OXITEC® 500E

O_2 Analyser System
with SME 5 Electronics

Installation & Operating Manual

Version No. 03
Valid from Software Version 1.42
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ENOTEC GmbH
Process and Environmental
Measuring Technology

DIN EN ISO 9001

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Preface

Dear customer,

Thank you for selecting our OXITEC® 500E as your InSitu flue gas oxygen measuring system.

For many years now, our OXITEC® oxygen analyser systems have been operating in numerous applications with many thousands produced, shipped and installed throughout 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 an increased measuring accuracy with more operational reliability due to 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 as 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®500E 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 office or approved distributor 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 on 16 February 2006
Dipl.-Ing. Fred Gumprecht
Managing Director
ENOTEC GmbH

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Table of Contents

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 cuvette 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.

MANUFACTURER:

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1.2 Declaration of EC-Conformity

ENOTEC GmbH
Höher Birken 6
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® 500E Oxygen Analyser System
Electronics Type:	OXITEC 500E - 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:	16 February 2006 signed. Fred Gumprecht
Position:	Managing Director

1.3 Information on the CE-certification

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 ground (Earth) connection must be installed thoroughly using the correct cable size of at least 1,5mm^2 minimum. It is very important that the equipotential bonding is installed correctly. In case of doubt please contact ENOTEC.

Please note that some electrical devices (e.g. frequency converter etc.) close to the system can create considerable electrical disturbance and instability. Therefore it is important that these devices be installed in accordance with the manufacturer's installation notes and guidelines.

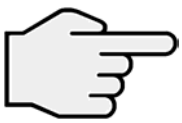
1.4 Notes on this Document

This document describes the design, installation, commissioning, operation, maintenance and troubleshooting of the OXITEC®500E 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

Stresses important information, which should be pointed out particularly.

Important

Warns of the risk of destroying the system or parts of it or to reduce its function.

Warning

Warns of dangers, which result from inappropriate handling, and which can entail death, bodily harm and/or substantial property damage.

Warning – Hot Surface

Warns of the danger of burns, from hot system parts.

2 Intended Use

Note

The OXITEC® 500E 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 location where combustible gases are present as the measuring cell temperature of 750°C could present an explosion hazard!

3 Safety Instruction for the Operation of OXITEC® 500E Analyser System

This equipment may only be operated by authorized trained skilled persons.

3.1 Safety Hazards

Warning

It is essential to switch the system power 'Off' before opening.

When using the OXITEC® 500E analyser system in combustible gases it can cause an explosion – because of the high temperature of the measuring cell.

Warning – Hot Surface

The measuring gas connections at the rear side of the analyser system become hot. Direct affecting of the hot parts for disassembly or maintenance leads to heavy burns! Wear protective gloves!

3.2 Maximum Ambient Temperature

Important

The maximum ambient temperature for the OXITEC® 500E is 55°C (131°F) for the instrument air version and 40°C (104°F) for the pump version. These ambient temperatures may not be exceeded in any circumstances. Please contact ENOTEC for other temperatures.

4 General System Description

4.1 The Measuring Principle

The OXITEC® 500E analyser system measures the real concentration of oxygen in the flue gas of combustion processes and other non-combustible gases.

The source voltage Uq (in former times called EMK for “electrical motive force”) is produced by a temperature-stabilised zirconium cell indicating the amount of oxygen concentration. Measurement takes place within the electronics housing using a measuring cuvette containing the zirconium oxide measuring cell.

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
U_q = 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 (rise 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 procedure 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 proportional to the water content in the flue gas.

4.2 Functional Description of the OXITEC® 500E Analysing System

The 19" module rack of the OXITEC® 500E contains the electronics SME 5 and also an oxygen measuring cuvette, whose tip is exposed to the process gas to be analysed. The mV signal of the measuring cell is converted into a digital signal in the electronics (14 bits 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 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 an 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.

5 Description of the OXITEC® 500E Analyser System

5.1 Scope of Supply

As well as the actual analyser the supply includes one subpackage containing the following components:

1 piece - power supply cable

3 pieces - support sleeves for the Swagelok fittings

1 piece - additional union nut for the Swagelok fitting to the task of test gas

1 piece - front locking ring for a Swagelok fitting

1 piece - rear locking ring for a Swagelok fitting

5 pieces - fuse (3 x 6,3A, 1 x 4A, 1 x 1A), see also chapter 10.2 on page 58

Two union nuts are on the measuring gas connections at the equipment.

Not included in the standard scope of supply are:

Test gas bottles, pressure-reducing valve, flow meter, pump for test air, hoses for process and test gases. If necessary these items can be ordered from ENOTEC.

5.2 Assembly of the OXITEC® 500E Oxygen Analysing System

The OXITEC® 500E oxygen analyser system consists of a 19" module rack in which the measuring cuvette (see Figure 37 on page 65) and the SME5 electronics are contained. All connections to the system are at the back. A mains cable is provided for the supply voltage.

The housing is fitted with a Swagelok screw connection for each of the measuring gas and/or test gas line and the exhaust gas line. The appropriate support sleeves are in the subpackage. The gas lines must possess an outside diameter of 6 mm and an inside diameter of 4 mm and are not included in the scope of supply. A measuring gas line made of PTFE is recommended.

A terminal strip is located in the centre at the back of module, to connect the signal lines for the external reading of the measured values, and for the external system control (see also the terminal diagram on page 22). If the signal lines have wires for potential deflection, then these can be wired at the PE clamps right beside the signal clamps.

The electronics unit has a LED graphic display with back lighting. The electronics is operated by means of four soft-keys and a ten-key keypad. The ENOTEC user interface permits intuitive operation by means of a self-explanatory menu structure.

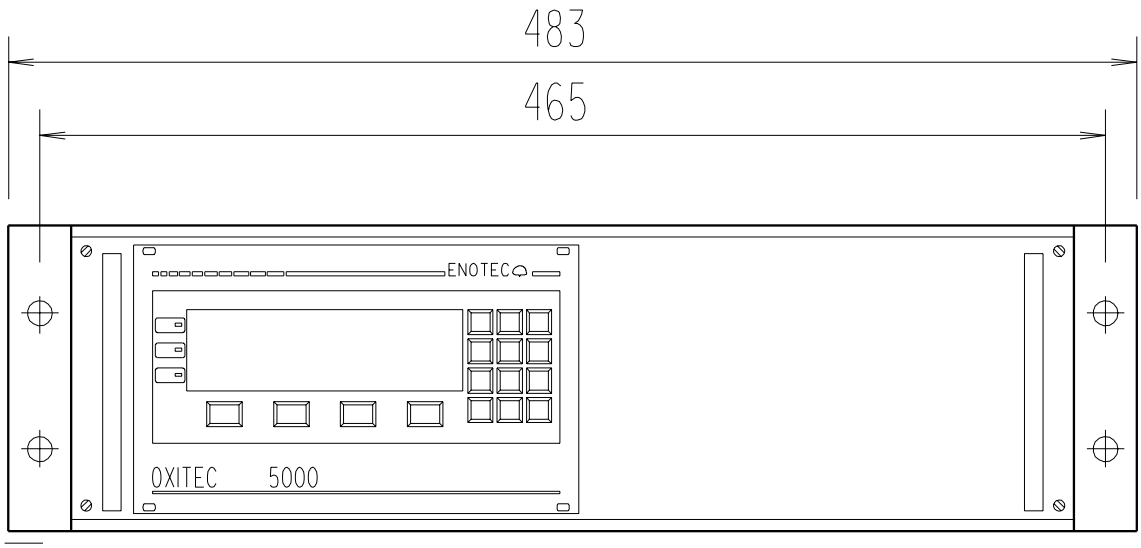
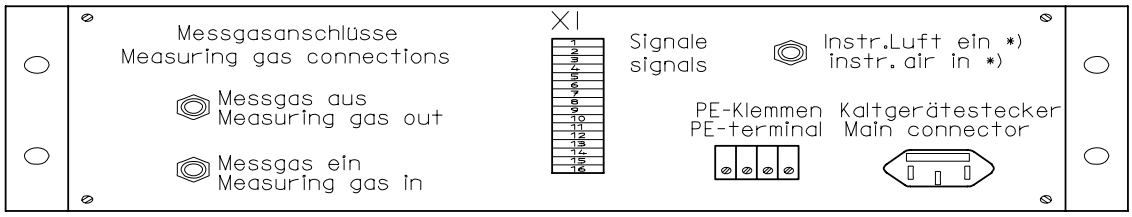


Figure 1 Front view of the housing



Instr.Luft ein *): Nur bei Ausführung mit Instrumentenluft
instr. air in *): only at design with instrument air

Figure 2 Rear View of the Housing

6 Installation of the Analyser System

6.1 General References

Note

Only accordingly authorized qualified personnel may work on this equipment. These personnel must be familiar with all warnings, safety references and maintenance procedures in accordance with this instruction manual. The perfect and safe operation of this equipment presupposes appropriate transport, professional storage, installation and assembly as well as careful handling and maintenance.

Warning

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® 500E it is very important that these devices be installed away from the system and in accordance with the manufacturer's installation notes and guidelines.

Note

When installing the analyser system, please ensure sufficient air circulation around the electronics housing and compliance of allowed ambient temperature between -20°C and +55°C (131°F) (instrument air version) and between -20°C and +40°C (104°C) (pump version).

6.2 Gas Connection

Because the OXITEC® 500E oxygen analyser system is a 19" module rack, the system must be assembled first into the swing frame of the analyser cabinet. Since the equipment is usually first calibrated after the assembly, necessary test air (test gas pump or instrument air) is attached at this stage.

At the measuring gas exit a drain has to be attached, otherwise an incorrect measurement and damage to the equipment (e.g. by humidity) may occur.

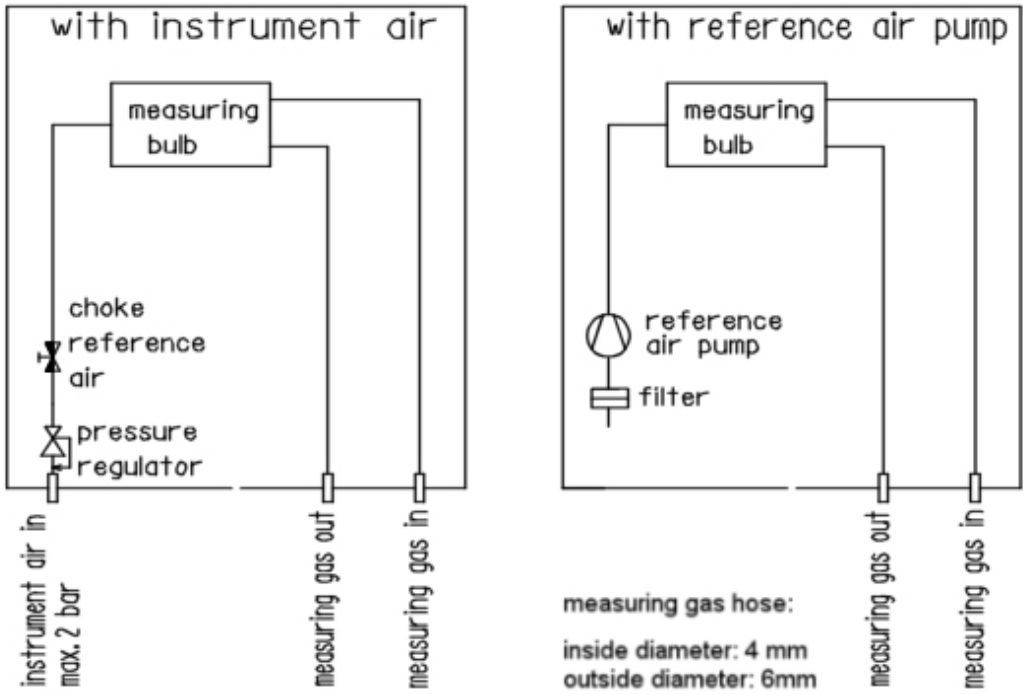


Figure 3 Gas Plan of the OXITEC® 500E Analysing System

The housing is fitted with a Swagelok screw connection for each of the measuring gas and/or test gas line and the exit gas line. The appropriate support sleeves are in the subpackage. The gas lines must possess an outside diameter of 6 mm and an inside diameter of 4 mm and are not included in the scope of supply. A measuring gas line made of PTFE is recommended.

6.2.1 Assembly Instructions for the Swagelok Fittings

The union nut at the measuring gas entry and/or exit should be loosened carefully, because the two locking rings are inside the union nut. The support sleeve is to be taken from the subpackage.

Warning – Hot Surface

The measuring gas connections at the back of the analyser system are hot. Directly affecting parts for assembly, disassembly or maintenance, which can be hot, leading to heavy burns! Wear protective gloves!

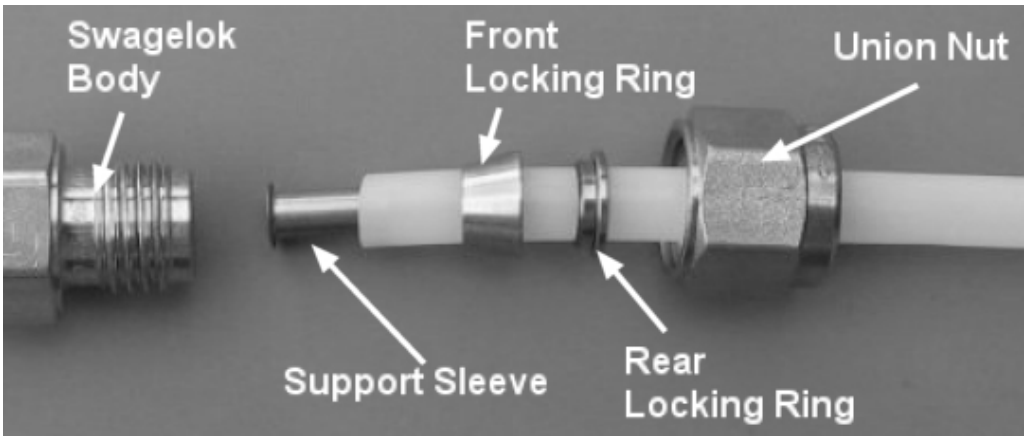


Figure 4 Swagelok Fittings

The union nut and the locking rings are to be slide over the hose, shown in Figure 4. The support sleeve has to be inserted into the hose end as far as possible. Now the hose should be pushed into the Swagelok body as far as possible and the union nut tightened hand-tight, after which the nut should be tightened one turn, using a wrench (SW 14).

Now the hose can be removed for the connection of the test gas hose. However support sleeve, locking rings and union nut are now firmly fixed to the hose and cannot be used again (with exception of the union nut) with another hose. Therefore an additional kit of screw connection material (support sleeve, rear and front locking ring and union nut) is enclosed for the attachment of the test gas hose.

6.3 Electrical Connections

The analyser system is connected to the mains power line using the cable supplied, having an inlet connector for non-heating apparatus.

Note

Before connecting the power supply cable, the mains voltage is to be checked and compared with the mains voltage indicated on the type label.

If the actual mains supply voltage corresponds to the OXITEC® 500E system mains voltage, the analyser system can be connected. Immediately after connection of the enclosed power supply cable the system starts and heats up.

Warning – Hot Surface

The measuring gas connections at the back of the analyser system are hot, directly affecting parts for assembly, disassembly or maintenance, which can be hot, leading to heavy burns! Wear protective gloves!

Since both the display of the oxygen value and the adjustments to the system (e.g. changes of measuring range, limit values, calibrations etc.), can be done remotely from external sources, a terminal strip is located at the back of the system on which the respective in and outlet lines can be connected in accordance with the terminal diagram (see Figure 5 on page 22).

If the signal lines have wires for potential deflection, these can be wired at the PE terminal next to the signal terminals.

6.4 The Connection to the Measurement Value Processing and for External Operation

The OXITEC® 500E analyser system can be operated from outside and attached to an external measurement value processing. For this purpose the cables are to be connected with c-clamps in accordance with the terminal connections diagram (see Figure 5). The terminal strip is positioned on the rear side of the equipment.

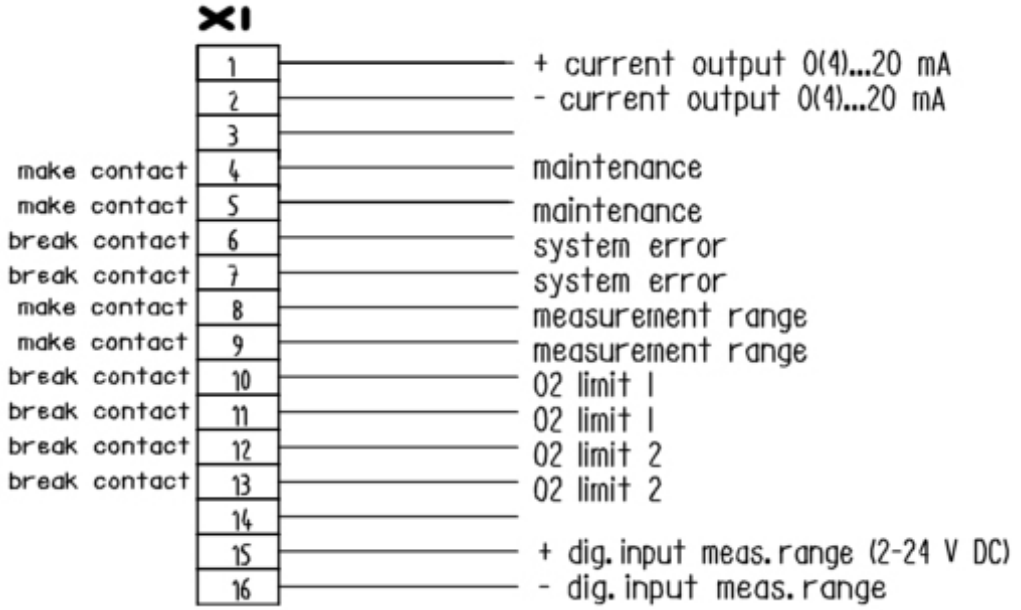


Figure 5 Diagram of Terminal Connections

7 Operating Instructions for the OXITEC® 500E Analyser System

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.

Note

Before start-up all electrical connections as well as the gas connections have to be inspected.

After start-up a two point calibration (see chapter 7.6.3 on page 36) should be carried out.

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 (see Figure 6).

The OXITEC® 500E '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.

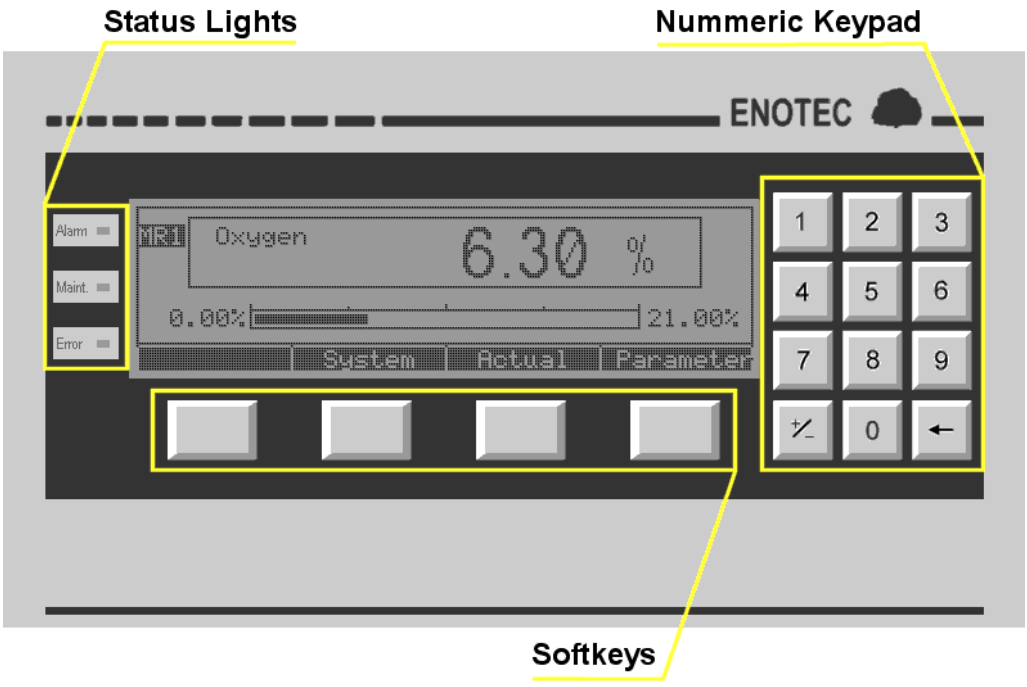


Figure 6 Front panel of the OXITEC® 500E analyser system (display in vol.%)

As well as the version with an O_2 display in vol.%, a software version with an O_2 display in ppm is available (see Figure 7).

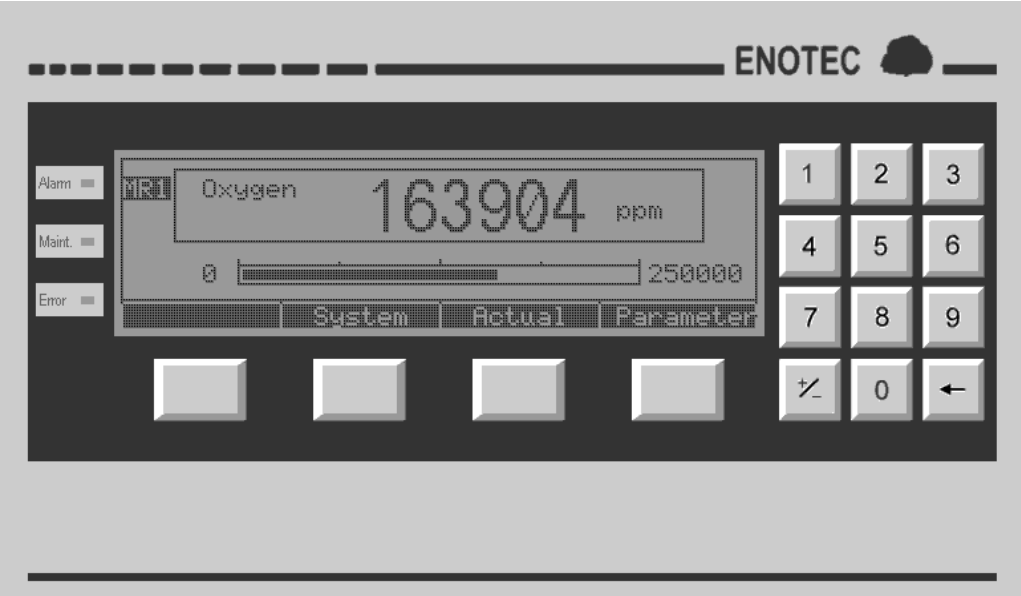


Figure 7 Front panel of the OXITEC® 500E analysing system (display in ppm)

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

The only difference with the vol.% version is the unit. Therefore only the displays with 'vol.%' are mentioned in the following.

7.1 General Operating Instructions

By pressing the soft keys [system], [actual] and [parameter] (see Figure 6) 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 8) 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].

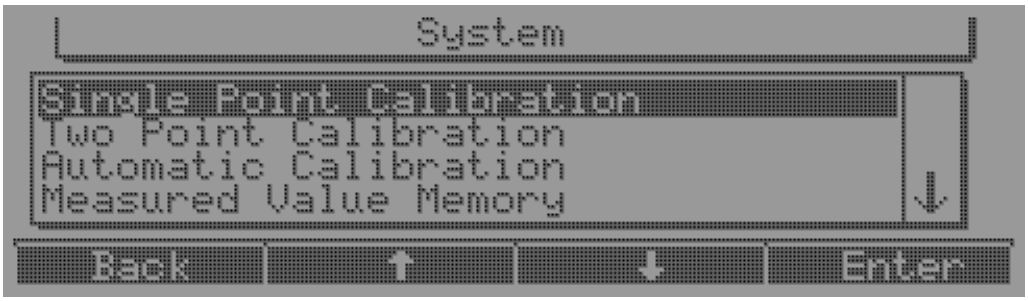


Figure 8 Display: system menu

7.2 Heating Phase

After connection of the OXITEC® 500E to the mains supply (see chapter 6.3 on page 21), the OXITEC logo appears on the display for a short time. During this time, all parameters relevant for a faultless operation 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 7.7 on page 43).

If the power-on check is completed without any errors, the heater window appears as shown in Figure 9). In this heater window the progress of the heating phase is indicated by a bar in the range 0°C to 804°C.

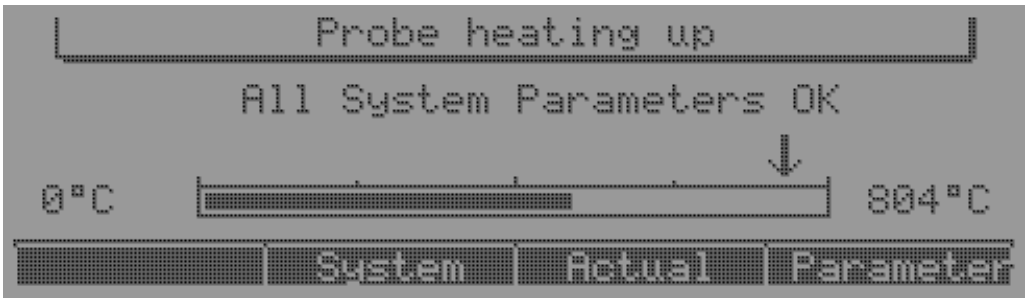
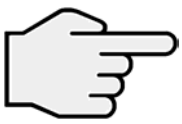


Figure 9 Display during the Heating Phase

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 (see Figure 10).

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 the heating phase (e.g. calibrations).



Note

System adjustments may only be made be specially trained personnel.

7.3 Main window

Figure 10 Display: main window

In the main window (see Figure 10) 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 (in this case MR1) is indicated. At moisture of > 0% "oxygen dry" is displayed to indicate that the O_2 value is a corrected value (see page 31).

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 7.6 on page 32.
Actual	Displays all actual values of the system. For a detailed description see chapter 7.4 on page 26.
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 7.5 on page 28.

Table 1 Branching of the main window

7.4 Actual Value Menu

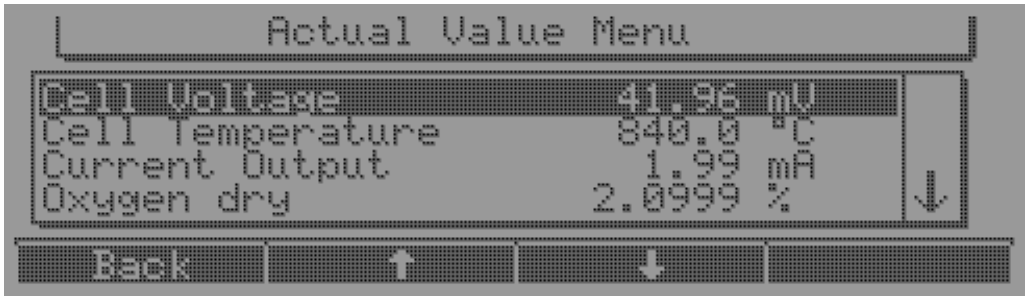


Figure 11 Display: actual value menu

In the actual value menu the following current actual values 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 7.5 on page 28)
oxygen dry	vol. % (ppm)*	At moisture of > 0% this is the corrected value (for details see chapter 7.5.3 on page 31). 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 7.4.1 on page 27).
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

Table 2 Actual value menu

* The OXITEC® 500E analyser system is also available with a ppm output. Because this is only a difference of units (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.

7.4.1 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.

7.5 Parameter Menu

In the parameter menu, the system parameters as shown in (Figure 12) can be displayed and altered.

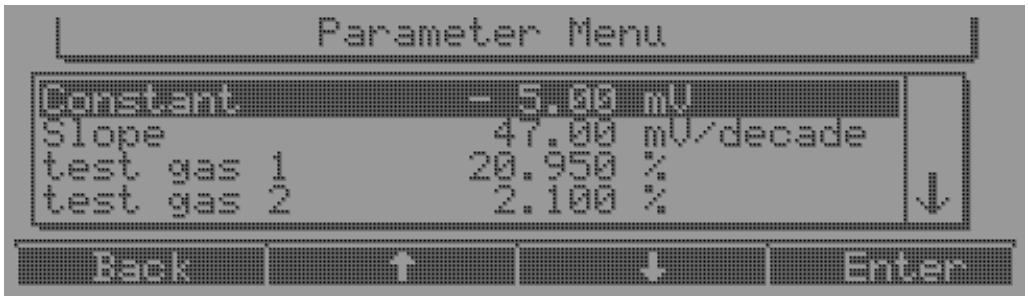


Figure 12 Parameter Menu

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 request using [Enter] without any input of numbers. To change the system code see chapter 7.6.10 on page 42.

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 settings 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.
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.
H_2O correction	%	0 % to 50 %	proportion of H_2O (water) in the flue gas

Table 3 Parameter menu

* The OXITEC® 500E analyser system is also available with a ppm output. Because this is only a difference of units (20% O_2 = 200000ppm O_2), it is not mentioned in the following descriptions.

7.5.1 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 “*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.

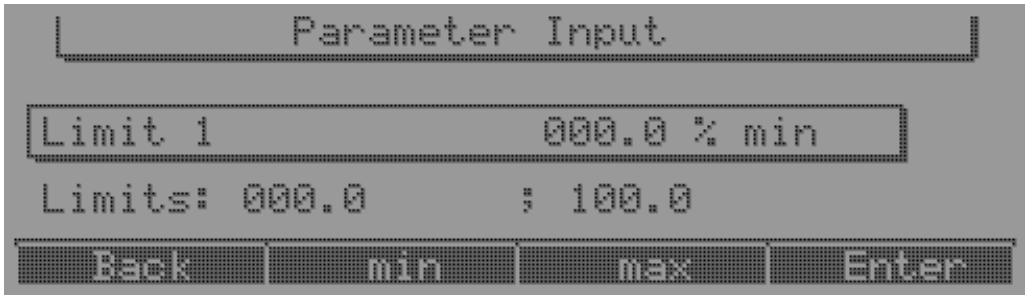


Figure 13 Display: parameter input (example limit value 1)

The parameter to be altered is displayed in clear text with the current value. If special functions are assigned to this parameter (like “min” in this example), these are also displayed. In addition the permissible input limits of this value are indicated (in this example 00.0 and 100.0).

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 (which can be needed if the cell constant has to be changed manually).

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 is maintained.

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

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

To reach the menu option "*Measuring Range 1*" the downward arrow in the parameter menu is pressed repeatedly until the point "*measuring range 1 from*" 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.

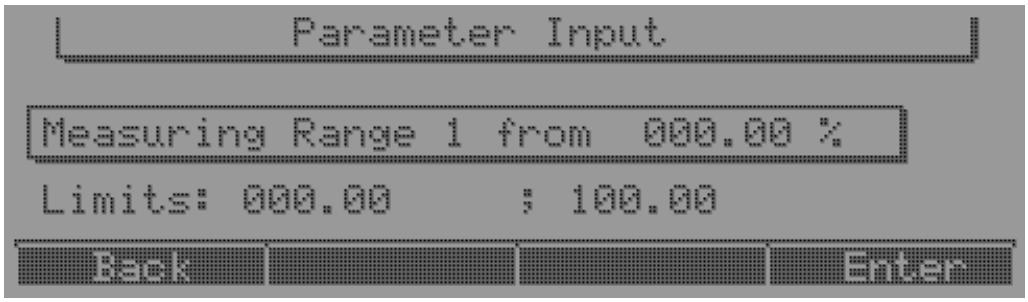


Figure 14 Display for entering the initial value for measuring range 1

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 also this value is confirmed using [Enter], 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 7.6.9 on page 42).

7.5.3 H_2O Correction

An OXITEC 500E oxygen analyser system measures the wet oxygen content. In menu item “*H2O correction*” of the parameter menu the water vapour content can be entered. Then the electronic calculates the dry oxygen value (“*Oxygen dry*”).

Note

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

7.6 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].

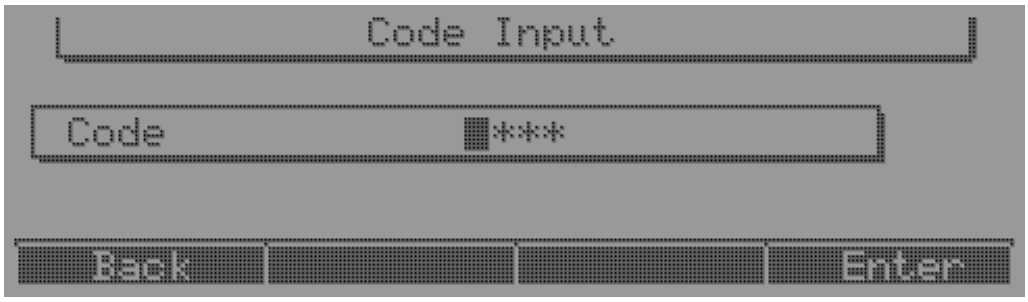


Figure 15 Display: code input

Note

The system code is factory-set to 0000.

After entering the system code, the system selection menu appears (see Figure 16).

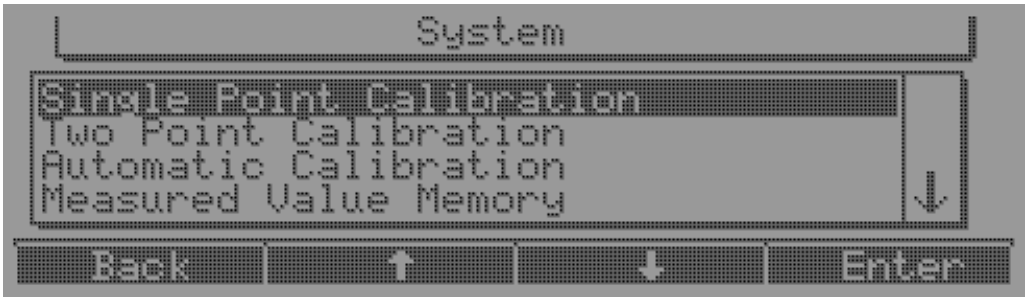


Figure 16 Display: system menu

More menu items can be reached using the Softkey [🡻].

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 4 System menu

* The menu item "*Automatic calibration*" cannot be accomplished with OXITEC® 500E.

A description of the individual functions is given below:

7.6.1 First Steps for Calibration

Before you begin with the calibration, please make sure that the pneumatic connections are correct (for details see chapter 15 page 66). You may find a description of the requirements of the gas supply in chapters 17.1 on page 68.

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

Figure 17 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.

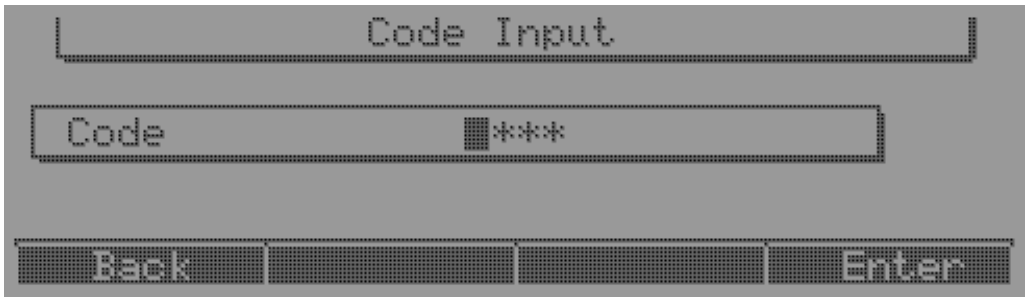


Figure 18 Display: code input

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 19 Display: menu entries for calibration

7.6.2 Single Point Calibration

Please take note of chapter 7.6.1 page 33 which explains how to get to this calibration point.

In this menu item, a single point calibration with ambient air can be done.

The supply of test air is made either by connection to the instrument air supply or by connection and feeding of a test air pump. The test gas line is attached with a Swagelok screw connection at the measuring gas entry (see chapter 6.2.1 on page 20). The gas line must possess an outside diameter of 6 mm and an inside diameter of 4 mm. In any case the test gas must be attached in such a way that - with the help of a flow meter - a test gas quantity of 30 - 60 l/h can be supplied.

Warning – Hot Surface

The measuring gas connections at the back of the analyser system are hot, directly affecting parts for assembly, disassembly or maintenance, which can be hot, leading to heavy burns! Wear protective gloves!

Note

The flow rate of test air must have a quantity of 30 - 60 l/h.

After selecting this menu item, you are requested to begin calibration with the soft key [Start].

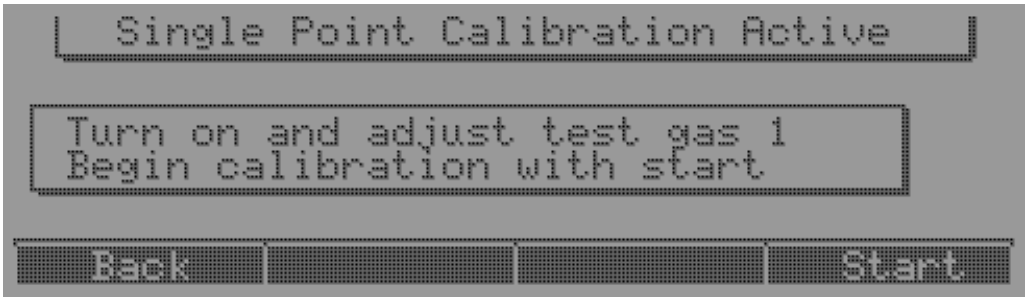


Figure 20 Request to the Task of Test Gas

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

A moving time bar indicates the progress of calibration.

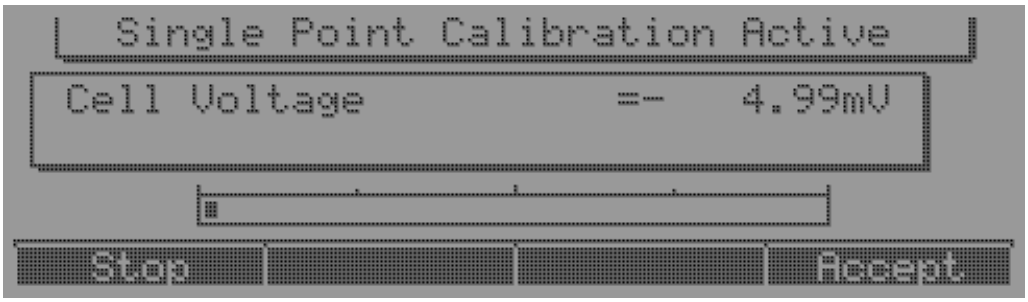


Figure 21 Display: O_2 single point calibration

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.

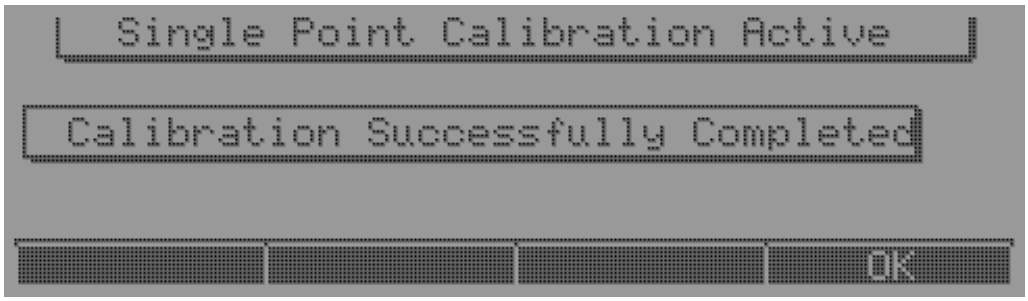


Figure 22 Advice for a successful calibration

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

After calibration the test air hose with the flow meter must be disconnected and the measuring gas hose re-connected.

7.6.3 Two Point Calibration

Please take note of chapter 7.6.1 page 33, where it is explained how to get to this calibration point.

In this menu item a two point calibration with test air (test gas 1) and with test gas (with a suitable O_2 concentration) (test gas 2) can be performed (see for this chapter 17.1 *Requirement of the Gas Supply* on page 68). It should be noted that the concentration of the test gases must correspond to the value shown in the parameter menu.

Note

The oxygen concentration of the test gases used must be first entered into the parameter menu (see also chapter 7.5 on page 28). ENOTEC recommends test air (for test gas 1) and a test gas concentration of 2.1% O_2 in N_2 (for test gas 2).

Before the calibration the respective test gas must be attached to the measuring gas entry beginning with air. The supply of test air is made either by the connection to the instrument air supply or from a test air pump (depending upon the system version installed). The test gas line is attached with a Swagelok screw connection at the measuring gas entry (see chapter 6.2.1 on page 20). The gas line must possess an outside diameter of 6 mm and an inside diameter of 4 mm. In any case the test gas must be attached in such a way that - with the help of a flow meter - a test gas quantity of 30 - 60 l/h can be supplied.

Note

The flow rate of test gas / test air must have a quantity of 30 - 60 l/h.

Warning – Hot Surface

The measuring gas connections at the back of the analyser system are hot, directly affecting parts for assembly, disassembly or maintenance, which can be hot, leading to heavy burns! Wear protective gloves!

After selection of this menu option you are requested to start the calibration by using the [Start] key.

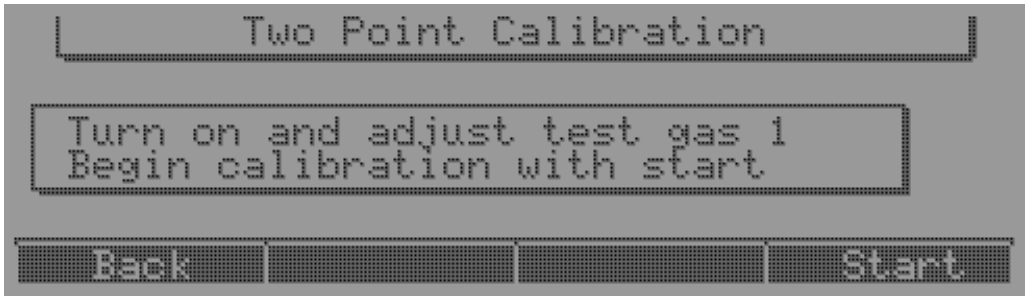


Figure 23 Display: Request to start two point calibration

The two point calibration takes place fully automatically in two steps. The first step of the calibration is effected with test air and the procedure progress is indicated in the display (see Figure 24).

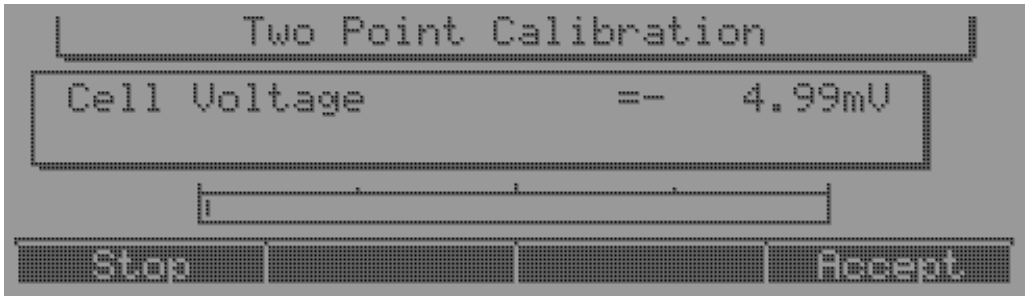


Figure 24 Display: Two point calibration 1.step

After completion of the first part of the calibration the request to supply and adjust test gas (test gas 2) and to start step 2 appears (see Figure 25).

After connection and charging of the second calibration gas this menu option is to be confirmed by [Start].

Note

The flow rate of test gas must have a quantity of 30 - 60 l/h.

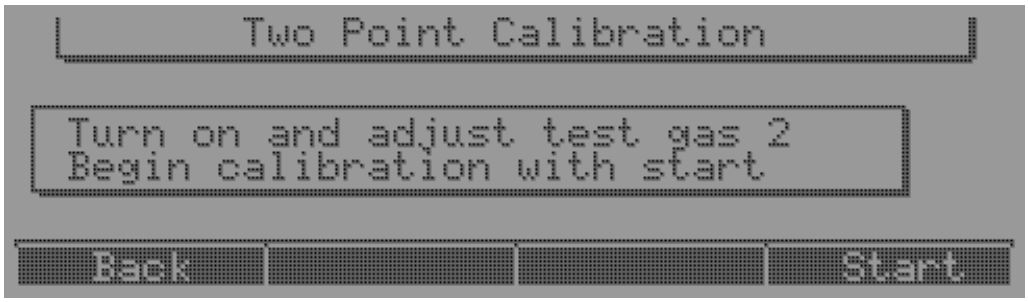


Figure 25 Display: Request to start 2. step of two point calibration

During the second step, the calibration with test gas is accomplished and displayed. The calibration operates fully automatically and needs two minutes per calibration step, which is indicated by a moving time bar (see Figure 26).

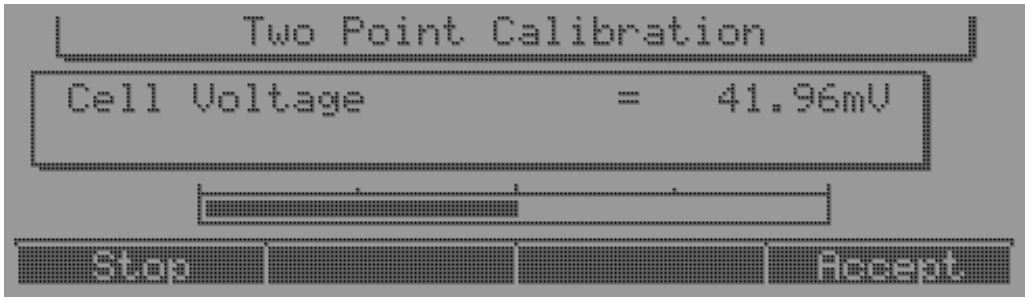


Figure 26 Display: O_2 two point calibration, 2.step

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 does not know then, 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*".

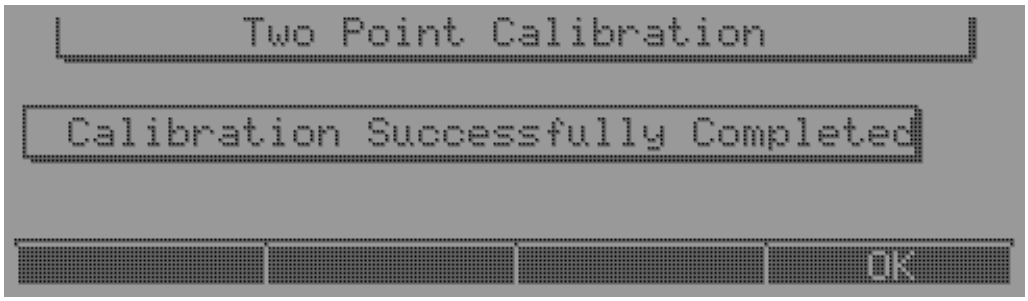


Figure 27 Advice for a successful calibration

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

After calibration the test air hose with the flow meter must be disconnected and the measuring gas hose must be re-connected.

7.6.4 Automatic Calibration (ACAL)

OXITEC® 500E does **not** have the possibility to accomplish calibrations in certain time intervals automatically (ACAL). The System Menu shows this option, because the SME5 Standard software is in use, but the OXITEC® 500E has no connection terminal for an external solenoid valve. If you need to use this function, please contact ENOTEC.

7.6.5 Measuring 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 the 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.

7.6.6 System Test with Test Gas

In this menu option a system test with test gas can be accomplished. The test gas has to be charged at the measuring gas entry by the connection of a test gas bottle. The test gas line is attached with a Swagelok screw connection at the measuring gas entry (see chapter 6.2.1on page 20). The gas line must possess an outside diameter of 6 mm and an inside diameter of 4 mm. In any case the test gas must be attached in such a way that - with the help of a flow meter - a test gas quantity of 30 - 60 l/h can be supplied.

Note

The flow rate of test gas must have a quantity of 30 - 60 l/h.

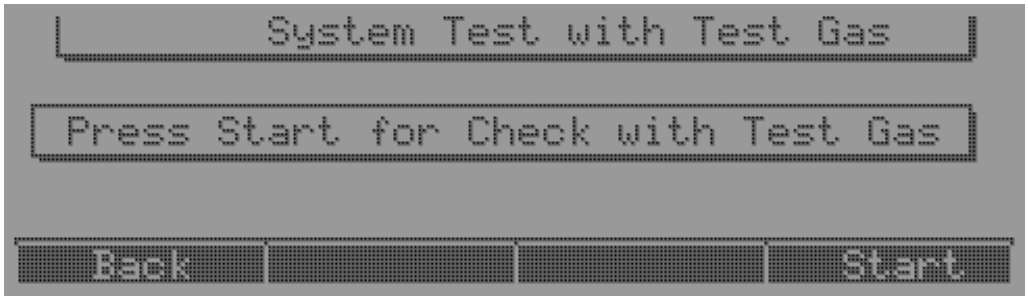


Figure 28 Display: request to start the System Test

Before System Test it must be checked in the parameter menu whether the entered value for test gas (test gas 2) agrees with the actual test gas concentration. If this should not be the case, the entry in the parameter menu has to be corrected.

Warning – Hot Surface

The measuring gas connections at the back of the analyser system are hot, directly affecting parts for assembly, disassembly or maintenance, which can be hot, leading to heavy burns! Wear protective gloves!

Note

Before system test the test gas must be attached.

After charging the test gas the system test can be started using the soft key [Start]. On the display the oxygen value and the cell voltage appear. The system test is to be determined by means of the soft key [Stop].

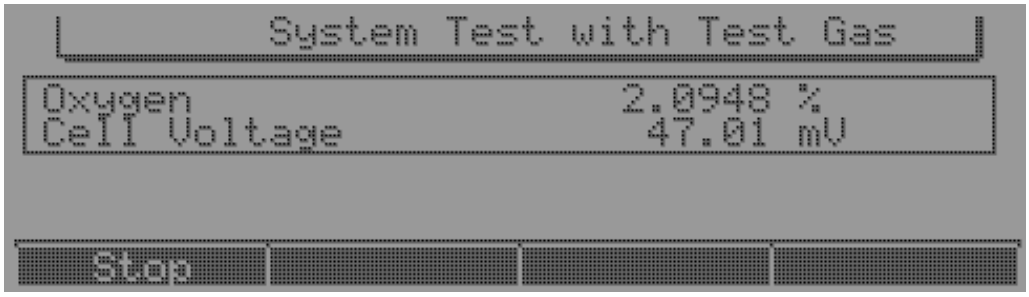


Figure 29 Display: System Test with test gas

Note

After System Test the test gas hose with the flow meter must be disconnected and the measuring gas hose reconnected.

7.6.7 System Test with Test Air

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

Before the System Test with test air is carried out the test air hose must be attached to the measuring gas entry. The supply of test air is made either by the connection to the instrument air supply or from a test air pump. The test gas line is attached with a Swagelok screw connection at the measuring gas entry (see chapter 6.2.1on page 20). The gas line must possess an outside diameter of 6 mm and an inside diameter of 4 mm. In any case the test air must be attached in such a way that - with the help of a flow meter - a test air quantity of 30 - 60 l/h can be supplied.

Note

The flow rate of test gas / test air must have a quantity of 30 - 60 l/h.

Note

Before system test the test air must be attached.

Before System Test with Test Air it has to be checked in the parameter menu whether the adjusted value for test air (test gas 1) is 20.95 %. If this should not be the case, the adjustment in the parameter menu has to be corrected.

After charging the test air the system test is to be started using the soft key [Start]. On the display the oxygen value and the cell voltage appear. The system test is to be determined using the soft key [Stop].

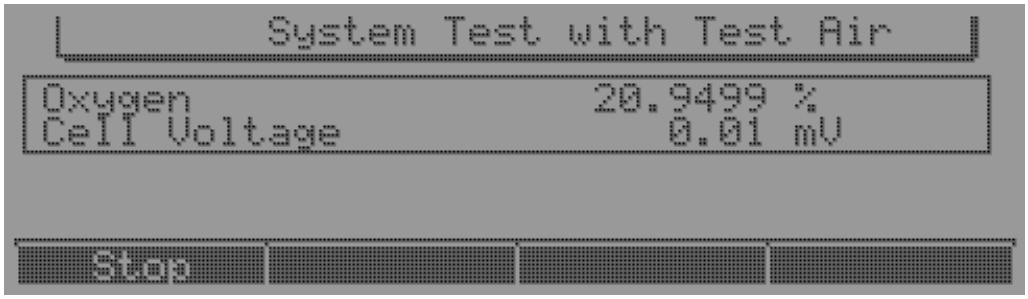


Figure 30 Display: System Test with test air

Note

After System Test the test air hose with the flow meter must be disconnected and the measuring gas hose must be reconnected.

7.6.8 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).

7.6.9 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).

7.6.10 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.

7.6.11 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.

7.6.12 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.

7.6.13 Change Language

In this menu item the language can be selected.

7.6.14 Service

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

7.6.15 Software

Here information about the software conditions is available.

7.7 Status Messages / Error Messages

Figure 31 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.

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 tolerance range is factory set to: -50mV to +10mV.

2. **Slope out of tolerance**

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

3. Heating system does not work

The probe could not heat to the nominal temperature (750°C). Test the heater fuses (see chapter 10.2 on page 58), 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!

4. 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.

5. Error cell signal out of range

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

6. Temp. of electronic out of spec.

The temperature of the electronics is out of the allowed operating limits (see also chapter 9 on page 56).

7. Probe temperature too high

The indicated temperature of the measuring bulb was or is over 800°C.

8. Probe temperature too low

The temperature of the probe was or is too low (<730°C). Please control the heater fuse and check the actual power supply voltage to the electronics (230V/115V ±10%).

9. Alarm limit1

Oxygen limit 1 out of range.

10. alarm limit2

Oxygen limit 2 out of range.

11. Data fault EEProm

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

12. Measured value memory active

The measured value memory is still active.

13. Error by trying ACAL

It was tried to make an Automatic Calibration. But it is not possible to accomplish an Automatic Calibration because the OXITEC® 500E has no connection terminal for an external solenoid valve.

8 System Description/Adjustments

8.1 In Case of Loss of the System Code

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

8.2 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.

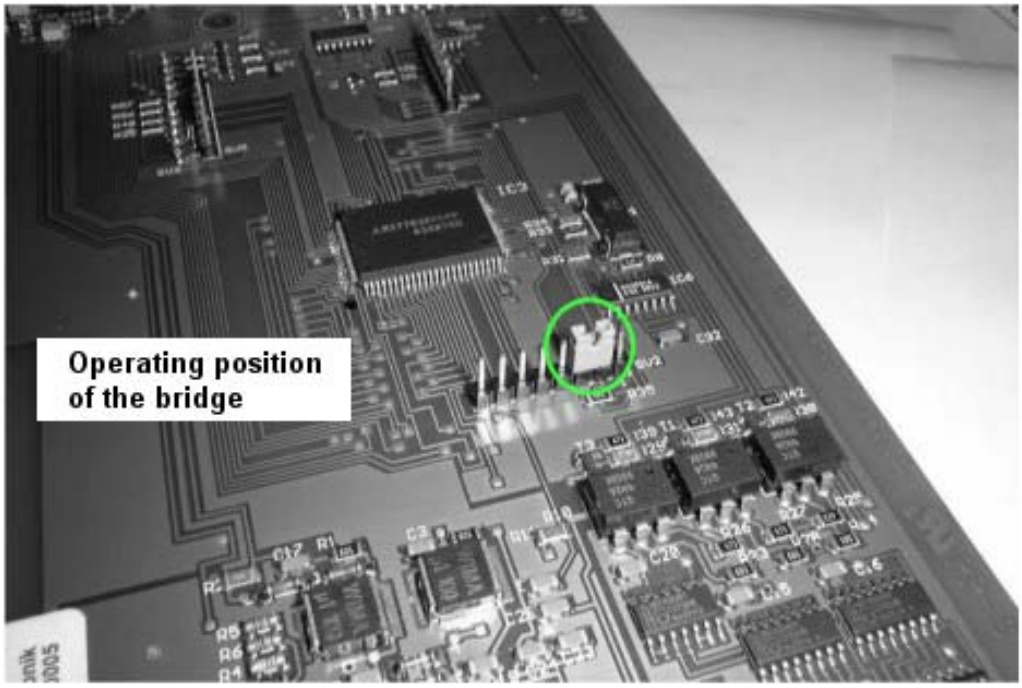


Figure 32 Rear Side of the display unit

8.3 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 33. To adjust the contrast it is necessary to remove the display board and power 'on' the system. Now the contrast can be adjusted by a small screw driver (type 2.5).

Warning

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

Warning – Hot Surface

Parts of the system (measuring bulb and screw connections of the measuring gas pipe) become hot.

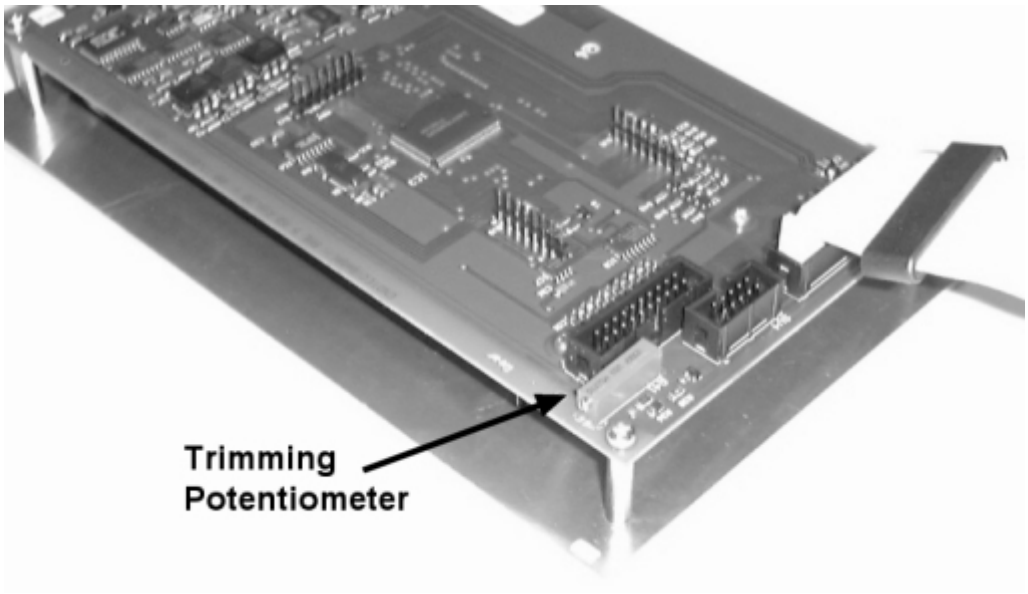


Figure 33 Adjustment display contrast

8.4 Relay Outputs / Functions and Correlation of the Relays

The relay contacts are designed for 24 V and 1A ~ , 1A =.

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
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 5 Relay outputs and functions

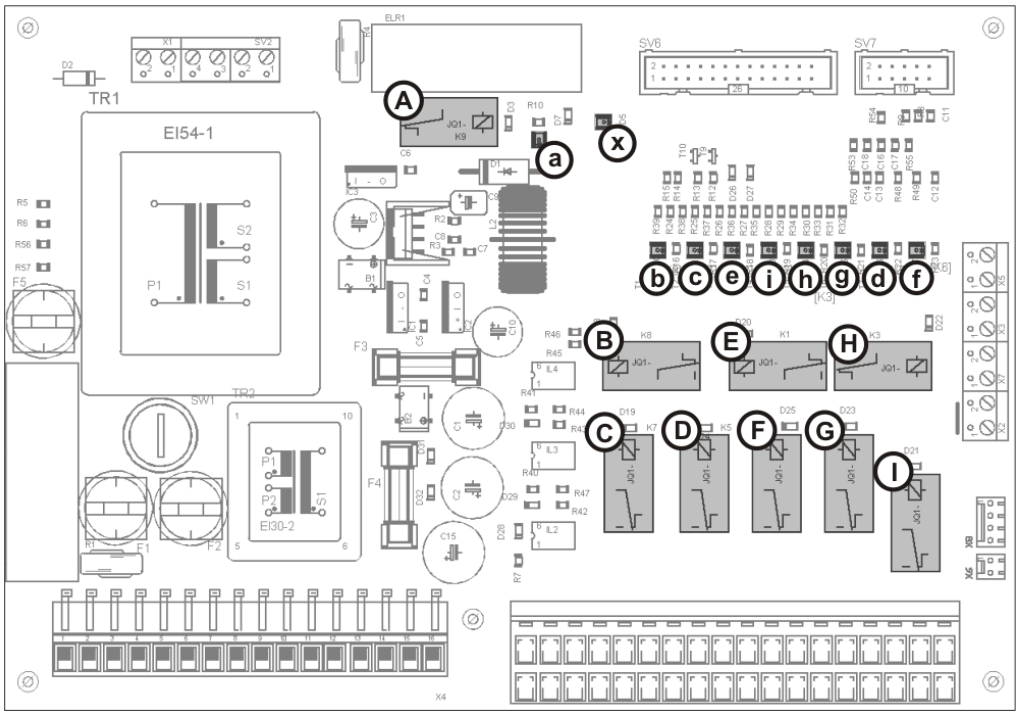


Figure 34 Relay plate with marked relays and LEDS

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 6

8.5 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	not used
Measuring range shift	Switching on the second measuring range

Table 7 Digital Inputs and their functions

8.6 Measuring Gas Flow Rate

The amount of measuring gas has to be between 30 l/h and 60 l/h. In order to ensure this, as the case may be a flow meter has to be installed by the user. This flow meter is not included in the scope of supply.

8.7 Flow Rates for Test Air and/or Reference Air

The amount of test gas has to be between 30 l/h and 60 l/h as well. In order to ensure this, a flow meter has to be installed by the user. This flow meter is not included in the scope of supply. The test gas has to be attached to the measuring gas entry.

The reference air flow rate amounts to 40l/h and is adjusted factory-made.

Concerning the requirement of the gas supply, compare chapter 17.1 on page 68.

8.8 Stability Criteria for Calibration

During calibration, the cell voltage 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.

8.9 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.

8.10 Extension Modules

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

8.10.1 RS 232 Interface (option)

8.10.1.1 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.

8.10.1.2 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.

8.10.1.2.1 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

8.10.1.2.2 Master 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 8

8.10.1.2.3 Answer Slave ➔ Master

8.10.1.2.3.1 Positive Answer (ACK)

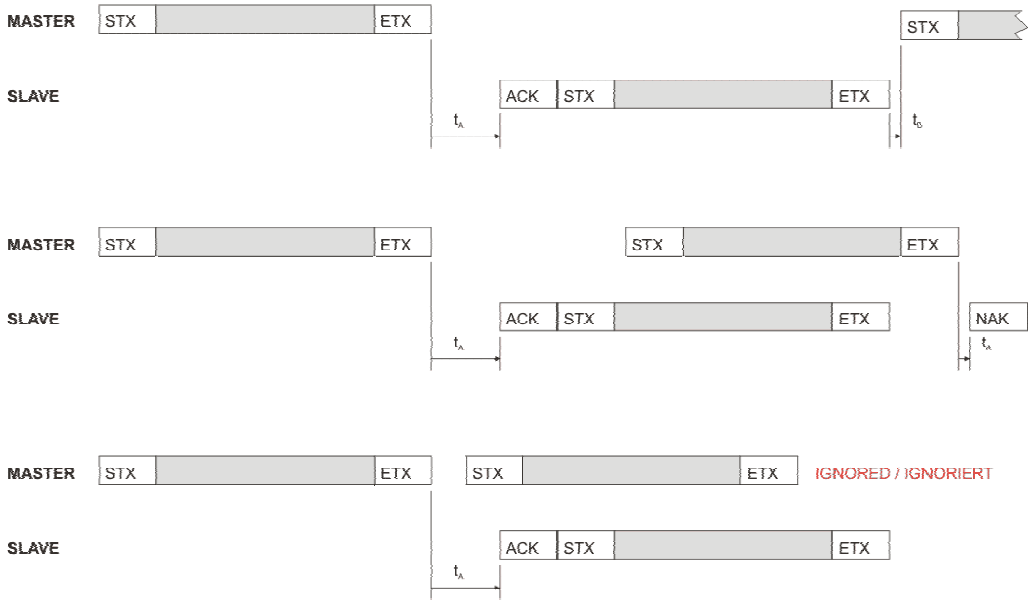
Positive answers will be transmitted to the master, if the request block could be interpreted correctly and also executed.
The answer transmission block is sent with a leading ACK control character.
<ACK><STX><C><NN><UUUU><F><D....D><HH>**<ETX>**
The description of the transmission format definition is described on chapter Table 8 on page 51.

8.10.1.2.3.2 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

8.10.1.2.4 Timing



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

8.10.1.2.5 Checksum Calculation

8.10.1.2.5.1 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.

8.10.1.2.5.2 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);
}
```

8.10.1.3 Operation Modes

8.10.1.3.1 Read Operation

8.10.1.3.1.1 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>**

8.10.1.3.1.2 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.

8.10.1.3.2 Write Operation

8.10.1.3.2.1 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.

8.10.1.3.2.2 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.

8.10.1.3.2.3 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.

8.10.1.3.3 Execute Operation

8.10.1.3.3.1 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

8.10.1.3.3.2 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.

8.10.1.4 Device Dependent Functions

8.10.1.4.1 Specification

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.

8.10.1.4.2 Example

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>**

8.10.1.5 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 9

9 Technical Specification

Dimensions:	See dimensional drawing chapter 13
Mains voltage:	Version with instrument air: 230 V / 50...60Hz Tolerance ±10% 115 V / 50...60Hz Tolerance ±10% Version with pump: 230 V / 50Hz Tolerance ±10% 115 V / 50Hz Tolerance ±10% 230 V / 60Hz Tolerance ±10% 115 V / 60Hz Tolerance ±10%
Power consumption:	400 VA during start up 100 -200 VA at work
Recommended pre-fusing:	10A
Ambient temperature during operation:	-20° C to +55° C (Version with instrument air) -20° C to +40° C (Version with pump) Other temperatures on request
Storage temperature:	-40°C to +80°C
Interference resistance:	See the conformity declaration at the beginning of this manual
Relay outputs, potential-free:	24V~, 24V= , 1 A ohm resistive load
Analogue input cell:	Re: > 9 MOhm Ue: -45mV to +265mV for the active measuring range
Resolution of the digitiser in the active measuring range:	14 Bit +sign
Analogue input thermocouple:	Re: > 900 kOhm
Temperature compensation:	Electronically
Signal output 0/4...20 mA:	Max. load 500 Ohm potential-free
Reaction time of the mA output:	With a change of 100 mV on the cell input < 200 ms
Display:	LC, LED-lit 240 x 64 dots graphic display
Accuracy of measurement:	±0,2% of measured value
Protection class:	IP20

10 Service and Maintenance

10.1 Switching between 230V und 115V Operation

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

Warning

De-energize system first!

Warning – Hot Surface

Parts of the system (measuring bulb and screw connections of the measuring gas pipe) become hot.

Please consider cooling times (approx. 60 min)!

The switch for changing the voltage (in Figure 35 marked with SW1) can be made with a screwdriver and rotating to the voltage which is required.

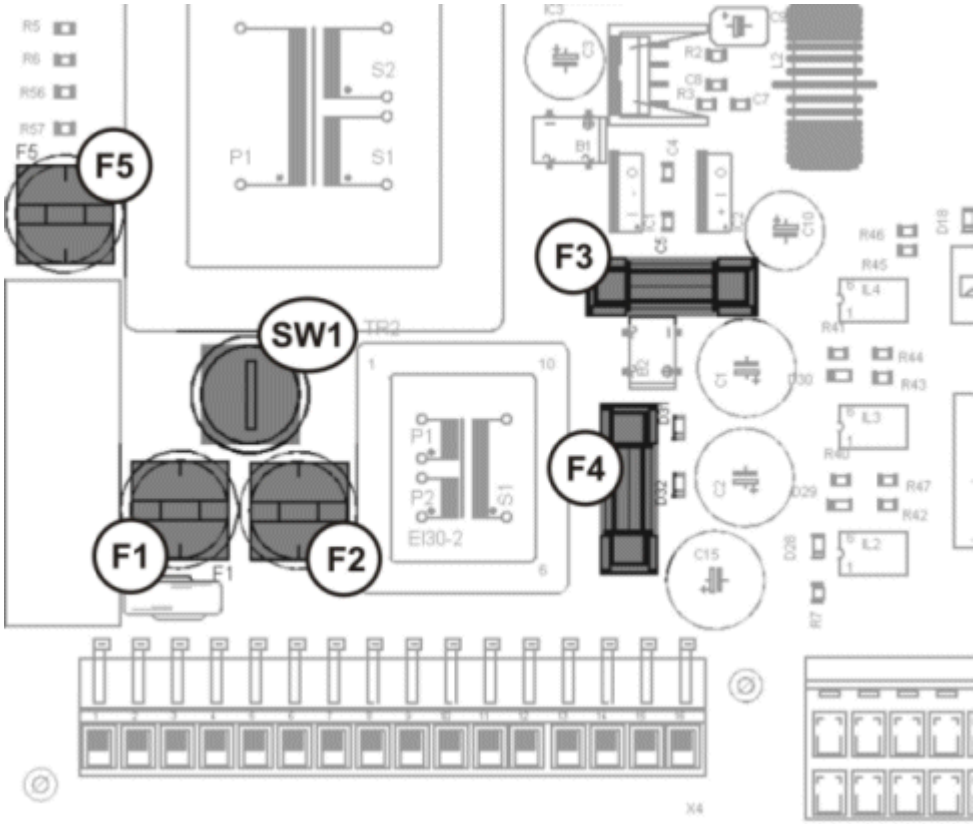


Figure 35 Switching between 230 V and 115 V operation (SW1)

Note

It must be noted that the standard pump version of the OXITEC® 500E 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.

10.2 Replacing of the Fuses

The electronics has two accessible 6.3 A fuses (semi-time lag 5x20mm glass tube fuses) in the power socket for protection of the whole device.

In addition the electronics has the five following fuses on the circuit board (see Figure 35):

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 10 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.

11 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

Telefone: 02264 - 4578-0

Fax: 02264 - 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 measuring 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.

11.1 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.

11.2 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 750°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 cuvette and check). Note: De-energize the system 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 cuvette

De-energize the analyser system.
Disconnect the cable from the cuvette 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 output measured directly at the cuvette is not equal to the mV value shown in the actual value menu please check the wiring between the cuvette and the electronics / power supply board.

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 cuvette, a 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 cuvette (measuring signal wire) or it is interrupted.
b) Combustibles in the flue gas.
c) Measuring cell defective

Remedy: Check whether the cuvette reacts to test gas. If it does, there may be a high proportion 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.

11.3 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 existent, problem is outside the electronics

Result 2: no mA value

Possible causes:
Electronics is defective. Repair or exchange the circuit board.

11.4 Unsteady, widely varying Measuring Value

Steps to localize the problem:

1. Check the measuring cell temperature (set value 750°C)
2. Intermittent contact in the cuvette - internal mV tap.

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

Result 1: Voltage values jump rapidly similar to the display

Causes:
a) Intermittent contact caused by wire break.

Remedies:
a) Repair intermittent contact.

12 Parts Lists for Spare Parts

12.1 Spare Parts List for the complete Oxygen Analyser System OXITEC® 500E SME5

Part No.: OEB-50000000

QUANTITY	UNIT	PART-NO.	TEXT/ DESCRIPTION
1	pc	0-L-000080	Electronic power board SME5 with all relay, terminals complete
1	pc	0-L-000002	SME5 microprocessor unit without front foil
1	pc	TRA-0019	Transformer for OXITEC 500E 44 V 330 VA, incl. mounting hardware
1	pc	KES-500E or KES-511E (MLT)	Measuring bulb, completely mounted and tested, incl. thermal insulation

12.2 Spare Parts List for the Measuring Bulb

Completely installed and tested, inclusive insulation block

Part No.: KES-500E or KES-511E (with MLT cell)

QUANTITY	UNIT	PART-NO.	TEXT/ DESCRIPTION
1	pc	ZO2-0500 or ZO2-0511 (MLT)	Measuring cell with measuring tube and measuring chamber mat.: 1.4571 for the standard version
2	pc	0-P-000061	Bulkhead fitting 6mm
1	pc	SIK-0501	Probe inner part assembly completely mounted and tested, with 48VAC heater
1	pc	ISO-0500	Measuring bulb insulation, complete

12.3 Spare Parts List for the Measuring Cell with Measuring Chamber

Part No.: ZO2-0500 or ZO2-0511 (with MLT cell)

QUANTITY	UNIT	PART-NO.	TEXT/ DESCRIPTION
1	pc	MKR-0500	Measuring chamber mat.: 1.4571 for the standard version
1	pc	MZD-0004	Gasket made of inconel 34,3 mm x 1,6 mm
1	pc	MSR-0500 or MSR-511E (MLT)	Measuring tube

12.4 Spare Parts List for the Measuring Bulb Inner Part

Completely installed and tested with 48V heater

Part No.: SIK-0501

QUANTITY	UNIT	PART-NO.	TEXT/ DESCRIPTION
1	pc	KER-132X	Ceramic rod 4-hole, length: 335mm
1	pc	HEI-0501	Probe heater for measuring bulb 48V/150W
1	pc	MT2-500X	Thermocouple (NiCrNi)
1	pc	MSD-500	Measuring signal wire for measuring bulb
1	pc	HZH-00003	Lava ceramic heater support
1	pc	0-R-000044	Pressure spring 9.0x1x52mm, material 1.4568
1	pc	0-R-000500	Hose clip, material steel, zinced
2	pc	0-R-000474	Heater clamp
2	pc	0-R-000009	Slotted cheese head screw
2	pc	0-R-000010	Nut M2 DIN 934 V4A
2	pc	0-R-000012	Spring ring M2 DIN128 V4A
1	pc	0-R-000461	Retaining bolt, material: aluminium
2	pc	0-R-000242	Allen screw M5*10 V2A DIN912
2	pc	0-R-000246	Lock washer B=5mm V2A DIN127

13 Dimensional Drawings of the OXITEC®500E Analysing System

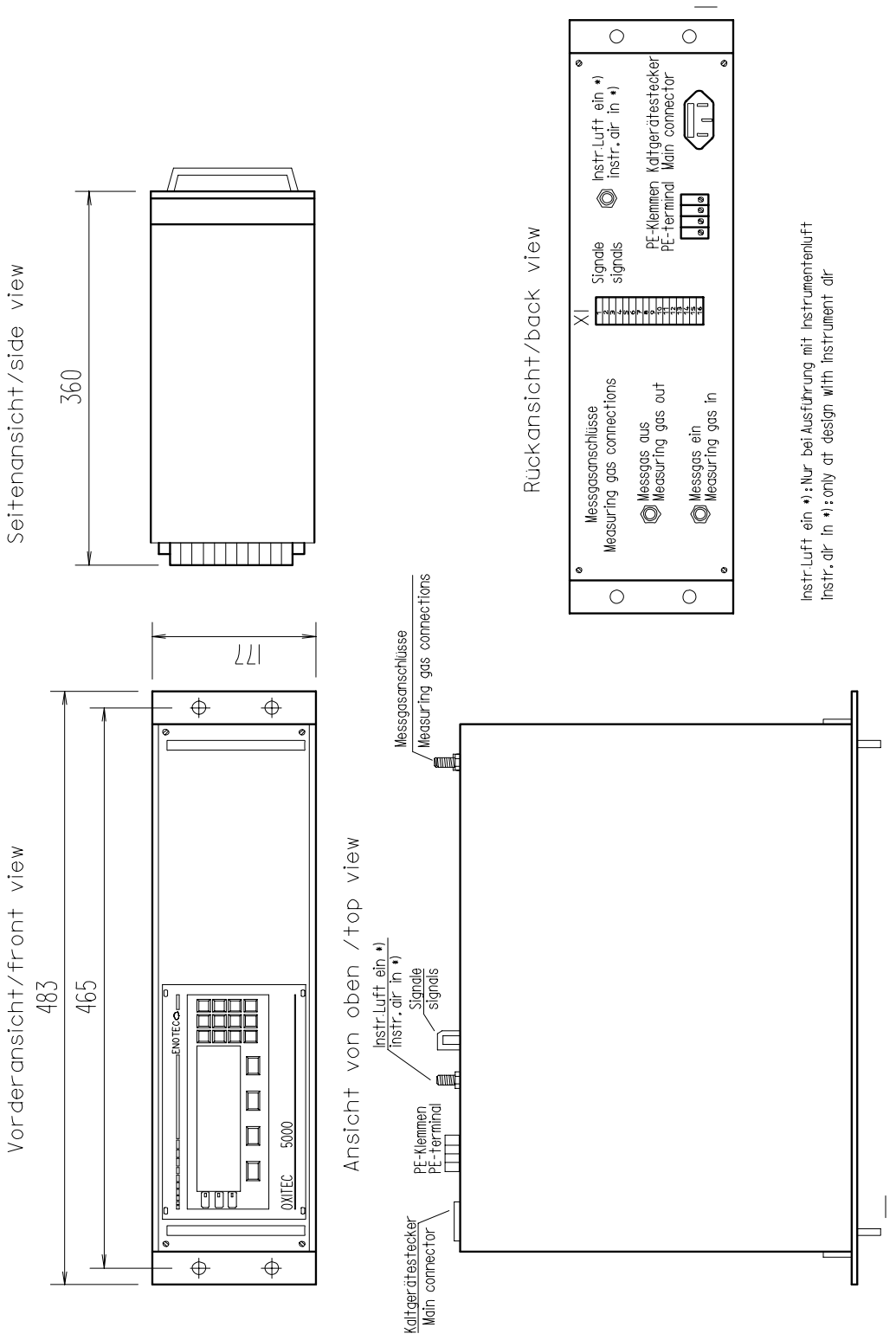


Figure 36 Dimensional Sheet of the Analysing System

14 Drawing of the Measuring Cuvette Components

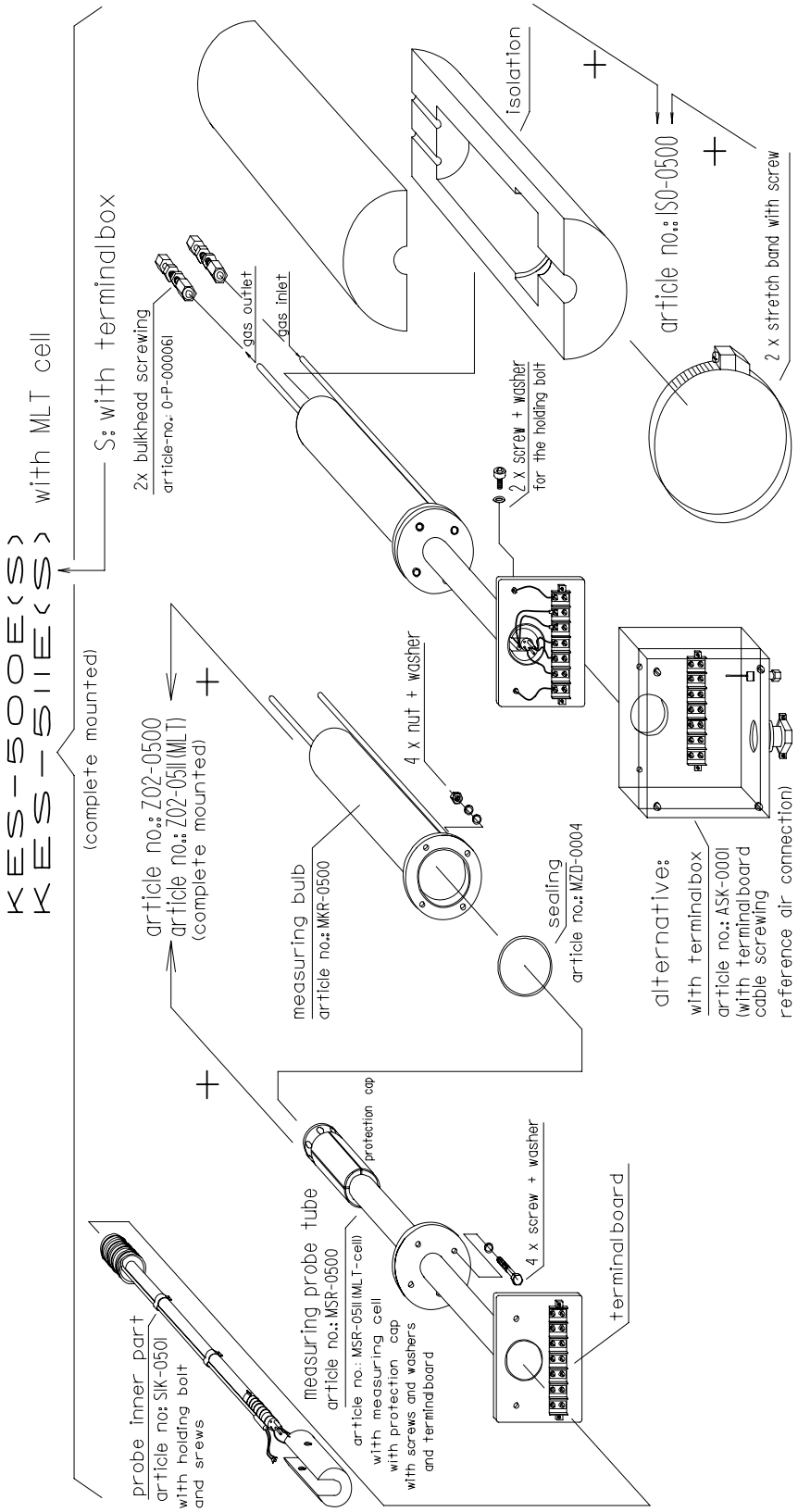


Figure 37 Measuring cuvette

15 Gas Plan

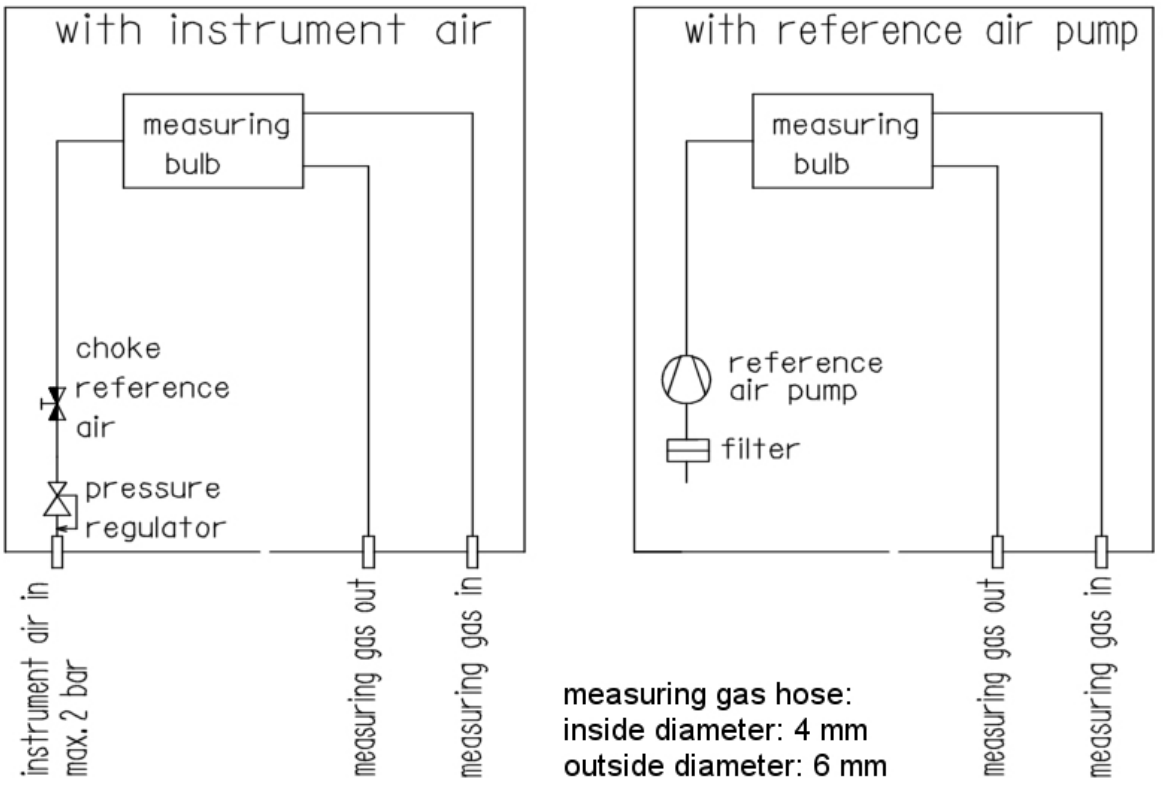


Figure 38 Gas plan

16 Terminal Connections

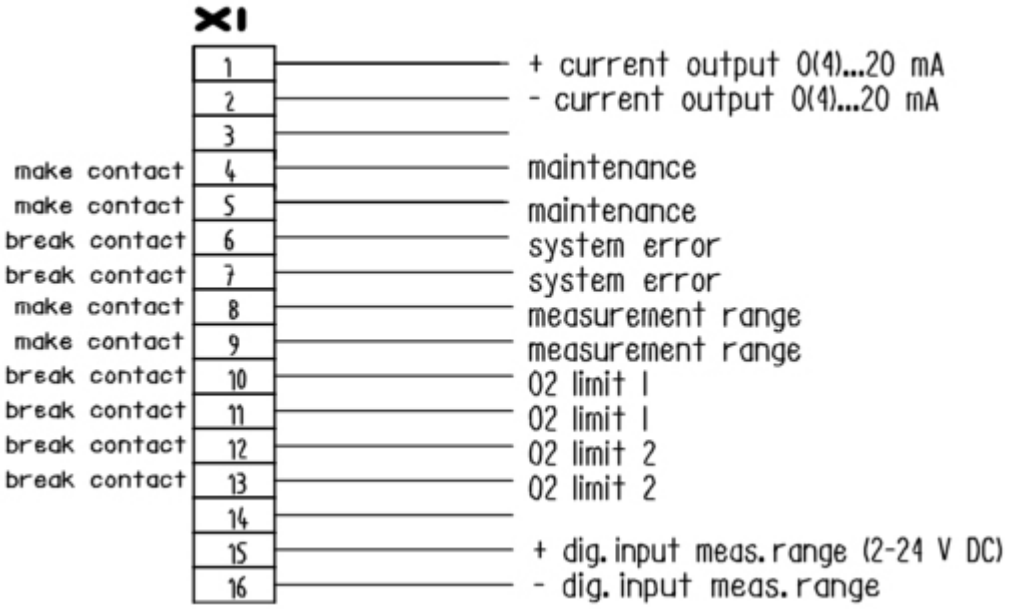


Figure 39 Diagram of Terminal Connection

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 60 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:	60 l/h during calibration

18 Table of Figures

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