SERVICE MANUAL

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Part 1: Functional description

Overview

This part

... contains the description of the physical basis and information regarding the registration of influential parameters

Content of this part

In this chapter you can find the following information

Physical basis

Principle of measurement

- NDIR procedure (**N**on**d**ispersive**I**nfra**r**ed analysis)
- The measuring effect is based on the resonance absorption of gas specific oscillating rotating bands of gas molecules with different atoms in the spectral ranges of the average infrared between 2.5 and 8 µm wavelength.
- Identification of the particular gases to be measured individually takes place through their specific absorption ranges. Each gas has such an absorption range (finger print)
  Exception
  - monatomic gases, such as inert gas
  - symmetrical gases, such as for example N_2, O_2, H_2
  - these named types of gas cannot be measured using this method
- The connection between the measured absorption of infrared rays and the measuring component is based on the LAMBERT-BEER law:

  $$A = (I0 - I1) / I0 = 1 - e^{-\varepsilon(\lambda) \cdot \rho \cdot l}$$

  when
  A = Absorption
  I0 = Rays entering into the cell
  I1 = Rays emerging from the cell
  $\varepsilon(\lambda)$ = Extinction coefficient of the measuring component
  ρ = Density of the measuring component
  l = Length of the measuring cell

  The relation between the density of the measuring component ρ and their volume concentration c is as follows

  $$\rho = \rho_0 \cdot c \cdot p/p_0 \cdot T_0/T$$

  when
  $\rho 0$ = Density of the pure gas
  p0 = Pressure
  T0 = Temperature
  under standard conditions (1013 hPa 0°C).

  The second equation shows that the volume concentration of the measuring component depends on the pressure and the temperature in the measuring cell.
  From the first equation, there is a non-linear connection between the absorption and the volume concentration.

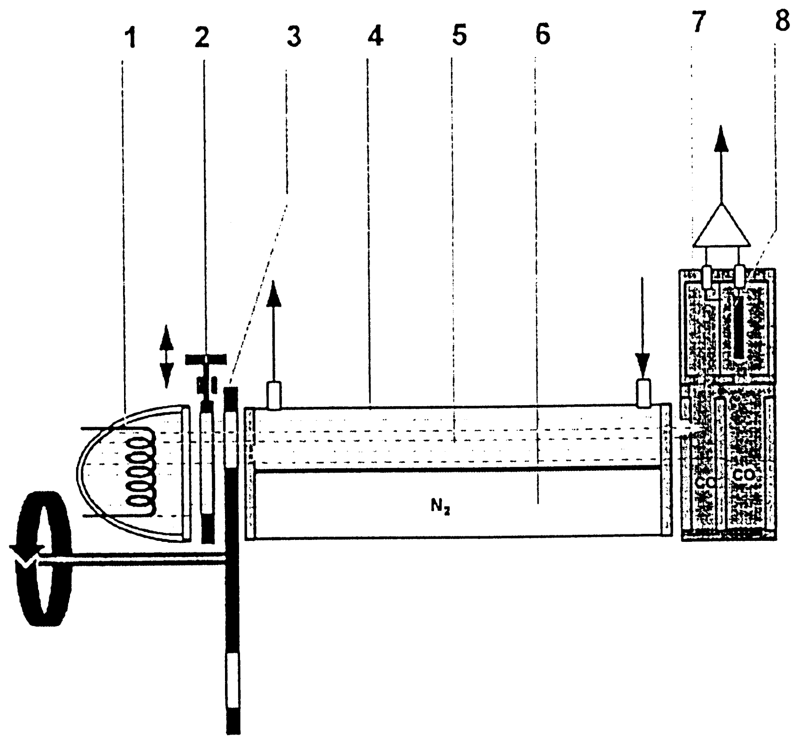
Physical basis, *continued*

Basic structure

The analyzer module is a dual-beam NDIR operational photometer without dispersive elements.
The module consists of a complete self-supporting optical device with the following elements:

- Infrared radiation source (emitter)
- Diaphragm wheel (chopper)
- Emitter diaphragm
- Measuring cell with measuring and fiducial chamber
- Infrared detector with diaphragm condenser

Figure 1-1 Principle of measurement



1 Emitter
2 Emitter diaphragm
3 Diaphragm wheel
4 Measuring cell
5 Measuring chamber
6 Fiducial chamber
7 Infrared detector
8 Diaphragm condenser

Physical basis, *continued*

IR radiation

- is generated by the emitter (wide band)
- is sent as a luminous beam alternately as a measuring and fiducial ray through the measuring or fiducial chamber of the measuring cell and is partially absorbed by the molecules of the measuring component.
- is modulated in antiphase by a motor-driven diaphragm wheel
- alternately enters the infrared detector in the form of two modulated luminous beams

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Diaphragms

- provide the radiation balance of the measuring and fiducial ray through appropriate adjustment

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Measuring cell

- is supplied with the measuring, zero-point and end-point gas (depending on the function) in the measuring chamber, thereby absorbing parts of the infrared rays depending on the concentration.
- is filled with a non-infrared absorbing gas (N_2) in the fiducial chamber so that the rays can pass through unhindered.

Infrared detector

- is a two-layer irradiation detector with front and rear chambers, which are both filled with the gas component to be measured. Thus the selectivity is determined by the infrared detector. The two chambers are separated by an infrared pervious window. Additionally, the two chambers are also separated by a taut metal diaphragm with backplate electrode. This unit is described as a diaphragm condenser.
- reacts to the presence of the measuring component as follows:
  - IR rays are reduced in the measuring chamber of the measuring cell and then enter the front chamber of the detector
  - the radiation balance between the measuring and fiducial rays, which was initially created by the diaphragm and calibration, is now disturbed
  - an energy difference arises (temperature change), which results in transient pressure in the front chamber
  - this transient pressure is converted into a change in capacity by the diaphragm condenser as the result of the deflection of the metal diaphragm against the fixed electrode.
  - As the diaphragm condenser is connected to a high-impedance DC voltage, a corresponding periodic AC signal is generated.

Influential parameters

Accompanying gas influential effects

The measuring gas is a mixture of gases comprising of the measuring component and the accompanying gas components. When the infrared absorption bands of one or more of the accompanying gas components overlap the bands of the measuring component, this influences the measuring result. The influence of the interfering gas components is called cross sensitivity or carrier gas dependancy.
The cross sensitivity is determined by connecting an inert gas (e.g. N_2) after the interfering gas component (corresponding to the measuring gas) has been added to the inert gas. This influence has an effect on the displayed measurement at the zero point.
The carrier gas dependancy, which is however rarely observed, is a result of the physical characteristics of the measuring gas differentiating sharply from those of the test gas. This interfering influence alters the slope of the device characteristics, it is corrected at the end point.
The following methods are available in the analyzer module to correct the interfering influences:

- Filter cells
- Internal electronic cross sensitivity correction
- Internal electronic carrier gas correction

Pressure

The volume concentration of the measuring cell that follows the gas law, is dependent on pressure in the measuring cell, and is therefore dependent on the process gas and atmospheric pressure. This influence affects the end point and is approx. 1% of the measurement per 1% pressure change (i.e. per 10 hPa). The influence is reduced to 0.2% by an internal pressure sensor.

Flow

The flow has an influence on the pressure in the measuring cell and the low-pass time of the module.
The flow should lie within the limits of 20...60 l/h.

Temperature

The temperature influence affects all optical components present in the optical path in different ways.
It is suppressed by the regulated heating of the optical components to 50°C.
Influence at zero point: ≤ 1% of the measuring span per 10°C
Influence at end point: ≤ 1% of the measurement per 10°C

Ambient air

There is a narrow slot between the measuring cell and the calibration equipment, and between the calibration equipment and the detector. The CO_2 of the ambient air present in this narrow slot influences the measuring signal.
This influence is compensated by assembling the module in an airtight housing.

Part 2: Components

Overview

This part

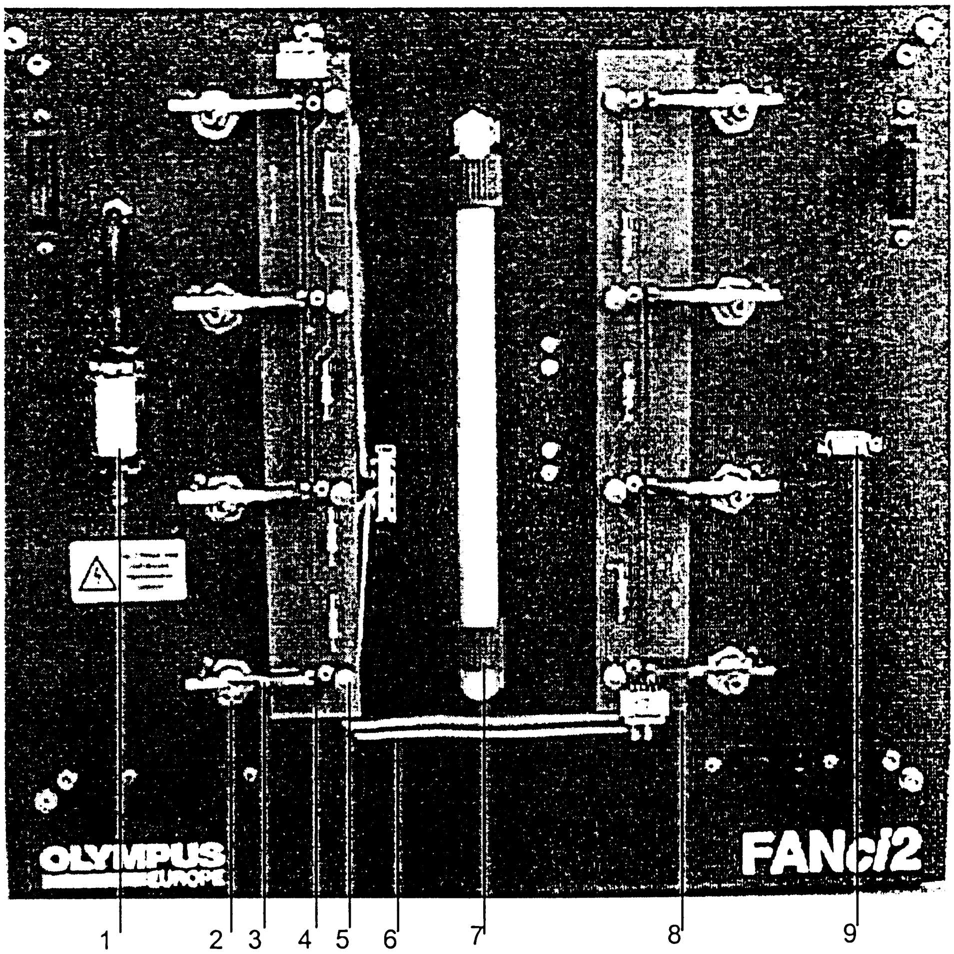
... contains the description of the individual units and components

Content of this part

Here you can find the following information

Overview

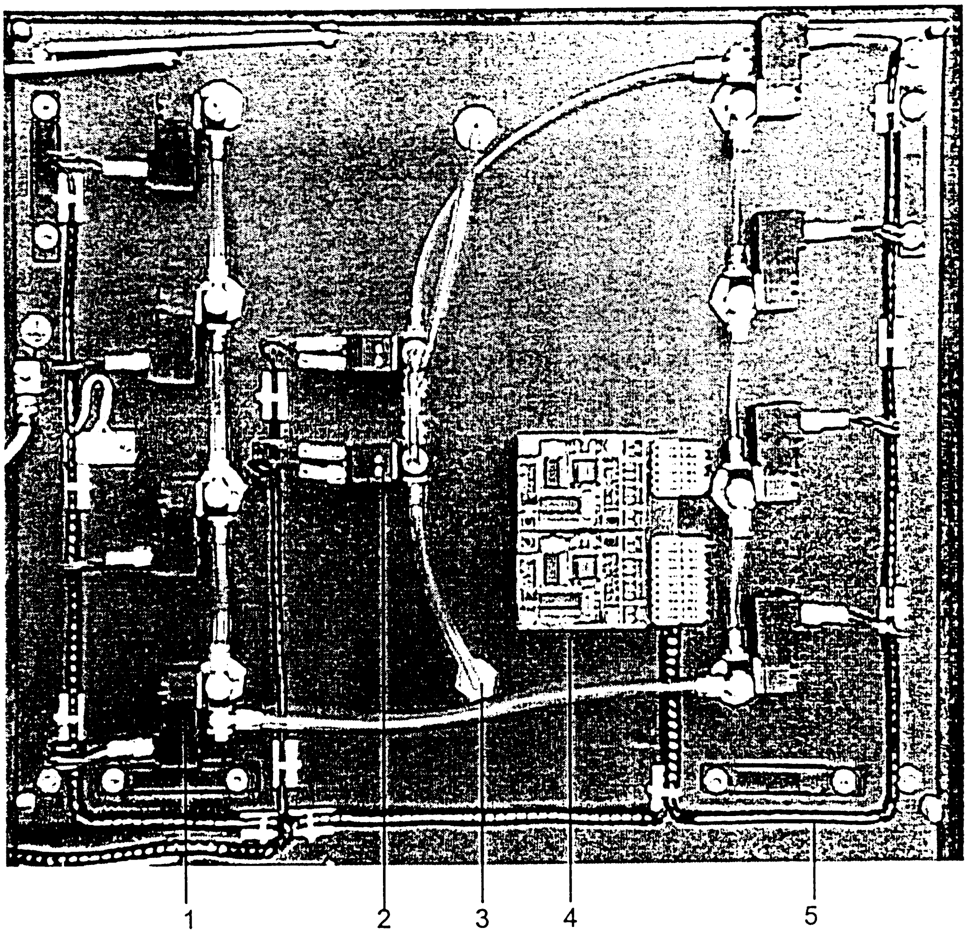
Figure 2-1a
Functional elements
on the exterior
of the housing door



1 Air filter
2 Sample inlet nozzle
3 Microswitches for sample recognition
4 Printed circuit board MSLS 1 (ports 1-4)
5 LED for display of the sample status
6 Connecting cable MSLS – DFL.SLIO
7 CO_2 absorber
8 Printed circuit board MSLS 2 (ports 5-8)
9 SUB D-9 female pin side connector for RS232

Overview, *continued*

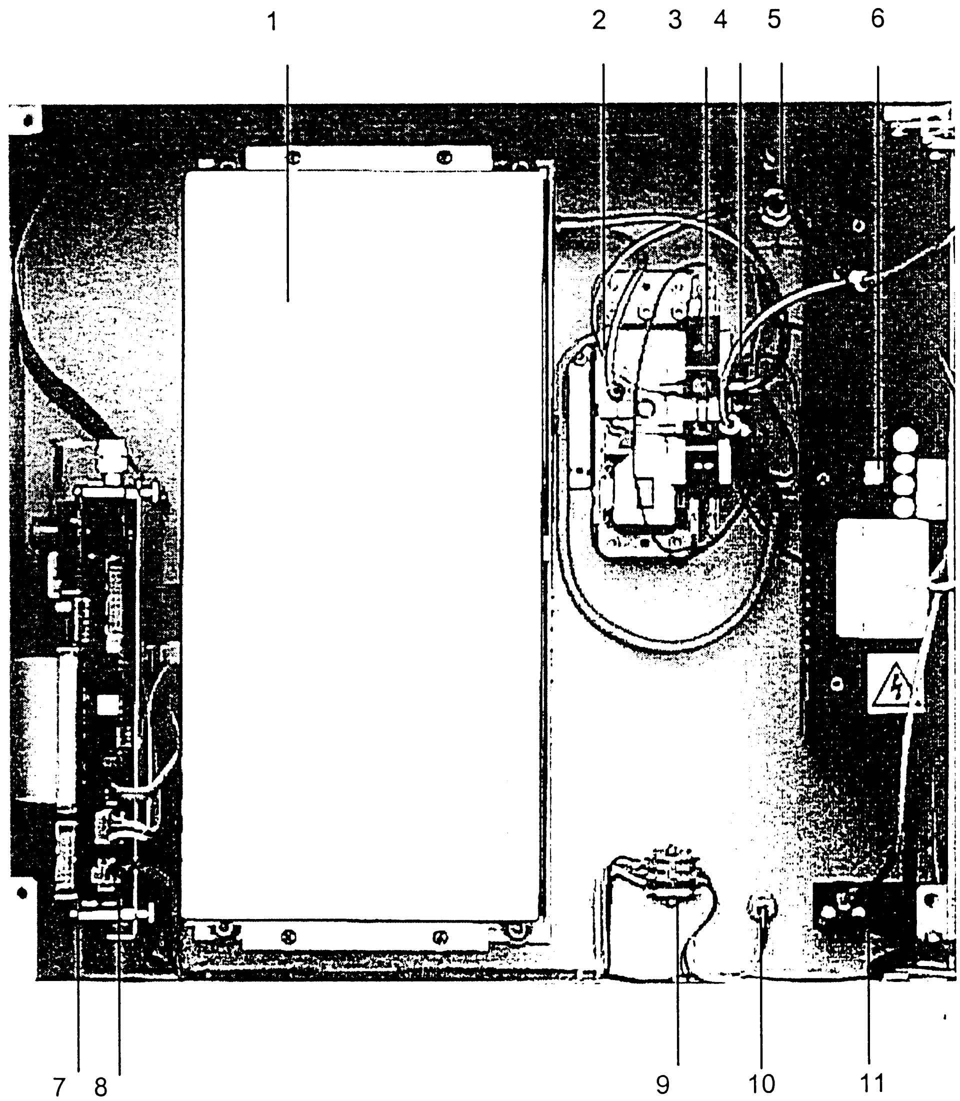
Figure 2-1b
Interior
of the housing door



1 Solenoid valves of sample ports VP 1 .. 8
2 Solenoid valves for neutral gas (VSN)
3 Quick fitting pipe union for CO_2 absorber
4 Printed circuit board DFL.SLIO with SLIOs
5 Cable tree

Overview, *continued*

Figure 2-1c
housing interior

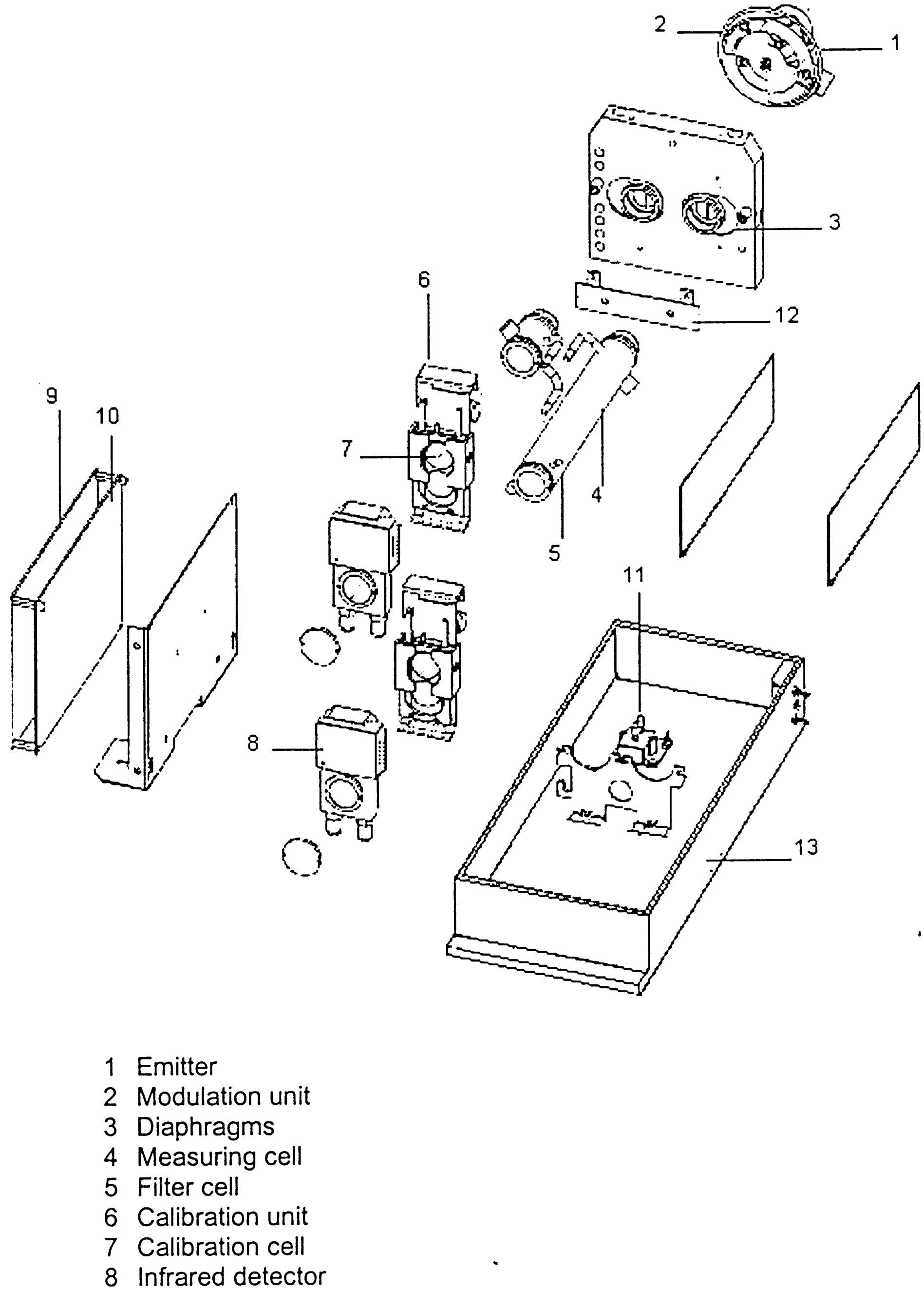


1 Analyzer module in airtight housing
2 Diaphragm pump
3 Solenoid valve for recirculation (VDA)
4 Printed circuit board VPL
5 Circulation gas adapter (upper inlet)
6 Switched mode mains power supply
7 Printed circuit board IR module
8 Printed circuit board sensor CPU
9 CAN distributor
10 Female pin side connector CAN bus
11 Appliance connection with switch

Analyzer module

Overview

Figure 2-2
Overview



1 Emitter
2 Modulation unit
3 Diaphragms
4 Measuring cell
5 Filter cell
6 Calibration unit
7 Calibration cell
8 Infrared detector
9 Printed circuit board IR module
10 Printed circuit board sensor CPU
11 Printed circuit board pressure detector
12 Printed circuit board temperature control
13 Airtight housing

Analyzer module , *continued*

Emitter

The 2 radiators are secured in the aluminium blockof the modulation unit.

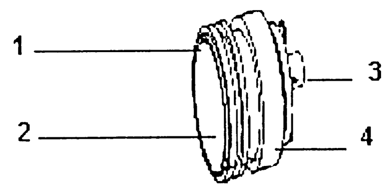
Structure

The radiator consists of a reflector body, in which a wire coil with a ceramic sleeve is positioned. This unit is sealed gastight with an infrared pervious window.
The radiator is filled with a special gas to increase service life.

Functioning

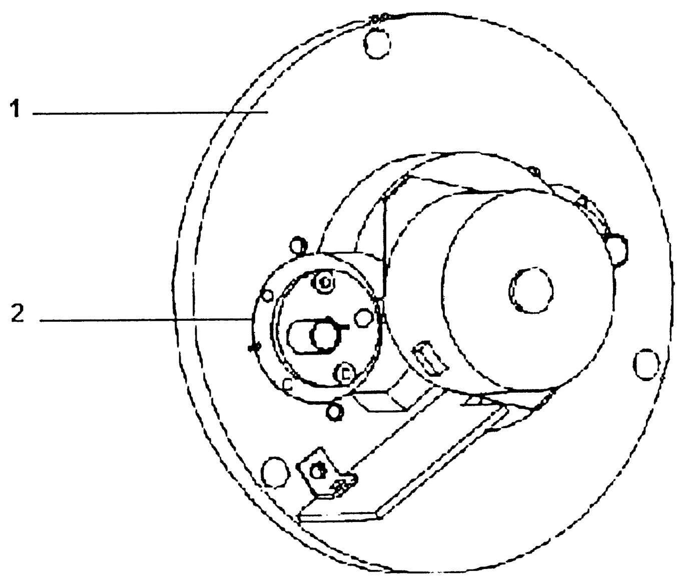
DC voltages of approx. 5...10 V are applied to the radiator depending on the measuring components and measuring ranges.
The coil sends a constant wide band infrared radiation of corresponding intensity.

Figure 2-3
Emitter insert



1 Infrared pervious window
2 Emitter coil (not visible here)
3 Electrical connections
4 Reflector housing

Figure 2-4
Modulation unit with emitter insert



1 Modulation unit (receiver piece)
2 Radiator

Modulation unit

The modulation unit is secured to the main mount with iris mode selection

Structure

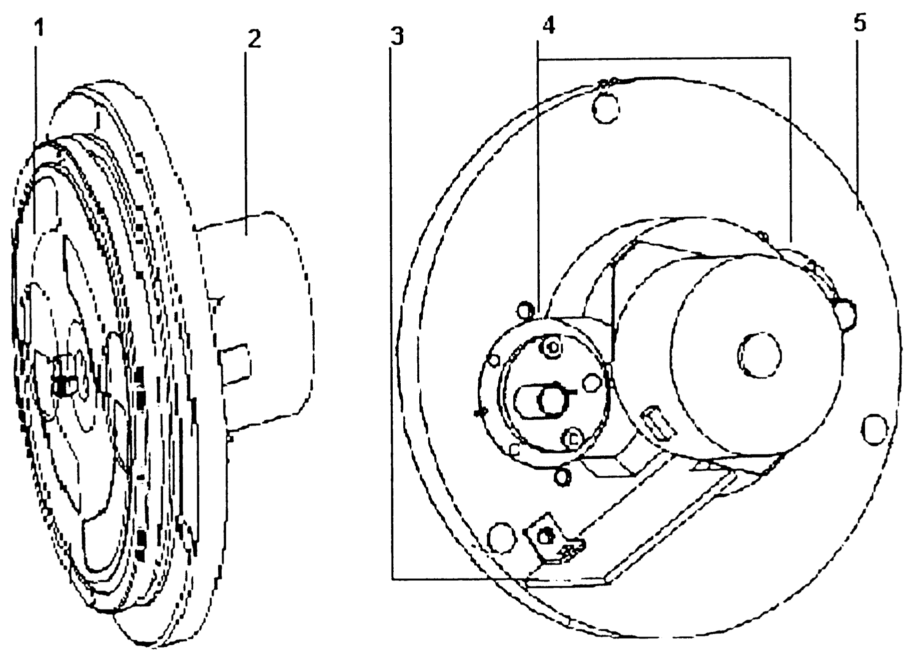
The modulation unit consists of:

- Receiver piece, on which all components are mounted
- 2 radiators
- Diaphragm wheel
- Synchronous induction motor to drive the diaphragm wheel
- Coupler between the synchronous induction motor and the diaphragm wheel
- Printed circuit board with
  - Connections for supply to emitter
  - Connection for synchronous induction motor
  - Forked light barrier
- O-rings for sealing the emitter inserts and the complete modulation unit

Functioning

The synchronous induction motor drives the diaphragm wheel by computer control. Modulation frequency: 7.3 Hz (standard setting). The diaphragm wheel driven in this way is designed so that it alternately covers the measuring or the fiducial chamber of the measuring cell so that the infrared radiation of the emitter alternately enters through each chamber twice per rotation.
Coordination is effected by the forked light barrier, by a tag which is fixed to the motor axis.
Through the chosen design, modulated radiation occurs which contributes to the high stability of the measuring signal.

Figure 2-5
Modulation unit



1 Diaphragm wheel
2 Synchronous induction motor
3 Printed circuit board emitter
4 Radiators
5 Receiver piece

Analyzer module , *continued*

Diaphragms

The diaphragms with adjusting screws are located on the main mount between the modulation unit and the measuring cells.

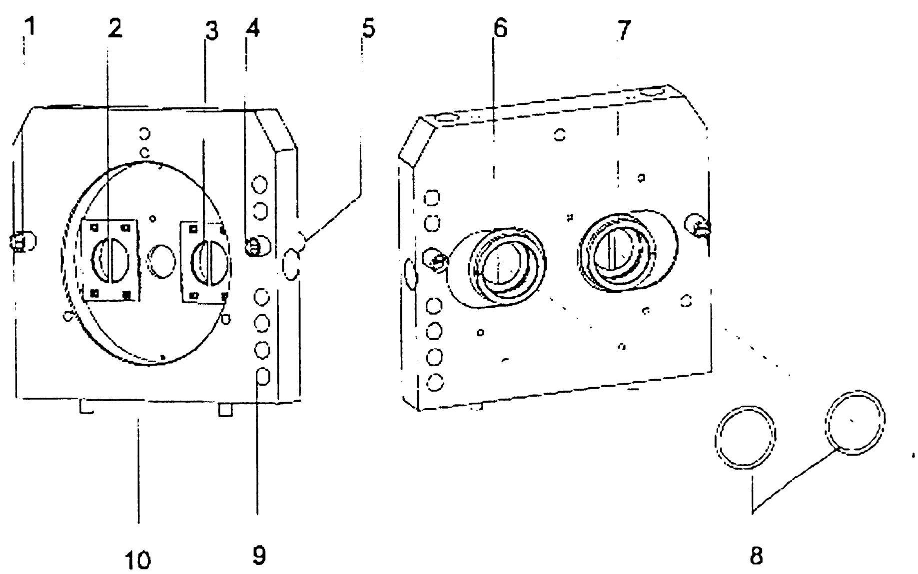
Structure

On the main mount, 2 diaphragms are always mounted which can be moved horizontally back and forth in sliding devices by a worm gear.
They are designed as a reproduction of the measuring cell divided into measuring and fiducial chamber.

Functioning

The diaphragms more or less shadow the infrared radiation of the emitter depending on the adjustment setting for the measuring or fiducial beam.
Aim: Same intensity for both beams in the infrared detector during the basic setting.
Asymmetries are caused by design or measuring gas.
Alignment takes place through the function "Optical alignment".

Figure 2-6
Diaphragms



1	Diaphragm adjusting screw for ray path 1
2	Diaphragm in ray path 1
3	Diaphragm in ray path 2
4, 5	Diaphragm adjusting screw for ray path 2
6	Receiver for measuring cell in ray path 2
7	Receiver for measuring cell in ray path 1
8	O-rings for sealing the measuring cell(s)
9	Hose openings
10	Main mount

Analyzer module , *continued*

Measuring cell

The measuring cell is mounted between the main mount with the modulation unit and the calibration unit.

Structure

The cell consists of a gold-plated profiled pipe. It is divided by separator into a measuring chamber and a fiducial chamber. The chambers are sealed on both sides by infrared pervious windows. The fiducial chamber is generally filled with N_2. The measuring chamber can be supplied with measuring gas by 2 gas connectors. The gas connectors are designed for pipe and hose connections. Positioning pins clearly position the measuring cell in the ray path. Due to the design, short measuring cells are also equipped with additional chambers in the measuring and fiducial beams which are filled with N_2.

Functioning

The cells are of different lengths depending on the measuring range.
As the infrared detectors are equipped with a permanently allocated signal efficiency for the component to be measured, the absorption adjustment must occur in the measuring cell according to the LAMBERT-BEER law. The absorption of infrared beams is dependant on the concentration to be measured (measuring range) and the optical path length.
The optical path length is the segment in the measuring and fiducial chamber between the two limiting windows.
The gold-plating of the chamber surface areas has the following purpose:

- Optimum reflection of beams
- Protection against corrosion of the cell

The reflection qualities are taken into account during optical alignment and calibration.

Analyzer module , *continued*

Filter cell

The filter cell is mounted between the measuring cell and the calibrating cell.

Structure

The filter cell consists of a gold-plated profiled pipe.
It is divided into a measuring chamber and a fiducial chamber by a link, which are connected by the gas.
The filter cell is sealed on both sides with infrared pervious windows. Two positioning pins correctly position the filter cell in the ray path.

Functioning

Measuring and fiducial sides are individually filled with the appropriate interfering gas. This effects the absorption of the proportion of radiation in the area of the interfering gas absorption lines.
Result: Cross sensitivity is greatly reduced.

Analyzer module , *continued*

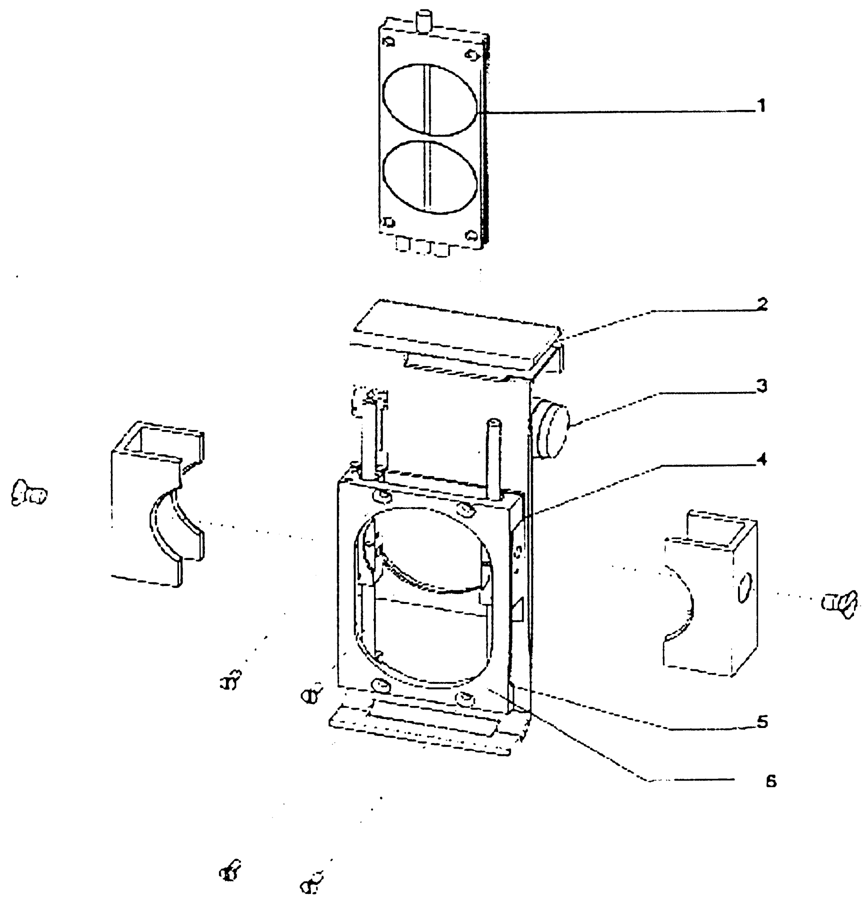
Calibration unit

The calibration unit is located between the filter cell and the infrared detector.

Structure

The calibration unit is a motor driven sliding unit for the calibration cell.
A small geared motor with a carrier hoop moves a slider.
In order to better position and fix the calibration cell, small permanent magnets are used.
Fastening is achieved using two U-elbow joints.

Figure 2-7
Calibration unit



1 Calibration cell
2 Printed circuit board plug-in termination
3 Geared motor
4 and 5 Permanent magnets
6 Slider

Analyzer module , *continued*

Calibration cell

The calibration cell is mounted in the calibration unit.

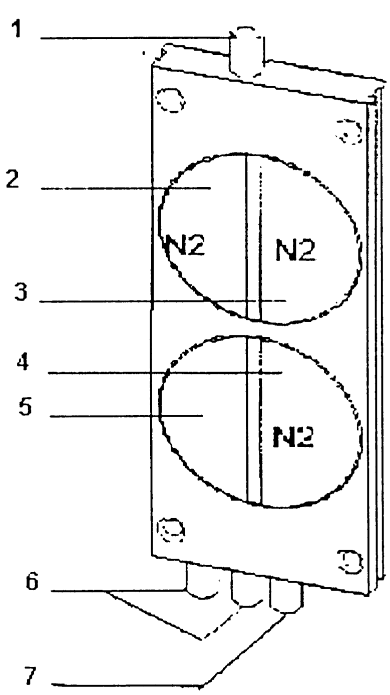
Structure

The housing of the calibration cell consists of a gold-plated metal frame with four chambers which are made gas tight by infrared pervious windows.
Three chambers are filled with nitrogen.
One chamber is filled with the necessary test gas mixture.

Functioning

The calibration cell is used for calibrating the end point.
One calibration cell is mounted in each ray path.
The gas filling of the calibration cell is comparable to that of a test gas cylinder.
The concentration printed on the calibration cell is the
filling concentration.
It is not identical to the calibration concentration. This must be determined with a test gas.

Figure 2-8
Calibration cell



1 Filling nozzle N_2 (sealed and soldered to be gas tight)
2,3 Chambers filled with N_2, in ray path during measuring operation and zero-point calibration
4 Chamber filled with N_2, in reference path of rays during end point calibration.
Chamber filled with test gas, in measured path of rays during
5 end point calibration
Test gas filling nozzles (sealed and soldered to be gas tight)
6 Filling nozzle N_2 (sealed and soldered to be gas tight)
7

Analyzer module , *continued*

Infrared detector

The infrared detector is located at the end of the filter cell.

Structure

The infrared detector consists of the following parts:

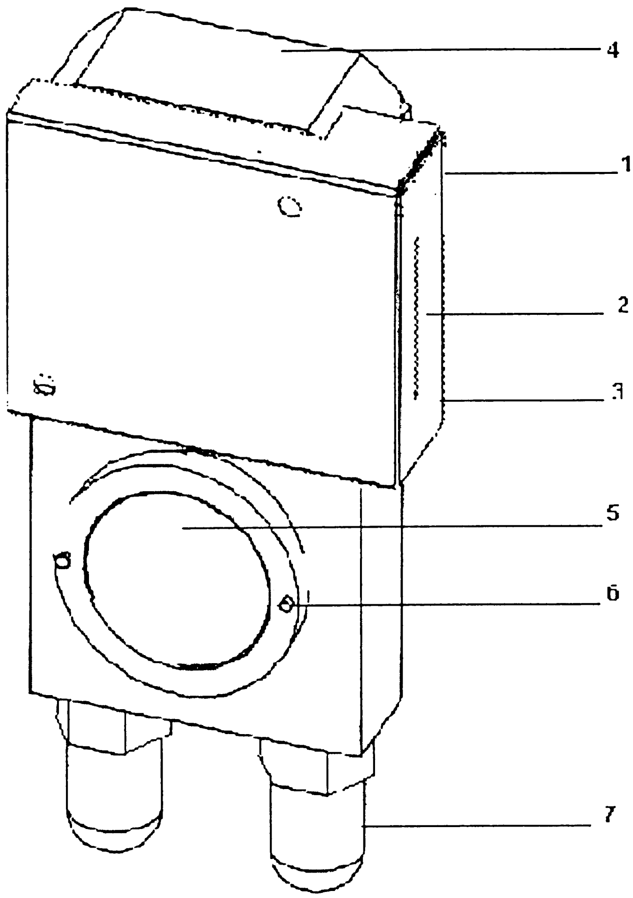
- Optopneumatic part consisting of two chambers lying one behind the other. They are separated from each other by infrared pervious windows.
  The chambers are equipped with a gas filling, which corresponds to the respective measuring component.
  In the non-irradiated part is the diaphragm condenser, consisting of a metal diaphragm installed gas tight between the two chamber parts and a stationary backplate electrode. Both parts are connected to the preamplifier through gas tight openings.
- Preamplifier - is an integral part of the detector.
  A temperature sensor is integrated into the preamplifier, which can be used to compensate the temperature (not configured).

Functioning

The rays which enter the detector are absorbed in the area of the absorption lines of the filler gas and instantly transformed by molecular collisions into thermal energy or pressure. This change in pressure is picked up by the diaphragm condenser.
Through a high-impedance circuitry, the applied voltage of 150 V generates a corresponding alternating voltage signal in the mV range.
The main absorption of the rays takes place in the front chamber (positive response). In the rear chamber, the edge-side proportion of rays of the rotation lines is active, which in the case of overlap for interfering gas components, leads to cross sensitivity. Due to the larger depth of the rear chamber, these interfering rays are largely absorbed, so that an increase in pressure also occurs here, which counteracts the pressure in the front chamber. In this way, a certain suppression of cross sensitivity influences can be reached.
The temperature sensor serves as a detector of the ambient temperature of the optical components. Therefore it can be used to compensate the temperature of the measuring signal. Only the sensor of the first infrared detector is used.

Analyzer module , *continued*

Figure 2-9
Infrared detector



1 Bridges for amplification adaption (hidden)
2 Preamplifier
3 Connection plug for the printed circuit board IR module (covered)
4 Diaphragm condenser
5 Front and rear chambers
6 Positioning pins / bores
7 Filling nozzles (mechanically sealed and soldered)

Figure 2-10
Preamplifier
Connector assignment

Connector 1 Connection to IR electronics	
SIGN. GND	1
+ 150V	2
	3
AGND	4
TEMP	5
+ 15V	6
GNDA	7
SIGN. INP	8
TEST	9
- 15V	10

Note

There is no pin 3 on plug ST1.
It was removed for coding (correct positioning of the plug).

Analyzer module , *continued*

Printed circuit board IR module

The printed circuit board is located latterally to the analyzer module and is plugged in the printed circuit board sensor CPU.

Structure

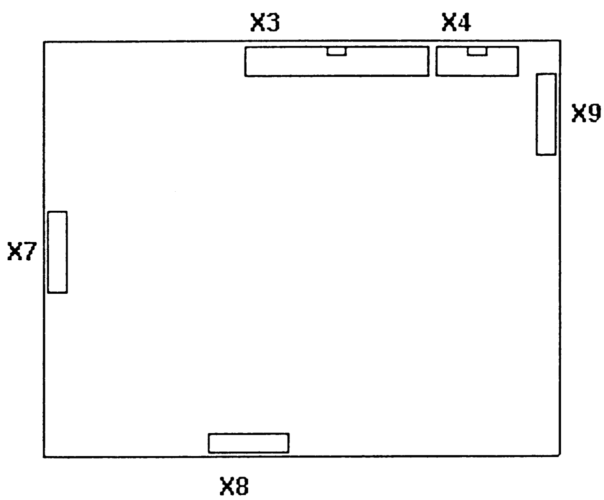
The printed circuit board is equipped with 3 socket boards for supply and signal transmission on its rear.
The connection to the optical components takes place using a 50 pole pin strip by means of a flat cable.

Functioning

The printed circuit board contains the following functions:

- 4-channel electronics for the 4 possible infrared detectors with the amplification adjustment of 0.3/1.0/3,5/12 controlled by the computer.
- Mains power supply 150 V for the diaphragm condensers
- Mains power supply for emitter 1 with computer controlled emitter output setting.
- Mains power supply for emitter 2 with computer controlled emitter output setting.
- Power supply for diaphragm wheel motor
- Light barrier signal
- Mains power supply for the motors of the calibration unit

Figure 2-11
Printed circuit board IR module (Schematic)



Inputs/Outputs

X3 Preamplifier infrared detector 1
Preamplifier infrared detector 2
Modulation unit (emitters 1 and 2, synchronous induction motor, forked light barrier)
Calibration unit 1
Calibration unit 2
Pressure sensor
X4 Preamplifier infrared detector 3 (not used)
Preamplifier infrared detector 4 (not used)
X7 Connection to printed circuit board sensor CPU
X8 Connection to printed circuit board sensor CPU
X9 Connection to printed circuit board sensor CPU

Analyzer module , *continued*

Figure 2-12
Plug X3 of the printed circuit board IR module

Plug X 3		Plug X3	
S1 +	1	CCVORH 1	39
S1 +	2	CC 1	40
F1 +	3	+ 15V	41
S1 -	4		42
F1 -	5		43
S2 -	6		44
S2 +	7	CCVORH 2	45
F2 -	8	CC 2	46
MOTOR 1	9	+ 15V	47
F2 +	10		48
MOTOR 2	11		49
	12		50
+ 5V	13		
L-SCHR	14		
+ 15V	15		
- 15V	16		
	17		
BARO 1	18		
	19		
+ 150V	20		
	21		
	22		
LN335 -1	23		
+ 15V	24		
	25		
VV 1	26		
VV-Test	27		
- 15V	28		
	29		
+ 150V	30		
	31		
	32		
LM 335-2(nc)	33		
+ 15V	34		
	35		
VV 2	36		
VV-Test	37		
- 15V	38		

Printed circuit board Sensor CPU

The printed circuit board sensor CPU is located laterally to the analyzer module and is linked to the printed circuit board IR module

Structure

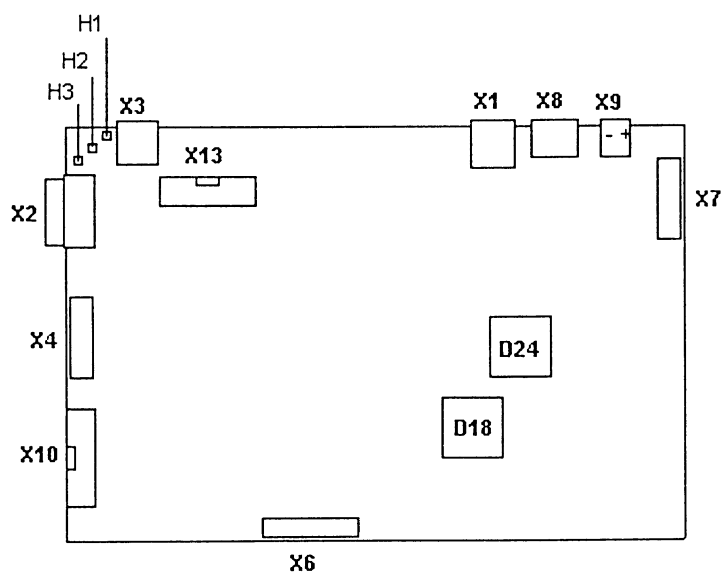
For signal transmission the printed circuit board sensor CPU is linked to the printed circuit board IR module using 3 pin strips.
Furthermore, there are 5 plug-type connectors to central and peripheral functions.

Functioning

The printed circuit board contains the following functions:

- Processor for module signal processing and controlling
- Auxiliary parameters A/D converter
- Multiplexer auxiliary parameters
- Signalling of the internal sample processing
- Mains power supplys 15V, 24V
- Reset generation
- Controller for internal bus

Figure 2-13
Printed circuit board Sensor CPU (Schematic)



Inputs/Outputs

X1	CAN bus
X2	RS232/Service
X3	RS232
X4	Connection to printed circuit board IR module
X6	Connection to printed circuit board IR module
X7	Connection to printed circuit board IR module
X8	Heating
X9	24V supply
X10	Connection to the internal sample processing (pump, valves)
X13	Dongle

Analyzer module , *continued*

Equipment

D24	Flash EPROM with firmware
D18	EEPROM with analyzer data
H1	Green LED, power supply
H2	Yellow LED, analyzer module needs service
H3	Red LED, sensor CPU failure

The EEPROM D18 contains all analyzer and electronic data.

Figure 2-14
Connector assignment
Sensor CPU

Connector X 1 CAN bus	
GNDCAN	1
CANL	2
CANH	3
GNDCAN	4

Connector X 2 RS232 Service	
	1
TXD1	2
RXD1	3
	4
GND	5
	6
	7
	8
	9

Connector X 3 RS232	
GND	1
RXD2	2
TXD2	3

Connector X 8 Heating	
24V heat	1
HEATING	2
GND	3
NTC1	4

Connector X 10 Pneumatics	
PUMP 24V	1
PUMP 24V	2
PUMP M	3
PUMP M	4
VDA 24 V	5
VDA M	6
VSN 24 V	7
VSN M	8
VEG 24 V	9
VEG M	10
NTC2	11
GROUND	12
not used	13 - 26

Printed circuit board pressure sensor

The pressure sensor is mounted on the base plate of the analyzer module.

Structure

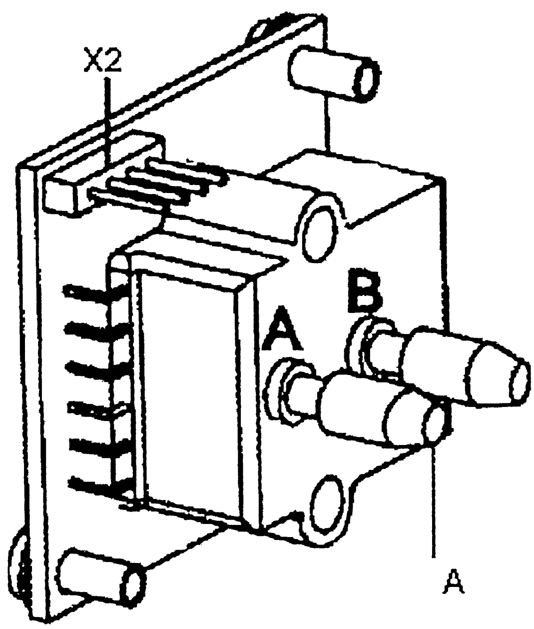
The pressure sensor is secured on a printed circuit board with appertaining circuitry.
The printed circuit board is linked to the printed circuit board IR module using a plug connection.

Functioning

The pressure sensor has the task of measuring the pressure in the measuring cell.
The signal is processed to correct the pressure of the measuring signal.
As an option, the pressure sensor can also measure external pressure using a separate hose line.
Technical features:

- Absolute pressure sensor
- Operating range 700...1300 mbar
- Offset calibration necessary

Figure 2-15
Printed circuit board
Pressure sensor



Inputs/Outputs

X2	Connection to printed circuit board IR module
A	Gas inlet (pressure in the measuring cell)

Analyzer module , *continued*

Printed circuit board temperature control

The printed circuit board is fixed to the main mount.

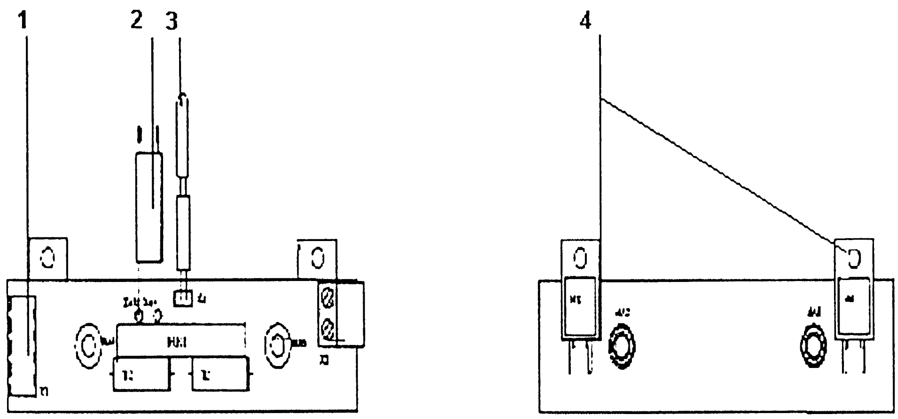
Structure

The printed circuit board contains 2 heating resistors. The temperature sensing device (NTC) is soldered on by means of a cable. Additionally a connection cable for the additional heating is soldered on. Supply and control is fed via a plug.The thermal link is connected by clamping.

Functioning

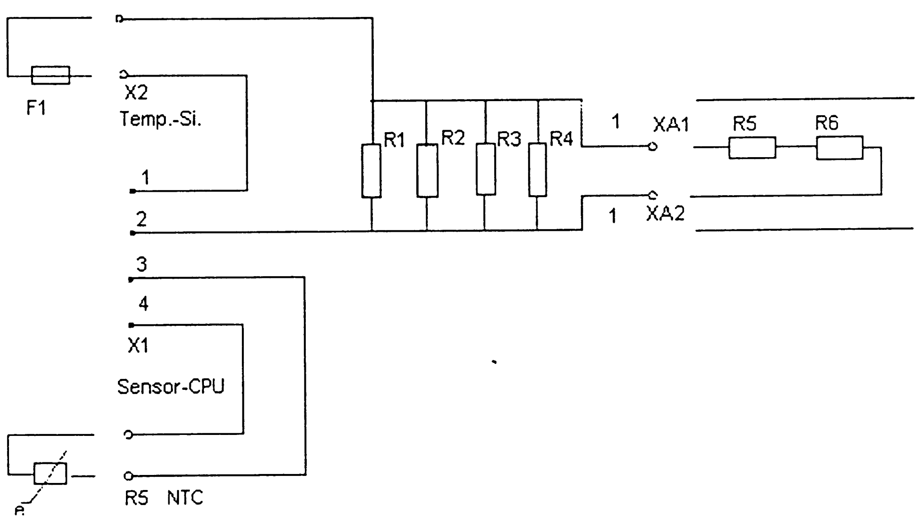
The printed circuit board temperature control is responsible for the temperature control of the optical components. The temperature control is set at 50°C.
The thermal link triggers at 85°C.

Figure 2-16



1 Connector X1 supply, control
2 Connection to additional heating in the hood
3 Temperature sensor (NTC)
4 Heating resistors

Figure 2-17
Connector assignment
Printed circuit board
Temperature control



Inputs/Outputs

X1	Plug-in termination for sensor CPU
X2	Terminal connection thermal link
R5	Soldering joints for temperature sensor NTC
XA1/XA2	Plug-in termination for additional heating in the hood

Airtight housing

The housing surrounds the optical components.

Structure

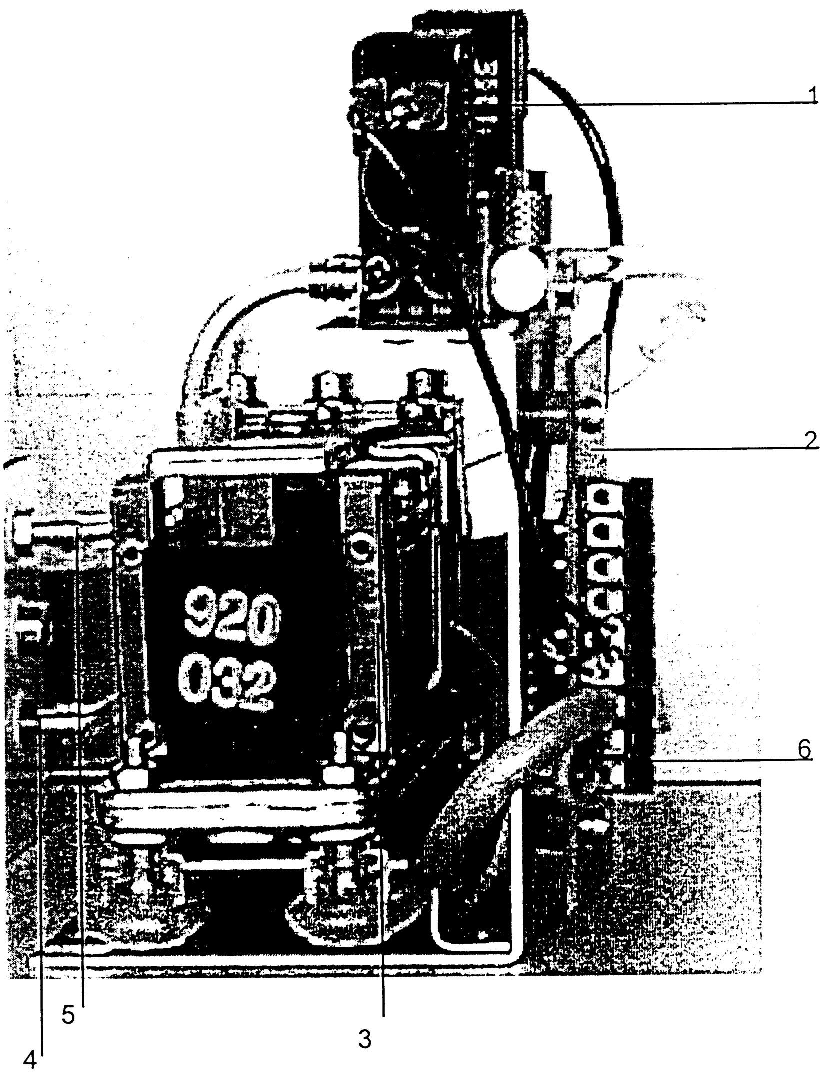
The airtight sealed housing consists of an aluminium tank with inlets for the signal lines and test gas. On each side, two heating elements are mounted. The tank is closed with a hood which is positioned on a rubber packing.

Functioning

The heated tank together with the heating on the main mount controls the temperature of all optical components. The heaters located at the side of the measuring cells are connected to the printed circuit board temperature control by a plug connection.
Also, the influence of ambient air on the measurement is prevented by the airtight sealed housing.

Metering and recirculation system

Figure 2-18
Overview



1 Solenoid valves (VDA) SP: pos.. 23
2 Printed circuit board VPL SP: pos.. 14
3 Diaphragm pump SP: pos.. 22
4 Input to analyzer module
5 Analyzer module output
6 Terminal screws SK on VPL

Structure

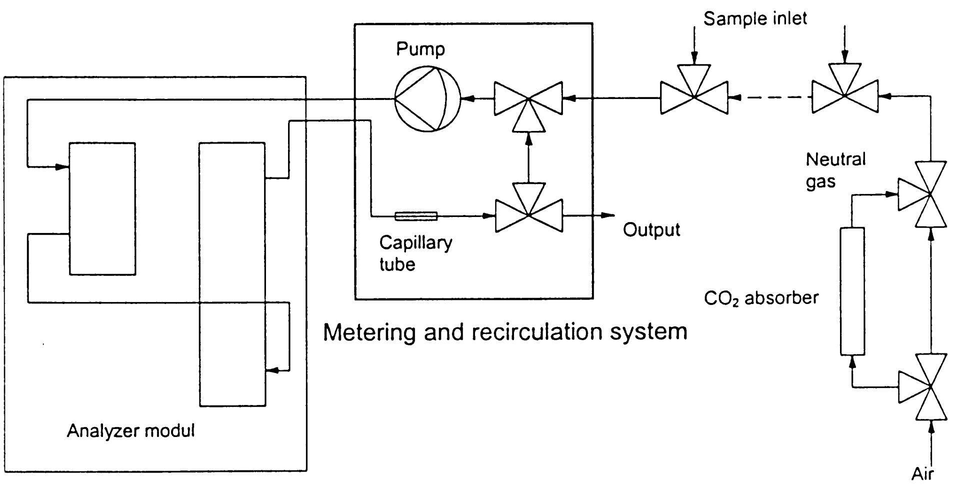
A diaphragm pump, a capillary tube, 2 3/2-way solenoid valves and the hose connections are parts of the metering and recirculation system. The measuring cells and the hose connections of the analyzer module also have to be regarded as parts of the metering and recirculation system.
In order to keep the recirculation volume low, it is located immediately next to the analyzer module.

Metering and recirculation system, *Continued*

Functioning

During the measuring of the gas samples, the analysis gas circulates. The metering and recirculation system controls the feeding of circulation gas and neutral gas, as well as the metering and recirculation of the measuring gas. When switching on the appliance, gas in the system circulates.

Figure 2-19 Metering and recirculation system



Assignment VPL

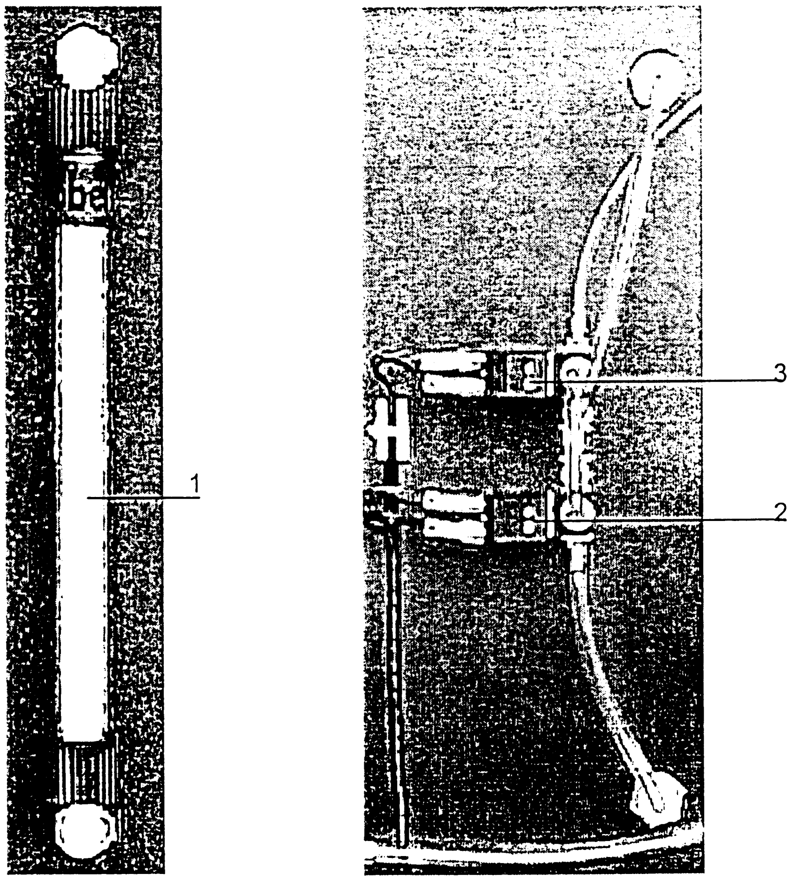
Terminal screws SK

Pin	Assignment
1	Pump (PE)
2	Pump (24 V)
3	Pump (GND)
4	VDA (24 V)
5	VDA (GND)
6	VSN (24 V)
7	VSN (GND)
8	VEG (24 V)
9	VEG (GND)

Neutral gas generator

Figure 2-20
Overview

Outside housing door | Inside housing door



1 CO_2 absorber — SP: pos.. 34
2 Solenoid valve VSN 1 — SP: pos.. 23
3 Solenoid valve VSN 2 — SP: pos.. 23

Structure

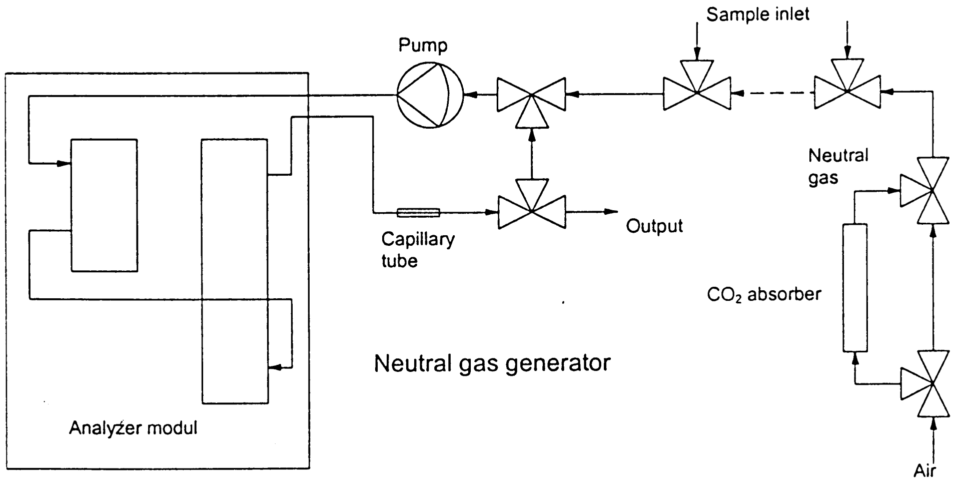
The neutral gas generator consists of a CO_2 absorber and 2 3/2-way solenoid valves. It is located directly behind the gas inlet.

Neutral gas generator, *Continued*

Functioning

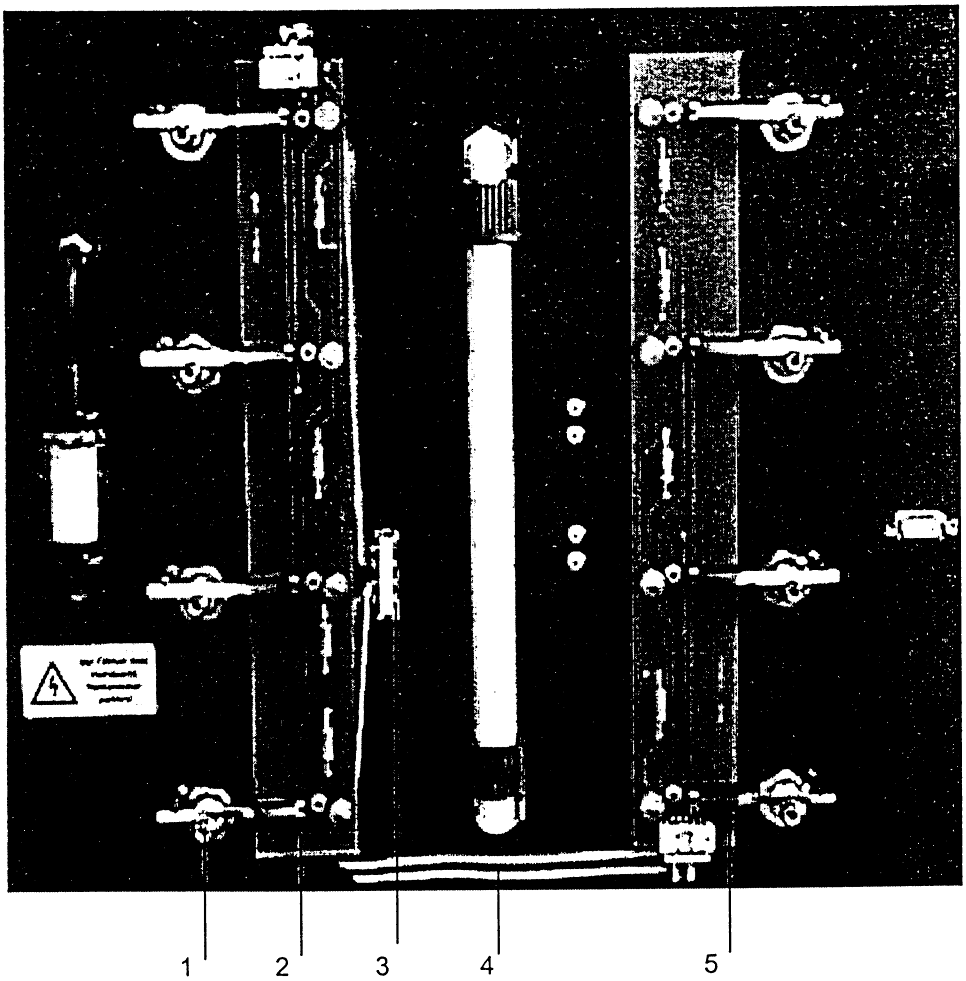
The CO_2 absorber generates air free of CO_2, which is needed for rinsing the gas pipes during the calibration and after and before each measurement.

Figure 2-21
Neutral gas generator



Sample inlet and control system

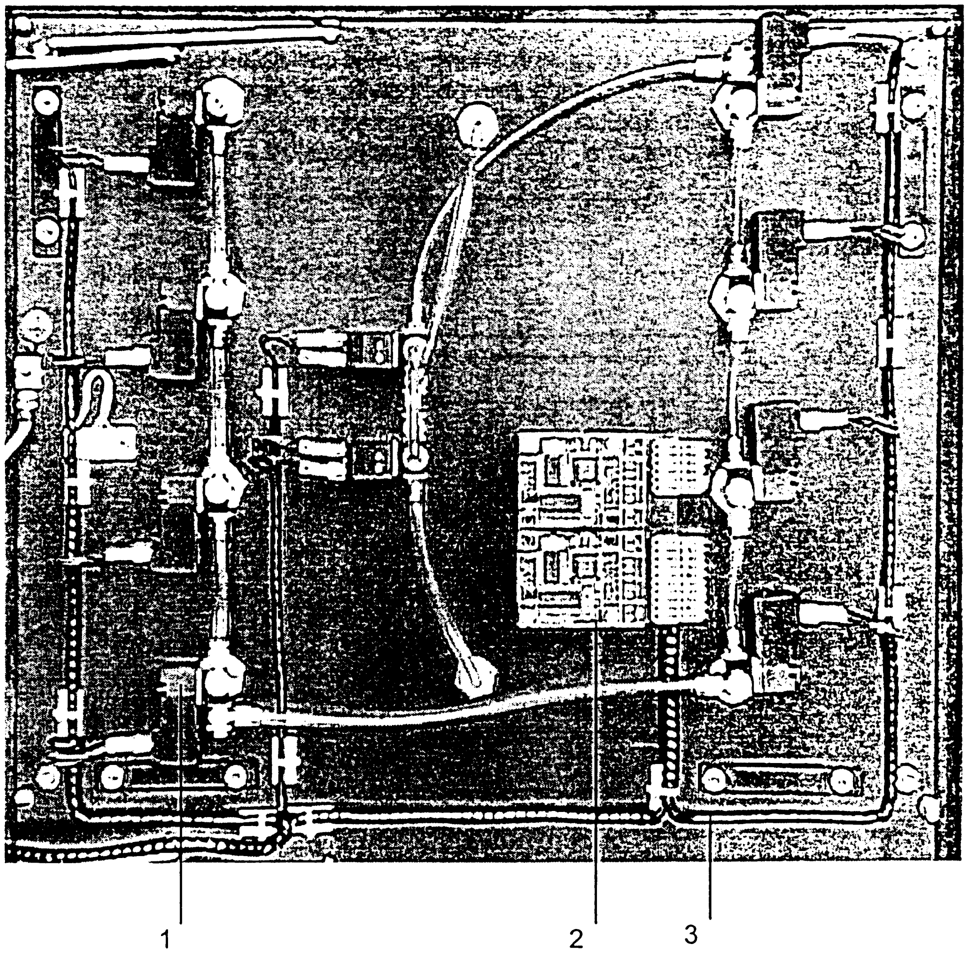
Figure 2-22
Overview (external)



1	Sample inlet nozzle	SP: pos.. 30
2	Printed circuit board MSLS 1 (ports 1-4)	SP: pos.. 15
3	Plug S5 on DFL.SLIO	
4	Connection cable to DFL.SLIO	SP: pos.. 7
5	Printed circuit board MSLS 2 (ports 5-8)	SP: pos.. 15

Sample inlet and control system, *Continued*

Figure 2-23
Overview (internal)



1 Solenoid valves of the sample portsVP 1 .. 8 — SP: pos.. 23
2 Printed circuit board DFL:SLIO with SLIOs — SP: pos.. 11-13
5 Cable tree

Structure

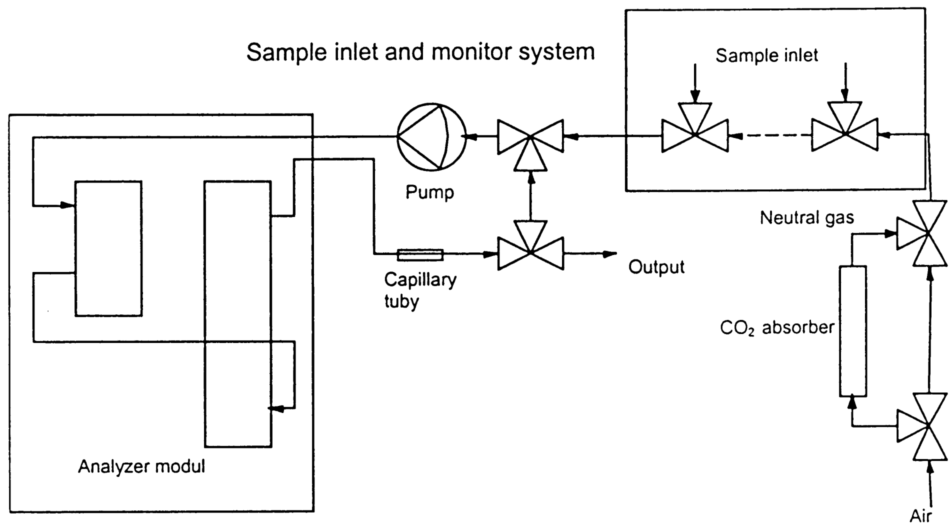
The sample inlet and control system consist of 8 sample connections, which are directly connected to the measuring gas valves. On the printed circuit boards MSLS 1 and MSLS 2 the microswitches for the sample recognition and the LED for showing the sample status are located. The signalling of the microswitches, the LED and the valves is effected by two SLIO cards, which are plugged onto the printed circuit board DFL.SLIO.

Sample inlet and control system, *Continued*

Functioning

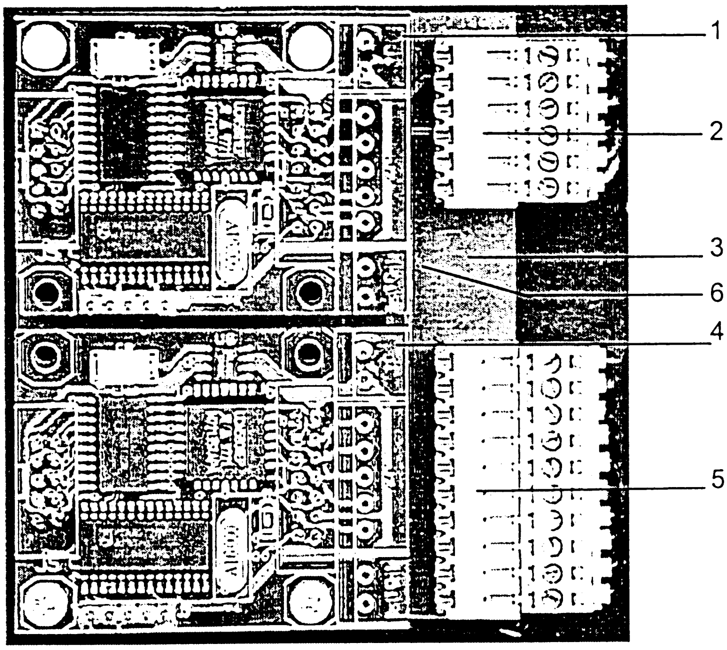
The feeding of the measuring gas into the metering and recirculation system and thus to the measuring cells is controlled by the sample inlet and control system.
A mechanical end-point switch signals if a sample is installed at any port.
In addition, the monitor system ensures that only one port can be opened at any one time. The status of each port is displayed by a green LED.

Figure 2-24
Sample inlet and control system



Sample inlet and control system, *Continued*

Figure 2-25
Printed circuit board DFL:SLIO with SLIOs
ET: Pos.. 11-13



1	SLIO 1 (ID: 0x40E)	SP: pos.. 12
2	Connector strip L1 (24 VDC and CAN bus)	
3	DFL.SLIO	SP: pos.. 11
4	SLIO 2 (ID: 0x40F)	SP: pos.. 13
5	Connector strip L2 (control system port valves)	
6	Connector S5 (underside)	

Connector assignment DFL.SLIO

Connector S5 (microswitches MS and LED)

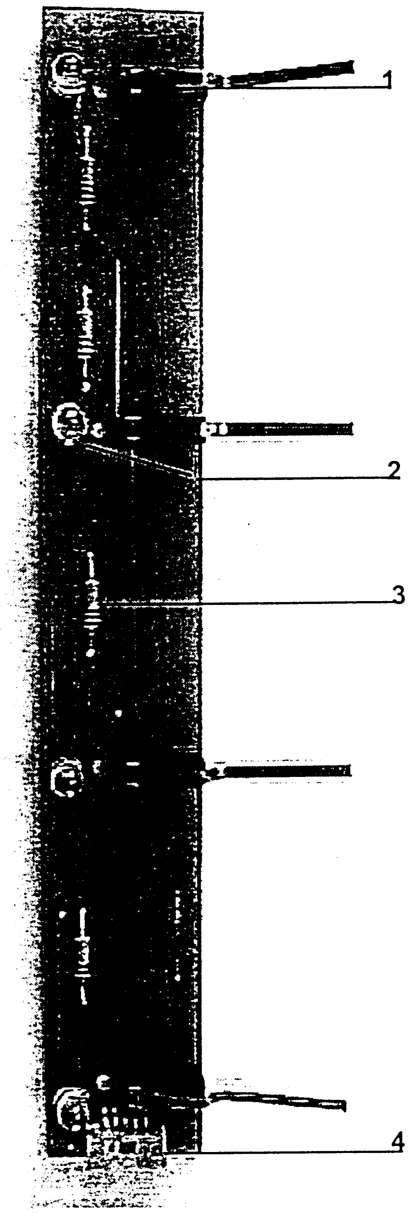
Pin	Assignment	Pin	Assignment
1	COM MS 1..4	11	-24 V LED 5
2	COM LED 1..4	12	+24 V MS 5
3	+24 V MS 1	13	-24 V LED 6
4	-24 V LED 1	14	+24 V MS 6
5	+24 V MS 2	15	-24 V LED 7
6	-24 V LED 2	16	+24 V MS 7
7	+24 V MS 3	17	-24 V LED 8
8	-24 V LED 3	18	+24 V MS 8
9	+24 V MS 4	19	COM LED 5..8
10	-24 V LED 4	20	COM MS 5..8

Connector L2 (port valves)

Pin	Assignment
1	COM MV 1..4
2	COM MV 5..8
3	-24 V MV 1
4	-24 V MV 2
5	-24 V MV 3
6	-24 V MV 4
7	-24 V MV 5
8	-24 V MV 6
9	-24 V MV 7
10	-24 V MV 8

Sample inlet and control system, *Continued*

Figure 2-26
Printed circuit board
MSLS 2
ET: Pos.. 15



1 Microswitches for sample recognition
2 LED for display of the sample status
3 Resistor for LED
4 Connector SL (connection to DFL.SLIO)

Connector assignment for the printed circuit board MSLS

The printed circuit board MSLS 1 (ports 1..4) and MSLS 2 (ports 5..8) are of the same design and only differentiate in the assignment of the pins on the connector SL

Connector SL on MSLS 1

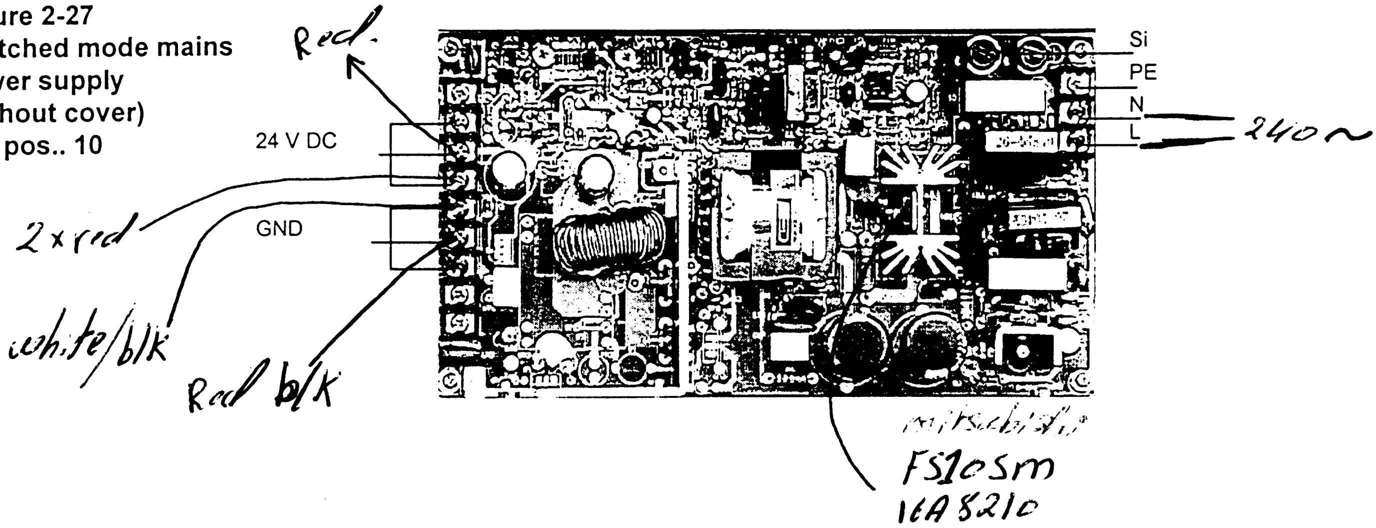
Pin	Assignment
1	COM MS 1..4
2	COM LED 1..4
3	+24 V MS 1
4	-24 V LED 1
5	+24 V MS 2
6	-24 V LED 2
7	+24 V MS 3
8	-24 V LED 3
9	+24 V MS 4
10	-24 V LED 4

Connector SL on MSLS 2

Pin	Assignment
1	COM MS 5..8
2	COM LED 5..8
3	+24 V MS 8
4	-24 V LED 8
5	+24 V MS 7
6	-24 V LED 7
7	+24 V MS 6
8	-24 V LED 6
9	+24 V MS 5
10	-24 V LED 5

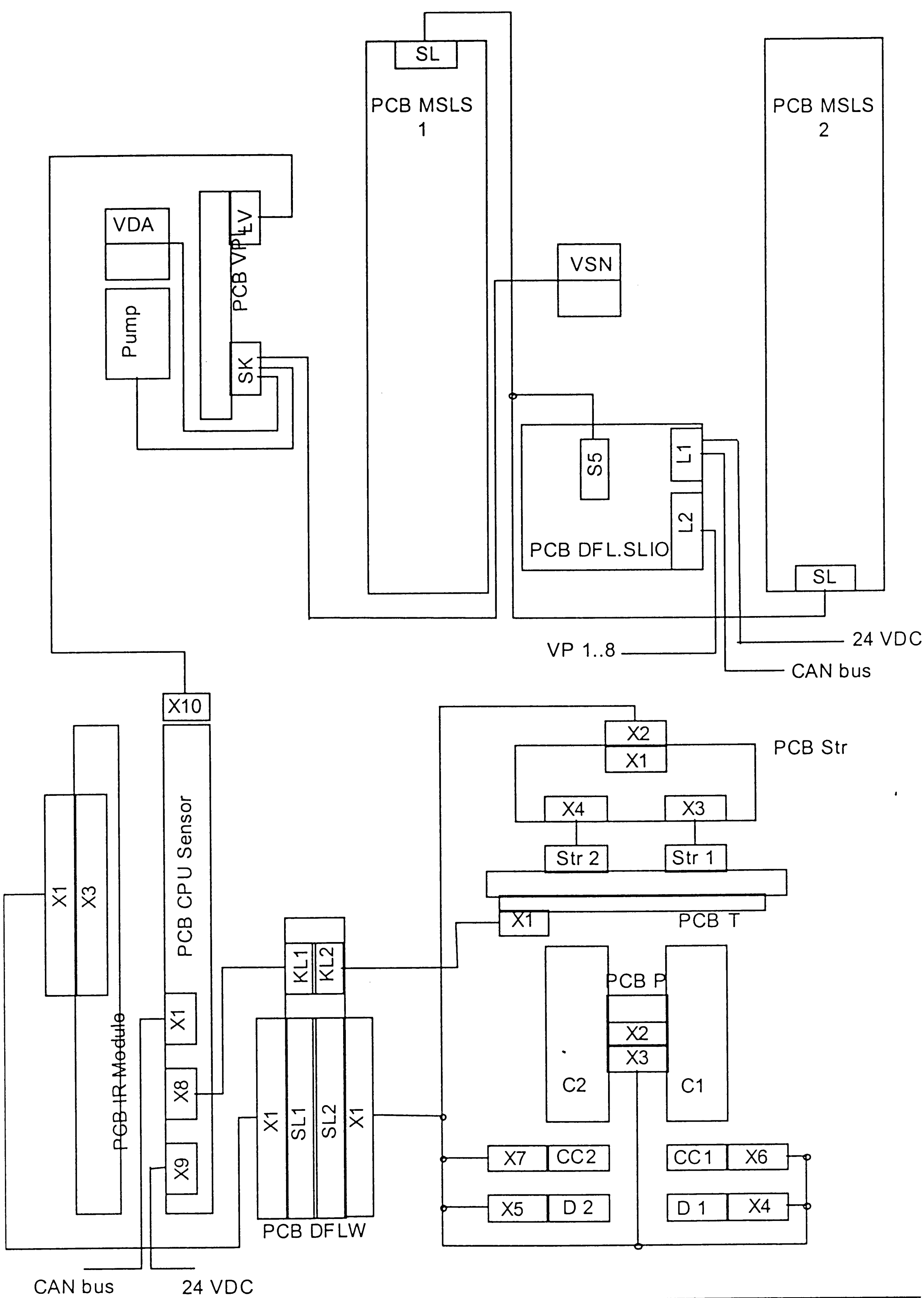
Supply

Figure 2-27
Switched mode mains power supply (without cover)
SP: pos.. 10



Electrical connections

Figure 2-28
General overview



Electrical connections, *Continued*

Designations

PCB IR	Printed circuit board IR module
PCB CPU	Printed circuit board sensor CPU
PCB Str	Printed circuit board emitter
PCB T	Printed circuit board heating
PCB P	Printed circuit board pressure sensor
PCB DFLW	Printed circuit board feedthrough tank
PCB VPL	Printed circuit board valves, pump
PCB DFL.SLIO	Printed circuit board feedthrough SLIO
PCB MSLS1, 2	Printed circuit board microswitches, LED 1 and 2
Str 1, 2	Emitter 1 and 2
C 1, 2	Measuring cells 1 and 2
CC1, 2	Calibration cells 1 and 2
D 1, 2	Detectors 1 and 2
VP 1..8	Port valves 1 to 8
VSN	Circulation gas/neutral gas valves
VDA	Recirculation valves

Electrical connections, *Continued*

Figure 2-30
Wiring in the analyzer

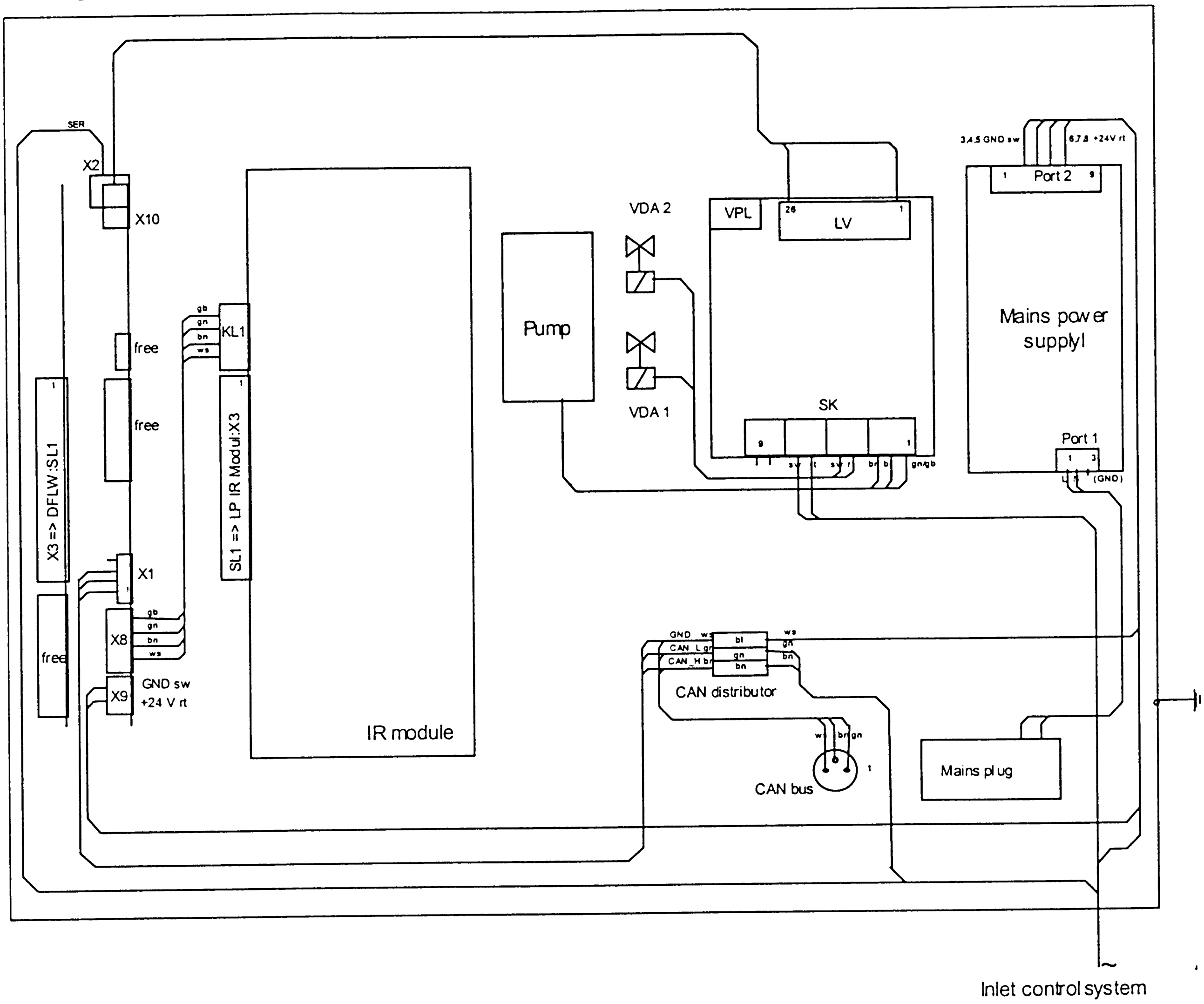
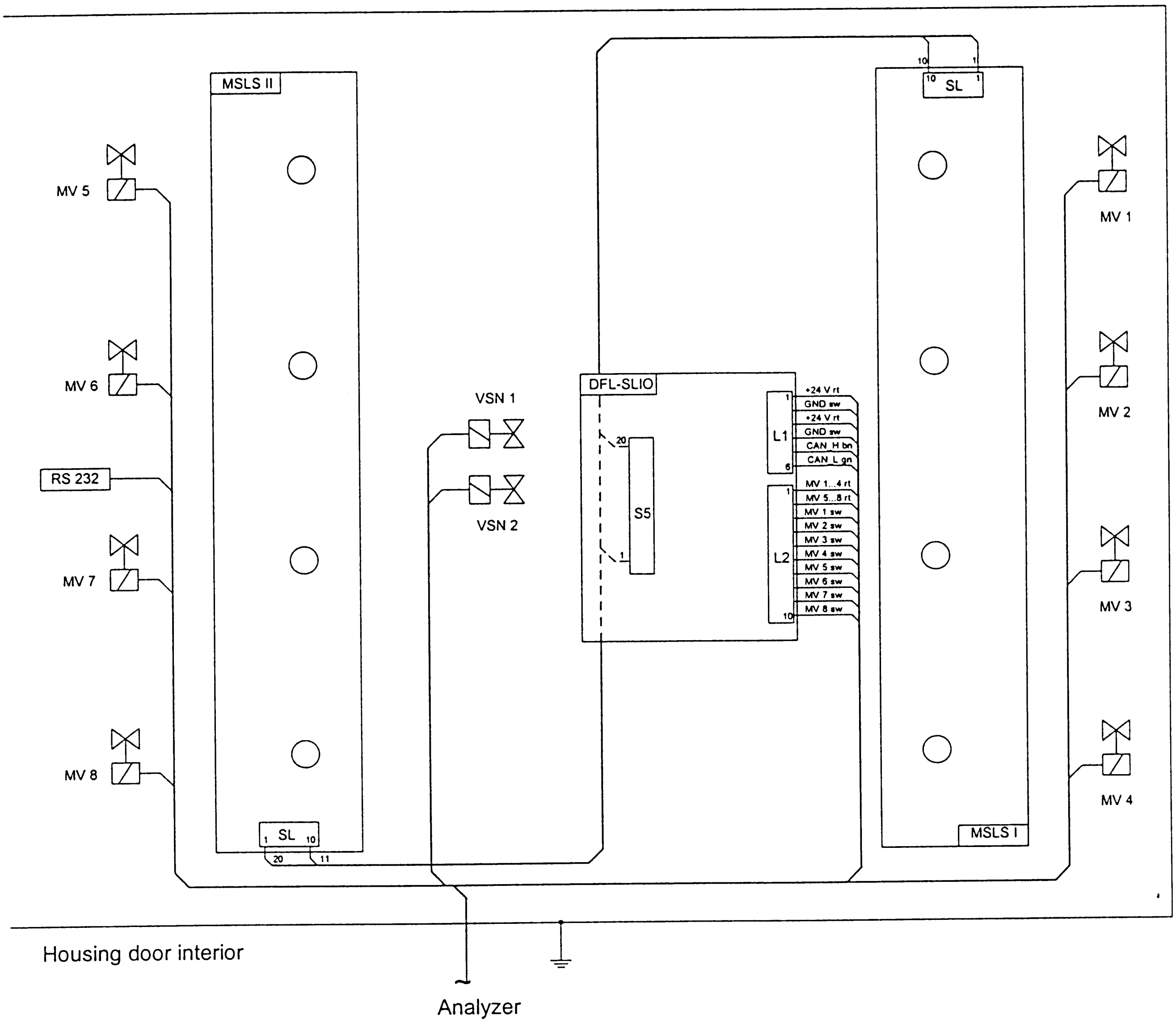
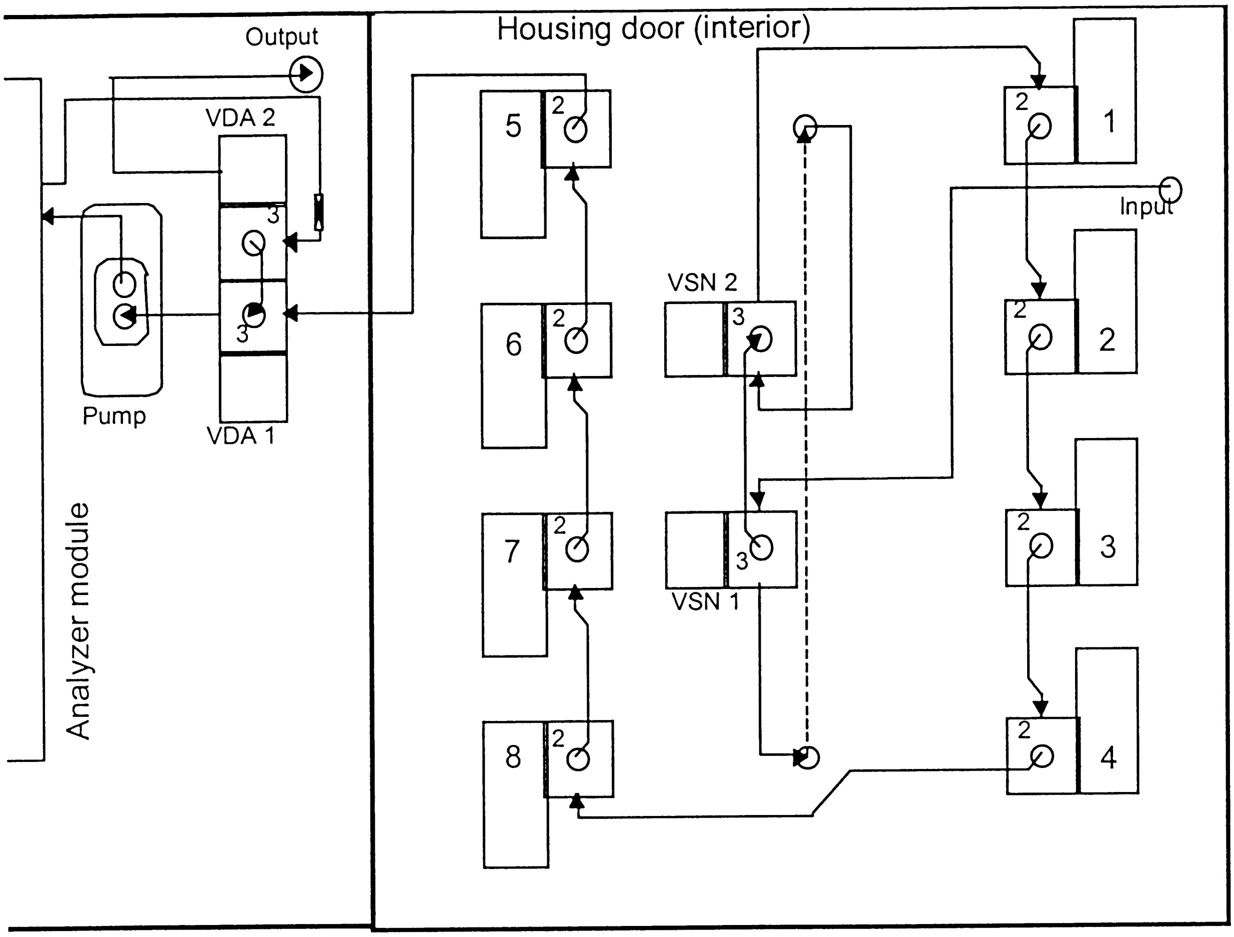


Figure 2-31
Wiring in the intel control system



Gas supply in FAN*ci2*

Figure 2-32
Gas mechanism



Control of gas flow in FAN*ci2*

In the basic state (potential free), the valves are switched as follows (also compare figures 2-19, 2-21 and 2-24):

- The *neutral gas valves* (VSN) are set at open, the gas flow extends from the inlet through the lower valve (VSN 1) directly to the upper valve (VSN 2) and from there to the port valve no. 1.
- The *port valves* 1..8 are also set at open. Here the gas flow extends from the neutral gas valve VSN 2 to valve 1, past valve 2 to valve 4, and from there to valve 8, 7.. up to valve 5 and from there to the metering and recirculation system (VDA 1).
- The *valves of the metering and recirculation system* are set at circulation: the gas flows from the lower recirculation valve (VDA 1) to the pump, is pumped from there through the cells of the analyzer and reaches through the capillary tube to the recirculation valve VDA 2 and from there back to recirculation valve VDA 1.

Gas supply in FAN*ci2*, *Continued*

In the rinsing phase

- the *neutral gas valves* are set at open (ambient air),
- the *port valves* are set at open and
- the *recirculation valves* now also are set at open.

The gas now flows from the inlet through the neutral gas valves (VSN), the eight port valves and the recirculation valve VDA 1 to the pump and from here is pumped to the outlet through the analyzer, capillary tube and VDA 2.
At fixed time intervals, the basic state is interrupted by this type of rinsing phase.

The rinsing of the system with neutral gas neutral gas rinsing is achieved by switching over the neutral gas valves VSN, so that the CO_2absorber is connected to the gas flow.

- The *neutral gas valves* are connected to the absorber (CO_2-free ambient air).
- The*port valves* are set to open.
- The*recirculation valves* are set to open.

The gas flows from the inlet through the neutral gas valve VSN 1, and from there past the absorber to VSN 2 and then further as described above in the rinsing phase.

Rinsing with neutral gas is carried out before each measurement and before external calibration. In this process, the recirculation operation is switched on many times in order to remove the remains of gas from the recirculation system (between VDA 1 and VDA2). During the internal calibration, the system is constantly rinsed with neutral gas.

If the concentration of the gas in the analyzer falls below a particular value, the test gas to be analysed is added. In this feeding phase

- the *neutral gas valves* are still switched to neutral gas,
- a *port valve* is now opened towards the respiratory gas bag and
- the *recirculation valves* set at open.

The gas (test gas) now flows from the bag past the corresponding port valve to the metering and recirculation valve VDA 1 to the pump and further through the analyzer cells, the capillary tube and valve VDA 2 to the outlet.

After a set time, or if the concentration of the test gas exceeds a particular value, recirculation is activated thus stopping the supply of test gas. Then the loop is briefly opened again, in order to accelerate the concentration compensation between the cells of the analyzer.

Further progression depends on the concentration of the test gas in the recirculation system. If the concentration is outside the previously calibrated range, the gas is gradually diluted. To this end, the port valve is set to open again, so that neutral gas can be added again from the neutral gas valve VSN 2. Now the loop is opened for a short time and then closed again thus diluting the test gas.
This process is repeated until the concentration in the recirculation system corresponds to the required value.

Gas supply in FAN*ci2*, *Continued*

If the concentration of the added test gas is in the acceptable range, the neutral gas valves as well as the port valve are set at open again. Then the actual measuring phase is started.
In this phase

- the *neutral gas valves* are set at open (ambient air),
- the *port valves* are also set at open, and
- the *recirculation valves* are set at circulation.

The test gas flows constantly in the loop as is described above for the basic state. Now the system waits for the measuring signal to be stabilised. After this, every 500 ms the measured values are recorded in the integration phase.

After the measurements have been taken, the loop is opened thus removing the test gas from the system (rinsing phase). When the concentration in the system has fallen below a particular value, the loop is closed again, so that the FAN*ci2* is in the basic state again.
If however there is a further sample to be measured, this phase is skipped and the measuring of the sample is prepared immediately (neutral gas rinsing).

When a respiratory gas bag is attached to a test port, this is registered by the inlet and control system, which can be seen on the exterior on the lit up LED at the corresponding port.
If the system is in the basic state, additionally the affected port valve is opened for a short time in order to extract the foreign air present in the pipe nozzle.
In this sample mode the valves are switched as follows:

- The *neutral gas valves* is set at open (ambient air).
- The corresponding *port valve* is open.
- The *recirculation valves* are set at open .

After a set time, the port valve is closed again. If the concentration of the gas flow falls below a particular value, the loop is also closed and the system returns to the basic state again.

Part 3: Testing

Overview

This part

... describes the testing of the components of FAN*ci2*

Attention!
The work described in this chapter requires special knowledge and may involve work on the open and live analyzer system!
Therefore, it must only be carried out by qualified and specially trained people!

Content of this part

Here you can find the following information

General functional testing

Preliminary remark

The function of the FAN*ci2* is fundamentally controlled by the gas management (gas supply by the diaphragm pump, valve setting) and the sample inlet and control system.

The tests described here should therefore be carried out on every initial operation of the FAN*ci2*. They provide early information regarding possible disorders in the system as they can also be carried out during the heating-up phase.

Resources

Service software FCISERV, respiratory gas bag

Also observe the instructions in part 2: Gas supply in FAN*ci2*.

Switching on the appliance

- Around 3 seconds after switching on the appliance, the tone of the synchronous induction motor which drives the diaphragm wheel of the modulation unit is audible.
- One second later, the diaphragm pump starts up with a somewhat lower tone.

In this way, you can ensure whether the power supply of the analyzer module is working.

Functional testing

To inspect the functions of the sample inlet and control system and further functions, carry out the following test:

- Connect the FAN*ci2* with the CAN interface of the PC using the CAN connection cable.
- Start up the service program FCISERV and wait until communication with the appliance has started. This is indicated by the appearance of the CAN address, the serial number of the appliance and the production number of the analyzer module in the titlebar of the application window. In addition the switching operation of a valve should also be audible.
- Turn on the graphic display in the **View** area of the service software by activating the checkbox *Graphic on/off.*
- Inflate one of the respiratory gas bags and attach it to one of the ports.
- The system should react as follows:

  ✓ The LED of the corresponding port lights up after a short delay.
  ✓ After approx. one second the recirculation valves are opened and immediately afterwards the corresponding port valve as well.
  ✓ Approximately one second after, the port valve is closed again.
  ✓ Later, the circuit is closed again (the time span for closing the loop depends on the system being in the heating mode (status line: Temper) or in the basic state (status message: Flushing). During the heating-up phase the time gaps are bigger.
  ✓ In the graphic, the respective states are shown in the shape of lines under the measuring value output:

- no line	the system is open and is being rinsed with ambient air.
- black line	the gas in the system is circulated.
- green line	a port valve is opened (whether the gas of the port valve reaches the analyzer depends on the setting of the recirculation valves)

General functional testing, *continued*

- blue line	the neutral gas valves are set at neutral gas (also here the setting of the recirculation valves decides whether the neutral gas reaches the analyzer system or not)
- red line	communication error (no response from FAN*ci*2)

✓ Two peaks should appear in the measuring value display a few seconds after opening the port valve: first the one for $^{12}CO_2$ (green) and then the one for $^{13}CO_2$ (red).

✓ When the display of the delta value (the relationship of ^{13}C to ^{12}C, related to a standard value) is activated, this value (black) shows a strong response, first downwards and then upwards and then it levels out at a particular value.

Attach the bag to the remaining test ports (when the bag is removed, the corresponding LED must go out).

With this test, the following functions of the FAN*Ci2* are tested:

- CAN bus
- Microswitches (switching on and off)
- LEDs
- Port valves
- Recirculation valves
- Diaphragm pump
- Hose connections
- Detector signals ($^{13}CO_2$, $^{12}CO_2$)

Inspection of the diaphragm pump

In order to inspect the functions of the diaphragm pump, carry out the following measures (the FAN*ci2* is switched on, the service software is running and communication is established):

- Under the menu item *Options*, activate the test mode (*Test mode*)
- Check the pressure reading (P in hPa) in the **Measured** area
- Switch the pump off by deactivating the checkbox *Pump on/off* in the **Control** area.
- As a consequence, the pressure in the system should fall by around 3 hPa (this takes some time).
- When you turn on the pump again (activate the checkbox again), the pressure increases back to the starting value.
- Finally, deactivate the test mode again in the menu item *Options*. This resets the system to its basic state.

Inspection of the calibration unit

In order to check whether the unit for displacing the calibration cells works, carry out the following steps (the FAN*ci2* is switched on, the service software is running and the communication is established):

- If you have not yet done this, activate the graphic in the **View** area
- Then activate the checkbox *Cal. cells up/down in the* **Control** area
- After this, a significant increase in the concentration of $^{13}CO_2$ and $^{12}CO_2$ must occur in the graphic. You can also observe this increase in the area **Measured.**
- Move the calibration cells down again, by deactivating the checkbox *Cal.cells up/down*.

General functional testing, *continued*

Plausible measuring values

After switching on the FAN*ci2* the analyzer module does not deliver any correct measuring values yet, because during the heating-up phase not all corrections are active. This can be recognised by the status displayed behind the measuring value of the detector in the service software FCISERV in the **Measured** area. After 30 to 40 minutes all detectors should have the status 0. The measuring values of the individual detectors should then lie in the following areas:

$^{13}CO_2$[ppm]..........	3 10 (ambient air)
$^{12}CO_2$ [Vol-%]........	0.02 - 0.09 (ambient air)
T (detector) [°C]....	45 - 50
T (controller) [°C]..	49.8 - 50.2
P [hPa].................	970 - 1030

When installing the FAN*ci2* after transportation, the zero-point may have offset sharply, so that the values for $^{13}CO_2$ and/or $^{12}CO_2$ could differ from those given above. These differences are compensated using internal calibration, which is however only possible if the system is thermally balanced.

Inspection of the neutral gas generator

In order to inspect the correct functioning of the CO_2 absorber and the neutral gas valves, carry out the following (the FAN*ci2* is switched on, the service software is running and communication is established):

- If you have not yet done this, activate the graphic in the **View** area
- Activate the Test mode under the menu item *Options*
- Set the concentration range for $^{13}CO_2$ in the graphic window to 0..10 ppm and the range for $^{12}CO_2$ to 0..0,1 vol%. Activate the settings by pressing the [Apply] button.
- Switch over to neutral gas, by activating the the checkbox *Zero gas on/off* in the **Control** area.
- The concentrations should significantly decrease after approx. 5 to 7 s, whereby the $^{12}CO_2$ concentration (green) decreases before the $^{13}CO_2$ concentration (red). Additionally, a slight decrease in pressure in the system should be noticeable (this can be indicated in the graphic by activating the checkbox for the pressure and adjusting the display range appropriately).
- Close the neutral gas valves again by deactivating the checkbox *Zero gas, on/off* in the **Control** area.
- The concentrations increase quickly as does the system pressure.
- Finally, deactivate the test mode again in the menu item *Options*. This resets the system to its basic state.

Remark:
When installing for the first time after transportation or a long period of storage (flat storage), it can occur that the sodium hydrogen carbonate lime laminas (particularly the fine particles) accumulate on one side of the absorber pipe, whilst on the other side there are large empty spaces. When operating the FAN*ci2* in an upright position, the gas then flows past the absorber.

TIP
After transporting the FAN*ci2*, the CO_2 absorber should be removed from its mount and should in the position, in which it would be used later, be prepared by using light taps (e.g. on a table edge).

General functional testing, *continued*

Inspection of the recirculation function

In order to inspect the functions of the recirculation valves, carry out the following measures (the FAN*ci2* is switched on, the service software is running and communication is established):

- Activate the graphic in the **View** area if this has not already been done.
- Activate the Test mode under the menu item *Options*
- Set the concentration range for $^{13}CO_2$ in the graphic window to 0..10 ppm and the range for $^{12}CO_2$ to 0..0.1 vol%. Activate the settings by pressing the Apply button.
- Switch over to circulation by activating the checkbox *Circulation on/off* in the **Control** area.
- After around 10 seconds switch the neutral gas valves over to the absorber. For this purpose activate the checkbox *Zero gas on/off in the* **Control** area
- The concentrations in the graphic display should not change
- Now open the recirculation valves (deactivate *Circulation on/off*) and after the concentrations have fallen by about half, close them again.
- New concentrations appear after a time. If you now switch the neutral gas valves to ambient gas again (deactivate the *checkbox Zero gas on/off*), the concentrations should remain unchanged.
- Then open the loop again by deactivating the checkbox circulation*on/off*in the **Control** area.
- The concentrations now increase to the starting values again.
- Finally, deactivate the test mode again in the menu item *Options*. This resets the system to its basic state.

Leak test

Resources

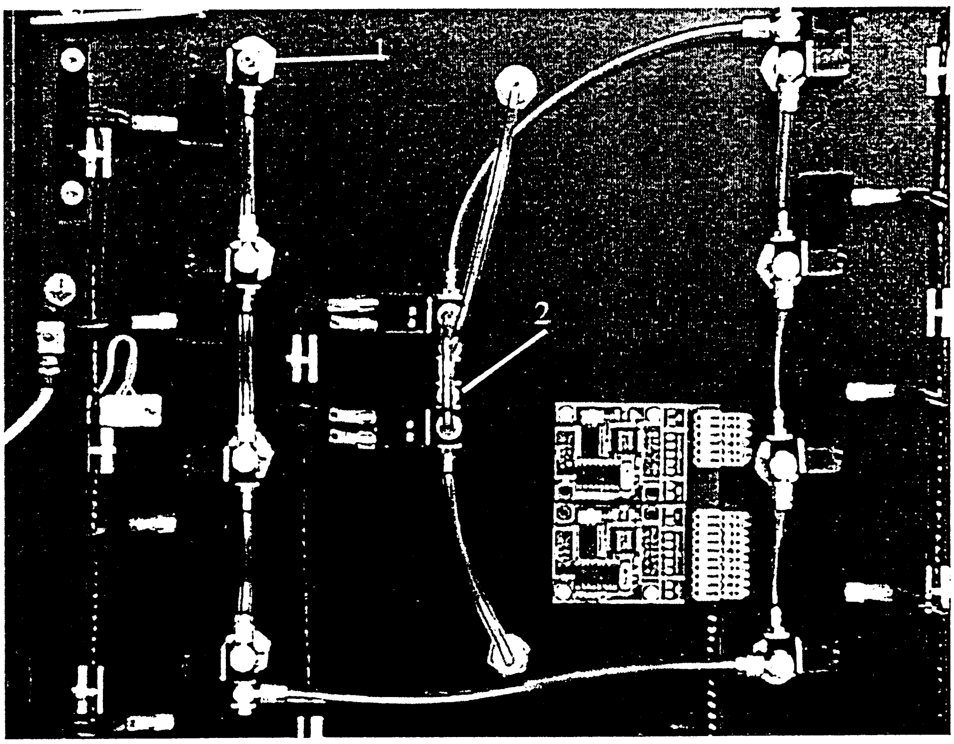
Hose, hose clips, T-joint, pressure gauge

Leak test of the sample inlet system

To check for leakages from the measuring gas pipes in the sample inletsystem carry out the following (see figure 3-1)

Step	Action
1	Close the outlet (1) of the gas pipe with hose to be tested using the hose clip
2	Connect the inlet (2) of the gas pipe with hose to be tested to a T-joint with a stop-cock (hose clip)
3	Connect the free end of the T-joint to the pressure gauge
4	Blow air through the other end until the gas pipe has an excess pressure of around 50 hPa. Close the stop-cock.
5	The pressure must not noticeably change (less than 3 hPa) within a period of 3 minutes.
6	In the event of sharp drops in pressure, locate the leak and repeat steps 1-5.

Figure 3-1
Leak test in sample inlet system



1. Connect the hose to the hose clip
2. Connect the T-joint to the hose; connect the pressure gauge to a free end, a hose to the other end through which the gas can be applied (50 hpa excess pressure) and which can also be closed with a hose clip.

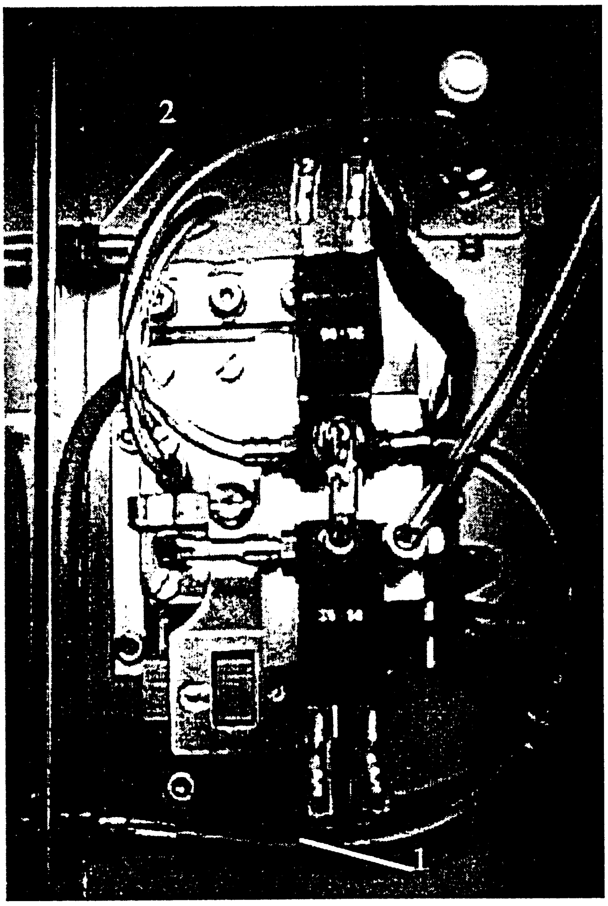
Leak test, *continued*

Leak test in the analyzer system

The leak test in the analyzer is carried out accordingly. A T-joint is connected to the inlet of the inner housing, the hose at the outlet is closed with a hose clip (see figure 3-2).

Attention!
The excess pressure must not exceed 50 hPa, in order not to damage the windows in the IR module!

Figure 3-2
Leak test
of the analyzer



1. Close this hose with a hose clip
2. Connect a T-joint to the hose here

Calibration cells

Functional testing

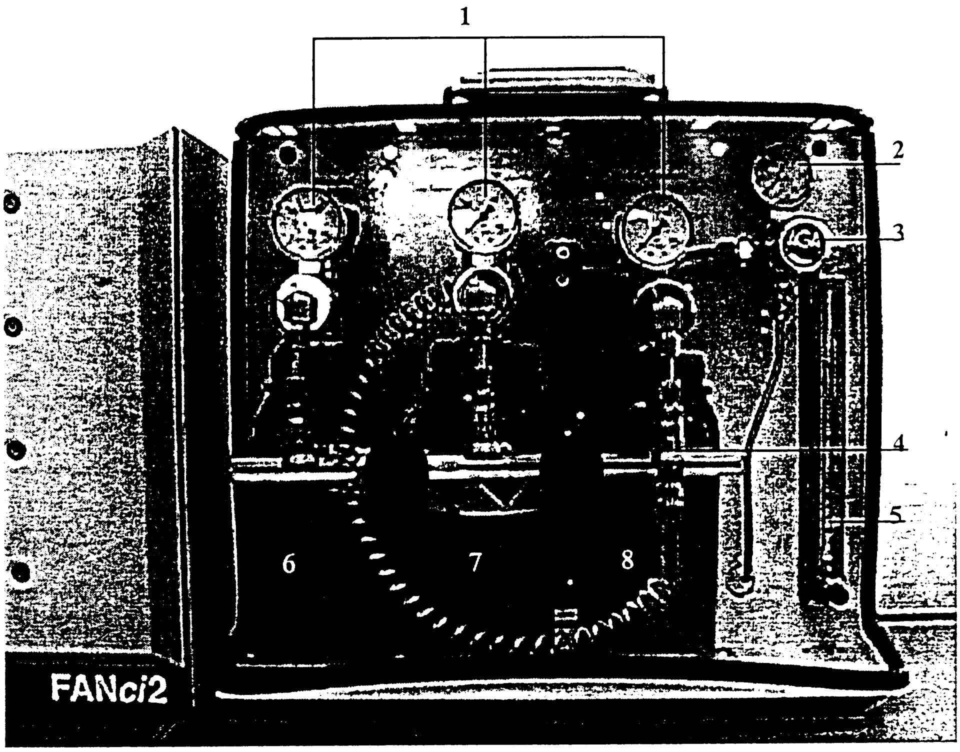
The concentration in the test gas chamber of the calibration cell is normally very stable for years.
However, once a year the calibration cells should be inspected.
Before the inspection of the calibration cell a new setting of the corresponding detector is necessary.
For this purpose, the corresponding test gases are required for the zero point and the end point.

☞ **The appliance must have run stably and without problems over a long period of time**

Resources

- Test gas set with
  -neutral gas (N_2 6.0)
  -end-point gas
  450 - 500 ppm $^{13}CO_2$ in N_2 for detector 1
  ~ 5 Vol-% CO_2 in N_2 for detector 2
  - Rotameter for determining the flow (around 10 l/h)
- Service software FCISERV

Figure 3-3
The test gas set



1 Manometer to display the pressure in the cylinder
2 Manometer to display the reduced pressure
3 Valve for pre-adjusting the flow
4 Test gas connection (quick release with stop-cock)
5 Rotameter with valve for fine adjustment
(5.3 scaling = 10 l/h)
6 Test gas cylinder (N_2 6.0)
7 Test gas cylinder (natural CO_2, ~ 5 vol%) in N_2
8 Natural gas cylinder ($^{13}CO_2$, 450 – 500 ppm) in N_2

Calibration cell, *continued*

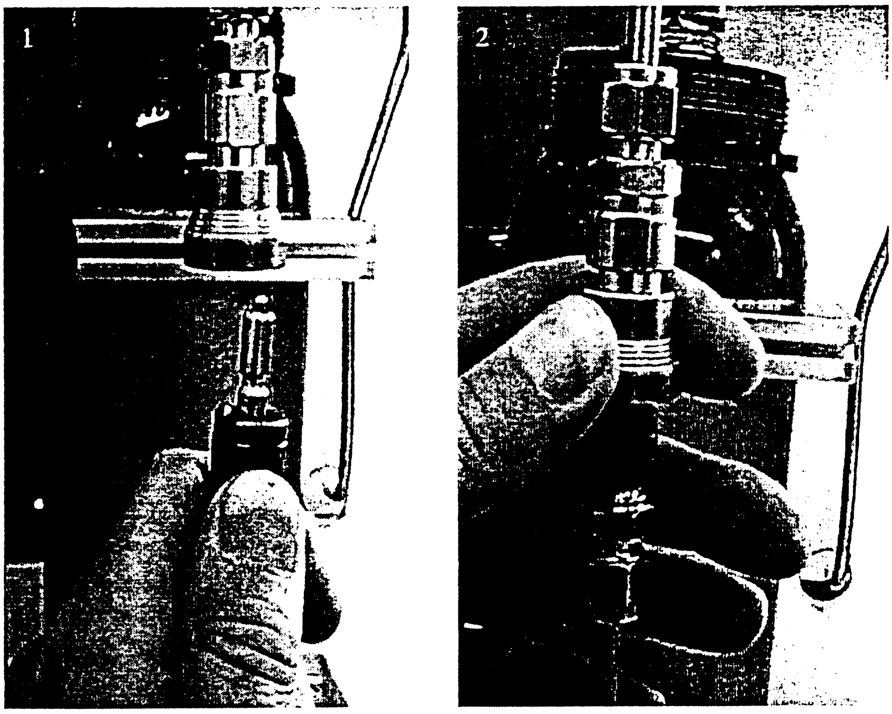


Figure 3-4
Connect (1) and open (2) the test gas connection

1. To connect the individual test gases, simply insert the quick release into the corresponding socket and push upwards with force until the connector engages.
2. To loosen the connection, simultaneously pull down the caps on the female-pin side connector and the male-pin side connector.

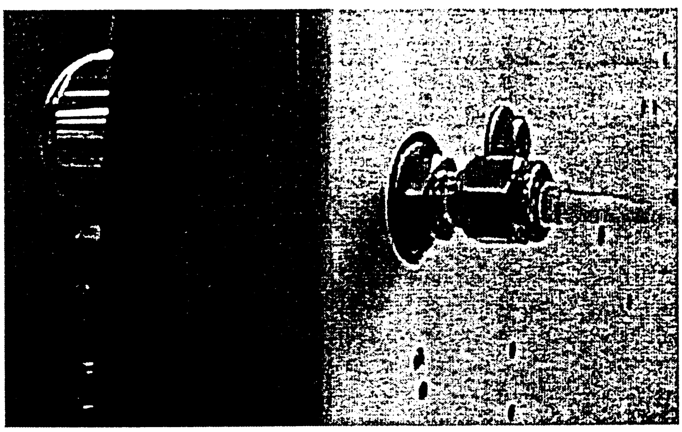


Figure 3-5
Connection to FAN*ci2*

The outlet of the test gas set is located on the back panel, directly next to the outlet of the rotameter. Here, the tube to the analyzer is connected.

Calibration cell, *continued*

Execution

The test of the calibration cells is executed in several steps:
1. Preparation of the FAN*ci2* for the direct connection of the test gas supply to the analyzer system (gas connections of the airtight inner housing)
2. Preparation of the test gas set (adjusting the flow on the rotameter – 10 l/h)
3. Carrying out the testing using service software FCISERV
4. Final work

Prior to the work, it should ensured that the FAN*ci2* has a secure and safe location. The test gas set should be installed immediately next to the appliance, but if possible on another table, so that vibrations during the work on the set do not affect the analyzer.

TIP
Before beginning the work, it should be ensured that there is enough test gas for the task that is to be carried out.

1. Preparation of the FAN*ci2*

In order to avoid loss of gas and inaccuracies due to possible leakages in the system, it is recommended to inspect the calibration cells directly on the analyzer system including the new adjustment of the detectors.
For this purpose, the following steps are required:

Step	Action
1	Open the appliance: Remove the casing by lightly pulling, loosen the four outer Allen screws and pull out the housing door to the front (the appliance remains in the upright operating position)
2	Disconnect the hose extending from the diaphragm pump to the analyzer inlet from the analyzer module (see figure 3-6 pos. 1)
3	Also disconnect the hose extending from the analyzer past the capillary to the (upper) recirculation valve 2 from the analyzer (see figure 3-6 pos. 2)
4	Guide the hose from the test gas set through the opening on the back of the FAN*ci2* (figure 3-7 pos. 3) and connect it to the inlet of the analyzer (figure 3-7 pos. 1)
5	Connect a piece of hose to the outlet of the analyzer, in order to discharge the gas (figure 3-7 pos. 2)
6	Check again that the hoses are secure and then close the housing door (only screw on lightly).

Calibration cells, *continued*

Figure 3-6
Gas connections
on the analyzer module

Analyzer module version 1 | Analyzer module version 2

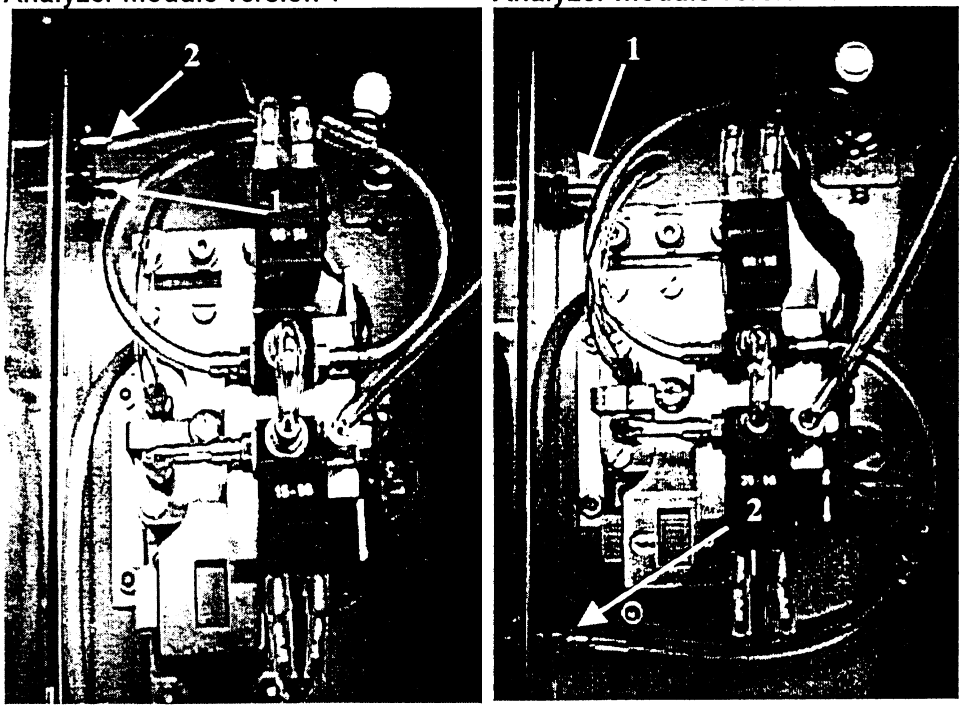
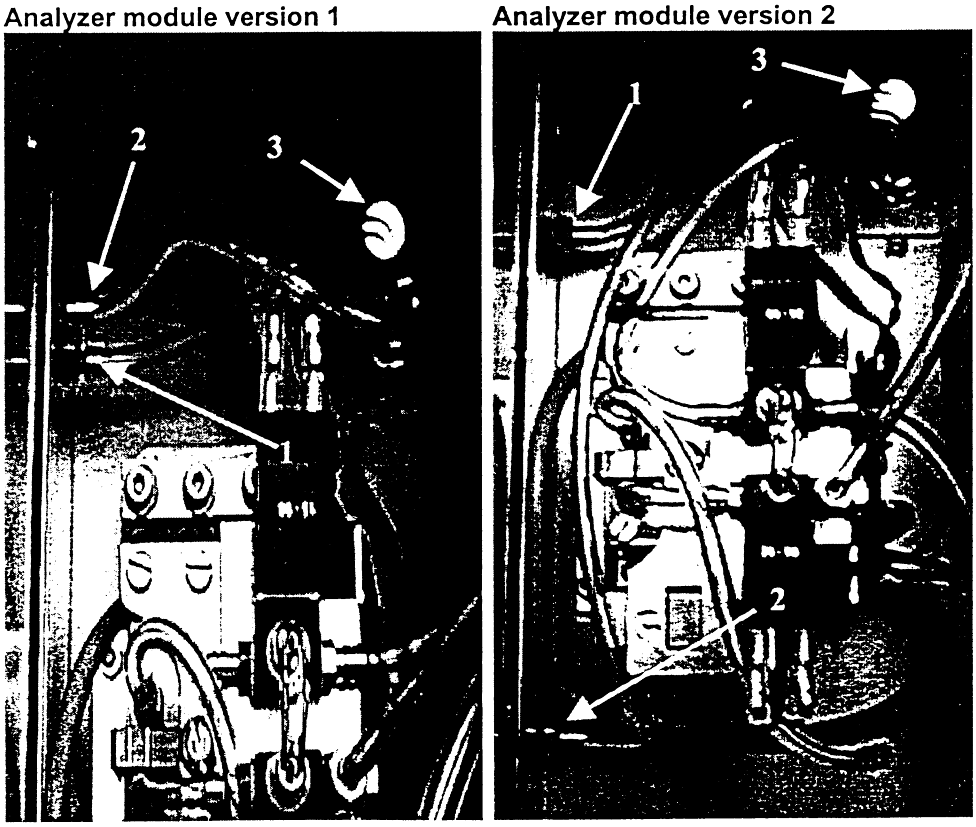


Figure 3-7
Test gas connections
on the analyzer module

Analyzer module version 1 | Analyzer module version 2



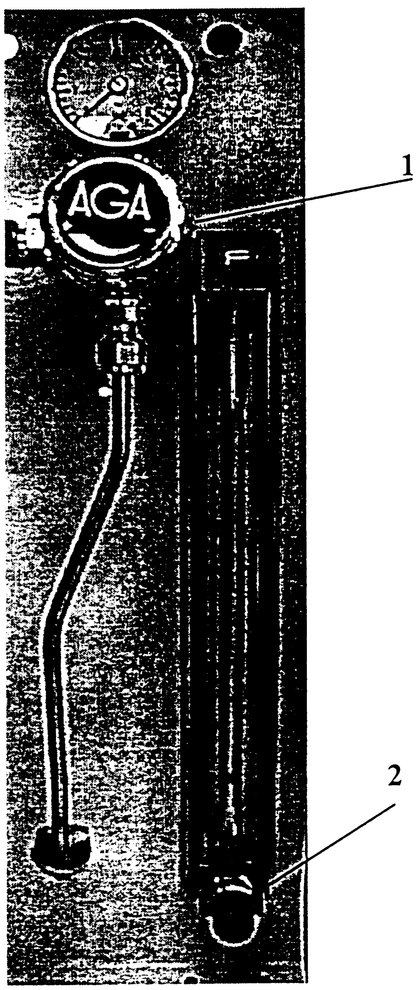
Calibration cells, *continued*

2. Preparation of the test gas set

It is very important that there is a constant flow through the FAN*ci2* with test gas during the new setting of the detectors and also during the measuring of the calibration cells. The adjustment of the flow speed is best carried out with neutral gas (N_2).

Step	Action
1	Connect the test gas connector to the N_2 cylinder according to figure 3-4.
2	Open the cylinder valve
3	Open the reducing valve and apply admission pressure of around 2 bar (Figure 3-8, pos. 1)
4	Using the valve on the rotameter (figure 3-8, pos.2), adjust the flow to around 5.5 on the scale (this corresponds to a flow speed of approx. 10 l/h) The exact value is not of primary importance, but that the flow during the whole process is constant.
5	Connect the hose from the FAN*ci2* to the outlet of the test gas set and make sure that the hose is secure. (see figure 3-5).

Figure 3-8
Adjusting the flow on the test gas set



Calibration cells, *continued*

3. Carrying out measurements on the calibration cells

As already indicated above, before taking measurements of the calibration cells, the corresponding detectors must be reset. The entire basic calibration process of the detectors and the measurement of the calibration cells is summarised in a dialogue in the service software.
This dialogue takes you through each operating cycle step by step.
Each operating cyle is only available when the previous one has been finished, so that operating errors can be avoided as far as possible.

Step	Action
1	Connect the appliance to the CAN interface of the PC using the CAN connection cable.
2	Start the service software FCISERV and activate the graphic display in the **View** area which is activated by the *Graphic on/off* checkbox.
3	Turn off the diaphragm pump, by deactivating the checkbox *Pump on/off* in the **Control** area.
4	Check the pressure value (P) in the **Measured** area; it should lie between 1000 hPa and 1030 hPa, dependant on the atmospheric conditions. When you have prepared the service set as described, the concentration of $^{13}CO_2$ and $^{12}CO_2$ should be near zero.
5	By choosing the menu item *Service/Measure CC* the dialogue <Measure of Calibration cells> is opened.
6	Choose the detector to be tested and enter the concentration of the reference gas.
7	Then begin the basic calibration of the chosen detector by clicking on the checkbox <Start calibration of detector>. After some initialisations, you will be asked at the next point if the neutral gas is connected.
8	After confirmation, the calibration of the zero point begins: In a display the measured raw value and any changes during the course of the calibration are shown. When the measured value is stable, confirm this by clicking the Button [Measured value is stable]. The display is closed and the measured raw value is saved.
9	Then you will be asked in the next point if the reference gas is connected. Disconnect the neutral gas by simply loosening the quick release on the service set (leave the valve of the cylinder open, as the neutral gas will be needed later) and immediately connect to the cylinder containing the gas required for the calibration of the chosen detector. Open the valve of the cylinder and confirm the question on the screen.

Calibration cells, *continued*

Step	Action
10	This starts the calibration of the end point of the corresponding detector: The process is exactly the same as that described under point 8, except that at the end, in addition to saving the measured raw value, now the new values for the zero and end point are calculated. After this, you are requested to disconnect the reference gas.
11	You should also do this by closing the cylinder valve and connecting the quick release to the neutral gas again, as this is now necessary for measuring the calibration cell. Confirm the question as to whether the neutral gas is connected and begin measuring the calibration cell by clicking on the checkbox <Start measure of calibration cell>.
12	Measuring begins: In a display, the measured value for the cell as well as its relative change are shown. Confirm when the displayed value is stable as before by clicking the button [Measured value is stable]. Now the new value for the calibration cell is calculated and saved. After this the new value next to the old value and the relative change is displayed under the status line. ☞ **Set values** ***The loss in concentration should not be more than 20% of the registered concentration.*** ***If there is a larger loss in concentration, the complete analyzer unit, including the printed circuit boards IR module and sensor CPU, is to be replaced as soon as possible.***
13	If a further detector is to be calibrated, leave the neutral gas connected and repeat points 6 - 12. Otherwise, you should now close the valve of the neutral gas cylinder.
14	After finishing the measurements, you can exit the dialogue using the [Close] button. The record taken during basic calibration and measurement of calibration cells is saved in the file CAL_MSC.TXT in the directory named with the last three digits of the serial number of FAN*ci*2.

Calibration cells, *continued*

4. Finishing work

Finally ensure the FAN*ci2* is ready for measuring again. For this purpose, the following steps are to be followed:

Step	Action
1	Open the housing door of the FAN*ci2*.
2	Remove the previously attached hoses from the analyzer module (see figure 3-7).
3	Restore the initial state, i.e. attach the hose from the outlet of the pump to the inlet of the analyzer module (pos. 1 in figure 3-6) and attach the hose leading to the recirculation valve VDA 2 (with capillary) to the outlet of the analyzer (pos. 2 in figure 3-6). Replace the hose if necessary.
4	Turn on the pump again, by activating the checkbox *Pump on/off* in the **Control** area.
5	Close the housing (securely tighten 4 Allen screws) and attach the casing.
6	Finally check again that all cylinder valves on the test gas set are securely closed.
7	After waiting a short time, the first internal calibration can take place with the newly set detectors and the newly measured calibration cells.

☞ **After measuring the cells, it is essential that an internal calibration and then also an external calibration are carried out.**

Measuring signal IR detector

Resources

- Test gas set with
  -neutral gas (N_2 6.0)
  -end-point gas
  450 – 500 ppm $^{13}CO_2$ in N_2 for detector 1
  ~ 5 vol% CO_2 in N_2 for detector 2
  - Rotameter for determining the flow (around 10 l/h)
- Service software FCISERV

When?

The detector is to be inspected when it is suspected that there is a loss in sensitivity.

☞ **The appliance must have run stably and without problems over a long period of time**

Step	Action
1	Connect the appliance to the computer using the CAN bus
2	Start the FCISERV service software
3	In the menu item *Options* set the *Test Mode* => circulation off.
4	In the **View** area turn on the graphic display on.
5	Prepare the test gas set (see previous section)
6	Guide the hose from the test gas set to the inlet of the FAN*ci2* and connect it (it is better to supply the test gas directly to the analyzer, as described in the previous section)
7	Connect the test gas (10 l/h) • Detector 1: $^{13}CO_2$ (450..500 ppm) • Detector 2: natural CO_2 (approx. 5 vol%)
8	The displayed value (**Measured** area) should correspond to the concentration value of the test gas
9	Securely close the test gases again
10	In the *Options* menu deactivate the *Test Mode* again

Heating

Resources	Multimeter
Electrical parameter	Resistance
Where?	• Common measurement of all heating resistors Disconnect the 4-pole socket from the printed circuit board sensor CPU X8 Measuring point on the socket between brown and white
Set value	• Total resistance approx. 9.5 Ω

Temperature sensor

Resources	Multimeter
Electrical parameter	Resistance of the NTC sensor
Where?	Disconnect the 4-pole socket from the printed circuit board sensor CPU X8 Measuring point on the socket between yellow and green
Set value	approx. 10 kΩ at 25 °C

Printed circuit board IR module

Preliminary remark

In the event of damage, the analyzer unit, together with the printed circuit boards IR module and sensor CPU are to be replaced.
In order to determine which function is defective, the following test can be carried out.

Visual check

SMD fuse

- F1 24 V supply emitter power supply 1
- F2 24 V supply emitter power supply 2

Resources

Multimeter

Electrical parameter

Voltage

Where?

- Printed circuit board IR module, plug X3

Set value

Function	Pin	Set value
IR detector 1	20 <-> 19	+150 V
	24 <-> 25	+15 V
	28 <-> 25	-15 V
IR detector 2	30 <-> 29	+150 V
	34 <-> 35	+15 V
	38 <-> 35	-15 V
Motor control		
Light barrier	13 <-> 12	+5 V
Pressure sensor	15 <-> 17	+15 V
	16 <-> 17	-15 V
Calibration cell	41 <-> 42	+15 V
Calibration cell 2	47 <-> 48	+15 V
Emitter 1	3 <-> 5 (-)	+5...10 V
Emitter 2	7 <-> 6 (-)	+5...10 V

Printed circuit board sensor CPU

Preliminary remark

In the event of damage, the analyzer unit, together with the printed circuit boards IR module and sensor CPU are to be replaced.
In order to determine which function is defective, the following test can be carried out.

Visual check

- LEDs
  - H1 green ⇨ 24 V supply
  - H2 yellow ⇨ Temperature control still outside the limit values
  - H3 red ⇨ Printed circuit board sensor CPU defective

  Normal: LED lights up for a short period after connection

- SMD fuses
  - F1 0.2 A ⇨ 24 V supply for solenoid valve (VDA)
  - F2 3.15 A ⇨ 24 V supply for temperature control
  - F3 3.15 A ⇨ 24 V supply for diaphragm pump
  - F4 0.2 A ⇨ 24 V supply for solenoid valve (VSN)
  - F5 0.2 A ⇨ 24 V supply for solenoid valve (VEG)

Resources

Multimeter

Electrical parameter

Voltage

Where?

- Printed circuit board sensor CPU, plugs X8 and X10

Setting value

Function	Plug	Pin	Set value out	Set value in	
Heating	X8	1 <-> 2	0 V	24 V	intermit
Pump	X10	2 <-> 3	0 V	0..24 V	
Solenoid valve (VDA)	X10	5 <-> 6	0 V	24 V	
Solenoid valve (VSN)	X10	7 <-> 8	0 V	24 V	
Solenoid valve (VEG)	X10	9 <-> 10	0 V	24 V	

Part 4: Troubleshooting

Overview

This part

... contains information on troubleshooting and error elimination

Attention!
The work described in this chapter requires special knowledge and may involve work on the open and live analyzer system!
Therefore, it must only be carried out by qualified and specially trained people!

Contents of this section

Here you find the following information:

Attention!
If there are errors in components of the analyzer unit, including its printed circuit board sensor CPU or IR module, the whole analyzer unit is to be replaced.

Power supply

Symptom	Possible cause	Solutions
Green lamp of the mains switch <u>does not come on</u>	• Power cable not inserted correctly	⇨ Check the position of the power plug
	• Mains fuse defective	⇨ Change fuse
	• Switch defective	⇨ Replace the switch
Green lamp of the mains switch <u>lights up</u> Green LED of the printed circuit board sensor CPU does not light up	• Internal connections loose or defective	⇨ Check the connections in the FAN*ci2* -switch – mains power supply -mains power supply – module
	• Mains power supply defective	⇨ Replace mains power supply
	• Switch defective	⇨ Replace switch

To inspect the power supply in the FAN*ci2*, carry out the following procedure:

- Check that there is voltage in the mains power supply component (1)
- Check that the mains power supply provides 24 V DC (2)
- Check that there is 24 V DC in the plug to supply the module (3)
- Check that there is 24 V DC in the plug to supply the SLIOs (see figure 4-3)

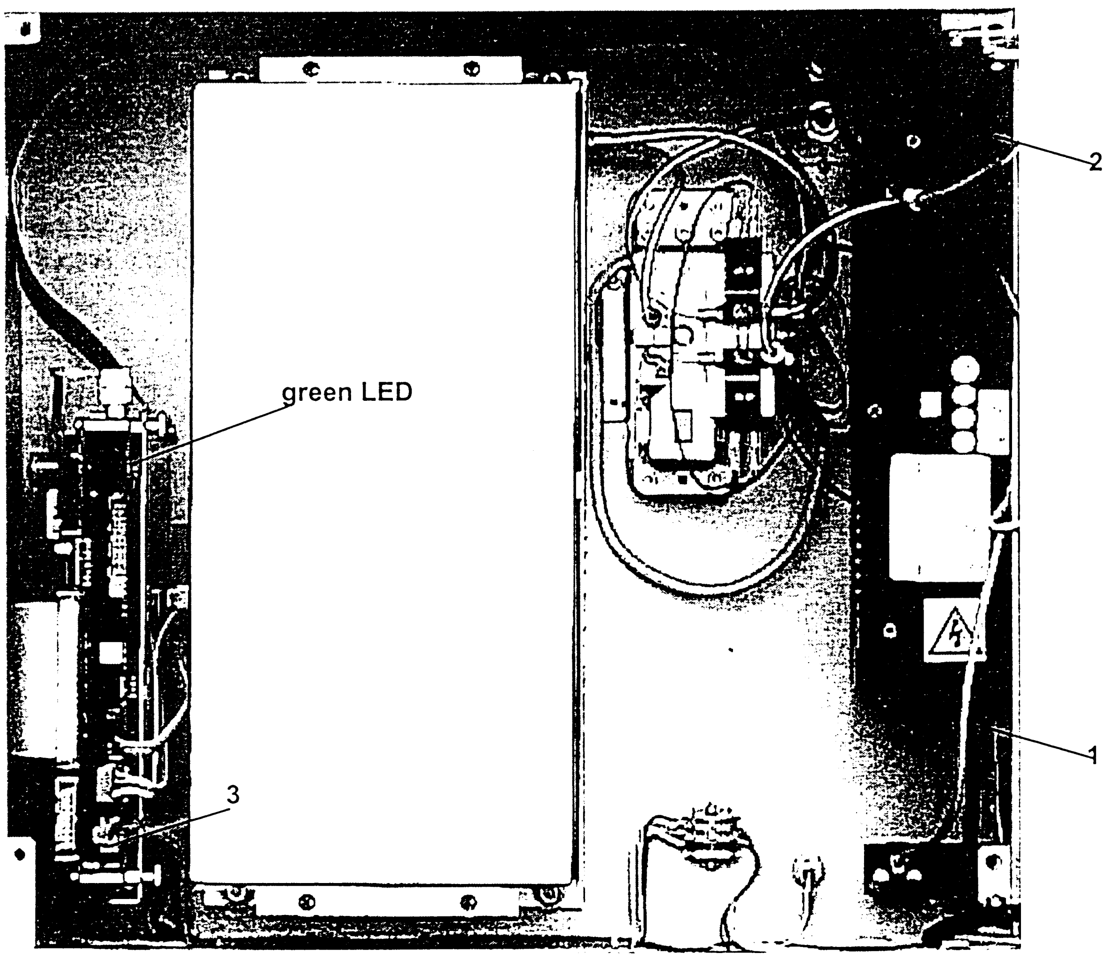


Figure 4-1: Power supply in the FAN*ci2*

CAN interface

The signalling of the inlet control system and the measuring value recording in the IR module are effected in the FAN*ci2* by the CAN bus. The function of the CAN bus is continuously monitored by the program. The user is informed of any faults by a corresponding message.

Message	Possible cause	Solutions
"Missing CAN-Card" at the start of the program	• Wrong CAN address in the INI file	Change address: PC-CAN: 0x240 (standard) Dongle 0x378 (LPT1)
	• CAN plug-in card in the PC or CAN dongle in LPT 1 loose	Check the CAN controller is securely connected
	• CAN plug-in card or CAN dongle defective	Replace CAN card (dongle)
"CAN-Error ..." at the start of the program	• Incorrect CAN baud rate in the INI file	Adjust baud rate to a value higher than 3
	• FAN*ci2* not running	Check that the appliance is turned on (check power supply)
	• CAN connection lead is not connected or is not securely connected or is defective.	Check the CAN cable is securely connected, replace it if necessary
	• Connections are interrupted in the internal CAN bus	Check all connections in the internal CAN bus (see figure 4-2); replace the internal Can bus if there is a cable rupture
	• Power supply or the CAN bus of the SLIOs is interrupted	Check the connections on the printed circuit board DFL.SLIO (see figure 4-3)
	• SLIO 2 is not programmed correctly or is defective	See instructions below: Configuration of the SLIOs
"CAN-Error ..." during running program	• FANci2 not running anymore	Check the power supply to the appliance
	• CAN connection cable is loose	Check CAN connection
	• Connections are interrupted inside	Check internal CAN bus, replace if necessary
	• Power supply or CAN bus of the SLIOs is interrupted	Check the connections on the printed circuit board DFL.SLIO (see figure 4-3)
	• SLIO 2 is not programmed correctly or is defective	See instructions below: Configuration of the SLIOs

CAN interface, *continued*

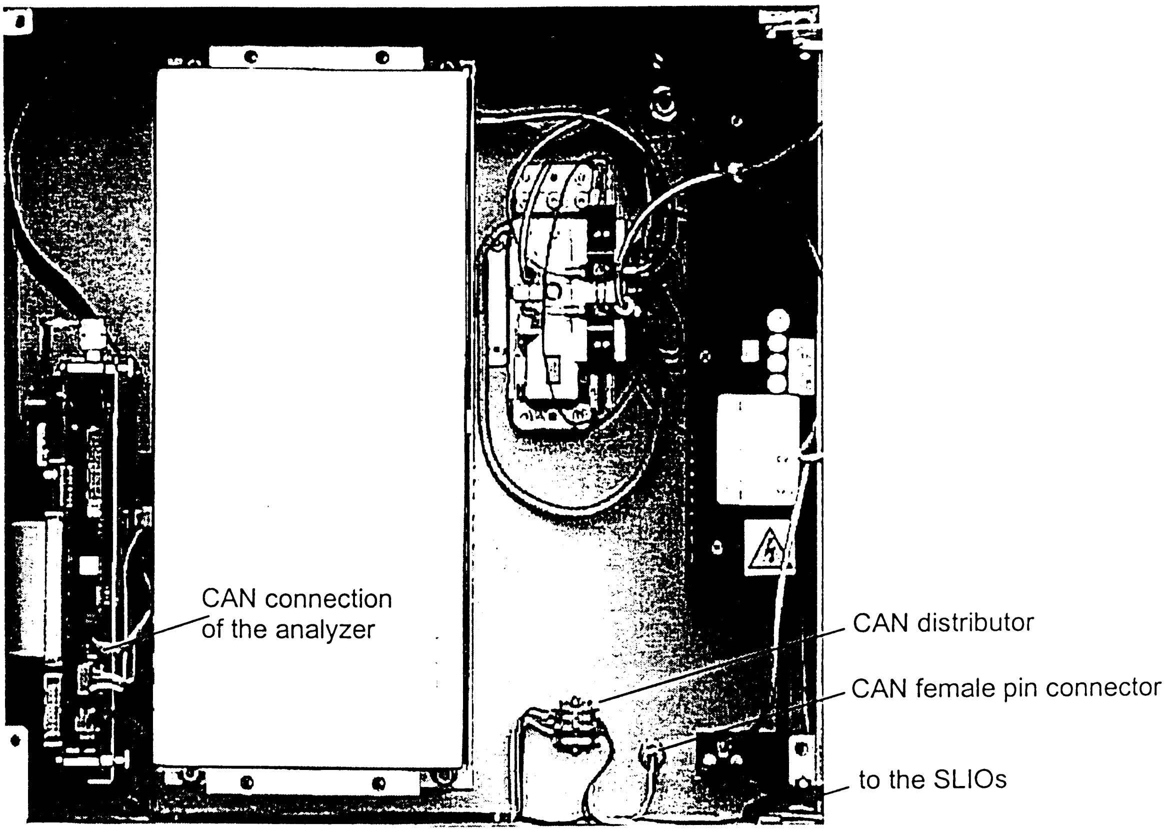


Figure 4-2: The internal CAN bus in the FAN*ci2*

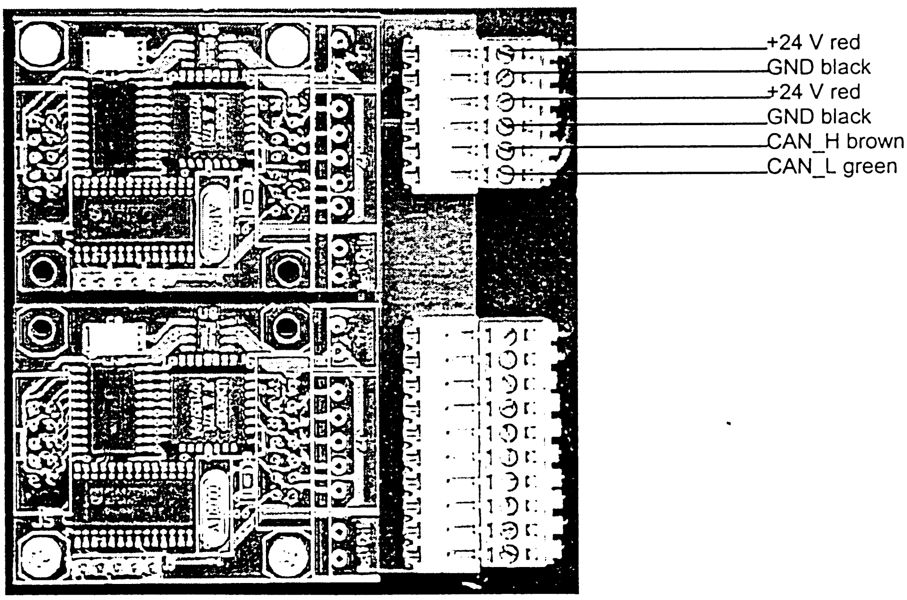


Figure 4-3: DFL.SLIO (terminal strip L1)

CAN interface, *continued*

In the FAN*ci*2, the CAN bus consists of three nodes:

1. IR module (measuring values, pump, recirculation valves and neutral gas valves)
2. SLIO 1 (microswitch and LED of the inlet control system)
3. SLIO 2 (valves of the test ports) - bus end

Each node works independently of the other nodes in the CAN network. If a node fails, the bus continues to work. The precondition is however that the bus end with the end resistance is detected. A failure of the SLIO 2 leads to a bus error with the corresponding message (see above).

The symptoms which are caused by the failure of a node are described here as follows. It is assumed that the previously described errors are excluded.

- **At all ports when a bag is plugged in, the corresponding LED does not go on.**

Possible causes:	*Solution:*
• Connection to the MSLS is interrupted	Test the position of the socket strip on plug S5 of the DFL.SLIO (see figure 2-22 in Part 2)
• SLIO 1 is not correctly configured or it is defective	see instructions 'Configuration of the SLIOs'

- **The IR module does not deliver any values (status line: Test), the inlet control system however works without errors**

Possible causes:	*Solution:*
• Internal CAN bus to the IR module is interrupted	Check the CAN connection of the analyzer and the connections on the CAN distributor (figure 4-2)
• CAN controller on the printed circuit board IR module has failed	The analyzer module must be completely replaced

Configuration of the SLIOs

- Start the service software FCISERV.
- Select the option *SLIO configuration* from the menu item *Options*.
- After a short time, the service software should indicate readyness.
- If this is not the case, try it again a few times.
- In the case of failure, replace the whole printed circuit board DFL:SLIO with the SLIOs.

Digital inputs/outputs

For the inspections to be carried out in this section, it is assumed that the power supply and CAN bus are in order.
Also observe the instructions in the section 'General functional testing'in part 3 Test

Symptom	Possible cause	Solutions
When plugging in a bag *the LED does not light up*, the*port valve is opened* (i.e. the microswitch and microswitch input as well as the valve output work)		
	Output SLIO 1 defective	Check the outputs of SLIO 1. On plug S5 on the DFL.SLIO – between pin 2 or 19 and the pin that corresponds to the LED of the port (see connector assignment DFL:SLIO below) 24 V have to be measured; if necessary, replace the DFL:SLIO with the SLIOs.
	Connection DFL:SLIO - MSLS interrupted	Check if 24 V are connected to the socket strip in plug SL of the corresponding printed circuit board MSLS between pin 1 and pin 4, 6, 8, or 10 (see connector assignment MSLS below); replace the cable if necessary.
	LED or MSLS defective	Replace the corresponding printed circuit board MSLS.

When plugging in a bag, *the LED lights up*, the *port valve does not open* (i.e. the microswitch and input microswitch as well as the output LED work)		
	Output SLIO 2 defective	Check the output of the SLIO 2. On the plug L2 on the DFL.SLIO - between pin 1 or 2 and the pin which corresponds to the valve of the port (see connector assignment DFL.SLIO below) 24 V have to be measured; if necessary, replace the DFL:SLIO with the SLIOs.
	Connection DFL.SLIO - valve is interrupted	Check that the connections of the corresponding valve have 24 V; check the flat connectors on the valve for rupture. Also check the screwed connection of the socket strip in the plug L2 on the DFL.SLIO. In the case of cable rupture in the cable tree, the whole inlet control system must be replaced.
	Valve is defective	Replace the corresponding valve.

Digital inputs/outputs, *continued*

Symptom	Possible cause	Solutions
When plugging in a bag *the LED does not light up* and *the port valve does not open*		
	Microswitches or MSLS defective	Check the function of the microswitches on the plug SL of the corresponding printed circuit board MSLS, by testing the conduction between pin 1 and pin 3, 5, 7 or 9. (see connector assignment MSLS below); if necessary change the printed circuit board MSLS.
	Connection DFL:SLIO – MSLS interrupted	Test the conduction on the socket strip in plug S5 of the printed circuit board DFL:SLIO between pin 1 or 20 and the pin, that corresponds to the microswitch of the port (see connector assignment DFL.SLIO below); change the connection cable if necessary.
	Inputs of the SLIO 1 are defective	Replace the DFL:SLIO with the SLIOs.
	The outputs of both SLIOs have failed.	When inspecting the outputs proceed according to the description for the first two symptoms.
	The connection DFL:SLIO – MSLS and the connection to the valves are interrupted	When inspecting the connections proceed according to the description for the first two symptoms.

Connector assignment DFL.SLIO

Plug S 5 (microswitch MS and LED)

Pin	Assignment	Pin	Assignment
1	COM MS 1..4	11	-24 V LED 5
2	COM LED 1..4	12	+24 V MS 5
3	+24 V MS 1	13	-24 V LED 6
4	-24 V LED 1	14	+24 V MS 6
5	+24 V MS 2	15	-24 V LED 7
6	-24 V LED 2	16	+24 V MS 7
7	+24 V MS 3	17	-24 V LED 8
8	-24 V LED 3	18	+24 V MS 8
9	+24 V MS 4	19	COM LED 5..8
10	-24 V LED 4	20	COM MS 5..8

Plug L2 (port valve)

Pin	Assignment
1	COM MV 1..4
2	COM MV 5..8
3	-24 V MV 1
4	-24 V MV 2
5	-24 V MV 3
6	-24 V MV 4
7	-24 V MV 5
8	-24 V MV 6
9	-24 V MV 7
10	-24 V MV 8

Connector assignment MSLS

Plug SL on MSLS 1

Pin	Assignment
1	COM MS 1..4
2	COM LED 1..4
3	+24 V MS 1
4	-24 V LED 1
5	+24 V MS 2
6	-24 V LED 2
7	+24 V MS 3
8	-24 V LED 3
9	+24 V MS 4
10	-24 V LED 4

Plug SL on MSLS 2

Pin	Assignment
1	COM MS 5..8
2	COM LED 5..8
3	+24 V MS 8
4	-24 V LED 8
5	+24 V MS 7
6	-24 V LED 7
7	+24 V MS 6
8	-24 V LED 6
9	+24 V MS 5
10	-24 V LED 5

Diaphragm pump, recirculation and neutral gas valves

Diaphragm pump, recirculation valves and neutral gas valves are driven by the analyzer module. In case of any errors in these components carry out the following measures (see also instructions in the section 'General functional testing' in Part 5):

Symptom	Possible cause	Solutions
Pump not running	• Connection leads loose • Pump defective • Output on printed circuit board sensor CPU defective	⇨ Test the terminal screws SK on the printed circuit board VPL (2 and 3) ⇨ Check the connection to the plug X10 on the sensor CPU (pin 2 and 3) ⇨ Replace the pump if necessary ⇨ In the case of a defect in the sensor CPU the analyzer module must be replaced
Recirculation valves (VDA) do not operate	• Connection leads loose • Valve(s) defective • Output on printed circuit board sensor CPU defective	⇨ Test the connections of the valves, including testing the flat connectors for rupture ⇨ Check the connections on the printed circuit board VPL (SK) (4 and 5) ⇨ Check the connection to the plug X10 on the sensor CPU (flat cable) ⇨ Check the plug X10: there must be 24 V between pin 5 and pin 6 when the valve is connected ⇨ Change valve(s) ⇨ In the case of a defective sensor CPU, replace the analyzer unit
Neutral gas valves (VSN) do not operate	• Connection leads loose • Valve(s) defective • Output on printed circuit board sensor CPU defective	⇨ Test the connections of the valves, check the flat connectors for rupture ⇨ Check the connections on the printed circuit board VPL (6 and 7) ⇨ Check the connection to the plug X10 on the sensor CPU ⇨ Check plug X10: There must be 24 V between pins 7 and 8 ⇨ Change valve(s) ⇨ In the case of a defective sensor CPU, replace the analyzer unit

Diaphragm pump, recirculation and neutral gas valves, *continued*

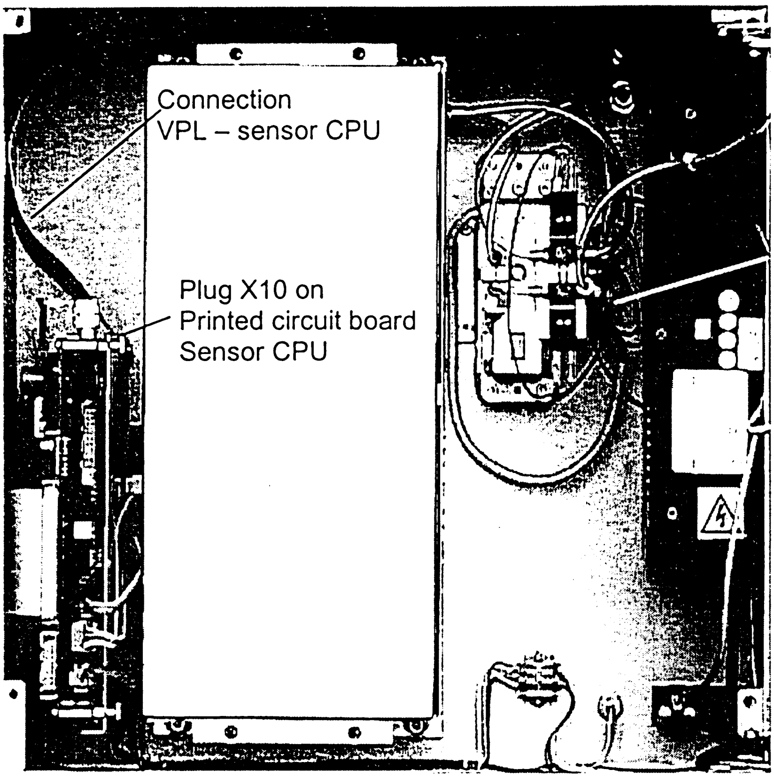


Figure 4-4: Inspection of pump, recirculation and neutral gas valves

Terminal screws SK on VPL

Pin	Assignment
1	Pump (PE)
2	Pump (24 V)
3	Pump (GND)
4	VDA (24 V)
5	VDA (GND)
6	VSN (24 V)
7	VSN (GND)

Plug X10 on sensor CPU

Pin	Assignment
1	Pump (24 V)
2	Pump (24 V)
3	Pump (GND)
4	Pump (GND)
5	VDA (24 V)
6	VDA (GND)
7	VSN (24 V)
8	VSN (GND)

Further information on these components can be found in the explanations for error messages of the system test

Errors during system test

During the system test, the functions of the FANci2 are tested.
At the end of the test a message is given regarding any errors experienced.
The record taken during the test (saved in file SYS_CHK.TXT) contains more details regarding the errors experienced.

The following table contains a list of the possible errors and causes as well as information for their elimination.

Section in record	Error	Causes Elimination
Detector status ⇨ Channel 1 and 2	Status = 4 or 8	• Emitter or receiver leaking • Calibration cell leaking ⇨ Replace analyzer unit
	Status = 1	• Diaphragm wheel not rotating • Light barrier defective ⇨ Replace analyzer unit
⇨ Temperature (control)	Status > 0	• Heating resistor defective ⇨ Replace analyzer unit
⇨ Pressure	Status > 0	• Pressure sensor defective ⇨ Replace analyzer unit
Pump	Increase of pressure not high enough	• Gas path not free on the suction side • Decrease in pump output • Pump defective or connections loose ⇨ Inspect gas path ⇨ Readjust pump output in INI file (max. 60%, otherwise replace) ⇨ Inspect connections ⇨ Replace pump if necessary
Neutral gas	Difference in the concentration of circulation and neutral gases too low	• CO_2 absorber exhausted • Output of the pump has decreased • Neutral gas valve(s) (VSN) not operating correctly ⇨ Change absorber ⇨ Readjust pump output in INI file (max. 60%, otherwise replace) ⇨ Inspect electrical connections of the valves ⇨ Replace valve(s)

Errors during system test, *Continued*

Section in record	Error	Causes Elimination
Circulation	Difference in concentration too high	• Recirculation valves (VDA) do not operate • Valves leaking ⇨ Inspect electrical connections of the valves ⇨ Replace valves
	Decrease in pressure in the circulation too great	• Recirculion valve (VDA 2) does not operate ⇨ Inspect connections ⇨ Replace valve
	Increase in pressure in circulation	• Recirculion valve (VDA 1) does not operate ⇨ Inspect electrical connections ⇨ Replace valve
Ports	Difference in concentration between ciculation and neutral gas too low	• CO_2 absorber on the edge of its capacity • Port valve does not operate • Valve leaking ⇨ Change absorber ⇨ Inspect electrical connections ⇨ Replace valve
End point	At least one of the given values can not be reached several times (even after calibration)	• Calibration cell does not start up • Internal calibration terminates with errors • Loud measuring signal ⇨ Carry out internal calibration and observe error messages ⇨ See next section (pages 4-11)
Zero point	Zero point lies outside the tolerance limits	• Restless measuring signal ⇨ Carry out internal calibration and observe error messages ⇨ See next section (pages 4-11)

Errors during internal calibration

Internal calibration

Internal calibration is used for adjusting the starting and end points of both measuring channels. It is carried out for each channel separately.

Error messages

During the course of internal calibration, two errors can occur:

1. Measuring signal is unstable

Possible causes:	*Measures:*
Position of the FAN*ci*2 unsteady	Change position and try again
Window in the emitter insert is dirty	Analyzer unit must be replaced
Diaphragm wheel does not rotate evenly	Change analyzer unit

2. Calculation error

Possible causes:	*Measures:*
Sliding unit defective (measuring value does not change during insertion of the cell)	Change analyzer unit
Emitter insert has failed (measuring value does not change)	Change analyzer unit
Diaphragm wheel not rotating (measuring value does not change)	Change analyzer unit
Light barrier defective (measuring value does not change)	Change analyzer unit
Preamplifier has failed (measuring value does not change)	

Error during internal calibration, *continued*

Drift

After completing the internal calibration, the sensitivity drift is calculated since the basic factory calibration.
If there is a loss in sensitivity (negative drift) and the loss exceeds a value of approx. 20%, an appropriate message will be given.
A subsequent system test shows the status 4 for the corresponding receiver (detector 1 or 2) under detector status.
The value for the drifts at the offset and end point can be directly read under drift.

Possible causes:

- Emitter insert or detector leaking
- Calibration cell leaking

With a simple test, you can determine which of the components is leaking:

- Start the service program FCISERV.
- Fill a bag with respiratory gas and plug it into a port.
- Begin measuring (activate the checkbox *Measure*) in the **Action** area.
- During measuring watch the R value (in the **Calculated** area).

For detector 1 ($^{13}CO_2$-Channel) the following applies:

• if R << 1.0 (~0.75)	⇨	Emitter insert 1 or $^{13}CO_2$-detector running empty
• if R > 1.1	⇨	Calibration cell for $^{13}CO_2$ running empty

For detector 2 ($^{12}CO_2$–Channel) the following applies:

• if R >> 1.5 (~2.0)	⇨	Emitter insert 2 or $^{12}CO_2$ detector running empty
• if R ~ 1.0	⇨	Calibration cell for $^{12}CO_2$ running empty

In any case the whole analyzer unit must be replaced!

Other errors

Temperature control

FAN*ci*2 is not yet ready for measuring even after several hours, i.e. it has not yet reached the operating temperature of approx. 50 °C.

Possible causes:	Connection to sensor CPU is interrupted Heating resistor is defective
Measures:	Inspect the plug connection to plug X8 on the sensor CPU is securely connected, retighten screws, test for cable rupture Inspect heating resistors (see part 3: Testing) In the case of defective heating resistors, the analyzer module must be replaced.

FAN*ci*2 is not yet ready for measuring, displayed temperature always at 14.5 °C.

Possible causes:	Connection of temperature sensor to the printed circuit board sensor CPU is interrupted Temperature sensor is defective
Measures:	Inspect the plug connection to plug X8 on the sensor CPU is securely connected, retighten screws, test for cable rupture Inspect temperature sensor (see part 3: Testing) In the case of defective sensor, the analyzer module must be replaced.

Drift $^{13}CO_2$ detector

Apparent sharp increase in sensitivity (positive drift of amplification) of the $^{13}CO_2$ receiver:

Possible cause:	Filter cell is leaking
Measures:	The analyzer module must be replaced

Part 5: Exchanging components

Overview

This part

... shows the steps for replacing components.

Attention!
The work described in this chapter requires special knowledge and involves work on open and live analyzer systems!
Therefore, it must only be carried out by qualified and specially trained people!

Contents

Here you can find the following information

Removing/installing the analyzer unit

The following parts belong to the analyzer unit (article no. F202-IR-00):

- the IR module in the gas tight housing (tank)
- the printed circuit boards IR module and sensor CPU (STL) with mount and
- the 50-pole flat cable FBK DFLW-STL

Removing the unit

In order to remove the analyzer unit, carry out the following steps (figure 5-1):

Step	Action
1	Switch off energy supply to the analyzer system.
2	Remove the power and CAN connection cables
3	Lay the appliance on the back panel, remove the casing and open the housing door (loosen the 4 outer Allen screws)
4	Loosen the cable connection to the PCBs IR module and sensor CPU (figure 5-1: 1).
5	Take out the printed circuit boards IR module and sensor CPU, to do this loosen the knurled nuts (figure 5-1: 2)
6	Also take out the mount for the printed circuit boards (2 x M5 ratchet nuts) and fix the printed circuit boards in the mount again
7	Loosen the hoses from the analyzer (figure 5-1: 3)
8	Loosen the 4 ratchet nuts with which the gas tight internal housing is fixed to the floor (figure 5-1: 4)
9	Remove the tank carefully from the housing and place it on a secure surface
10	Remove the 50-pole flat cable from the module, the connecting lead to the heating remains on the tank
11	At this point you can begin preparing the analyzer unit for transportation (see below)

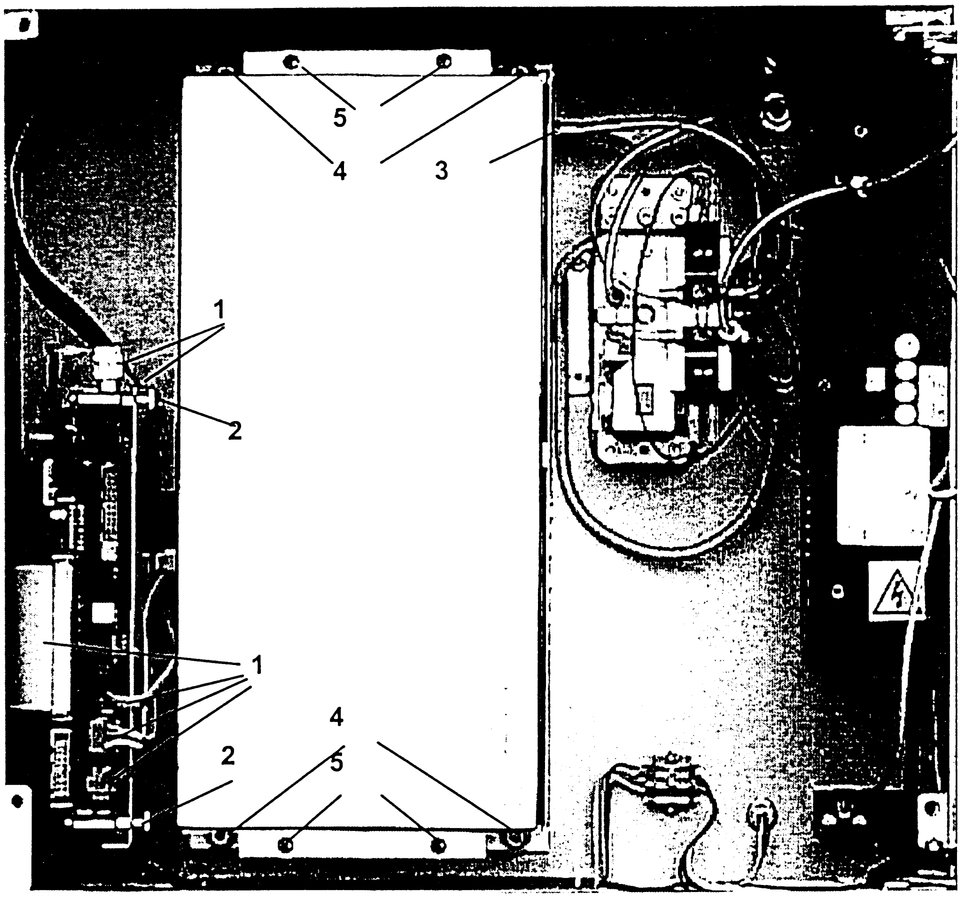
Installing the unit

To install the analyzer unit, carry out the following steps:

Step	Action
1	Lay the appliance on the back panel, remove the casing and open the housing door (loosen the 4 outer Allen screws)
2	Plug the 50-pole flat cable to the tank
3	Remove the printed circuit boards IR module and sensor CPU from the mount
4	Carefully place the analyzer unit on the four threaded bolts on the floor of the housing (Caution: do not squash any cables). Then attach the 4 insulating sleeves and secure the tank with 4 M5 ratchet nuts.
5	Replace and secure the mount for the printed circuit boards and then insert and secure the printed circuit boards IR module and sensor CPU (tighten the knurled nuts – figure 5-1: 2)
6	Reconnect all cable connections (figure 5-1: 1).
7	Connect hoses to the tank (if necessary use new hoses) according to figure 3-6 in part 3: • Pump output to module input • Module output to VDA 2 (hose with capillary)
8	If not already done, now remove the transportation safety devices from the sliding units of the calibration cells (c.f. preparation of the FAN*ci2* after transportation)
9	Once again, inspect all connections and then close the housing door, securely screw on, and replace casing.

Removing/installing the analyzer unit, *continued*

Figure 5-1:
Removing/installing the analyzer unit



1: Cable connections
2: Knurled nuts to secure the printed circuit boards
3: Hose connections (see also figure 3-6 in part 3)
4: Ratchet nuts to secure the analyzer
5: Phillips screws to secure the cover

Removing/installing the analyzer unit, *continued*

Preparing for transportation

In order to prepare the analyzer unit for transportation, the following steps are necessary:

Step	Action
1	Loosen the 4 Phillips screws on the cover (figure 5-1: 5)
2	Carefully remove the cover, if necessary lever out with a screw driver
3	Pull the transportation safety devices (2 rubber hoses) onto the bars of the sliding units of the calibration cells (c.f. figure 5-2 and 5-3)
4	Replace the cover and tighten the 4 Phillips screws
5	Pack the analyzer unit together with the flat cable and the well padded printed circuit boards in the padded transportation box.

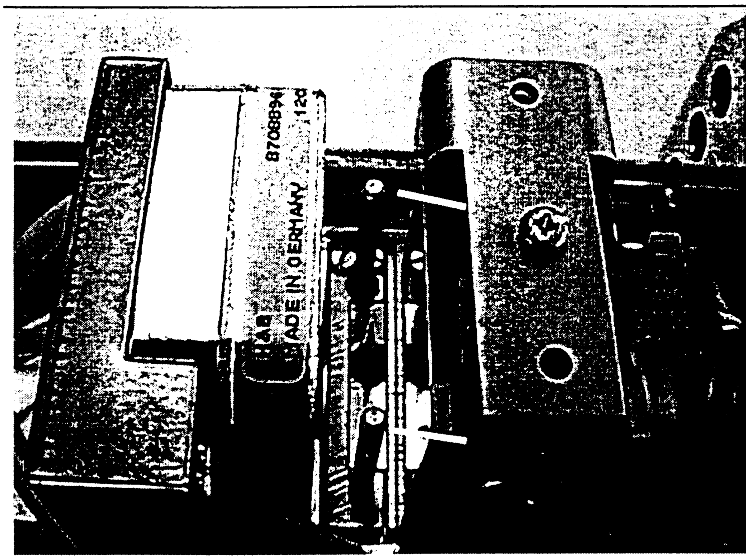


Figure 5-2: The sliding unit of the calibration cells

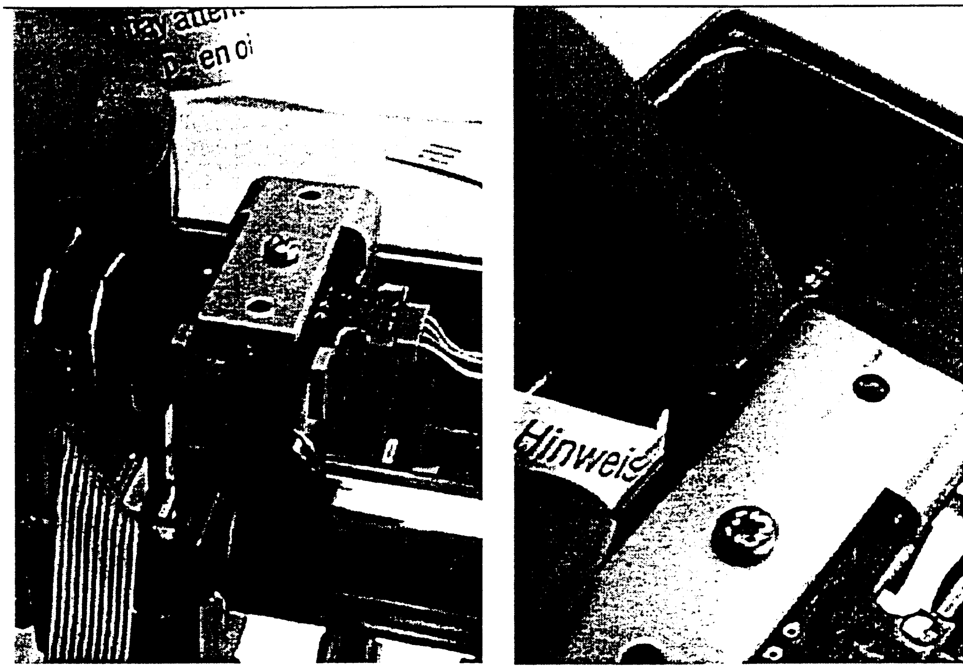


Figure 5-3: Attaching the transportation safety devices

Removing/installing the analyzer unit, *continued*

Preparing for use

In order to prepare the analyzer unit for measuring operations after transportation, the following steps are necessary:

Step	Action
1	Lift the analyzer unit out of the transportation container and place it on a secure surface
2	Loosen the 4 Phillips screws of the cover (figure 5-1: 5)
3	Carefully remove the cover, if necessary lever out with a screw driver
4	Remove the transportation safety devices from the bars of the sliding unit of the calibration cells (figure 5-2)
5	Inspect the cable connections on the IR module
6	Inspect the rubber packing
7	Replace the cover and tighten the four screws
8	Proceed as described above under 'Installing the analyzer unit'

Note

Carry out an inspection of the basic functions after installing the FANci2. Do this as described in part 3 under 'General functional testing'.

Information

After changing the analyzer unit, a warm-up time of at least 24 hours is required before the analysis system runs stably.
Then, an internal calibration must first be carried out.
During this initial calibration, it can occur that the calibration ends with a time-out error (caused by a zero offset). In this case, repeat the calibration in order to make sure the zero point is correctly set.

Removing/installing the metering and recirculation system

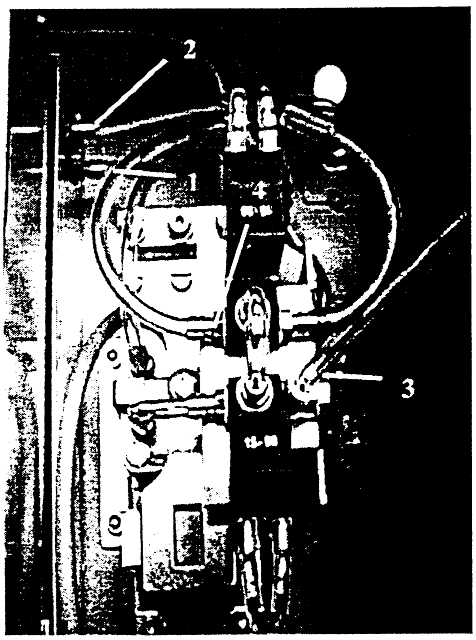
Removing the metering and recirculation system

In order to remove the metering and recirculation system, carry out the following steps:

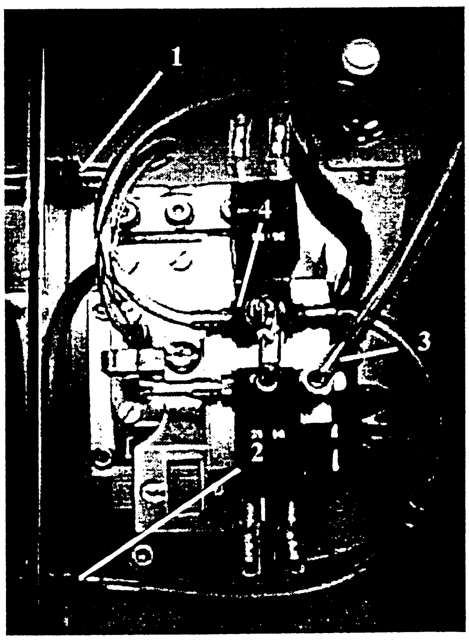
Step	Action
1	Disconnect the energy supply to the analyzer system.
2	Remove the power and CAN cables
3	Lay the appliance on the back panel (use padding), remove the casing and open the housing door.
4	Remove the hose connections between the analyzer module and valve or pump on the module (figure 5-4: 1, 2)
4	Disconnect the hose connection to the housing door on valve VDA 1 (Figure 5-4: 3)
5	Disconnect the hose connection to the outlet on valve VDA 2 (Figure 5-4: 4)
5	Remove the 26-pole flat cable from the printed circuit board sensor CPU
6	Unscrew the four nuts (M4) on the housing floor
7	Remove the pump with mount and valves and loosen the connection leads for the neutral gas valves at the terminal strip.

Figure 5-4
Gas connections on the metering and recirculation system

Analyzer module version 1



Analyzer module version 2



Installing the metering and recirculation system

Installation takes place in the reverse order. Do not forget the connection leads for the neutral gas valves VSN on the terminal strip of the printed circuit board VPL.

Attention!
When attaching the hose connections make sure they are securely connected. If necessary, use a new hose!

Changing the measuring gas valve

Removing the measuring gas valve

In order to remove the measuring gas valve, carry out the following steps:

Step	Action
1	Switch off the energy supply to the analyzer system.
2	Open the door of the system housing
3	Remove the hose connections from the corresponding valve
4	Carefully remove the electrical connections (flat connectors) from the corresponding valve
5	Unscrew the valve together with the sample inlet nozzle (2 nuts M19)
6	Carefully remove the sample inlet nozzle (be careful of the bow of the microswitch).
7	Unscrew the screw from the valve and screw it in at the same position in the new valve. If necessary replace seals.

Assembling the measuring gas valve

Installation takes place in the reverse order.
Ensure the valve is in the right position!

Attention!
When attaching the hose connections make sure they are securely connected. If necessary, use a new hose!

Removing/installing the printed circuit board MSLS

Removing the printed circuit board MSLS

In order to remove the printed circuit board MSLS, carry out the following steps:

Step	Action
1	Switch off the energy supply to the analyzer system.
2	Remove the 10-pole plug
3	Unscrew the four plastic nuts (M3)
4	Carefully remove the printed circuit board from the threaded bolts

Installing the printed circuit board MSLS

In order to install the printed circuit board MSLS, carry out the following steps:

Step	Action
1	Place the printed circuit board carefully on the threaded bolts Take care of the switch bows of the microswitches!
2	Screw down the four plastic screws (M3)
3	Plug in the 10-pole plug
4	Press the bows of the microswitches between the pipe union and the guiding bolt, if necessary bend somewhat, so that they can move freely
5	Check that the microswitches switch on connecting a bag

Removing/installing the switched mode mains power supply

Removing the switched mode mains power supply

In order to remove the mains power supply, carry out the following steps:

Step	Action
1	Switch off the energy supply to the analyzer system.
2	Pull out the power plug
3	Open the housing door
4	Unscrew the two nuts (M5) above the mains power supply
5	Unscrew the connections to the appliance connector plug
6	Remove the mains power supply from the upper threaded bolts and then from the lower guide
7	Unscrew the cable at the output (24 V) and completely remove the mains power supply

Re-install the switched mode mains power supply

In order to install the mains power supply, carry out the following steps:

Step	Action
1	Connect the 24 V cable (ensure the correct polarity)
2	Press the circuit into the lower guide and then push onto the upper threaded bolts
3	Screw down the mains power supply using the 2 nuts (do not forget the cable lug of the earthed conductor)
4	Re-install the connection to the mains switch

Removing/installing the mains switch

Removing the mains switch

In order to remove the mains switch, carry out the following steps:

Step	Action
1	Switch off the energy supply to the analyzer system.
2	Pull out the power plug
3	Open the housing door
4	Unscrew the connection to the switched mode mains power supply
5	Press the mains switch out of the housing, from inside to outside, thereby pushing together the mounts on the sides (if necessary use a screw driver to help)

Installing the mains switch

In order to install the mains switch, carry out the following steps:

Step	Action
1	From outside to inside, press the mains switch with all connection leads into the back wall of the housing until it engages
4	Connect it to the mains power supply