INSTRUCTION MANUAL

Gas Monitor
M.A.C 2040

Revision April 2007
Subject to change without notice

ppm Messtechnik

Your Contact:

Your local Representative:

Safety Instructions

Please read these safety instructions carefully and make sure that you understand them fully before you start operating the Measuring Computer M.A.C 2040.

APPLYING POWER
Before using the Measuring Computer, check that the available mains voltage is within the specified range of the instrument.

AVOID LIQUID CONDENSATION INSIDE THE MEASURING CHAMBER

Liquids must be prevented from entering the measuring chamber!

It is therefore important that warm, humid or saturated gases are not drawn into a could measuring chamber because condensation will occur. In such a measurement situation, one should ensure that the gases are drawn through a water-trap filter before they enter the Measuring Computer.
The water-trap filter should be used in the immediate environment of the instrument to ensure that its temperature is never higher than in the measuring chamber. In this connection, it is important to let the Measuring Computer warm up before starting a measurement.

Some gases may be absorbed by the water trapped in the filter. This will reduce the gas concentration.

EXPLOSION HAZARD
The Measuring Computer M.A.C 2040 is not designed for use in potentially explosive environments.

Never place and operate the instrument in areas with a potentially explosive atmosphere!

When monitoring potentially flammable or toxic gases it is essential that:

- the instrument itself is placed in a well-ventilated area outside the potentially hazardous zone; and
- that a sufficiently long tube is connected to the gas return outlet on the back panel so that the sampled gas is carried away to the open air or to an extraction and/or filtration unit.

TABLE OF CONTENTS

1. General Instructions 1
1.1 Indications 1
1.2. Transportation/ Storage/ Unpacking 1

2. Description of Measuring Computer M.A.C 2040 2
2.1 Instrument layout 2
2.1.1 Front view 2
2.1.2. Rear View 3
2.1.3. Lateral View 3
2.2 Description of function 4
2.2.1 Measuring principle 4
2.2.2 Description of sensor function 5
2.2.3. Equipment Diagram (schematic) 6
2.2.4 Description of equipment function 7
2.3 Supplier-based configuration 8
2.4 Adaptations at customer's facility 8
2.4.1 Adjustment local time/ date 8
2.5. Technical data 10

3. Mounting and Installation 11
3.1 Mounting 11
3.2 Installation for plant control. 11
3.2.1 preparations at machine 11
3.2.2 Measuring instrument 12

4. Start-up 14

5. Operation 14
5.1 Self-testing of instrument 15
5.2 Warm-up period 15
5.3 Zero adjustment 16
5.4 Automatic measurement operation 18
5.5 Externally controlled measurement operation 18
5.6 Measurement process 19

6. Operational Failures 22
6.1 Messages on instrument display 22
6.1.1 Warning messages 22
6.1.2 Failure messages 23
6.2 Communication problems between instrument and plant control 27
6.2.1 Errors caused by plant control 27
6.2.2 Error on interface cable 28
6.2.3 Error on measuring computer - interface module 28

7. Maintenance 29
7.1 General hints 29
7.2 Exchange of Activated Carbon filter 29
7.3 Exchange of sample gas filters (dust filter) 31
7.4 Exchange of instrument fuses 32
7.4.1 Fuse in power supply assembly 32
7.4.2 Fuse on MG/MIF-Assembly 33
7.4.3 Fuse on Printer Module (Option V214) 34
7.5 Calibration of Instrument 34

8. Options 35
8.1 Integrated dot matrix printer V214/V226) 35
8.1.1 Printing Options 35
8.1.2 Replacing the paper roll and the ribbon cartridge 36
8.2 Parallel Interface V216 38
8.3 Serial interface 39
8.3.1 RS-232C Interface (option V105) 39
8.3.2 RS-485 Interface (option V106) 40
8.4 Analog-outputs 41
8.4.1 Options V218/V219 - analog recorder output 0-20mA / 4-20mA 41
8.4.2 Option V220 - analog recorder output 0-10V 43
8.5 Option V230 - Additional Memory (SRAM-Card) 43
8.5.1 Storage of average values 44
8.5.2 Obtain information about occupancy of storage space on Memory Card 46
8.5.3 Readout and erasure of Memory-Card 46
8.5.4 Exchange of Lithium-Battery 46

Annex A : Installation a1
1. Installation site. a1
2. Electric connection a1
3. Sample gas connection a2
4. Interface Cable a3
A1 : Connection of Instrument to Machine/Plant a4
A2 : Pin Assignment of Standard-Interface-Cable for M.A.C 2040 ..... a5
A3 : Standard-Interface-Cable between M.A.C 2040 and Machine a6
A4 : Description of Interface M.A.C 2040 - Plant Control a7
A5 : Pin Assignment of Machine-Interface Connector M.A.C 2040 ..... a8

Annex B : Available sensors a9

Annex C : Conversion of concentration units mg/m³ ⇔ ppm a10
Definitions : a10
1.) Mass concentration, unit mg / m³ : a10
2.) Volume concentration, unit ppm : a10
Conversion of the units : a10
Conversion table : a10

1. General Instructions

1.1 Indications

This manual has to be read carefully before switching on the instrument. The instructions must be strictly adhered to.

Non-observance of these instructions may lead to the loss of right to claim for damages or warranty !

Meaning of signs used in this instruction manual:

 : warning

 : indication of particular importance

 : avoid actions marked with this sign

CATCHWORDS appear in italics on the right hand margin

1.2. Transportation/ Storage/ Unpacking

During transportation please make sure that the instrument is being protected against violent shocks or impacts. Transportation of instrument should as a matter of principle only be made in original cardboard box containing shock absorbing elements. When storing the instrument for a longer period of time , it should be wrapped in a plastic hood together with a silica gel bag for protection against humidity. During storage or transportation exposure of the instrument to temperatures below - 10° or higher than +60° C must be avoided.

TRANS-PORTATION DAMAGES?

Immediately after unpacking the instrument should be visually inspected for external damage which might have been caused to it during transportation. In the event of such damage, the supplier has to be informed immediately and the instrument must not be switched on by any means.

2. Description of Measuring Computer M.A.C 2040

2.1 Instrument layout

2.1.1 Front view

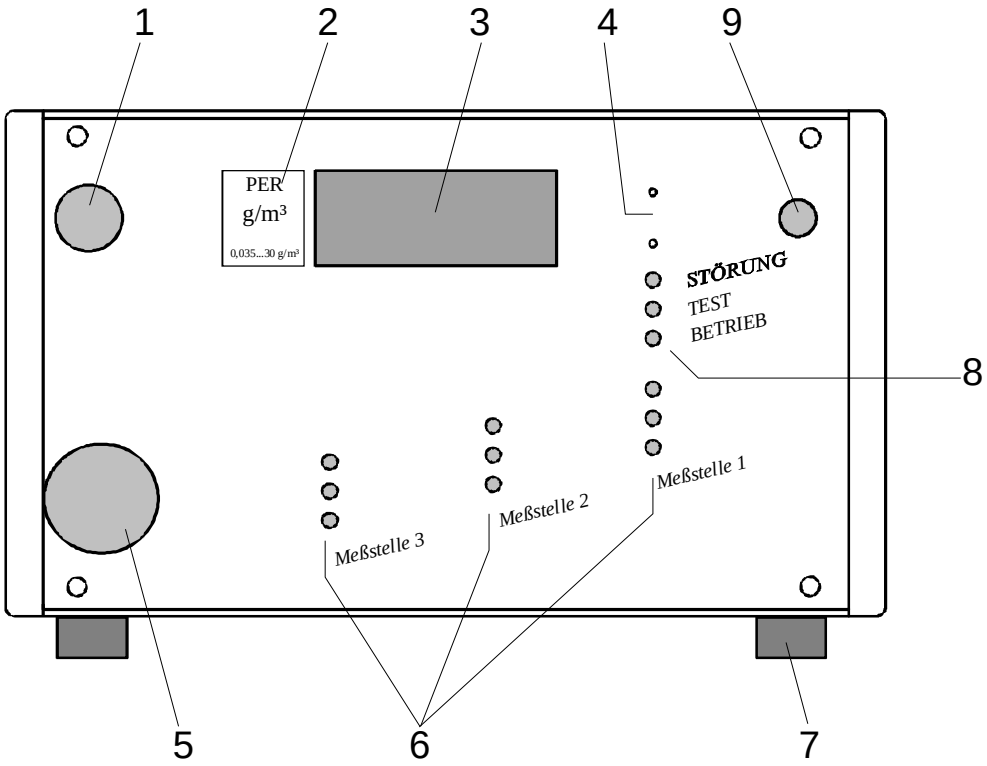


Fig. 1 Front View

1 mains switch
2 label indicating substances and instrument range
3 LED-Display
4 pushbuttons (behind front panel) for instrument setup
5 cover activated carbon filter
6 measurement channel status display
7 instrument base
8 instrument status display
9 service interface

2.1.2. Rear View

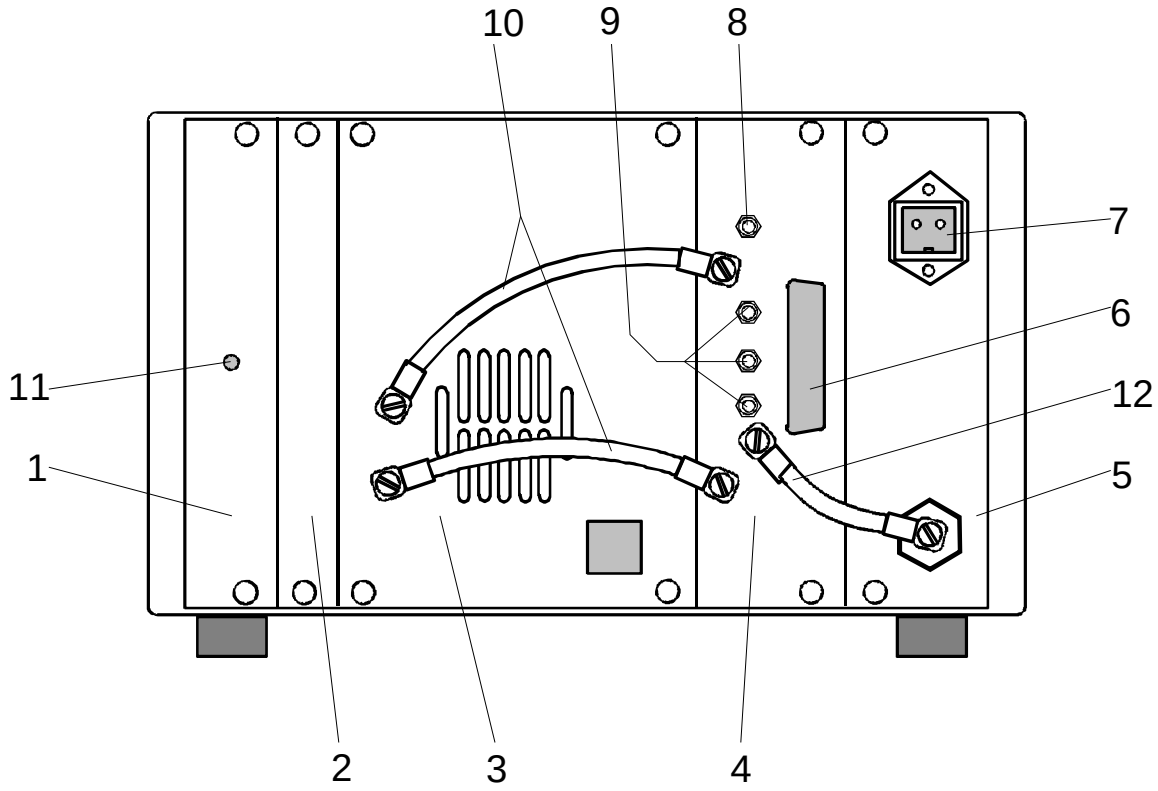


Fig. 2 Rear View

1 CPU-Assy
2 optional equipment (analog output, parallel interface ...) or blind plate
3 Sensor-Assy
4 MG/MIF-Assy
5 Power Supply Assy
6 SUB-D-connector machine interface
7 connector for mains power
8 gas outlet
9 gas inlets (1...3)
10 tubing MG/MIF - Sensor
11 Reset-button
12 tubing MG/MIF-activated carbon filter

2.1.3. Lateral View

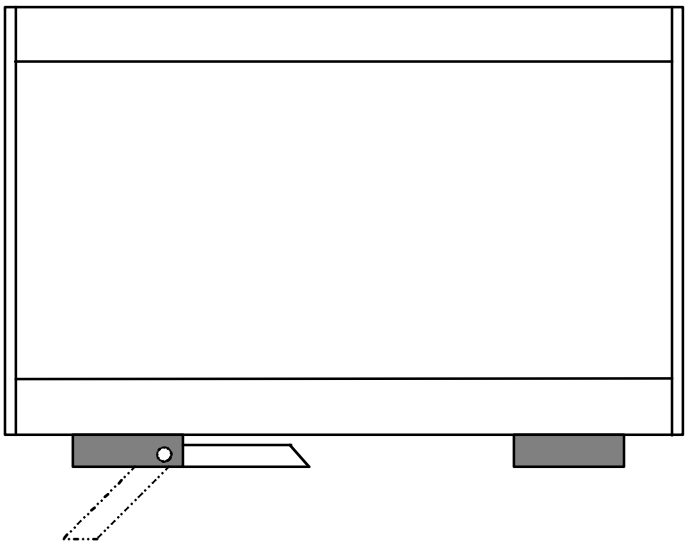


Fig. 3 Lateral View

2.2 Description of function

2.2.1 Measuring principle

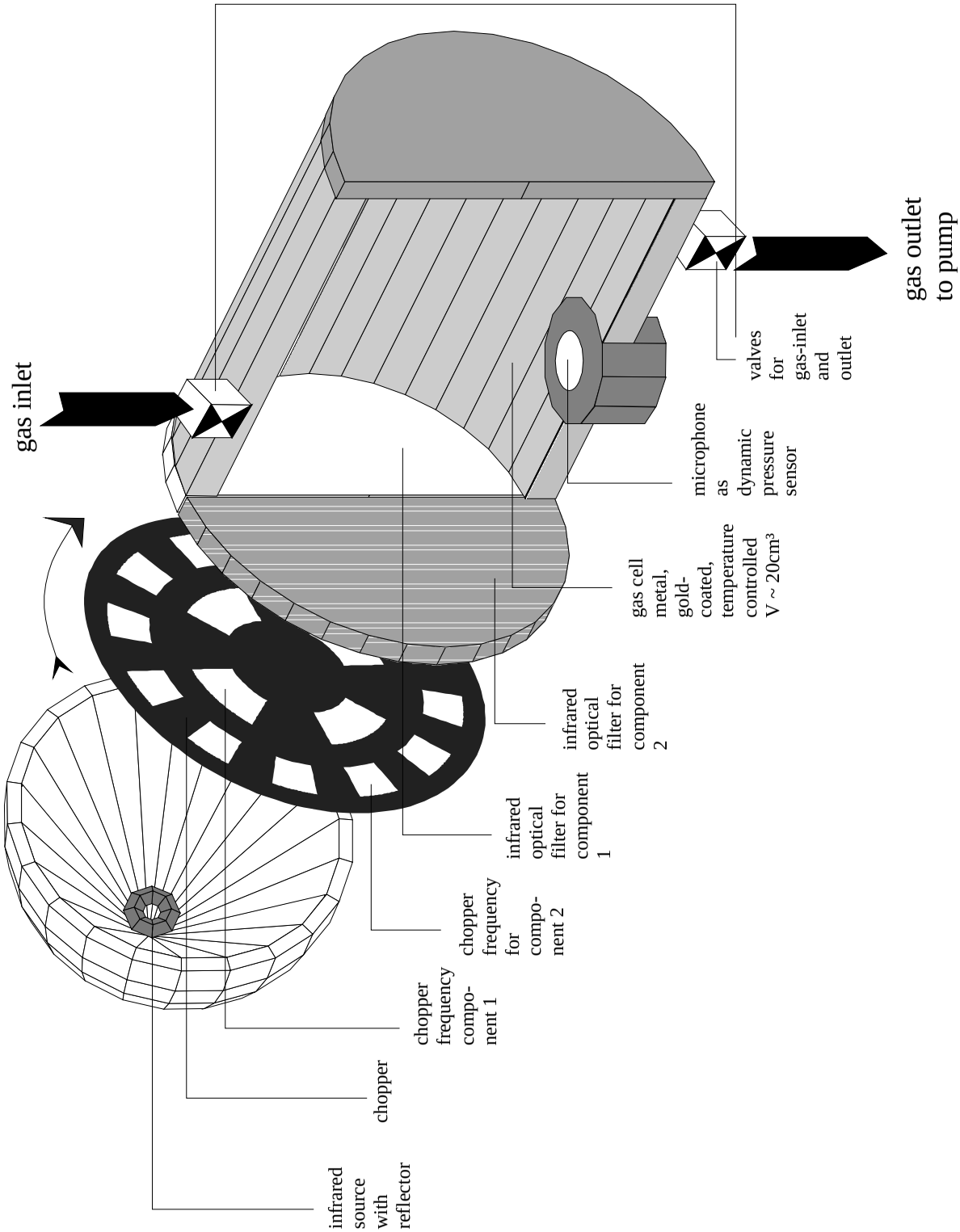


Fig. 4 Measurement principle

2.2.2 Description of sensor function

In Measuring computers M.A.C 2040 a sensor is being used which operates on the principle of

Infrared - Optoacoustics.

By means of which the physical quality of many gases to react to electromagnetic waves (for instance infrared rays) is being exploited as they respond to a single (or to several) wave length(s) specific to every kind of gas as well as absorb such energy. A side effect of this process permits the use of a measuring microphone which serves as a signal converter. This technique is being described in more detail hereafter.

PRINCIPLE

An infrared radiation source emits IR-radiation of a wide range of different wave lengths. Typically two optical filters permit the passage of only two defined wave lengths of small band width from the radiation source's spectrum. Those two defined bandwidths are each characteristic for the gas components 1 and 2 to be determined . At those wave lengths the gas components will absorb IR-radiation. A rotating shutter (Chopper) between radiation source and gas measuring cell causes periodical interaction (rectangular signal) of IR-rays on the gas to be measured. The chopper design as depicted is such that each component generates its own intermitting frequency differing from the other one. This permits exact attribution of the measuring signals to the specific gas under test.
In case the gas measuring chamber contains molecules which are sensitive to the wave lengths passing the optical filter, such molecules will be excited by the periodical radiation impulses which means they absorb energy and warm up briefly the gas in the test chamber as long as the chopper aperture permits radiation to pass. The gas will cool down immediately, however , as soon as the chopper stops passage of radiation. The previous described cyclic interactions will generate pressure impulses in the (closed) test chamber , whose intensity is proportionate to the gas concentration contained. The pressure impulses will then be converted into electric signals by a measuring microphone. The electronic evaluation unit will filter and amplify the transmitted overlapping electric signals and from a plurality of individual measurements it will determine a final value separately for each gas component. Based on those final values the concentrations of gas components 1 and 2 are being calculated via calibration functions characteristic for every sensor and filed in the measuring computer's configuration library. The measured data (concentrations) are then being displayed and being available for printout, transfer and storage.

2.2.3. Equipment Diagram (schematic)

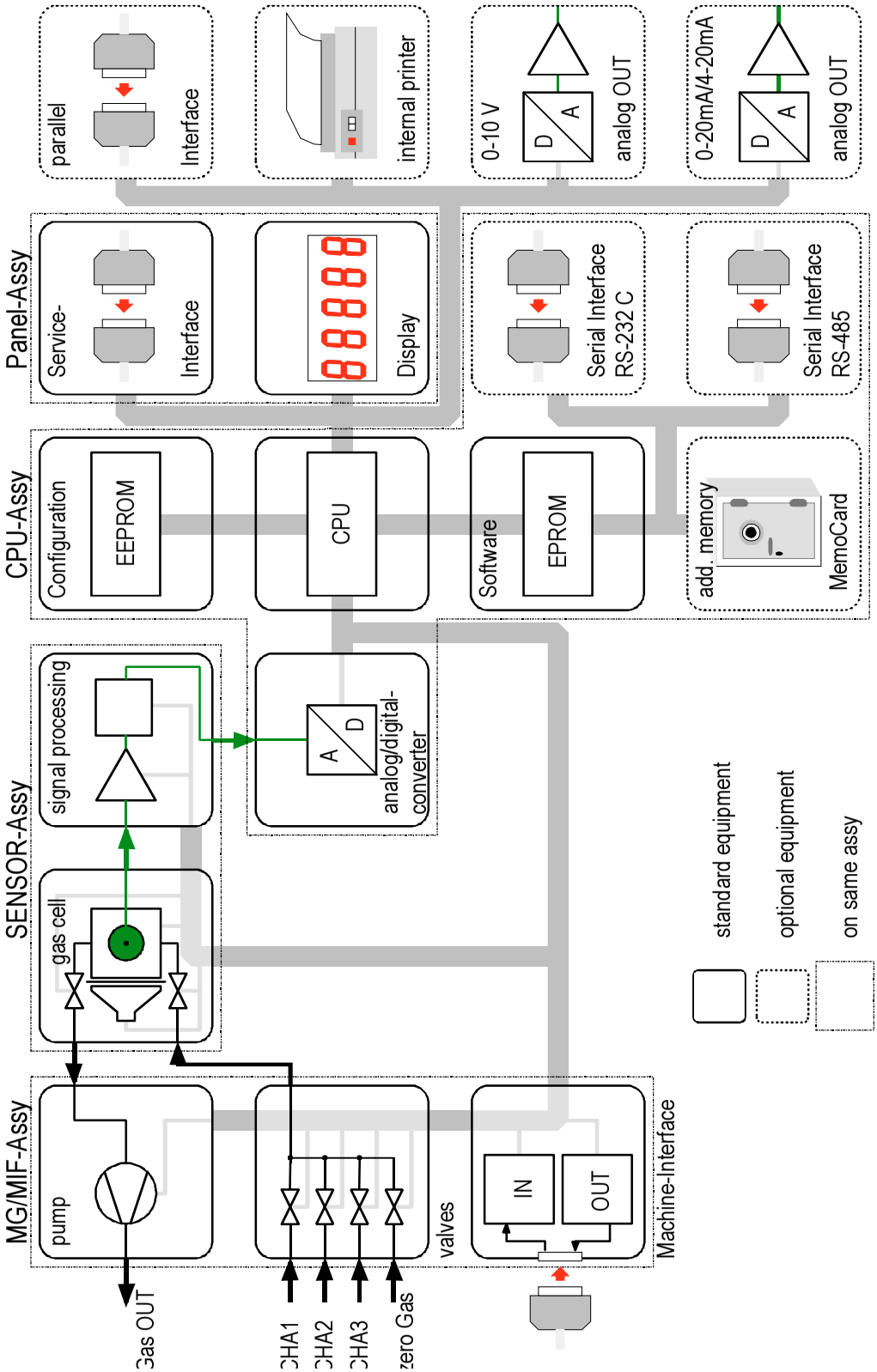


Fig. 5 Equipment Components Diagram

2.2.4 Description of equipment function

Main purpose of instruments type M.A.C 2040 is the measuring of gas concentrations in plants, workrooms and the ambient air M.A.C 2040 instruments are equipped with between 1 and 3 gas sampling inlets, which may be controlled either automatically by the equipment software or by an external control unit (of an installation or machine).The limiting values (alarm levels) for each measuring channel may be set separately in correspondence to existing requirements.
For measurement of the gas concentration at the selected measuring channel the gas to be analyzed is being sucked into the sensor (active sample extraction) by a built-in diaphragm pump via a dust filter and the measuring gas tube. The valves installed in the test chamber are being closed after there. During the measuring process which lasts about 10 seconds as a standard, a large number of individual measured data is being integrated. The resulting values show up on the display consecutively for comparison with the limiting value applicable to the actual measuring channel. After termination of the measuring procedure the test chamber is being flushed with the new actual gas in preparation for the next test sequence.
A complete cycle takes about 20 seconds as a standard. An evaluation of the comparison: limit values vs. measured values takes place after a certain delay preset by the equipment software in order to avoid incorrect readings eventually caused by momentary oscillations of gas concentration.
In case the comparative evaluation shows values below the given limit the connected plant/machine control is being informed by closure of a measurement channel related potential free relay contact. The corresponding optical „STOP - GO " indicator will signal "below limit" (green light). Exceeding of preset limit will lead to omission of contact and the red light will be on. Quitting the measurement channel in this state will cause the optical and additionally an acoustic signal to go to the alarm state, an alarm contact being activated. When switching from one measurement channel to the other or from any test channel to the stand by mode, an built-in printer(Option !) will print out automatically the last measured concentration and in addition the evaluation in reference to the preset limit. In addition average values of gas concentration over certain time intervals may be established and printed out subsequently. A Memory Card (Option!) will permit long time accumulation of average concentration values as well as facilitate access to their evaluation and storage outside of the instrument.

2.3 Supplier-based configuration

For best possible adaptation of instrument to the envisaged task the following parameters of the configuration may be determined by the customer for their integration at the factory or by authorized service personnel.

⇒	alarm thresholds	(in g/m3)
⇒	operating mode	(externally controlled or automatic measuring operation)
⇒	cyclic zero value measuring	(activated, not activated, time intervals)
⇒	reference temp. and -pressure	Standard: 0 °C and 1013 mbar
⇒	time for measuring cycle	Standard: 20 seconds

The changing of operating mode and/or of cycle time requires exchange of standard software against special software.

2.4 Adaptations at customer's facility

2.4.1 Adjustment local time/ date

At the right-hand side of the display and above the test indicator light two switches are to be found behind two small bores in the front plate. These switches may be activated with a simple slim screwdriver or with a similar tool (Fig. 1, item 4) in order to set for instance exact local time and calendar date.
The setting of time and date is achieved by following steps:

- Switch off instrument
- Keep upper switch in pressed down position and switch on instrument

  The instrument display will read as follows:

  1 = mode "set hours" XX = hours

- At the upper switch any full hour between "00 and 23 "may be selected and set
- Confirm the hour set by briefly pressing the lower switch

The instrument display will then read as follows:

2 = mode "set minutes" XX = minutes

- With the upper switch any setting of minutes between "00" and "59" may be selected
- Confirm the minute(s) set by briefly pressing the lower switch

The display reading will then go to

3 = mode "set day" XX = day

- Select any desired day between "01" and "31" on the upper switch
- Confirm calendar day set on lower switch with brief pressure

Next reading on the instrument display will be:

4 = mode "set month" XX = month

- Select any desired month between "01" and "12“ on upper switch
- Confirm this input with brief pressure on lower switch

What appears next on the display is:

5 = mode "set year" XX = year

- Select with the upper switch any appropriate figure between „95" and "10" to mark the actual year of operation within the time period from 1995 until year 2010
- Confirm that input with lower switch too.

- At this point three brief beeps will confirm the entered adaptations
- The instrument will continue with normal start-up.

2.5. Technical data

Dimensions :	Height approx.:	135 mm = 5.31 in
	Width (standard unit) approx.:	235 mm = 9.25 in
	Depth approx. :	225 mm = 8.86 in
	with integrated printer width is approx.:	320 mm = 12.6 in
Weight :	approx. 4 kg (standard unit)	
Electrical mains :	115/230 Volts AC, 50/60 Hz	
Power consumption :	max. 45 Watt with integrated printer :max. 65 Watt	
Temperature range :	during storage: between approx.	-10°C to +60°C (+14°F to +140°F)
	during operation: between	+10°C to +40°C (+50°F to +104°F)
Air moisture range:	0 to 95%, non condensing relative humidity	
Digital display :	5-digits, 7-segment-LED-display	
Measuring principle :	physical, infrared spectroscopy, opto-acoustic sensor	
Measuring range : (typically)	standard sensor (E) : 0,5 g/m³ - 6,0 g/m³ resp. approx. 70 ppm - 800 ppm(1) optional sensor (N) : 35 mg/m³ - 29,6 g/m³ .5 ppm - 4.000 ppm(1) optional sensor (G) : 5 mg/m³ - 8,9 g/m³ resp. approx. 1 ppm - 1.200 ppm(1)	

(1) data for PERC, at 0°C, 1013 mbar

3. Mounting and Installation

3.1 Mounting

MOUNTING SITE

In order to assure trouble-free functioning of the instrument, mounting it at a site as free of vibrations as possible is of essence. The instrument should be kept at a safety distance of at least 5 cm away from all surrounding walls to ensure free airflow for cooling of the equipment (see also chapter 3.2.2 for reference).

Exposure of the instrument to low frequency vibrations(up to 30 cycles per seconds) is to be avoided

The instrument has been specified for an ambient temperature range from +10°C (+50°F) up to +40°C (+104°F). Condensation of air moisture inside the instrument is to be avoided.

FILTERS

For protection of valves and measuring chamber against pollution all measuring points have to be provided with appropriate filters. The filters must be installed right after the valves of the machine or at the gas-intake pipe respectively

Suitable filters are of such quality that they will neither adsorb molecules of the gas components to be measured in the filter housing nor in the filter element itself. Moreover will they permit filtration of particles the size of 5 micrometers.

3.2 Installation for plant control.

3.2.1 preparations at machine

Installation of the instrument has to be carried out in accordance with instructions lined out in **Annex A.**

LENGTH OF GAS TUBING

It should be noted that the measuring computer has been laid out for measuring gas line lengths up to 5 m (16 ft) of PTFE-hose (of 4/2,5 mm diameter). In case there should exist a requirement for hoses of a different length or diameter, then the necessary steps have to be coordinated with pfm before installation.

MACHINE INTERFACE

Communication between measuring computer and machine control device normally takes place via the machine interface. Inputs and outputs are assigned to Sub-D-Connector (rear panel of instrument), see fig. 2, item 6. The connector assignment as well as the denomination of the signals are depicted in **Annex A, fig. A2, A4, and A5.** The inputs are galvanic separated from the measuring instrument by means of an optocoupler.
The outputs consist of potential free relay contacts. The interface connector is connected with the machine control or with another sort of control via the interface-cable. (Please refer to **Annex A, fig. A2 and A3)**.

The communication between Measuring computer and machine control may also be performed via the serial data interface RS-232C/RS-485. For this purpose the standard software would have to be exchanged against a special software.

3.2.2 Measuring instrument

INSTALLATION AT MACHINE CONTROL PANEL ETC.

For integration into control panel of machine or similar location
The intended installation site should offer following environment:

1. ambient temperature between +10°C and +40°C (+50°F to +104°F)
2. lowest possible vibration level
3. unimpeded airflow to integrated instrument cooling fans

When mounting instrument in machine panel maintain free spacing (distance to other instruments, switchboard, cabinets etc.) of at least 50 mm (2 in) laterally, on top and below. At the rear end at least 60 mm (2.4 in) of free space must remain for connection of control cable and for gas tubes.

The reduction of the clearance around the instrument may lead to overheating and logically to malfunction or total failure of measuring computer!

Installation of the instrument has to be carried out in accordance with the instructions given in **Annex A**.

Electric connection

The electric mains for M.A.C 2040 must meet the following requirements:

Nominal voltage	115 / 230 Volt A/C (if printer is integrated, pay attention to preset supply voltage!)
frequency	50 or 60 Hz
power consumption	max. 45 Watt without integrated printer, (with integrated printer max. 65 Watt)

Before connecting instrument to electric mains verify if supply voltage meets those requirements and if it has been expertly fuse protected. Incorrect voltage may cause the fuse of the instrument to blow or damage the instrument itself.

WARNING ! HIGH VOLTAGE!

Prior to opening up of instrument for any reason, its main power supply cable must be unplugged!

Sample gas connections

The sample gas inlet and outlet of M.A.C 2040 are shown in **Chapter 2.1.2, fig. 2, items 8 and 9**.
Additional detailed information concerning sample gas tubes, installation of dust filter and about sampling of measuring gas is given in **Annex A**. Periodical changing of filters is described in **Chapter 7**, Maintenance.

Installation of filters and undue extension of maintenance intervals will inevitably lead to malfunctions or to damages on the measuring instrument !

In order to avoid clogging of valves or contamination of measuring chamber, the instrument should only be operated with appropriate filters installed right behind the valves at the measurement point!

4. Start-up

Before connecting the instrument to the main, make sure that supply voltage strictly corresponds to the requirements detailed in **Chapter 3.2.2**.

Before starting-up the instrument, remove from instrument the transportation safety device of the printer and the dust seals from the measuring gas inlets and outlets. Also check the existence of the zero gas filter.

Now you may start the instrument by activating the Master Switch on the instrument front panel (fig. 1, item 1).

5. Operation

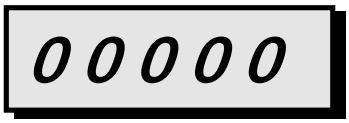
As soon as the instrument has been connected to the mains and switched-on, it will automatically run through the following routine before starting the actual measuring operation :

- **Self-Testing**
- **Warm-up period**
- **Auto-zero adjustment**

After switching on the instrument the L/C display will indicate

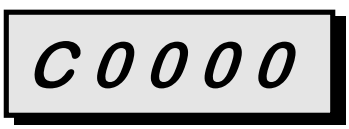
meaning a panel test is on-going.

The subsequent indication



signalizes a brief automatic self-test

and with



the warm-up period begins.

5.1 Self-testing of instrument

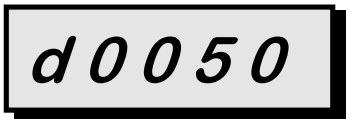
During the warm-up period and also while in normal operation (except while in Stand-By-Mode!) the instrument will carry out automatic self-testing at intervals of approx. 20 seconds as a check on important instrument functions. At such moments the control lamp ***Test*** will flare up briefly.
In the event of any malfunction, the warm-up period or the actual measurement cycle will be interrupted with the most probable fault appearing as error code on the display (see **Chapter 6, -** Malfunctions). Simultaneously an acoustic as well as an optical alarm (flashing of display and of the fault indicating lamp) will come on, which can be stopped by pressing the alarm-quit-button (if realized at the connected machine/plant) or which will stop automatically after 1 minute. In case of a malfunction of the instrument, a restart of the latter becomes necessary.

5.2 Warm-up period

The measuring chamber of the sensor is being heated up until 53°C (127°F) have been reached. This will take approximately 15 minutes at an ambient temperature of 20°C (68°F). The actually prevailing temperature inside the measuring chamber will be displayed in °C.

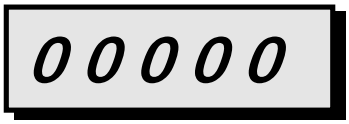
XX represent the temperature reached. After 53°C (127°F) have been reached, warming up is being continued for another 300 seconds (5 minutes) by precaution in order to make sure that the whole unit has adopted the desired operating temperature.
Once sensor-operating temperature has been reached, display will show

whereby the positions **XXX** will indicate the number of seconds remaining until termination of warm-up period.
When display changes to



sensor valves, zero gas valves and instrument outlet valve are being opened and the measuring gas pump switched on in order to flush the sensor during the remaining 50 seconds.

Following then is the next self-testing cycle, the display reading again



Now the instrument starts a zero adjustment

5.3 Zero adjustment

Repetitive zero adjustment will compensate possible changes in the sensor equipment (e.g. aging of infrared source) and this way eliminate zero drift. Ambient air is being sucked in through the installed activated carbon filter (fig. 1, item 5) or as may be the case through an external zero gas inlet (see below) and measured in the sensor. Since in a properly serviced zero filter the activated carbon will adsorb the measurable substance(s), the concentration of substance(s) in the sensor equals zero.

To provide error-free zero adjustment , the activated carbon filter must be changed regularly. Spent activated carbon filters will lead to incorrect test results or to error indication

INTERNAL MEASURING RANGES

M.A.C 2040 may be delivered with different sensors (**see Annex E**) which, depending on the requirements, have up to 3 internal auto-switching measuring ranges each. The zero concentration is being measured and adjusted for every internal measuring range. Only under the condition that at least **4 consecutive zero adjustment cycles** are within a specified tolerance, the zero value will be accepted. In case a measuring value exceeds the specified tolerance (caused e.g. by a contaminated measuring chamber or by leaks etc.) the number of hitherto measured values will be reset to zero. M.A.C 2040 will then renew its effort for zero adjustment. If after 50 attempts less than 4 consecutive values prove to be correct, the instrument will stop zero adjustment and indicate a failure (see **Chapter 6**).

DURATION OF ZERO ADJUSTMENT

Duration of zero adjustment for every internal measuring range is approx. 4 minutes in a favorable case. In the most unfavorable case this operation may take up to 15 minutes if e.g. the gas path or the measuring chamber are contaminated. If no correct zero adjustment is being achieved within this time bracket, then a failure indication will be given (see **Chapter 6**).

ALTERNATIVE ZERO GAS

In the event that the gas to be measured is a substance which can not be retained on activated carbon, then an external zero gas (e.g. nitrogen or clean air) may be applied to the zero gas inlet **at zero pressure**.

DISPLAY

During the zero adjustment the display will show the measuring range actually under test and additionally the progress of the zero adjustment:

X indicates the actual measuring range, **YY** the number of measurements whose results lie within the specified tolerance bracket.

After successful zero adjustment the instrument will automatically switch to "Stand-By-Mode"

Depending on the configuration of the instrument this stand-by mode will either be maintained or it will automatically switch over to measuring at a pre-configured channel.

AUTOMATIC ZERO ADJUSTMENT

M.A.C 2040 automatically carries out a zero adjustment procedure after every activation of the mains switch.

MANUAL ZERO ADJUSTMENT

In those cases where M.A.C 2040 has been in operation over a period of several days **without interruption** and only low gas concentrations are to be measured, a manual zero adjustment is recommended.
The user may trigger such manual zero adjustment by pressing the push-button ”Reset” on the rear front plate of the CPU-Module (see fig. 2, item 11).
The instrument will then initiate the power-up-cycle described in this chapter . This sequence includes carrying out a zero adjustment.

CYCLIC ZERO ADJUSTMENT

In cases where the instruments are intended to serve in continuous operation, it is recommendable for the user to opt for activation of the program function "cyclic zero adjustment" at the manufacturer's side or by authorized service personnel, rather than selecting the repetitive manual triggered zero adjustment.

As an interval for cyclic zero adjustment any full hour within a time bracket between 1 and 35 hours may be set up to the program. The interval to be set should reflect the intensity of operation as well as other local influencing factors e.g. change of shift etc. Unless specified differently by the User, an interval of 12 hours will be programmed by the manufacturer.

After every lapse of the programmed time interval **counting from the start-up moment**, the measuring operation will be interrupted to be followed by a zero point adjustment. Thereafter the measuring operation will be resumed.

5.4 Automatic measurement operation

When programmed for automatic measuring operation, M.A.C 2040 will directly change over to measurement operation after successful zero adjustment (see **Chapter 5.6,** Measuring process).

With programmed automatic measuring operation the Stand-by-mode is not activated

5.5 Externally controlled measurement operation

When programmed for externally controlled measurement operation, the instrument will fall into the passive mode ”Stand-by” after successful zero adjustment and show at the display

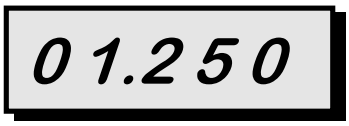
whereby the decimal point will slowly move from left to right across the display and no measuring activity goes on.
While all other components are fully available at this stage, only the pump is switched off for optimization of its service life. However, only 30 seconds after a measurement request has been put in, would the instrument resume its measuring activity.

In this mode M.A.C 2040 is expecting a request for measurement to be put in. By means of the standard machine interface that request will be sent to the instrument by the external control using the signal MRQ(1..3), (for reference see **Annex A, fig. A1, A2**).
The request for measurement, however, may also be transmitted via serial interface RS-232C/RS-485. That configuration will require an exchange of the standard software against special software.

5.6 Measurement process

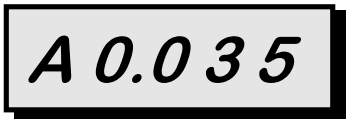
DISPLAY

The instrument display is informing the user during the measuring process continually about the actually measured gas concentration in units of **g / m³** (referring to preset normalized parameters) where by example



corresponds to a concentration of 1,25 g/m^3

If the lowest result on display is headed by the letter ***A***, this means that the measured result is beyond the measuring range of the installed sensor. In clear: an ***A*** in front of the lowest measured result signifies that the really measured concentration value is lower than the displayed result,



whereas an ***A*** in front of the highest displayed value indicates that this value has actually been exceeded (overflow of measuring range):

REFERENCE CONDITIONS

The displayed measuring results for concentration are referring normally to a reference temperature of 0°C (+32°F) and to an atmospheric pressure of 1013 mbar (14.69 psi). Other reference temperatures and -pressures may be preset by the factory. The actual atmospheric pressure on site will be measured in M.A.C 2040 and the concentration values corrected accordingly. The measuring gas will be kept at a constant temperature of 53°C (127°F), so that in a normal case the influence of the measuring gas temperature may be neglected.
In **Annex D** the conversion from concentration units g/m³ to ppm is being explained for several substances.

During every measurement the standard measuring program will run trough the following cycle:

1. the measurement cell is being flushed with actual measuring gas for about 5 seconds.
2. then the instrument goes on hold for about 3 seconds to let gas pulsation calm down.
3. now the measurement is carried out. The result of the measurement will be a mean value being formed from quite a number of single measurements.
4. the measurement result is being compared with the preset alarm threshold value and if it falls short of the alarm limit as well as remains within the time frame allowed for evaluation, a corresponding signal is transmitted via signal line MOK(1..3) (closing of a contact) through the standard machine-Interface (see **Annex A, fig. A2**).

   The evaluation allowance , i.e. time span during which the result must steadily remain below the alarm threshold value until a MOK(1..3)-signal will be released can be changed by manufacturer. Standard value is 2 measuring cycles.

The standard measurement cycle takes 20 seconds. Special software versions with different cycle times are available.

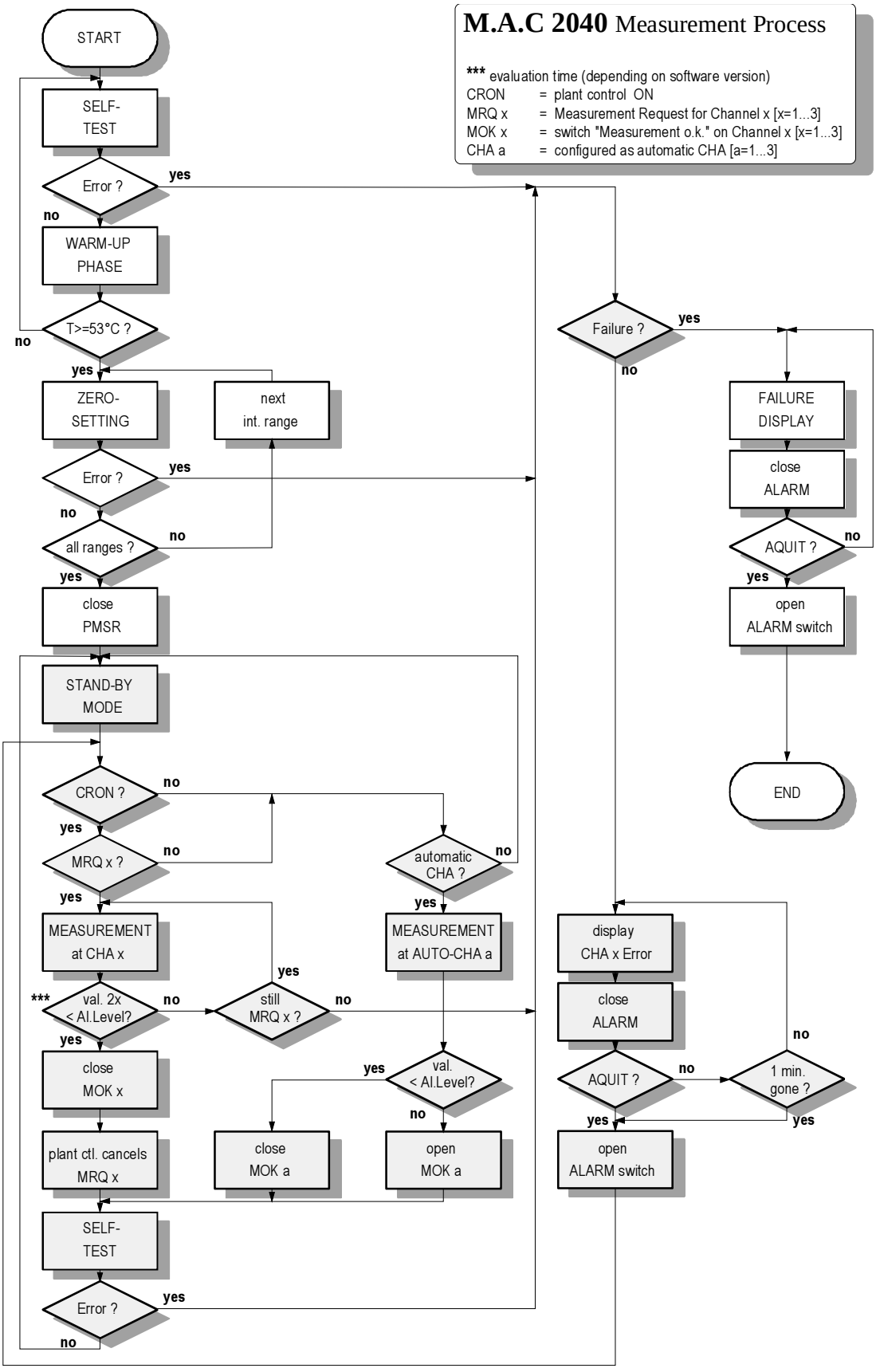


Fig. 6 Measurement Process

6. Operational Failures

6.1 Messages on instrument display

Messages about errors are displayed as coded information.
Simultaneously the contact PMSR (instrument ready for measurement) on the machine-interface (see also **Annex A, fig. A2 and A5**) is opened and the contact ALARM will be closed. The alarm may be quitted via the input AQUIT (quit alarm, machine control) or it will come off after 1 minute automatically. In case of malfunctions of the instrument (e.g. IR-source defect), PMSR will not be closed again and operation of the instrument cannot be continued right away. In the event of other errors, continuation of operation is possible in normal cases (see below).

There are two kinds of messages to be differentiated:

WARNINGS

6.1.1 Warning messages

indicating a critical operational state of the instrument or warning about critical ambient conditions.

Warning messages should cause the operator in charge to take corrective action towards termination of critical state

If the critical condition is terminated, the warning will come off automatically

<u>E 4001</u> - "Printer not on-line"

cause:
- printer not on-line

corrective action:
set printer on-line

<u>E 4003</u> - "Error data storage - memory card not inserted"

cause:
- data storage device missing

corrective action:
install data memory card

6.1.2 Failure messages

are indicating (with acoustic alarm and blinking failure-indicating lamp) that a direct return to normal operation of the program is not possible. The instrument must be switched off. After successful elimination of cause for failure or breakdown instrument may be switched on again for normal start-up procedure.

WARNING ! HIGH VOLTAGE!

Prior to opening up of instrument for any reason, its main power supply cable must be unplugged!

E 1001 - "Error Sensor - Chopper"
Explanation:
Chopper-motor not starting.

probable causes:
- instrument temp. too low (< 10°C resp. < 50°F)
- transportation damage (shutter of chopper bent, motor is jamming)
- motor defect

corrective action:
if instrument is too cold:
Acknowledge receipt of signal/ignore it, let instrument run in this condition for 15 minutes, switch off instrument and restart it after 30 seconds. If failure re-occurs more than twice consecutively, exchange of the measurement cell will be required (service org.)

in case of transportation damage or of motor defect:
switch off instrument and restart it after 30 seconds. If failure reoccurs more than twice, exchange of measurement cell will be required (authorized service organization)

E 1002 - "Error Sensor - Heating "
Explanation:
Measurement cell is not heating up

probable causes:
- heater cartridge defect-
- electronic control defect-

corrective action:
switch off instrument and restart it after 30 seconds. In case failure re-occurs twice, exchange measurement cell (service org.)

E 1003 - "Error Sensor - IR-Source"
Explanation:
Evidently no power consumption at infrared source

probable causes:
- electronic control defect
- infrared source defect
- transportation damage (filament broken)

corrective action:
- exchange measuring cell (service org.)

E 1004 - "Error Sensor - no signal of component 2"
Explanation:
Measurement amplifier defect or instrument-integrated calibration data destroyed (stored on EEPROM) or measuring cell defect

corrective action:
- send instrument for repair (factory or authorized service org.)

E 1005 - "Error Sensor -Calibration no signal“
Explanation:
instrument-integrated calibration data destroyed (stored on EEPROM) or measuring cell defect

corrective action:
- send instrument for repair (factory or authorized service org.)

E 1006 - "Error Sensor - zero setting unstable (filter spent?)
Explanation:
Sensor unable to conform preset value within determined tolerances during zero setting.

probable causes:
- zero-gas filter spent
- measurement chamber leakage at inlet/outlet gate valve because of insufficient dust filtration or excessive suction (higher than 50 mbar = 0.7 psi)
- Excessive suction may also be caused by tube lengths exceeding permissible length.

corrective action:
replace zero-gas filter (activated-carbon filter on instrument front panel). If problem re-occurs, exchange of measuring cell is required (service org.).

Incorrect installation of filter and undue extension of maintenance intervals will cause malfunctions or damages of measuring instrument.

<u>E 1009</u> - "Operating temperature too high“
Explanation:
Ambient temperature higher than 40° C resp. 104°F.

probable causes:
- Instrument is directly exposed to external heat sources (inadequate ventilation, high solar radiation, problematic installation site).
- blower-fan (or fan control) defect
- electronic control of heater defect

corrective action:
- At occurrence of this error message, operator in charge should at first check if external influences are causing this critical situation, and if applicable, eliminate those negative influences.
- In case error message was not caused by external influences, defect module(s) should be replaced (Service org.).

<u>E 2001</u> - "Error pneumatic system - pump“
Explanation:
Pump does not supply measuring gas (no pump noise audible)

probable causes:
- pump defect
- gas return-tube or -valve (at machine) is blocked

corrective action:
- replace MG-MIF-module (Service org.)
- remove circulation blockage in gas return system .

E 3001 - "RTC (Real Time Clock) module defect“
Servicing required. Send instrument for repair

E 3002 -"AD-converter defect“
Servicing required. Send instrument for repair

E 3003 - "EEPROM defect"
Servicing required. Send instrument for repair

E 3004 - "incorrect/corrupt configuration data“

probable causes:
- defect in data-/program - memory or manipulated data

corrective action:
- Servicing required. Send instrument for repair

E 4004 - "Error data storage - capacity used up“

cause:
- data storage capacity used up

corrective action:
- exchange data storage device

E 4005 - "Error data storage - memo-card write protected“

cause:
- write protection on memo-card

corrective action:
- remove write protection

E 4008 - "Error data storage - memo-card defect“

cause:
- memo-card defect

corrective action:
- replace memo-card

E 6001 - "Error during (re-) calibration“
For cause of error and for corrective action see service instructions

E 9999 - "Error of operator“
Error in operation of instrument. For corrective action please refer to corresponding instruction in instruction manual and or service guide.

6.2 Communication problems between instrument and plant control

Further down some malfunctions are listed which may occur during communication between plant control and the Measuring Computer M.A.C 2040

For easy detection of these problems use the Interface-Tester G1289. 

6.2.1 Errors caused by plant control

- **MRQ(1..3)-Signal not constant during request for measurement**
  If significant voltage breakdowns (longer than 50 ms) occur, unintentional switch-over to a non-selected channel may happen.

- **Involuntary switch-over of channel**
  If on request from plant control the instrument is measuring on a particular channel and if by mistake plant control requests simultaneously an additional channel for measuring, the instrument will automatically switch to the higher numbered channel.

- **No reaction of instrument on channel switch-over.**
  If (on interconnection systems with D/C-voltage) the plus and minus wires of MRQ(1..3) signals are twisted by mistake, this will not damage the interface, but the instrument will not react to request(s) for measurement either.

- **No reaction of instrument**
  In case the signal „CRON“ has not been set by the machine control, instrument will not react to any requests for measurement.

- **Alarm-reaction of instrument on channel change-over**
  If, at a changing-over of channels, the control lamp of the quit channel starts blinking alternating with the control lamp of the consecutively selected channel and if at the same time the alarm comes on, then this channel change-over has presumably been initiated at a moment when either gas concentration was in excess of limit or the evaluation time allowance was too short. In such case the plant control obviously performed an automatic switch-over without waiting for the MOK(1..3)-signal from the instrument.

6.2.2 Error on interface cable

- **No reaction of instrument**
  broken wires on interface cable or on plug

6.2.3 Error on measuring computer - interface module

- **No reaction of instrument on request for channel change**
  If the instrument does not change measuring channels, although the control signals MRQ(1..3) and CRON have correctly been issued at the plant control side, at first the interface cable has to be inspected for defects (broken wires or bad contacts). If no defect can be located there, the interface module has to be replaced (service org.).

- **No reaction of instrument even if results remain below limit**
  In case the instrument does not evaluate results respectively does not acknowledge signal, although at plant control side the control signals MRQ(1..3) and CRON are found to be o.k., check first if the red - or the green light of the channel concerned is activated on the instrument front panel or not. If no such light is on, measuring time should be extended. If situation is not improved thereby, verify if result signal contacts are properly connected at plant side. In the affirmative, the interface cable should be inspected for possible wire damage. In case no defect is found on cable either, the interface module has to be replaced (service org.).

7. Maintenance

7.1 General hints

The instrument has been designed for optimum maintainability. A skilled User may perform all conditioning maintenance work himself if required.

CLEANING

The instrument housing may be cleaned with a smooth cloth which has been wetted with water and only a few drops of cleansing agent.

Never use organic solvents (e.g. PERC, TRI, Acetone).Organic solvents may be harmful to instrument front panel and painted surfaces.

7.2 Exchange of Activated Carbon filter

ACTIVATED CARBON FILTER EXCHANGE

In order to receive flawless zero adjustments, the activated carbon filter must be changed regularly. The exchange interval will strongly depend on:

- dust content and concentration of components to be measured as well as content of chemical combinations in the ambient air which may be adsorbed by activated carbon. The higher the contents, the sooner an exchange of the filter element will become necessary.
- the frequency of zero adjustments (among others dependent on operating period of plant).

We recommend to change the activated carbon filter every 3 months.

Wrong installation of activated carbon filter or postponement of due maintenance will lead to malfunctions of the instrument !

For filter change proceed as follows:

- The activated carbon filter (zero filter) is located behind the circular cover plate on the front panel, Figure 1, Item 5.
- Lift up this circular cover plate by carefully levering it open with a small screw driver. Insert the screwdriver at the flattened edge of the cover plate.

- Insert the supplied filter-exchange tool into the opening. Turn it carefully until it clicks into place. Now unscrew filter from its socket by turning tool counterclockwise.

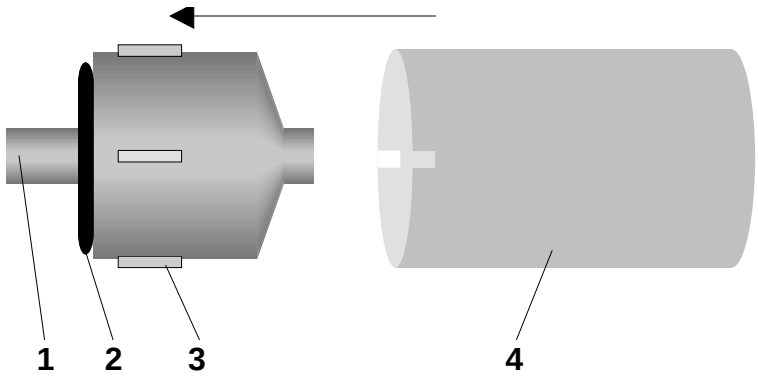


Fig. 7
1 thread
2 rubber gasket
3 click-in-pins on filter
4 filter-exchange tool

- Insert new filter into filter-exchange tool .Make sure that the rubber gasket (fig. 7, item 2) of the filter cartridge is in place. Insert tool with filter into opening on instrument front panel.
- Screw in filter clockwise into its panel-mounted socket. Tighten filter **applying gentle effort only**.

Never tighten filter too much otherwise thread might break off!

- Let circular cover (fig 1, item 5) snap back into front panel with flattened cover edge pointing to left hand side.
- Complete printed text on supplied sticker by filling in actual date into line reading

"last filter change on....."

and apply sticker on left side of instrument right next to the name plate. This will facilitate your control of observance of filter change schedule.

Always keep a sufficient quantity of the original Activated Carbon filters and of dust filters available on stock.

Used-up dust- and Activated Carbon filter-cartridges may be returned to ppm Messtechnik or to service shop for proper disposal.

Spare Part	Order No.
Activated Carbon filter set (4 each)	E 02853
Dust filter 1 (1 fitting) set (4 each)	E 02851
Dust filter 2 (2 fittings) set (4 each)	E 02852

Subject to change

7.3 Exchange of sample gas filters (dust filter)

Appropriate dust filters are of such nature as they will neither adsorb molecules of the sample gas components in the filter element nor in the filter housing. Furthermore must they permit filtration of 5 micrometer particle size.

In order to avoid contamination of valves , of sample gas tubing, and of the measuring cell, the instrument must exclusively be operated using the original ppm dust filters!

When changing dust filters ,proceed as follows:

- In order to avoid contamination of sample- gas tubing during changing of filters, switch off instrument or pull off suction tube at rear side of instrument.
- Unscrew the dust filter screw caps .
- Insert the new dust filter. A label attached to it is showing an arrow indicating the flow direction of sample gas.

The arrow must point towards tube end leading to instrument (not towards end leading to plant)!

- Write down actual calendar date on filter label. This will facilitate control of observance of filter-change schedule.

We recommend to exchange dust filters every 3 months .

7.4 Exchange of instrument fuses

As an additional safety feature on M.A.C 2040 fuses are installed on the power supply assembly, on the MG/MIF-assembly, (see **Annex A5**) and on the optional integrated printer module (see **Chapter 8**, Options).

Prior to replacing any defective fuse ,check at first for fault causing the defect and eliminate fault.

7.4.1 Fuse in power supply assembly

The electrical power supply assembly is secured with a fuse

5x20mm, 250V 2A MF.

When exchanging this fuse, proceed as follows:

WARNING ! HIGH VOLTAGE!

Prior to opening up of instrument for any reason, its main power supply cable must be unplugged!

- disconnect tubing (fig. 2, item 12) between MG/MIF-Assembly and Power- Supply Assembly on rear side of instrument
- unscrew the 2 knurled thumb screws of the Power Supply Assembly (fig. 2, item 5) and pull out that assembly from instrument housing
- remove fuse from its socket. If fuse is defective replace it by new fuse of identical type and specification.

Never use any fuse of a specification different from the values indicated by the instrument manufacturer ! Wrong fuses may destroy the measuring instrument!

- Put Power- Supply Assembly back into instrument housing and fasten it with the knurled thumb screws. Re-install tubing between MG/MIF- Assembly and Power-Supply Assembly after making sure that the gaskets on the couplings are properly in place.

7.4.2 Fuse on MG/MIF-Assembly

Between the two pins 21 an 22 of the SUB-D-Connector on the MG/MIF-Assembly a voltage of 12V DC is supplied which is reserved exclusively for connection with the Interface-Tester G1289!

Caution:

Do NOT connect any external consumer devices to this voltage! Or else a potentially hazardous galvanic bridging with the instrument electronics will take place!

In case of a short-circuit or an overload the fuse

5x20mm, 250V 0,25 A T

may blow. If this should happen, the fuse has to be replaced as described in the following:

- disconnect all channel tubes and return gas tube from MG/MIF-Assembly on rear side of instrument housing (fig. 2, item 4) after marking tubes in order to avoid mix-ups during re-installation.
- disconnect as well the tubing (fig. 2, item 12) between MG/MIF-Assembly and Power Supply Assembly as between MG/MIF-Assembly and Sensor-Assembly (fig. 2, item 10).
- unscrew the two knurled thumbscrews of the MG/MIF-Assembly and pull out this module from instrument housing
- remove fuse from its socket on module and, if you find fuse to be defective, replace it with a new one of identical type and specification.

Never use any fuse of a specification different from the values indicated by the instrument manufacturer ! Wrong fuses may destroy the measuring instrument!

- Slide back MG/MIF-Assembly into instrument housing and fasten module with knurled thumbscrews. Re-install the prior marked tubing (making sure that the gaskets on the couplings are in perfect condition and in place).

7.4.3 Fuse on Printer Module (Option V214)

The Printer Module (see. **Chapter 8**, Options) is secured with a fuse

5x20mm, 250V 0,63A T

In case exchange of this fuse is required ,proceed as follows:

WARNING ! HIGH VOLTAGE!

Prior to opening up of instrument for any reason, its main power supply cable must be unplugged!

- unscrew the 5 knurled thumbscrews of the printer module cover plate on the rear side of the measuring computer housing and lift off cover.
- remove fuse from its socket. If fuse is defective, replace it by a new one of identical type and specification.

Never use any fuse of a specification different from the values indicated by the instrument manufacturer ! Wrong fuses may destroy the measuring instrument!

- Slide back plug-in printer module and fasten cover plate with the 5 knurled thumbscrews.

7.5 Calibration of Instrument

The instrument-integrated functions concerning avoidance of zero-drift are described in chapter 5.3 of this instruction manual.

The possibility for re-calibration of the measuring computer M.A.C 2040 is conventionally included in the scope of functions of every software version. For reference see separate calibration instructions in service guide.

The re-calibration job may be done on site by authorized service personnel.

Naturally the re-calibration may also be performed by the manufacturer, with either manufacturer's calibration certificate or with a calibration certificate issued by a calibration inspector in accordance with the requirements of the appropriate law or regulation.

Inform yourself which type of re-calibration is being required by your competent local authority.

8. Options

8.1 Integrated dot matrix printer V214/V226)

In connection with option V226 (enlargement of the chassis to 340 mm) a miniature matrix-printer can be installed.
The printer with its 4 needle-matrix-head and 32 character per line prints on normal paper. The paper roll is 58 mm wide with a diameter of 48 mm. The paper is automatically rolled back during printing, which facilitates the storage of the printed data without gaps.

8.1.1 Printing Options

PROTOCOL

After switching the instrument on, warm-up and zero-setting a protocol is printed in any case. The protocol contains the following data:

- Alarm threshold per channel
- gas components to be measured
- current date and time
- location of the instrument (company, location)

STANDARD PRINTOUT

A printing of the measured values is done as a default when the measuring location is left. The printout has the format:

- Indication, if the last measured concentration has been above (value > than...) or below (value < than...) the threshold setting for the measurement channel. (Printout of the alarm threshold in g/m3 and ppm).
- Concentration value at he end of the measurement in g/m3
- Name of the measurement channel, current date and time

PRINTOUT OF AVERAGE VALUES

By changing the settings in the configuration table (by manufacturer or authorized service) the printout of concentration averages over certain periods of time is possible. As time intervals 10, 15, 30, 60 or 480 minutes can be chosen. The average is printed out automatically at the end of the interval. The printout of the average can be activated for each measuring channel individually.

If measurement at a certain channel is interrupted by switching over to another channel within the evaluation time (1 to 5 measuring cycles depending on software-version), an error message is printed out:

```
Meas. time too short for evaluation!
Location X ..DD.MM.YY HH.MM.SS
```

Measurement Location X	=	Name of measurement channel
DD.MM.YY	=	Date
HH.MM.SS	=	Time

Further error messages are not printed by the standard-measurement program.

8.1.2 Replacing the paper roll and the ribbon cartridge

The paper roll and the ribbon-cartridge can be accessed and replaced through front door.

Fig. 8 The path the paper follows inside the printer

The paper path inside the printer can be seen in drawing 8.
First, the front plate of the printer has to be opened by unscrewing the upper two knurled thumbscrews. Then, the printer mechanism can be swung out of the instrument housing. By pulling out the axis of the paper roll, the kernel of the used paper roll can be taken out.

The fresh paper roll is slided over the axle of the paper roll holder and clipped back into the holder, where it is locked (watch paper direction of the roll).
Cut the lead end of the paper straight and thread it into the paper retraction slit at the lower side of the printer mechanism. When pushing the paper feed button, the printer will automatically pull in the paper and transport it through the slit in the front plate. Once the paper lead end gets within reach of your finger tips, it may be gently pulled out for about 25 cm (10 in) and fed back into the equipment housing through the slit between the hinges. Wind it around the core of the paper wind-up reel. The reel flange has now to be slided home upon the reel core. This will fasten the paper to the winder.
Swing the printing mechanism back to the instrument housing and fix the front plate with the upper two knurled thumbscrews.

Take care not to unwind too much paper from the fresh roll when loading or else the paper loop between supply reel and printer housing may grow to such a circumference that it could not be stowed well on closing of the printer housing.
Pay attention not to clamp the paper when closing the front plate.
Be sure not to squeeze the cable on the lower left-hand side of panel. Such cases might lead to malfunction of the printer.

EXCHANGE OF RIBBON CARTRIDGE

For exchange of ribbon cartridge, first open the front plate by loosening the upper two knurled thumbscrews. Then remove the front plate by loosening the third thumbscrew in the upper middle of the plate. Behind the plate there is a relatively large cutout through which the ribbon is accessible. By applying gentle pressure on its left-hand side, the ribbon cartridge is levered out of the printer mechanism. Insert the new cartridge after tightening the ribbon by turning the serrated ribbon transport wheel. Snap the ribbon cartridge simultaneously on both ends into the printer unit. Load paper as described before. Make sure that the ribbon is sitting neatly and straight in the paper outlet slit. If necessary, re-tighten it by turning the serrated ribbon transport wheel. Swing the printing mechanism back to the instrument housing and fix the front plate with all three thumbscrews.

8.2 Parallel Interface V216

The instrument can optionally be equipped by the manufacturer or authorized service personnel with a parallel interface for an external printer. The pin-assignment of the 25 pin Sub-D-Connector is Centronics compatible and can therefore be used with most of the standard printers. The printers can be connected using a standard PC-printer cable.

The form of printout using this interface is equal to the printout of the internal printer (see chapter 8.1.1.). The printout is carried out with 10 pitch (characters/inch) and independent of the type of printer being used. The instrument does not send any form feed.

The length of the printer cable must not exceed 5 meters (16 feet)!

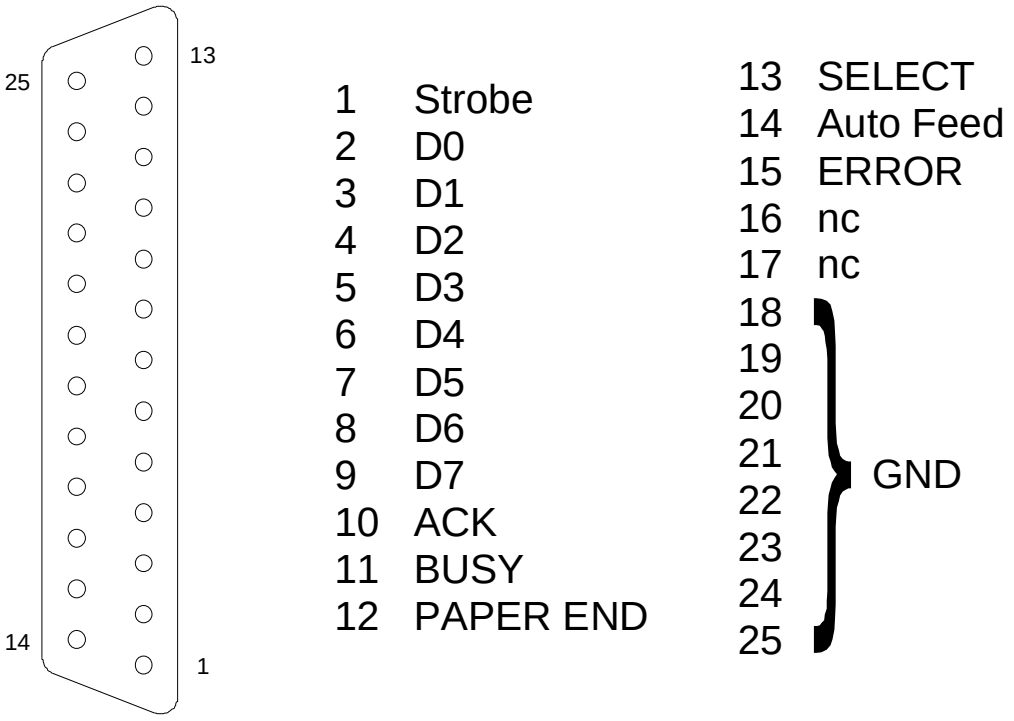


Fig. 9
25 pin Sub-D-Connector, pin assignment parallel interface

8.3 Serial interface

The serial interface can be either delivered as RS-232C- or RS-485 interface. The RS-232C interface can be used for data transmission of up to 15m (50 ft) distance. RS-485 can cover distances of up to 1200m (4000 ft).

8.3.1 RS-232C Interface (option V105)

The instrument can be equipped at the factory with a serial RS-232C interface for data transfer. The 9-pole Sub-D-Connector is located on the back of the CPU-assembly, (fig. 2, item 1.). Pin assignment see fig. 10.

The length of the connecting cable must not exceed 15 meters (50 feet)!

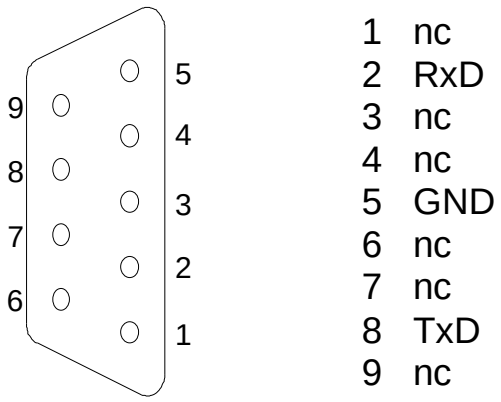


Fig. 10
9-pin Sub-D-Connector, female, pin assignment RS-232C

The data transfer rate is set to 9600 baud, no parity bit, 8 data bit, 1 stop bit (9600,N,8,1) by the manufacturer. The standard software does not support serial interfaces! For this purpose, the standard software must be replaced. The data transfer protocol is described in the according software description.

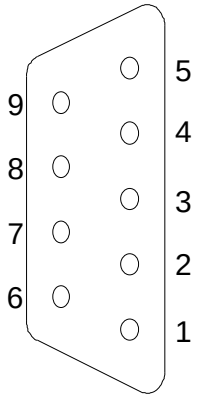
The data is transmitted without hardware/software handshake!

8.3.2 RS-485 Interface (option V106)

The instrument can be equipped at the factory with a serial RS-485 interface for data transfer.
The 9-pole Sub-D-Connector is located on the back of the CPU-assembly (fig. 2, item 1). For pin assignment see fig. 11.

On the receiver-unit an RS-485 Interface must be available!

The maximum length of the connecting cable is limited to 1200 meters (4000 feet)!



1 nc
2 wire A+
3 nc
4 nc
5 GND
6 nc
7 nc
8 wire B-
9 nc

Fig. 11
9-pole SUB-D-Connector, female, pin assignment RS-485

The data transfer rate is set to 9600 baud, no parity bit, 8 data bit, 1 stop bit (9600,N,8,1) by the manufacturer. The standard software does not support serial interfaces! For this purpose, the standard software must be replaced. The data transfer protocol is described in the according software description.

The data is transmitted without hardware/software handshake!

8.4 Analog-outputs

8.4.1 Options V218/V219 - analog recorder output 0-20mA / 4-20mA

When option V218/V219 is installed, M.A.C 2040 is equipped with a galvanic separated current output.

Resolution of the output current is dependent on sensor type installed and on the preset spread. During warm-up period and zero adjustment the recorder output is set to 0 mA respectively 4 mA . This corresponds to a concentration of 0 g/m^3. During actual measuring the recorder output is set - prior to every pumping cycle - to the current which corresponds to the actually measured concentration. If an underflow of the measuring range occurs, the output is set to that current value which corresponds to the lower limit of the measuring range.

In dependence from sensor type and option installed the following values will result there from.

Sensor-Type	Spread	Option V218 0-20 mA					
E-Sensor	1	1	mA = 0,5	g/m^3	20 mA =	10	g/m^3
	10	10	mA = 0,5	g/m^3	20 mA =	1	g/m^3
	100	resolution not possible					
N-Sensor	1	0,014	mA = 0,035	g/m^3	20 mA =	50	g/m^3
	10	0,14	mA = 0,035	g/m^3	20 mA =	5	g/m^3
	100	1,4	mA = 0,035	g/m^3	20 mA =	0,5	g/m^3
G-Sensor	1	0,01	mA = 0,005	g/m^3	20 mA =	10	g/m^3
	10	0,1	mA = 0,005	g/m^3	20 mA =	1	g/m^3
	100	1	mA = 0,005	g/m^3	20 mA =	0,1	g/m^3

Sensor-Type	Spread	Option V219 4-20 mA					
E-Sensor	1	4,8	mA = 0,5	g/m^3	20 mA =	10	g/m^3
	10	12	mA = 0,5	g/m^3	20 mA =	1	g/m^3
	100	resolution not possible					
N-Sensor	1	4,011	mA = 0,035	g/m^3	20 mA =	50	g/m^3
	10	4,112	mA = 0,035	g/m^3	20 mA =	5	g/m^3
	100	5,12	mA = 0,035	g/m^3	20 mA =	0,5	g/m^3
G-Sensor	1	4,008	mA = 0,005	g/m^3	20 mA =	10	g/m^3
	10	4,08	mA = 0,005	g/m^3	20 mA =	1	g/m^3
	100	4,8	mA = 0,005	g/m^3	20 mA =	0,1	g/m^3

The following settings (adjustments) can be made on the card:

Jumper	
J1, J2	graduation of spread 1/10/100
J4, J5	output current range 0-20 mA/4-20 mA
J6	resistance load (burden) high /low

- **Spread:**

  The spread of the output current is set with the Jumpers J1 and J2 . The following settings are possible:

J1	**J2**	**Spread**
OFF	OFF	1
ON	OFF	10
OFF	ON	100

ON:	Jumper shorted
OFF	Jumper open

  The different resolutions resulting there from may be gathered from the tables above .

- **Current output 0-20 mA/4-20 mA:**

  With Jumpers J4 and J5 the card is adjusted for output current 0-20 mA respectively 4-20 mA . Always **both** Jumpers have to be set for the **same** mode of operation.

- **Resistance Load (Burden):**

  With the Jumper J6 the rating of the connected resistance can be selected. If the Jumper is set on position 'RLOAD LOW' (Resistance load low), the connected current load must not exceed 400 Ohms. In the position 'RLOAD HIGH' the driver power is sufficient for up to 800 Ohms.

8.4.2 Option V220 - analog recorder output 0-10V

When option V220 is installed, M.A.C 2040 will be equipped with a galvanic separated voltage output.

The resolution of the output voltage is depending on sensor types installed and on the preset spread. During warm-up time and zero point measuring the recorder output is set to 0 V. This corresponds to a concentration of 0 g/m3. During actual measurement the recorder output is being set prior to every pump cycle to that voltage which corresponds to the actually measured concentration. If an underflow of the measuring range occurs, the output is set to that voltage which corresponds to the lower limit of the measuring range.

This will lead to the following values:

Sensor-Type	Spread	Option V220 0-10Volt					
E-Sensor	1	0,5	V = 0,5	g/m^3	10	V = 10	g/m^3
	10	5	V = 0,5	g/m^3	10	V = 1	g/m^3
	100	resolution not possible					
N-Sensor	1	0,007	V = 0,035	g/m^3	10	V = 50	g/m^3
	10	0,07	V = 0,035	g/m^3	10	V = 5	g/m^3
	100	0,7	V = 0,035	g/m^3	10	V = 0,5	g/m^3
G-Sensor	1	0,005	V = 0,005	g/m^3	10	V = 10	g/m^3
	10	0,05	V = 0,005	g/m^3	10	V = 1	g/m^3
	100	0,5	V = 0,005	g/m^3	10	V = 0,1	g/m^3

8.5 Option V230 - Additional Memory (SRAM-Card)

With option V230 it is possible to store average values permanently. As storage medium a PCMCIA 2.0 (JEIDA 4.0) SRAM memory-card with a maximum capacity of 1 MB is used.

The maximum number of storable average values is depending on the type (and capacity) of the memory card used:

with a capacity of	256 Kbytes approx.	5200 values
with a capacity of	512 Kbytes approx.	10400 values
with a capacity of	1024 Kbytes approx.	20800 values

The number of resulting operation hours is depending on the chosen average-time, the available capacity on the memory card and the number of already stored data files.

The average values are written as an ASCII-File in DOS-format to the memory card. With a PCMCIA 2.0 memory-card PC-drive, the data can be read by PC at any time. With the PC the transferred data can be processed by numerous spreadsheet programs.

8.5.1 Storage of average values

The average values are stored automatically, if the memory card is inserted.

Insertion and removing of the memory card may only be done during operation when the TEST indicator is NOT on. Non-complying to this rule may result in the total loss of stored data!

If the instrument is switched off, the memory card may be changed at any time.

The memory-card is equipped with a write protection switch on its front-end. If this switch is on, this will result in an error message '**E4005**' and the measuring operation will be discontinued. To continue operation, the switch must be turned off and the instrument must be restarted.

If there is no memory card inserted during the startup of the M.A.C 2040, a warning message '**F4003**' together with a 20 second acoustical signal is put out. Subsequently the instrument automatically continues with the normal start up procedure.

An unformatted memory card is automatically formatted by the M.A.C 2040. If during the formatting procedure a defect of the memory card is encountered, the instrument issues an error message **'E4008'** on the display and the measuring operation is discontinued. For reason of data security, we recommend to format the memory card with a PC drive.

The insertion of the memory card is possible during operation of M.A.C 2040 under observation of the yellow test-indicator. In this case a new file will be created.
After the zero adjustment a file with today's date as filename is created in the root-directory of the card. In order to be able to distinguish between different files created on the same day, a counter in the file extension is used. The file format will look like:

e.g.	02_05_95.000	1st file of May, 2nd, 1995
	02_05_95.001	2nd file of May, 2nd, 1995
	.	
	.	
	03_05_95.000	1st file of May, 3rd, 1995

Each file can contain up to 1000 data records. If this number is reached, a new file is created.

The number of data files on a memory card is limited to 64 files. If the creation of a new file is impossible, a warning message „**F4006**“ of 1 second duration together with an acoustical signal is produced after each measuring cycle.

If the storage capacity is exhausted, a warning message „**F4007**“ together with an acoustical signal is issued. In this case, on the PC the memory card has to be deleted partly or completely after archiving the data.

The storage of the average values is done at the end of the configured average time. The data is then written in the format:

```
ppm Messtechnik
Copyright 1991-2000

Company: Sample Company
Loc.   : Cleaner 47
CHA1   : Ambient Air    AL:   50 ppm
CHA2   : Drum           AL:  270 ppm
CHA3   : Carbon Unit    AL:  100 ppm

1;03.05.95; 9:10; 9:11; 0,035;0;-2
2;03.05.95; 9:11; 9:12; 0,035;0;-2
3;03.05.95; 9:12; 9:13; 0,035;0;-2
4;03.05.95; 9:13; 9:14; 0,035;0;-2
```

When opening a file, a header with data concerning the company, location and the names of the channels is stored in connection with the alarm threshold values.

The average values are stored with sequential record number, date, start of average interval, end of average interval and the concentration of the channels in g/m^3

In the concentration data among „real“ values the following supplementary values can occur:

- 0 $\Rightarrow$ channel has not been requested for measurement during the preset time interval
- -1 $\Rightarrow$ too less values for averaging
- -2 $\Rightarrow$ this channel is not configured for averaging

The storage of the average values can be interrupted by ejection of the memory card. After re-inserting the memory card, the instrument will continue the storage of the measuring values automatically. In this case, a new data file will be created first.

8.5.2 Obtain information about occupancy of storage space on Memory Card

To obtain information about the already occupied storage capacity of the Memory-Card proceed as follows:
When M.A.C 2040 is switched off ,press the lower switch behind the front panel, keep it pressed while switching-on the instrument.
On the display will appear the reading

wile the memory card is being surveyed for already occupied storage capability. This survey may take a few seconds and is finished as soon as the following data will appear on the display:

whereby XXX = already occupied storage space in percent.

If memory card is not inserted or not snapped in, the error-message **'E9999'** (operator's mistake) will show up.

The indication mode or the error message mode may only be abandoned by switching instrument off or by pushing Reset button.

8.5.3 Readout and erasure of Memory-Card

Readout and erasure of the memory card is performed using a JEIDA PC-drive assembly. Please follow the instructions of manufacturer of the PC-drive when performing such a job.

8.5.4 Exchange of Lithium-Battery

When M.A.C 2040 is switched off , the data on the Memory-Card will be held by a lithium battery. Under normal conditions a fresh lithium battery cell on a memory card will warrant a data storage life of about 3 years. When exchanging the lithium battery please follow the relevant instructions delivered with the memory card.

Annex A : Installation

1. Installation site.

In order to warrant a trouble-free operation of the Measuring Computer M.A.C 2040 the equipment should be installed in a vibration-free installation site.

Any exposure of instrument to low-frequency vibrations (up to 30 Hz) are to be avoided.

The installation location is to be selected in such a manner that the instrument may be operated and read with ease. It is equally important that the activated carbon filter installed behind the instrument front panel is easily accessible for scheduled filter replacement.

For cooling purposes the instrument must be set up in such a manner that free circulation of the ambient air is unobstructed. On the other side it must also be protected from exposure to very dusty environment or to splash-water.

In practice a clearance of at least 5 cm (2 inches) away from any surrounding wall must be omni-laterally kept to permit proper cooling.

The instrument has been designed for operation in an ambient temperature range from +10°C (50°F) up to +40°C (104°F) maximum. Condensation of air humidity is to be avoided. An integrated protection mechanism will switch off the measuring operation if the maximum permissible internal temperature is exceeding a limit of + 60°C (140°F). In this case the instrument will issue a malfunction message.

2. Electric connection

Nominal Supply voltage :	115 / 230 Volt A/C (if printer is integrated, pay attention to preset supply voltage!)
Frequency:	50 or 60 Hz
Power Consumption:	max. 45 W without integrated printer) (**with** integrated printer max. 65 W)

Connection of the instrument to the mains should be secured with a safety fuse (e.g. automatic fuse 8 A) and it should be separated from the mains connection of the plant resp. machine. If both connections are circuited together there is a danger of infiltration by EM-bugs via such direct connection with the plant. Securing such problematic interconnection against EM-bugs would be an alternative.

3. Sample gas connection

The sample gas ports (suction and return) at the plant end must be shut off by a 2/2-way-valve each. Those valves have to be opened or shut by the plant control.

Since pressure differences between sample gas- inlet and -outlet influence the measurement result and if exceeding differential pressure of 50 mbar (0.7 psi) they might even damage the sensing microphone, it is essential that gas samples tapped from the plant are returned to the plant through a port very close to the suction point!

The sample gas return system must be provided with a 2/3-way valve, which is switched by plant control in parallel to the outlet valve.

The valve of the sample gas return system must be connected in such a way that an escape of the returning sample gas into the ambient is possible if the valve is switched off e.g. during measurement of ambient air, purging of measuring cell in the passive mode, zero adjustment!

The sample-gas feed tubes must be provided with one each dust filter version 2 (see also c**hapters 7.3 and end of 7.2**).The filters must correspond to the requirements as per Chapter 3.1 and be installed at the beginning of each gas tube. By means of the filters the measuring instrument and the measurement system tubes are protected against pollution. Suitable filters are of such quality that they will neither adsorb measurable gas components in the filter element nor in the filter housing. As an additional feature the filters must permit the filtration of particles size 5 micrometers.

In order to avoid pollution of valves and of measuring chamber, the instrument may only be operated with filters protecting all measuring channels. The filters are to be placed right behind the valves at the plant respectively at the sample gas port.

Polluted gas tubes will adsorb molecules of the gas components to be measured and will lead to incorrect measuring results, i.e. the sample gas arriving at the measuring instrument is picking up additional molecules of the gas under test from the tube walls and is therefore reaching a higher concentration than at the sample gas port. Although this 'enriched' concentration will decrease continuously, it will, nevertheless, in correlation to the degree of tubing pollution delay the indication of the true concentration value.

For protection of measuring tubes and of measuring chamber please use original dust filters only.

All tubing should be made of **PTFE (Teflon)** in order to avoid adsorption which may cause faulty measurement results.

Do NOT use Nylon- or Silicon - tubes by any means !

The length of the tubes (diameter of 4/2,5 mm) must in a normal case not exceed 5 meters (16 ft), since pump timing and measuring cycles are optimized on the base of this length.

If a given situation at the plant requires different tube lengths or diameter, then the necessary steps have to be coordinated with before installation.

Take utmost care to prevent liquids from penetrating into the measuring chamber. Equally important is the avoidance of humidity condensation in the measuring cell. Any such event will immediately lead to the destruction of the optical filters and microphone !

4. Interface Cable

The electrical control connection between instrument and plant-/machine -control is provided for by a cable configured by . For details please see **figures. A2 and A3** on the subsequent pages.
In order to prevent EM-interference from entering the measuring computer via this cable, the shielding of the cable must be grounded at the plant-side (yellow/ green wire).
The standard length of the Interface-cable is 5 m (16 ft). Other cable lengths available on request.

A1 : Connection of Instrument to Machine/Plant

For gas-tubing use hoses of PTFE (Teflon) only

4,0 mm outer diameter, 2,5 mm inner diameter, max. length 5 m

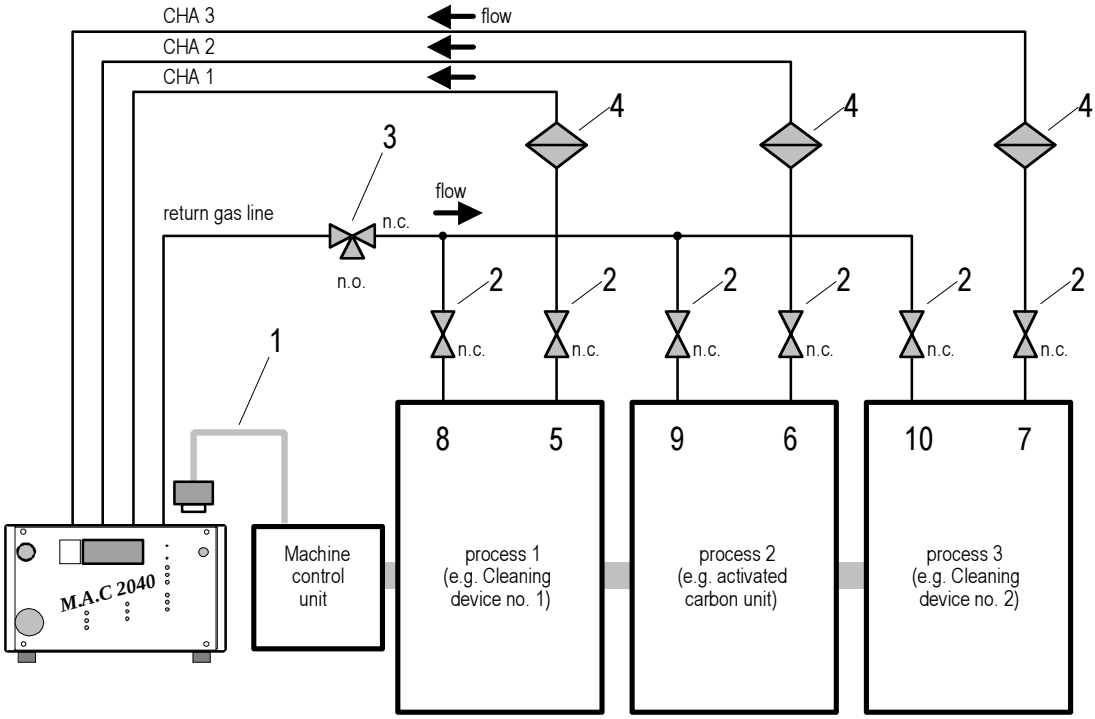


Fig. A1
Connection of Instrument to Machine/Plant

1	standard Interface Cable (see Appendix A2)
2	2-way solenoid valve (normally closed)
3	2/3-way solenoid valve (open to ambient when switched off)
4	dust filter (see Chapter 3)
5, 6, 7	measuring point (CHA1...3), suction
8, 9, 10	gas return points (see Chapter 3)

A2 : Pin Assignment of Standard-Interface-Cable for M.A.C 2040

(order-no. K01550)

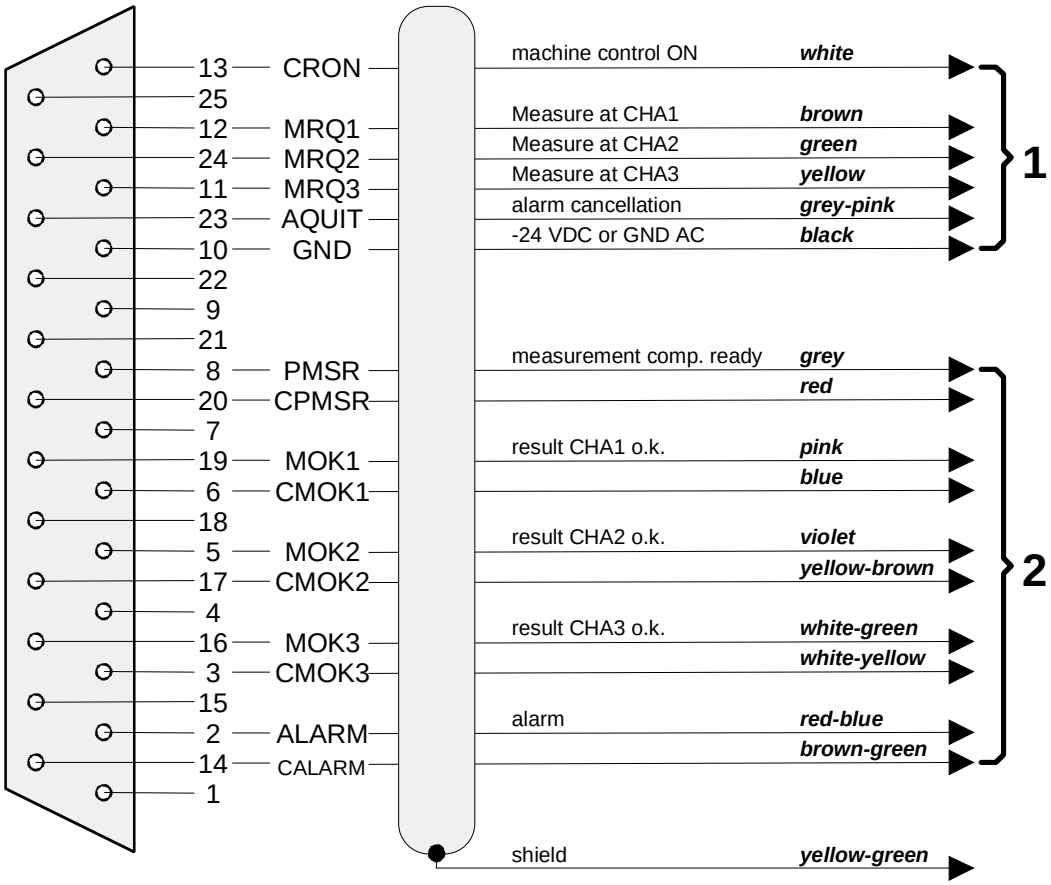


Fig. A2

connector, female, series sub-d, 25 pins
with connecting cable, 16 wires, shielded (LiYCY 0,34 mm²)
total length of I/F cable l = 5000 mm, with 200 mm free cable endings
shield connected to yellow-green wire, soldering point protected by shrinking hose sleeve

1 output of machine control, input to M.A.C 2040
24 V DC or 24 V AC

2 output of M.A.C 2040, input to machine control
potential free contacts
@ standard cable only the normally open contacts are wired
contact load max. 0,3 A, 48 V

A3 : Standard-Interface-Cable between M.A.C 2040 and Machine

(order-no. K01550)

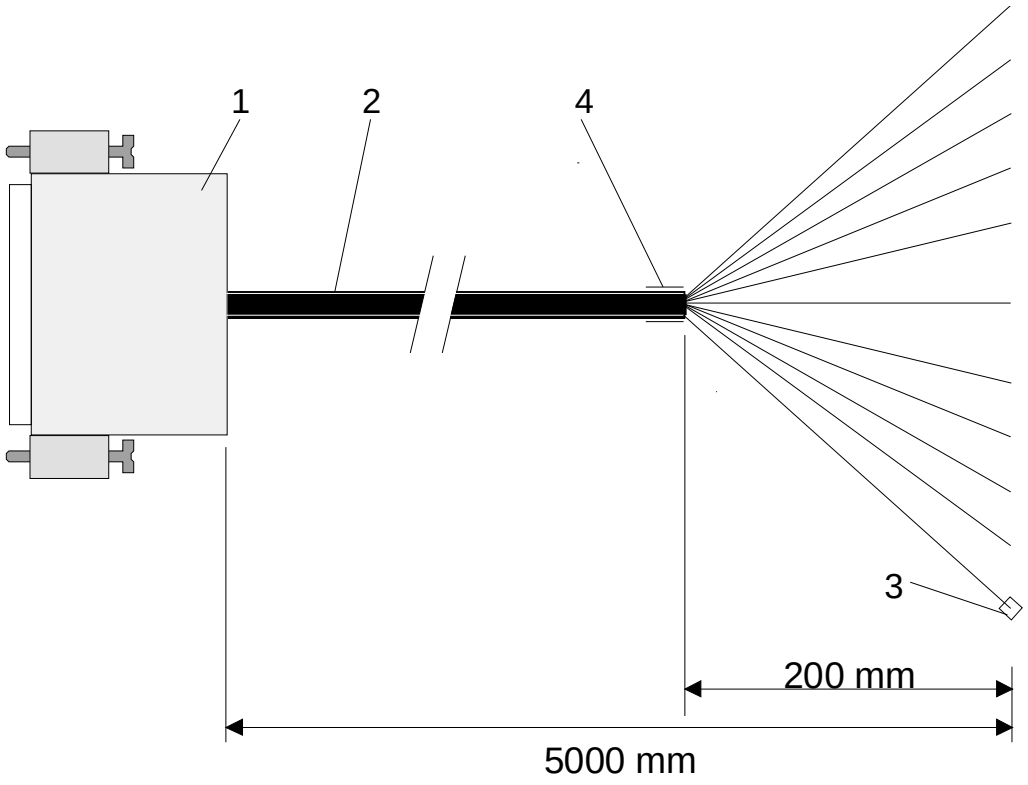


Fig. A3

1 connector, female, series sub-d, 25 pins
2 connecting cable, 16 wires, shielded (LiYCY 0,34 mm²)
3 connection to shield (yellow-green)
4 shrinking hose sleeve

A4 :Description of Interface M.A.C 2040 - Plant Control

a) Signals from Plant Control to M.A.C 2040 :

Description	Code Signal	24 V to Pin No.	GND to Pin No.	Action M.A.C 2040
Plant ON	CRON	13	10	Request for measurement will be accepted if ready for measuring
Request for measurement on channel CHA1	MRQ1	12	10	starts measuring cycle on channel CHA1 Pin 6+19 open
Request for measurement on channel CHA2	MRQ2	24	10	starts measuring cycle on channel CHA2 Pin 5+17 open
Request for measurement on channel CHA3	MRQ3	11	10	starts measuring cycle on channel CHA3 Pin 3+16 open
Alarm is acknowledged	AQUIT	23	10	Alarm is reset Pin 2+14 open

b) Signals from M.A.C 2040 to Plant Control :

Description	Code Signal	Output
Instrument. ready for measurement	PMSR	Pin 8+20 closed
Result on channel CHA1 is: < limit value	MOK1	Pin 6+19 closed
Result on channel CHA2 is < limit value	MOK2	Pin 5+17 closed
Result on channel CHA3 is <limit value	MOK3	Pin 3+16 closed
Alarm or Failure	ALARM	Pin 2+14 closed

Notes :

1.) The voltage on CRON, MRQ(1..3) and AQUIT may be 24 V DC as well as 24 V AC.
2.) Max. admissible load at output contact : 48 V , 0,3 A
3.) The output contacts for measuring channels which have not been requested for measurement, are generally open
4.) The alarm coming on at channel-change will be quit by M.A.C 2040 automatically after 1 minute: Pins 2+14 open

A5 : Pin Assignment of Machine-Interface Connector M.A.C 2040

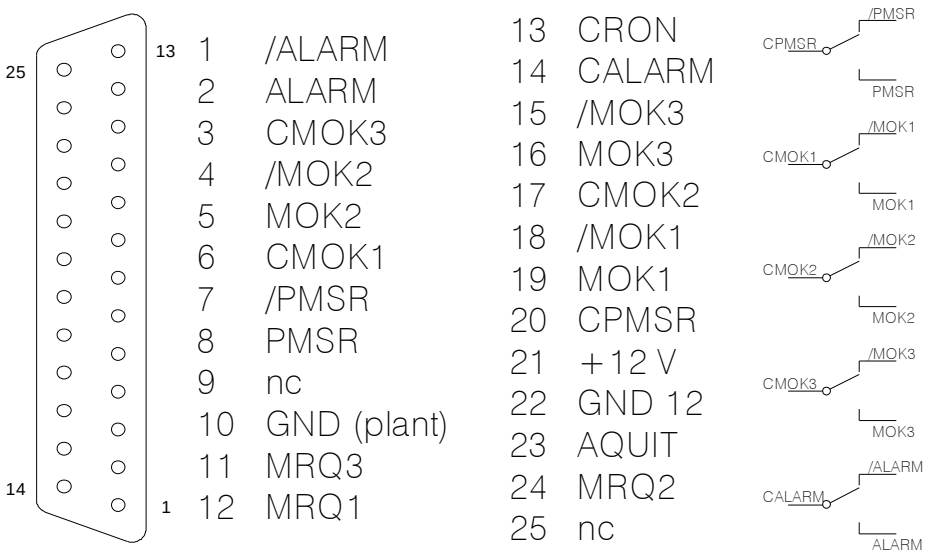


Fig. A5

output of machine control, input to M.A.C 2040
24 V DC or 24 V AC
Pins 11, 12, 13, 23, 24 against GND, Pin 10

output of M.A.C 2040, input to machine control
potential free contacts
Pins 1, 2, 14 (Alarm)
Pins 6, 18, 19 (MOK1), 4, 5, 17 (MOK2), 3, 15, 16 (MOK3)
Pins 7, 8, 20 (PMSR)

max. contact load 0,3 A, 48 V

Warning:

The voltage of 12 V DC at pin 21 (+12V) and pin 22 (GND 12) is for use with the Interface-Tester G1289 only!
Never connect any external devices! There would be a galvanic connection to the instruments electronics! In case of short circuit or overload the built-in fuse will be blown and has to be exchanged according to chapter 7.4

Annex B : Available sensors

Opto-acoustic infrared sensors for concentration measurements of the following substances are available :

- PERC, (Tetrachloroethylene)
- Trichloroethylene
- Methylene Chloride (Dichloromethane)
- CFC11, (Fluorotrichloromethane)

Depending on the application, customers can choose between different accuracy and measuring ranges of the sensors :

Substance	Sensor type Accuracy	Measuring range mg/m³	Application				
			Dry cleaning		IC / AC		ambient air
			closed sys.	open sys.	in-line m.	emissions	pollution
PERC	**E**	500 up to 6000	**X**		**X**		
PERC TRI DCM	**N**	35 up to 29600	**X**		**X**		**X**
PERC TRI DCM	**G**	5 up to 8900		**X**		**X**	**X**
CFC 11	**N**	6 up to 15000	**X**		**X**		**X**

IC = Industrial cleaning / metal degreasing plant
AC = Air conditioning plant / Refrigerating plant

Sensors for other gases are available. Please ask your local representative or visit -website further information.

Annex C : Conversion of concentration units mg/m³ ⇔ ppm

Definitions :

1.) Mass concentration, unit mg / m³ :
The mass concentration specifies the composition of a mixture as a mass of a substance concerned in a total volume. Since the volume of a gas highly depends on temperature and pressure, its mass concentration is equally dependent on temperature and pressure. Therefore temperature and pressure must be specified when a mass concentration is being indicated.

2.) Volume concentration, unit ppm :
The volume concentration specifies the composition of a mixture as volume of the substance concerned in a total volume. The volume concentration is non-dimensional.
ppm stands for "parts per million".(e.g.: volume of the substance to be analyzed in cm³ (ccm) per 1 million cm³ [1 m³] (1 cbm)
The volume concentration only depends to a small degree on temperature and pressure.

Conversion of the units :

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

$$\mathbf{P \cdot V = m / M \cdot R \cdot T}$$

(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), 0°C (32°F) ppm = x . mg/m³	**Conversion factor y** at 1013 mbar (14.69 psi), 0°C (32°F) mg/m³ = y . ppm
PERC	7,403	0,1351
Trichloroethylene	5,366	0,1864
Dichloromethane	3,792	0,2637
CFC 11	6,133	0,1631