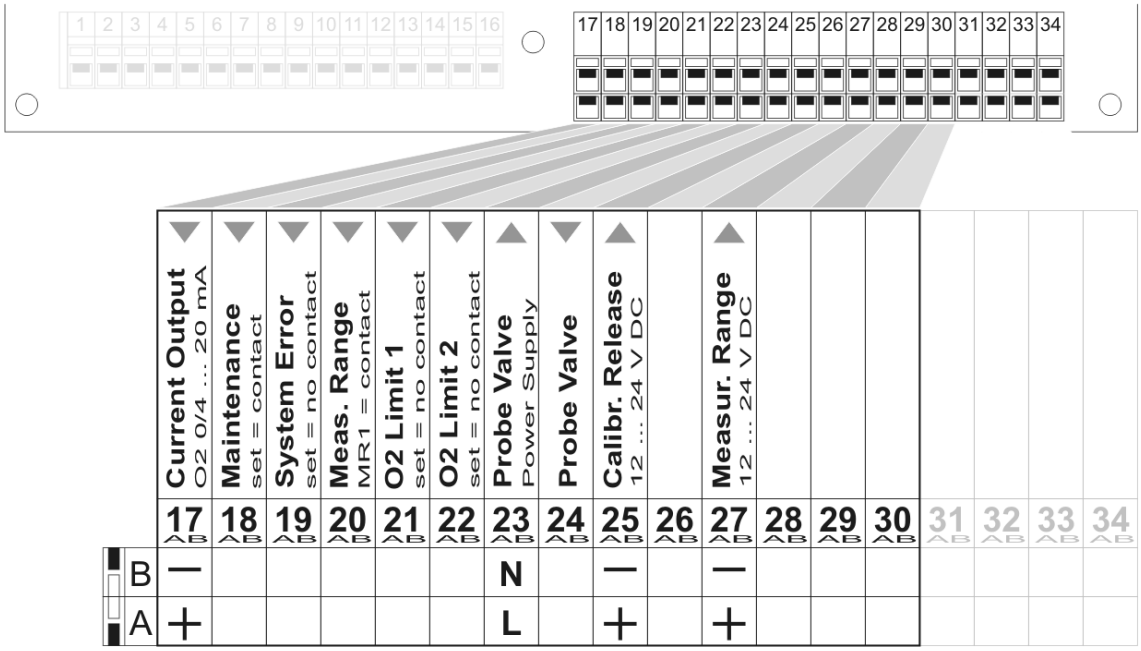


Figure 4 Terminal connections OXITEC® 5000 field housing

6.6.1 Terminal Allocation according to the installed options

Depending on the selected options, terminals 28 to 30 have the following functions.

6.6.1.1 Terminal Allocation for the *Limit Curves* Option

Name of terminal	Terminal allocation
28 A	+ Analogue Input, Burner Load 4 to 20 mA (0...100%)
28 B	- Analogue Input, Burner Load 4 to 20 mA (0...100%)
29 A	+ Digital Input 1, select fuel, current input (0..4mA, 5..20mA)
29 B	- Digital Input 1, select fuel, current input (0..4mA, 5.. 20mA)
30 A	+ Digital Input 2, select fuel, current input (0..4mA, 5..20mA)
30 B	- Digital Input 2, select fuel, current input (0..4mA, 5..20mA)

Table 2

6.6.1.2 Terminal Allocation for the Process Pressure Correction Option

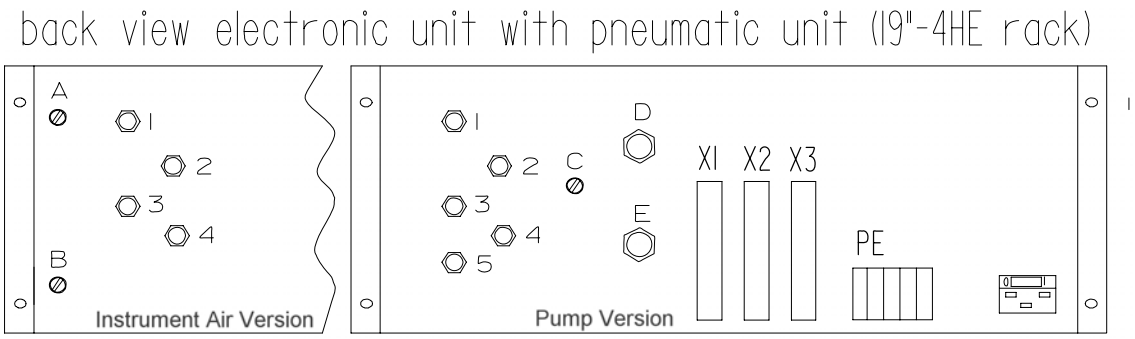
Name of terminal	Terminal allocation
28 A	Not Used
28 B	Not Used
29 A	+ Analogue Input, process pressure, 4 to 20 mA
29 B	- Analogue Input, process pressure, 4 to 20 mA
30 A	Not Used
30 B	Not Used

Table 3

Important

The external current for the inputs (28 to 30) must be electrically isolated from Ground. Otherwise a malfunction or damage to the electronics is possible.

6.7 Terminal Connections for the 19” (4HE) Rack Mounting Version of the SME5 Electronics



X1		X2	
1	Probe solenoid valve L	1	Maintenance
2	Probe solenoid valve N	2	
3	PE	3	System fault
4	Probe heater L (black)	4	
5	Probe heater N (blue)	5	Measure range
6	PE	6	
7	O2 Cellvoltage + (brown)	7	Limit 1
8	O2 Cell voltage – (white/brown)	8	
9	Thermocouple + (green)	9	Limit 2
10	Thermocouple – (white)	10	
11		11	Dig. Input calibration release 12..24V+
12	O2 output 0/4...20mA +	12	Dig. Input calibration release 12...24V-
13	O2 output 0/4...20mA -	13	Dig. Input measure range switch 12...24V+
14		14	Dig. Input measure range switch 12...24V-
15		15	
16		16	

Figure 5 Terminal connections 19" 4HE housing

6.8 Terminal Connections for the 19” (3HE) Rack Mounting Version of the SME5 Electronics

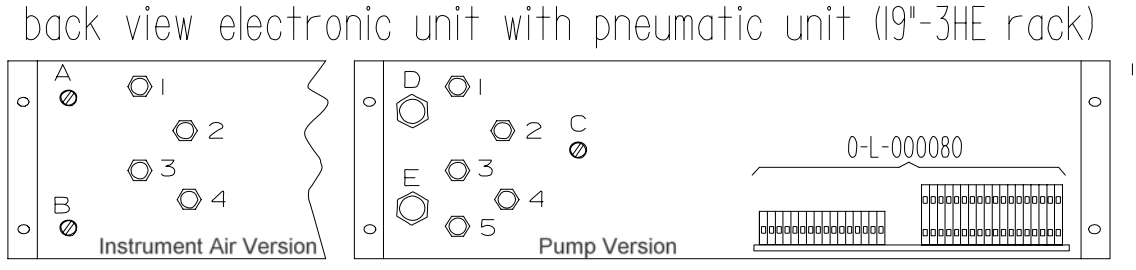


Figure 6 Terminal connections 19" 3HE housing

With the SME5 electronics in the 19" rack (3HE) the terminal strip of the power board (0-L-000080) is directly led outwards. The terminal connections are identical to the terminal connection of electronics in field housing described in chapter 6.6 on page 24.

6.9 Connection Diagram OXITEC® 5000

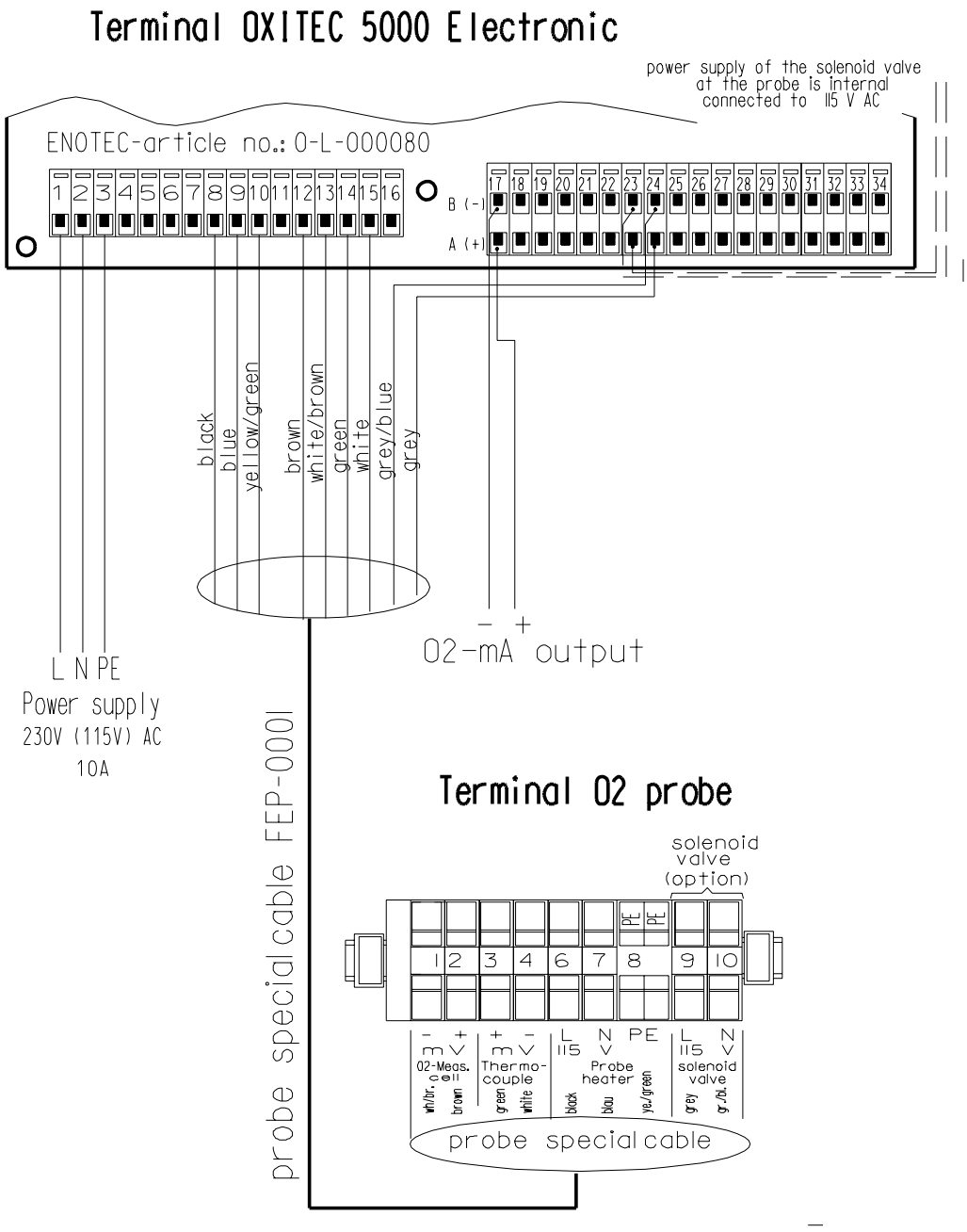


Figure 7 Connection diagram OXITEC® 5000

7 Installation of the OXITEC® 5000 Analyser System

Note

Only qualified and authorized personnel may work on this instrument. These personnel must be familiar with all warnings, safety instructions and maintenance work in accordance with these operation instructions. The reliable and safe operation of this equipment requires careful transportation, professional storage, and installation and commissioning, as well as careful operation and maintenance.

7.1 Checking the Location for the Probe Installation

Flue gas temperature, pressure and all other process conditions must be in accordance with the specification. Allow enough space for insertion/removal of the probe and protection tube (if supplied) and ensure access to the measuring probe and/or connecting box.

Before cutting the hole in the flue gas duct, make sure that the inside of the duct has enough space for probe installation, and that no soot is blown nearby, or any obstructions are in the way.

For probe lengths exceeding 2000 mm, a support must be mounted inside the duct (every 2 m) to prevent the probe and mounting tube from flexing or bending.

7.2 Installing the Probe

Note

The fastest possible response time is obtained with horizontal installation. We recommend installing the probe horizontally in preference

The dimensions for the hole in the flue gas duct and the mounting of the adapter plate (mating flange) are shown in the dimensional sheet (Figure 73 on page 93). The mating flange is to be fitted by the customer and when mounted, ensures an airtight seal.

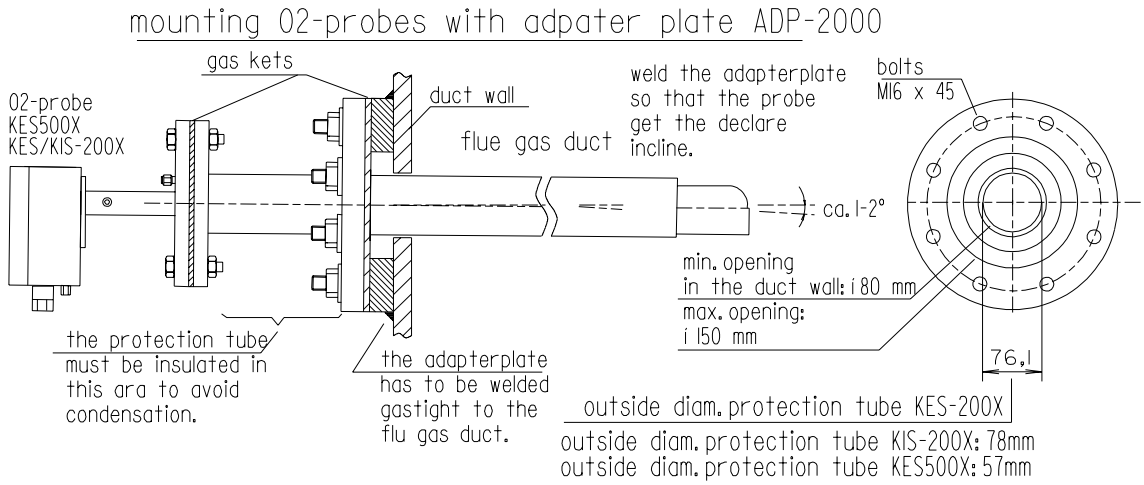


Figure 8 Mounting dimensions of the O_2 probe KES/KIS-200x with ADP-2000

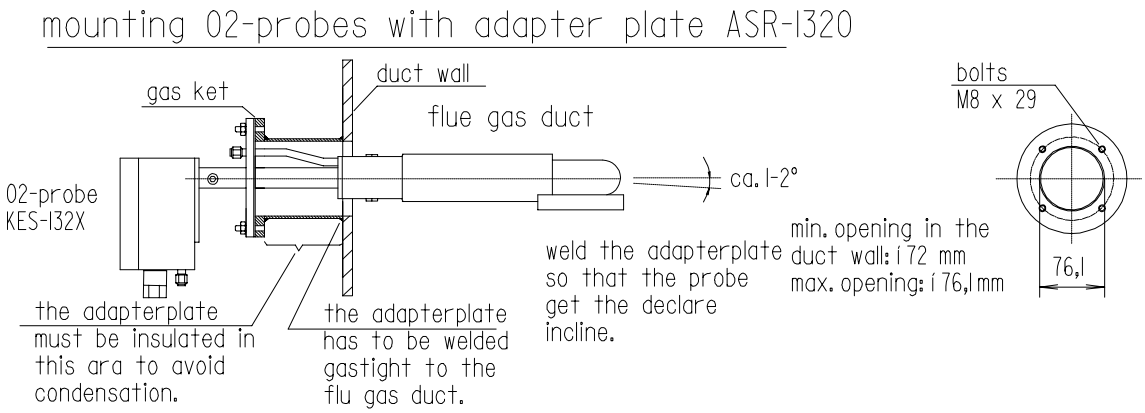


Figure 9 Mounting dimensions of the O_2 probe KES-132x with ASR-1320

All dimensional sheets can be found in chapter 15 on page 91 and the following.

Note

The part of the protection tube projecting from the duct wall must be insulated or heated if necessary, to prevent its temperature from dropping below the dew point.

Electrical heaters are available from ENOTEC as accessories. The bolts of the probe flange must remain accessible.

The special cables for pneumatic and electronic systems must be left long enough (coiled up) so that the probe can be removed out of the protection tube without disconnecting it.

Important

The ground (earth) connection must be installed thoroughly using the correct cable of at least 1,5mm² minimum. It is very important that the equipotential bonding is installed correctly.

Please note that some electrical devices (e.g. frequency converter etc.) close to the system can create considerable electrical disturbance and instability. So for normal function of the OXITEC® 5000 system it is important that these devices be installed away from the system and in accordance with the manufacturer's installation notes and guidelines.

Please do not run the probe cable near power supply cables, or near motors and their cables, as frequency converters control them and could cause interference. If possible, do not cross the cables because this could also cause interference. However, if this is unavoidable please make sure that these cables are only crossed at right angles.

Important

The shielding of the special probe cable FEP0001 must only be connected at one end - at the electronic housing with the ground wire (PE terminal). In no circumstances should the shield of the special probe cable be connected at the probe.

7.3 Adjusting the Filter Head (only Probes with V-shield Dust Deflector)

Note

Before installing the probe, the direction of flue gas flow must be determined and the filter head assembly turned to such a position that the flue gas flow hits the V-deflector. The filter head can be turned freely a full 360° for this purpose, by loosening the holding screws and lock nuts, rotating the filter head/V-shield to the required position, and then tightening both holding screws and lock nuts.

Filter heads with sintered metal filter (without V-shield) for gas fired clean flue gas applications do not have to be aligned.

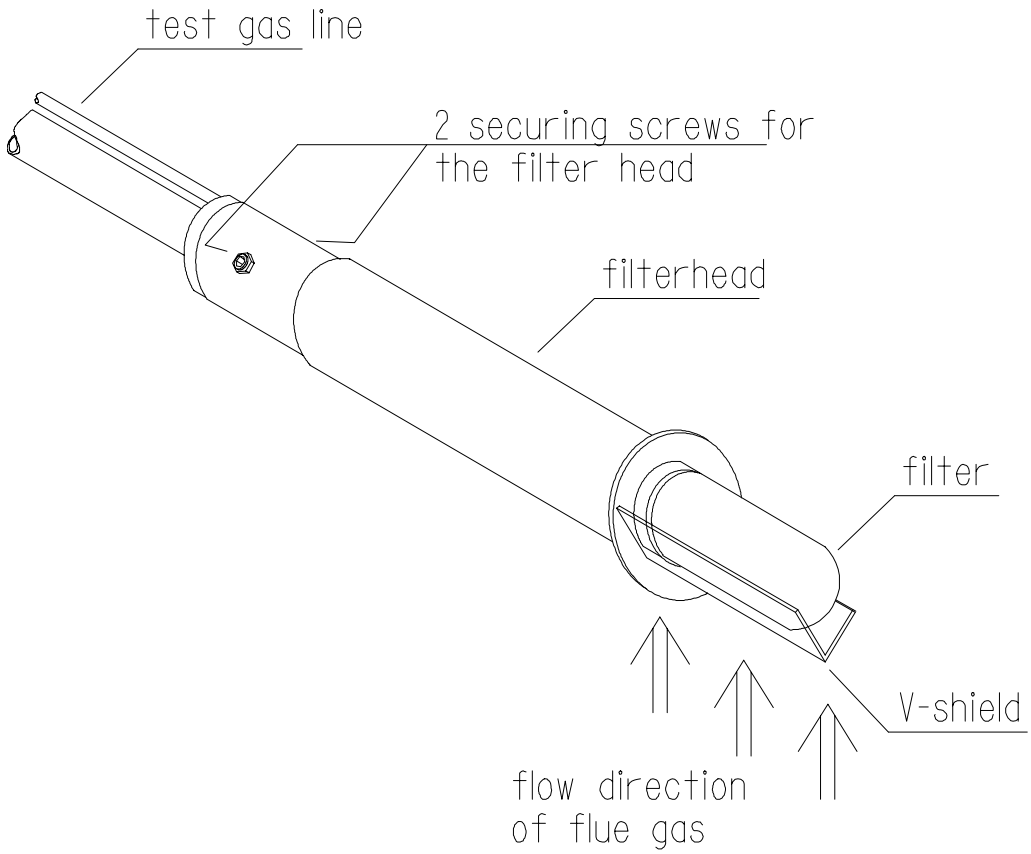


Figure 10 Adjusting the filter head

7.4 Electrical and Pneumatic Terminations at the Probe Connection Box

The special ENOTEC probe cable (FEP-0001) and the pneumatic tubing (FEP-0002) must be connected in accordance with Figure 1 and Figure 12 on page 32 (probe with test gas valve) or Figure 13 (probe with solenoid valve) on page 33. Both cables have PUR sheathing and are designed for a maximum permissible ambient temperature of +90°C.

Note

All special probe signal cables must be treated as measuring lines. Do not connect the shield of the probe cable at the probe.

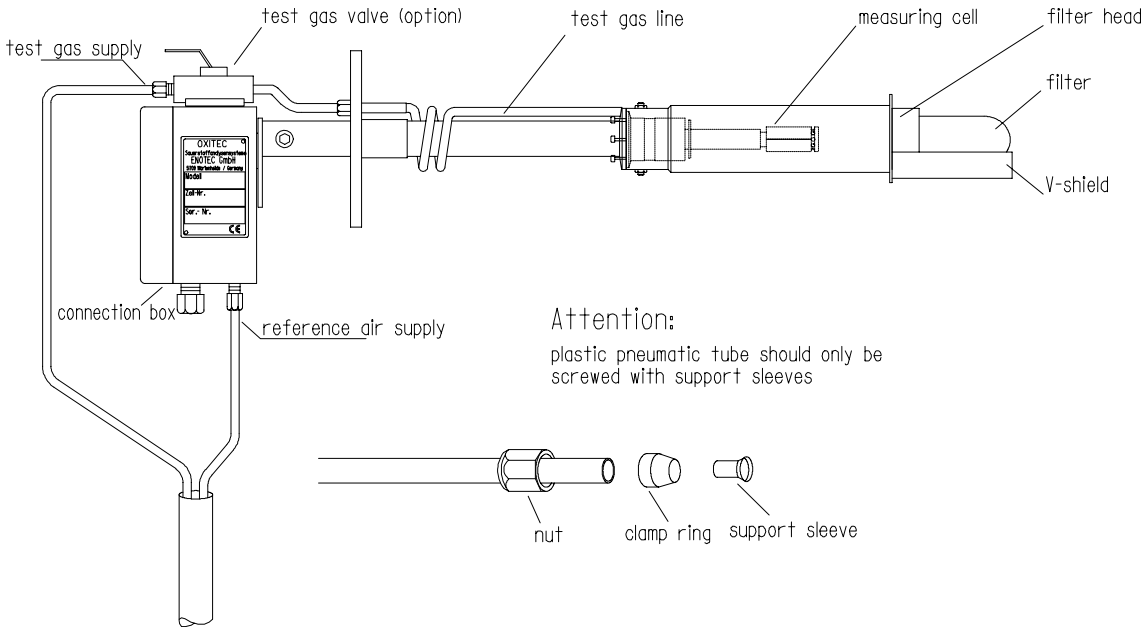


Figure 11 Overview of the cable connections at the probe

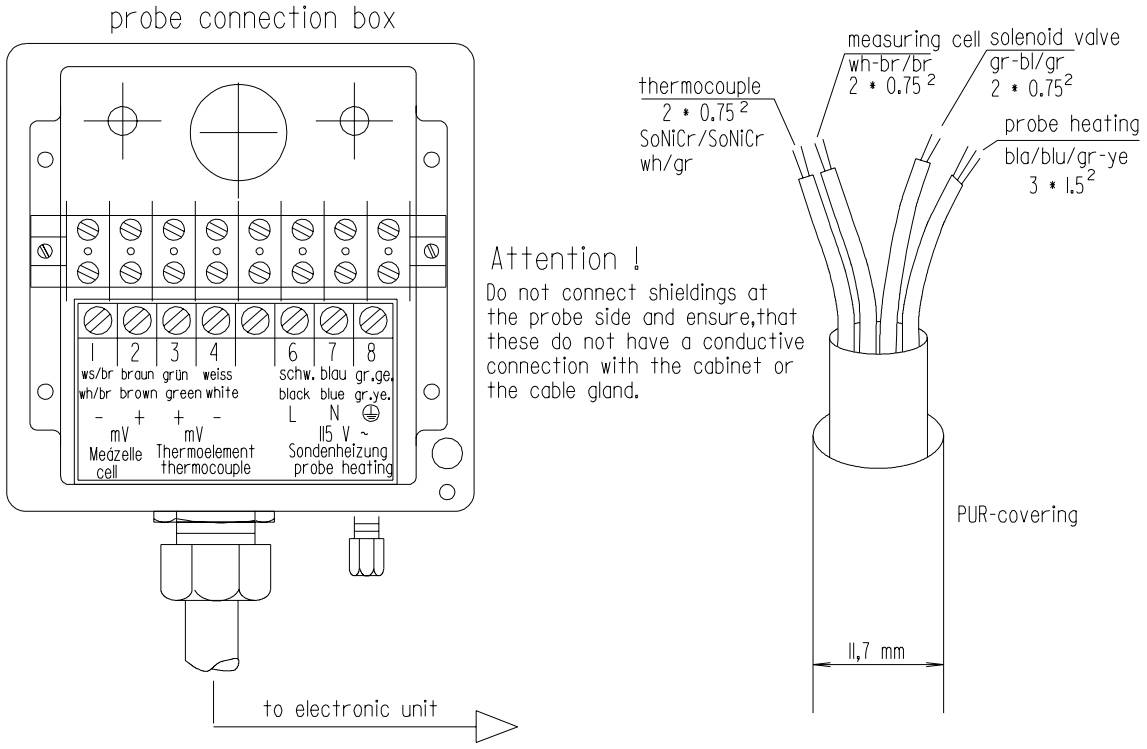


Figure 12 Connection box with clamp allocation (probe with test gas valve)

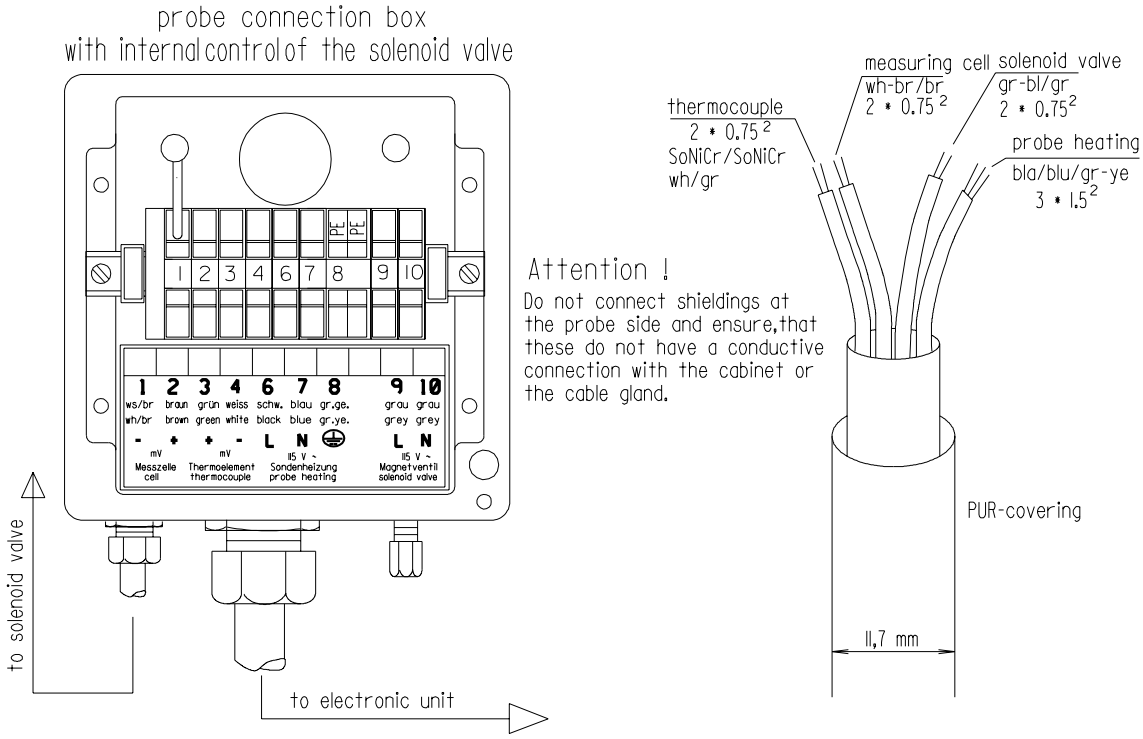


Figure 13 Connection box with clamp allocation (probe with solenoid valve)

Important

The Standard supply voltage to the solenoid valve at the probe is internally connected to 115V AC.

When using solenoid valves with other voltages a change/modification is required within the electronics unit.

7.5 Requirements for the Location of the Electronics Unit

Note

When installing the electronic unit, please ensure sufficient air circulation around the electronics housing and make sure that the permissible ambient temperature is met.

The permissible ambient temperature range for the standard steel box field housing with instrument air or without pneumatic unit is –20°C to +55°C, and for the unit with built-in reference air and calibration gas pumps -20° to +50°. For the 19” rack mounting version, the permissible ambient temperature is 0°C to +60°C.

The location of the electronics unit must be selected, so that it is easily accessible ensuring that the door can be fully opened after installation.

The place should be largely weather-protected to enable inspection even under the worst weather conditions.

7.6 Requirements for Connecting Power Supply and other Electrical & Pneumatic Cables

For connection of the supply voltages, it is necessary to use cable of min. 1,5mm² and maximum length of 150 meters.

Before putting the system into operation, it is essential that all electrical connections, supply voltage and pneumatic connections are checked and, if applicable, the instrument air pressure and quality, too.

Special care must be taken not to mix up the connections for test gas and reference air.

Important

The shielding of the special probe cable FEP-0001 must only be connected at one end - at the electronic housing - with the ground wire (PE terminal). In no circumstances should the shield of the special probe cable be connected at the probe.

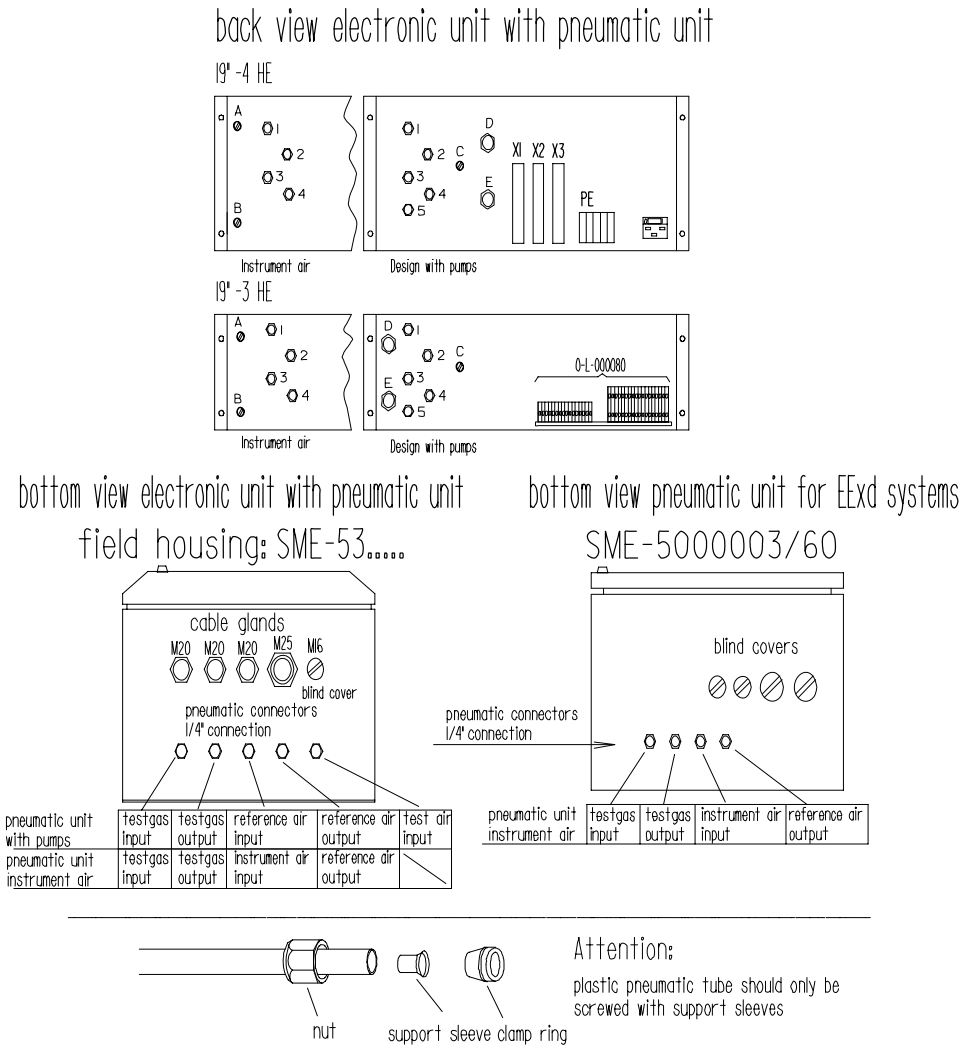
The enclosed ferrite sleeves must be placed over the leads of the stripped cable (see chapter 7.9 on page 36). CE-conformity is invalid if these ferrite sleeves are not fitted!

The ground (earth) connection must be installed thoroughly using the correct cable size of at least 1,5mm² minimum. It is very important that the equipotent bonding is installed correctly.

Please note that some electrical devices (e.g. frequency converter etc.) close to the system can create considerable electrical disturbance and instability. So for normal function of the OXITEC® 5000 system it is important that these devices be installed away from the system and in accordance with the manufacturer's installation notes and guidelines.

Please do not run the probe cable near power supply cables, or near motors and their cables, as frequency converters control them and could cause interference. If possible, do not cross the cables because this could also cause interference. However, if this is unavoidable please make sure that these cables are only crossed at right angles.

7.7 Connection of Gas Supply



	1	2	3	4	5
Pneumatic Unit with Pumps	Testgas Input	Testgas Out-put	Reference Air Input	Reference Air Output	Test Air Input
Pneumatic Unit Instrument Air	Testgas Input	Testgas Out-put	Instrument Air Input	Reference Air Output	

A	Regulator Test Air
B	Regulator Reference Air
C	Regulator Test Air
D	Test Air Filter
E	Reference Air Filter

Figure 14 Pneumatic connections of the OXITEC® 5000 electronics

7.8 Instructions for Connection of Probe Special Cable

Note

The probe special cable contains two white wires. When connecting the cable it is to be made certain that the colours are assigned to the correct conductors.

One of the white wires is marked with a brown line around to indicate the allocation to the brown wire.

White and green wires→ thermocouple
Brown and white wires → measuring cell

To confuse the white wires may result in a measuring error and the basic accuracy of the equipment can not then be guaranteed.

Polarity of thermocouple	DIN IEC 584	DIN 43710 (old German)	ANSI MC 96.1 (US)
+	**green**	red	yellow
-	**white**	green	red

Table 4 International colour codes for NiCrNi Thermocouple wires

7.9 Fitting the ferrite sleeves (EMC)

Important

Do not connect the cable shield at the probe.

The enclosed ferrite sleeves must be put over the leads of the stripped cable (see Figure 15). Please use all ferrite sleeves ENOTEC supplied, because of their small size.

CE-conformity is invalid, if these ferrite sleeves are not fitted!

Figure 15 Ferrite sleeves

8 Start-up of the OXITEC® 5000 System

Important

Before the OXITEC® 5000 analyser system is powered up make sure that the conditions comply with the following points:

Does the supply voltage correspond with the voltage shown on the type label of your OXITEC® 5000?

Are all electrical connections made in accordance with the instructions in this manual?

Is the OXITEC® 5000 probe installed in a flue gas that corresponds with the probe specification?

Are all pneumatic connections made correctly and gas tight to prevent the probe from ingress of ambient air?

8.1 Probe Heating Phase

After switching on the OXITEC® 5000 analyser system, the OXITEC® logo appears on the display for a short time. During this time, all parameters relevant for faultless functioning and start-up are checked automatically.

If during this check any system errors are found, the electronic unit will show them in clear text. You will find a detailed error and warning description in chapter 9.6 on page 61.

If the power-on check is completed without any errors, the heater window appears as shown in Figure 16. In this heater window the progress of the heating phase is indicated by a bar in the range 0°C to 900°C.

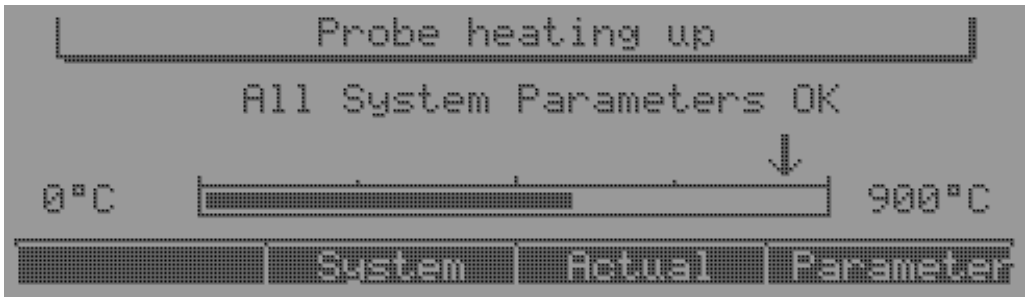


Figure 16 Display: heating phase

When the probe temperature is stable within ± 1.0°C (after approx. 20 to 60 minutes, depending on the process conditions), O_2 measurement is released and the main window appears on the display.

Figure 17 Display: main window

During the heating phase, all actual values can be called up in the corresponding menu window with the soft key [actual]. You can also enter the system menu and the parameter menu by pressing the corresponding soft keys. Please note that some functions will not be available in heating phase (e.g. calibrations).

Note

System adjustments may only be made be specially trained personnel.

9 Operating Instructions for the OXITEC® 5000 Electronics

Note

Only qualified and authorized personnel may work with this instrument. These personnel must be familiar with all warnings, safety instructions and maintenance work in accordance with this Installation Manual.

The electronics are operated by means of four software-configured function keys (subsequently called soft keys) and a numeric keypad. The functions of the soft keys always adapt to the current menu window. The numeric keypad serves only for entering numerical values.

The OXITEC® 5000 'user interface' is designed for intuitive usage of the electronic unit. This means that as a rule there is no need for the instruction manual during operation.

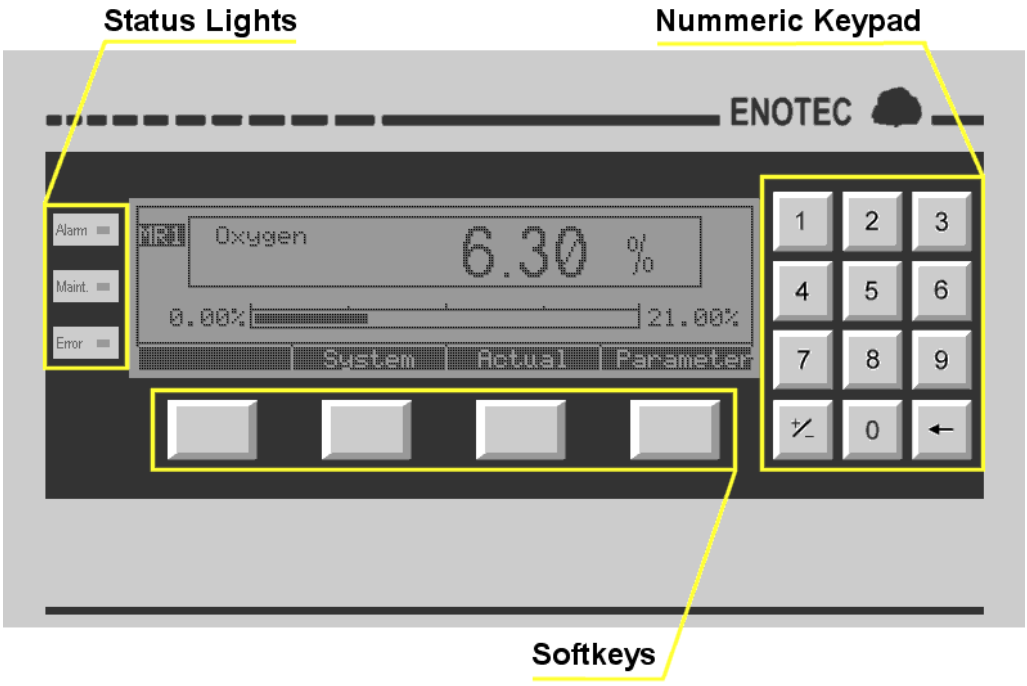


Figure 18 Front panel of the OXITEC® 5000 electronic unit

Beside the version with an O_2 display in vol.%, a software version with an O_2 display in ppm is available (see Figure 19).

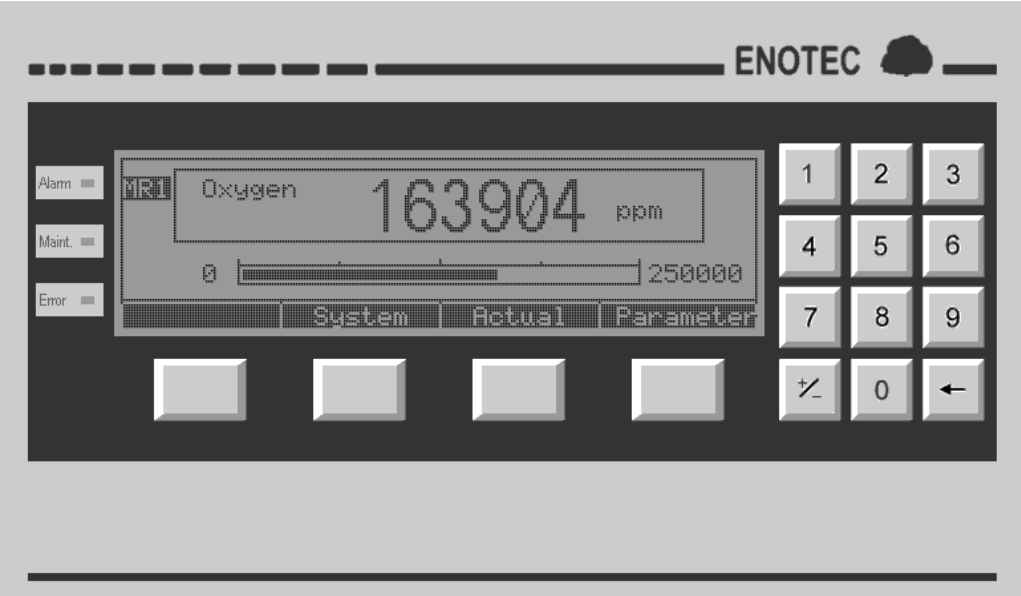


Figure 19 Front panel of the OXITEC® 500E analysing system (display in ppm)

If the present version is a system with ppm output, all parameters and values except for the both test gas concentrations and the moisture been output in ppm.

The only difference to the version with vol.% is the unit, therefore just the displays with 'vol.%' are mentioned in the following.

9.1 General Operating Instructions

By pressing the soft keys [system], [actual] and [parameter] (see Figure 18) the respective selection menus can be achieved. In each of this menus various options can be selected from a list (as shown as an example in Figure 20) with the soft keys [🡻] and [🡹]. If there are more than 4 options, this is indicated by an arrow on the right hand side of the menu list. This arrow indicates that there are more options to follow. The option which can current be selected has a black background and light letters and can be confirmed with the soft key [Enter].

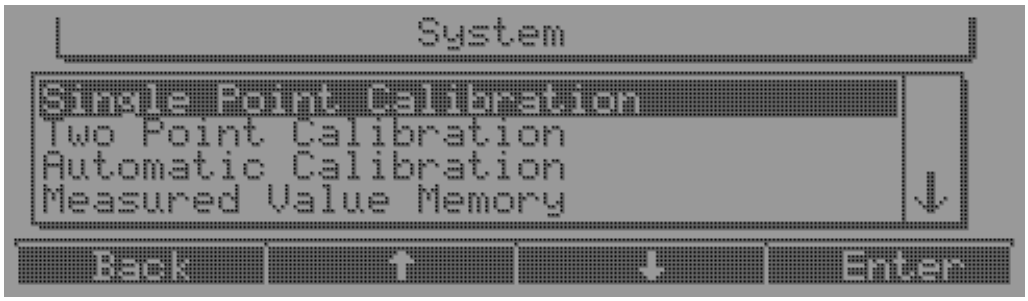


Figure 20 Display: system menu

9.2 Main Window

In the main window (see Figure 21) the measured oxygen current value is displayed. An additional bar graph below the measured value display represents the instantaneous value related to the measuring range.

In the left upper corner the current measuring range is indicated. At moisture of > 0% "oxygen dry" is displayed to indicate that the O_2 value is a corrected value (see page 46).

Figure 21 Display: main window

This main window branches into four menus:

Menu	Description
Status resp. MR1/2	If the Measuring Range Switching is set to “local” and there is no error or alarm, the measuring range can be selected with this key. In this case the soft key is marked with "MR1/2". In the case of an error or alarm this soft key is labelled with "status" and with this soft key the errors and/or alarms can be called up.
System	Calls up the system menu, in which you have access to calibration functions, system settings, system tests etc. For a detailed description see chapter 9.5 on page 48.
Actual	Displays all actual values of the system. For a detailed description see chapter 9.3 on page 41.
Parameter	Calls up the parameter menu, in which several parameters are shown. These parameters such as measuring range, test gas… can also be altered. For a detailed description see chapter 9.4 on page 43.

Table 5 Branching of the main window

9.3 Actual Value Menu

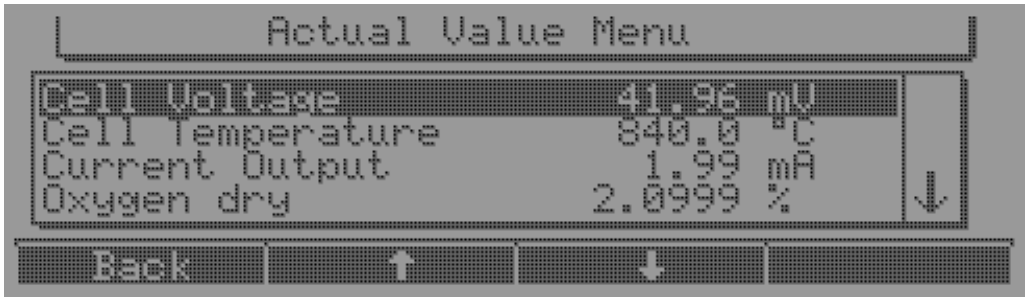


Figure 22 Display: actual value menu

In the actual value menu the following current actual values of the electronics unit can be called up:

Actual Value	Unit	Description
cell voltage	mV	Measured cell voltage of the O_2 zirconium oxide cell
cell temperature	°C	Measured cell temperature of the O_2 zirconium oxide cell
current output	mA	Calculated O_2 value current output depending on the O_2 range. The O_2 range is set and can be changed in the parameter menu (for details see chapter 9.4 on page 43)
oxygen dry	vol. % (ppm)*	At moisture of > 0% this is the corrected value (for details see chapter 9.4.3 on page 46). This value is also displayed in the main window.
oxygen wet	vol. % (ppm)*	This is the measured and calculated O_2 value based on the cell voltage.
lambda		Air/fuel ratio (see chapter 9.3.1 on page 42).
cold junction temperature	°C	Cold junction temperature of the thermocouple element
flow rate reference gas	l/h	Only available on systems with integrated pneumatic unit. This value shows the measured flow rate of the reference gas (20.95% O_2) used for the zirconium oxide cell
process pressure	bar	Only with process pressure correction option
process pressure	psi	Only with process pressure correction option
burner load	%	Only with limit curves option
actual limit1	%	Only with limit curves option
actual limit2	%	Only with limit curves option
fuel	%	Only with limit curves option

Table 6 Actual value menu

* The OXITEC® 5000 analyser system is also available with a ppm output. Because this is only a different of unit (20% O_2 = 200000ppm O_2), it is not mentioned in the following descriptions.

Note

If, instead of a ‘value’ only underscores are shown, this means that no valid value for this parameter is currently available.

9.3.1 Lambda

The air ratio factor Lambda, describes the relationship of air flow supplied effectively before combustion, to the theoretical amount of air which is necessary for complete combustion. A Lambda value of 1 means the exact relationship of gaseous fuel and air needed for complete combustion, and this mixture is designated as the stoichiometric gas air mixture. With complete combustion of the fuel, the oxygen supplied is also completely used at this stoichiometric point. In practice this value cannot be attained. Which Lambda value here is considered as acceptable, depends on the respective application.

The value for Lambda (air relationship) is determined by the electronics according to an approximate equation and under no circumstances replaces one, e.g. in the control room calculated value, which presupposes still further measured values.

$$\lambda \approx \frac{21}{21 - O_2}$$

Approximate equation for Lambda

As a matter of course this approximate equation is not valid for a below-stoichiometric combustion condition. It applies therefore, only to combustion with excess air.

9.4 Parameter menu

In the parameter menu, the system parameters as shown in (Figure 23) can be displayed and altered.

Note

With the limit value curves option, a selection menu appears between system parameters and limit value curves, after selection of the parameter menu.

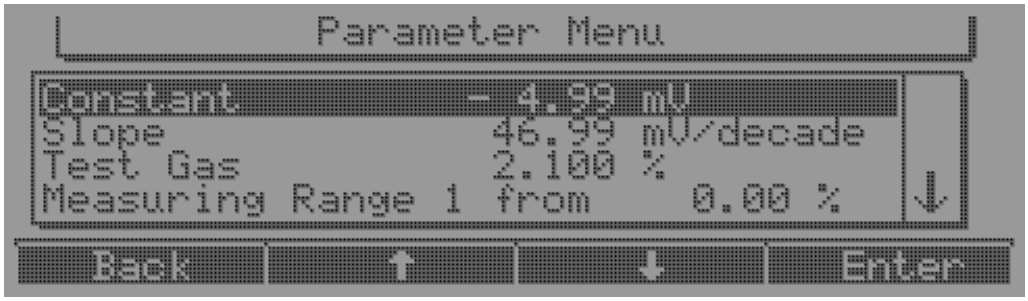


Figure 23 Display: parameter menu

Having selected a parameter for the first time with the soft key [Enter], a window appears requesting the entry of a code. If the maintenance code was not yet, changed after installation, then one confirms the inquiry using [Enter] without any input of numbers. To change the system code see chapter 9.5.10 on page 60.

Note

The system code is factory-set to 0000.

Having entered the valid system code, a window appears where the corresponding value can be selected.

In this menu the following parameters can be changed:

Parameter	Unit	Input limits	Comment
constant	mV	-50mV to 10mV	O_2 cell constant Note: a successful O_2 single point or two point calibration will overwrite this zirconium oxide cell constant.
slope	mV/dec	+35mV to +55mV	O_2 cell slope Note: a successful O_2 two point calibration will overwrite this zirconium oxide cell slope.
test gas 1	%	0 % to 100 %	O_2 concentration of the test gas Note: only available in systems without integrated pneumatics unit
test gas 2	%	0 % to 99 %	O_2 concentration of the test gas
measuring range 1 from	% (ppm)*	0% (000000ppm) to setting of value of “measuring range 1 to”	Start value of the O_2 measuring range 1
measuring range 1 to	% (ppm)*	setting of value of “measuring range 1 from” to 100% (999999ppm)	End value of the O_2 measuring range 1
measuring range 2 from	% (ppm)*	0% (000000ppm) to setting of value of “measuring range 2 to”	Start value of the O_2 measuring range 2
measuring range 2 to	% (ppm)*	setting of value of “measuring range 2 from” to setting of value of “measuring range 1 to”	End value of the O_2 measuring range 2
limit 1	% (ppm)*	0% to 100.0% (000000ppm to 999999ppm), min or max	Limit value 1 for O_2 min (alarm is set when the O_2 concentration falls below the limit value) or max (alarm is set when the O_2 concentration rises above the limit value) alarm. Not available with limit value curves option!
limit 2	% (ppm)*	0% to 100.0% (000000ppm to 999999ppm), min or max	Limit value 2 for O_2 min (alarm is set when the O_2 concentration falls below the limit value) or max (alarm is set when the O_2 concentration rises above the limit value) alarm. Not available with limit value curves option!
H_2O correction	%	0 % to 50 %	proportion of H_2O (water) in the flue gas

Table 7 Parameter menu

* The OXITEC® 5000 analyser system is also available with a ppm output. Because this is only a different of unit (20% O_2 = 200000ppm O_2), it is not mentioned in the following descriptions.

9.4.1 Changing a Parameter Value using the Alteration of O_2 Limit as an Example

In this chapter the alteration of a parameter will be explained using the example of value “*O2 limit 1*”. For this purpose the downward arrow in the parameter menu is pressed repeatedly until the point "*limit 1*" is reached. The point is then called up using [Enter], and the system code entered and confirmed. On the display the window "Parameter Input" appears.

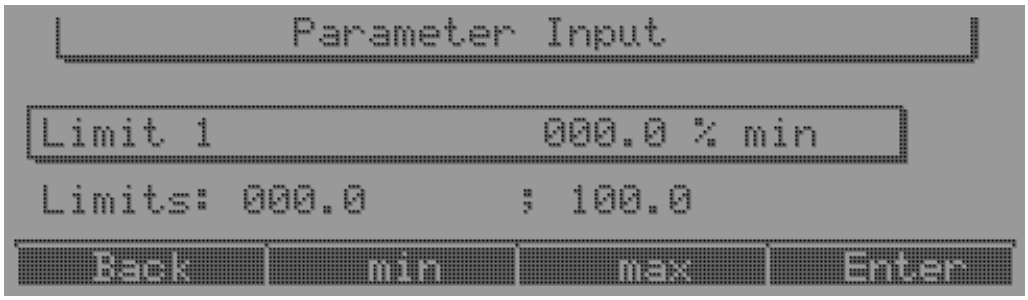


Figure 24 Display: parameter input (example limit value 1)

The parameter to be altered is displayed in clear text with the current value. If special functions are assigned to this parameter (like “min/max” in this example), these are also displayed. In addition the permissible input limits of this value are indicated (in this example 00.0 and 99.0).

With the numeric keypad, the value can be altered. To correct, the cursor can be moved back with the [←] key. The sign can be selected independently of the cursor position with the [±] key.

The secondary parameter “min/max” can be changed by the corresponding soft keys.

Note

If a value cannot be entered, it should be checked whether this value is outside the permitted limits. In such a case, the entry of the value is not permitted, but the corresponding limit value is selected.

The altered value has to be confirmed with the soft key [Enter].

Note

When pressing the soft key [Back], the altered value is cancelled and the old value maintained.

9.4.2 Changing a Parameter Value using the Alteration of Measuring Range 1 as an Example

The electronics possesses two freely adjustable O_2 measuring ranges. The measuring ranges of the electronics can be determined freely. For example one changes the “*O2 Measuring Range 1*” as follows:

To reach the menu option "*O2 Measuring Range 1*" the downward arrow in the parameter menu is pressed repeatedly until the point "*Measuring Range 1*" is reached. The point is then accessed by using [Enter], and the system code is then entered and confirmed.

In the menu option "*Measuring Range 1 from*", the initial value of the measuring range can be indicated now.

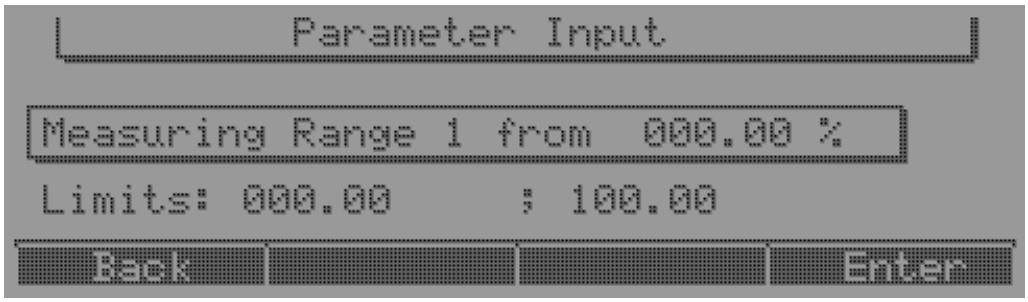


Figure 25 Display for entering the initial value for measuring range 1

Note

It is to be noted that the initial value of the measuring range cannot be larger than the final value. Likewise the final value cannot be selected as smaller than the initial value. Otherwise the electronics does not permit the entered values.

The same rule applies for the second measuring range, which has to be smaller than the first measuring range. Otherwise the electronics will not accept such settings.

After the input of the initial value, this value will be confirmed with [Enter] and the final value of the measuring range can be entered in the menu option "*O2 Measuring Range to*". As soon as this value is confirmed using [Enter], the electronics is updated with the new measuring range.

Note

By default, the change-over between the two measuring ranges is set to "remote". If a manual (local) change-over is required, this can be altered in the system menu (see chapter 9.5.9 on page 59).

9.4.3 H_2O Correction

The OXITEC® 5000 oxygen analyser measures InSitu the wet oxygen value. In the menu item „*H2O correction*“, the H_2O value of the flue gas can be entered. Then the electronics calculates the dry oxygen value (“*Oxygen dry*”).

Note

If a moisture value greater than 0% is entered, the electronics indicates in the main window that this is a corrected value - with the text “*oxygen dry*”.

9.4.4 Limits, Limit Curves (option)

The standard electronic unit is fitted with two adjustable limits. As an option, the electronic unit is available with limit curves adjustable for a maximum of 4 different fuels.

9.4.4.1 Fuel Select

In the menu "*Select Fuel*" there is a submenu for the 4 different fuels. In this submenu, the four O_2 points and the Min or Max function of the limit value points can be adjusted.

9.4.4.2 Limit Value Curves

In the menu "*Limit Curves for Fuel X*" the five O_2 points for the corresponding fuel can be entered. The Min or Max function can also be entered. The electronics calculates the theoretical point for 0% burner load from the points of 20% and 40%.

The burner load signal is connected at the analogue input "*Burner Load*". This signal must be 0 to 100% for 4 to 20 mA.

At digital input 1 and 2 the fuel should be selected. This selection is coded as follows:

	Digital Input 2	**Digital Input 1**
fuel 1	0	0
fuel 2	0	1
fuel 3	1	0
fuel 4	1	1

Table 8

In this connection, logic 0 corresponds to 0..4mA and logic 1 corresponds to 5..20mA.

Important

The external current supply must be electrically isolated from ground. Otherwise a malfunction or damage to the electronics is possible. Do not exceed the maximum current of 20mA.

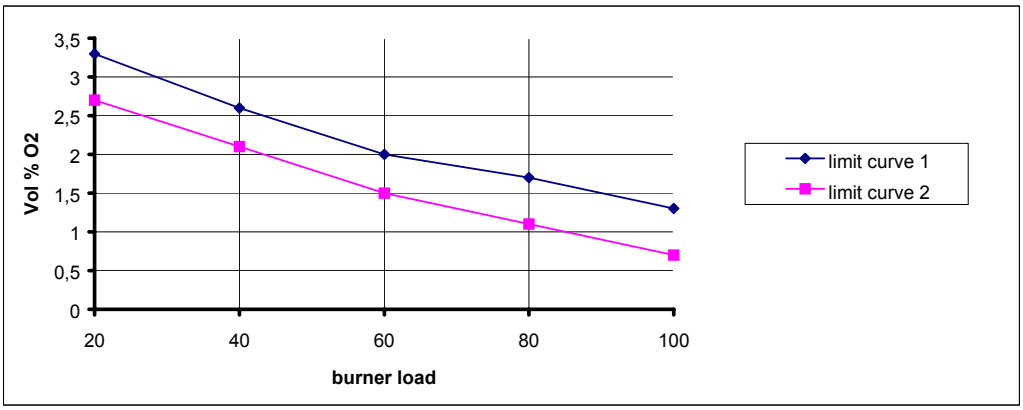


Figure 26 Limit value curves ((default values for all kind of fuel)

Note

The space between the O_2 points is calculated by the electronics. The accuracy of this calculation is ± 0,1Vol%.

The actual burner load and the corresponding limits can be shown in the actual value menu (see chapter 9.3 on page 41).

9.5 System Menu

When selecting the system menu with the corresponding soft key, a code enquiry appears, where the system code **(factory-set to 0000)** must be entered and confirmed with [Enter].

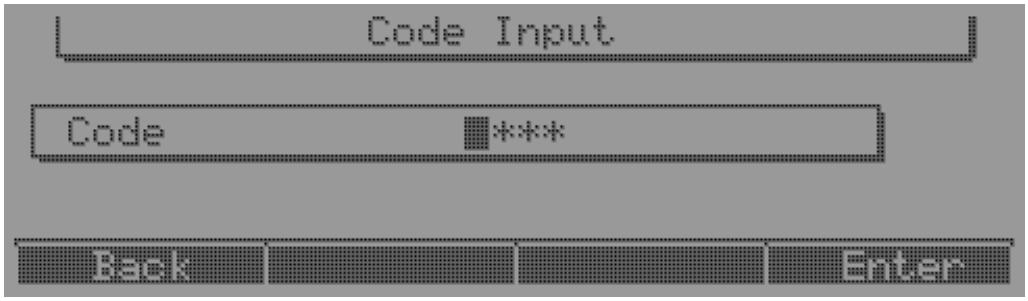


Figure 27 Display: code input

Note

The system code is factory-set to 0000.

After entering the system code, the system selection menu appears (Figure 28).

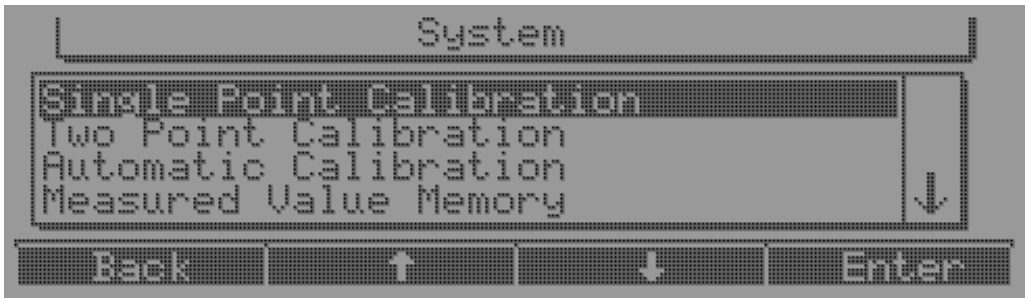


Figure 28 Display: system menu

In this menu the following functions can be called up:

Menu Point	Description / Remarks
Single point calibration	Performs an O_2 single point calibration with test air
Two point calibration	Performs an O_2 two point calibration with test air (20.95 % O_2) and test gas
Automatic calibration	Calls menu for the automatic calibration of the O_2 measurement at fixed time intervals
Measured value memory	If the measured value memory is switched on, it "freezes" the last measured value for O_2 while in calibration
System test with test gas	Performs a measuring verification with test gas
System test with test air	Performs a measuring verification with test air
Setting of current output	Changes between 0-20mA and 4-20mA output
Measuring range switching	Sets the operation mode to either "local" or "remote"
Change code	Changes the system code
Damping mA output	Allows alteration to the damping time of the mA output for O_2
Call up max./min. values	The lowest and/or highest measured values can be called up here.
Change language	Change language to either "English" or "German"
Service	Calls the service menu
Software	Shows the software version of the OXITEC® 5000 analyser system

Table 9 System menu

A description of the individual functions is given below:

9.5.1 First Steps for Calibration

Before you begin with the calibration, please make sure that the pneumatic connections are correct (for details see chapter 16 page 96). You may find a description of the requirements of the gas supply in chapters 17.1 on page 100.

The calibration starts from the O_2 value display (main window).

Figure 29 Display: main window

Press the soft key [System] to select the *system menu*.

Before you enter the system menu, you are asked to first put in the system code.

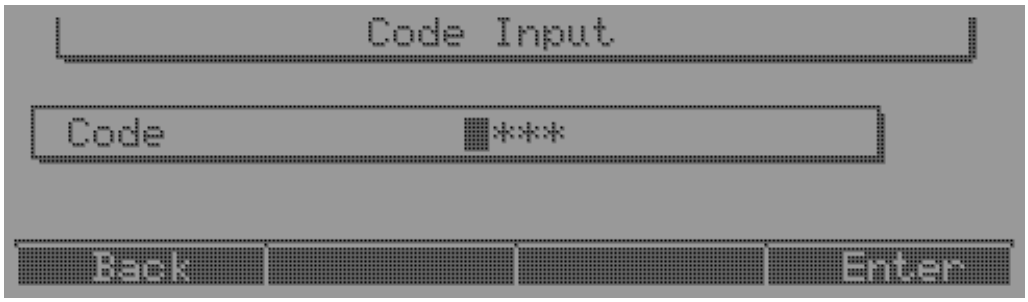


Figure 30 Display: code input

Normally you have only to confirm the factory default code by pressing the soft key [Enter]. This only works if the system code has not been changed. Otherwise put in the 4-digit system code using the keypad on the right side of the display panel, and then press the soft key [Enter].

After entering the system menu press the soft key [🡻] several times until the menu entry for the required calibration is selected. Confirm with [Enter].

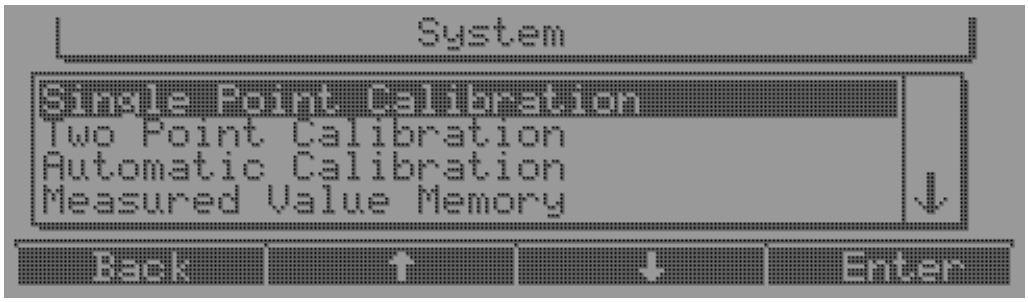


Figure 31 Display: menu entries for calibration

9.5.2 Single Point Calibration

Please take into account to chapter 9.5.1 on page 49 which explains how to get to this calibration point.

Note

If the electronic unit is connected to a probe without solenoid valve, the manual test air valve must first be opened before calibration.

In this menu item, a single point calibration with ambient air can be done. After selecting this menu item, you are requested to begin calibration with the soft key [Start]. If the system has no pneumatic unit, test air must be supplied, and the flow rate adjusted before the start of the calibration.

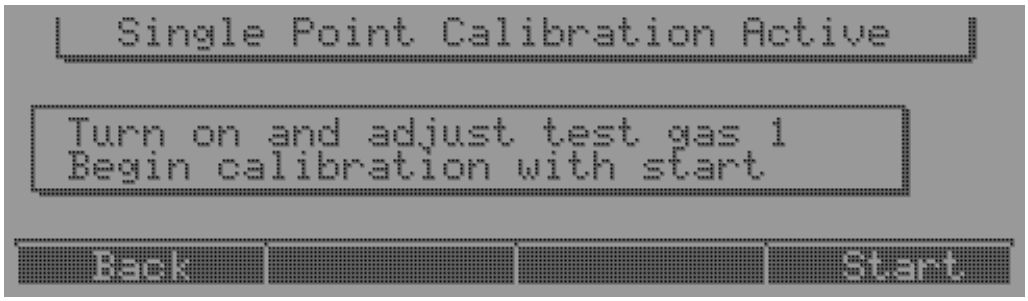


Figure 32 Request to start the calibration (system without pneumatic unit)

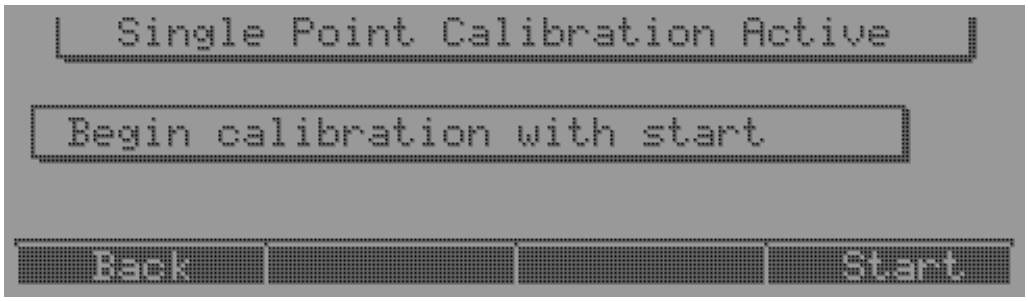


Figure 33 Request to start the calibration (system with pneumatic unit)

The single point calibration starts immediately and works fully automatically - no manual intervention is required.

In the version with integrated pneumatics, the quantity of test gas is supervised by the electronics. The horizontal bar of the following display shows the current value of the flow rate of test air. If the gas flow corresponds to the requirements, then this display appears only for a very short time, and the calibration starts automatically.

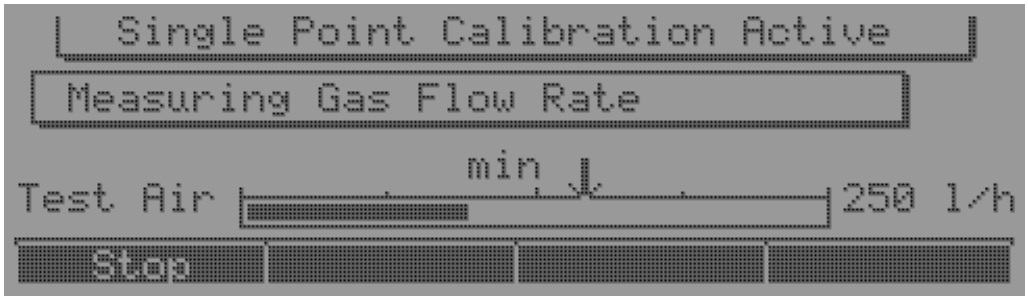


Figure 34 Display: Measuring of the flow rate (only systems with intetrated pneumatic unit)

Should this not occur and the bar does not end at the point marked by an arrow (see Figure 34), the flow rate must be adjusted accordingly. You have some minutes before an error message will be displayed. If an error message occurs, the message must be confirmed, the correct flow rate adjusted and the calibration procedure started again.

As soon as the correct flow rate is adjusted, the calibration starts automatically (if no error message appeared).

A moving time bar indicates the progress of calibration.

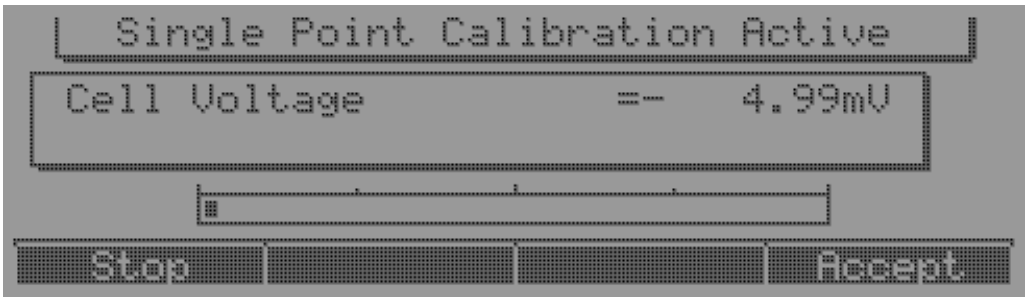


Figure 35 Display: O_2 single point calibration (system without pneumatic unit)

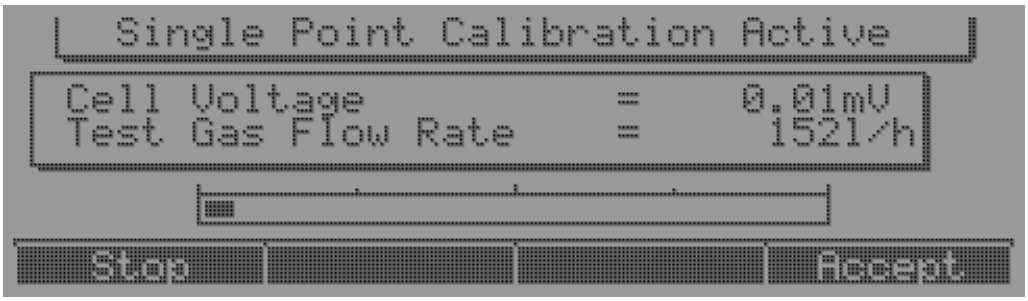


Figure 36 Display: O_2 single point calibration (system with pneumatic unit)

During calibration, the cell voltage is checked for stability. This check works according to the following criteria. The last measured value is temporarily saved, and when the next value is outside the tolerance (±0.5mV), the internal timer is reset, and the new value temporarily saved. This means that if the timer was not reset, the value is stable. In this way, the last measured value after the timer has lapsed (2 min.) is used to calculate the constant or slope. The moving time bar indicates the internal timer, if the internal timer is reset, the time bar is also reset.

When the calibration is completed, the display shows a message, which demands the acknowledgement [Ok]. In the case of a successful calibration, the message will be "*Calibration Successfully Completed*"; otherwise it will be "*Cell Constant out of Tolerance*". In this case the determined calibration values will not be accepted and the system will continue to work with the old values.

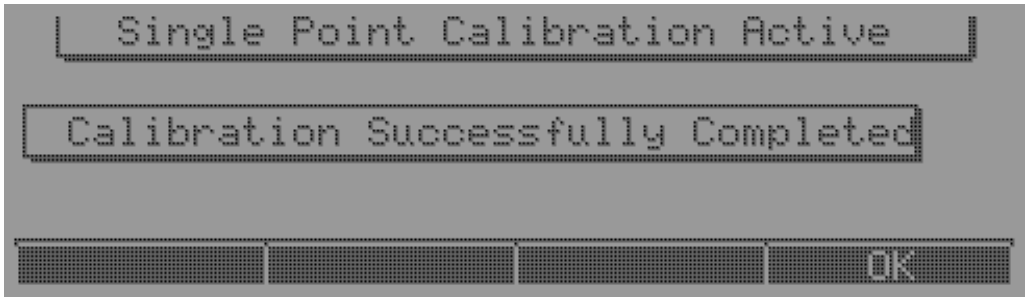


Figure 37 Advice for a successful calibration

During calibration, it is possible to accept the value of the cell voltage with [Accept] and to have the calibration parameters calculated in advance. It should however be noted that the advanced acceptance of the cell voltage is not recommended, because in this case the electronics system does not know if the output is stable, and therefore the value may not be correct.

Note

If the electronic unit is connected to a probe without solenoid valve, the test air manual valve must be closed after calibration.

9.5.3 Two Point Calibration

Please take into account chapter 9.5.1 on page 49, where it is explained how to get to this calibration point.

In this menu item, a two point calibration with air and with a test gas with a suitable test gas concentration can be performed (see for this chapter 17.1 *Requirement of the Gas Supply* on page 100). It should be noted that the concentration of the test gas must correspond to the value shown in the parameter menu.

Note

If the electronic unit is connected to a probe without solenoid valve, the manual test air valve must first be opened before calibration.

Note

The oxygen concentration of the test gas used must be first entered in the parameter menu (see also chapter 9.4 on page 43).

After selection of this menu option you are requested to start the calibration by pushing the [Start] key. In systems without integrated pneumatic unit, test air must be supplied and the flow rate adjusted before the start of calibration.

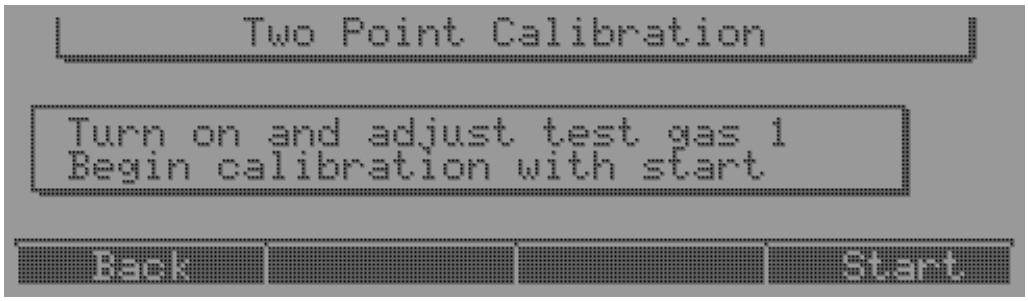


Figure 38 Display: Request to start two point calibration (system without pneumatic unit)

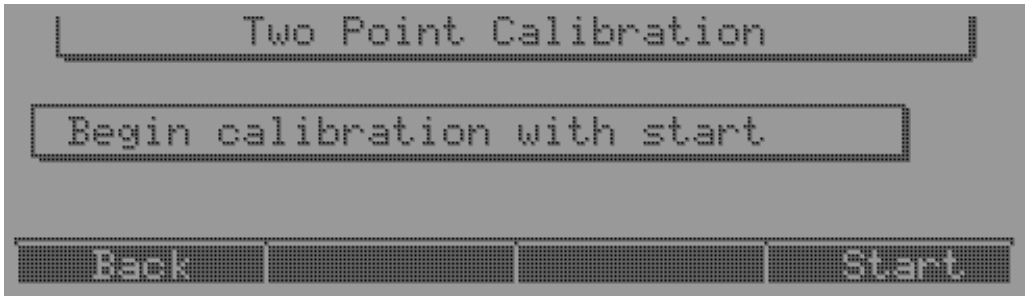


Figure 39 Display: Request to start two point calibration (system with pneumatic unit)

The first part of the calibration now starts fully automatically; and manual interference is not necessary.

With the version with integrated pneumatic unit the quantity of the test gas is supervised by the electronics. The horizontal bar of the following display shows the current value of the test air flow rate. If the gas flow corresponds to the requirements this display only appears for a very short time, and the calibration begins automatically.

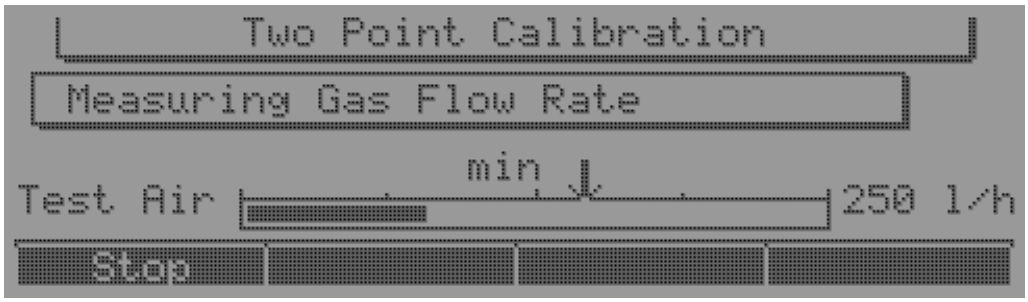


Figure 40 Display: Flow rate measuring (only systems with integrated pneumatic unit)

Should this not occur and the bar does not end at the point marked by an arrow (see Figure 40), the flow rate must be adjusted accordingly. You have some minutes before an error message will be displayed. If an error message occurs, the message must be confirmed, the correct flow rate adjusted and the calibration procedure started again.

As soon as the correct flow rate is adjusted, the calibration starts automatically (if no error message appeared).

The two point calibration takes place fully automatically in two steps. The first step of the calibration is effected with test air and the process progress is indicated in the display (see Figure 41 and Figure 42 respectively).

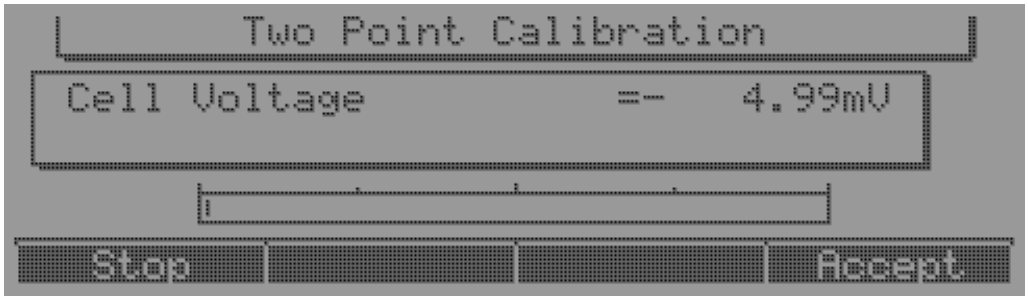


Figure 41 Display: Two point calibration 1.step (system without integrated pneumatic unit)

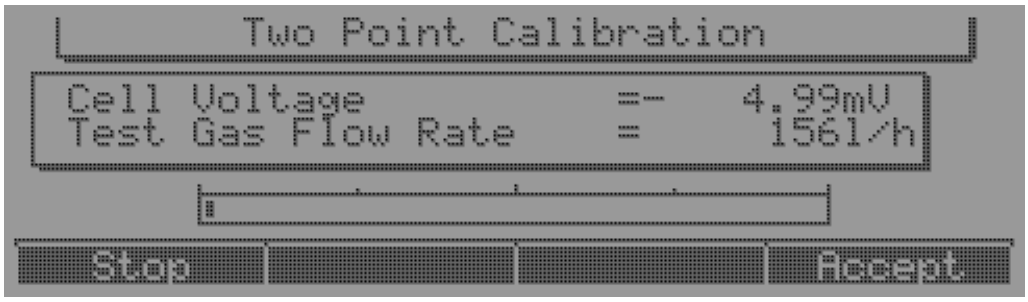


Figure 42 Display: Two point calibration 1.step (system with integrated pneumatic unit)

After completion of step 1 for systems without integrated pneumatic unit the request to supply and adjust test gas, and to start step 2 appears (see Figure 43). For systems with integrated pneumatic unit step 2 starts automatically (see Figure 44).

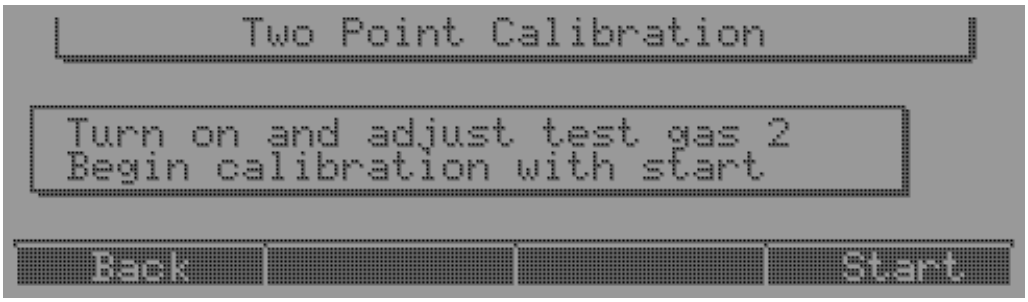


Figure 43 Display: Request to start 2. step of two point calibration (system without pneumatic unit)

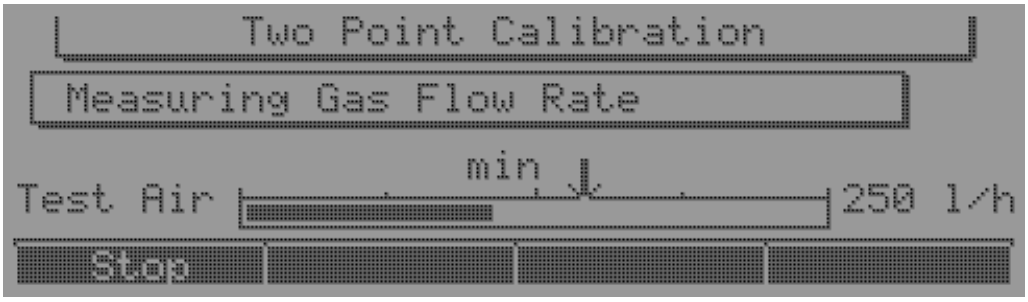


Figure 44 Display: Flow rate measuring (only systems with integrated pneumatic unit)

During the second step, calibration with the test gas is accomplished and displayed. The calibration operates fully automatically and needs two minutes per calibration, which is indicated by a moving time bar (see Figure 45 and Figure 46 respectively).

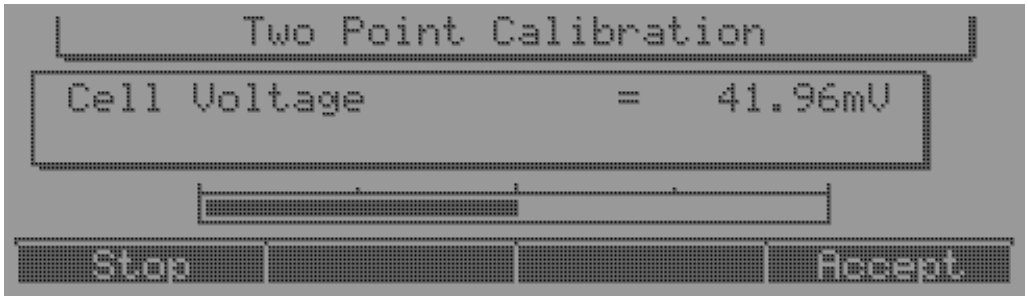


Figure 45 Display: O_2 two point calibration, 2.step (system without integrated pneumatic unit)

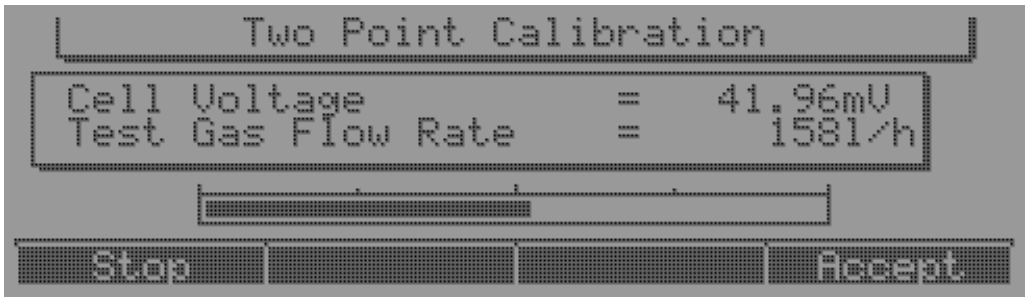


Figure 46 Display: O_2 two point calibration, 2.step (system with integrated pneumatic unit)

During calibration, the cell voltage is checked for stability. This check works according to the following criteria. The last measured value is temporarily saved, and when the next value is outside the tolerance (±0.5mV), the internal timer is reset and the new value temporarily saved. This means that if the timer was not reset, the value is stable. In this way, the last measured value after the timer has lapsed (2 min.) is used to calculate the constant or slope. The moving time bar indicates the internal timer, if the internal timer is reset the time bar is also reset.

During the Two Point Calibration, the cell voltage can be accepted in advance with [Accept], but it should be noted that for the Two Point Calibration two cell voltage values are required. It may therefore occur that after the manual acceptance of a value, the calibration progress bar jumps to the halfway position. This is not an error, but means that the electronics are now determining the second value, which can also be accepted manually.

It should, however, be noted that an advance acceptance of the cell voltage is not recommended, because the electronic system then does not know if the output is stable and may therefore not be correct.

When the calibration is completed the display shows a message, which demands the acknowledgement [Ok]. In the case of a successful calibration, the message will be "*Calibration Successfully Completed*"; otherwise it may be "*Cell Constant out of Tolerance*" and/or "*Slope out of Tolerance*".

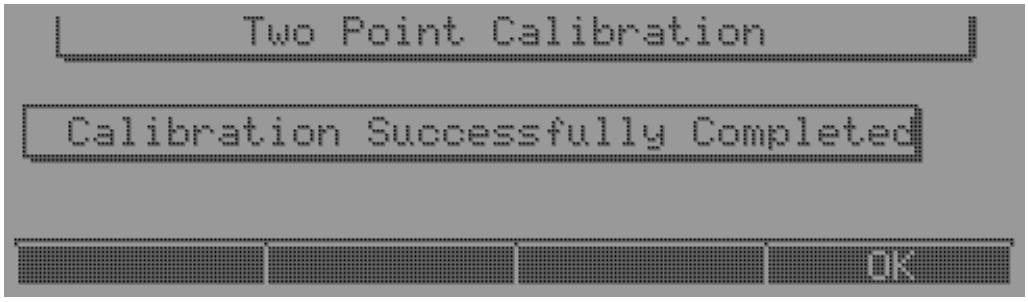


Figure 47 Advice for a successful calibration

If the parameters determined by calibration are outside the plausibility limits, this is indicated by an error message. In this case the electronics will continue to work with the old values.

Note

If the electronic unit is connected to a probe without solenoid valve, the manual test air valve must be closed after calibration.

9.5.4 Automatic Calibration (ACAL) with Air (20.95% O_2)

OXITEC® 5000 offers the opportunity of automatically performing a calibration procedure at regular intervals. All settings required for an automatic calibration can be made in this menu.

These are:

- **Type of Calibration (Single Point or Two Point)**
  At this point, the type of calibration can be selected.

- **Automatic Calibration On/Off**
  As a standard, ACAL is off. In this item, ACAL can be activated.

- **Calibration every xx days (e.g. 90 days)**
  Indication of the calibration cycle time in days. At a value of 0 days the calibration starts immediately upon release, this is important for a manual remote calibration.

- **Authorisaton (internal or external)**
  If External is selected, a calibration is made only when the digital input C*alibration release* has a “high” signal and the cycle time has elapsed. (See Chapter 0 on page 66)
  Internal means that independently of the release input status, calibration will be made when the cycle time has elapsed. If the cycle time has elapsed, but no release has been given, calibration starts immediately upon release.

- **Remaining time xx days and xx hours**
  The remaining time until the next calibration is indicated under this item.

Note

For automatic calibration it is essential to connect a probe with solenoid valve and to ensure that the test gas “air” is always available and under pressure (instrument air version) or a pneumatic unit with pumps must be installed (for details see chapter 16 on page 96).

Important

If the calibration time interval in the parameter menu is set to zero seconds for example - to make a remote calibration - it is very important that the release signal has a maximum time of 60 seconds. A release signal of more then 60 seconds could restart the calibration a second time.

Please note, there is no "real time" clock in the electronics. It does not know time of day, month or year. Only a clock-pulse generator is used for automatic calibration purposes.

9.5.5 Measured Value Memory

Under this menu item a measured value memory can be switched on during calibration. With the measured value memory ”*on”* the last measured value before calibration is saved so that at the current (mA) output, the measured value, which changes during the calibration, has no effect. The currently measured value is released again, after an adjustable delay, and when the calibration is completed.

9.5.6 System Test with Test Gas

In this menu option, a system test with test gas can be accomplished. In systems without integrated pneumatic unit the test gas has to be supplied at the probe. For systems with integrated pneumatic unit, the test gas has to be supplied at the test gas entry on the electronic unit.

Before the System Test, check in the parameter menu, whether the set value of oxygen concentration of test gas, agrees with the actual test gas concentration. If this should not be the case, the value in the parameter menu has to be corrected (see chapter 9.4 on page 43).

The System Test starts by pressing the soft key [Start].

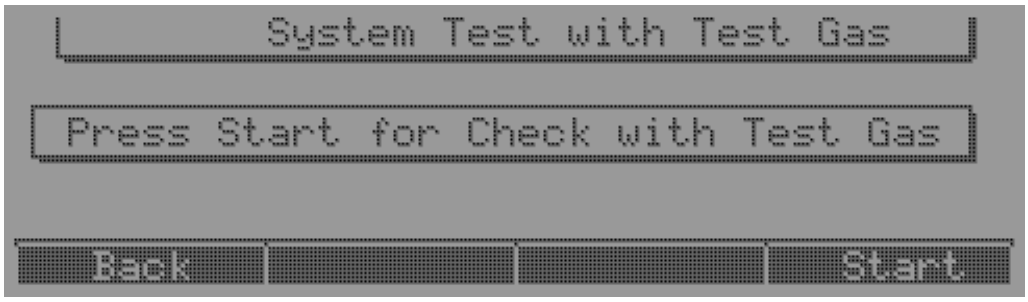


Figure 48 Display: request to start the System Test

Now the oxygen concentration of test gas is displayed (see Figure 49 and Figure 50 respectively).

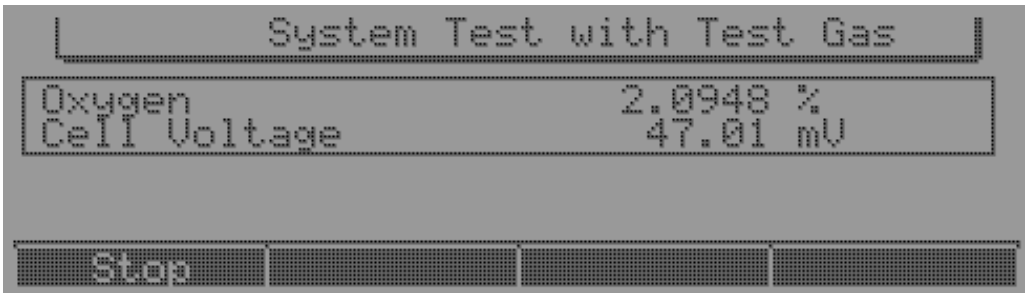


Figure 49 Display: System Test with test gas (system without pneumatic unit)

Figure 50 Display: System Test with test gas (system with pneumatic unit)

In addition, this menu permits the adjustment of the correct flow of test gas required for two point calibrations (only systems with integrated pneumatic unit). The bar indicating the flow rate of test gas must end close to the vertical arrow.

Note

If the electronic unit is not connected to a probe with solenoid valve, the manual test gas valve must be opened before System Test, and closed after finishing.

9.5.7 System Test with Test Air

In this menu option a system test with test air can be accomplished.

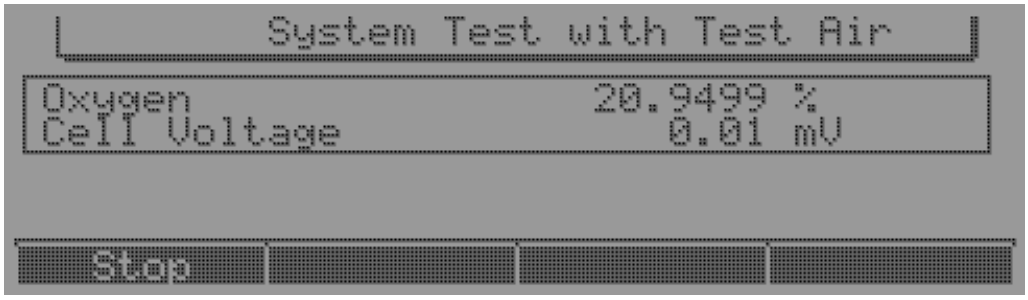


Figure 51 Display: System Test with test air (system without integrated pneumatic unit)

Figure 52 Display: System Test with test air (system with integrated pneumatic unit)

Note

If the electronic unit is not connected to a probe with solenoid valve, the manual test gas valve must be opened before System Test and closed after finishing.

9.5.8 Setting Current Output

Here, the initial value of the current output of the measured O_2 value can be selected with the keys [↑] and [↓] (0mA or 4mA).

9.5.9 Measuring Range Switching

The electronics has two measuring ranges. The switching mode of the ranges can be made manually from the instrument keypad or by an external remote 12- 24 volt input signal. In this menu item it can be determined which mode of range switching is required – “local” or “remote”.

The factory preset default in the electronic unit is "remote" range switching. This means that in case of an open digital input, the measuring range 1 is active. At the modus "local“, the measuring range can be changed in the main menu with the soft key MR1/2 by hand.

Note

In case of errors and alarms, the soft key MR1/2 in the main menu is used for status information. The status function has the highest priority, therefore this means in case of errors the measuring range cannot be changed manually (by hand).

9.5.10 Change Code

In this menu item, the system code can be changed.

Important

Note! Make sure that the current system code is well noted! Loss of the system code would necessitate a System RESET. This RESET is only possible after consultation with ENOTEC.

9.5.11 Damping of O_2 mA Output

The mA-output can be damped if required. There are optional settings, from 0 sec. (without damping), to a maximum of 55 sec. possible.

Damping is useful if the electronics unit oxygen output signal is spiky or rough due to sudden process condition changes. A smooth or damped output can be obtained with the attenuation setting feature.

9.5.12 Call up max. / min. Values

The electronics unit continuously saves the lowest and highest measured value. These values can be called up here. After quitting this item, the current minimum and/or maximum value can be deleted in order to restart recording minimum and maximum from this point in time.

9.5.13 Change Language

In this menu item the language can be selected.

9.5.14 Service

This menu item is reserved for ENOTEC service personnel only. It is factory-coded.

9.5.15 Software

Here information about the software conditions is available.

9.6 Status Messages /Error Messages

Figure 53 Display: error messages

If errors or alarms occur during operation, these are displayed as clear text in the status menu. All errors and alarms must be acknowledged in this menu display by pressing the soft key [Enter].

A 'help' function for the status messages is available in this menu.

Note

If the electronics unit is put into operation without a probe connected, some system errors will occur. E.g. "*Heating System Does Not Work"*, "*Error Cell Signal out of Range*", E*rror Wire Breakage Thermo Element"*. When the electronics unit is then connected to a probe, these errors will be displayed again, because the microprocessor stores the errors as they occur in a permanent memory (EEPROM). After acknowledgement of each of these errors, the system operates normally.

With the key [Enter] an error or an alarm can be reset, if the condition does not exist any longer (e.g. "Limit Value Injury") or the error is eliminated.

Following status messages are possible:

1. **Cell constant out of tolerance**
   As the result of a calibration check, the calculated cell constant is outside the tolerance range parameters of the microprocessor settings. Therefore the electronics continues with the previous/former cell constant value. The microprocessor tolerance range is factory set to: -50mV to +10mV.

2. **Slope out of tolerance**
As the result of a calibration check, the calculated mV/Decade slope is outside the tolerance range. The electronics therefore continues with the previous/former slope value. The microprocessor range is factory set to: 35mV to 55mV per decade.

3. **Ref.gas flow too low (only with integrated pneumatic unit)**
The reference gas flow is too low (min. 5 litre-per-hour). Please test the pressure of the instrument air supply (min. 1 bar) and if necessary, try to adjust the reference air (see page 78). With the pump version, test the pneumatic tubes for kinks or blockages. If the problem is due to the pump itself, it is possible to change the pump. Please contact ENOTEC in this instance.

4. **Cal.gas flow too low (only with integrated pneumatic unit)**
The calibration gas flow during the calibration was too low (min 150 litre-per-hour). Please see point 3 above.

5. **Heating system does not work**
The probe could not heat to the nominal temperature (840°C). Test the heater fuses (see page 78), then measure the resistance of the probe-heater, to ensure that it is between 37.5 and 40.0 Ohms.

Warning

Make sure that the power is switched off when doing this test!

6. **Wire breakage thermo element**
The electronic unit has detected an error with the thermocouple. Possible reasons: reverse connection of thermocouple (check wire connections), wire breakage, faulty thermocouple.

7. **Error cell signal out of range**
The cell voltage detected by the electronics is out of the input range (-45mV to +265mV) Possible reasons: wire breakage, extra large amount of combustibles in the measured flue gas (CO, etc.) or mechanical breakage of the cell.

8. **Temp. of electronic out of spec**
The temperature of the electronics is outside the allowed operating limits (-20°C to +55°C within its housing)

9. **Probe temperature too high**
The indicated temperature of the probe is over 890°C. Please test the temperature of the flue gas (see Chapter 11.2 - on page 76). Please contact ENOTEC.

10. **Probe temperature too low**
The temperature of the probe was or is too low (<820°C). Please look at the heater fuse and check the actual power supply voltage to the electronics unit (230V/115V ±10%).

11. Alarm limit1
Oxygen limit 1 out of range.

12. Alarm limit2
Oxygen limit 2 out of range.

13. Data fault EPROM
A data error has occurred in the microprocessor and the electronics continues with factory default values. Please contact ENOTEC.

14. Measured value memory active
The measured value memory is still active.

15. Error by trying ACAL
Automatic calibration has failed. Possible reasons: mV output value/signal from probe not stable, cell constant or mV/Dec slope outside of microprocessor tolerance/range (Note: the corresponding error is shown on the electronics display), no calibration air (instrument air version only).

10 System Description / Adjustments

10.1 In Case of Loss of the System Code

In case of loss of the system code, it is possible to reset the code to factory standard (0000). Therefore contact to ENOTEC is required.

10.2 Bridge on the Rear Side of Display Unit

Important

On the rear side of the display unit a bridge exists. This bridge is used for the first run in the factory. Don't move or remove this bridge, otherwise a fault function of the electronics unit is possible. In this case contact to ENOTEC is required.

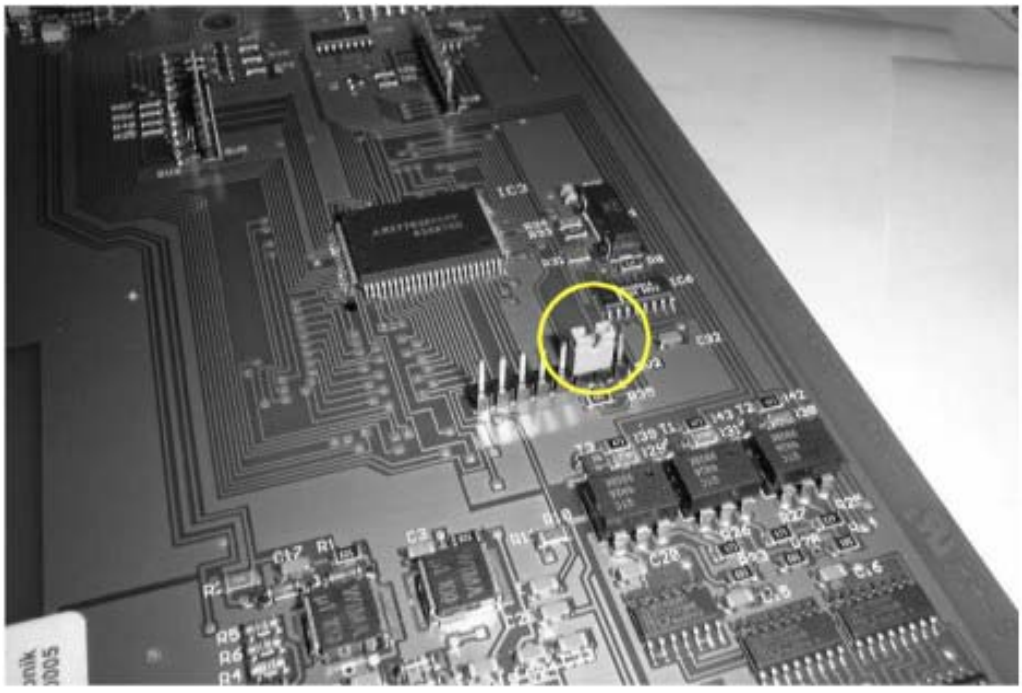


Figure 54 Rear side of the display unit

10.3 Adjustment of Display Contrast

The contrast of the display can be adjusted if necessary. This could be necessary at higher ambient temperatures. The trimming potentiometer is shown on Figure 55. To adjust the contrast it is necessary to remove the display board and power 'on' the system. Now the contrast can be adjust by a small screwdriver (type 2.5).

Warning

Working under power is only allowed for authorized, trained skilled persons in complying with the corresponding safety instructions (e.g. VDE 0105).

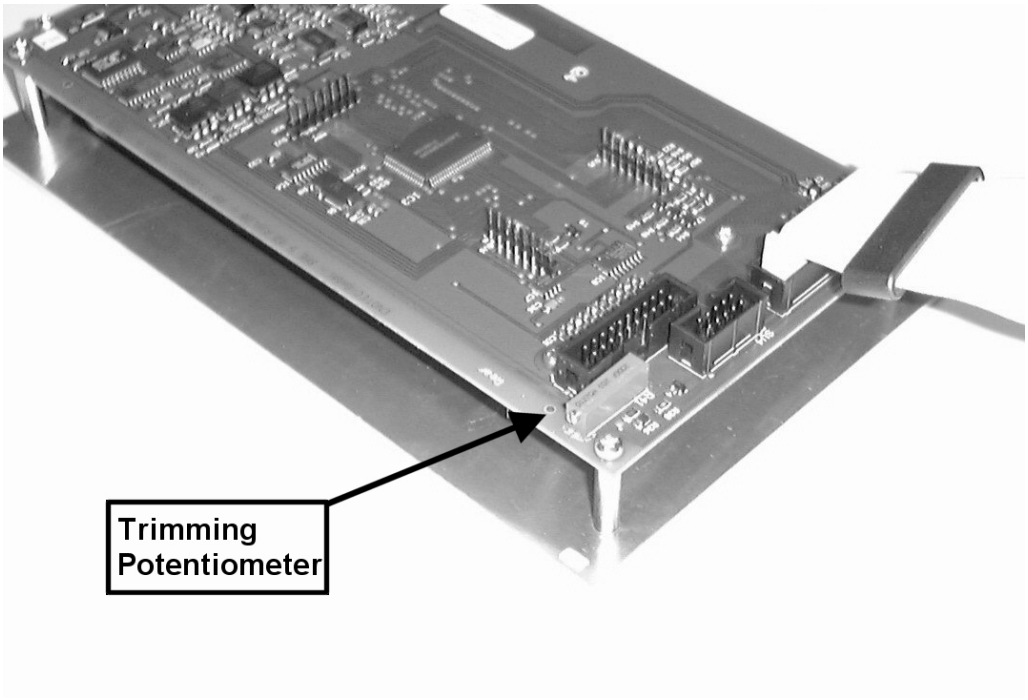


Figure 55 Adjustment display contrast

10.4 Relay Outputs / Functions and Correlation of the Relays

The relay contacts are designed for 24V and 1A ~, 1A = (Exception: probe valve)

Relay	Contact	Function
System error	break contact	Signals operation-critical errors
Service	make contact	Service code was entered, system is in service mode
Measuring range	make contact	Open: Measuring range 1 active Closed: Measuring range 2 active
Probe valve*	make contact	Triggering of the probe valve
Limit value 1	break contact	Signals a violation of limit value 1
Limit value 2	break contact	Signals a violation of limit value 2

Table 10 Relay outputs and functions

* The relay contact for the probe valve is designed for 230V and 1A ≅.

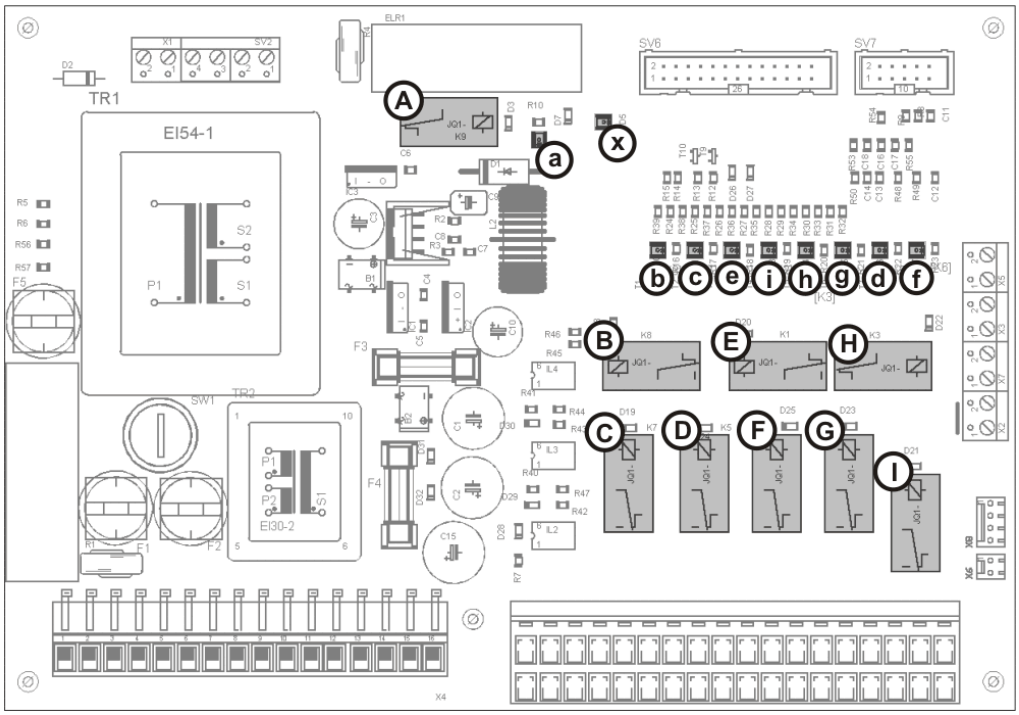


Figure 56 Relay plate with marked relays and LEDS

Relay Mark	LED Mark	Function	Terminal.Contact
A	**a**	Main probe heater relay	
B	**b**	Maintenance	X4.18
C	**c**	System error	X4.19
D	**d**	Limit O2 1	X4.21
E	**e**	Measuring range	X4.20
F	**f**	Limit O2 2	X4.22
G	**g**	Probe valve	X4.23/X4.24
H	**h**	Solenoid valve test gas 1	X7
I	**i**	Solenoid valve test gas 2	X2
	x	Probe heater control	

Table 11

10.5 Digital Inputs

The digital inputs are designed for a direct voltage of 12 V - 30 V for logical “High”. Logical “Low” agrees a voltage less than 1 V.

Digital input	Function
Calibration release	External release for calibration with ACAL
Measuring range shift	Switching on the second measuring range

Table 12 Digital inputs and their functions

10.5.1 Digital Inputs at Limit Curves Option

These digital inputs are designed for a current of 0..4mA for logical “low”, and 5..20mA for logical “high”.

Terminal names	Terminal function
29 A	+ Digital Input 1, select fuel, current input (0..4mA, 5..20mA)
29 B	- Digital Input 1, select fuel, current input (0..4mA, 5.. 20mA)
30 A	+ Digital Input 2, select fuel, current input (0..4mA, 5..20mA)
30 B	- Digital Input 2, select fuel, current input (0..4mA, 5..20mA)

Table 13

Important

The external current for the inputs (28 to 30) must be electrically isolated from ground. Otherwise a malfunction or damage to the electronics unit is possible.
Do not exceed the maximum current of 20mA.

10.6 Pressure and Flow rates for Test Air and/or Reference Air

The systems are factory-set to the correct amounts of test air and/or reference air.

The instrument air versions are designed for an inlet pressure of 1-10 bar. With a higher inlet pressure of 6 bar, it is necessary to readjust the flow of reference air and/or test air (see chapter 12.3 on page 78).

The flow rates for air should be in the following range:

Test air: 150l/h - 180l/h
Reference air: 30l/h - 40l/h

The flow of reference air can be checked in the actual value menu. In systems with integrated pneumatic unit, test air and/or test gas flow can be examined and adjusted in the system menu under System Test (see page 58).

10.7 Stability Criteria for Calibration

During calibration, the cell is checked for stability. This check operates according to the following criteria.

The last measured value is always temporarily saved. When the next value is outside the tolerance, the internal timer is reset and the new value temporarily saved. This means that if the timer was not reset, the value is stable. In this way, the last measured value after the timer has elapsed (2 min.) is used to calculate the cell constant or slope.

10.8 Reaction Time of the mA Output

The reaction time of the mA output to a change of the O_2 cell input voltage is less than 200 ms.

10.9 Extension modules

As an option, the electronic unit is available with a RS 232 Interface Module.

10.9.1 RS 232 Interface (option)

10.9.1.1 Global Description

The bidirectional OXITEC®/COMTEC® serial interface protocol is used for value requests, parameters settings and function executions. The transmission is frame-oriented; it means that each transmission block is framed by defined control characters. Within the frame only readable characters (ASCII) are allowed. The length of each transmission block is dependant upon the function and also its assigned data.

The serial communication protocol has no address attribute, therefore it is not possible to use it for a multi-slave communication bus. Within each transmission frame there are only ASCII characters allowed but no control characters. Therefore digits and values are transmitted as text. Memory dumps are transmitted as HEX character strings. A CRC8 checksum secures each transmission frame and is placed at the end of each transmission block as a HEX character string.

10.9.1.2 Description of the Transmission Block (Frame)

In principle the structures of the transmission blocks of a master request (e.g. PC) and of a slave answer (e.g. OXITEC or COMTEC) are identical. Additionally the answers of the slave have a leading ACK control character to identify a successful transmission. The slave transmits a NAK control character on any transmission faults or unsupported functions. Each transmission block is framed by the control character STX and ETX.

10.9.1.2.1 Definition of the Control Characters

The control characters are transmitted as 8 bit values and they are defined as follows:

Control Character	Value (decimal)	Value (hexadecimal)
STX	2	0x02
ETX	3	0x03
ACK	6	0x06
NAK	21	0x15

10.9.1.2.2Master Request ➔ Slave

Any request is defined as follows:

<STX><C><NN><UUUU><F><D....D><HH>**<ETX>**

Definition	Description	Count of Characters
<STX>	STX control character	1
<C>	Operation Mode: '1' read operation '2' write operation '3' execute operation	1
<NN>	Function Number (see also the following chapters) '00' to '99'	2
<UUUU>	Dimension (Unit) In Clear Text, e.g.: ' %' ' mV' ' mA' ' °C' ...	4
<F>	Format Character 'A' ASCII (not used yet) 'F' floating point, single precision 'D' floating point, double precision (not used yet) 'I' 16Bit INTEGER, signed 'U' 16Bit INTEGER, unsigned 'L' 32Bit INTEGER, signed 'N' 32Bit INTEGER, unsigned	1
<D..D>	Values as hex character string (memory dump) or as plain text (for format ‚A' only)	0...22
<HH>	CRC8 checksum, hexadecimal character string e.g. ‚3B' or ‚04'	2
<ETX>	ETX control character	1

Table 14

10.9.1.2.3Answer Slave ➔ Master

10.9.1.2.3.1 Positive Answer (ACK)

Positive answers will be transmitted to the master, if the request block could be interpreted correctly and also executed. The answer transmission block is sent with a leading ACK control character.

<ACK><STX><C><NN><UUUU><F><D....D><HH>**<ETX>**

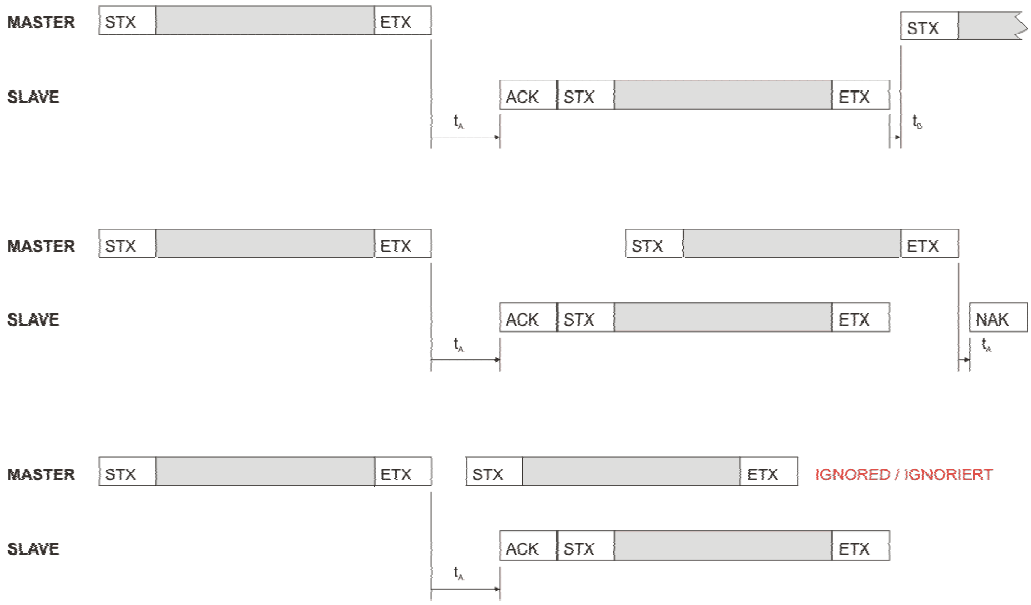
The description of the transmission format definition is described on chapter Table 14 on page 69.

10.9.1.2.3.2 Negative Answer (NAK)

Negative answers will be sent back to the master, if:

- more than 32 characters were transmitted by the master within the STX and ETX control characters
- the STX control character is missing
- the checksum is not correct
- the operation mode is not defined (in general or not for the desired function, e.g. a write access to a read-only value)
- less than required characters were transmitted
- invalid characters has been detected within the transmission block
- the function number is not supported

10.9.1.2.4Timing



t_A answer time, min. 0ms, max. 1000ms
t_D delay time to the next request after an answer, min. 0ms

10.9.1.2.5Checksum Calculation

10.9.1.2.5.1 Specification

The checksum is defined as CRC8 with its polynomial

$$C(x) = x^8 + x^2 + x + 1$$

The CRC8 calculation includes all characters within the STX and ETX control character except the two CRC8 checksum characters itself.

10.9.1.2.5.2 C Example

```
unsigned char stxetx_getcrc8(void *src, int count)
{
  unsigned                crc= 0x00;
  int                     i;
  while(count--) {
    crc^= *((unsigned char*)src);
    ((unsigned char*)(src))++;
    for(i= 0; i<8; i++) {
      if(crc & BIT(7)) {
        crc<<= 1;
        crc^= 0x07;
      } else crc<<= 1;
    }
  }
  return((unsigned char)crc);
}
```

10.9.1.3 Operation Modes

10.9.1.3.1Read Operation

10.9.1.3.1.1 Specification

The read operation opcode is 1.
The read operation transmission block consists of at least 5 characters:

Request: **<STX>**1<NN><HH>**<ETX>**
Answer : **<ACK><STX>**1<NN><UUUU><F><D....D><HH>**<ETX>**

10.9.1.3.1.2 Example

Request for an oxygen value:

Request: **<STX>**100E3**<ETX>**
Answer : **<ACK><STX>**100 %F9A99A741C8**<ETX>**

The function returns a floating point (single precision) memory dump which is interpreted as 20.95% O_2.

10.9.1.3.2Write Operation

10.9.1.3.2.1 Specification

The write operation opcode is 2.
The write operation transmission block consists of a format dependent block length.

Request: **<STX>**2<NN><UUUU><F><D....D><HH>**<ETX>**
Answer: **<ACK><STX>**2<NN><UUUU><F><D....D><HH>**<ETX>**
The format characters (<UUUU>) can be set blank on request. The format character must have the correct function-dependent format.
A format character which is not supported by the desired function will be acknowledged by a NAK control character.

The data which must be transferred are defined as HEX character string of the memory dump.

10.9.1.3.2.2 Value Limitation

Each data can be limited by a function-dependent minimum and maximum value. If the value exceeds this limits it will be automatically set to its depended limitation value. In this case the answer contains the new limited value.

10.9.1.3.2.3 Example

The following example shows how the O_2 cell constant can be written. The set value of 50.00mV exceeds the maximum value of 10.00mV; therefor it is limited to a value of 10.00mV.

Request: **<STX>**210 F00004842F8**<ETX>**
Answer: **<ACK><STX>**210mVF000020411A**<ETX>**

The set value of 50.00mV is limited to 10.00mV, therefor the limited value is returned.

10.9.1.3.3Execute Operation

10.9.1.3.3.1 Specification

The execute operation opcode is 3.
The execute transmission block consists of at least 5 characters:

Request: **<STX>**3<NN><HH>**<ETX>**
Answer: **<ACK><STX>**3<NN> U<DDDD><HH>**<ETX>**

The answer contains the execution status which is defined as follows:

0000	normal execution, process running
0001	previous execution process is still running
FFFF	not supported

10.9.1.3.3.2 Example

The following example executes a single point calibration. The execution status is directly returned.

Request: **<STX>**3201F**<ETX>**
Answer: **<ACK><STX>**320 U0000E3**<ETX>**

In this case the execution progress must be requested by a read operation of the calibration status variable, function number 05.

10.9.1.4 Device Dependent Functions

10.9.1.4.1Specification

Because of supporting different devices, there are some functions which were only implemented in COMTEC® and OXITEC® respectively.
If a function is not supported by the device the return value is always 0. Also the unit definitions contain only space characters.
The device type can be requested by function no. 26.

10.9.1.4.2Example

The following request asks for the CO_e value on an OXITEC® system. The CO_e value is not supported by OXITEC®.

Request: **<STX>**106F1**<ETX>**
Answer: **<ACK><STX>**106 F0000000048**<ETX>**

10.9.1.5 Implementation Table

Fn	Operation	Description	Format	Dimension (Unit)	min	max
00	read only	oxygen value	F	%		
01	read only	O_2 cell voltage	F	mV		
02	read only	O_2 cell termpature	F	°C		
03	read only	O_2 current output	F	mA		
04	read only	status signals	N			
05	read only	O_2 calibration status 0 last calibration successful 1 last calibration fault 2 calibration still active 3 calibration pending	U			
06	read only	CO_e value	F	ppm		
07	read only	CO_e sensor resistance	F	Ohm		
08	read only	CO_e sensor temperature	F	°C		
09	read only	CO_e heater resistance	F	Ohm		
10	read / write	O_2 cell constant	F	mV	-50.00	+10.00
11	read / write	O_2 cell slope	F	mV	+35.00	+55.00
12	read / write	O_2 limit 1	F	%	+0.00	+21.00
13	read / write	O_2 limit 1 function	N		0 (min)	1 (max)
14	read / write	O_2 limit 2	F	%	+0.00	+21.00
15	read / write	O_2 limit 2 function	N		0 (min)	1 (max)
16	read / write	O_2 lower range	F	%	0.00	O_2 upper range
17	read / write	O_2 upper range	F	%	O_2 lower range	21.00
18	read / write	O_2 current output average time	N	sec	0	55
19	read / write	not used				
20	execute	single point calibration	U			
21	execute	O_2 two point calibration	U			
22	read	CO_e current output	F	mA		
23	read / write	CO_e calibration zero offset	F	Ohm	0	999999
24	read / write	CO_e calibration span	F	Ohm	0	999999
25	read / write	CO_e measuring range	F	ppm	500	10000
26	read only	device type 0 OXITEC 1 COMTEC	U			
27	read only	CO_e calibration status 0 last calibration successful 1 last calibration fault 2 calibration still active 3 calibration pending	U			
28	execute	CO_e single point calibration	U			
29	execute	CO_e two point calibration	U			

Table 15

11 Technical Data

11.1 Technical Specification Electronics Unit

Dimensions:	see dimensional sheets for the different housings
Mains voltage:	Instrument air version: 230 V / 50...60Hz Toleranz ±10% 115 V / 50...60Hz Toleranz ±10% Pump version: 230 V / 50Hz Toleranz ±10% 115 V / 50Hz Toleranz ±10% 230 V / 60Hz Toleranz ±10% 115 V / 60Hz Toleranz ±10%
Power consumption:	400 VA during start up 100 - 200 VA running
Recommended fuse:	10A
Working ambient temperature:	Version without pneumatic: -20°C to +55°C Instrument air version: -20°C to +55°C Version with pumps: -20°C to +50°C Version in 19“ housing: 0°C to +60°C other temperatures on request
Storage temperature:	-40°C to +80°C
Interference resistance:	to EMC regulations & Low Voltage Regulation 73/23 EEC EN 50081-2: July 1993 EN 50082-2: March 1995
Relay outputs, potential-free:	24V ≂ 1A
Max. relay output solenoid valve:	230V ~ 1A
Analogue input cell:	Re: > 9 MOhm Ue: -45mV to +265mV for the active measuring range
Resolution of the digitizers in the active measuring ranges:	14 Bits + sign
Analogue input thermocouple:	Re: > 900 kOhm
Temperature compensation:	on the circuit board
Signal output 0/4...20 mA:	maximum load 500 Ohm, potential-free
Reaction time of the mA output:	With a change of 100mV on the cell input <200 ms
Display:	LC, LED-lit 240 x 64 dots graphic display
Measuring accuracy:	±0.2% of actual measured value
Protection class:	Field housing: IP66 GFK housing: IP66 19“ housing: IP20

11.2 Technical Specification Probe

Flue gas temperature:	KES-132x:	up to 400°C up to 1400°C with protection tube
	KES-200x:	up to 600°C up to 1400°C with protection tube
	KIS-200x:	up to 800°C up to 1400°C with protection tube
	KES500x:	up to 600°C up to 1400°C with protection tube
Depth of immersion:	KES-1321:	385mm
	KES-1322:	475mm
	KES-1323:	615mm
	KES-2001:	495mm
	KES-2002:	925mm
	KES-2003:	1835mm
	KES-2004:	2768mm
	KES-2005:	3682mm
	KES5001:	520mm
	KES5002:	950mm
	KES5003:	1865mm
Measuring principle:	Zirconium oxide	
Flue gas pressure:	-50 to +50mbar	
Flow velocity:	0 to 50m/s	
Ambient temperature:	-40°C to +80°C	
Response time (lag time):	0,5s (flue gas flowing at > 10m/second)	
T90 time:	5s (flue gas flowing at > 10m/second)	
Probe material:	V4A (1.4571/316SS)	
Type of protection:	IP65	
Detection limit:	< 1ppm	
Voltage supply:	via electronic unit	
Dimension:	see types of probes	

12 Service and Maintenance

12.1 Switching between 230 V and 115 V Operation

The working voltage can only be changed after removing the board cover.

Warning

De-energize system first!

The switch for changing the voltage (in Figure 57 marked with SW1) can be made with a screwdriver and rotating to the voltage which is required.

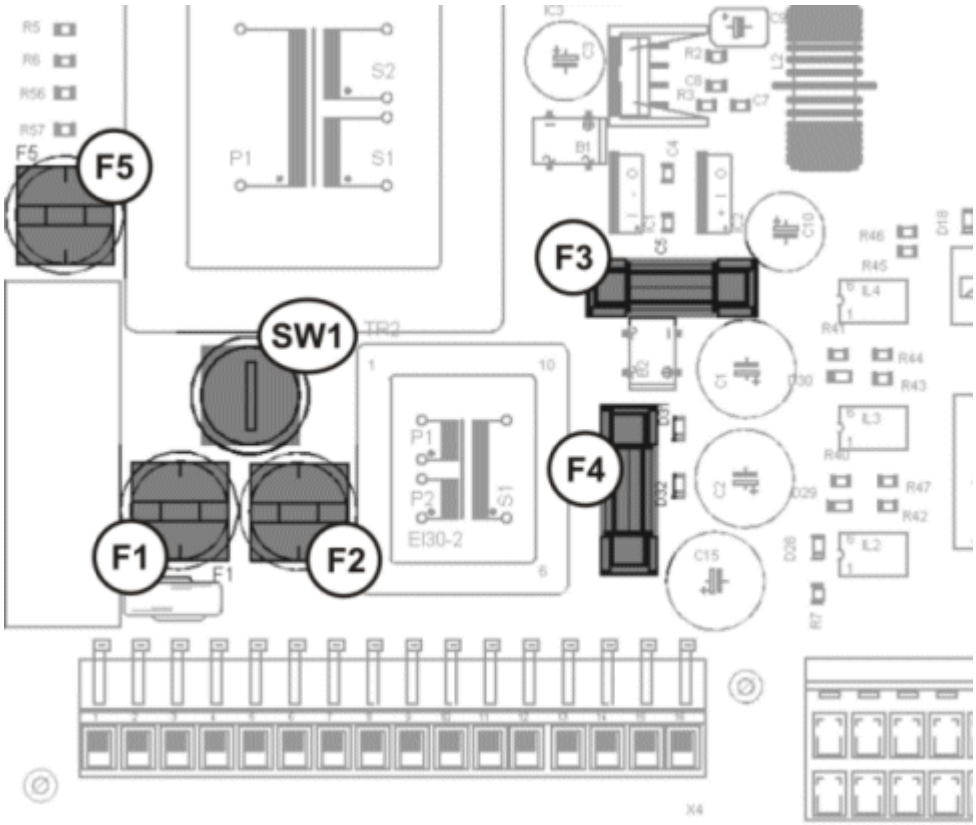


Figure 57 Switching between 230 V and 115 V operation (SW1)

Note

It must be noted that the standard pump version of the OXITEC® 5000 is designed for 50Hz.

For the pump version for 60Hz mains, a special order is necessary. The mains frequency cannot be changed by the customer.

The instrument air version is specified for 50-60Hz power supply.

12.2 Replacing the Fuses

The electronics has four accessible fuses (see Figure 57):

Fuse	Nominal Current	Description
F1	6.3 A	semi time-lag 5x20mm glass tube fuse – to protect the entire system
F2	4 A	semi time-lag 5x20mm glass tube fuse – to protect the probe heater
F3	1 A	semi time-lag 5x20mm glass tube fuse – to protect the electronic
F4	1 A	semi time-lag 5x20mm glass tube fuse – to protect the electronic
F5	1A	semi time-lag 5x20mm glass tube fuse – to protect the solenoid valve, the test gas pump and reference gas pump

Table 16 Fuses

Important

The fuses on the circuit board below the cover (F3 and F4) protect the electronics unit and should only be replaced by service personnel. Otherwise damage to the electronics cannot be excluded.

12.3 Adjusting the Flow Rate of Reference and Test Air

In a system with an integrated pneumatic unit, it is possible to adjust the reference and test air at the electronic unit.

At this point, the pump and instrumental air versions are different:

- In the pump version, **only**, the flow rate of **test air** can be adjusted (see Figure 58).
- In the instrumental air version **both** flow rates (test air and reference air) can be adjusted (see Figure 59).

The flow rate of reference air can be read in the actual value menu (see chapter 9.3 on page 41). The flow rate of calibration air can be read in the system menu under the menu point "*System Test with Test Air*" (see chapter 9.5.7 on page 59).

You may find the flow rates which have to be adjusted in chapter 10.6 on page 67.

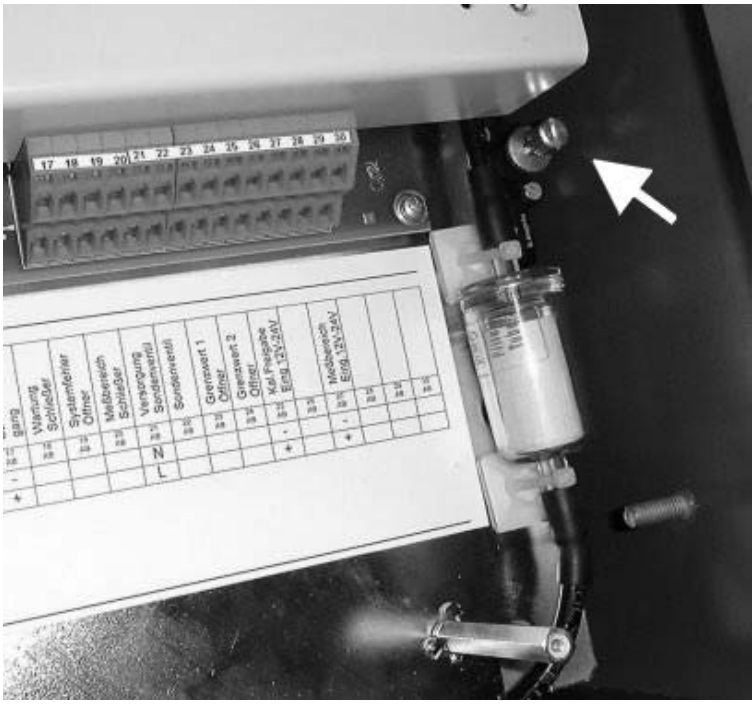


Figure 58 Position of valve (pump version)

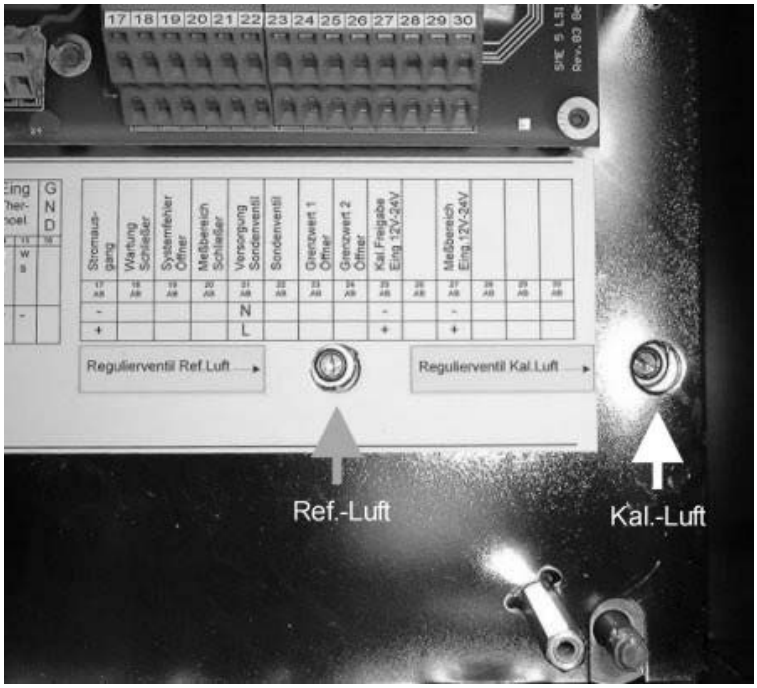
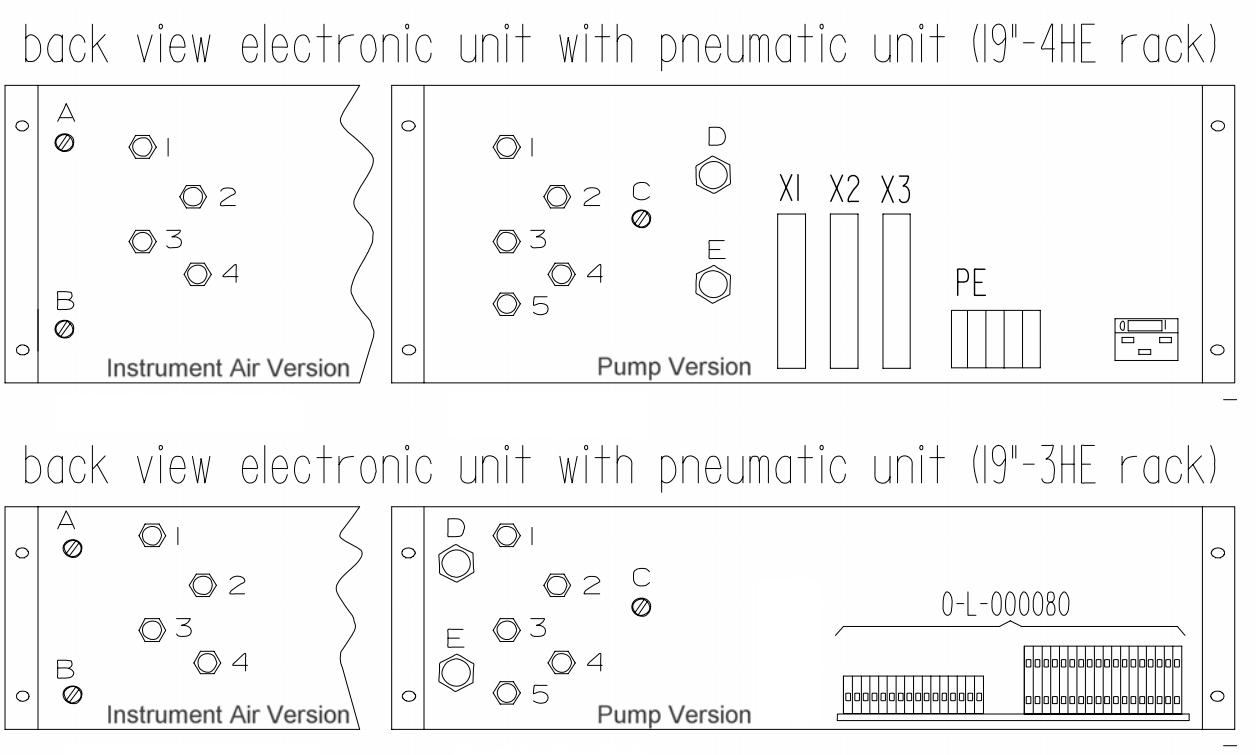


Figure 59 Position of valves (instrument air version)

At systems in 19“ racks the reference air and test air quantity can be adjusted at the back side of electronics.



A	Regulator Test Air
B	Regulator Reference Air
C	Regulator Test Air
D	Test Air Filter
E	Reference Air Filter

Figure 60 Regulating valves for adjustment of reference air and test air quantity (electronics in 19” racks)

12.4 Replacing Filter

Note

Only cemented ceramic, basalt and sintered metal filters can be replaced.

a) Loosen both fixing screws at the filter head and pull off the filter head from the probe.

Warning – Hot Surface

Probe may be hot!

b) Clamp the filter head into a vice.

c) Remove the old filter completely. Also, clean the grooves in the metal fixing.

b) Insert new filter with cement as follows:
Mix cement thoroughly, and coat both the grooves in the seat and the filter around the seat on the outside. Press the filter into the seat by turning it. Wipe the cement between filter and seat and remove excess material inside as well.

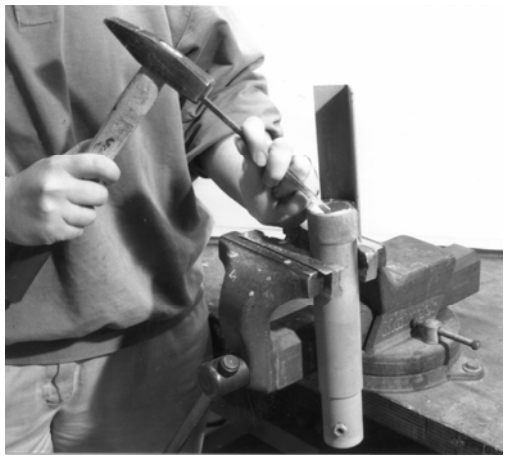


Figure 61 Dismantling of filter

Note

The cement dries at room temperature within 24 hours. Using the cement supplied by ENOTEC, all types of ceramic, basalt and sintered metal filters supplied by can be inserted and fixed.

12.5 Exchange of ZrO_2 Measuring Cell

Note

An exchange of the measuring cell is only necessary if the cell is leaking (erratic or incorrect measured values).

Switch off the electronics unit, take the probe out of the protection tube and wait until it has cooled down.

Warning – Hot Surface

The probe may only be removed with heat-insulated gloves. Before removing the probe, always switch off the supply voltage to the electronic system. After removal, store the probe in a safe, protected place and wait until it has cooled down below 35°C.

If necessary, clean the probe, removing dirt and dust, after it has cooled down.

Disconnect the wires in the connection head and loosen the two allen screws, which hold the inner parts of the tube. Pull off the thin transparent reference air pipe from the entry fitting at the connection box.

Pull out probe internal assembly (4-hole ceramic rod with signal measuring wire, thermocouple element and heater) carefully.

Important

The measuring signal wire may be fused/fixed solid with its contact net to the inside of the ZrO_2-cell.

Pull off the orange insulation from the measuring signal wire but do not pull out the signal wire with the probe inner parts, if may be fixed/fused to the inside of the cell.

Loosen the four allen screws at the flange of the measuring cell and remove the measuring cell from the measuring cell tube (with signal wire, if fixed/fused to it).

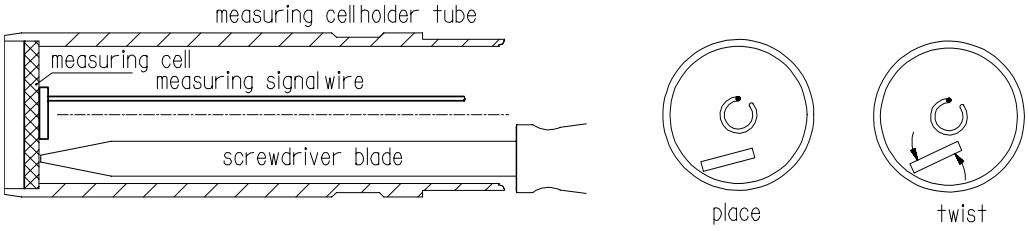


Figure 62 Measuring cell holder tube in cut

Insert a screwdriver or the like carefully between the measuring cell holder tube and the contact net of the measuring signal wire and prise the contact sideways away by turning the screwdriver. Remove the loosened measuring signal wire. Slide the measuring signal wire back into the 4-hole ceramic rod and make certain that the round contact net lies in the recess of the heater support.

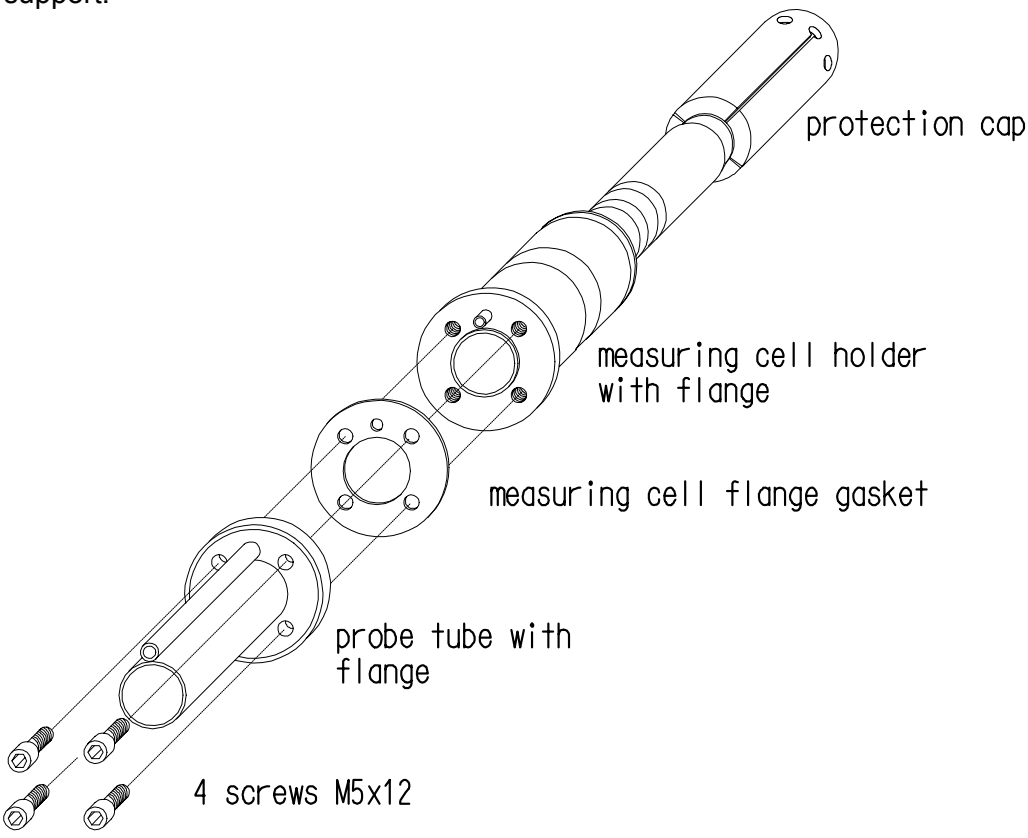


Figure 63 Measuring cell assembly

Clean the flange at the probe tube with fine sandpaper. Tighten the new measuring cell with a new metal gasket sealing and four new screws at the measuring cell flange of the probe tube. Insert the probe inner parts and ensure that the inner parts do not bind in the probe tube. Press the locking bolt against the spring, so that the inner parts assembly is pressed against the measuring cell with enough spring tension.

Tighten locking bolt and connect wires as follows:

Terminal	Colour	Description	Polarity	Unit
1	green/yellow	signal wire, measuring cell	-	mV
2	Orange	signal wire, measuring cell	+	mV
3	Green	thermocouple element	+	mV
4	White	thermocouple element	-	mV
5		free		
6	Black	heating element		
7	Blue	heating element		
8	green/yellow	ground/earth heater		

Table 17

Note

With older probes the colours of the connecting leads of the thermocouple can be designed according to the old colour code (see Table 18).

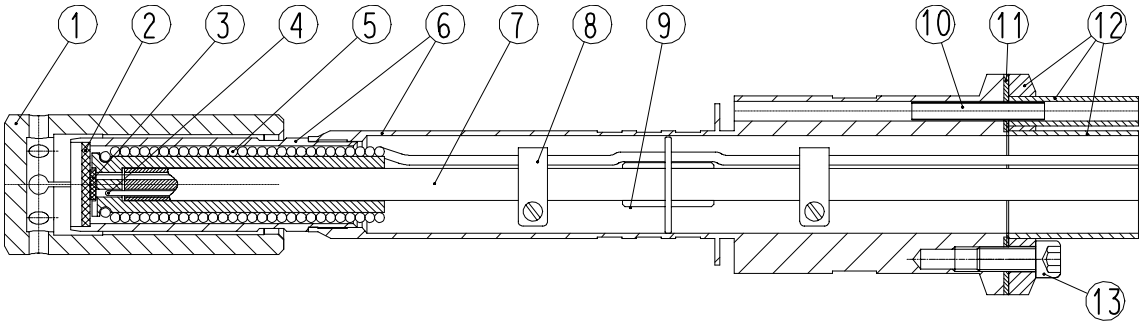
Polarity of thermo-couple	**DIN IEC 584**	DIN 43710 (old German)	ANSI MC 96.1 (US)
+	**green**	red	yellow
-	**white**	green	red

Table 18 International colour codes for NiCrNi thermocouple wires

Warning – Hot Surface

In addition, the outside surface of the probe is hot (300°C).

Install the probe and carry out an O_2 two point calibration.



1. protection cap
2. cell
3. signal wire pad
4. thermocouple
5. heater
6. cell holdering type
7. ceramic rod
8. fixing clamp
9. spacer
10. test gas connetion tube
11. flange gasket
12. measuring probe tube
13. screws M5

Figure 64 Construction of the measure cell holder tube

12.6 Exchange of Probe Inner Parts

Proceed as described in paragraph 12.5 on page 81 to dismantle the probe inner parts assembly. The exchange of the thermocouple element is an exception, because this can be changed without dismounting the probe inner part as a whole.

12.6.1 Exchange of Thermocouple Element

The thermocouple element is a covered thermocouple element with an Inconel-covering and a Ni-Cr-Ni thermocouple.

The thermocouple element is in one hole of the 4-hole-rod. Disconnect the thermocouple element at the probe connection box, pull it out and insert a new thermocouple element. If the probe is very long, it may be necessary to pull out the probe complete inner parts assembly.

12.6.2 Exchange of Heating Element

Remove the probe inner parts assembly, loosen the clamp, pull out the signal measuring wire and pull off the heater complete with ceramic support, from the 4-hole ceramic rod.

Assemble the new heater, if necessary with new ceramic support and new 4-hole ceramic rod.

Insert signal measuring wire and thermocouple element; assemble clamps and connection sleeves (for long probes).

Important

The heater support has three drillings, which must correspond with three holes of the 4-hole ceramic rod. Through one hole the reference air flows, another hole is for the thermocouple and the third one is for the signal measuring wire. Make sure that the grip net lies in the recess of the heating support.

12.6.3 Exchange of Signal Measuring Wire

The signal measuring wire has a specially shaped contact for taking the mV-value of the reference electrode of the ZrO_2-measuring cell. The contact wire is pressed against the measuring cell by means of spring tension of the inner parts assembly.

If there is not enough spring tension or if the wire is broken, the mV-signal can not be received any longer, and an error signal will occur.

12.6.4 Exchange of 4-Hole Ceramic Rod

Depending on the length, the probe has one or more 4-hole rods. In the case of long probes, you have to ensure during assembling, that the holes correspond to one another, so that installation can be carried out and the reference air can be routed to the inner reference air side of the O_2 measuring cell.

13 Trouble Shooting

The following information is intended as a key element to assist trouble shooting. It is not a comprehensive list of all possible system errors.

If defects cannot be repaired, please contact us or an approved service agent directly:

E N O T E C G m b H
M a r i e n h e i d e
H ö h e r B i r k e n 6
51709 Marienheide - Rodt
Germany

Phone: (++49) 2264 4578-0
Fax: (++49) 2264 4578-31
Email: info@enotec.de

If the measured O_2 value appears doubtful, first check all system parameters. If all Parameters are correct, check the system with test gas. If the system works correctly with test gas and there are no leakages in the area of the probe (flanges, calibration gas connection), then the measurement is correct.

If for instance, certain system parameters are wrong, then the measured O_2 value cannot be correct. With the following instructions, try to localize or repair the disorder.

13.1 Display remains at the Measuring Range End or is higher than expected

Steps to localize the problem:

1. All system parameters are correct and the ENOTEC O_2 analyser system shows the correct value with test gas.

Action: Check all flanges and screw connections for tightness.

Result 1: O_2 value drops to normal level.

Result 2: O_2 value remains high

Cause: Leakages at the measuring probe or at the measuring cell flange seal.

Remedy: Exchange measuring cell or replace measuring cell flange metal gasket seal. In case of a leakage in the area of the zirconium oxide measuring cell, this must be replaced.

13.2 O_2 Display Indicates 0 %, although the Process Operation Mode expects a higher O_2 Value

Steps to localize the problem:

1. Check the measuring cell temperature (set value 840°C)

A cell temperature below 600°C may lead to a 0% display.

Result 1: Cell temperature okay, next check.

Result 2: Wrong measuring cell temperature.

Causes:
a) Measuring probe heater defective (resistance must be approx. 35-42 Ohm, disconnect probe and check). Note: De-energize probe first.
b) Thermocouple defective (check resistance, approx. 2-80 Ohm)
c) Fuse for heater voltage defective.
d) Transformer (230/115V) defective, check voltages.
e) Triggering for temperature control or electrical load relay defective.

2. Check the mV value of the O_2 measuring cell

Result 1:
The mV value is outside the usual range (see characteristic line) e.g. above 267 mV or below - 45 mV.

3. Check the mV value directly on the probe

De-energize electronic system.
Disconnect the probe cable from the probe on terminals 1 + 2 and switch on the electronic system. After the heating phase measure the cell voltage with a high-resistance voltmeter on the probe strip terminal.

Result 1:
If the mV value at the probe is measured which yields - according to the cell slope and at the correct measuring temperature, a probable O_2 value, the error lies between the probe and the electronics.

Possible causes:
a) Cable short circuit
b) Electronics input defective
c) Wire break

Remedies:
a) Check wiring
b) Measure probe cable

Result 2:
At the probe, an mV value is measured which is outside the usual range from - 45 mV to 267 mV.

Possible causes:

a) There is no mV contact in the probe (measuring signal wire) or it is interrupted.
b) Combustibles in the flue gas.
c) Measuring cell defective

Remedy: Check whether the probe reacts to test gas. If it does, there may be a high portion of combustibles in the flue gas. In this case, there are reducing conditions on the probe cell, which reduce the oxygen content on the cell surface. **Caution: Explosion hazard!**
If the probe does not react, check the inner parts assembly.

13.3 Local Displays correct, Output not correct

Steps to localize the problem:

1. Check measuring range. Check whether the current value is outside the measuring range
2. Measure the mA output on the strip terminal.

Result 1: mA value present, problem is outside the electronics

Result 2: no mA value

Possible causes: Electronics is defective.

13.4 Unsteady, widely varying Measuring Value

Steps to localize the problem:

1. Check the measuring cell temperature (set value 840°C or 800°C EExd)
2. Intermittent contact in the probe - internal mV tap.

Action:
Measure the mV value on the terminals on the board.

Result 1: Voltage values jump rapidly like the display

Causes:
a) Intermittent contact caused by wire break.

Remedies:
a) Repair intermittent contact.

14 Dimensional Sheets of the Electronics Unit

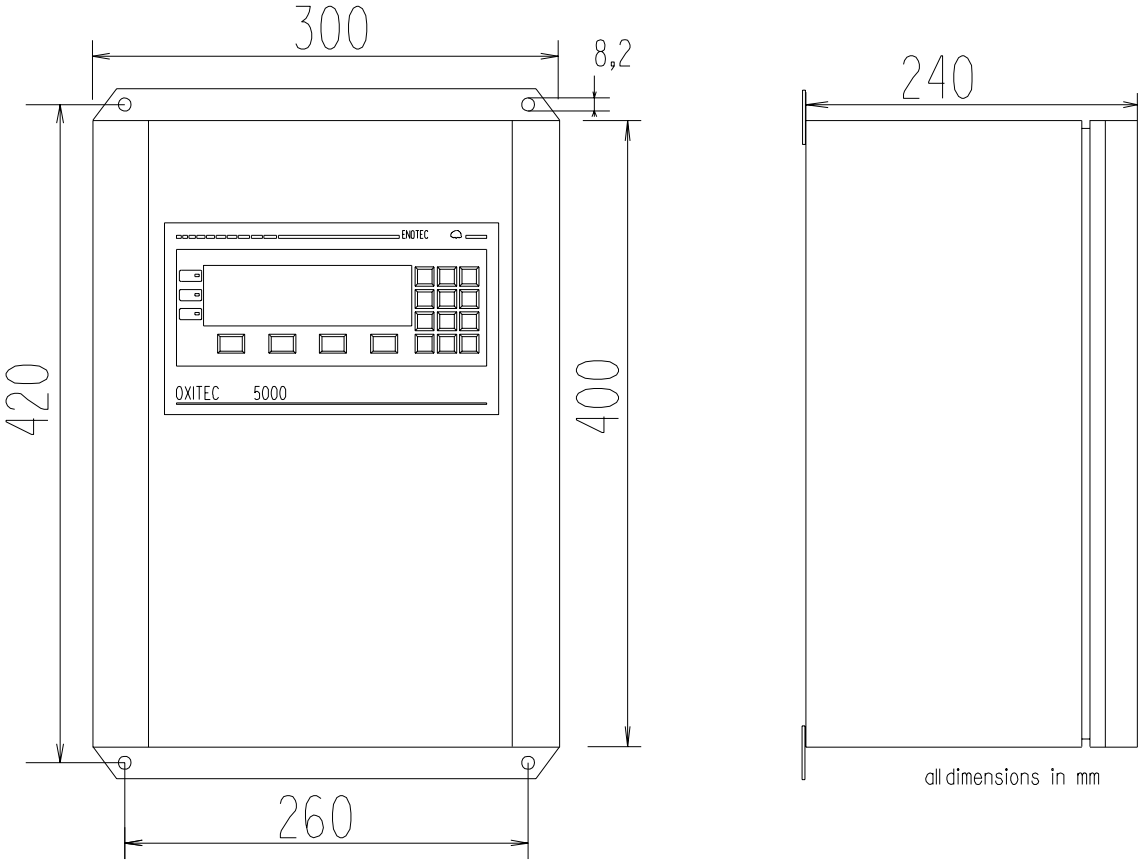


Figure 65 Field housing (sheet steel) IP66

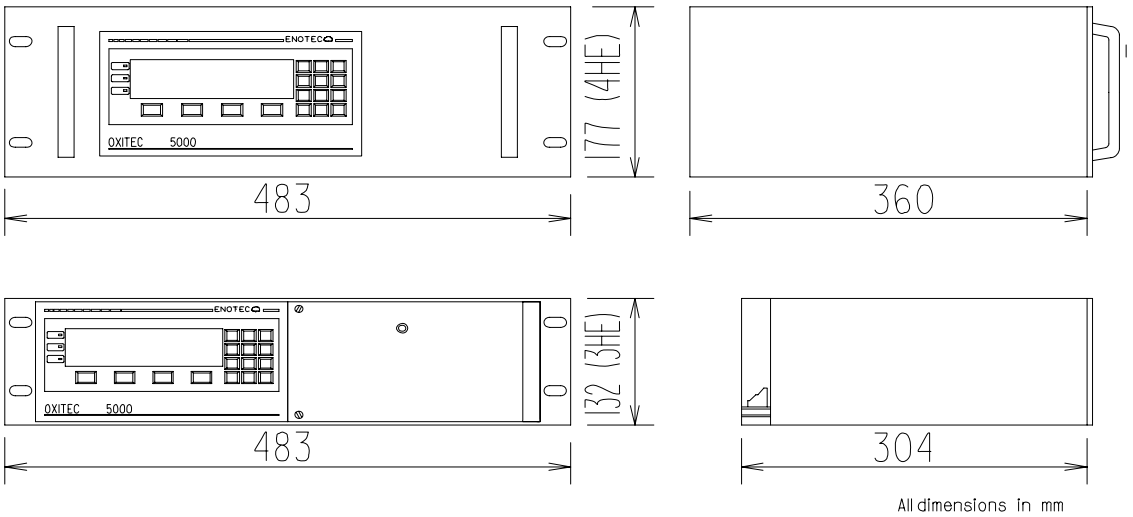


Figure 66 Electronics in 19 inch housing (4HE above, 3HE below), aluminium IP20

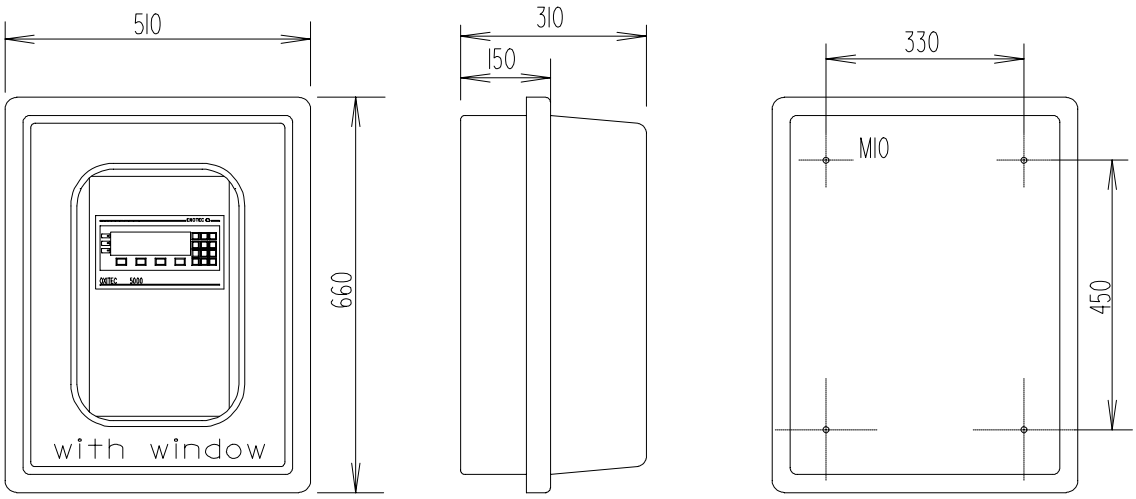
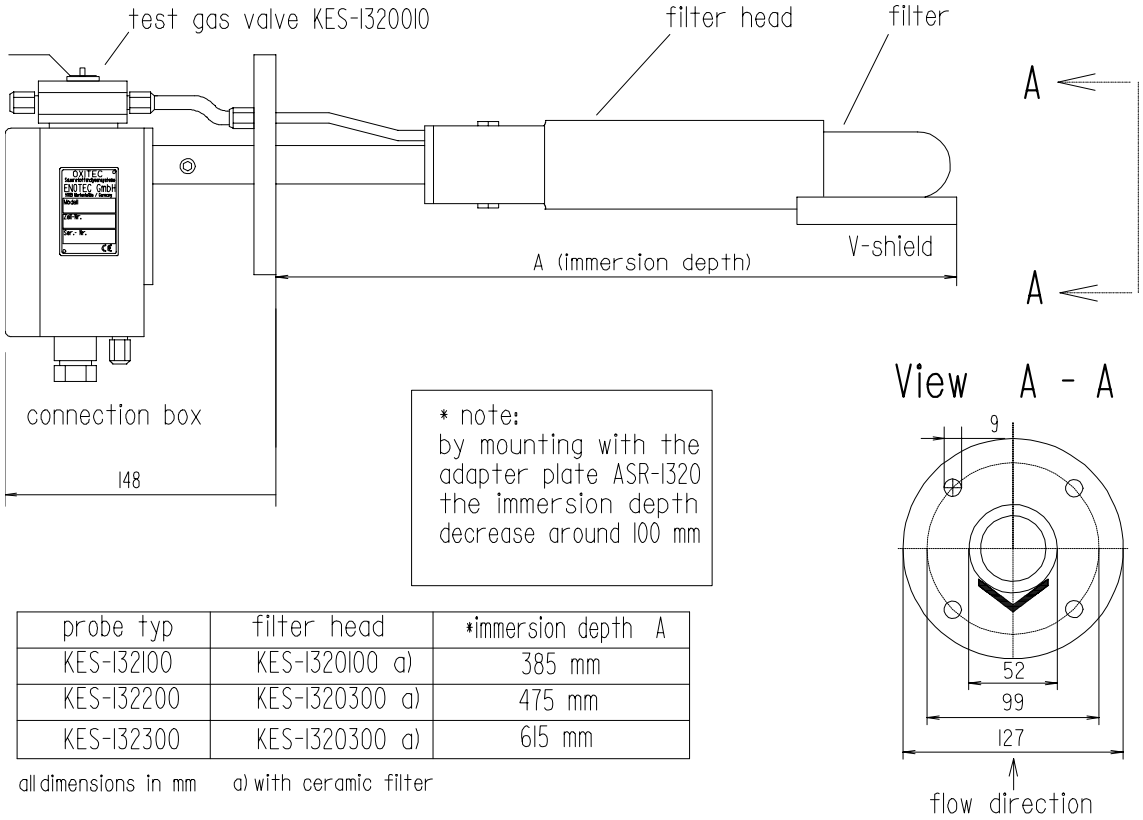


Figure 67 GFK housing IP 66 (option)

15 Dimensional Sheets of Probes



probe typ	filter head	*immersion depth A
KES-132100	KES-1320100 a)	385 mm
KES-132200	KES-1320300 a)	475 mm
KES-132300	KES-1320300 a)	615 mm

all dimensions in mm a) with ceramic filter

Figure 68 Dimensions of the probes KES 132x

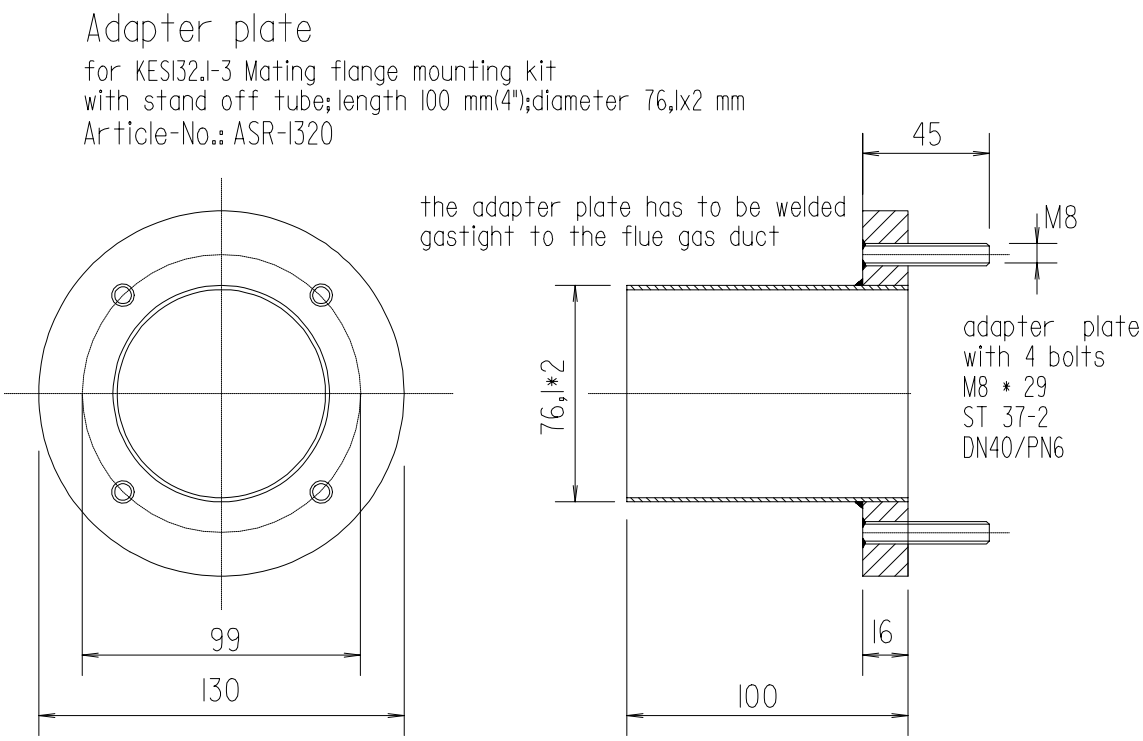
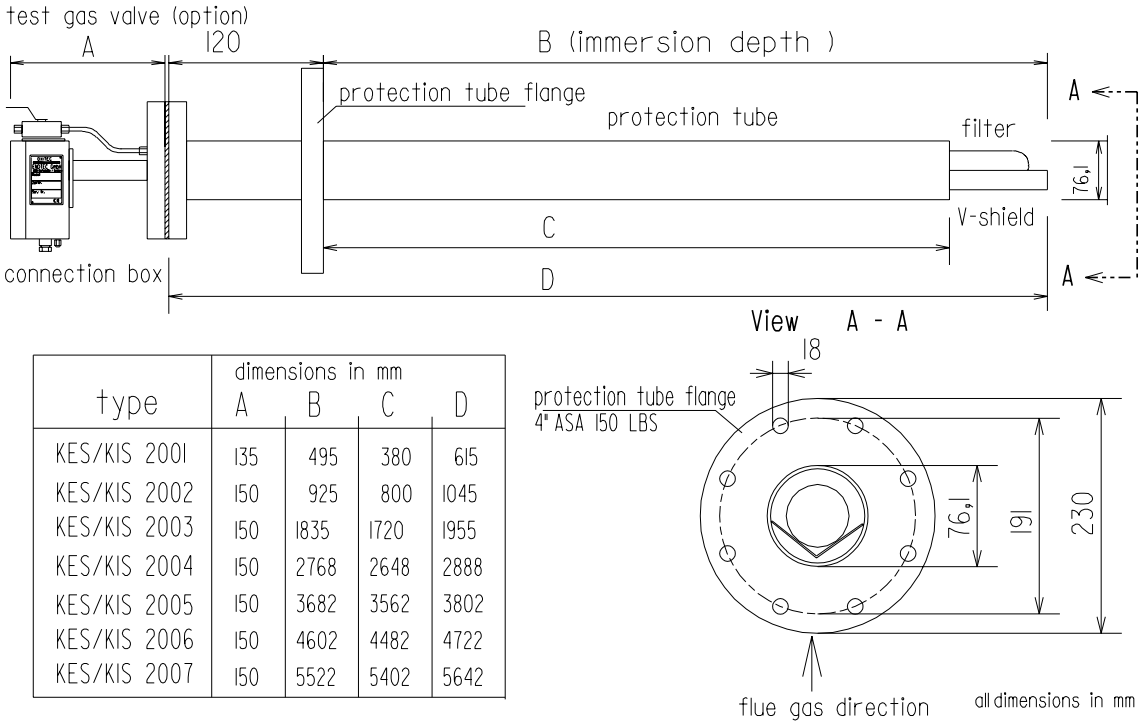


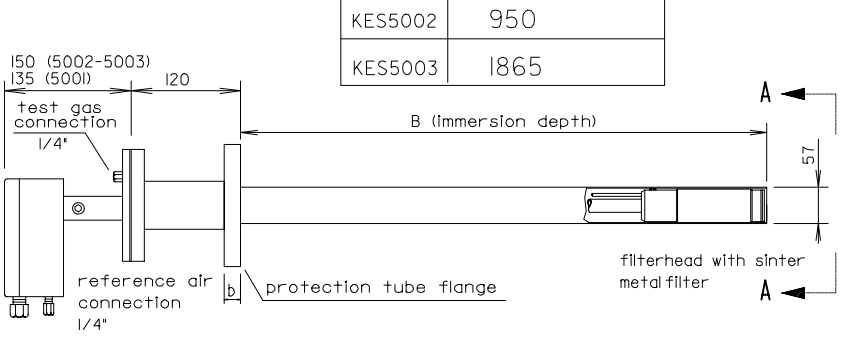
Figure 69 Dimensions of adapter plate for KES-132x

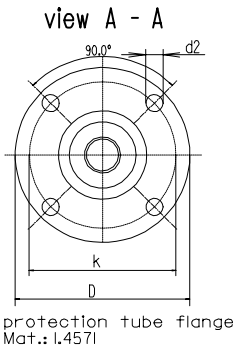


type	dimensions in mm A	B	C	D
KES/KIS 2001	135	495	380	615
KES/KIS 2002	150	925	800	1045
KES/KIS 2003	150	1835	1720	1955
KES/KIS 2004	150	2768	2648	2888
KES/KIS 2005	150	3682	3562	3802
KES/KIS 2006	150	4602	4482	4722
KES/KIS 2007	150	5522	5402	5642

Figure 70 Dimensions of the probes KES-200x

Typ	B (immersion depth)
KES5001	520
KES5002	950
KES5003	1865

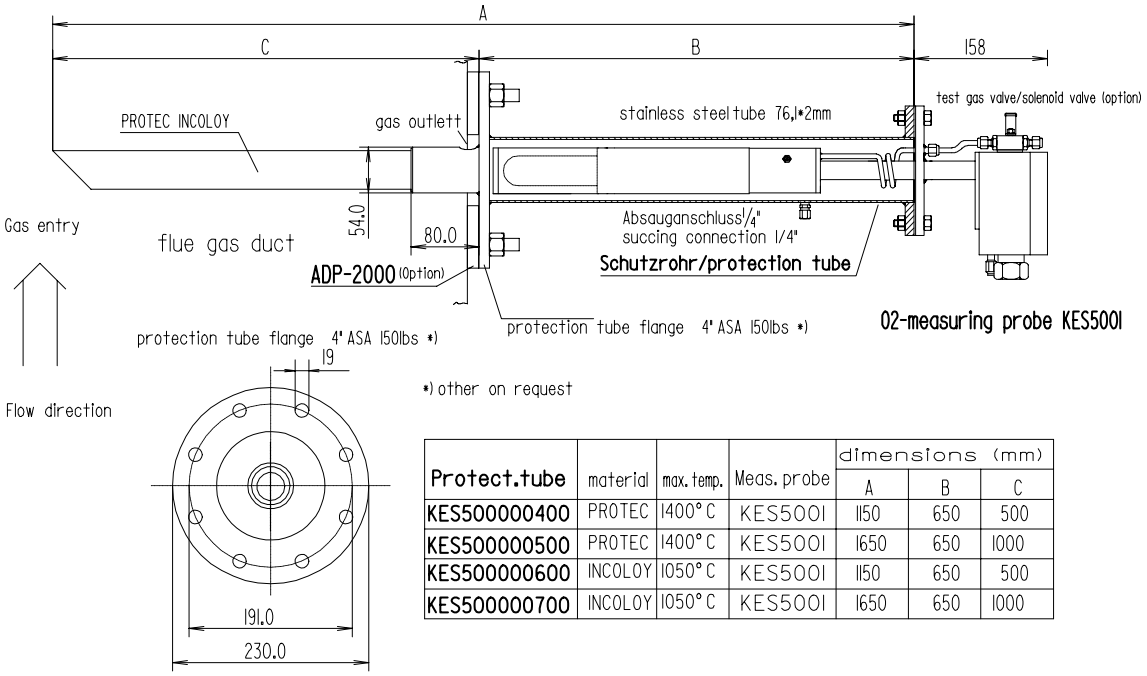




dimensions of the protection tube flange in mm (inch)

article no.:	0-R-000974	0-R-000972	0-R-000973	0-R-000971	0-R-000975	0-R-000976	0-R-000977	
type of flange / dimension	ANSI 4 B 150 LB FF equivalent	DIN 2527 DN65/PN16	DIN 2527 DN65/PN6	ANSI 2" 150lbs	DIN 2527 DN50/PN16	ANSI 3" 300 lbs	for 1;1,5 ;2 m ZFG2 standard probes	
D	228,6 (9.00)	185 (7.28)	160 (6.27)	153 (6.00)	165 (6.47)	209,5 (8.22)	165 (6.47)	
b	12,0 (0.47)	12,0 (0.47)	12,0 (0.47)	12,0 (0.47)	12,0 (0.47)	12,0 (0.47)	12,0 (0.47)	
k	190,5 (7.50)	145 (5.708)	130 (5.118)	121 (4.75)	125 (4.902)	168,3 (6.6)	140 (5.49)	
d2	19 (0.70)	18 (0.706)	14 (0.549)	20 (0.75)	18 (0.706)	22,2 (0.87)	12,5 (0.50)	
number of holes	8	4	4	4	4	8	6	
letter in order formular	(A)	(B)	(C)	(D)	(E)	(F)	(G)	all dimensions in mm

Figure 71 Dimensions of the probes KES-500x



Protect.tube	material	max. temp.	Meas. probe	dimensions (mm)		
				A	B	C
KES500000400	PROTEC	1400° C	KES500I	1150	650	500
KES500000500	PROTEC	1400° C	KES500I	1650	650	1000
KES500000600	INCOLOY	1050° C	KES500I	1150	650	500
KES500000700	INCOLOY	1050° C	KES500I	1650	650	1000

Figure 72 Dimensions of the probes KES-500x with cooling protection tube

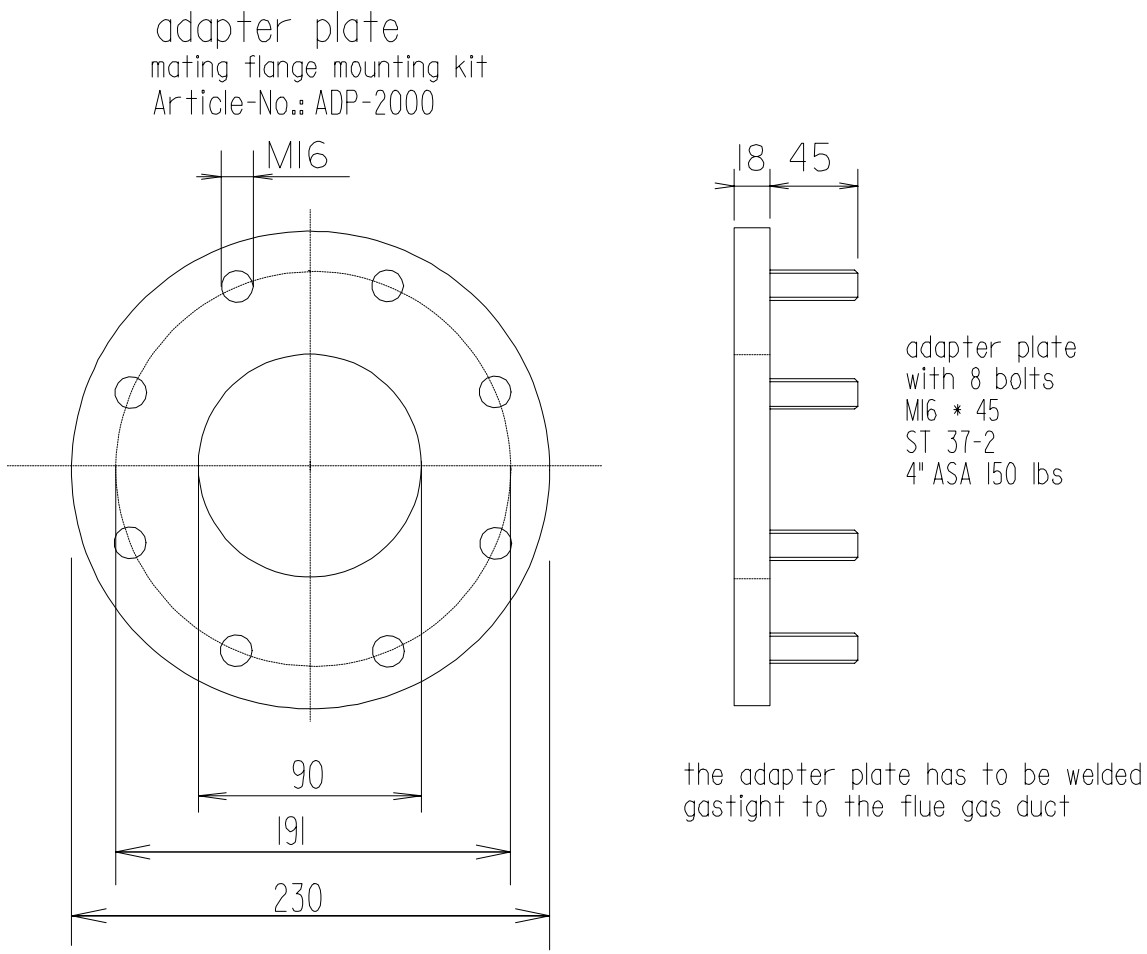


Figure 73 Dimensions of adapter plate ADP-2000

15.1 Probe Components

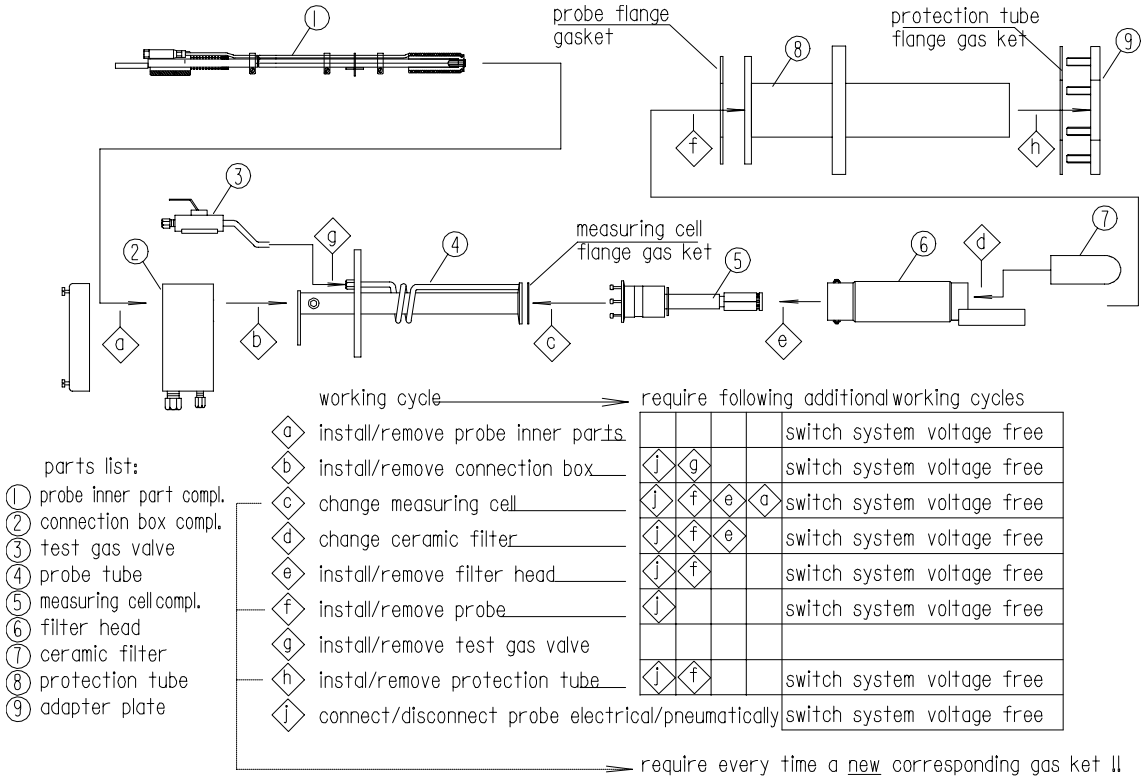


Figure 74 Probe components with working cycles

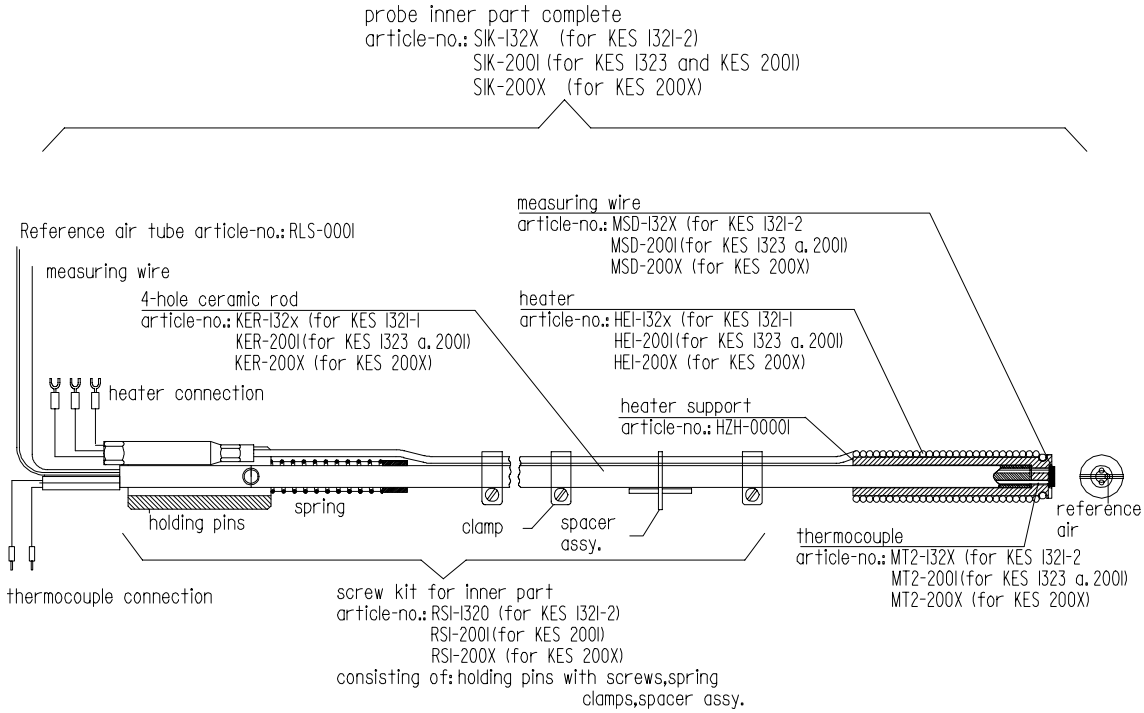


Figure 75 Probe inner parts assembly

15.2 Parts List of Probes

No.	Designation	For Probe Type:	Article-No.
1	Probe inner part assembly, complete	KES/KIS 2001 KES/KIS 2002 / 5002 KES/KIS 2003 / 5003 KES/KIS 2004 KES/KIS 2005 KEX 5001 KEX 5002 KES/KIS 1321-2	SIK-2001 SIK-2002 SIK-2003 SIK-2004 SIK-2005 SIK-5001EX SIK-5002EX SIK-132x
2	Connection box	all except for EX probes	ASK-0001
3	Test gas valve/ solenoid valve	KES 5001	KES500001000 please contact ENOTEC
4	Probe tube	KES/KIS-2001 KES/KIS-2002 / 5002 KES/KIS-2003 / 5003 KES/KIS-2004 KES/KIS-2005 KEX-5001 KEX-5002 KES/KIS-1321-2	MSR-2001 MSR-2002 MSR-2003 MSR-2004 MSR-2005 MSR-5001EX MSR-5002EX MSR-132x
5	Measuring cell	for all KES/KIS probes for KES-200X EX probes for KEX-500X EX probes	Z02-0001 Z02-0001EX Z02-0002EX
6	Filter head		please contact ENOTEC
7	Ceramic filter		please contact ENOTEC
8	Protection tube		please contact ENOTEC

16 Pneumatic Connection and Mounting Overview

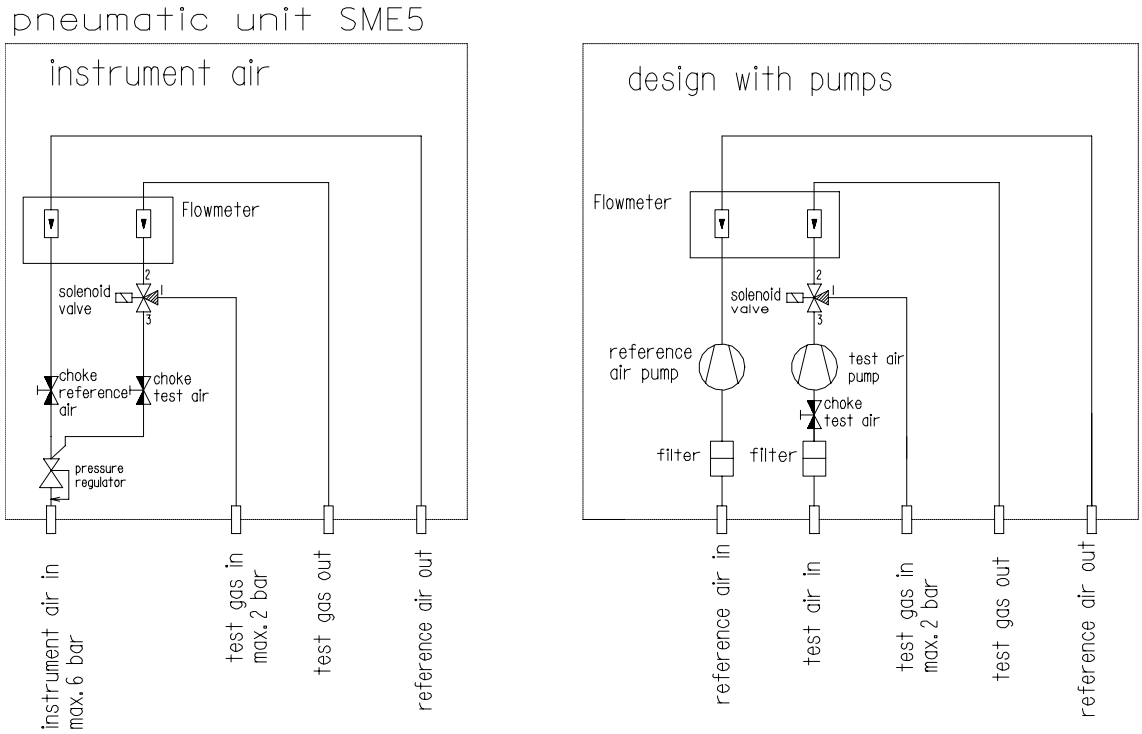


Figure 76 Gas plan

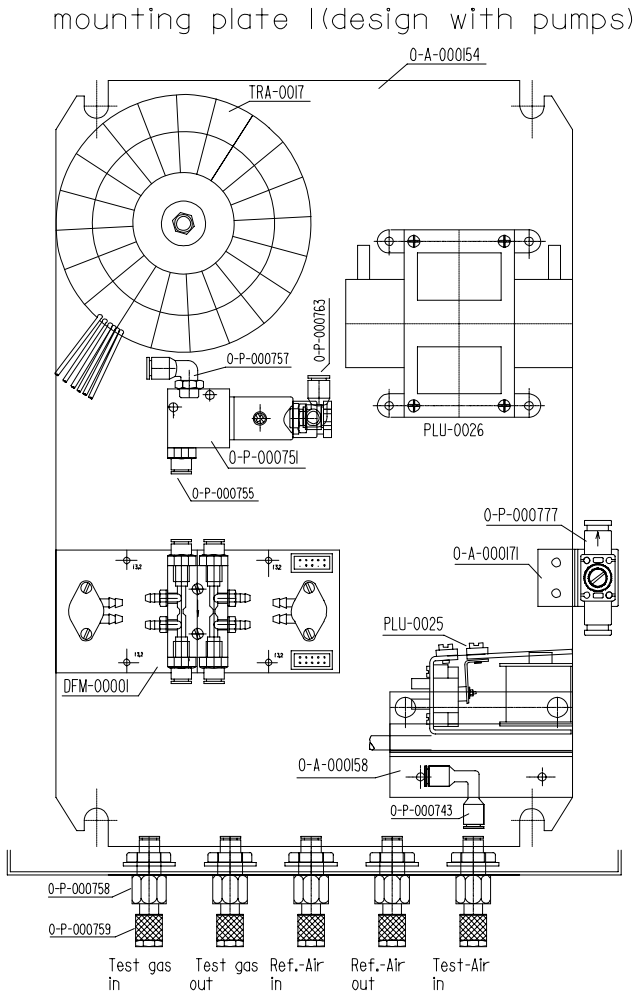


Figure 77 Mounting plate 1 (design with pumps)

Parts List

Test gas and reference air unit with two internal pumps

1	pc	DFM-00001	internal flow meter for reference air and test gas SME5
1	pc	0-P-000751	solenoid valve 3/2 ways, 110V/50Hz; G1/8; for SME 5
1	pc	TRA-00017	toroid transformer 2x115V; sec. 115 V / 330 VA
1	pc	0-P-000757	female elbow fitting G1/8 for 6 mm hose
1	pc	0-P-000755	screw in union G1/8" for 6 mm hose
1	pc	0-P-000658	Miniature filter 9933-05-AAQ elimination rate 99,999%
1	pc	PLU-0026	Test air pump for SME5 720 l/h 115V/50Hz cable 40 cm
1	pc	0-P-000743	angle fitting 6/6mm LF3000-W-STA-6
1	pc	PLU-0025	Reference air pump for SME5 30 l/h, 115V/50Hz cable 40 cm
5	pc	0-P-000758	plug in connection G1/4 for 6mm hose
5	pc	0-P-000759	fitting G1/4 for 6 mm hose
1	pc	0-P-000763	female elbow fitting M5 for 6 mm hose
1,5	m	0-R-001045	PU-hose 6x4 mm black
1	pc	0-P-000777	one-way-restrictor, 6mm, for 6mm hose

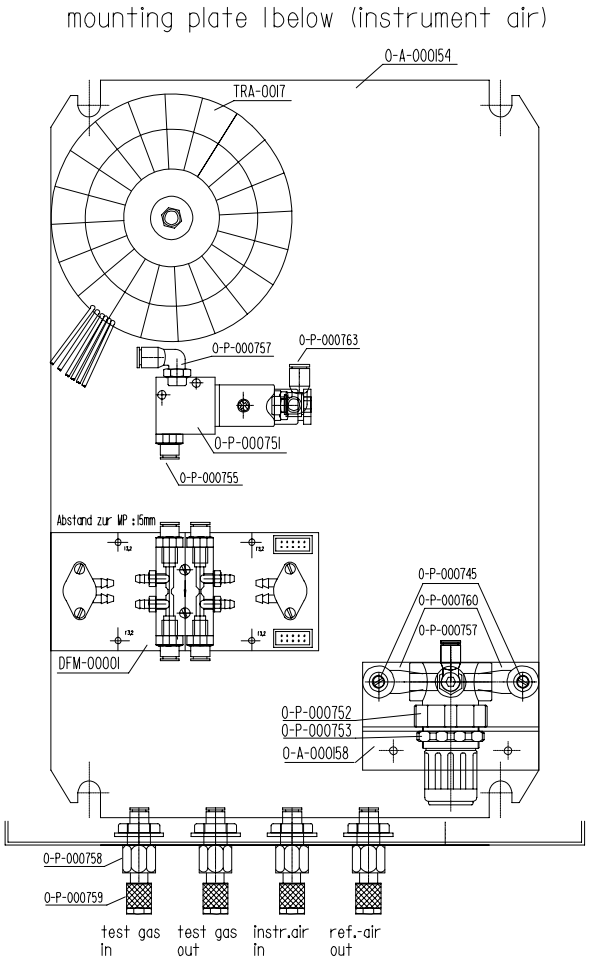


Figure 78 Mounting plate 1 (design with instrument air)

Parts List

Test gas and reference air unit for instrument air

1	pc	DFM-00001	internal flow meter for reference air and test gas SME5
1	pc	0-P-000751	solenoid valve 3/2 ways, 110V/50Hz; G1/8; for SME 5
1	pc	TRA-00017	toroid transformer 2x115V; sec. 115 V / 330 VA
1	pc	0-P-000757	female elbow fitting G1/8 for 6 mm hose
1	pc	0-P-000755	screw in union G1/8" for 6 mm hose
4	pc	0-P-000758	plug in connection G1/4 for 6mm hose
4	pc	0-P-000759	fitting G1/4 for 6 mm hose
1	pc	0-P-000753	nut for pressure control valve
2	pc	0-P-000745	angle screw-in fitting R 1/8"- G 1/8"
2	pc	0-P-000760	one-way-restrictor G1/8 for 6mm hose
1	pc	0-P-000757	female elbow fitting G1/8 for 6 mm hose
1	pc	0-P-000763	female elbow fitting M5 for 6 mm hose
1,5	m	0-R-001045	PU-hose 6x4 mm black

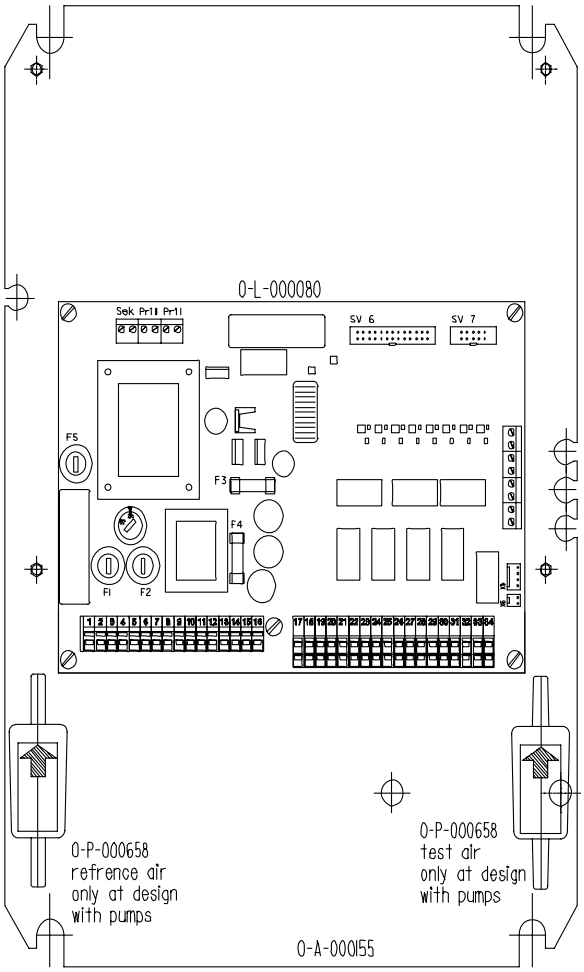


Figure 79 Mounting plate 2

Parts List **Mounting plate 2**			
1	pc	0-A-000155	mounting plate 2
1	pc	0-L-000047	mA output board
1	pc	0-L-000080	power board
2	pc	0-P-000658	miniature filter
1	pc	0-X-000351	micro terminal PE clip
1	pc	0-X-000353	cover for micro terminal
2	pc	0-X-000352	end clip E/MK
3	cm	0-X-000355	mounting rail NS15, punched

Figure 80 Display and microprocessor unit

Parts List **Display and microprocessor unit**			
1	pc	0-L-000035	Display and microprocessor unit WITHOUT Pneumatic
1	pc	0-L-000036	Display and microprocessor unit WITH Pneumatic

17 Appendix

17.1 Requirement of the Gas Supply

Instrument Air

Attribute:	According to ISO 8573-1 class 2 (Particle size max. 1µm, Particle density max. 1mg/m³, Oil content max. 0,1mg/m³, Pressure dew point max. -20°C)
Input pressure:	4 - 10 bar
Flow rate:	40 l/h during measurement 250 l/h during calibration

Test Gas (Test gas 2)

Attribute: (recommended)	2.1 Vol.-% O_2 in N_2 (accuracy +/- 2%)
Input pressure:	1,1 +/- 0,1 bar
Flow rate:	200 l/h during calibration

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