METROTEC

Systeme zur Messung und Regelung von Sauerstoff

Operating manual

U15-DIGITAL

Oxygen Measuring and Control Device

U15 Series Measuring module

*** Version 1.6 ***

EC Declaration of Conformity

for

Oxygen measuring and control unit Typ U15-Serie

This device has been designed for industrial purposes in accordance with:

EN 61000-6-4
EN 61000-6-2

It is compliant with the directives:
EMC Directive: 2014/30/EU
Low Voltage Directive: 2014/35/EU
RoHs: 2011/65/EU
Radio Equipment Act Directive: 2014/53/EU

This device complies with following standards:
EN 61010-1
EN 61000-6-4
EN 61000-6-2
EN 63000
EN 300220-2

Description of measures taken to assure compliance:
Quality management system DIN EN ISO 9001:2015, No. 12 100 27736 TMS

This declaration becomes invalid if changes are made without our consent.

Kirchheim/Teck, 27/11/2019

Place, Date Signature

Heinkelstraße 12 • D-73230 Kirchheim
Telefon 07021/95336-0 • Fax 07021/95336-13
www.metrotec.eu • info@metrotec.de

Table of Contents

1 Safety Instructions

Please read through this operating manual very carefully before installing and commissioning the unit.
Incorrect utilisation will invalidate the guarantee!

Correct functioning and the operating safety of the unit can only be guaranteed if the ambient conditions specified in the Specifications chapter are maintained.

Only qualified specialists are permitted to commission and operate the unit. The owner of the unit must ensure that the installation complies with the relevant laws and directives. These include, for example, the EU Directives covering safety in the workplace, national safety in the workplace regulations and the prevention of accidents regulations, etc.

You must ensure that the power supplies concur with the details listed on the nameplate. All of the covers needed to ensure that the unit cannot be touched when operating must always be fitted. You must consider the effects of the overall operation and take the necessary precautions if the unit will be linked up with other equipment and/or devices before you switch on.

Parts and surfaces will occasionally become and remain hot during the installation or de-installation. Suitable precautions must be taken in order to prevent injuries or damage to the unit from occurring.

If the unit shows signs of having been damaged and you are of the opinion that that safe operation is no longer possible then you must not run the unit. We recommend that periodical inspections are carried out at our factory or by our customer service department at least once a year.

Future disposal must always comply with the legal regulations.

2 Preface

With the aid of an oxygen sensor , the measurement unit serves to measure the oxygen partial pressure in gaseous atmospheres. Such sensors work at high temperatures and so it is necessary for measures to be taken to ensure that no flammable gas mixtures contact the sensor or the unit. In the event of the sensor ceramic suffering breakage the measurement gas could escape or air could enter the measurement gas side of the unit and so suitable measures have to be taken to avoid such an event leading to environmental pollution or damage being done to equipment.

In the event of incorrect parameters being set or the occurance of leakage, corrosion, condensation, etc., damage could be done to the equipment and incorrect measurement results be indicated and so it is essential that all parts of equipment be regularly serviced.

The oxygen sensor and its accessories are subjected to thorough quality control in accordance with DIN ISO 9001 in the course of their manufacture and testing.
They must only be installated and used in compliance with all applicable local and special regulations, particularly the VDE and DVGW standards that apply in Germany.
The measurement accuracy and effective function of the measurement device will need to be checked at intervals whose frequency will depend on the applicaton concerned. Such a check must be effected in the course of a calibration and examination check on the equipment being first put into operation.

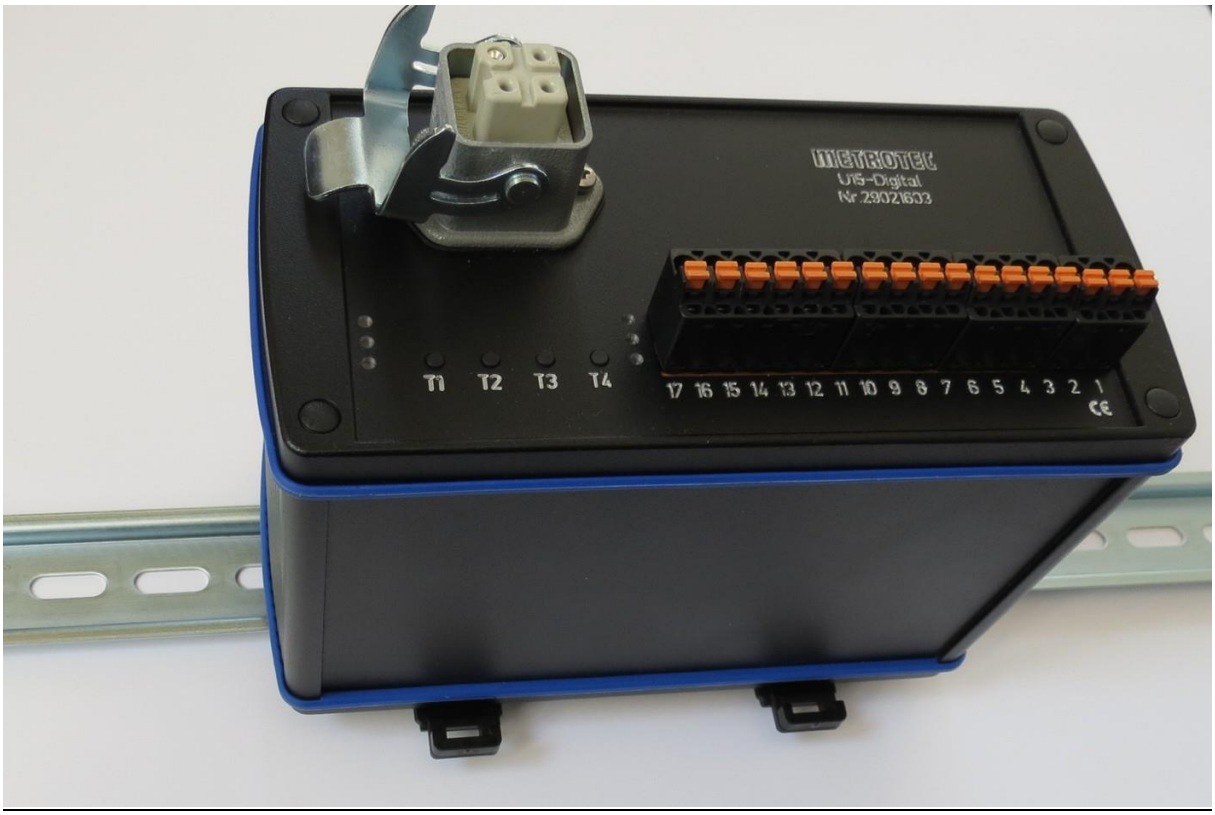


Figure: Oxygen Measuring Module Type U15-Digital

This description is valid for the versions listed here				
Versions of u15-Digital				
Designation	**Sensor**	**Output**	**Alarm**	**Supply**
U15-Digital	Extractive	1	2	230VAC
U15-Digital-2	Extractive	2	2	230VAC
U15-Digital-24	Extractive	1	2	24VDC
U15-Digital-224	Extractive	2	2	24VDC
U15-Digital-C	Inline	1	2	230VAC
U15-Digital-2C	Inline	2	2	230VAC
U15-Digital-C24	Inline	1	2	24VDC
U15-Digital-2C24	Inline	2	2	24VDC

3 Introduction

3.1 Measuring Principle

Oxygen measurement units are designed to process signals transmitted from an oxygen sensor constructed of stabilized zirconium oxide. Zirconium oxide, a ceramic material that is also spoken of as a solid-state electrolyte, acts as an excellent oxygen-ion conductor when at a high temperature.
Within certain temperature limits, that depend on the doping of the material concerned, such ion conductors are able to fill empty spaces in their crystal lattice with oxygen ions. The oxygen ions occur against an electrically conductive surface that is generally of platinum.
The concentration of oxygen in a measurement gas is thus decisive for the extent of oxygen activity, and thus for the number of oxygen ions.
An oxygen sensor consists essentially of a solid-state electrolyte with a contact surface on both sides.
One side of the electrolyte is in contact with a reference gas such as air, and the other with the gas whose oxygen content is to be measured. The mechanical construction of the sensor prevents contact between the two gases so that there is no risk of their being intermixed.
Depending on the application concerned, heated or unheated sensors are used. Unheated sensors are generally used in furnaces while heated sensors are used for applications where the gas to be measured is at a temperature of less than around 600 degrees Celsius (the measurement principle necessitates the sensor being maintained at a temperature of not less than 500 - 650 degrees Celsius).
Heated sensors are maintained at a set temperature by an electronic temperature regulator that forms part of the electronic control unit. The temperature of both heated and unheated sensors as measured by the electronic control is an important parameter for inclusion in the calculation of the oxygen content (oxygen partial pressure) in accordance with the following equation:

$$EMF = \frac{R \cdot T}{4 \cdot F} \cdot \ln(\frac{P_1}{P_2})$$

whereby:

R = 8.31J/mol K
T = Temperature in Kelvin
F = 96493 As/mol
P_1 = Oxygen partial pressure on the reference side with 0.20946 bar
P_2 = Oxygen partial pressure on the measurement gas side
EMF = Electromotive forcein Volts

3.2 Measuring Module

The U15-DIGITAL series measuring module includes the following functions:

- Measures the oxygen partial pressure in connection with a separate series A or C sensor
- Output of measured value 0 to 20 mA, switchable to 4 to 20 mA.
- Generation of alarms

The module is parameterized after the installation, if necessary, and will operate permanently with these settings.

Note:
In order to implement extensive changes and to display measured values, the "METROTEC U15 App" for Android Smartphones is required.

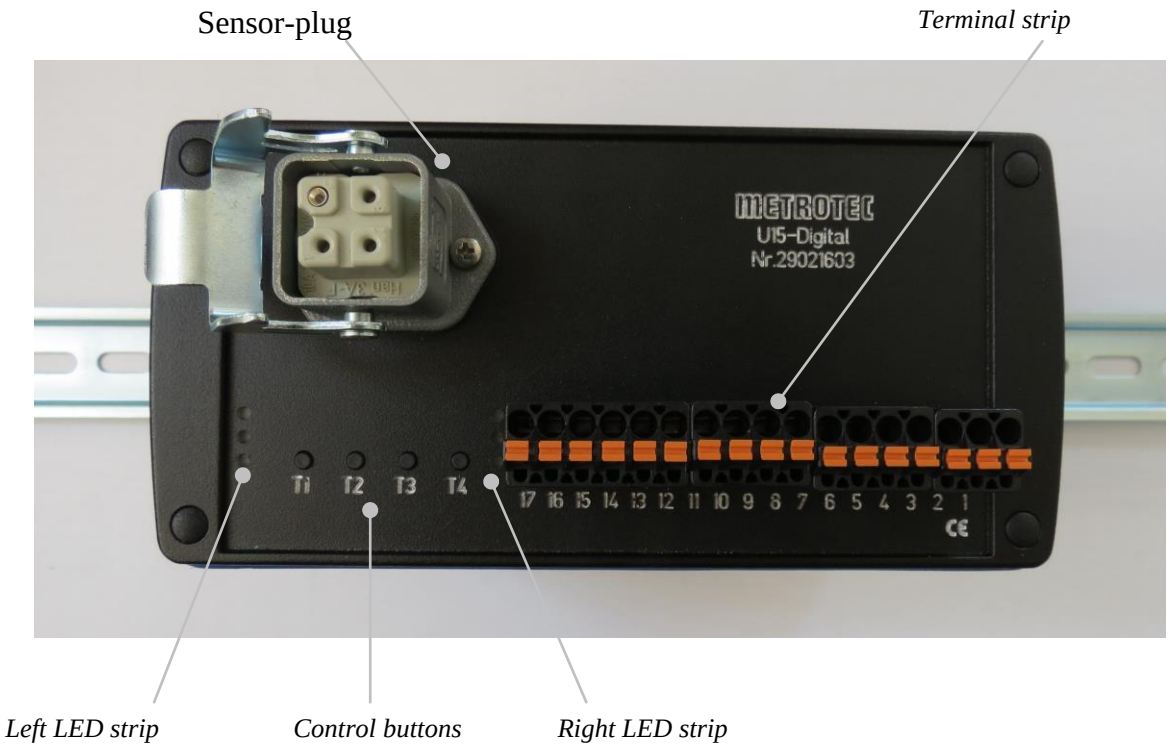
3.3 Sensor

Depending on the version, the measuring module requires a separate extractive oxygen sensor or an inline sensor to carry out its functions.
Connecting the sensor: See section "Connection Diagram" as well as separate operating instructions of the sensor.

4 General Layout

4.1 Description of the Measuring Electronics

The front is divided into several areas representing key panel and display.



5 Device Start-up

5.1 Switching the Measuring Module on

The measuring module is wired up in accordance with the wiring diagram. The module is ready to start when the supply voltage is applied.

The right LED strip lights up. See Table 1, Figure 1.
After heating up the sensor, the green LED signals readiness. See Table 1, Figure 2.
If the current measured value is below the set limit, both LEDs are green. See Table 1, Figure 3.

Table 1: Status display of right LED array

Waiting for sensor temperature	Sensor temperature reached, measuring value has exceeded the limit value.	Readiness and measuring value have exceeded the limit value.
		
Figure 1	Figure 2	Figure 3

Ab Bereitschaft liefert das Messmodul am mA-Ausgang den übertragenen Messwert.

5.2 Measurement

After the starting routine the device is ready for use and can determine the oxygen content in gases. This requires supplying the sample gas according to the sensor type. Alternatively the sample gas contains the sensor. See the operating instructions of the respective sensor.

5.3 Switching the Measuring Module off

It is advisable to keep the device in operation continuously. This will avoid the condensation of steam in heated sensors which may cause corrosion.
Should the unit need to be switched off, the energy supply of the measuring module will be interrupted.
See the operating instructions of the respective sensor.

6 Measured Value Output

The measuring module can output the measured value in linear or logarithmic mode. The standard setting is "linear". This setting can be changed on location. See section "Definition of analog outputs".

6.1 LIN Measured Value Output

The linear output of measured values implicates the assignment of the measured values to either the 0 to 20 mA or the 4 to 20 mA output in linear mode. This assignment is permanent and can only be changed on location by means of the "METROTEC U15 App" for Android Smartphone .

6.2 LOG Measured Value Output

The logarithmic output of measured values implicates the assignment of the measured values to either the 0 to 20 mA or the 4 to 20 mA output in logarithmic mode. This assignment is permanent and can only be changed on location by means of the "METROTEC U15 App" for Android Smartphone .
The output can take on values between 10^{0} and 10^{-30} . The values represent the logarithm of the oxygen partial pressure. This presentation helps to output values stretching over many powers of ten.

Conversion table				
%	**bar**	**ppm**	**log (x)**	**10^{x}**
100	1	1000000	0,00	10^{0}
10	0,1	100000	-1,00	10^{-1}
1	0,01	10000	-2,00	10^{-2}
0,1	0,001	1000	-3,00	10^{-3}
0,01	0,0001	100	-4,00	10^{-4}
0,001	0,00001	10	-5,00	10^{-5}
0,0001	0,000001	1	-6,00	10^{-6}
0,00001	0,0000001	0,1	-7,00	10^{-7}
0,000001	0,00000001	0,01	-8,00	10^{-8}

The measurement module can process values between 10^{0} and 10^{-30} .

7 Configuration

Configuration changes can be carried out on location while only limit value and measured value adjustments can be performed without METROTEC U15 App for Android Smartphone

Note:

In order to implement extensive changes and to display measured values, the "METROTEC U15 App" for Android Smartphones is required.

7.1 Enabling Configuration

The configuration will be enabled by pressing "T1" until the bottom LED of the left LED array lights up. See Table 2, Figure 2.
See also sections "Correction of Measured Values" and "Limit Value Setting"

Table 2: Status display of left LED array

No settings possible	Adjustment mode for reference point	Adjustment mode for Measured value	Setting mode for Limit value
			
Figure 1	Figure 2	Figure 3	Figure 4
--------	LED flashes while value is being changed via "T3" or "T4".		

7.2 Correcting the Measured Value

The current measured value can be corrected, if required. In this case it is advisable to make the adjustment after a stable measurement has been achieved and possible errors in measurement can be ruled out.
The adjustment will be started by pressing "T1" until the bottom LED of the left LED array lights up. See Table 1, Figure 2.
The measuring module has now switched the reference point to the measuring output. If required, the measuring output will also be set to the midpoint of the measuring output range.

In the 0 to 20 mA configuration this is at 10 mA, in the 4 to 20 mA configuration this is at 12 mA.
An adjustment should be made only, if the following conditions are met:

1. The sensor must have reached operating temperature
2. The sensor must have been flushed with clean air

The adjustment is made by pressing "T3" for PLUS and "T4" for MINUS.
Pressing "T1" again switches the left LED array to the next stage. See Table 2, Figure 3.
The measuring module has now switched the measured value to the measuring output. If required, the measuring output will be set to the expected measured value. An adjustment should be made only, if the following conditions are met:

3. The sensor must have reached operating temperature
4. The sensor must have been flushed with a known sample gas or test gas.

The adjustment is made by pressing "T3" for PLUS and "T4" for MINUS. The continued pressing of the buttons accelerates the steps while the LED is flashing.

When finished, the setting is saved by pressing "T2" which also serves to leave the setup menu. All LEDs in the left array are off. See Table 1, Figure 1.

7.3 Adjusting the Limit Value

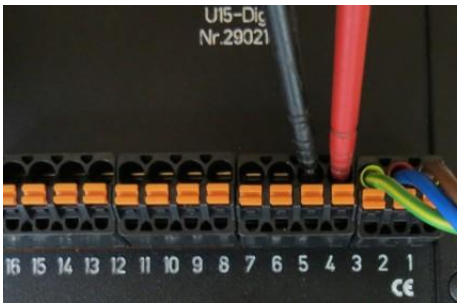
The limit value is switched when the current measured value exceeds the current limit value. Usually the limit value is within the programmed measuring range. An alarm status is signalled at the bottom of the right LED array. See Table 1, Figure 2. At the same time the semiconductor relay, which is connected to the terminals 10 and 11 of the terminal strip, switches.

The approval for changing the setting will be started by pressing "T1" until the bottom LED of the left LED array lights up. See Table 2, Figure 2. The measuring module has now transformed the limit value into a measured value and connected it with the measuring output. The new adjustment is made by pressing "T3" for PLUS and "T4" for MINUS. The continued pressing of the buttons accelerates the steps while the LED is flashing.

When finished, the setting is saved by pressing "T2" while the setup menu is exited at the same time. All LEDs in the left array are off. See Table 1, Figure 1.

7.4 Practical approach

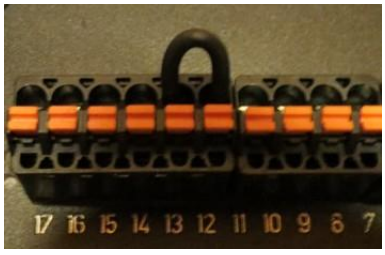
In many cases the visual display of the mA signal is not within sight distance of the measuring module. Thus our recommendation is to disconnect the mA connection from terminals 4 and 5 and replace it by a commercially available portable mA measuring device.



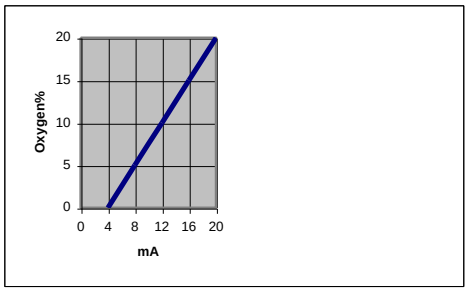
Now the adjustments and settings described above can be carried out. After finishing these settings the previously disconnected connections are restored.

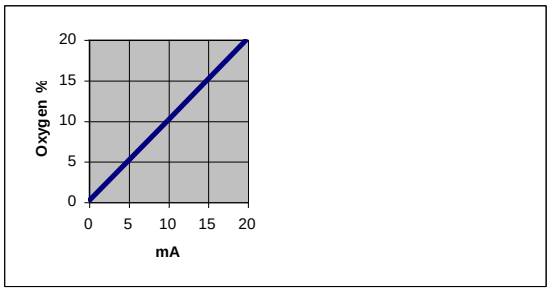
7.5 Definition of Analog Outputs

Switching the analog output from 4 to 20 mA to 0 to 20 mA occurs by means of a jumper between the terminals 12 and 13. Should there be a 2nd analog output, it will also be switched over in the process.

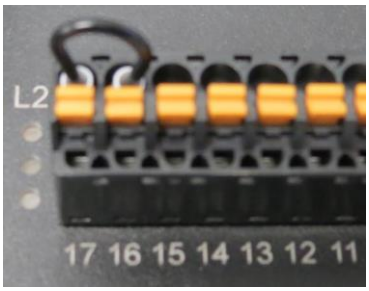


Example for 0 to 20 mA and for 4 –20 mA at 0-20% oxygen.

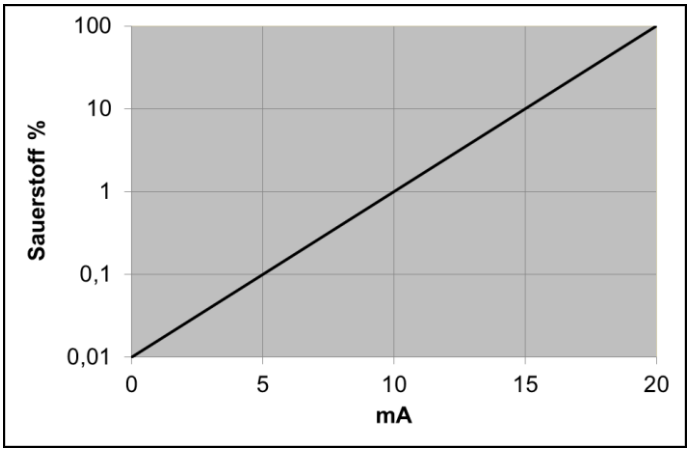




Switching the analog output to linear / logarithmic occurs by means of a jumper between the terminals 16 and 17. Should there be a 2nd analog output, it will also be switched over in the process.



Example for logarithmic output 0 to 20 mA at 0.01-100% oxygen.



Interfaces

7.6 Analog Interfaces

There are 1 or optionally 2 analog 0/4-20 mA interfaces. These can be used at the same time.

7.7 Digital Interfaces

Semiconductor relay for oxygen limit value
Semiconductor relay for readiness

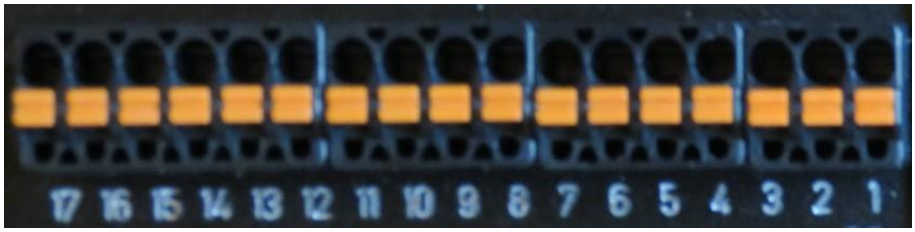
8 App for Android Smartphone

The "METROTEC U15 App" for Android Smartphone enables you to look at measuring values and change configuration settings. First the measuring module must be activated. This is done by pressing "T2". The top green LED in the right LED array starts to flash. This signals readiness for establishing a Bluetooth connection. Now the "METROTEC U15 App" for Android Smartphone can be connected up. As soon as the connection has been established, the LED will light permanently. Pressing "T2" again will switch the Bluetooth connection and the green LED off.
An exact description is available in the "METROTEC U15 App" for Android Smartphone operating instructions.

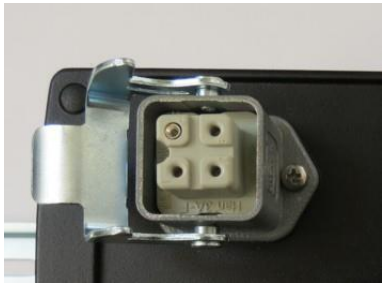
9 Specifications

Measuring range	100 % to 10^{-35} bar O_2
Ambient temperature	0 to 45 degrees Celsius
Measuring accuracy	+/- 0.3 mV of the sensor e.m.f. +/- 2 degrees Celsius +/- 2% of the mA output +/- 2% of the log oxygen partial pressure
Dimensions	ca. 150 x 180 x 90 mm (HxWxD)
Weight	ca. 1.5 kg
Supply voltage	230 VAC, 24 VDC Observe type plate! Wrong power supply can destroy the module!
Output	Acc. to sensor type, ca. 100 VA max.
1 (optionally 2) analog output(s)	0/4 – 20 mA configurable, floating
2 Relay outputs	configurable for alarms, 1A, 24 V (ohmic)

10 Connection Diagrams



Note:
Digital outputs are floating semiconductor contacts (1A, 24V)
mA Output 1 and 2 are electrically isolated from one another.



Connecting sensors

Note: Please refer to the operating instructions of the respective sensor.

Extraktive Sensoren	
Pin	**Function**
1	Heating
2	Heating
3	Sensor +
4	Sensor -

Inline-Sensoren	
Pin	**Function**
1	Thermocouple +
2	Thermocouple -
3	Sensor +
4	Sensor -

U15-Digital		
Terminal	Function	Definition
1	230 VAC	Supply
2	230 VAC	Supply
3	PE (Protective Earth)	Protective Earth
4	mA+	Measured value output 1 +
5	mA-	Measured value output 1 -
6	----	----
7	----	----
8	Semiconductor relay	Readiness 24 VDC, 1 A
9	Semiconductor relay	Readiness 24 VDC, 1 A
10	Semiconductor relay	Limit value 24 VDC, 1 A
11	Semiconductor relay	Limit value 24 VDC, 1 A
12	Connection to 13	Connection if 0-20 mA
13	Connection to 12	Connection if 0-20 mA
14	----	Test output for factory setting
15	----	Test output for factory setting
16	Connection to 17	Connection if logarithmic measuring output
17	Connection to 16	Connection if logarithmic measuring output

U15-Digital-2		
Terminal	Function	Definition
1	230 VAC	Supply
2	230 VAC	Supply
3	PE (Protective Earth)	Protective Earth
4	mA+	Measured value output 1 +
5	mA-	Measured value output 1 -
6	mA+	Measured value output 2 +
7	mA-	Measured value output 2 -
8	Semiconductor relay	Readiness 24 VDC, 1 A
9	Semiconductor relay	Readiness 24 VDC, 1 A
10	Semiconductor relay	Limit value 24 VDC, 1 A
11	Semiconductor relay	Limit value 24 VDC, 1 A
12	Connection to 13	Connection if 0-20 mA
13	Connection to 12	Connection if 0-20 mA
14	----	Test output for factory setting
15	----	Test output for factory setting
16	Connection to 17	Connection if logarithmic measuring output
17	Connection to 16	Connection if logarithmic measuring output

U15-Digital-C		
Terminal	Function	Definition
1	230 VAC	Supply
2	230 VAC	Supply
3	PE (Protective Earth)	Protective Earth
4	mA+	Measured value output 1 +
5	mA-	Measured value output 1 -
6	----	----
7	----	----
8	Semiconductor relay	Readiness 24 VDC, 1 A
9	Semiconductor relay	Readiness 24 VDC, 1 A
10	Semiconductor relay	Limit value 24 VDC, 1 A
11	Semiconductor relay	Limit value 24 VDC, 1 A
12	Connection to 13	Connection if 0-20 mA
13	Connection to 12	Connection if 0-20 mA
14	----	Test output for factory setting
15	----	Test output for factory setting
16	Connection to 17	Connection if logarithmic measuring output
17	Connection to 16	Connection if logarithmic measuring output

U15-Digital-2C		
Terminal	Function	Definition
1	230 VAC	Supply
2	230 VAC	Supply
3	PE (Protective Earth)	Protective Earth
4	mA+	Measured value output 1 +
5	mA-	Measured value output 1 -
6	mA+	Measured value output 2 +
7	mA-	Measured value output 2 -
8	Semiconductor relay	Readiness 24 VDC, 1 A
9	Semiconductor relay	Readiness 24 VDC, 1 A
10	Semiconductor relay	Limit value 24 VDC, 1 A
11	Semiconductor relay	Limit value 24 VDC, 1 A
12	Connection to 13	Connection if 0-20 mA
13	Connection to 12	Connection if 0-20 mA
14	----	Test output for factory setting
15	----	Test output for factory setting
16	Connection to 17	Connection if logarithmic measuring output
17	Connection to 16	Connection if logarithmic measuring output

U15-Digital-24		
Terminal	Function	Definition
1	24 VDC +	Supply
2	24 VDC -	Supply
3	PE (Protective Earth)	Protective Earth
4	mA+	Measured value output 1 +
5	mA-	Measured value output 1 -
6	----	----
7	----	----
8	Semiconductor relay	Readiness 24 VDC, 1 A
9	Semiconductor relay	Readiness 24 VDC, 1 A
10	Semiconductor relay	Limit value 24 VDC, 1 A
11	Semiconductor relay	Limit value 24 VDC, 1 A
12	Connection to 13	Connection if 0-20 mA
13	Connection to 12	Connection if 0-20 mA
14	----	Test output for factory setting
15	----	Test output for factory setting
16	Connection to 17	Connection if logarithmic measuring output
17	Connection to 16	Connection if logarithmic measuring output

U15-Digital-224		
Terminal	Function	Definition
1	24 VDC +	Supply
2	24 VDC -	Supply
3	PE (Protective Earth)	Protective Earth
4	mA+	Measured value output 1 +
5	mA-	Measured value output 1 -
6	mA+	Measured value output 2 +
7	mA-	Measured value output 2 -
8	Semiconductor relay	Readiness 24 VDC, 1 A
9	Semiconductor relay	Readiness 24 VDC, 1 A
10	Semiconductor relay	Limit value 24 VDC, 1 A
11	Semiconductor relay	Limit value 24 VDC, 1 A
12	Connection to 13	Connection if 0-20 mA
13	Connection to 12	Connection if 0-20 mA
14	----	Test output for factory setting
15	----	Test output for factory setting
16	Connection to 17	Connection if logarithmic measuring output
17	Connection to 16	Connection if logarithmic measuring output

U15-Digital-C24		
Terminal	Function	Definition
1	24 VDC +	Supply
2	24 VDC -	Supply
3	PE (Protective Earth)	Protective Earth
4	mA+	Measured value output 1 +
5	mA-	Measured value output 1 -
6	----	----
7	----	----
8	Semiconductor relay	Readiness 24 VDC, 1 A
9	Semiconductor relay	Readiness 24 VDC, 1 A
10	Semiconductor relay	Limit value 24 VDC, 1 A
11	Semiconductor relay	Limit value 24 VDC, 1 A
12	Connection to 13	Connection if 0-20 mA
13	Connection to 12	Connection if 0-20 mA
14	----	Test output for factory setting
15	----	Test output for factory setting
16	Connection to 17	Connection if logarithmic measuring output
17	Connection to 16	Connection if logarithmic measuring output

U15-Digital-2C24		
Terminal	Function	Definition
1	24 VDC +	Supply
2	24 VDC -	Supply
3	PE (Protective Earth)	Protective Earth
4	mA+	Measured value output 1 +
5	mA-	Measured value output 1 -
6	mA+	Measured value output 2 +
7	mA-	Measured value output 2 -
8	Semiconductor relay	Readiness 24 VDC, 1 A
9	Semiconductor relay	Readiness 24 VDC, 1 A
10	Semiconductor relay	Limit value 24 VDC, 1 A
11	Semiconductor relay	Limit value 24 VDC, 1 A
12	Connection to 13	Connection if 0-20 mA
13	Connection to 12	Connection if 0-20 mA
14	----	Test output for factory setting
15	----	Test output for factory setting
16	Connection to 17	Connection if logarithmic measuring output
17	Connection to 16	Connection if logarithmic measuring output