MANUAL

Instruction manual for
Smoke measuring equipment
MIC type EC-912
Serial no.: 20000201-20000222

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List of symbols

I	[A]	current
U	[V]	voltage
R	[Ω]	resistance
τ	[s]	time constant
p	[Pa]	pressure
t	[°C]	temperature
h	[%]	relative humidity

List of subscripts and abbreviations

MIC	Measuring Ionization Chamber
MIREX	Measuring InfraRed EXtinction
FCU	Flow Control Unit
MCU	MIC Control Unit
CC	Control Cabinet
VP	Vacuum Pump
CAL	Calibration
GND	Ground
CH (C)	Chamber
CHO	Chamber, equilibrium
in (i)	input
out (o)	output
C.W.	Clockwise
C.C.W.	Counter clockwise

1. General information

WARNING

THE MEASURING IONIZATION CHAMBER EC-912-10

CONTAINS A WEAK RADIOACTIVE SOURCE. DO NOT

ATTEMPT TO DISMOUNT THE MIC WITHOUT FOLLOWING

THE SAFETY PRECAUTIONS GIVEN IN SECTION 5.1.1 .

1.1 Introduction

Smoke density can be measured using several different techniques. However, for reference measurements of smoke density in connection with testing of ionization smoke detectors for automatic fire detection systems, it is advantageous to use a measuring instrument based on the ionization chamber principle. This is because of the complex nature of smoke, which means that measuring errors are likely to occur if the reference measuring instrument reacts to other properties of the smoke than the detector under test.

Different reference ionization chambers have been developed in the past. [1][3][4]. However, since the measuring characteristics of the ionization chamber depend on several parameters, including the design of the ionization chamber, it is important to reach international acceptance of one particular ionization chamber design in order that measuring results may be comparable in general.

The measuring ionization chamber (MIC) which is the smoke sensor in smoke measuring equipment EC-912 has reached this status. The chamber, which is originally designed by Cerberus AG, Switzerland [2][3], has been included in the European standards for smoke detectors [5][6] issued by CEN[1] and the UL[2] standards UL 217 and UL 268 [8][9]. Furthermore, the chamber has now been specified in recent ISO[3] draft documents for point smoke detectors and great interest for the chamber has been shown by several countries.

The MIC instrument can be used alone or in combination with the optical smoke measuring equipment MIREX type EC-911 (MIC/MIREX system designation EC-910 *see annex* 3) which also complies with the European standards for smoke detectors [5][6].

[1] CEN: European Committee for Standardization

[2] UL: Underwriters Laboratories Inc.

[3] ISO: International Organization for Standardization

1.2 General description

The smoke measuring equipment EC-912 comprises a measuring ionization chamber, a control cabinet and a vacuum pump as shown in *fig. A.1.1 in annex 1.*

The control cabinet (CC) comprises a control unit for the measuring ionization chamber, a flow control unit and a power supply.

The CC can also accommodate a control unit for the optical smoke measuring equipment MIREX type EC-911 and a calculator unit type EC-913.

The measuring ionization chamber (MIC) is placed in the location where the smoke density is to be measured. The MIC is provided with a wind shield which makes the measurements of the device independent of air movement in the location where it is mounted. This wind shield, however, makes it difficult for the smoky air to merge into the measuring volume, so air is sucked through the MIC by a vacuum pump (VP).

The air passes the flow control unit (FCU) on its way from the MIC to the VP. In the FCU the air can be set to a flow rate with needle valve. An exchangeable filter is inserted before the flow meter in order to reduce smoke deposits in this instrument.

The current in the MIC, which is a measure of the smoke density, can be measured with the MIC control unit (MCU). The current in the MIC is transformed into a proportional voltage in a built-in amplifier in the MIC. This voltage is fed to the MCU and transformed to an expression for smoke density which can be presented on the display of the MCU. Furthermore, a recorder output is provided. The MCU is provided with an electrical calibration facility for check and setting of zero point and full scale deflection of the measuring system.

1.3 Applications

As mentioned in the introduction, the MIC smoke measuring equipment EC-912 is intended for reference measurements of smoke density in type approval tests of smoke detectors. The following two applications are typical in this area:

a) Smoke tunnel (box) measurements.

   The smoke measuring equipment is used to measure the actual smoke density in the smoke tunnel where the detector under test is subjected to a slowly increasing smoke density. The sensitivity of the detector is expressed in terms of the value of smoke density measured at the moment of response. The detector sensitivity under specific reference conditions and the change in sensitivity due to variations in the operating parameters environment etc., are measured in this way.

b) Measurements during fire sensitivity tests.

The smoke measuring equipment is used to measure the smoke density under the ceiling in the fire test laboratory, where the detectors under test are subjected to different test fire categories. The smoke readings are used for determining if the test fires are correctly reproduced.

The smoke measuring equipment can also be used in other applications, where measurements of smoke density are needed.

1.4 Specifications

1.4.1 System specifications

Measuring accuracy:	The overall measuring accuracy of the whole system is limited by the measuring accuracy of the MIC, which is better than ±4% of full scale reading (X = 1) for $0 \leq X < 0.9$.
Mains supply:	110 to 240 Vrms, 50 to 60 Hz without switch-over. Power consumption max. 120 W independent of the applied voltage. Mains supply for vacuum pump, *see 1.4.5.*
Cabinet:	19 inch desktop/subrack cabinet with power supply for MIC, MIREX and Calculator unit (optional).

The subunits are intended for operation in normal laboratory environment. However, the measuring ionization chamber may be applied in the temperature range 0-100°C.

1.4.2 Measuring Ionization Chamber (MIC) type EC-912-10

General:

The MIC is designed to fulfil the specification in EN54-7. *See ref. [6].*

Radioactive source:

Isotope:	Am 241
Activity:	129.5 kBq (3.5 µCi) ±5%
Average α-energy:	4.5 M eV ±5%
Mechanical construction:	Americium oxide embedded in gold between two layers of gold. Covered with a hard gold alloy. The source is in the form of a circular disc ø = 27 mm, which is mounted in a holder in such a way that no open cut edges are accessible.

Ionization chamber:

Chamber quiescent current:	I_{CHO} = 100 pA
Chamber impedance:	$R_{CHO} = 1.9 \bullet 10^{11} \Omega \pm 5\%$

The characteristics are measured in aerosol free air at:

Air pressure:	$p = 1.013 \bullet 10^5$ Pa (760 mm Hg)
Air temperature:	t = 25°C
Rel. humidity:	h = 48%

Measuring time delay $\tau \leq 10$ sec. where τ is defined as the time from the moment when the MIC is subjected to a smoke step function to the moment when the output has reached 63% of its final value. The figure for τ is based on a flow rate of 30 1/min.

Relative smoke sensitivity: $$\frac{X}{X_R MIC} = 1.00 \pm 3\%,$$

where X_RMIC is the smoke density measured with DELTA's standard chamber MIC, type EC 23095-1 Serial no. 830101.

Refer to *section 5.2* and the certificate of calibration for further details.

Output: Multipole connector for the cable to the CC.

1.4.3 MIC Control Unit (MCU) type EC-912-20

Readout:	3.1 digit LCD display. Chamber voltage or smoke density X can be selected. With calculator unit (optional) also smoke density Y and Y_{20} can be displayed.
Recorder output X:	0.0 to 10.0 VDC corresponding to a smoke density X of 0.00 to 1.00.
Recorder output Uc:	Approx. 14 to 25 VDC corresponding to the chamber voltage.
Recorder output Y:	0.00 to 11.00 VDC corresponding to a smoke density Y of 0.00 to 11.00 (not active without the calculator unit).
Recorder output Y_{20}:	0.00 to 11.00 VDC corresponding to a smoke density Y_{20} of 0.00 to 11.00 (not active without the calculator unit).

1.4.4 Flow Control Unit (FCU) type EC-912-40

Flow rate:	Adjustable between 0-50 1/min
Filter:	Replaceable filter element P/N 448842 from Mine Safety Appliances Co., USA

1.4.5 Vacuum Pump (VP), Rietschle type VTE 3

Technical data:

Mains voltage:	230 V ±10%, 50-60 Hz
	115 V ±10%, 60 Hz
	100 V ±10%, 50-60 Hz
Motor rating:	Approx. 0.15 kW
Capacity:	3.5 $m^3/h \cong 58$ l/min, 50 Hz
	4.2 $m^3/h \cong 70$ l/min, 60 Hz
Degree of protection:	IP54
Weight:	6.3 kg
l x w x h	209 x 152 x 165[4] mm

[4] To top of pipe branches

2. Installation

2.1 Preparation for use

2.1.1 Unpacking

Unpack the smoke measuring equipment and remove tape strips etc. used for fixing during transportation.

Check that the following items are enclosed in the shipment:

1	pc.	Measuring Ionization Chamber, type EC-912-1
1	pc.	Allen wrench, 1.5 mm metric
10	m	P.V.C. hose
1	pc.	multicable (10 m cable with connectors with yellow coding)
1	pc.	control cabinet with MIC Control Unit, type EC-912-20 and Flow Control Unit, type EC-912-40.
1	pc.	mains cord with plug (female)
2	pcs.	pre-filter P/N 448842, manufacturer MSA, Mine Safety Appliances Co., Pittsburgh, Pennsylvania, USA.
1	pc.	vacuum pump, Rietschle type VTE 3
1	pc.	filter cartridge for vacuum pump
4	pcs.	carbon blades for vacuum pump
1	pc.	instruction manual
1	pc.	certificate of calibration

Inspect the items for possible damage due to transportation and report to the forwarding agency as soon as possible if damages are found.

Check for correct operating voltage rating of the VP.

2.1.2 Mains cord

Plugs corresponding to the type of electrical outlet in concern have to be mounted on the mains cord to the CC and VP, in accordance with the following information:

Control cabinet: 3-wire mains cord:

Brown	-	live
Blue	-	neutral
Green/yellow	-	ground (chassis)

Vacuum pump: 3-wire mains cord:
See connection information on the lid of the terminal housing

Consult an electrician for proper mains installation.

Note: The MIC must be earthed through the mains connection (green/yellow wire).

2.1.3 Performance check

Check the performance of the smoke measuring equipment as follows:

a) Interconnect the MIC and the CC (rear side) with the multicable, the MIC connectors have yellow insulation rings. Align the code marks and push the plug gently into the connector when fitting the cable.

b) Connect a voltmeter (range 0-10 VDC) to recorder output X on the rear of the CC.

c) Connect the CC to the mains and switch on power. The MCU display shall light up, the MODE indicator shall indicate Uc mode and the CAL ON indicator shall light up.

d) Press the MCU MODE button to indicate mode X. The MCU display may read a value deviating from 1.00.

e) Adjust the offset trimmer on the MCU until the display reads 1.00. The corresponding recorder output voltage shall be 10.0 VDC.

f) Press the MCU CAL button. The CAL ON indicator shall extinguish. The display may read a value deviating from 0.00.

g) Adjust the Uc trimmer on the MCU until the display reads 0.00. The corresponding recorder output voltage shall be 0.0 V.

h) Press the CC MODE button to indicate mode Uc. The display shall read a value between 14.0 and 25.0 (19.0 is typical). The voltage on recorder output Uc at the rear of the MCU shall be the same as the value on the display.

i) Connect the VP and air outlet on the rear of the FCU with a piece of hose.

j) Turn the flow meter needle valve in the FCU fully C.W.

k) Connect the VP to the mains and switch on power. The ball in the flow meter on the FCU shall stay in its lowest position.

l) Turn the flow meter needle valve C.C.W. until the middle point of the ball indicates approx. 40 l/min. Block the air inlet on the rear panel of the FCU with a finger and control that the ball drops to its lowest position. Fasten the finger screws on the filter unit and checks for other leaks if this does not happen.

Attention: Do not remove your finger from the air inlet before the VP has been switched off and stopped. Otherwise, the ball may be damaged by collision with the flow meter needle valve.

2.2 Installation of Measuring Ionization Chamber (MIC)

The MIC is intended for mounting on a plane surface (e.g. wall, ceiling, etc.) in the location in concern, as shown in *fig 2.2*. A circular opening in the mounting surface 10-12 cm in diameter is adequate. Care should be taken that the cable and hosing are not bent sharply. Keep a distance of min. 12 cm to objects behind the mounting surface.

The MIC should not be mounted too close to devices which may be sensitive to air movements since the air flow through the MIC causes slight disturbances in the surrounding air. The nominal flow rate of 30 l/min. corresponds to a mean air velocity of approx. 4 cm/sec. in the plane of the air entrance openings in the chamber housing. Since the air velocity decreases rapidly with the distance from the entrance openings, a spacing of 10 cm or more between the MIC and other devices is usually sufficient.

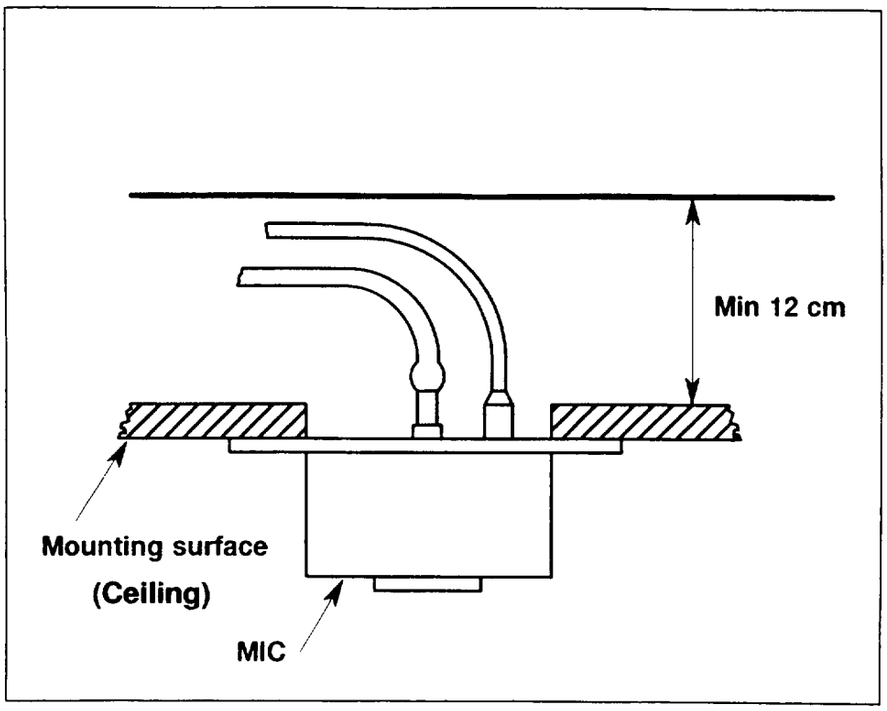


FIG. 2.2 Mounting of MIC

2.3 Installation of Vacuum Pump (VP)

Smoke measuring equipment EC-912 is delivered with a vane-type vacuum pump Rietschle type VTE 3. The VTE 3 pump is quiet in operation (noise level 58 dBA with exhaust hose). The pump is provided with a factory-set by-pass valve, which prevents damage in case the inlet is blocked. An outlet is provided, from where the smoky air can be led to the outside via a hose. So, the VTE 3 pump can be placed in a suitable place in the laboratory. Refer to the installation instructions from Rietschle in *annex 2* for further information.

2.4 Installation of Control Cabinet (CC)

The CC is housed in a 19 inch cabinet which can be used as a desktop cabinet or as a subrack for mounting in a 19 inch rack system. The CC is delivered as a desktop cabinet with a bottom plate with four feet. If the CC is to be installed in a 19 inch rack system the whole bottom plate has to be removed, by unscrewing the four screws in the bottom plate.

3. Operation

3.1 Operating controls, connectors and indicators

The function of the controls, connectors and indicators located on the different units of smoke measuring equipment EC-912 is defined as follows:

3.1.1 Measuring Ionization Chamber (MIC)

Multipole connector: The male connector of the multicable fits into this connector. Align the code marks and push the plug gently into the connector. Do not use force. When disconnecting the cable, be sure to pull on the fluted part of the connector and never on the cable.

Air outlet: Pipe branch for hose to air inlet on rear of FCU.

3.1.2 Control Cabinet (CC)

Rear plate (see *fig. A.1.4* in *annex 1)*

Mains switch: The mains switch is part of the EMI filter and mains plug assembly placed on the left at the rear of the cabinet.

Sockets calibration: A short between these sockets (red-blue) initiates the automatic calibration function when the calculator unit (optional) is plugged into the CC. Calibration may be activated e.g. from a data acquisition system for remote calibration of the system.

Sockets lock: A short between these sockets (red-blue) disables the automatic calibration function when the calculator unit (optional) is plugged into the CC. Lock may be activated, e.g. from a data acquisition system, to avoid unintended calibration during smoke measurements.

Sockets m/Y: A voltage which is proportional to the measured extinction module m [dB/m] from the MIREX divided with the measured smoke density Y from the MIC is present on these sockets when the MIREX Control Unit (optional) and the calculator unit (optional) are plugged into the CC.

Connector MIC: The female plug of the multicable fits into this connector. Align the code marks and push the plug gently into the connector. Do not use force. The plug on the cable is secured with a locking system which avoids unwanted disconnecting. When

disconnecting the cable, be sure to pull on the fluted part of the connector and never on the cable.

Sockets U_c: The actual chamber voltage U_c is present on these sockets.

Black: Ground Red: Output voltage
14.0 VDC ≤ Uc ≤ 25.0 VDC
Load impedance ≥ 100 k

Sockets X: A voltage which is proportional to the measured X signal is present on these sockets.

Black: Ground Red: Output voltage
0.0 VDC for X = 0.00
10.0 VDC for X = 1.00
Load impedance ≥ 100 kΩ

Sockets Y: A voltage which is proportional to the measured Y signal is present on these sockets when the calculator unit (optional) is plugged into the CC.

Black: Ground Yellow: Output voltage
0.00 VDC for Y = 0.00 (X = 0.00)
11.00 VDC for Y = 11.00 (X = 0.91)
Load impedance ≥ 100 kΩ

Sockets Y_{20}: A voltage which is proportional to the measured Y_{20} signal is present on these sockets when the calculator unit (optional) is plugged into the CC.

Black: Ground Yellow: Output voltage
0.00 VDC for Y_{20} = 0.00
11.00 VDC for Y_{20} = 11.00
Load impedance ≥ 100 kΩ

Note: The calibration sockets and the lock sockets must be shorted with a potential free contact e.g. a switch or a relay.

3.1.3 MIC Control Unit (MCU)

Front panel (see *fig. A.1.3* in *annex 1*)

MODE button: With this button, different display modes can be selected. Without the calculator unit chamber voltage U_c and smoke density X can be selected. With the calculator unit (optional) also smoke densities Y and Y_{20} can be selected.

CAL button: When the CAL button is pressed indicator ON light up and the MIC is now ready for offset calibration by means of the offset trimmer.

Offset trimmer: Screwdriver trimmer for offset calibration.

U_c trimmer: Screwdriver trimmer for adjustment of the chamber voltage.

Calculator area: The two colour indicator in this area is only active when the calculator unit (optional) is plugged into the CC, and has the following indications:

Steady green: Normal status of MIC after calibration. X = 0.00 prior to measurement.

Flashing red: Automatic calibration function is active. Wait for steady green indication.

Steady red: Calibration error.

3.1.4 Flow Control Unit (FCU)

Front panel (see *fig. A.1.3* in *annex 1*)

Flow meter valve: Needle valve for adjustment of air flow rate in the range 0-50 l/min. The flow rate is indicated on the flow meter and read at the middle of the ball.

Rear panel (see *fig. A.1.4* in *annex 1*)

Air inlet: Pipe branch for hose to air outlet on MIC.

Air outlet: Pipe branch for hose to air inlet on VP.

Finger screws: Screws for disassembling the filter unit.

3.1.5 Vacuum Pump (VP)

(See *annex 2*)

Air inlet: Pipe branch for hose to air outlet on rear of FCU.

Air outlet: Pipe branch for hose to appropriate place.

By-pass valve: Valve for adjustment of minimum pressure. The by-pass valve is fitted to ensure that the pressure does not drop below 150 mbar, when the inlet is blocked. The by-pass valve is adjusted

by DELTA to a minimum pressure of approx. 500 mbar. This setting is locked with lacquer and should not be changed unless the new setting is controlled with a manometer.

3.2 Smoke density measurements

3.2.1 Measuring set-up

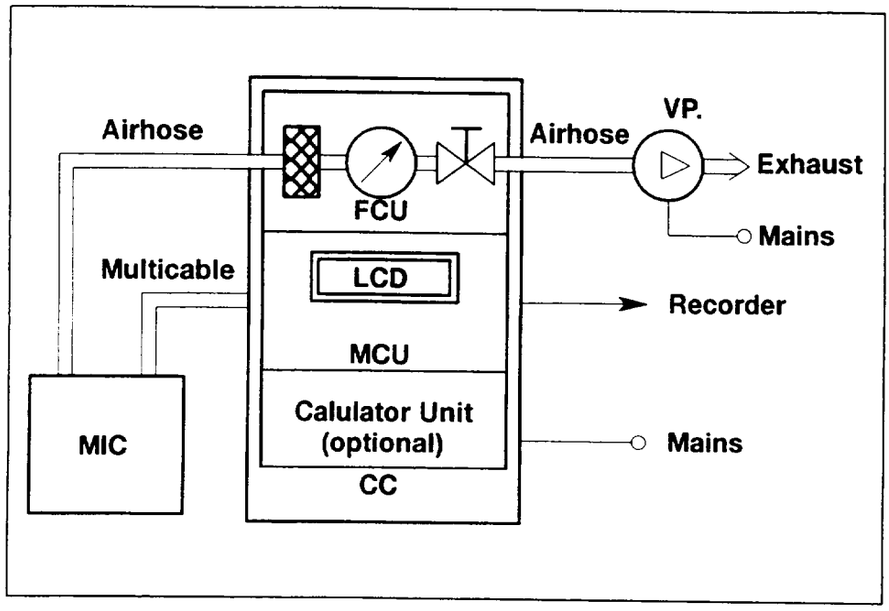


FIG. 3.2.1 Measuring set-up principle

Connections:

a) Air hose between air outlet on MIC and air inlet on FCU.
b) Air hose between air outlet on FCU and air inlet on VP.
c) Multicable between MIC and the MIC connector on the rear of the CC.
d) Cable between recorder outputs at the rear of CC to recorder (if used).
e) Mains cord for VP and CC.

3.2.2 Measuring procedure

a) Turn the flow meter needle valve in the FCU fully C.W.
b) Switch on the mains to the VP and turn the needle valve on the FCU slowly C.C.W. until the flow meter reads 30 l/min. Rate of flow is read at the middle point of the ball.

c) Switch on the mains on the control cabinet and allow the instrument to stabilise for about 15 min.
d) Press the MODE button on the MCU to indicate mode X.
e) Press the CAL button on the MCU (CAL ON indicator lights up) and adjust the offset trimmer until the display reads 1.00 or the recorder output X is 10.0 VDC.
f) Press the CAL button again (CAL ON indicator extinguish) and adjust the Uc trimmer on the MCU until the display reads 0.00 or the recorder output X is 0.0 VDC.
g) Subject the MIC to the smoke exposure the density of which shall be measured.
h) Subject the MIC to aerosol-free air and repeat point e) and f) before the next smoke density measurement. Also check the rate of air flow, point b).

If the calculator unit (optional) is plugged into the CC procedures d - f are replaced by the following procedure:

d) Press the MODE button on the MCU to indicate mode X, Y or Y_{20}.
e) Press the CAL button on the calculator unit and wait until the flashing red indicator on the MCU becomes steady green.
f) The display shall now read 0.00 independent of the chosen mode.

4. Theory of operation

4.1 General working principle for ionization chambers for smoke density measurements

The use of ionization chambers as smoke sensors is well known and the associated theory outlined in the literature.

The working principle for the ionization chamber for smoke density measurements is shown in *fig. 4.1.*

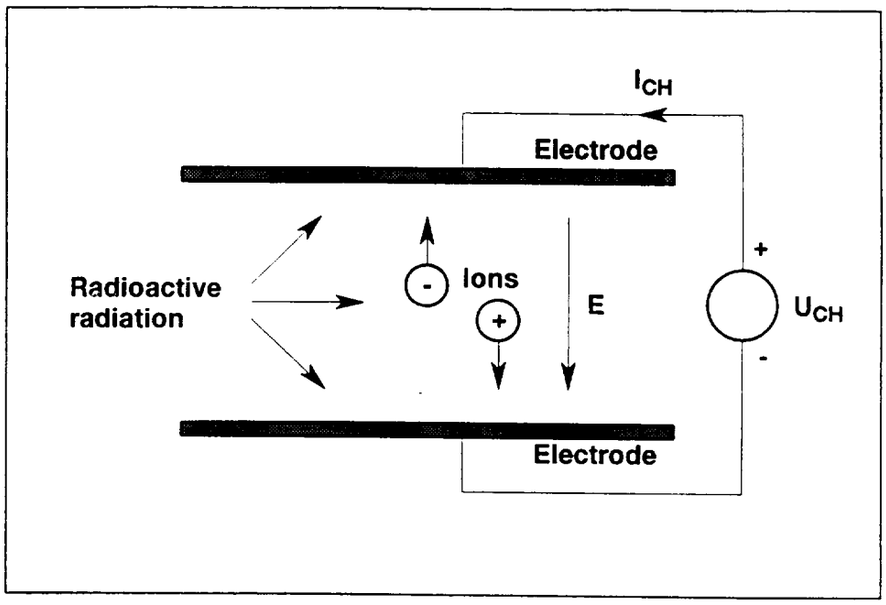


FIG. 4.1 Working principle for ionization chamber

The chamber consists of a pair of electrodes between which a volume of atmospheric air is present. The electrodes are connected to a voltage source U_{CH} so an electrical field E is applied to the air. Radioactive radiation from a small radioactive source bombards the air and ion pairs are created between the electrodes. The positive and negative air molecules forming the ion pairs are deflected towards the negative and positive electrode, respectively. Some of the ions recombine before they reach the electrode surfaces and become neutral air molecules. Other ions exchange electrons with the electrode surfaces. This electron exchange results in a small electrical current I_{CH} in the external circuit.

When the air between the electrodes is clean, the ions formed move to the electrode with a certain mean velocity and each ion which does not recombine in the volume contributes to the current. However, if smoke particles penetrate the volume between the electrodes, the ions and the smoke particles will be attached to each other with a certain probability. Since the smoke particles are much heavier than the ions, the mobility of ions attached to smoke particles is greatly reduced and the probability for recombination increased. So, their contribution to the external current becomes negligible. Thus the external current is a function of the smoke particle density in the measuring volume.

The smoke density can be defined in terms of X as follows:

$$X = \frac{I_{CHO} - I_{CH}}{I_{CHO}} \qquad (0 \le X \le 1) \qquad (4.1.1)$$

I_{CHO} [A] is the chamber quiescent current (clean air)
I_{CH} [A] is the chamber current when smoke is present

It appears from eq. 4.1.1 that X = 0 in clean air and X = 1 when the smoke density is infinite.

Smoke density can also be expressed in Y-values which are related to the X-values as follows [1]:

$$Y = X \cdot \frac{2 - X}{1 - X} \qquad (4.1.2)$$

The Y-value can also be transferred to a value related to a chamber voltage of 20 V. This Y_{20}-value is related to the Y-value as follows:

$$Y_{20} = \frac{Y}{U_c} \cdot 20 \qquad (4.1.3)$$

The advantage of expressing the smoke density in terms of Y- and Y_{20}-values is that these values are proportional to the number of smoke particles per unit volume.

Besides smoke density, the X-, Y-, and Y_{20}-values depend on the design of the ionization chamber and a number of environmental parameters.

So, the readings obtained from different ionization chamber configurations cannot be compared unless the correction factor for the chambers is known, e.g. from calibration.

4.2 Measuring Ionization Chamber (MIC)

4.2.1 Ionization chamber design

The MIC has a parallel plate electrode configuration in which the radioactive source (Am 241) is part of one of the electrodes. This configuration provides a measuring volume in which the ionization is uniform and approx. parallel to a constant electrical field.

The air is sucked through the chamber in order to reduce wind dependence, but the air in the measuring volume between the electrodes is stationary since the sucked air flows in a duct which is separated from the measuring volume by means of a wire mesh. Smoke is transferred from the air flow to the measuring volume by diffusion.

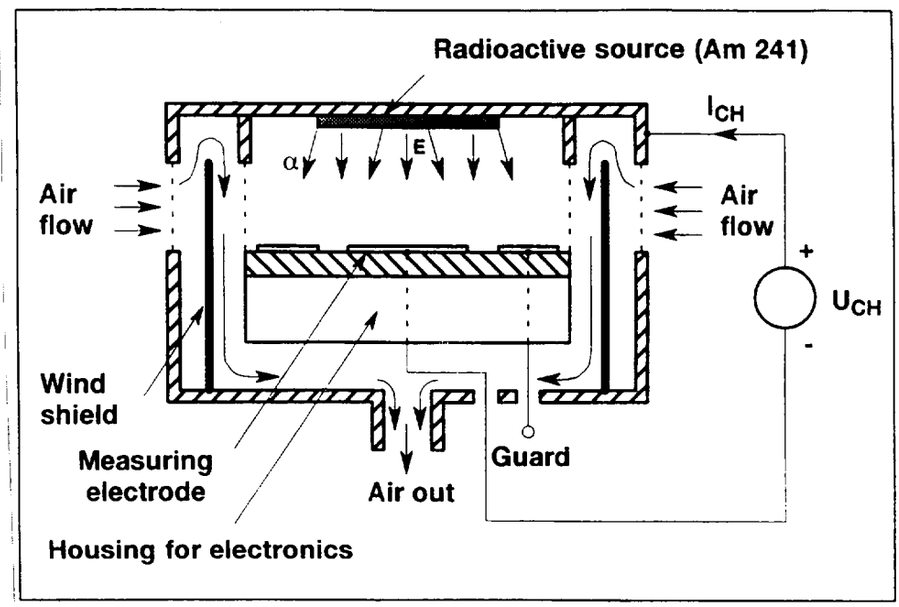


FIG. 4.2.1 Principle of ionization chamber design in the MIC

The radioactive source is mounted in a holder which may be unscrewed for cleaning purposes, refer to *section 5.1.1.*

The chamber is operated in the proportionality range with a clean air quiescent current of 10^{-10}A (100 pA) corresponding to a chamber voltage of approx. 19 V.

4.2.2 Electronics for impedance transformation

An impedance transforming circuit is built into the MIC. The principle of the impedance transforming circuit is shown in *fig. 4.2.2.* The circuit converts the ionization current at a high impedance level to a proportional voltage at a low impedance level. So, the length of the connecting cable between the MIC and the CC becomes uncritical.

The relay, which is shown in *fig. 4.2.2,* is used for calibration of the impedance transforming circuit and the MCU. This facility will be described in *section 4.3.*

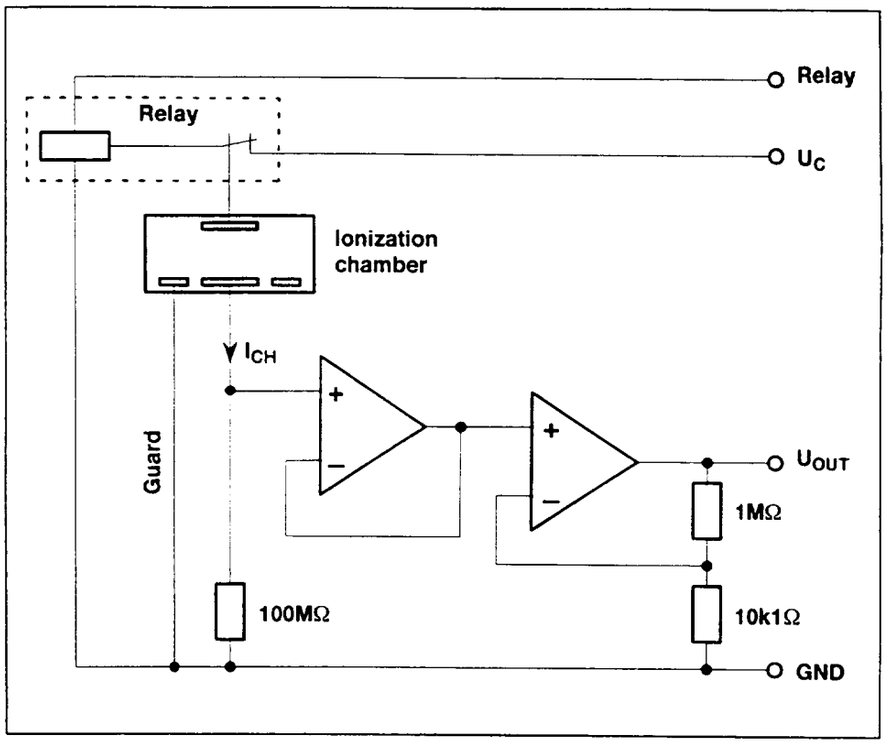


FIG. 4.2.2 Principle of MIC impedance transforming circuit

4.3 MIC Control Unit (MCU)

The low impedance voltage from the MIC is first amplified 10 times by a differential amplifier. Then the voltage is inverted and the offset voltage set by the offset trimmer on the front of the MCU is added. This resulting voltage is transferred to the display and the recorder output X when the MCU is in X mode.

During calibration the relay in the MIC disconnect the chamber voltage and the chamber current becomes zero. The voltage to the MCU also becomes zero and the offset trimmer is then used to adjust the X value to 1.00.

The voltage from the Uc trimmer is amplified and used for adjustment of the chamber voltage in the MIC. The chamber current is proportional to the applied chamber voltage and the chamber voltage is used to adjust the chamber current to 100 pA in aerosol free air. A chamber current of 100 pA equals a X value of 0.00.

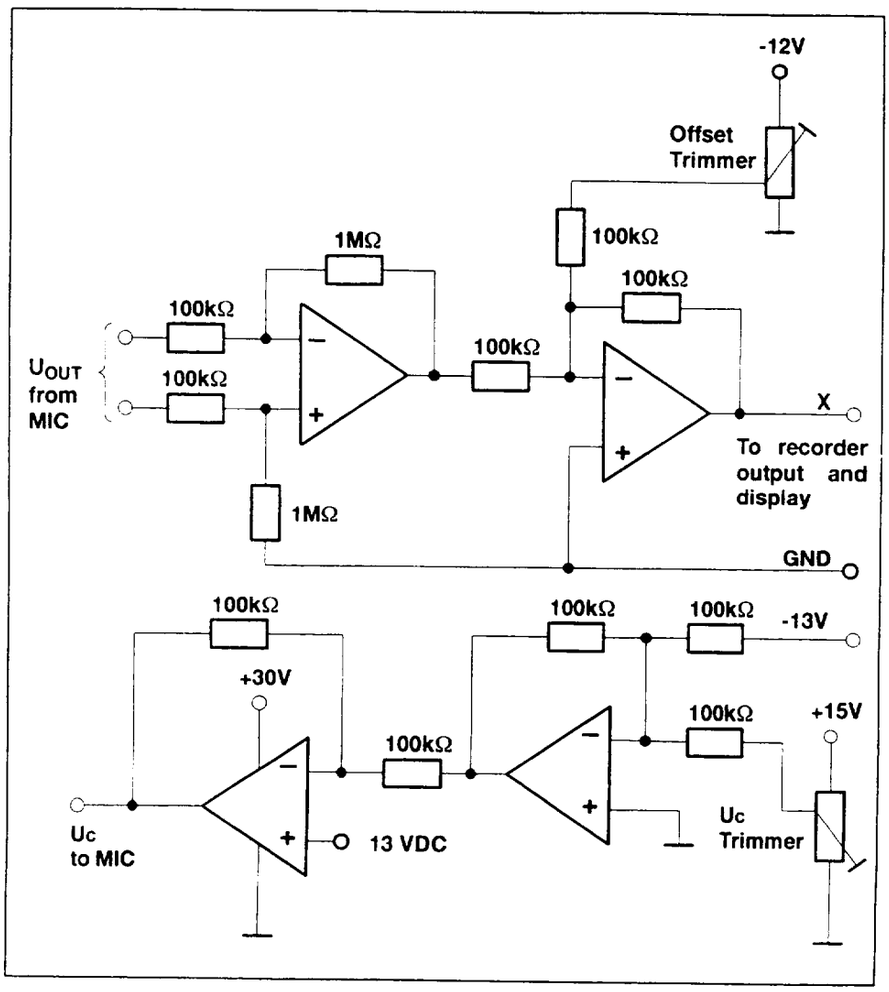


FIG. 4.2.3 Principle of MCU analogue circuit

5. Maintenance and service

5.1 Periodic maintenance

5.1.1 Measuring Ionization Chamber (MIC)

The MIC should be cleaned at regular intervals since smoke deposits in the ionization chamber especially on the radioactive source and the electrode assembly can affect the measuring characteristics. Smoke deposits on the radioactive source will increase the clean air chamber resistance while smoke on the electrode assembly may cause leakage currents.

Cleaning of the radioactive source:

The holder for the radioactive source may be unscrewed for cleaning, without dismounting other parts of the MIC, by loosening the locking screw (refer to *fig. A.1.2* in *annex 1*) and unscrewing the source holder. Make sure that the serial number of the source corresponds to the ionization chamber (see note in *section 5.2).*

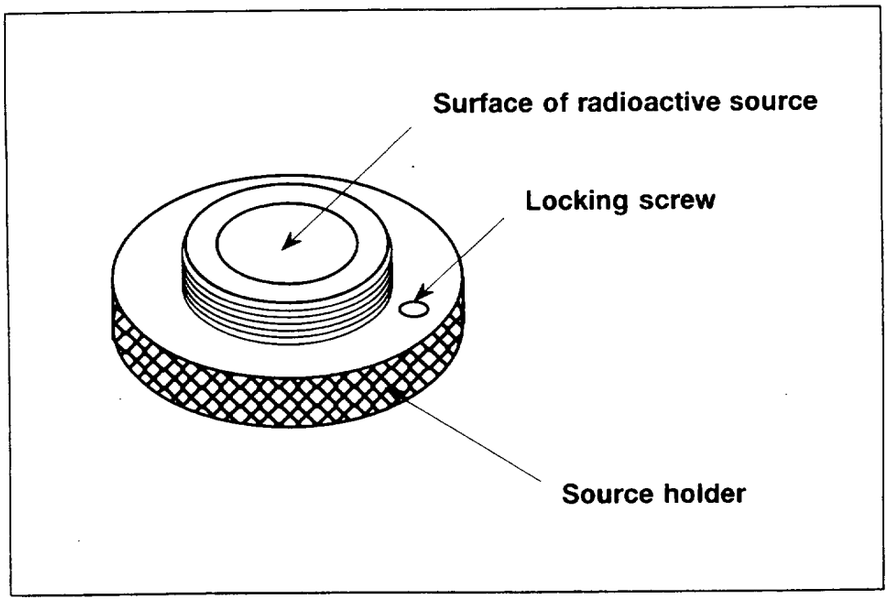


FIG. 5.1.1 Holder with radioactive source

The following procedure and precautions should be followed for radiation protection reasons:

a) Never touch the surface of the radioactive source (*see fig. 5.1.1*) with your fingers, use disposable gloves during the work.
b) Avoid scratching the surface with hard metal tools or the like.
c) Keep a distance of at least 10 cm from the unscrewed source holder to your eyes.
d) Do not take the source holder apart.
e) Clean the surface of the source with paper tissues wetted with alcohol. Do not touch the tissues with your fingers, use plastic tweezers.
f) Dispose the tissues in a metal container marked "radioactive disposal". Leave the container to the competent national authority for destruction when filled up.
g) Never leave the source holder on the table after cleaning. Screw it into the MIC and fasten the locking screw.
h) Wash your hands after having cleaned the radioactive source.

Cleaning of ionization chamber:

Attention should be given to the fact that the insulating materials (polycarbonate[5]) in the MIC, especially the electrode support plate can be attacked by a number of liquids. So, it is highly recommended to follow the procedure below. Modern cleaning techniques, such as ultrasonic, should not be used. Furthermore, the amount of cleaning liquid should be kept to a minimum to avoid ingress to the electronic housing.

For your information a list of liquids to which polycarbonate is claimed to be resistant, respectively **not** resistant is given below. The list should not be regarded complete.

Polycarbonate is resistant to:

Alcohol (Ethanol)
Benzine
n-Butyl or sec-Butyl Alcohol (1- or 2-Butanol)
Cyclohexane
Acetic Acid, 10%

Polycarbonate is NOT resistant to:

Bases
Organic Solvents
Acetone
Chloroform (Trichloromethane)
Carbon Tetrachloride (Tetrachloromethane)
Toluene
Xylene

[5] Brand names: LEXAN, MAKROLON

a) Dismount the MIC housing by loosening the three screws around the holder for the radioactive source and gently pulling the housing from the mounting plate.
b) Clean the inside of the housing with paper tissues with a little alcohol. The radioactive source shall be unscrewed and cleaned separately as described above.
c) Clean the measuring electrode, the guard ring and the insulating electrode support plate with paper tissues with a little alcohol, avoid excessive liquid.
d) Allow the parts of the MIC to dry before assembling.

Assembling:

Be careful not to leave any fingerprints or other impurities on the internal parts of the MIC during assembling.

a) Assemble the MIC by pressing down the housing and aligning the three distance pieces with the three holes in the housing and fasten the screws. Make sure that the alignment marks on the housing and mounting plate match.
b) Screw the holder with radioactive source in the top of the housing and fasten the locking screw (Allen screw 1.5 mm, metric).

5.1.2 MIC Control Unit (MCU)

No maintenance of the MCU is required.

5.1.3 Flow Control Unit (FCU)

The maintenance of the FCU concerns cleaning of the flow meter and needle valve and exchange of filter element.

Cleaning of flow meter:

Before cleaning the flow meter is has to be dismounted from the FCU and disassembled in the following way:

a) Remove the FCU from the CC by loosen the four screws in the front plate, remove the two air hoses from the pipe branch on the rear plate and on the filter and pull out the FCU by pressing on the filter unit.
b) Remove the four screws in the rear plate, loosen the hose connections on the flow meter and remove the rear plate with the filter and the two hoses.
c) Loosen the four screws holding the flow meter mounting plate and pull back the mounting plate with the flow meter approx. 5 cm. The screws are accessible through holes in the two side profiles of the FCU and can slice in the two slices in the side profiles.
e) Remove the two screws holding the flow meter to its mounting plate and pull out the flow meter.
d) Turn the flow meter needle valve fully C.C.W. and pull out the needle. Remove the upper hose connector and unscrew the rest of the needle valve with a 16 mm ratchet socket.

e) Remove the screw on the top of the flow meter and take out the ball by inverting the flow meter and allowing the ball to fall into your hand.

The flow tube, needle valve and ball can now be cleaned with a little pure soap and water and a bottle rinser. Avoid the use of benzene, acetone, carbon tetrachloride, alkaline detergents, caustic soda, liquid soaps which may contain chlorinated solvents, etc. and avoid prolonged immersion. Remove the soap water by rinsing with clean water and allow the flow meter to dry before assembling.

To assemble the flow meter and the FCU just follow the above instructions in the opposite order. A little stop cock grease or petroleum jelly on the O-rings will help maintain a good seal as well as facilitate assembly.

Exchange of filter element:

The filter unit is incorporated in the FCU to reduce the smoke deposits in the flow meter. The filter element can be exchanged by dismounting the removable part of the filter unit on the rear of the FCU (refer to *fig. A.1.4 in annex 1*). The filter unit is intended for filter element P/N 448842 manufactured by MSA, Mine Safety Appliances Co., Pittsburgh, Pennsylvania, USA. However, before the filter is placed in the filter unit the outer 7 mm of the filter has to be cut away so only the corrugated part remains. This part is pressed into the fixed filter unit and the filter unit assembled. (Refer to *fig. 5.1.2*).

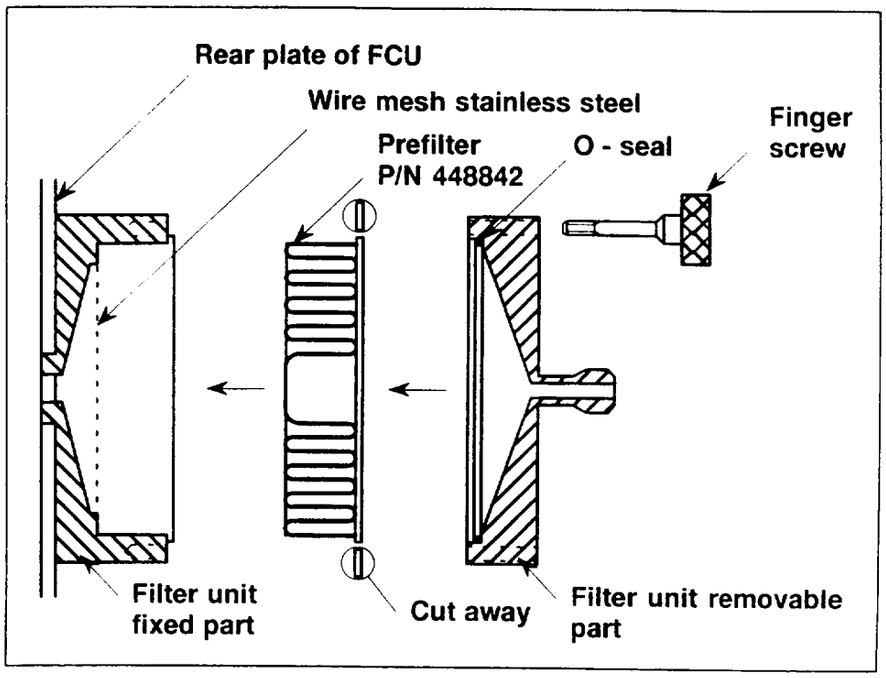


FIG. 5.1.2 Exchange of filter element

The filter element may be blocked by smoke more or less rapidly depending on the type of smoke measured. In some applications it may be more practical to replace the MSA filter with a 10-12 mm thick polyurethane filter cut circular with a diameter of 68 mm.

The consequence of this is of course that cleaning of the flow meter is needed more often. A filter combination which prevents smoke deposits in the flow meter and gives acceptable operating times without filter exchange should be aimed at.

When assembling the filter unit make sure that the O-seal remains in position in the removable part.

Check the filter unit for tightness by the method outlined in *section 2.1.3 k and 1*, after assembling filter unit.

5.1.4 Vacuum Pump (VP)

The Rietschle type VTE 3 pump contains an inlet filter and rotor blades which should be checked regularly. The pump is delivered with an extra filter cartridge and a set of rotor blades. Refer to the Rietschle instructions in *annex 2* for further details.

5.2 Smoke calibration

The MIC was calibrated with smoke before shipment. The calibration was performed in a smoke tunnel where the smoke density was slowly increased while smoke density readings were taken simultaneously with the MIC under test and a MIC type EC 23095-1 serial number 830101, which we have nominated as standard at DELTA.

The test procedure, set-up and results from this smoke calibration are issued in a separate certificate of calibration which is included in the technical documentation of the smoke measuring equipment in concern.

Regular smoke calibration of the MIC is not absolutely necessary, since the sensitivity of the MIC is determined mainly by the mechanical construction of the ionization chamber and thus stable when properly maintained. However, the smoke calibration can be repeated at DELTA if required.

Note: Before the smoke calibration, the electrode distance and the active area of the radioactive source of the individual measuring ionization chambers have been adjusted. So, be sure that the serial number of the radioactive source corresponds to that of the MIC.

5.3 Possible errors and hints

5.3.1 Flow system

If it is not possible to adjust the flow rate on the flow meter to 30 l/min then there is either a leak or a block in the VP, the FCU or the hose connections. First check the performance of the VP and the FCU as described in *section 2.1.3 point i) -l)* by using a short new piece of hose. If the performance of the VP and FCU is OK there is either a leak or a block in the hose connections. Inspect the hose connections for a possible leak or block and replace the damaged hose connection. If the performance of the VP and MCU is not OK then there is probably a block in the filter for the MCU, in the flow meter or in the filter for the VP. Refer to *section 5.1.3* for cleaning of flow meter and exchange of filter element in the FCU.

5.3.2 Electronics

The mains fuse is in the mains plug assembly which is placed on the left at the rear of the CC. First remove the mains plug and then remove the fuse holder with a screwdriver. On delivery a replacement fuse is placed inside the fuse holder.

Recorder output X should follow the reading on the display with a factor of 10 when the MCU is in X mode and the recorder output Uc should follow the display reading when the MCU is in Uc mode. If this is not the question then either the load impedance on the recorder output is to low (load impedance $\geq$ 100 kΩ) or the MCU electrical circuit is malfunctioning. Refer to *section 5.4* if the latter is the matter.

If the chamber voltage Uc necessary for calibrating the MIC is greater than 25 V, the radioactive source is probably covered with smoke deposits and needs cleaning. Refer to *section 5.1.1* for cleaning of the radioactive source.

5.3.3 Electrical leakage

The leakage current in the MIC can be checked by dismounting the holder for the radioactive source as described in *section 5.1.1* and following this procedure:

a) Press the MCU MODE button to indicate mode Uc and adjust the Uc trimmer on the MCU until the display reads 25.0.
b) Press the MCU MODE button to indicated mode X.
c) Press the MCU CAL button. The CAL ON indicator shall light up.
d) Adjust the Offset trimmer on the MCU until the display reads 1.00.
e) Press the MCU CAL button. The CAL ON indicator shall extinguish
f) Notice the display reading XLEAK.

The leakage current in the MIC is: $I_{LEAK} = 100 \bullet (1.00 - X_{LEAK})$ [pA]

The leakage current in the MIC should be less than 1 pA. If the leakage current in the MIC is greater than 1 pA the electrode assembly is probably covered with smoke deposits and needs cleaning. Refer to *section 5.1.1* for cleaning of ionization chamber.

5.4 Service and repair

If necessary, consult:

DELTA
Alarm & Security Systems
Venlighedsvej 4
DK-2970 Hørsholm
Denmark

Tel. +45 45 86 77 22
Fax +45 45 86 58 98
email info@delta.dk
http://www.delta.dk

for repair advice, spare parts delivery, etc.

The addresses of the Rietschle representatives in various countries are enclosed in *annex 2*.

6. References

[1] H.H. Gilson & J.P. Hosemann: Messkammer nach dem Kleinionenanlagerungsprincip zum quantitativen Nachweis von Aerosolpartikeln. Forschungsberichte des Landes Nordrhein-Westfalen Nr. 2336 Westdeutscher Verlag Opladen 1973.

[2] A. Scheidweiler, Cerberus AG: The ionization chamber as smoke-dependent resistance.

[3] A. Scheidweiler, Cerberus AG: Description of the Measuring Ionization Chamber (MIC).

[4] P.E. Burry: Standard Ionization Chambers. Tagungsbericht zum 7. internationalen Vortragsseminar über Probleme der automatischen Brandentdeckung, Aachen 5. und 6. März 1975. Page 243-255.

[5] CEN, European Committee: for Standardization EN54-9: Fire sensitivity test. July 1982.

[6] CEN, European Committee: for Standardization EN54-7: Point type smoke detectors. Detectors using scattered light, transmitted light or ionization. July 1982.

[7] M. Avlund: ECR-71: Reference Measurements of Smoke Density, ElektronikCentralen, May 1977.

[8] Underwriters Laboratories Inc. UL 217, single and multiple station smoke alarms.

[9] Underwriters Laboratories Inc. UL 268, smoke detectors for fire protective signalling systems.

Annex 1

Figures

(4 pages)

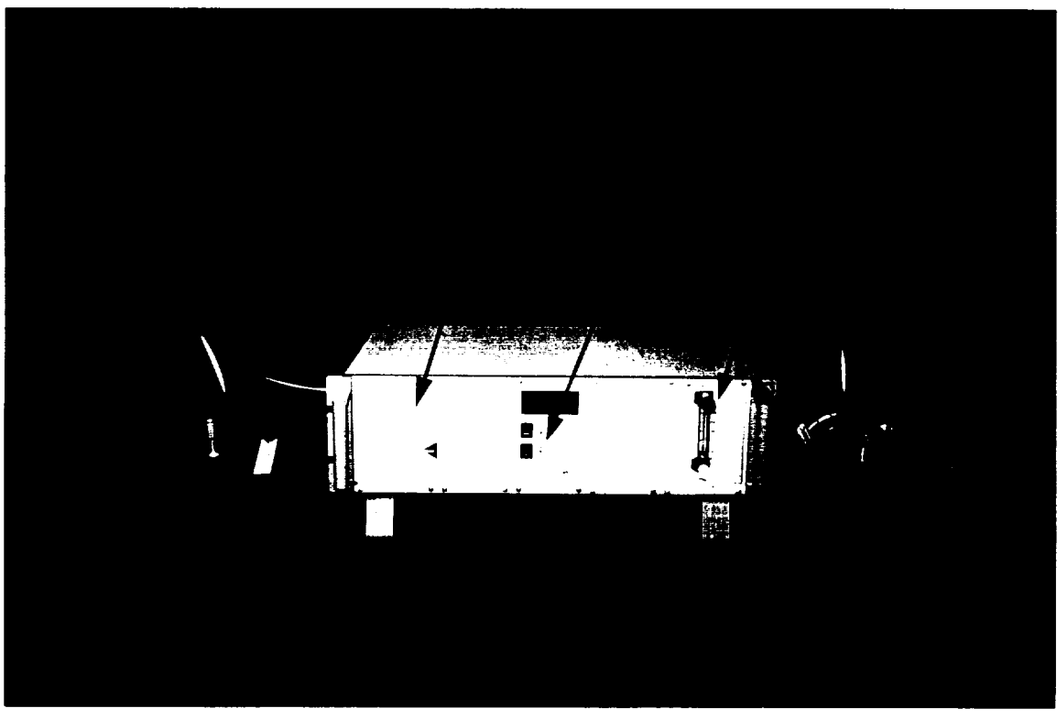


FIG. A.1.1 Smoke measuring equipment EC-912

a Measuring Ionization Chamber (MIC) EC-912-10
b Control Cabinet (CC) EC-910-10
c MIC Control Unit (MCU) EC-912-20
d Flow Control Unit (FCU) EC-912-40
e Vacuum Pump, (VP) Rietschle type VTE 3

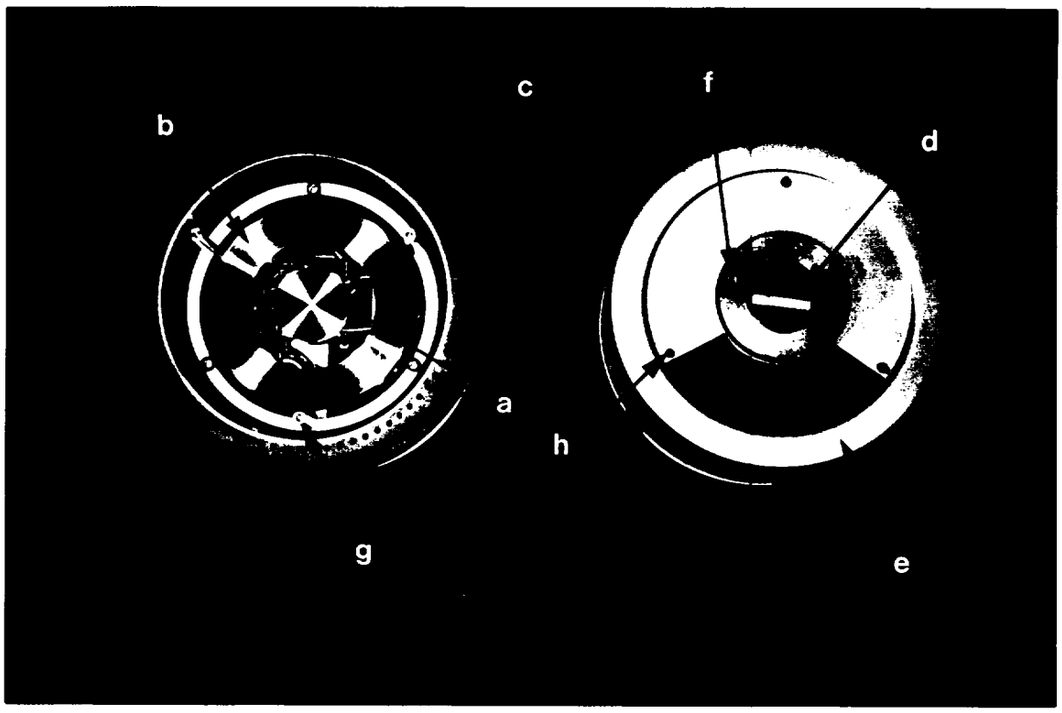


FIG. A.1.2 Measuring Ionization Chamber (MIC) EC-912-10 with chamber housing removed

a Measuring electrode
b Guard ring
c Wind shield
d Radioactive source holder
e Chamber housing
f Locking screw for radioactive source holder
g Distance pieces for chamber housing
h Holes for screws to distance pieces

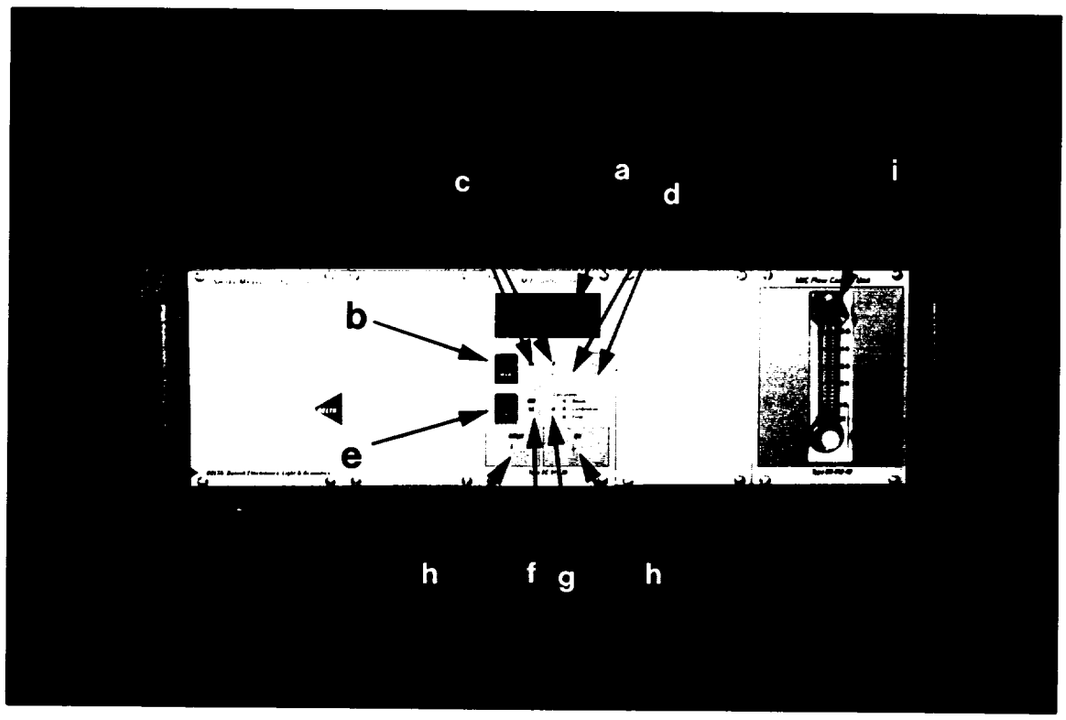


FIG. A.1.3 Front of control cabinet EC-910-10 with MIC control unit EC-912-20 and flow control unit EC-912-40

a 3.1 digit LCD display
b Mode selector button
c Mode indicators Uc and X
d Mode indicators Y and Y_{20} (only active with calculator unit)
e Calibration button
f Relay ON indicator
g Calibration status indicator (only active with calculator unit)
h Trimmers for offset and chamber voltage adjustments
i Flow meter needle valve

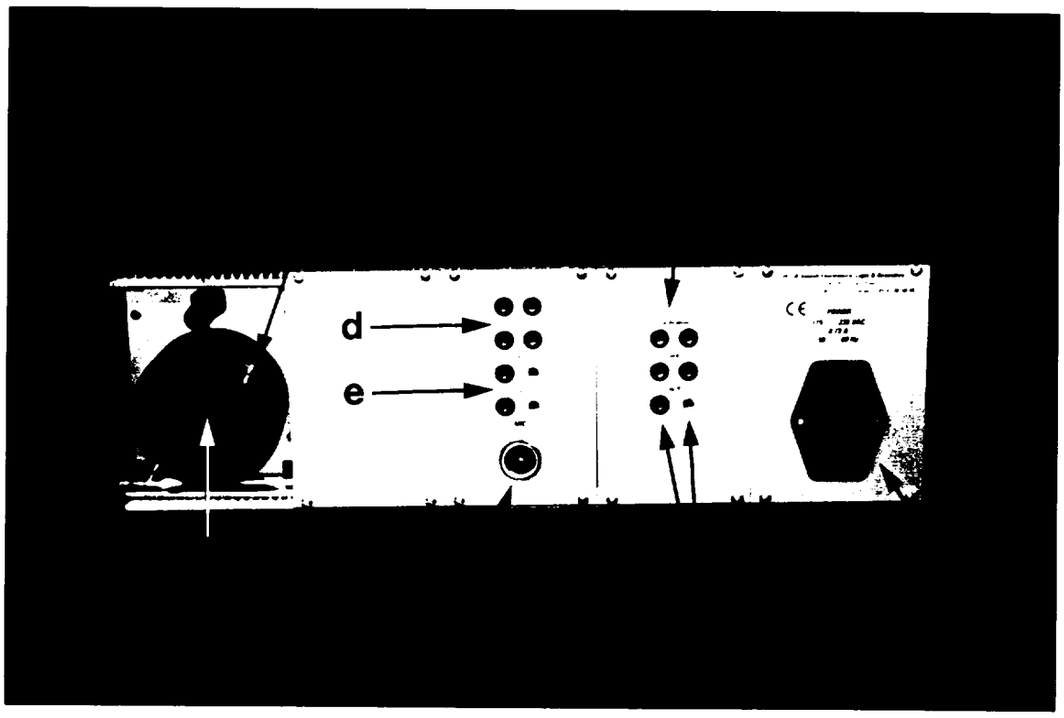


FIG. A.1.4 Rear of control cabinet EC-910-10 with flow control unit EC-912-40

a EMI filter with mains switch, mains socket and fuse holder
b Digital inputs for remote calibration (only active with calculator unit)
c Analogue recorder output m/Y (only active with calculator unit)
d Analogue recorder output for chamber voltage Uc and smoke density X
e Analogue recorder outputs for smoke density Y and Y_{20} (only active with calculator unit)
f Connector for multicable to MIC
g Air outlet pipe branch for hose to vacuum pump
h Air inlet pipe branch for hose from MIC
i Finger screws for disassembling of filter unit

Annex 2

Specifications, service and list of representatives for Rietschle vacuum pump

(8 pages)

Service

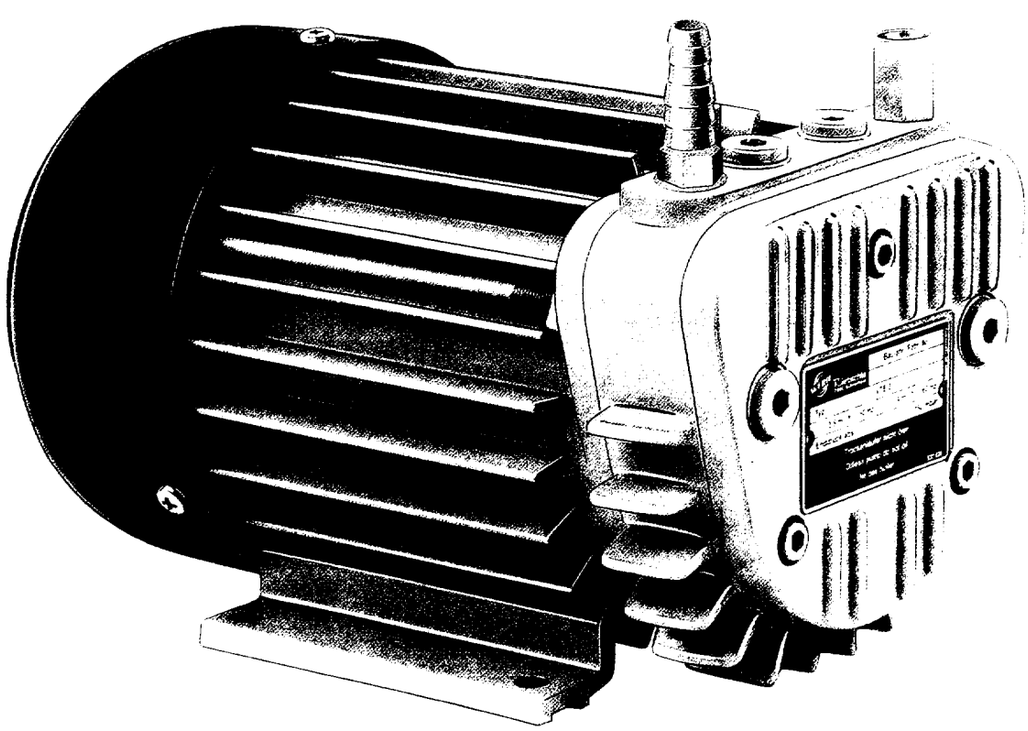
Rietschle

Vakuum-pumpen | Vacuum Pumps | Pompes à vide | Pompe per vuoto

VTE

PICOLINO

VTE 3
VTE 6



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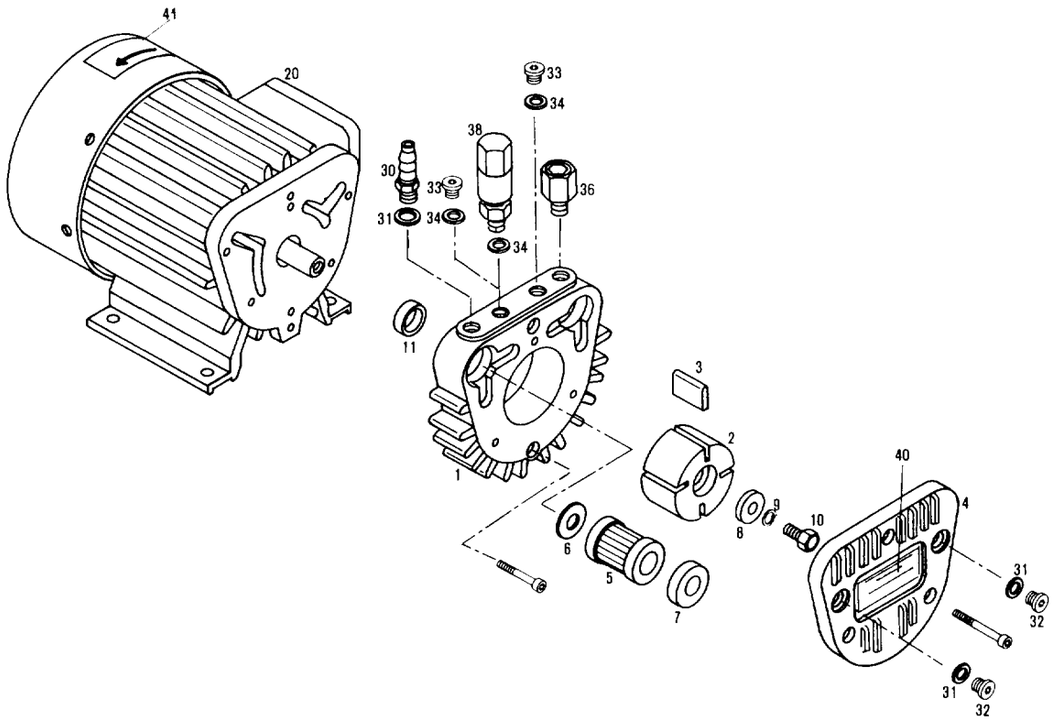
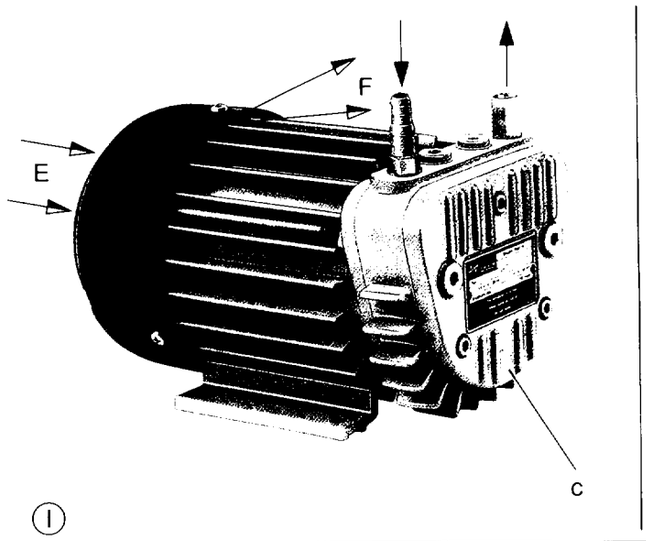


		Grundteile	Parts	Eléments de base	Parti fondamentali
1		Gehäuse	Housing	Corps	Corpo pompa
2		Rotor	Rotor	Rotor	Rotore
3	V	Lamelle	Blade	Palette	Paletta
4		Gehäusedeckel	End cover	Couvercle de corps	Coperchio corpo pompa
5	V	Filterpatrone	Filter cartridge	Cartouche filtre micronique	Cartuccia filtrante microfine
6	D	Dichtring	Sealing ring	Anneau d'étanchéité	Anello guarnizione
7	D	Dichtscheibe	Sealing disc	Disque d'étanchéité	Disco guarnizione
8		Scheibe	Disc	Disque	Disco
9		Federscheibe	Spring shim	Rondelle ressort	Disco elastico
10		Sechskantschraube	Hexagon head screw	Boulon six pans	Vite con testa esagonale
11		Distanzscheibe	Spacer shim	Rondelle entre-toise	Disco distanziatore
20		Motor mit Anschlußdeckel	Motor with connection cover	Moteur avec couvercle raccordement	Motore con coperchio di collegamento
		Anbauteile	**Assembly parts**	**Eléments de montage**	**Elementi di montaggio**
30		Schlauchanschluß	Hose connection	Raccord tuyau	Allacciamento flessibile
31	D	Dichtring	Sealing ring	Anneau d'étanchéité	Anello guarnizione
32		Verschlußschraube	Plug	Bouche obturateur	Vite di chiusura
33		Verschlußschraube G 1/8	Plug G 1/8	Bouche obturateur G 1/8	Vite di chiusura G 1/8
34	D	Dichtring	Sealing ring	Anneau d'étanchéité	Anello guarnizione
36		Ausblasschalldämpfer	Exhaust silencer	Silencieux refoulement	Silenziatore allo scarico
		Zubehör	Optional extra	Accessoires	Accessori
38		Vakuum-Regulierventil ZRV 6	Vacuum regulating valve ZRV 6	Valve réglage vide ZRV 6	Valvola regolazione vuoto ZRV 6
		Schilder	**Labels**	**Plaque signalétiques**	**Targhette**
40		Datenschild	Data plate	Etiquette caractéristique	Targhetta dati
41		Motordatenschild	Motor data label	Etiquette caractérist. moteur	Targhetta dati del motore

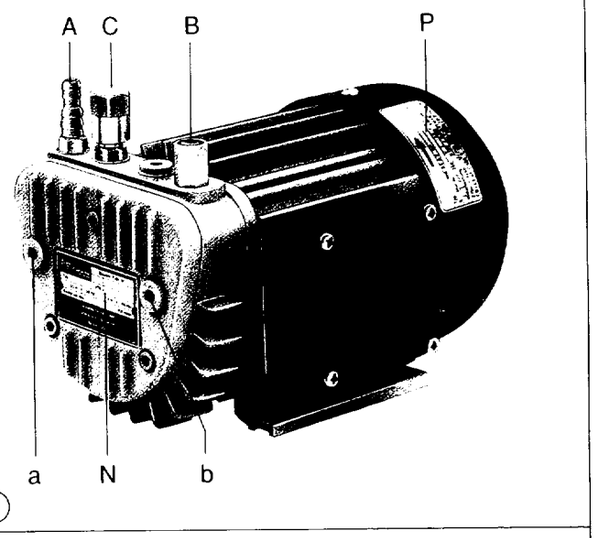
Bei Bestellungen folgendes angeben: Typ, Fabrikations-Nr., Positions-Nr., Motor (kW, V, Hz).
To order please indicate: model, serial-no., item-no., motor (kW, V, Hz).
En cas de commande préciser: type, d'appareil, no. position des pièces, moteur (kW, V, Hz).
Nell'ordine indicare: tipo, il numero di matricola, il numero di posizione dei recambi, il motore (kW, V, Hz).

V = Verschleißteile
V = Fast-wearing parts
V = Pièces d'usure
V = Parti usurabili

D = Dichtungen
D = Seals
D = Joints
D = Guarnizioni



(I)



(II)

Eignung
Die Typen VTE 3 und VTE 6 sind trockenlaufende Vakuumpumpen und eignen sich zum Fördern von Luft mit normaler Feuchtigkeit und trockenen Gasen bis zu einem Enddruck (abs.) von 150 mbar.
Achtung! **Die Umgebungstemperatur darf 40°C nicht überschreiten. Bei höheren Temperaturen bitten wir um Rücksprache.**
Es dürfen keine gefährlichen Beimengungen (z.B. Lösemittel), extrem feuchte Luft, Wasserdampf, aggressive Gase oder Spuren von Öl und Fett angesaugt werden.

Standort
Beim Einbau der Pumpe muß für Wartungsarbeiten vor dem Gehäusedeckel (c) genügend Platz vorhanden sein. Zusätzlich ist zu beachten, daß der Kühlluft. Eintritt (E) und der Kühlluft-Austritt (F) mindestens 8 cm Abstand zur nächsten Wand haben (austretende Kühlluft darf nicht wieder angesaugt werden).

Inbetriebnahme
Bei Aufstellung und Betrieb ist die Unfallverhütungsvorschrift »Verdichter« VBG 16 zu beachten.
1. Motordaten (Motordatenschild (P)) mit vorhandenem Stromnetz vergleichen (Stromart, Spannung, Netzfrequenz, zulässige Stromstärke).
2. Motor über Motorschutzschalter anschließen (zur Absicherung des Motors ist ein Motorschutzschalter und zur Zugentlastung eine PG-Verschraubung vorzusehen).
   Wir empfehlen die Verwendung von Motorschutzschaltern, deren Abschaltung zeitverzögert erfolgt, abhängig von einem evtl. Überstrom. Kurzzeitiger Überstrom kann beim Kaltstart der Maschine auftreten.
   Der Elektroanschluß darf nur von einer Elektrofachkraft unter Beachtung der Unfallverhütungsvorschrift »Elektrische Anlagen und Betriebsmittel« VBG 4 vorgenommen werden.
3. Pumpe zur Drehrichtungs-Überprüfung (Motordatenschild (P)) kurz starten.
   Achtung! Vakuumanschluß muß offen sein, sonst können bei falscher Drehrichtung die Lamellen brechen.
4. Saugleitung an (A) anschließen. Die Abluft wird durch den Ausblasschalldämpfer (B) ausgeblasen.
5. Der Schlauchstutzen (A) und der schalldämpfende Ausblasschalldämpfer (B) können wahlweise auch stirnseitig an den Stellen (a) und (b) eingeschraubt werden.
6. Vakuum-Regulierventil (Zubehör):
   Die Einstellung des Vakuums kann durch Drehen des Regulierknopfes (C) erfolgen.

Application
VTE 3 and VTE 6 models are dry running vacuum pumps and are designed for handling air with normal relative humidity and dry gases up to an ultimate vacuum of 150 mbar.
Please note: **The ambient temperature may not exeed 40°C. At higher temperatures please contact us.**
No dangerous mixtures (i.e. solvent), excessive humid air, water vapour, or aggressive gases or traces of oil or grease in the air can be handled.

Positioning
When the pump is built-in there must be enough space in front of end cover (c) for maintenance. Also cooling air entries (E) and cooling air exits (F) should have at least 8 cm distance from any walls. Do not recirculate heated up cooling air.

Initial start
When fitting and operating the compressor the Health and Safety rules at work should always be applied.
1. Check the incoming voltage and frequency to see that they correspond to the motor (motor data label (P)).
2. Connect the motor to the incoming supply. It is advisable to use a motor starter to protect the motor.
   We recommend that motor starters should be used that are fitted with a time delayed trip resulting from running beyond the amperage setting. When the unit is started cold over amperage may occur for a short time.
   Electrical connections should only be made by a qualified electrician.
3. Check direction of rotation by switching the motor on and off (motor data label (P)).
   Please note: To prevent the rotor blades being damaged do not connect the vacuum pipe until the correct direction of rotation is achieved.
4. Connect vacuum pipe at (A). The air is exhausted through the exhaust silencer (B).
5. The hose connection (A) and exhaust silencer (B) can be fitted alternatively in the front cover in the positions (a) **and (b).**
6. **Vacuum regulating valve (Optional extra): The vacuum can be regulated by regulating valve (C).**

Application
Les pompes modèles VTE 3 et VTE 6 sont des pompes à vide fonctionnant à sec et qui atteignent un vide limite de 150 mbar absolu. Elles sont conçues pour aspirer et véhiculer de l'air à teneur d'humidité normale ainsi que des gaz secs.
Attention: **La température ambiante ne doit pas dépasser 40°C. Pour les températures plus élevées veuillez nous consulter.**
Des mélanges dangereux (ex. solvants), de l'air à teneur de vapeur d'eau, d'huile ou de gaz corrosifs ne peuvent être aspirés.

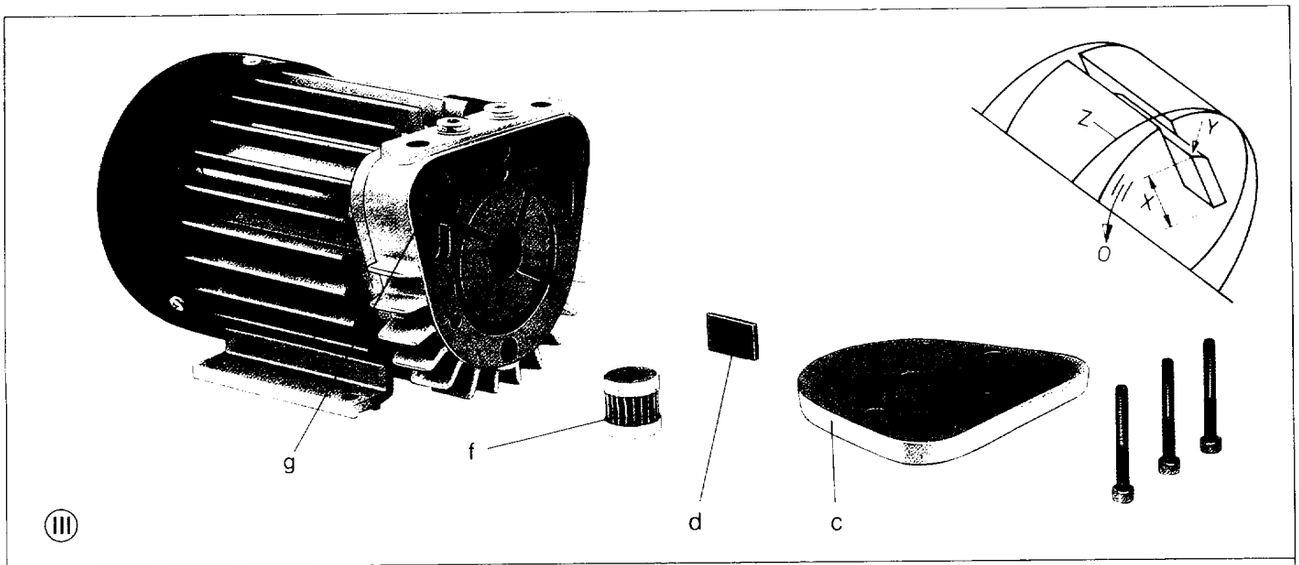
Installation
Pour permettre les opérations de contrôle et de maintenance, le couvercle de corps (c) doit rester facilement accessible.
Lors de l'implantation il y a lieu de faire en sorte que l'entrée (E) et la sortie (F) d'air de refroidissement soient situées au minimum à 8 cm des parois environnantes. (L'air de refroidissement refoulé ne doit pas pouvoir être réaspiré).

Mise en service
Lors de l'installation et utilisation, il faut respecter les conseils d'utilisation et de protection.
1. Vérifier que la tension, la fréquence et l'ampérage de l'installation électrique soient adaptés au moteur (étiquette caractérist. moteur (P)).
2. Les moteurs électriques doivent être protégés à l'aide d'un disjoncteur. Le cable électrique sera bloqué à l'aide d'un presse-étoupe.
   Nous recommandons un disjoncteur à coupure temporisée, indépendament d'une surtension éventuelle. Lors d'un démarrage à froid, peut intervenir une surtension momentanée.
   Les travaux de raccordements électriques doivent être effectués par un électricien agréé.
3. Vérifier le sens rotation (étiquette caractérist. moteur (P)) par une mise en route momentanée.
   Attention! L'orifice d'aspiration doit **rester ouvert, car lors d'une inversion de sens de rotation les palettes peuvent être détériorées.**
4. **Raccorder la tujauterie d'aspiration en (A). L'air refoulé est évacué par le silencieux (B).**
5. **Les embouts (A) ainsi que le silencieux de refoulement (B) peuvent également être monter sur la partie avant en position (a) air (b).**
6. **Valve de réglage du vide (accessoire): Le réglage du vide se fait à l'aide de la valve (C).**

Impiego
Le pompe per vuoto a secco della serie VTE 3 e VTE 6 sono adatte per il convogliamento di aria avente un tasso di umiditá normale e gas secchi fino a un vuoto finale (ass.) di 150 mbar.
Attenzione! **La temperatura ambiente non devere superare i 40°C. Nel caso deve di temperature piú alte vi preghiamo di comunicarcelo preventivamente.**
Non devono essere aspirate miscele pericolose (ad. es. solventi), aria molto umida, vapore acqueo, gas aggressivi o tracce di olio o grasso.

Installazione
Installando la pompa bisogna prevedere uno spazio sufficiente davanti al coperchio corpo pompa (c) per la manutenzione. Inoltre le entrate (E) e le uscite (F) dell'aria di raffreddamento devono distare almeno 8 cm. dalla parete più vicina (l'aria servita per il raffreddamento non deve essere riaspirata).

Messa in servizio
Durante il montaggio ed il funzionamento osservare le norme antifortunistiche.
1. Verificare che i dati del motore (dati del motore (P)) corrispondano ai valori di rete (tensione, frequenza, corrente nominale).
2. Avviare il motore tramite salvamotore. I cavi di allacciamento vanno ancorati a mezzo di apposite fascette di fissaggio.
   Raccomandiamo l'impiego di salvamotori la cui disinserzione viene ritardata in presenza di una eventuale sovracorrente. Una sovracorrente di breve durata è riscontrabile nell 'avviamento a freddo della macchina.
   L'allaciamento elettrico può esserc eseguito soltanto da elettricisti specializzati.
3. Avviare brevemente la pompa per controllare il senso di rotazione (dati del motore (P)).
   Attenzione: Il collegamento della tubazione aspirante dev'essere aperto, altrimenti, nel caso di rotazione in **senso contrario, le palette potrebbero spezzarsi.**
4. **Collegare la tubazione aspirante al punto (A). L'aria utilizzata viene scaricata al punto (B).**
5. **Il tronchetto del tubo flessibile (A) ed il silenziatore (B) possono essere avvitati in alternativa anche frontalmente nei punti (a) e (b).**
6. **Valvola regolazione vuoto (accessorio): La regolazione del vuoto può essere effettuta sull'apposita valvola di regolazione (C).**



(III)

Wartung
Bei Maßnahmen zur Instandhaltung, bei denen Personen durch bewegte oder spannungsführende Teile gefährdet werden können, ist die Pumpe durch Ziehen des Netzsteckers oder Betätigen des Hauptschalters vom E-Netz zu trennen und gegen Wiedereinschalten zu sichern.
Schmierung:
Alle Typen haben eine Dauerfettschmierung und brauchen nicht geschmiert werden.
Luftfilterung:
Filterpatrone (f) muß monatlich gereinigt und jährlich ausgewechselt werden (bei extremen Bedingungen müssen diese Wartungsintervalle je nach Notwendigkeit verkürzt werden.
Filterwechsel:
Gehäusedeckel (c) abschrauben, Filterpatrone (f) mit Dichtungen aus Filterraum (g) herausnehmen. Filter reinigen und Dichtungen überprüfen. Der Einbau erfolgt in umgekehrter Reihenfolge.

Die Typen VTE haben vier Kohlelamellen. Die erste Kontrolle soll nach 6000 Betriebsstunden, danach alle 3000 Betriebsstunden erfolgen.
Lamellenwechsel: Gehäusedeckel (c) abschrauben. Lamellen (d) zur Überprüfung herausnehmen. Alle Lamellen müssen eine Höhe (X) von größer als 12 mm haben. Verdichtergehäuse ausblasen und Lamellen in Rotorschlitze einlegen. Beim Einlegen ist darauf zu achten, daß die Lamellen mit der schrägen Seite (Y) nach außen zeigen und diese Schräge in Drehrichtung (O) mit dem Gehäuseradius (Z) übereinstimmt. Gehäusedeckel (c) leicht anschrauben. Pumpe kurz einschalten und den freien Lauf der Lamellen überprüfen. Gehäusedeckelschrauben fest anziehen.

Maintenance
During maintenance, which could endanger personnel because of moving parts or live connections the pump has to be separated from the incoming power supply. The power supply connection should be completely disconnected or turn off the main isolator, making sure that it can not be turned on without the appropriate authority.
Lubrication:
All models are assembled with sealed for life bearings and need no lubrication.
Air Filtration:
The filter cartridge (f) should be checked and cleaned monthly and replaced once a year depending on operating conditions. To change filter remove end cover (c), remove filter cartridge (f) with gasket of filter room (g). The filter can be cleaned by using oil free low pressure compressed air. Check the gasket and reassemble all parts.

VTE models have four carbon blades. Check vanes after the first 6000 operating hours and thereon after every 3000 operating hours.
Changing blades: Remove end cover (c). Take out vanes (d) for control. All vanes must have a height (X) of larger than 12 mm. Clean the cylinder, replace new blades into the rotor slot with the curved side of the blade (Y) in line with the radius of the rotor (Z) and direction of rotation (O). Replace end cover (c) and slightly tighten the screws. Start pump and check for free and smooth running blades. Then firmly tighten end covers screws.

Maintenance
Mesures de Sécurité. Lorsque des personnes peuvent être exposées au contact de parties électrifiées, il faut débrancher la pompe soit en retirant la fiche soit en actionnant le sectionneur et sécuriser tout rebranchement.
Lubrification:
Tous ces appareils sont équipés de roulements à graissage permanent.
Filtration de l'air:
La cartouche filtrante (f) doit être nettoyée mensuellement et remplacée annuellement. Selon le degré d'impureté de l'air aspiré, ces intervalles d'intervention devront être réduits.
Remplacement de la cartouche filtrante: retirer la cartouche (f) avec les joints après avoir retiré le couvercle de corps (c) enlevé la bague (i). Nettoyage par soufflage ou par tapotement.

Les modèles VTE comprennent 4 palettes graphites. Leur premier contrôle s'effectue après 6000 h de service puis toutes les 3000 heures de service supplémentaires.
Remplacement de palettes Enlever le couvercle de corps (c), retirer les palettes (d) pour contrôle. Leur hauteur minimum est de 12 mm. Nettoyer la chambre de compression par soufflage. Les palettes doivent être mises en place dans les rainures du rotor de telle manière que leur côte biseauté (Y) soit orienté vers le haut et que leur chanfrein épouse le rayon du corps (Z) dans le sens de rotation (O). Resserer légèrement le couvercle de corps (c). Mettre la pompe momentanément en marche afin de vérifier le libre mouvement des palettes puis bloquer le couvercle de corps.

Manutenzione
Si faccia attenzione che qualunque operazione di manutenzione sulle pompe venga effettuata solamente in assenza di tensione!
Lubrificazione:
Tutti questi tipi sono ingrassati a vita e non richiedono pertanto alcun ulteriore ingrassaggio.
Filtri aria:
Le cartucce (f) dei dispositivi filtranti vanno pulite mensilmente e sostituite annualmente, abbreviando comunque opportunamente questi intervalli in condizioni di servizio gravose.
Sostituzione del filtro: Svitare il coperchio corpo pompa (c), la cartuccia (f) con le guarnizioni. Pulire il filtro con un soffio d'aria scuotendolo, e controllare le guarnizioni. Per i montaggio, eseguire queste operazioni in sequenza inversa.

Le pompe per vuoto VTE hanno quattro palette in grafite. Il primo controllo va effettuato dopo 6000 ore di servizio, in seguito ogni 3000 ore.
Sostituzione delle palette: svitare il coperchio corpo pompa (c). Estrarre le palette (d) per il controllo. Tutte le palette della pompa devono avere un'altezza minima di 12 mm. Pulire con un soffio d'aria l'interno del corpo pompa e inserire le palette nelle fessure del rotore facendo attenzione che la smussatura (Y) dello spigolo corrisponda al raggio del rotore (Z). Riavvitare il coperchio (c). Avvitare leggermente il coperchio corpo pompa (c). Avviare brevemente la pompa per verificare che le palette scorrano liberamente. Serrare le viti del corpo pompa.

DATEN

Vakuumpumpen
Vacuum Pumps
Pompes à vide
Pompe per vuoto

RIETSCHLE

PICCOLINO VTE 3 – VTE 6

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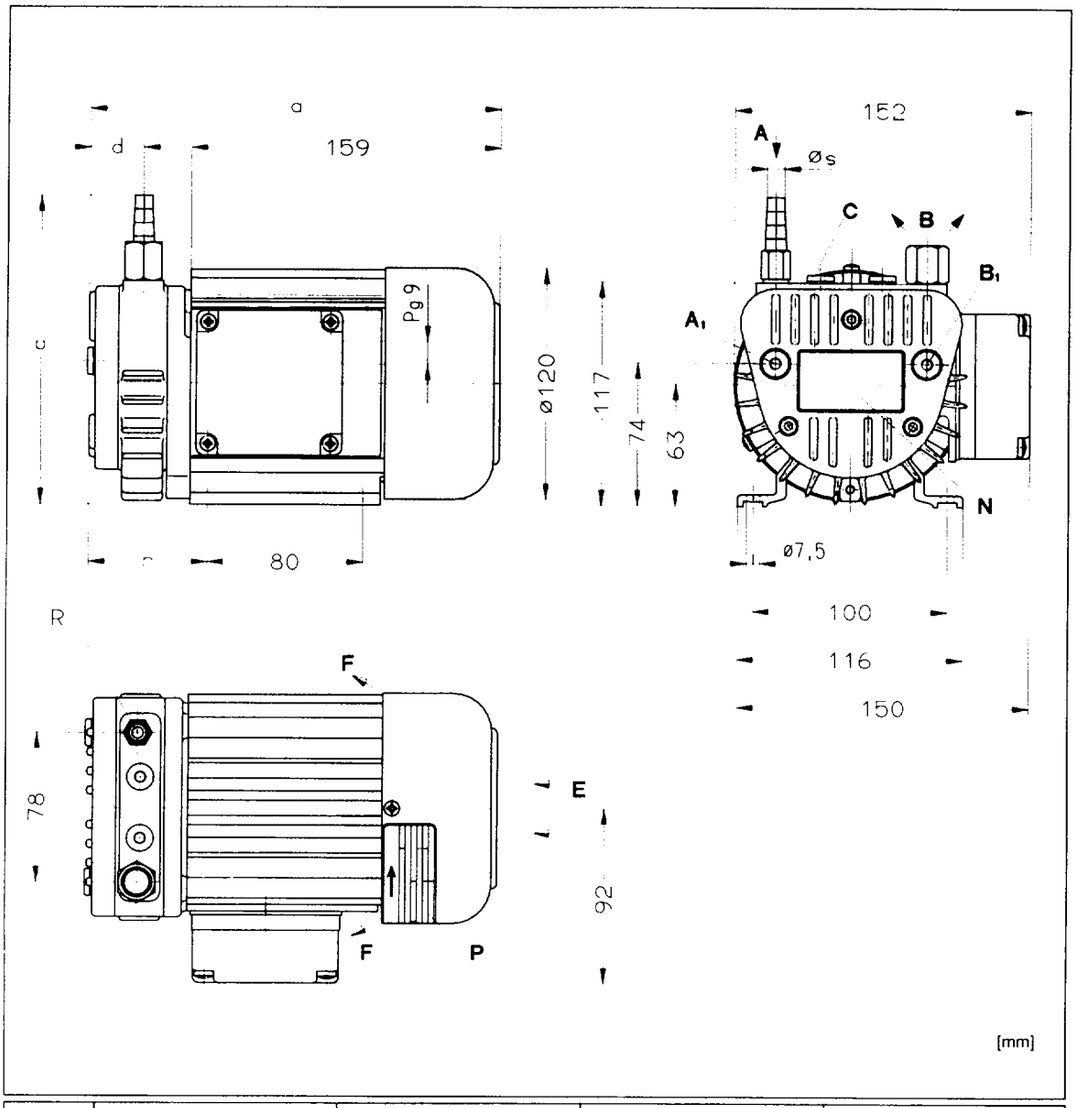


A	Vakuum-Anschluß	Vacuum connection	Raccord du vide	Attacco vuoto
A1	Alternativer Vakuum-Anschluß	Vacuum connection alternative	Raccord alternatif du vide	Attacco vuoto alternativo
B	Abluft-Austritt	Exhaust	Refoulement	Scarico aria
B1	Alternativer Abluft-Austritt	Exhaust alternative	Refoulement alternatif	Scarico aria alternativo
C	Anschlußmöglichkeit für Vakuum-Regulierventil	Connection possibility for vacuum regulating valve	Possibilité de raccordement pour valve réglage vide	Possibilita di allacciamento per valvola regolazione vuoto
E	Kühlluft-Eintritt	Cooling air entry	Entree air refroidissement	Entrata aria di raffreddamento
F	Kühlluft-Austritt	Cooling air exit	Sortie air refroidissement	Uscita aria di raffreddamento
N	Datenschild	Data plate	Etiquette caractéristique	Targhetta dati
P	Motordatenschild	Motor data label	Etiquette caractérist. moteur	Targhetta dati del motore

VTE		3	6
[mm]	a	209	224
	c	152	158
	d	24	38
	r	59	74
	s	9	12
	R	G 1/4	G 3/8

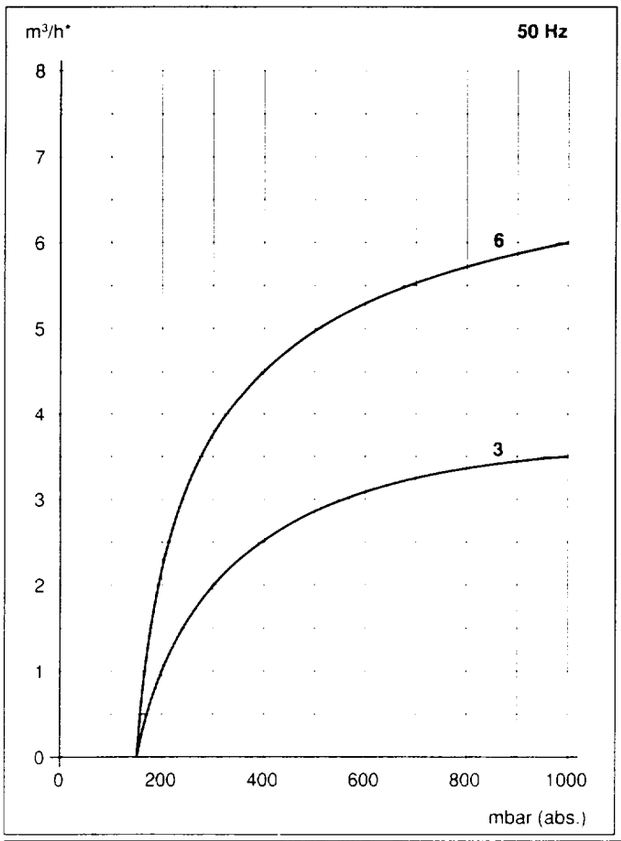
WERIE Rietschle

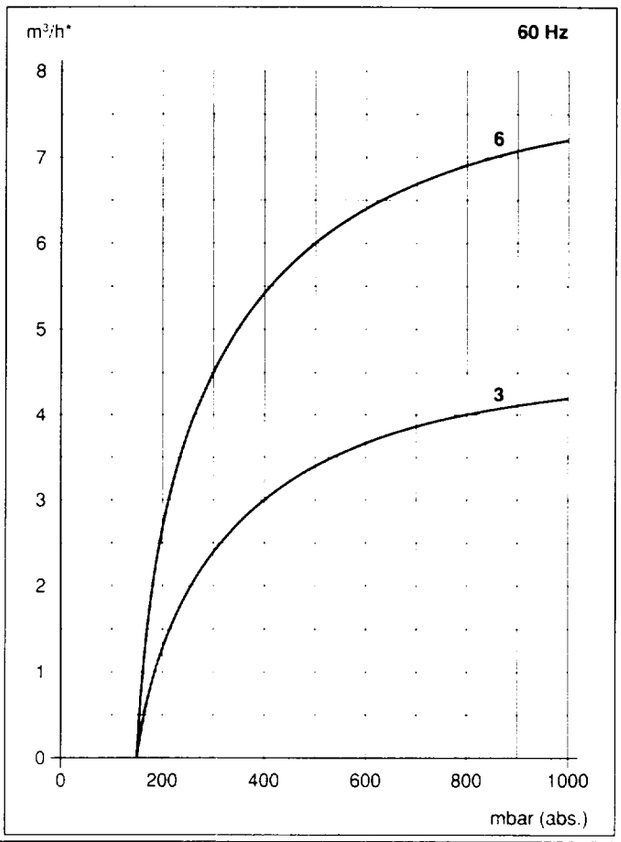
D 187 1.6.92

VTE		3	6
m^3/h	50 Hz	3,5	6,0
	60 Hz	4,2	7,2
mbar (abs.)*		150	
3 ~		200...255/346-440 V (50/60 Hz)	
1 ~		230 V ± 10% (50/60 Hz)	
kW (50 Hz)	3 ~	0,12	0,25
	1 ~	0,12	0,25
kW (60 Hz)	3 ~	0,145	0,30
	1 ~	0,145	0,30
A (50 Hz)	3 ~	1,1/0,63	1,4/0,81
	1 ~	1,3	2,3
A (60 Hz)	3 ~	0,9/0,52	1,44/0,83
	1 ~	1,4	2,5
min^{-1}	50 Hz	2750	
	60 Hz	3300	
dB(A)	50 Hz	57	60
	60 Hz	58	61
kg		6,3	7,9

ZRV	6	6	
ZRK	6 (03)	6 (03)	
ZMS (50 Hz)	3 ~	16/10	16/10
	1 ~	16	24
ZMS (60 Hz)	3 ~	10/10	16/10
	1 ~	16	40

m^3/h	Saugvermögen	Capacity	Débit	Portata
mbar (abs.)*	Enddruck	Ultimate vacuum	Pression limite	Pressione finale
mbar (abs.)	Ansaugdruck	Suction pressure	Pression d'aspiration	Pressione di aspirazione
3 ~/1 ~	Motorausführung	Motor version	Exécution moteur	Esecuzione motore
kW	Motorleistung	Motor rating	Puissance moteur	Potenza motore
A	Stromaufnahme	Current drawn	Intensité absorbée	Corrente nominale
min^{-1}	Drehzahl	Speed	Vitesse rotation	Numero giri
dB(A)	mittlerer Schallpegel	Average noise level	Niveau sonore moyen	Rumorosità media
kg	max. Gewicht	Weight max.	Poids maxi.	Peso massimo
	Zubehör	Optional extras	Accessoires	Accessori
ZRV	Vakuum-Regulierventil	Vacuum regulating valve	Valve de règlage vide	Valvola regolazione vuoto
ZRK	Rückschlagventil	Non return valve	Clapet anti-retour	Valvola di non ritorno
ZMS	Motorschutzschalter	Motor starter	Disjoncteur moteur	Interruttore magnetotermico





*bezogen auf den Zustand im Sauganschluß. / related to suction conditions at inlet connection. / Relatif à l'état régnant à l'aspiration. / riferito alle condizioni in aspirazione.
Kennlinien und Tabellenangaben beziehen sich auf betriebswarme Vakuumpumpen. / Curves and tables refer to vacuum pump at normal operating temperature. / Les courbes et tableaux sont établis, pompe à température de fonctionnement. / Le curve caratteristiche ed i dati riportati nelle tabelle si riferiscono alle pompe per vuoto con funzionamento a regime.
Technische Änderungen vorbehalten! / We reserve the right to alter technical information! / Sous réserve de modification technique! / Salvo modifiche tecniche!

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Annex 3

MIREX and Calculator product information

(2 pages)

MIREX TYPE EC-911

Smoke measuring equipment

GENERAL

The MIREX smoke measuring equipment is now in production and for sale. MIREX has been developed specifically for reference measurements of smoke density by Cerberus Ltd. of Switzerland. DELTA Electronics Testing has been granted an exclusive license to manufacture and sell this unique equipment to customers worldwide.

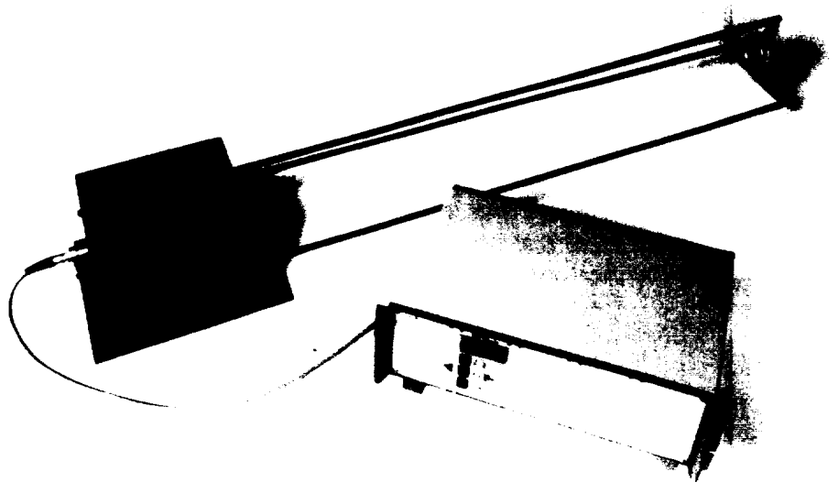
The MIREX instrument is based on the light extinction principle and is a supplement to the well-proven Measuring Ionisation Chamber MIC, rather than an alternative.

MIREX is suitable for smoke measurements e.g. in connection with testing of smoke detectors. The instrument complies with the European Standards EN54-7 and EN54-9, issued by the European Committee for Standardisation (CEN). In addition the instrument will be suitable for the UL smoke box and other applications where accurate and reproducible smoke measurements are required.

APPLICATIONS

Reference measurements of smoke density by smoke detector testing:

- *In smoke tunnel measurements according to EN54-7.*
- *In fire sensitivity testing according to EN54-7/9.*
- *In the UL smoke box is according to UL 217 and UL 268.*
- *In other applications where accurate smoke measurements are required.*



The MIREX smoke measuring equipment.

DELTA Electronics Testing - Venlighedsvej 4 - DK-2970 Hørsholm - Denmark - Tel. (+45) 45 86 77 22 - Fax (+45) 45 86 58 98 - www.delta.dk

D-PI-2804B

TECHNICAL SPECIFICATIONS

The MIREX smoke measuring system type EC-911 consists of the following parts:

- *A MIREX smoke measuring head with reflector, incl. mounting kit.*
- *A multicable, 10 m (other lengths on request).*
- *A MIREX control unit with power supply.*
- *Accessories, instruction manual, etc.*

The smoke measuring head is installed at the measuring site and connected to the control unit and power supply are housed in a cabinet which can be placed in a convenient location.

SYSTEM SPECIFICATIONS

Measuring range:
Transmission 100-0% or light obscuration 0-100% (corresponding to 0-10.0 dB/m with 1.00 m measuring path).

Measuring accuracy:
Better than ± 0.5% points on transmission in the range 100-40%.

Calibration:
Digital clean-air calibration with compensation for dirt accumulation on optical surfaces. The calibration can be locally or remotely controlled.

System check:
Built-in mesh filter which can be activated from the control unit.

System lock:
Input for disabling of calibration and system check.

Mains supply:
100-240 VAC, 50-60 Hz without switchover.

Cabinet:
19 inch bench top/rack cabinet with power supply for MIREX, MIC (optional) and calculator unit (optional). The cabinet can accommodate the following typical system configurations:
a) one MIREX
b) one MIREX and calculator
c) one MIREX and one MIC
d) one MIREX, one MIC and calculator
e) two MIREX.

MEASURING HEAD

Light beam:
Infrared, maximum at 880 nm. Distance between mounting surface and centre axis of light beam adjustable in 2 cm steps from 7-17 cm.

Measuring path:
1.00 metre (measuring head - reflector) as standard.

CONTROL UNIT

Readout:
3.5 digit LCD display. Transmission or obscuration can be selected. With calculator unit (optional) also extinction in dB/m or obscuration module can be displayed.

Analog outputs:
10.0 - 0.0 VDC corresponding to 100-0% transmission.
Load impedance ≥ 100 kΩ.

Options
- *Neutral density filters with 1.0, 2.5 and 4.0 dB attenuation.*
- *Calculator unit type EC-913-20.*

INFORMATION

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NB: Specification may be subject to changes for improvement without prior notice.

CALCULATOR UNIT TYPE EC-913-20

For MIC/MIREX smoke measuring equipment

GENERAL

A calculator unit is available for the conversion of the measuring values from the MIC and MIREX smoke measuring equipment type EC-912 and EC-911, respectively. In addition the calculator unit provides analog outputs for recording the calculated values. A further feature provided by the calculator unit is system calibration, making the operation of the MIC/MIREX equipment more easy. The calculator unit has been developed by Cerberus Ltd. of Switzerland and is now manufactured and sold to customers worldwide by DELTA Electronics Testing.

FEATURES

The calibration unit fits into the MIC/MIREX control cabinet and provides the following functions:

- *Conversion of MIC values*
  - *Conversion of smoke density X to Y*
  - *Conversion of Y to Y_{20}*
- *Conversion of MIREX values*
  - *Conversion of transmission T(%) to extinction module m (dB/m)*
  - *Conversion of light obscuration D(%) to light obscuration per metre D1(%/m).*
- *Calculation of m/Y ratio.*
- *System calibration.*

Analog output signals (0.0 - 10.0 VDC and 0.0 - 11.0 VDC, respectively) are available for all the converted and calculated parameters. Load impedance ≥100 kΩ.

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NB: Specification may be subject to changes for improvement without prior notice.

Calculator unit in front of the MIC/MIREX control cabinet.

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