Oxygen Flue Gas Analyzer BA 2000

Some combustion processes, e.g. process heaters, steam boilers or heating furnaces the air required to achieve optimal system efficiency can easily fluctuate. And the economic optimum of the process fluctuates within a relatively narrow range. Both elevated NO_x or SO_x emission due to an excess supply of air (excess O_2) as well as energy loss within the system due to incomplete combustion (lack of O_2) require measuring the oxygen level in the flue gas of the combustion process. Sampling near the combustion chamber is therefore just as vital as using a rapid response sensor to allow for responding to changes in the combustion gas temperature and/or other variables in the combustion process promptly.

The BA 2000 was developed specifically for this application.

- Fast response time
- Tool-less filter change
- Easy handling
- Flue gas temperatures up to 1600 °C
- Durable ZrO_2 measuring cell
- Display includes O_2
- 4-20 mA output signal
- Ambient temperature -20 to +70 °C
- No reference gas required
- No test gas required
- No gas conditioning required
- Calibration with instrument air

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Description

The injector built into the filter housing constantly supplies the ZrO_2 sensor with fresh process gas. The self-regulating probe part is heated to 180 °C to prevent condensation. The ZrO_2 sensor in the BA 2000 provides accurate, extremely fast measurements.

No reference gas needed for operation. The sensor's 1-point calibration uses instrument air also needed to operate the injector. If necessary, 2-point calibration may also be performed. The test gas additionally needed for calibration in this case should ideally correspond with the O_2 concentration of the sample gas.

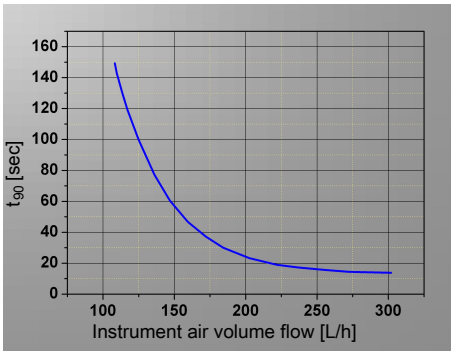
A filter built into the probe protects the measuring cell from dust exposure. The filter can be changed in seconds without tools by simply turning the handle 90°.

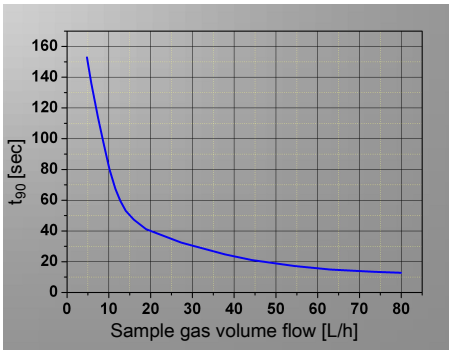
The filter elements are available in ceramic, sintered or star-pleated stainless steel.

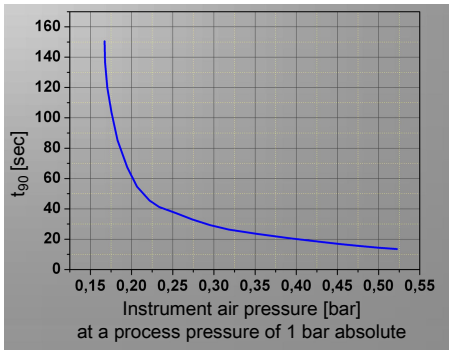
Together with the filters listed, the BA 2000 can be used for gases with a dust load of up to approx. 2 g/m³.

The BA 2000 will provide all the information required for safe operation. The controller features a display with key pad for entering commands, alarm output, calibration function and 4 - 20 mA output signal.

t_{90} times depending on volume flow and pressure







Oxygen measurement principle with ZrO_2 cells

The NERNST equation serves as the basis for determining the oxygen concentration in gases by zirconium dioxide measuring cell.

$$(L)\ U = \frac{RT}{4F} \ln \frac{p_{O_2,\,air}}{p_{O_2,\,sample\ gas}}$$

U	Cell voltage in V
R	Universal gas constant, R = 8.31447 J/(mol·K)
T	Measuring temperature in K
F	Faraday-constant, F = 96485.34 C/mol
$p_{O_2,\,air}$	Partial pressure of oxygen at the reference electrode in dry air in Pa
$p_{O_2,\,sample\ gas}$	Partial pressure of oxygen at the reference electrode in dry air in Pa

The conductivity of the oxide ions of zirconium oxide increases exponentially with the temperature and reaches adequate values above 600 °C.

Provided the total pressures of the gases are about equal on both electrodes (in this case volume concentrations can be used in place of partial pressures), after adding the numeric values for the constants in equation (I) results in the following equation for the oxygen concentration.

$$(II)\quad \varphi_{O_2} = 20{,}9 \cdot e^{(-46{,}42 \cdot \frac{U}{T})}$$

φ_{O_2}	Oxygen concentration in sample gas in Vol.-%
U	Potential difference in mV
T	Measuring temperature in K
$20{,}9$	Oxygen concentration in dry air in Vol.-%

The BA 2000 uses a potentiometric cell. The reference and the sample gas electrode are located in two different gas chambers with different oxygen partial pressure. The two chambers are separated by the gas-tight ZrO_2 tube. The electrodes generate e.m.f. (electromotive force) proportional to the partial pressure difference of the oxygen. The NERNST equation applies.

Technical Data

BA 2000 Technical Data	
Sampling tube length:	0.5 ... 2 m
Voltage:	115 or 230 V, 50/60 Hz
Probe heat output:	400 W
Measuring range:	0.1 to 21 Vol.-% O_2
Output signal:	4-20 mA = 0-21 Vol.-% O_2 (scalable 0-2.5/0-5/0-10/0-15)
Accuracy:	relative error < 5 %
Sensor T_{90} time:	< 15 sec
Alarm Sensor:	Upper and lower limit of nominal value for heating (fixed) Upper and lower limit of O_2 concentration (adjustable)
Probe alarm:	Insufficient temperature
Ambient temperature:	-20 ... +70 °C
Process temperature:	up to 1600 °C, depending on sampling tube
Probe operating temperature:	max. 200 °C
Probe material:	1.4571
Test gas 1-point calibration:	Instrument air 20.9 Vol.-% O_2
Test gases 2-point calibration:	Instrument air 20.9 Vol.-% O_2 and test gas 0.1 to 15 Vol.-% O_2

Ordering instructions

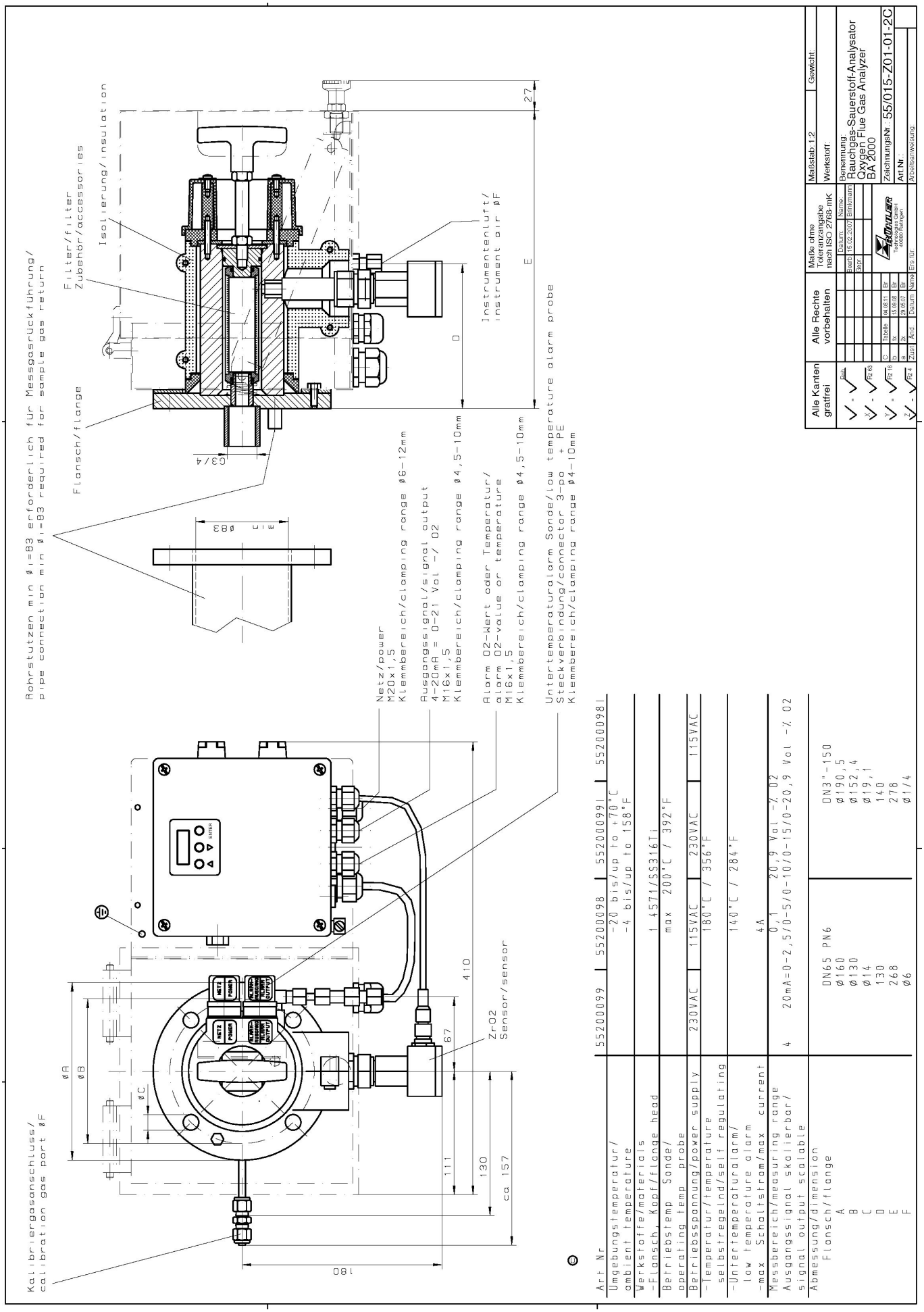
Item no.	Description
55200099	BA 2000, 230 V 50/60Hz
55201099	BA 2000-MF, 230 V 50/60Hz
55202099	BA 2000-SE, 230 V 50/60Hz
55200098	BA 2000, 115 V 50/60Hz
55201098	BA 2000-MF, 115 V 50/60Hz
55202098	BA 2000-SE, 115 V 50/60Hz
55200098I	BA 2000I, 115 V 50/60Hz, US sized
55201098I	BA 2000I-MF, 115 V 50/60Hz, US sized
55202098I	BA 2000I-SE, 115 V 50/60Hz, US sized
55200099I	BA 2000I, 230 V 50/60Hz, US sized
55201099I	BA 2000I-MF, 230 V 50/60Hz, US sized
55202099I	BA 2000I-SE, 230 V 50/60Hz, US sized

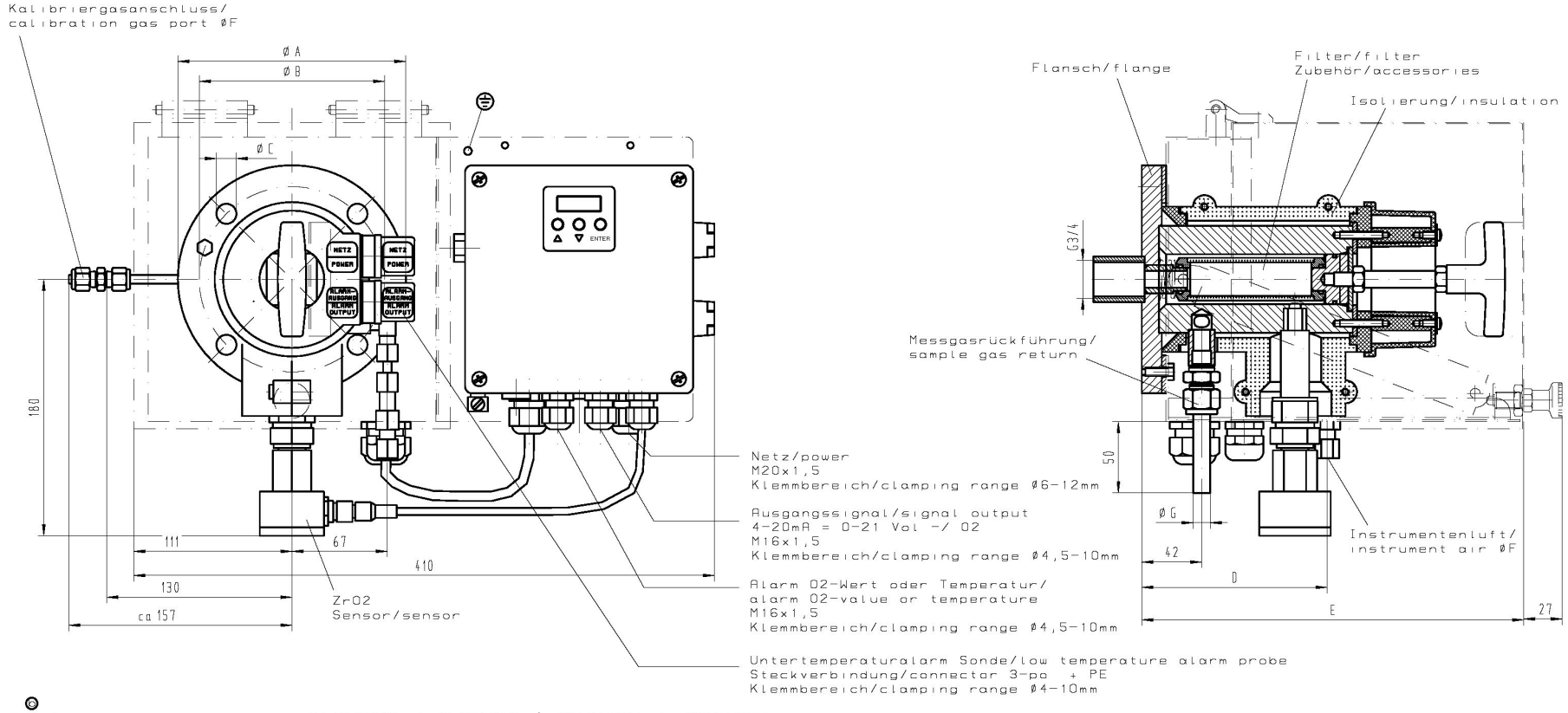
MF = separate sample gas recovery
SE = separated electronics up to approx. 15 m

Adapter flanges

Item no.	Description
55200001	Adapter flange DN65 PN6 to Servomex
55200002	Adapter flange DN65 PN6 to Thermox
55200001I	Adapter flange DN3-150 to Servomex
55200002I	Adapter flange DN3-150 to Thermox

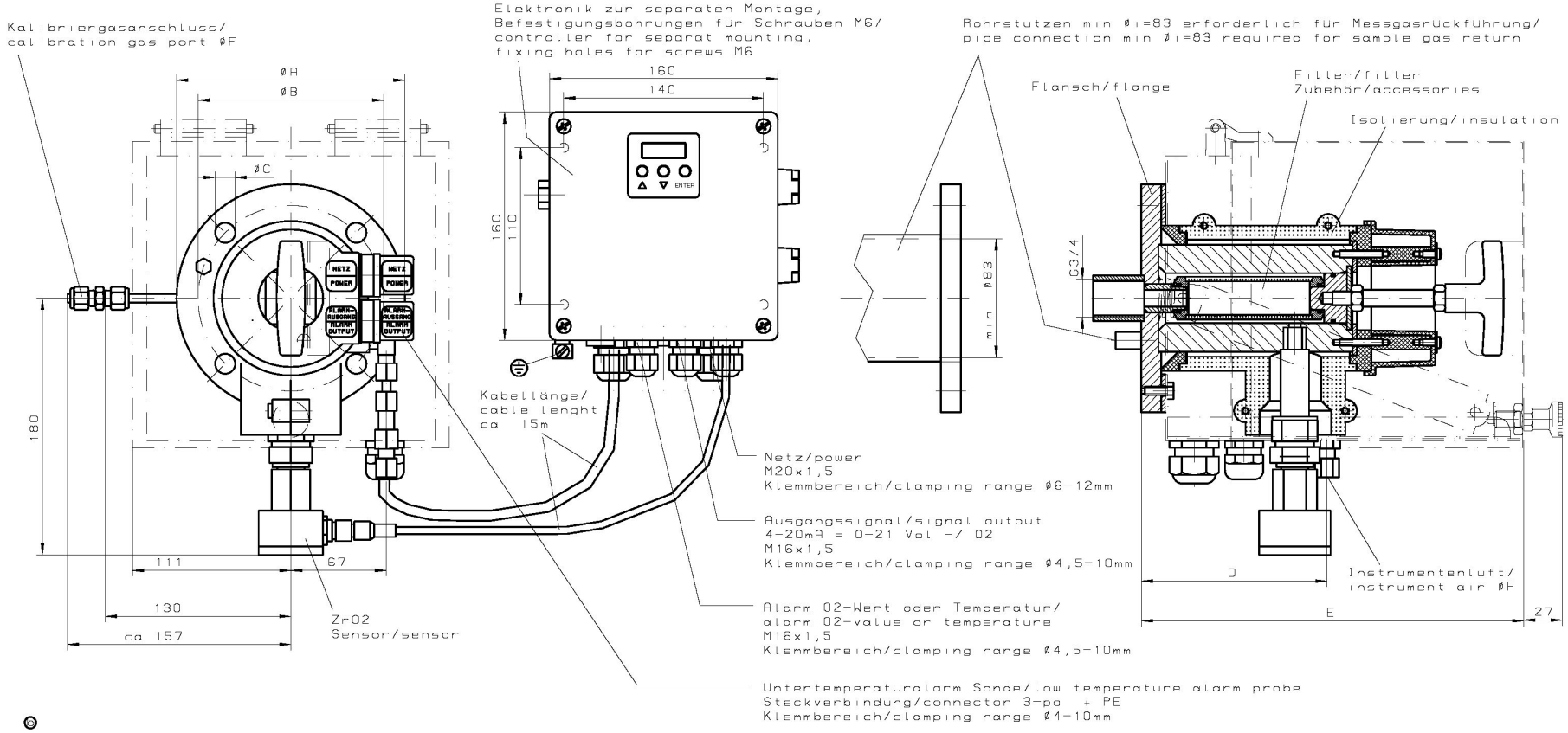
Drawings


Rohrstutzen min Øi=83 erforderlich für Messgasrückführung/
pipe connection min Øi=83 required for sample gas return
Filter/filter
Zubehör/accessories
Isolierung/insulation
Flansch/flange
Instrumentenluft/
instrument air ØF
Netz/power
M20x1,5
Klemmbereich/clamping range Ø6-12mm
Ausgangssignal/signal output
4-20mA = 0-21 Vol -/ O2
M16x1,5
Klemmbereich/clamping range Ø4,5-10mm
Alarm O2-Wert oder Temperatur/
alarm O2-value or temperature
M16x1,5
Klemmbereich/clamping range Ø4,5-10mm
Untertemperaturalarm Sonde/low temperature alarm probe
Steckverbindung/connector 3-po + PE
Klemmbereich/clamping range Ø4-10mm
Kalibriergasanschluss/
calibration gas port ØF
ZrO2
Sensor/sensor
ØA
ØB
ØC
410
67
111
130
ca 157
180
27
E
D
G3/4
min Ø83
ENTER
Art Nr
Umgebungstemperatur/
ambient temperature
Werkstoffe/materials
-Flansch, Kopf/flange head
Betriebstemp Sonde/
operating temp probe
Betriebsspannung/power supply
-Temperatur/temperature
selbstregelnd/self regulating
-Untertemperaturalarm/
low temperature alarm
-max Schaltstrom/max current
Messbereich/measuring range
Ausgangssignal skalierbar/
signal output scalable
Abmessung/dimension
Flansch/flange
A
B
C
D
E
F
55200099 | 55200098 | 55200099I | 55200098I
-20 bis/up to +70°C
-4 bis/up to 158°F
1 4571/SS316Ti
max 200°C / 392°F
230VAC | 115VAC | 230VAC | 115VAC
180°C / 356°F
140°C / 284°F
4A
0,1 20,9 Vol -% O2
4 20mA=0-2,5/0-5/0-10/0-15/0-20,9 Vol -% O2
DN65 PN6
Ø160
Ø130
Ø14
130
268
Ø6
DN3"-150
Ø190,5
Ø152,4
Ø19,1
140
278
Ø1/4
Alle Kanten gratfrei
Alle Rechte vorbehalten
Maße ohne Toleranzangabe nach ISO 2768-mK
Maßstab: 1:2
Gewicht:
Werkstoff:
Benennung:
Rauchgas-Sauerstoff-Analysator
Oxygen Flue Gas Analyzer
BA 2000
Zeichnungs Nr.: 55/015-Z01-01-2C
Art Nr.:
Arbeitsanweisung:
Bühler Technologies GmbH
40680 Ratingen



Art Nr	55201099	55201098	55201099I	55201098I
Umgebungstemperatur/ ambient temperature	-20 bis/up to +70°C -4 bis/up to 158°F			
Werkstoffe/materials -Flansch, Kopf/flange head	1 4571/SS316Ti			
Betriebstemp Sonde/ operating temp probe	max 200°C / 392°F			
Betriebsspannung/power supply	230VAC	115VAC	230VAC	115VAC
-Temperatur/temperature selbstregelnd/self regulating	180°C / 356°F			
-Untertemperaturalarm/ low temperature alarm	140°C / 284°F			
-max Schaltstrom/max current	4A			
Messbereich/measuring range	0,1 20,9 Vol -% O2			
Ausgangssignal skalierbar/ signal output scalable	4 20mA=0-2,5/0-5/0-10/0-15/0-20,9 Vol -% O2			
Abmessung/dimension Flansch/flange	DN65 PN6		DN3"-150	
A	Ø160		Ø190,5	
B	Ø130		Ø152,4	
C	Ø14		Ø19,1	
D	130		140	
E	268		278	
F	Ø6		Ø1/4	
G	Ø12		Ø1/2	

Alle Kanten gratfrei	Alle Rechte vorbehalten	Maße ohne Toleranzangabe nach ISO 2768-mK	Maßstab: 1:2	Gewicht:
			Werkstoff:	
Reh.		Datum: Name:	Benennung: Rauchgas-Sauerstoff-Analysator Qxygen Flue Gas Analyzer BA 2000-MF	
X Rz 63		Bearb. 15.09.2008 Brinkmann		
Y Rz 16		Gepr.		
Z Rz 4	b Tabelle 05.08.11 Er	BÜHLER Technologies GmbH 40880 Ratingen	ZeichnungsNr.: 55/015-Z09-01-2B	
	a 2x 26.11.08 Er		Art.Nr.:	
	Zust. Änd. Datum Name	Ers.für:	Arbeitsanweisung:	



Art Nr	55202099	55202098	55202099I	55202098I
Umgebungstemperatur/ ambient temperature	-20 bis/up to +70°C -4 bis/up to 158°F			
Werkstoffe/materials -Flansch, Kopf/flange head	1 4571/SS316Ti			
Betriebstemp Sonde/ operating temp probe	max 200°C / 392°F			
Betriebsspannung/power supply	230VAC	115VAC	230VAC	115VAC
-Temperatur/temperature selbstregelnd/self regulating	180°C / 356°F			
-Untertemperaturalarm/ low temperature alarm	140°C / 284°F			
-max Schaltstrom/max current	4A			
Messbereich/measuring range	0,1 20,9 Vol -% O2			
Ausgangssignal skalierbar/ signal output scalable	4 20mA=0-2,5/0-5/0-10/0-15/0-20,9 Vol -% O2			
Abmessung/dimension Flansch/flange	DN65 PN6		DN3"-150	
A	Ø160		Ø190,5	
B	Ø130		Ø152,4	
C	Ø14		Ø19,1	
D	130		140	
E	268		278	
F	Ø6		Ø1/4	

Alle Kanten gratfrei	Alle Rechte vorbehalten	Maße ohne Toleranzangabe nach ISO 2768-mK	Maßstab: 1:2	Gewicht:
Roh		Datum: Name:	Werkstoff:	
X Rz 63		Bearb 04.05.2009 Brinkmann	Benennung: Rauchgas-Sauerstoff-Analysator Qxygen Flue Gas Analyzer BA 2000-SE	
Y Rz 16		Gepr.		
Z Rz 4	b Tabelle 05.08.11 Br a 2x 11.10.10 Br	BÜHLER Technologies GmbH 40880 Ratingen	ZeichnungsNr.: 55/015-Z11-01-2B	
	Zust Änd. Datum Name	Ers.für:	Art.Nr.:	
			Arbeitsanweisung:	

We reserve the right to amend specification.