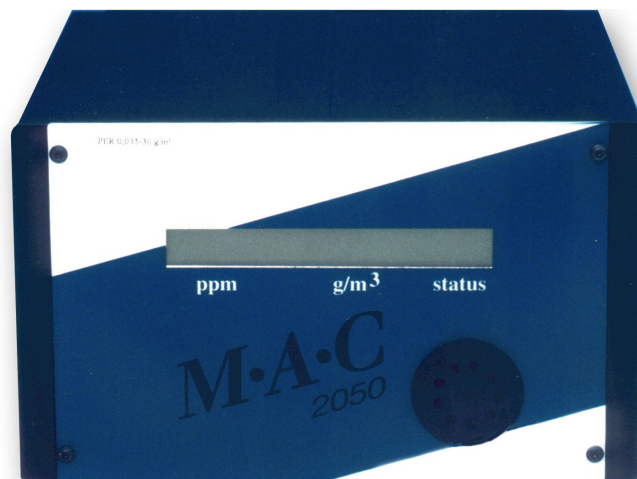


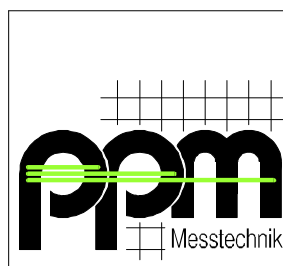
# Instruction Manual

## Measuring Computer

### M.A.C 2050



Issue 3.3  
Revision April, 2007  
Subject to change without notice



**This manual has to be read carefully before switching on the instrument.**

**The instructions must be followed strictly.**

**Non-observance of these instructions can lead to the loss of right to claim for damages or guarantee.**

**Conventions used in this instruction manual :**

**the following icons appear in the margins to indicate the following points :**



: warnings.



: important hints.



: avoid actions marked with this icon.

*CATCHWORDS* appear in italics in the margins.

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**YOUR CONTACT:**

**Your local Representative:**

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# 1. General Instructions

## 1.1 Instrument layout

### 1.1.1 Front view

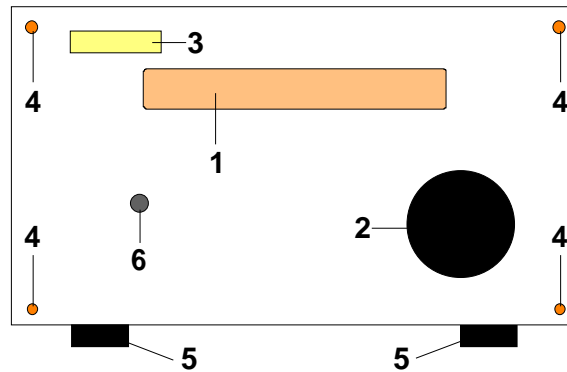


Figure 1 :

- 1 LC display
- 2 Activated Carbon filter (Zero-gas filter) with venting holes and coarse-dust filter
- 3 label indicating substance (measured gas) and measuring range
- 4 Allen screws
- 5 tippable instrument bases
- 6 hole for push button (for instrument reset)

### 1.1.2. Rear view

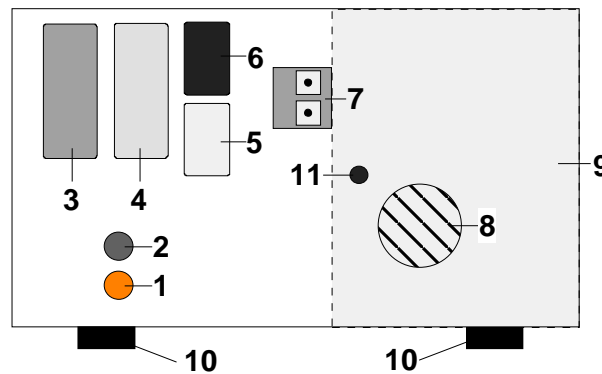
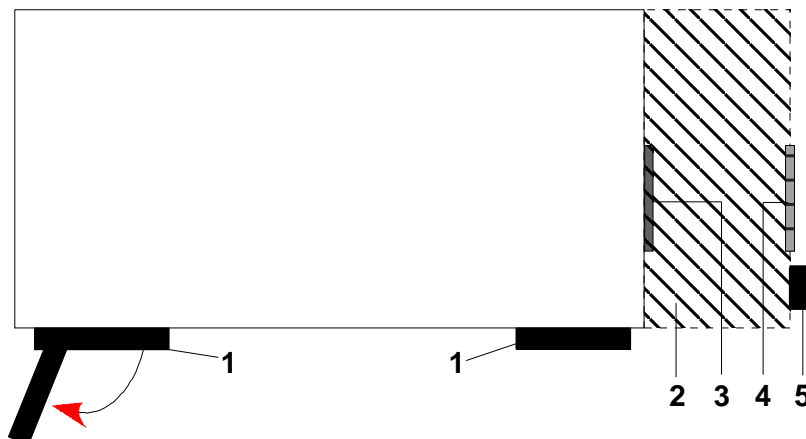


Figure 2 :

- 1 Gas inlet
- 2 Gas outlet
- 3 female connector for machine interface (sub-d type)
- 4 optional parallel interface
- 5 optional serial interface RS-232 or RS 485
- 6 servicing interface connector (RS-232)
- 7 terminal for power connection (low voltage AC/DC)
- 8 blower
- 9 optional AC power supply 110/230 V AC
- 10 instrument bases
- 11 grounding connection point

### 1.1.3 Side view



**Figure 3 :**

- 1 instrument bases
- 2 optional AC power supply 110/230 V AC
- 3 blower
- 4 blower slots
- 5 mains connector of optional AC power supply (110/230 V AC)

## 1.2. Installation notes

### 1.2.1. Preparation

During storage and transportation the temperature should be kept between  $-10^{\circ}\text{C}$  (  $14^{\circ}\text{F}$  ) and  $+60^{\circ}\text{C}$  (  $140^{\circ}\text{F}$  ).

*EXTERNAL  
DAMAGE ?*

The equipment must be inspected immediately after unpacking for external damage which may have been caused by transportation etc. Any damage found on the equipment must be notified to the supplier without delay : **the equipment must not be switched-on.**

#### 1.2.1.1 Preparation of machine/plant

The installation of the equipment must be carried out in accordance with the instructions of the ANNEX A.

*LENGTH  
OF SAMPLE  
GAS TUBES*

The measuring computer is adjusted for sample gas tubing of PTFE (TEFLON) with ext./int. diameter of 4/2.5 mm which have a normal length of 5 m (16.5 feet). If longer tubing is needed contact the manufacturer for information on how to proceed.

**Note :**

**To avoid dust and dirt in tubing, valves and the sensor itself the instrument must be only operated if it is equipped with the appropriate filters. This is mandatory for all kind of operations. The filters must be installed immediately after the valves of the machine (sample gas outlet).**



The material of appropriate filters is of such a kind, that neither in the filter element nor in the filter housing solvent will be adsorbed and particles sized 5 micron and more are not allowed to pass.

**1.2.1.2 Instrument**

**1.2.1.2.1 Preparation for installation as stand-alone instrument**

*INSTALLATION  
SITE*

To ensure a proper function of the equipment, the installation site should be free from vibrations as much as possible. Low frequency vibrations (up to 30 Hz) should be avoided. To ensure a sufficient ventilation of the M.A.C 2050 the distance of the instrument to the surrounding walls must be at least 5 cm (2 inches) (see chapter 7.2.4).



Low frequency vibrations (up to 30 Hz) should be avoided.



The equipment is specified for an ambient temperature range from +10°C ( +50°F) up to +40°C ( +104°F ). Condensation of humidity inside the equipment must be avoided.

For installation of M.A.C 2050 observe the instructions in **ANNEX A.**

**1.2.1.2.2 Preparation for installation of built-in version**

The installation site must meet the following requirements :

1. the ambient temperature must not exceed the temperature range from +10°C ( +50°F) up to +40°C ( +104°F ).
2. vibrations should be as little as possible and their frequency not less than 30 Hz.
3. there must be a sufficient air flow to the blowers built-in in M.A.C 2050.

For installation of M.A.C 2050 observe the instructions in **ANNEX A.**

## 1.2.2 Electrical connection

### 1.2.2.1 Operation by low voltage

**In its standard configuration the instrument is designed for connection to a low voltage power source.**

The AC power supply must meet the following requirements :

Voltage: **14 up to 28 V AC**, Freq. 50/60 Hz

Voltage: **20 up to 28 V DC**

Current : **max. 2.5 A** (at 24V DC)



**Before installation of the instrument make sure that the AC power supply meets these requirements. Otherwise the installed fuse can be blown. Exchange of fuse see chapter 4.2.3..**



**Never connect the terminal for power connection at the rear side of M.A.C 2050 to the mains. The instruments electronics would be destroyed immediately! The optional AC power supply V101 is necessary for operation with mains voltage (110 or 230 V AC). Refer to ANNEX A for installation.**



Connect the electrical cables to the terminal at the rear side of the M.A.C 2050 (see Figure 2, position no. 7).

**You can neglect the polarity.**

M.A.C 2050 is protected by an internal fuse.

For exchange of this fuse see chapter 4.2.3.

### 1.2.2.2 Operation by mains voltage (optional AC power supply (V101) required)

When M.A.C 2050 is operated with mains voltage the optional AC power supply must be attached to the rear side

See :

⇒ chapter 1.1.2, Figure 2, position no.9

⇒ chapter 7.1.,Figure 9

## 1.2.3 Sample gas connections

The gas inlet and outlet of M.A.C 2050 is shown in chapter 1.1.2, Figure 2, position no.1 and 2.

### Note :

Before switching on the instrument the dust caps of the sample gas inlet and outlet must be removed. Check if Activated Carbon filter is installed ( see chapter 1.1.1, Figure 1, pos.no. 2 and 1.1.2., Figure 2, pos.no. 1,2).





### 1.2.3.1 Layout of gas sampling

The details of gas tubing, installation of dust filter and gas sampling arrangement are described in ANNEX A. Periodical exchange of the dust filter is explained in chapter 5, "Maintenance".

**Strictly observe these instructions.**

**Wrong installation and infrequent maintenance will lead to malfunctions or damage of the instrument!**



**Note:**

**To avoid dust and dirt in tubing, valves and the sensor itself the instrument must be operated only if it is equipped with the appropriate filters. This is mandatory for all kind of operations. The filters must be installed immediately after the valves of the machine (sample gas outlet).**



## 1.3 Adjustments made at the Factory

At the factory the following parameters are set :

Parameter	Options	Standard version
Alarm limit	settable as required	2 g/m <sup>3</sup>
Operation mode	controlled by external signal or automatically	controlled by external signal
Cyclic zero adjustment	activated or not activated	not activated
Reference temperature and pressure	settable as required	temperature: 0°C (+32°F) pressure: 1013 mbar (14.69 psi)
Measurement cycle time	depending on required accuracy	20 seconds

The instrument configuration ( except the operation mode and measurement cycle time ) can be changed later on by authorized service personnel only.

The operation mode and measurement cycle time can be changed only by installation of a different software version.

## 2. Starting of operation

### 2.1 Operation by low voltage

As soon as the instrument is connected with a low voltage source it starts to operate as described in chapter 3.

**M.A.C 2050 has no power-on switch!**



### 2.2 Operation by mains ( using optional AC power supply )

The optional AC power supply is described in chapter 7.1.

Before the AC power supply is connected to the mains the voltage selector has to be set to the right voltage :

Voltage selector : see chapter 7.1, Figure 9, position no. 5.

Switch the M.A.C 2050 on by using the power-on switch at the rear side of the AC power supply.

See chapter 7.1, fig. 9, position no. 7.

### 3. Operation

After connecting M.A.C 2050 to the power source or after switching power-on, the LC display (chapter 1.1.1, fig. 1, position no.1) shows (example) :

```
MARC2050 V.52ZZ92S (C)PPM 93/2006
TEL. 0700-77656364
```

**Note:**

The number after **V.** indicates the **software version number** (in this case **52ZZ92S**). This number can be helpful if service is required.



As next the configuration parameters of the instrument will be displayed.  
For example :

```
SENSOR PER E
AL. 270 PPM = 2.00 G/M3
AT 0°C/1013 MBAR
{ CYC.ZM: 480 MIN }
```

**Note:**

These parameters are set by the manufacturer or by service personnel. These are important information if service is necessary. The message in parentheses is only displayed if cyclic zero-adjustment is activated.



For factory-set adjustments see chapter 1.3

#### 3.1 Self-test of the instrument

During the entire operation the major functions of M.A.C 2050 are checked by an internal program function. As next this function is activated and the display indicates :

```
SELFTEST
```

The display is blinking. If an error occurs, an error message appears on the display. See chapter 4, "Error description".

### 3.2 Warm-up period

The next step on the operating procedure is the heating of the measuring cell up to 53°C (+127.4°F). A normal warm-up time of approximately 10 minutes is required at ambient temperature of 20 °C ( +68°F). The actual temperature is indicated in degrees centigrade (°C). For example :

**TEMP. : 45.5 °C**

### 3.3 Zero-adjustment

Possible alterations of the sensor ( e.g. performance reduction of the infrared source caused by ageing ) are compensated by zero-adjustment. During zero-adjustment procedure ambient air is sucked through the Activated Carbon filter ( fig. 1, position no.2) into the measuring cell. If the Activated Carbon filter is changed regularly ( according to chapter 5.2., "Maintenance" ), the measured substance will be absorbed by the active carbon filter. Therefore pure air enters the measuring cell and the concentration measured is equal to zero.

**For trouble free operation the Activated Carbon filter must be changed regularly in adequate time intervals!**



*AUTO-ZERO  
ADJUSTMENT*

The zero-adjustment procedure is started automatically by M.A.C 2050 after connecting the instrument to power source respectively after switching-on when optional AC power supply is installed.

*MANUAL  
ZERO  
ADJUSTMENT*

A manual zero adjustment can be carried as follows :

Insert a small screwdriver, paperclip or similar into the hole at the front panel (see Figure 1, position no.6) and push the reset button behind.

Then M.A.C 2050 starts the sequence described in this chapter, what includes an auto-zero adjustment.

*MEASURING  
RANGES*

The sensor for M.A.C 2050 can be chosen from 3 different sensor types, see ANNEX C. What sensor is built-in, is shown on the label at the front panel (see fig. 1, position no.3), as well as on the data plate.

Each sensor type has up to 4 internal measuring ranges. The zero-values are measured and stored for each single internal measuring range. The measured zero-values are only accepted, if at least 5 consecutive zero-measurements are within the predetermined tolerances.

During zero adjustment the LC display shows 3 indications. For example :

field 1	field 2	field 3
<b>A: 1</b>	<b>S: 4</b>	<b>Z P 1</b>

The following table shows the meanings of these indications :

Field1	Field2	Field3	Status	Meaning
<b>A: nn</b>				Number of attempts for zero adjustment nn=number 0 to 20
	<b>S: nn</b>			Number of measurement results within the tolerance range. nn=number 0 to 5
		<b>Z</b>		Zero adjustment under execution
			<b>P</b>	Purging of measurement cell with zero gas
			<b>C</b>	Leveling period (calm)
			<b>M</b>	Measurement
			<b>n</b>	Number of active internal measuring range. Depends on sensor type. n=number 1 to 4

The third field of the display shows the progress of zero adjustment. The following cycle is passed in every measurement (with standard software version) :

1. the measuring cell is flushed for 5 seconds with ambient air via Activated Carbon filter.
2. M.A.C 2050 waits for 3 seconds, to calm the pulsations of gas inside the measurement cell.
3. the measurement is performed (12 seconds). The final result is the mean value of a large number of single measurements values.
4. M.A.C 2050 checks the measuring signal for noise and deviations. If the result is within the predetermined tolerance it will be accepted as steady result.

This standard measurement cycle takes about 20 seconds.

The zero adjustment of one measuring range requires five consecutive steady results. If an unsteady result occurs, the number of steady results is set back to zero. In this case M.A.C 2050 begins a new zero adjustment sequence. If less than 5 consecutive steady results have been measured after 20 cycles, M.A.C 2050 cancels the zero adjustment procedure and displays :

**ZEROING ERROR**

Possible sources of this error and their removal are described in chapter 4, "Failure description and trouble shooting".

### 3.4 Direct measurement mode

If the software version for direct measurement is installed, M.A.C 2050 proceeds with the direct measurement operation (see chapter 3.6 "Measurement process").

**For the direct measurement mode the Stand-by and Passive mode cannot be activated!**



### 3.5 Externally controlled measurement mode

If the software version for externally controlled measurement is installed, M.A.C 2050 can proceed after the zero-adjustment procedure in 2 different ways :

#### 3.5.1 Stand-By mode

The signal **CRON** (see ANNEX A, Figure A2) **is not activated** ( e.g., the machine that controls M.A.C 2050 is switched off ).  
The LC display shows :

**STAND-BY**

To minimize ageing of the optical components the infrared radiation source is switched off in the Stand-by mode.

As soon as the CRON signal is activated, M.A.C 2050 starts auto-zero adjustment (see chapter 3.3, "Zero-adjustment").

#### 3.5.2 Passive mode

The signal **CRON** (see ANNEX A, Figure A2) **is activated** ( e.g., the machine, that controls M.A.C 2050, is switched on ).

The LC display shows :

**READY**

M.A.C 2050 now waits for a measurement request from the machine control device. The measurement request is activated by the signal MRQ1 (see ANNEX A, Figure A2).

### 3.6 Measurement process

During measurement process the LC display continuously indicates :

- the actual result : gas concentration in units of ppm in field 1
- the actual result : gas concentration in units of g / m<sup>3</sup> (referred to preset normalized parameters; see 1.3) in field 2
- the actual process in field 3.

For example :

Field 1	Field 2	Field 3
<b>270</b>	<b>1.997</b>	<b>RP▼</b>
<b>ppm</b>	<b>g/m<sup>3</sup></b>	<b>status</b>

*CONCENTRATION  
UNITS  
ppm , g/m<sup>3</sup>*

The displayed measuring results for concentration (field 1 and 2) are referred to temperature 0°C (+32°F) and atmospheric pressure 1013 mbar (14.69 psi) in the standard version. Other reference temperatures and pressures can be adjusted by factory. The actual atmospheric pressure is measured in M.A.C 2050 and the results are corrected accordingly. The measured gas is kept at constant temperature of 53°C (+127.4°F). In ANNEX B the conversion between concentration units is explained.

*MEASURING  
CYCLE*

The following cycle will be passed in every measurement (with standard version) :

1. the measuring cell is flushed for 5 seconds with sample gas.
2. M.A.C 2050 waits for 3 seconds, to calm the pulsations of gas inside the measurement cell.
3. next the measurement is performed (12 seconds). The displayed result is the mean value of a large number of single measurements values.
4. M.A.C 2050 compares the measurement result with the preset alarm limit. Corresponding to this evaluation a signal is sent to signal port MOK1 (see ANNEX A, fig. A2)

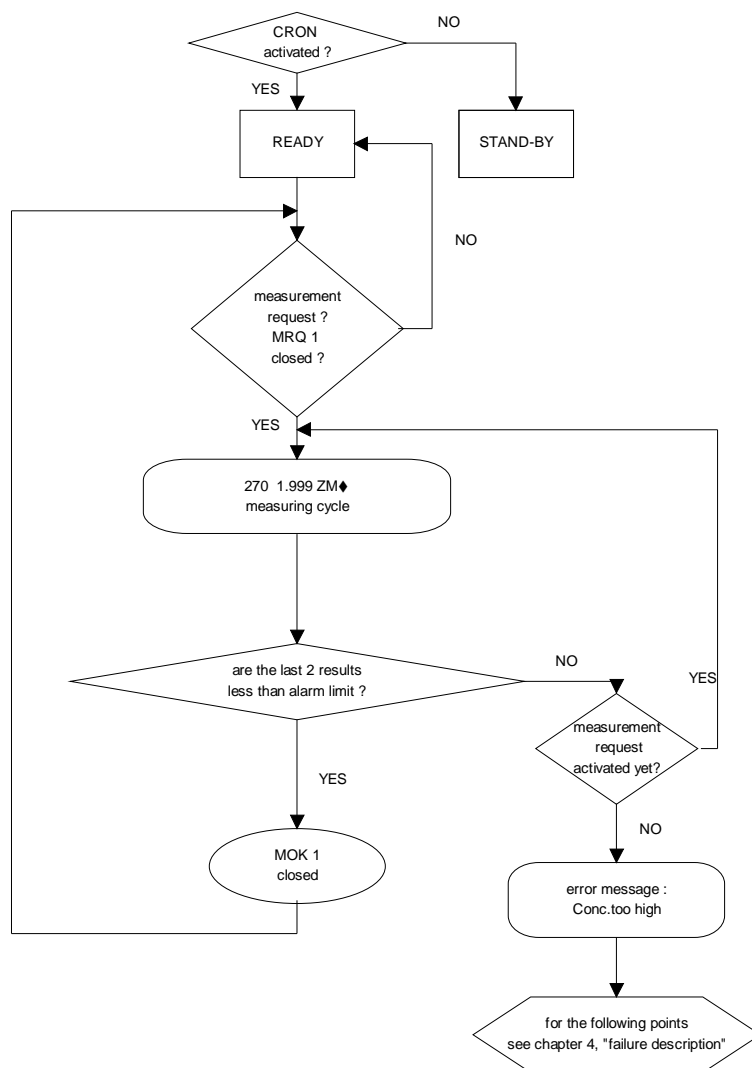
This measurement cycle takes about 20 seconds. If other cycle times are required, special software versions are available on request.

From field 3 - "status" - the user can read off the actual process performed by the instrument :

<b>Message</b>			<b>Meaning</b>
<b>R</b>			cyclic measurement (running)
	<b>P</b>		flushing with sample gas (purging)
	<b>C</b>		leveling (calm)
	<b>M</b>		Measurement
		▲	measurement result exceeds alarm limit
		▼	measurement result is below alarm limit



M.A.C 2050 communicates with the machine control device via the built-in machine interface. The input and output ports are attached to the male connector, series sub-D, 25 pins, at the rear side of M.A.C 2050 (see Figure 2, position no.3). The plug connections and the designations of the signals are described in ANNEX A, Figure A2, A4 and A5. By optocouplers the inputs are galvanically separated from the instrument. The outputs are potential-free relay contacts. The machine interface connector is connected to the machine control device via the interface cable (see ANNEX A, Figure A2 and A3).



**Figure 4**  
Flow chart : measurement procedure for external control. Standard version.


## 4. Failure description and trouble shooting










### 4.1 Error messages at M.A.C 2050

Error messages are displayed in clear on LCD. At the same time the relay contact PMSR (instrument ready) at the machine interface (see ANNEX A, Figure A2 and A5) is opened and the contact ALARM is closed. Via the input AQUIT (quitting of alarm signal via machine control device) this alarm can be quitted or it is quitted automatically after one minute. If instrument errors occur, the output PMSR remains open and M.A.C stops operation. In case of other errors usually the instrument continues operation. (see following table )



**This icon indicates : Call your local representative or service.**

Display/Message	Possible causes, check :	action of user
Zeroing error	<ol style="list-style-type: none"> <li>1. Activated Carbon filter is saturated</li> <li>2. leakage of sample gas supply</li> <li>3. 3. measuring cell is dirty (e.g. dust filter not changed)</li> </ol>	<ol style="list-style-type: none"> <li>1. change filter</li> <li>2. check tubes and connections</li> <li>3. </li> </ol>
Interface-Error	Signal CRON is not activated, but MRQ1 is active. Defective interface cable (see ANNEX A)	check control device of the machine
M.T. too short	Measurement request (MRQ1) has been removed too early	check control device of the machine check interface cable
Conc. too high alarm at the machine control device	Measurement request (MRQ1) has been removed by machine control device, though measurement result > alarm limit (MOK1 open) (ALARM closed)	Quit alarm at machine control device (signal AQUIT). Or after 1 minute alarm is quitted automatically. check control device of the machine. check interf. cable

<b>Display/Message</b>	<b>possible causes, check :</b>	<b>action of user</b>
Printer Error (display blinks 5 times, operation will be continued till next print command)	<ol style="list-style-type: none"> <li>1. printer switched off</li> <li>2. faulty connection to printer</li> <li>3. other problems with parallel port or printer</li> </ol>	<ol style="list-style-type: none"> <li>1. switch on printer</li> <li>2. check cables and plug, set printer online</li> <li>3. exchange printer or</li> <li>4. </li> </ol>
Sensor ..... or Sens. Temperature too high !	<p>Temperature of measuring cell is too high</p> <ol style="list-style-type: none"> <li>1. cooling air is not sufficient</li> <li>2. unsuitable site for instrument (exposure to sunlight etc.)</li> <li>3. instrument failure</li> </ol>	<ol style="list-style-type: none"> <li>1. see note in chapter 1.2.1 and <b>ANNEX A</b></li> <li>2. choose a better suited site</li> <li>3. </li> </ol>
Error in Pneum.-System	<ol style="list-style-type: none"> <li>1. faulty tubes, junctions or dust filter: (leaking, not tight, crushed, blocked etc.)</li> <li>2. gas sample tubes are too long</li> <li>3. instrument failure</li> </ol>	<ol style="list-style-type: none"> <li>1. repair or exchange</li> <li>2. install shorter gas tubes</li> <li>3. </li> </ol>
Sens. heating defective	instrument failure	
Ref.-Source Comp.-Signal defective	instrument failure	
Ref.-Source Main-Signal defective	instrument failure	
Ref.-Source Main-Signal + Comp.-Signal defective or Chop.-Motor-Stop	instrument failure	
IR-source defective	instrument failure	
ADC Timeout	instrument failure	

## 4.2 Other failures



### 4.2.1 Failures concerning instrument communication with the external control device

The following table explains malfunctions, that can occur during communication between machine control device and the instrument.


**These failures can be detected easily by using the Interface Tester G1289.**




Failures in external measuring request, resp. at machine control device :

Failure description	Causes	Repair
Display : "M.T. too short", though MRQ1 and CRON are activated	MRQ1-signal is not stable, e.g. voltage break-down for more than 50 ms)	repair or call supplier of your machine/control device
M.A.C2050 does not measure, though measurement is requested (MRQ1) and CRON-signal activated Display : Ready	1. defective interface cable 2. electronic assembly for machine interface defective in M.A.C 2050	1. check interface cable 2. 
M.A.C2050 does not measure though measurement is requested (MRQ1) activated  Display : Interface-Error	1. signal CRON is not activated 2. interface cable defective 3. electronic assembly for machine interface defective in M.A.C 2050	1. repair or call supplier of your machine/control device 2. check interface cable 3. 




Failures at electronic assembly for machine interface, at the plug or interface cable :

<b>Failure description</b>	<b>Causes</b>	<b>Repair</b>
Control signals CRON, MRQ1 and AQUIT are sent from control device, but M.A.C 2050 responds faulty.	broken wires in interface cable or bad contact	exchange cable and/or plug
Control signals CRON, MRQ1 and AQUIT are sent from control device, connections and cable are o.k., but M.A.C 2050 responds faulty	instrument failure	

#### 4.2.2 Failures at gas sampling

Failure description	Causes	Repair
measurement results too high	<ol style="list-style-type: none"> <li>1. Dust deposits in dust filter (see maintenance)</li> <li>2. Dust deposits in sampling tubes (before or inside valves)</li> <li>3. dust filter is not installed directly behind the valve at machine</li> <li>4. date for calibration is clearly exceeded (approx. 1 year)</li> </ol>	<ol style="list-style-type: none"> <li>1. change dust filter</li> <li>2. clean or exchange tubes, clean valves at machine</li> <li>3. install instrument correctly</li> <li>4. recalibration</li> </ol> 

#### 4.2.3 No message on display

Failure description	Causes	Repair
No message on display, display not working, no pumping noise noticeable (inside M.A.C 2050)	<ol style="list-style-type: none"> <li>1. M.A.C 2050 is not connected to operating voltage</li> <li>2. fuse is blown</li> <li>3. if AC power supply is installed: instrument is switched off</li> <li>4. if AC power supply is installed: fuse inside AC power supply is blown (perhaps wrong setting of voltage selector )</li> </ol>	<ol style="list-style-type: none"> <li>1. connect to operating voltage, check</li> <li>2. exchange fuse. If fuse is blown repeatedly : </li> <li>3. switch to power-on</li> <li>4. exchange fuse (see chapter 7.1). If fuse is blown repeatedly : </li> </ol>
No message on display, display is working	Electromagnetic interference on operating voltage : system does not boot or is blocked.	<p>push reset button (see fig. 1, pos.6 and chapter 3.3). If failure occurs again: </p>

**EXCHANGE  
OF  
FUSE**

In M.A.C 2050 a fuse (**5 x 20 mm, 2 A slow to blow**) is provided for additional safety. Exchange of fuse for **low voltage operation**:

1. disconnect the operating voltage at the terminal, fig. 2, pos. no. 7.

**Never open the instrument when operating voltage is connected!**

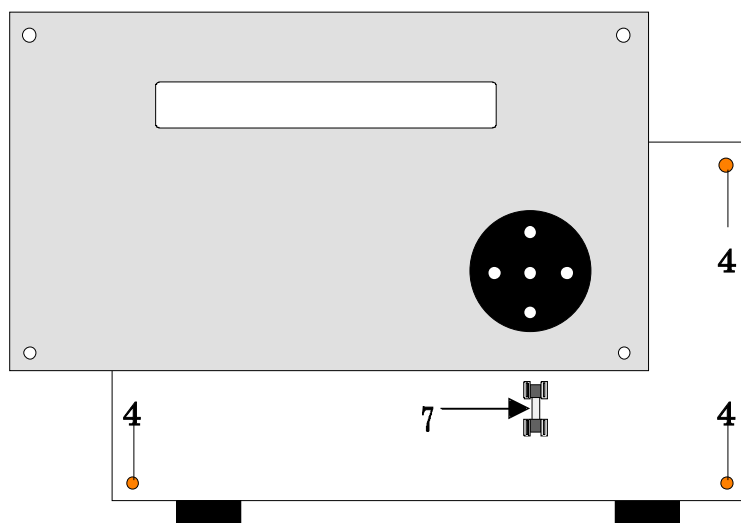


1. loosen the 4 allen screws at the front panel. (Figure 5 and Figure 1, pos. no. 4) with a hex screwdriver size
2. Unfix the front panel.
3. pull the fuse out of the bracket (Figure 5, pos. no. 7) and exchange it by a new one of same type.

**Never apply fuses with other values than noticed above!  
Wrong fuses can lead to damage of the instrument !**



4. insert the front panel and fix it with the 4 allen screws. Connect M.A.C 2050 to the operating voltage.



**Figure 5**

- 4 Allen screws
- 7 fuse, 5 x 20 mm, 2 A, slow blow

The exchange of the fuse (when optional AC power supply is installed) is described in chapter 7.1.2, "Exchange of fuse (optional AC power supply)" .

## 5. Maintenance

### 5.1 General hints

Because of its construction, M.A.C 2050 requires a minimum of effort for maintenance. A skilled user can do the maintenance by himself.

The instrument housing can be cleaned with a smooth damp cloth, which has been wetted with water and a little bit of rinsing agent.

**Never use organic solvents (e.g. PERC, acetone).  
Organic solvents will damage the front panel.**



### 5.2 Exchange of Activated Carbon filter

For trouble free operation the Activated Carbon Filter has to be changed regularly! The exchange interval depends on :

content of dust and solvents in the ambient air. The higher the content, the shorter the intervals for exchange.

how often zero-adjustment is performed. This depends inter alia on the working time of the plant (e.g. how often the instrument is switched on and off).

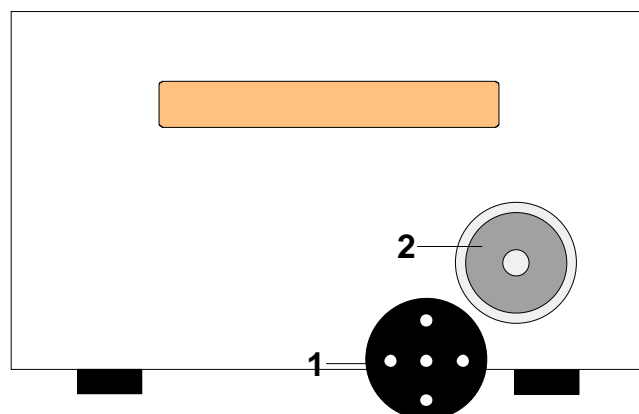


We recommend to exchange the filter **every 3 months**.

*EXCHANGE  
OF  
A.-CARBON  
FILTER*

For exchange of Activated Carbon filter observe the following instructions :

1. The Activated Carbon Filter (zero-gas filter) is located behind the circular cover plate on the front panel, Figure 1, pos. 2 and Figure 6, pos. no. 1. Remove this circular (black, perforated) cover plate by levering it up with a small screwdriver. Insert the screwdriver at the leveled side of the cover plate.

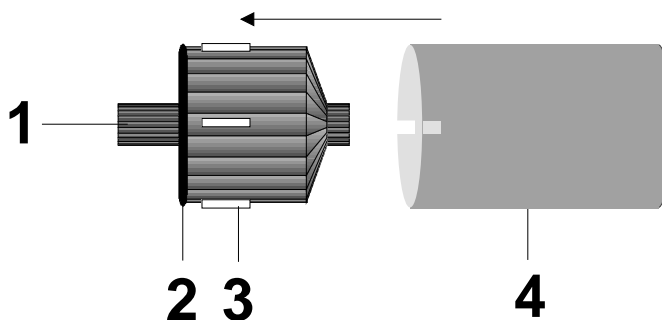


**Figure 6**

- 1 cover plate
- 2 Activated carbon Filter (zero gas filter)



2. Insert the supplied tool (accessory) into the opening. Turn it carefully until it clicks into place. Then turn the filter counterclockwise out of the mounting.



**Figure 7**

- 1 thread
- 2 rubber gasket
- 3 naps to click in
- 4 filter exchange tool

3. Insert the new filter into the tool. Make sure, that the rubber gasket ( Figure 7., pos. no. 2 ) is present. Insert the tool with the filter inside into the opening .
4. Screw in the filter carefully (clockwise). Fasten the filter.  
**Do not overtighten.**

**Never tighten the filter too strong!  
Otherwise the thread can break.**



5. Then put the cover plate (fig. 6, pos. no. 2) back in place (leveled side down).
6. Record the actual date on the label "last exchange date.....".  
So the user can check if the filter needs to be replaced attach the label at the right side of the instrument next to the identification plate. .

**Be sure to have an appropriate amount of filters in store.**



Filters can be ordered from the manufacturer or the local representative.

### 5.3 Exchange of sample gas filter (dust filter)

**To avoid dust and dirt in tubing, valves and in the sensor itself the instrument must be operated only equipped with appropriate filters. This is mandatory for all kind of operations!**



For exchange of the dust filter observe the following instructions:

1. To avoid contamination of sample gas tube during exchange switch off the instrument or pull off the suction tube at the rear side .
2. Unscrew the filter at the screw caps.
3. Insert the new dust filter. A label showing an arrow is attached to the dust filter .

This arrow indicates the flow direction of sample gas. **The arrow must direct to the tube, that leads to the M.A.C 2050 (not to the machine).**

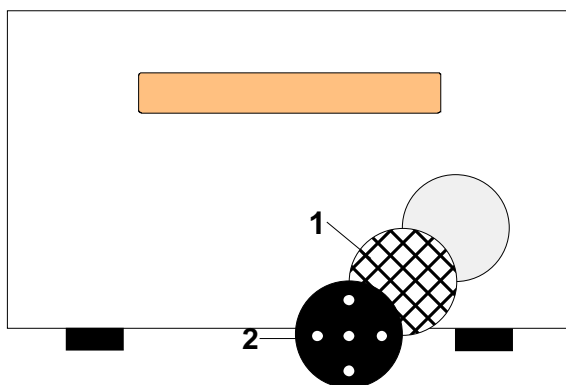
We recommend to exchange the dust filter **every 3 months**

### 5.4 Cleaning of ventilation air inlets and outlets

The ventilation in- and outlets should be cleaned on the occasion of **regular maintenance every 3 months**.

For cleaning proceed as follows :

1. Remove the circular (black, perforated) cover plate by levering it up with a small screwdriver. Insert the screwdriver at the leveled side of the cover plate (fig. 8 and fig. 1, pos. no. 2)



**Figure 8**

- 1 coarse dust filter  
(**Technical change : Coarse dust filters are obsolete since January 2002**)
- 2 cover plate

2. Remove dust and dirt using compressed air or similar, also clean the air outlet slits on back plate.
3. rearrange the parts and fix the cover plate to the front panel.

## 5.5 Manual zero adjustment

M.A.C 2050 automatically performs an auto-zero adjustment, when operating voltage is applied again after it was switched off before (e.g. when control device has been shut off).

In the cases, where M.A.C 2050 works several days **without interruption**, a manual zero adjustment is recommended.

Proceed as follows:

Insert a small screwdriver, paperclip or similar into the hole at the front panel (see Figure 1, position no.6) and push the reset button behind it.

Then M.A.C 2050 starts the sequence described in chapter 3. This sequence includes an auto-zero adjustment.

## 5.6 Recalibration

The internal software of M.A.C 2050 provides the opportunity to recalibrate the instrument.

The recalibration can be done by authorized service personnel or at the factory.

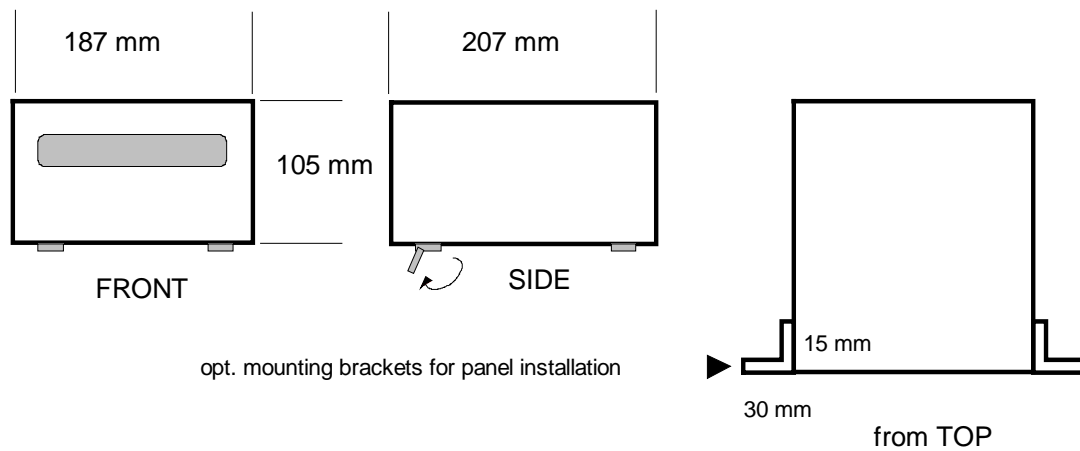
**In case of questions concerning calibration of M.A.C 2050, contact our local representative.**



## 6. Technical data

### Dimensions :

height : 105 mm = 4.13 inch, width : 187 mm = 7.36 inch,  
depth : 207 mm = 8.15 inch



### Weight :

approx. 1.5 kg

### Electric. connection :

14 - 28 V AC, 50/60 Hz  
or 20 - 28 V DC

### Power requirements :

max. 50 W

### Storage temperature range :

- 10°C (+14°F) to + 60°C (+140°F)

### Operating temperature range :

+ 10°C (+50°F) to + 40°C (+104°F)

### Ambient humidity :

0 to 95% relative humidity, non condensing

### Display :

16 digit, 1 line, LC display

### Measuring principle :

physically, optoacoustical IR sensor

### Measurement ranges :

standard type (E) sensor :

0.5 g/m<sup>3</sup> - 6.0 g/m<sup>3</sup> ,

corr. to 70 ppm - 800 ppm <sup>(1)</sup>

optional type (N) - sensor :

35 mg/m<sup>3</sup> - 29.6 g/m<sup>3</sup>

corr. to 5 ppm - 4.000 ppm <sup>(1)</sup>

optional type (G) - sensor :

5 mg/m<sup>3</sup> - 8.9 g/m<sup>3</sup>

corr. to 1 ppm - 1.200 ppm <sup>(1)</sup>

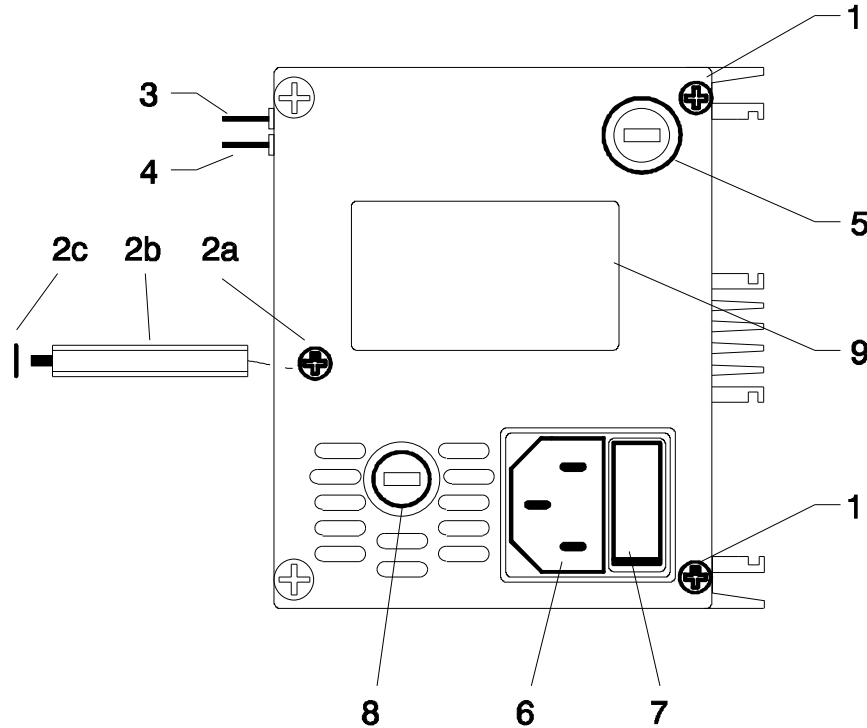
<sup>(1)</sup> referred to PERC at 0°C (+32°F), 1013 mbar (14.69 psi)

For available sensors and substances (gases) contact us or our website.

## 7. Options

### 7.1 AC Power supply 110/230 V AC ( V101)

If no low voltage source for operation of M.A.C 2050 is available, the instrument can be equipped with optional AC power supply V101. In this way the instrument can be also operated by mains (110/220 V AC 50/60 Hz).



**Figure 9**

- 1 mounting screw long 60 mm
- 2a mounting screw short 9 mm
- 2b distance bolt, hexagonal, M3x38 mm
- 2c grounding washer
- 3 connector pin for 24 VAC output
- 4 connector pin for 24 V AC output
- 5 voltage selector 110/220 VAC
- 6 mains plug
- 7 main switch
- 8 fuse 630 mA slow to blow
- 9 identification plate

**Before plug-in of the power cable, make sure that the voltage selector (position 5) shows the right line voltage.**

**Make sure that a short cut between the connector pins positions 3 and 4 is impossible!**



### **7.1.1 Attachment of AC power supply**

1. Remove AC cables from terminal (fig. 2, pos. 11) (if installed)
2. Remove the grounding connection at the ground point (fig.2, pos. 11)
3. Screw together the distance bolt (Figure 9, Pos. 2b) and the intermediate grounding washer (fig. 9, pos. 2c) with ground point.
4. Remove the 2 fixing screws for rear panel (right side)
5. Insert the 2 connector pins (fig. 9, pos. 4) into the input jack of M.A.C 2050 (Figure 9, Pos. 3).
6. Position the AC power supply above the distance bolt at the ground point, turn it a little bit clockwise to let the connector pins pass the terminal. By turning counterclockwise insert the connector pins into the terminal (fig. 2, pos. 7).
7. Tighten the 2 mounting screws, pos.1, carefully.
8. Insert the mounting screw fig. 9, pos. 2a, and screw it on carefully.
9. Check the position of the AC power supply, correct the position if necessary, and fasten all 3 mounting screws.
10. Fix the connector pins Figure 2, Pos. 7 at the terminal.
11. Switch (if necessary) the voltage selector to appropriate position according to line voltage.
12. Insert the mains plug.

Switch on the instrument with main switch fig. 9, pos. 7, if required.

### **7.1.2 Exchange of fuse (optional AC power supply)**

The AC power supply V101 is secured internally by a fuse (5 x 20 mm, 630 mA, slow to blow).

*EXCHANGE  
OF  
AC POWER  
SUPPLY  
FUSE*

Observe the following instructions for exchange of this fuse:

1. Unplug the power cable.

**Never exchange the fuse when the operating voltage is connected!!**



2. Turn the fuse support (fig. 9, pos. 8) counterclockwise using a screwdriver. Take off the fuse support.

- Remove the fuse from the support and exchange it with a new one of the same type.

**Never apply fuses with other values than noticed above!  
Wrong fuses can lead to damage of the instrument !**



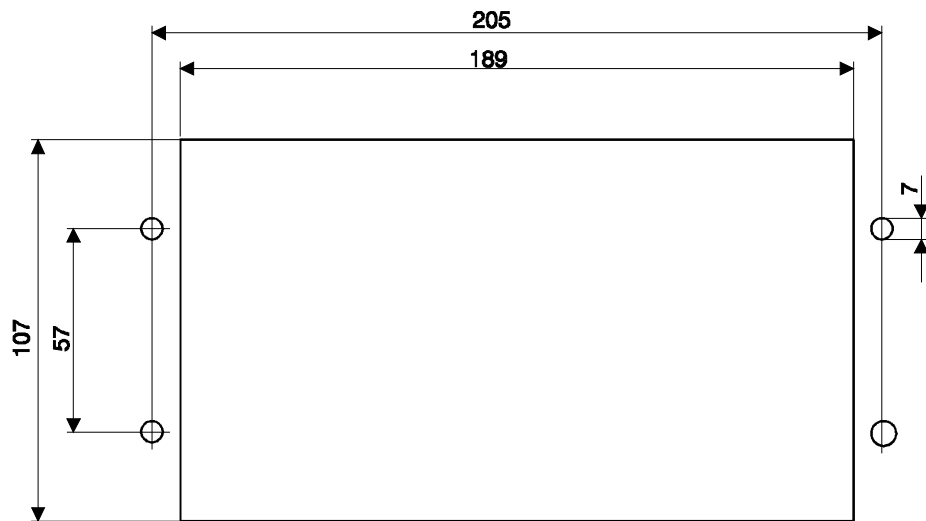
- Insert the fuse support into the AC power supply and turn it clockwise under gentle pressure until it stops. Plug in the power cable.

## 7.2 Brackets (V102) and Grips (V107) for panel mounting of instrument

The optional mounting brackets for integration of M.A.C 2050 into the control panel of a machine and the optional instrument grips are usually installed, when M.A.C 2050 is delivered. Subsequent installation is also possible.

*CUTOUT FOR  
PANEL-  
MOUNTED  
M.A.C 2050*

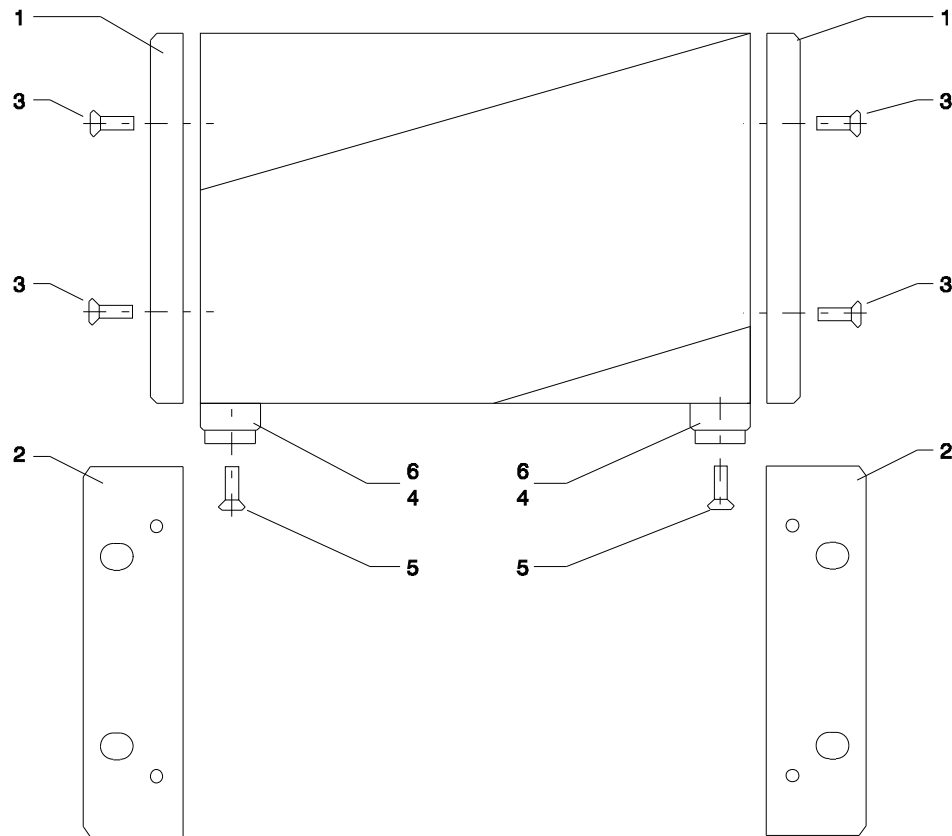
### 7.2.1 Control-panel Cutout



**Figure 10 Cutout for panel-mounted instrument**  
(dimensions in mm)

Clearances for the tubing connections, optional AC power supply (if installed) and ventilation must be given (see chapter 7.2.4, fig. 13) behind the panel.

## 7.2.2 Installation of mounting brackets (V102)



**Figure 11**

- 1 profiles/standard version
- 2 mounting brackets for control panel
- 3 mounting screws for profiles
- 4 instrument bases (front)
- 5 mounting screws for bases
- 6 instrument bases (rear)

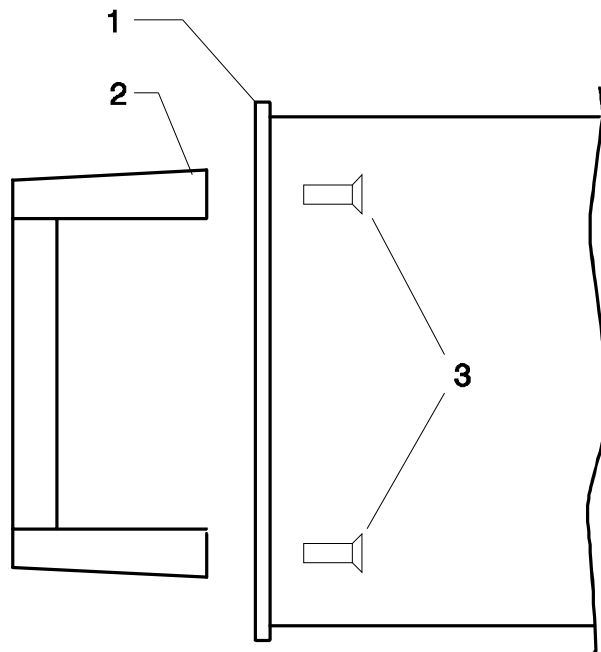
Follow these instructions for the modification of the standard version M.A.C 2050 into the panel-mounted version follow these instructions :  
(all position numbers refer to Figure 11)

1. Remove the 4 screws (pos. 3) and take-off the fitted profiles (pos.1) from the instrument.
2. install the mounting brackets (pos. 2) by fixing the 4 screws (pos. 3).
3. Pull the rubber insertions out of the instrument bases (pos. 4 and 6).
4. Remove the instrument bases by unscrewing the mounting screws (pos. 5)

Now the instrument is ready for integration into the control panel.



### 7.2.3 Instrument grips (V107)



**Figure 12**

- 1 Mounting brackets for integration into control panel
- 2 instrument grip (3 pieces)
- 3 mounting screws for grips

1. Put the grips together (if necessary)
2. Put the mounting screws (pos. 3) through the mounting brackets (pos.1) from rear side and screw it together with the instrument grips (pos. 2).
3. Tighten the screws.

*SUBSEQUENT  
INSTALL. OF  
THE GRIPS*

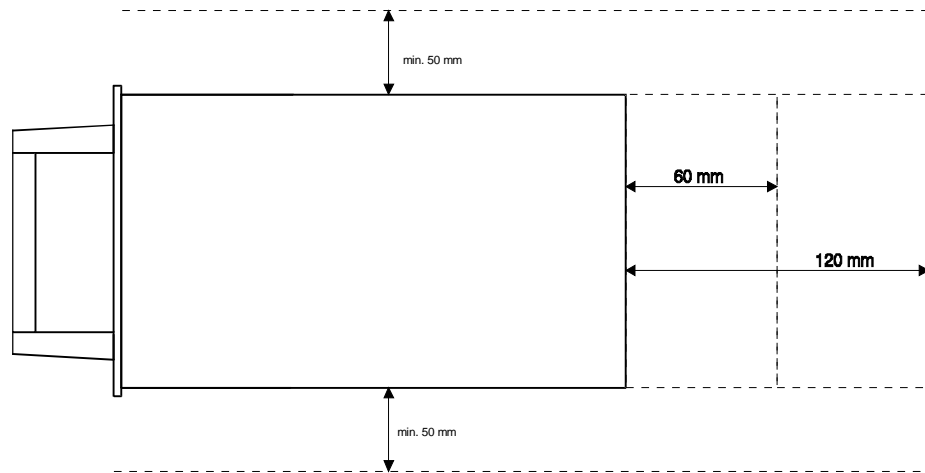
## 7.2.4 Clearances

*DISTANCE  
TO OTHER  
DEVICES*

When M.A.C 2050 shall be built-in to machines etc. a clearance to the surrounding must be given to ensure a sufficient ventilation. This clearance must be **50 mm minimum at the sides, overhead and at the bottom.**

**At the rear side** the clearance must be **60 mm (2.4 inches) minimum** for tubes and power cable connection.

**If the optional AC power supply (V101) is installed**, the distance from the instrument rear side to surrounding devices etc. must be **not less than 120 mm (4.8 inches).**



**Figure 13** Minimum clearances  
( dimensions in mm, 1mm = 0.04 inch )

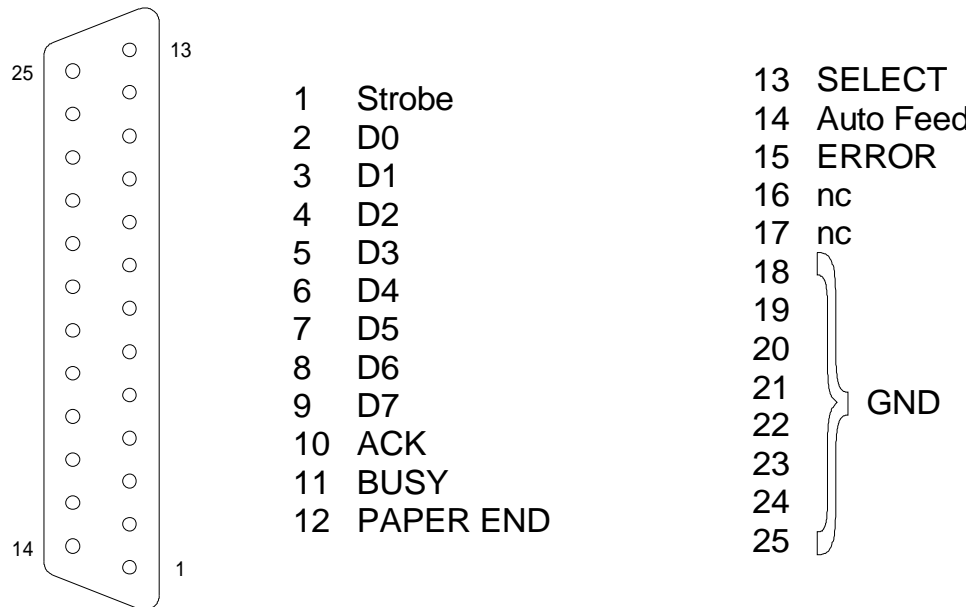
## 7.3 Parallel port (V103)

M.A.C 2050 can be equipped at the factory with an parallel port for connection of an external printer. The pin location (fig. 14) of the female connector at the rear side of the instrument (fig. 2, pos. 4) compatible to the Centronics port. Therefore all PC-printers with Centronics port are connectable.

**The length of the printer connection cable must not exceed 5 meters ( 16.4 feet ) !**

**M.A.C 2050 has no built-in clock. If the printout shall show date and time, the printer must provide these data. (Option V104 miniature printer can provide these data)**

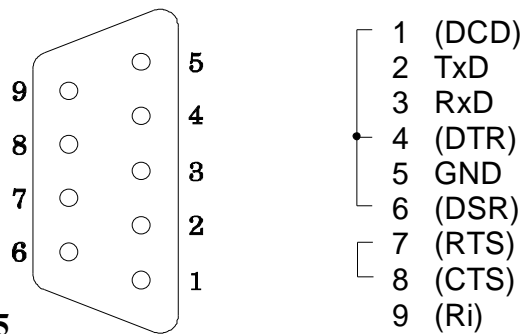




**Figure 14** pin location of parallel port. Female connector, series sub-d, 25 pins

## 7.4 Serial port

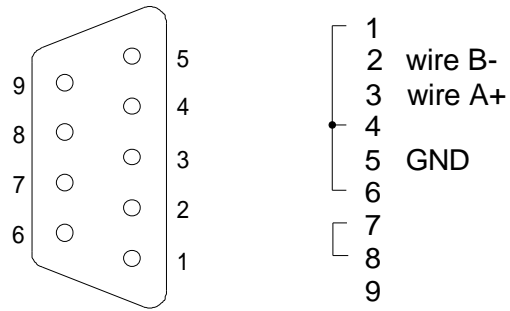
### 7.4.1 RS-232-interface V105



**Figure 15** pin location serial port RS 232, series sub-d, 9 pins

Detailed information is available from the manufacturer on request.

### 7.4.2 RS-485 interface (V106)



**Figure 16**

pin location serial port RS 485, series sub-d, 9 pins

Detailed information is available from the manufacturer on request.

### 7.4.3 Transfer protocol

not included

Detailed information is available on request from the manufacturer.

### 7.5 Cyclic zero adjustment

In those cases, when M.A.C 2050 is operated continuously, it is recommended to activate the built-in program function "cyclic zero adjustment". This can be performed by the factory or by authorized service technicians.

The cyclic zero adjustment is executed in the following manner :

After start of the instrument (e.g. connection to operating voltage) M.A.C 2050 performs the normal measuring program.

When the cycle time is elapsed the normal measuring program stops and M.A.C 2050 executes a cyclic zero adjustment automatically.

(see chapter 3.3.). When the auto-zero adjustment is finished the instrument continues the normal measuring program (or passive mode).

The following intervals (cycle times) are available :

4	hours	or	240	minutes
8	hours	or	480	minutes
12	hours	or	720	minutes
24	hours	or	1440	minutes

It depends on the individual case (business hours, shift work etc.), what interval time the user should choose. He should inform the local representative, what interval time he needs. Otherwise a 12-hour interval time is set as standard by the factory (only if "cyclic zero adjustment" is activated).

## ANNEX A

### Installation :

#### 1. Electrical connection

##### 1.1 Operation by low voltage

Voltage: **14 up to 28 V AC**, Freq. 50/60 Hz

Voltage: **20 up to 28 V DC**

Current : **max. 2.5 A** (at 24V DC)

Power consumption: **max. 50 Watts**

Connect the electrical cables to the terminal at the rear side of M.A.C 2050 (see chapter 1.1.2, fig. 2, position no. 7).

Neglect the polarity.

M.A.C 2050 is protected by an internal fuse. For exchange of this fuse see chapter 4.2.3.

##### 1.2 Operation by mains voltage (optional AC power supply required)

**Voltage :** 110/220 VAC +/- 10%, 50/60 Hz

**Power consumption :** max. 50Watts

The connection should be electrically separated from the machine mains and have its own fuse/circuit breaker. In case of electrical connection with the machine, electromagnetic interferences from the machine can be dragged-in. Therefore such direct connections must be avoided or the equipment must be protected additionally against electromagnetic interferences.

#### 2. Sample gas connection

The suction point and the gas return point must be provided each with a 2/2-way-valve. These valves must be controlled by the machine control device.

Because pressure differences between gas inlet and outlet at the machine will influence the measuring values and, in case they are larger than 50 mb (0.7 psi) could even damage the sensor's microphone.

**Therefore the exhaust gas of the sensor must be returned to the plant very close to the suction point.**



The suction point at the machine must be equipped with a dust filter type 2 (see also chapter 5.3). The filter must fulfill the requirements according to chapter 2. It must be installed directly after the suction point valve. The filter protects the sampling tube to the instrument and the instrument itself against dust and dirt. The deposits of dust and dirt in the sampling tube absorb solvent and this can lead to incorrect measurement results and it takes much longer until the correct values are reached.

All sampling tubes have to be made only from PTFE (Teflon) to avoid absorption and adsorption which may cause faulty measuring values.

**Never use Nylon (polyamide) or silicon tubes !**



The length of the tubes (with a diameter of 4 mm outside and 2,5 mm inside) should not exceed 5 m ( 16.5 feet ) each, because the pumping time and the pumping cycle is tuned to this length. Should sampling tubes for longer distances be required, contact the manufacturer to get information how to proceed.

**Warning:**

**In any case avoid entering of liquid solvent or water into the instrument. The valves and parts of sensor (optical filter and microphone) will be damaged irreversibly.**



**3. Interface cable**

The instrument and the machine are electrically interconnected by an interface cable provided by the manufacturer (see details on the following pages). To avoid EM-Interferences via this cable the shielding has to be grounded on the side of the plant.

#### 4. Installation site

To grant trouble-free operation of the measuring computer, the installation site should be free of vibrations as much as possible. Especially frequencies below 30 Hz must be avoided.

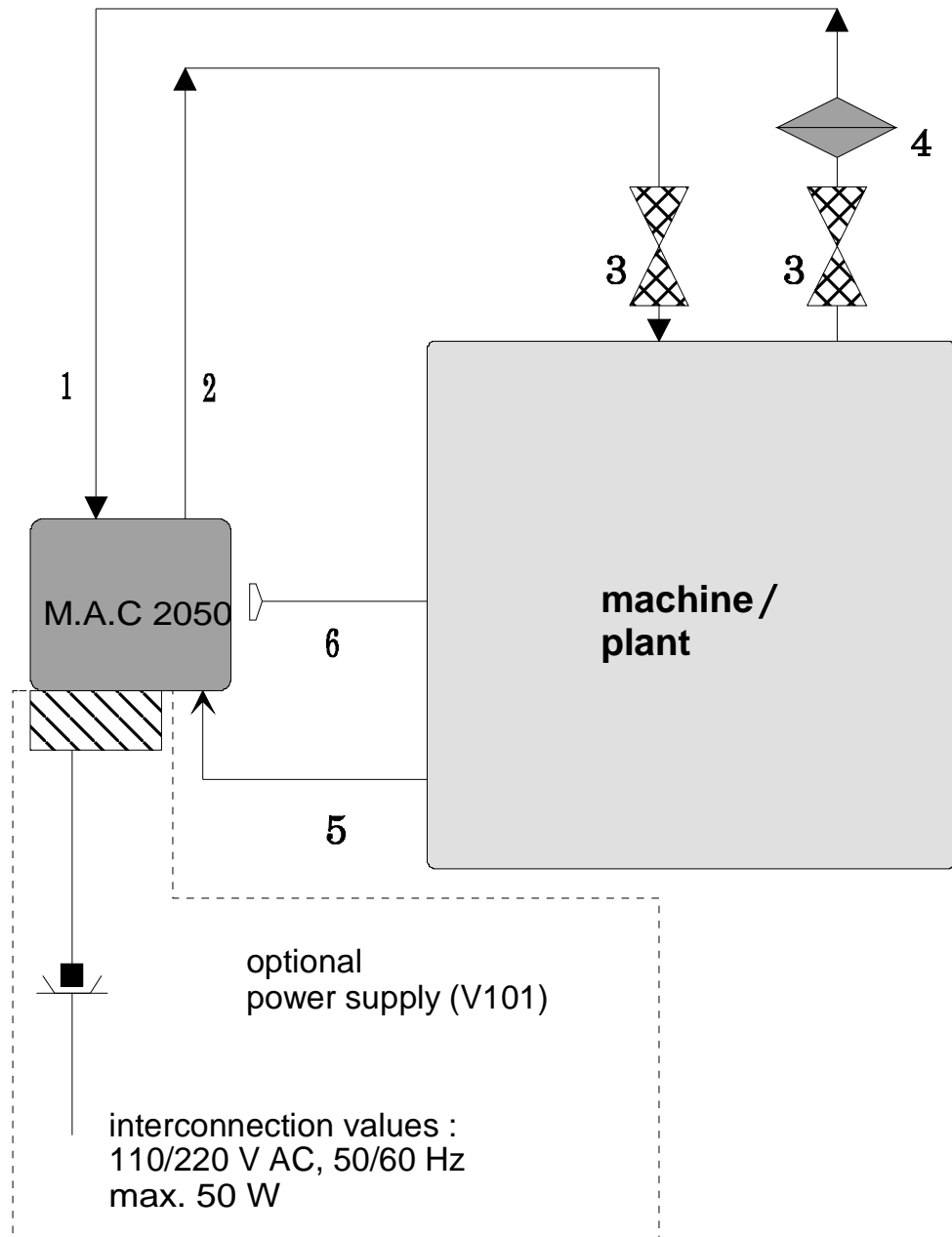
The installation site must allow easy operation of the instrument and good visibility of the indications. The Activated Carbon filter on the front panel must be easy accessible for regular exchange.

The instrument must be placed in a way, that the instrument cooling by ambient air is assured (see also chapter 7.2.4.). The instrument must be protected against heavy dust and watersplash.

Operating temperature range is specified from +10 ° C (50°F) to +40 ° C (104°F). A built-in overheating protection system switches the instrument off, when the **maximum temperature (60°C / 140°F)** inside the instrument is exceeded.



## A1 : Assembly of M.A.C 2050 with machine/plant



**Figure A1**

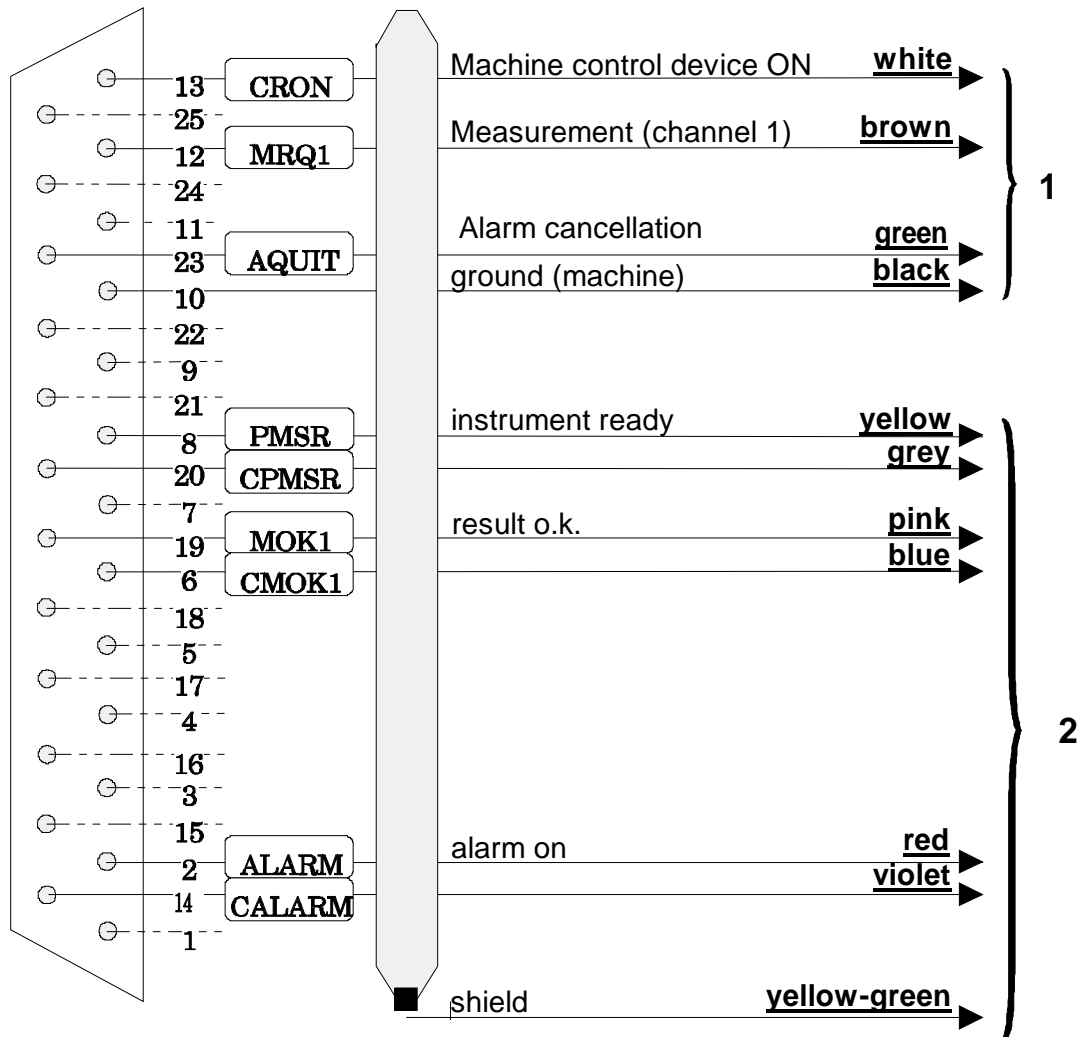
- 1 Sample gas inlet / suction
- 2 Sample gas outlet / return
- 3 2/2-way valves
- 4 Dust filter type 2 (ord.no. G01530)
- 5 Operating low voltage (when optional AC power supply (V101) is **not** installed)
- 6 Interface cable

**All gas tubing made of PTFE (Teflon)  
4.0 mm outer diameter, 2.5 mm inner diameter,  
max. length for standard set-up is 5 m ( 16.5 feet )  
Extended length on request**



## A2 : Pin location of interface cable for M.A.C 2050

(order.no. K02849)

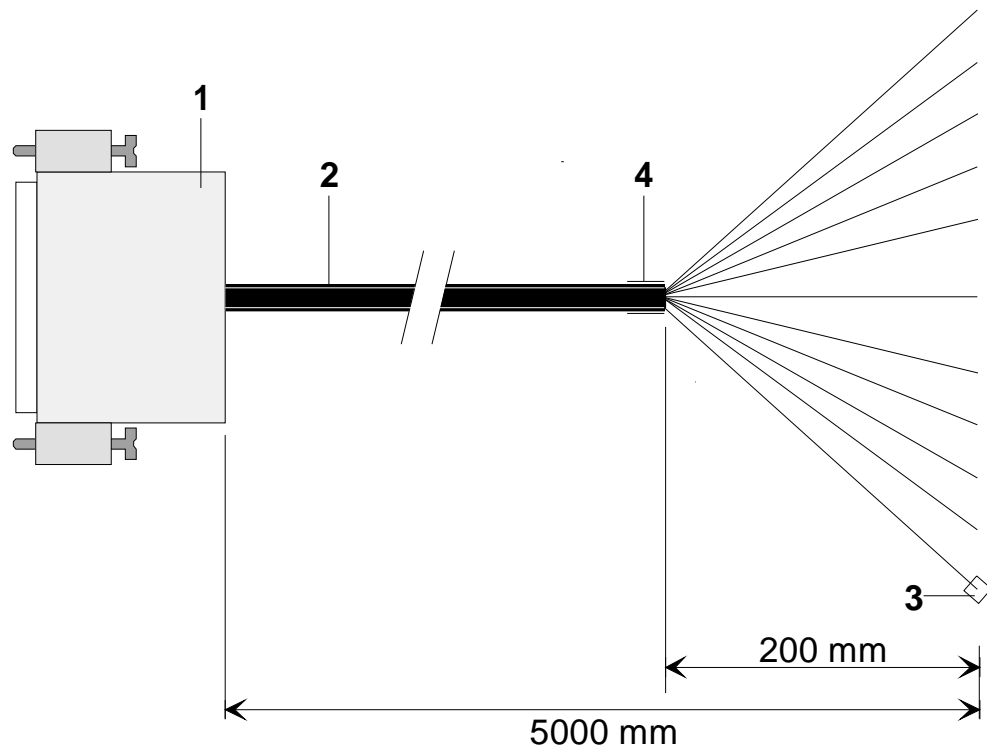


**Figure A2**

connector, female, series sub-d, 25 pins  
 with connecting cable, 10 leads, shielded  
 0.34 mm<sup>2</sup>, 8.5 mm outer diameter  
 total length of interface cable 1 = 5000 mm,  
 200 mm free cable endings.  
 Shield connected to yellow-green wire and  
 protected by shrinking hose sleeve.  
 (1mm = 0.04 inch)

- 1 output from machine, input for M.A.C 2050  
 20 to 28 V DC or 14 to 28 V AC
- 2 output from M.A.C 2050 to machine  
 potential-free contacts  
 normally open  
 max. 0.3 A, 48 V load

**A3 : Standard interface cable M.A.C 2050 - machine**  
Installation kit standard cable assy  
(order.no. K02849)



**Figure A3**

- 1 connector female, series sub-d, 25 pins
- 2 connecting cable, 10 leads, shielded, 0.34 mm<sup>2</sup>, 8.5 mm outer diameter (1mm = 0.04 inch)
- 3 shield ( yellow-green )
- 4 shrinking hose

#### A4 : Description of interface M.A.C 2050 - machine control device

- a) **signal outputs from control device (machine, plant etc.) to M.A.C 2050 :**

<b>Description</b>	<b>designation</b>	<b>24 V on Pin no.</b>	<b>GND on Pin no.</b>	<b>Action M.A.C 2050</b>
Machine/control ON	CRON	13	10	Switches from Stand-by to READY
Measurement is requested	MRQ1	12	10	Starts measurement Pin 6+19 open
alarm was stopped	AQUIT	23	10	Alarm is cancelled Pin 14+2 open

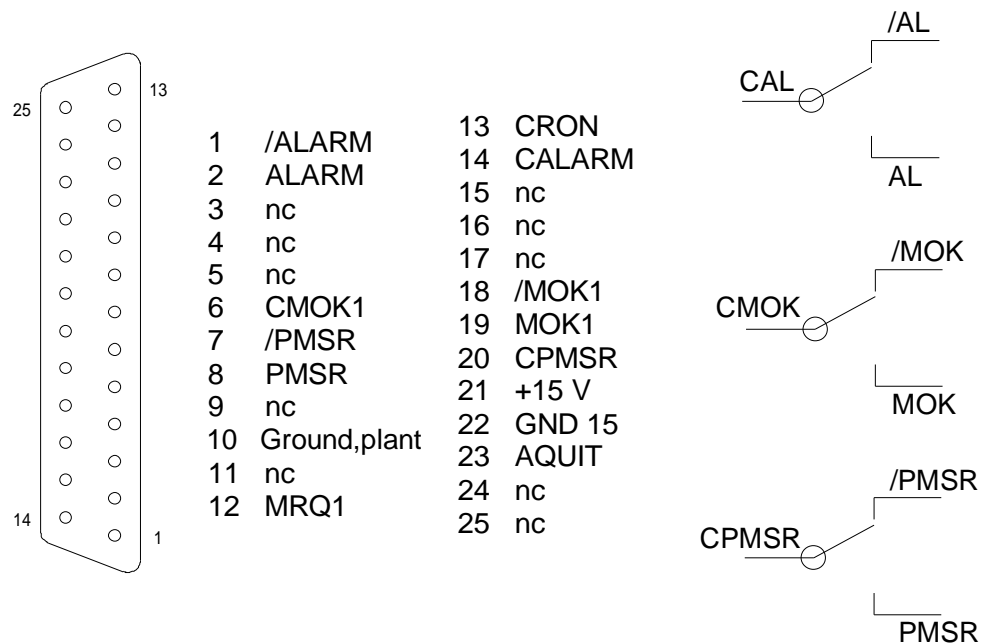
- b) **signal outputs from M.A.C 2050 to control device (machine, plant etc.) :**

<b>description</b>	<b>designation</b>	<b>output</b>
M.A.C 2050 is ready for measurement	PMSR	pin 8+20 closed
meas. result is < limit	MOK1	pin 19+6 closed
alarm or malfunction	ALARM	pin 14+2 closed

notes :

- 1.) Voltage on CRON,MRQ1 can be 14 to 28 V AC as well as 20 to 28 V DC
- 2.) Max. approved load on output contacts is 0.3 A at 48 V.
- 3.) M.A.C 2050 stops the alarm automatically after 1 minute : pin 14+2 open

## A5 : Pin location of machine interface at M.A.C 2050



**Figure A5**

Outputs from machine control device, inputs at M.A.C 2050  
 20 to 24 V DC or 14 to 28 V AC  
 pins 12, 13, 23 against ground pin 10

outputs from M.A.C 2050, inputs at machine control device,  
 potential-free contacts  
 Pins 1, 2, 14 (Alarm)  
 Pins 6, 18, 19 (MOK1)  
 Pins 7, 8, 20 (PMSR)

max. 0.3 A, 48 V

**Warning :**

**The voltage (15 V DC) applied to pins 21 (+15V) and 22 (GND 15) are provided exclusively for the interface tester G1289 (see chapter 4.2.1)! Never connect any other external devices ! It would be galvanically connected to the instrument's electronics !**

**When a short cut occurs the fuse will be blown and must be exchanged (see chapter 4.2.3.).**



## ANNEX B : Conversion of concentration units mg/m<sup>3</sup> ⇔ ppm

### Definitions :

1.) Mass concentration, unit mg / m<sup>3</sup> :

The mass concentration specifies the composition of a mixture. Because the volume of a gas highly depends on temperature and pressure, the mass concentration also highly depends on temperature and pressure as well. Therefore temperature and pressure must be specified when the mass concentration is indicated.

2.) Volume concentration, unit ppm :

The volume concentration specifies the composition of a mixture as volume of the substance referred to the total volume.

ppm means "parts per million".

(e.g. : the volume of the substance in cm<sup>3</sup> (ccm)

in 1 m<sup>3</sup> ( 1 cbm) = 1 million cm<sup>3</sup>)

### Conversion of the units :

The relation between temperature, pressure, volume and mass of the substance used in M.A.C 2050 standard version is :

$$P \cdot V = m / M \cdot R \cdot T \quad (\text{ideal gas law})$$

P : pressure ( atmospheric pressure )

V : volume

m : mass of the measured component

M : molar mass of the measured component

R : universal gas constant

T : absolute temperature

### Conversion table :

The following table shows the conversion factors for PERC ( Tetrachloroethylene), Trichloroethylene, Dichloromethane and CFC11 (Fluorotrichloromethane) :

Substance	Conversion factor x at 1013 mbar (14.69 psi), and 0°C (32°F)	Conversion factor y at 1013 mbar (14.69 psi), 0°C (32°F)
	mg/m <sup>3</sup> = x • ppm	ppm = y • mg/m <sup>3</sup>
PERC	7,403	0,1351
Trichloroethylene	5,366	0,1864
Dichloromethane	3,792	0,2637
CFC 11	6,133	0,1631