SIEMENS

PGC 302 edition II
Process
Gas Chromatograph

Manual

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Siemens Aktiengesellschaft

Contents

Information for the user Conformity certificates Safety information Disclaimer of liability Sensitive components Abbreviations and symbols Explosion protection	**1**
Software and networking The software The IBM-compatible PC Installation of software Parameterization of control unit Problems and errors Networking	**2**
Installation Installation location Assembly Technical data	**3**
Commissioning Shutting down	**4**
Operation with keyboard and screen	**5**
Software supplements GCLAN, GCARCHIV, PGCSIM	**6**
	7
Function description of analytical system Gas supply Sample input Columns Detectors Oven Column switching	**8**
Function description of electronics Summary of electronics Detector electronics Control electronics Circuit diagrams	**9**
	10
Application data	**11**
Dimensional drawings	**12**
External piping and wiring diagrams	**13**
Data sheets and certificates	**14**
Spare parts lists	**15**

NOTE:

For clarity reasons this Instruction Manual does not contain all detailed information on all types of chromatograph. It cannot refer to all possible cases in conjunction with installation, operation or repair either.

Should you require further information, or should particular problems occur which are not handled in sufficient depth in this Manual, help can be requested through your local Siemens office or representative.

The contents of this Instruction Manual are not part of a previous or existing agreement, commitment or statutory right and do not change these. All commitments on the part of Siemens are contained in the respective sales contract which also contains the complete and solely applicable warranty conditions. These warranty conditions in the contract are neither extended nor limited by the contents of this Instruction Manual.

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

Technical data are subject to change.

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INFORMATION FOR THE USER

Page

Conformity certificates 3

Safety information 4

Symbols and abbreviations 5

Explosion protection

Special fittings 8
Conditions 8
Temperature class 8
Isolating relay 8
Opening the electronics door 8

Pressurized enclosure, switching on the chromatograph 9
Starting the automatic purging time 9
Key switch, bypassing of purging time controller . . 9
Purging time monitoring unit 9

Design of the classified PGC 302 10
Degrees of protection used in the classified PGC 302 10
Heaters for oven, liquid injection valve and heated line 10
Solenoid valve for carrier gas H_2 10
Classified FID 10
Classified TCD 10

Maintenance of classified parts . . . 11

EG conformity certificate

The master of the EG conformity certificate can be consulted at:

Siemens AG
AUT 362
D-76181 Karlsruhe

Contents of EG conformity certificate

This chromatograph has been developed and manufactured in line with

- 89/336/EWG
  Guideline for electromagnetc comaptibility (changed by 91/263/EWG, 92/31/EWG and 93/68/EWG)
- 73/23/EWG
  Guideline for voltage limits in use of electrical equipment (changed by 93/68/EWG)

The following international standards are applied:

- EN 50081-1
- EN 50082-2
- EN 61010

Safe electrical isolation

The low-voltage circuits are isolated safely from the power supply circuits. The chromatograph has been designed according to DIN VDE 0100, Part 410: *Protective measures, Protection against dangerous shock currents*, in particular Section 4.3.2 *Functional extra-low voltage with safe isolation.*

The chromatograph complies with the requirements of DIN VDE 0106, Part 101: *Protection against dangerous shock currents, Basic requirements for safe isolation*.

Explosion protection

Explosion-proof chromatographs have been designed in accordance with:

- EN 50014: 1977 + A1 ... A5 General regulations
- EN 50016: 1977 + A1 Pressurized enclosure p
- EN 50018: 1977 + A1 ... A3 Flameproof enclosure d
- EN 50019: 1977 + A1 ... A3 Increaseded safety e

Refer to the conformity certificate in Register 14.

Recommendation

You retain this status and guarantee danger-free operation if you observe the information and warnings in this manual.

SAFETY INFORMATION

The chromatograph complies to the safety regulations. Following our handling instructions and safety informations the chromatograph normally won't cause any substancial damage or any personal injury.

This safety information is to warn you of dangers which could lead to personal injury or damage to property. This information is present

- **in this manual**
- **on the chromatograph**
- **on components of the chromatograph.**

The following are differentiated depending on the degree of danger:



DANGER

This means that death, severe personal injury or substantial damage to property will occur if the specified safety precautions are not observed.



WARNING

This means that death, severe personal injury or substantial damage to property can occur if the specified safety precautions are not observed.



CAUTION

This means that slight personal injury or damage to property can occur if the specified safety precautions are not observed.



WARNING

If you open the door or remove the covers certain parts in electrical devices become accessible which possess dangerous voltages during operation.

Only suitably qualified staff should work on this device or in its vicinity.

These should be thoroughly familiar with all warnings and maintenance measures according to this manual.

Correct and safe operation of this device is dependent on:

- Proper transport
- Correct storage
- Correct installation and assembly
- Proper operation and maintenance

Please follow the directions for use in this manual to avoid personal injury or damage to property

Qualified person

A qualified person in the sense of this manual and the warning information on the chromatograph and its components is one who is familiar with the installation, design, commissioning and operation of the chromatograph and who has the appropriate qualifications, e.g.

- Is trained and authorized to energize, de-energize, ground and tag circuits and devices/systems in accordance with established safety practices, especially in potentially explosive atmospheres.
- Is trained in the proper care and use of protective equipment in accordance with established safety practices.
- Is trained in first aid.

WARNING: Dangerous gases!

The chromatograph uses various gases, some of which may be dangerous.

Before working on the chromatograph, establish which gases are used in the chromatograph, and in particular the composition of the sample gas.

Route all exhaust gases via a common line out of the chromatograph and away from the position of use.

Always ensure there is sufficient ventilation:

- If you are working with hydrogen. Hydrogen produces an explosive mixture with air
- If you are working with liquid CO_2. The inhalation of larger quantities of CO2 leads to an oxygen shortage and even to unconsciousness and suffocation.
- If you allow the sample gas line to run empty and the sample gas contains corrosive or toxic components.

WARNING: Explosive gases!

The chromatograph uses various gases, some of which may produce an explosive mixture with air!

Before working on the chromatograph, establish which gases are used in the chromatograph.

Route all exhaust gases via a common line out of the chromatograph and away from the position of use.

Always ensure there is sufficient ventilation.

CAUTION: Flames!

In some detectores a flame is still burning although the chromatograph is electrically switched off! Switch off the gases and allow the detector to cool down before you open such a detector!

CAUTION: Hot parts!

Some parts of the chromatograph need to be hot while working although they must be accessible, e.g. the oven, the detectors and injectors.

CAUTION: Radioaktive!

If the chromatograph is equipped with ECD or HID: ECD and HID are radiators. They are subject to governmental supervision. Observe the regulations!

Route all exhaust gases via a common line out of the chromatograph and away from the position of use.

Observe the maximum operating temperatures of these detectors!

These detectors are marked with the corresponding label.

Electrostatically sensitive devices!

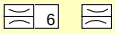
Before you touch such components/modules:

- Switch off the chromatograph.
- Discharge any static from yourself by touching a grounded object or by using an ESD wristband.
- Only use tools which are free of static charges.
- Do not touch any connection pins or conductor paths. Only touch the modules by their edges.

Disclaimer of liability for external accessories

If you wish to use or connect accessories which we have not specifically recommended for the chromatograph, please ask us to first confirm that the operational safety of the chromatograph is not influenced by the accessory. Without this approval, we will not accept any liability for the operational safety.

Symbols and abbreviations used in this manual

Name	Symbol	Abbreviation	Remarks
Pressure regulator		DR	
Pressure converter		DW	
Manometer		MA	
Restrictor		DB	with and without class specification
Needle valve		NV	with Teflon or graphite gasket
Capillary		DS	
Solenoid valve		MV	closed when de-energized
Solenoid valve		MV	open when de-energized
Absorber			
Preliminary column		VS	
Main column		HS	
Detectors			
Flame ionization detector		FID	
Electron capture detector		ECD	
Flame photometric detector		FPD	
Thermal conductivity detector		WLD	
Oxygen-selective detektor, modified FID		O-FID	
Helium ionization detector		HeD	
Injectors			
Liquid injection valve		FDV	
Gas injection valve		GDV	

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EXPLOSION PROTECTION

The installation and operation of electrical equipment in potentially explosive atmospheres is subject to regulations. These regulations refer to the general rules applicable in technological applications.

Special fittings

Some chromatographs are provided by us with special fittings according to customer requirements. The conditions for special fittings are regulated in § 10 of Elex V:

> *If an electrical unit has been specially manufactured for a particular operation, it must not be used until the authorized inspector has established that it complies with the requirements of this regulation and has provided a certificate on the result of this test.*

This test can be carried out at the same time as the test which must be carried out anyway before the chromatograph is used for the first time.

WARNING:
The test certificate for your classified chromatograph only applies to the original configuration and to the connection and installation according to the Siemens circuit diagrams and piping diagrams. The classified protection for your device is cancelled if the configuration or ignition class of one of more components is changed.

Following conversions and maintenance on components relevant to the explosion protection the chromatograph must be certified again by an authorized inspector.

Conditions

The conformity certificate with its supplements contains all conditions specified by the authorized inspector for the installation and operation of the chromatograph.

Temperature class

To ensure retention of the temperature class, the heated components of the chromatograph are protected by temperature limiters. The temperature limiters must be reset manually in the event of an error: open the door to the electronics area and press the corresponding red button.

WARNING:
An explosion may occur if the electronics door is opened too soon because of hot components and residual electrical charges in the chromatograph. An appropriate warning label is present on the door!

Isolating relay

An isolating relay must be interconnected if signal contacts of the chromatograph supplied by an external source are used in a division 1 area. These isolating relays are positioned on the left in the electronics area (type of protection e) and are switched by the safety monitoring equipment.

Opening the electronics door

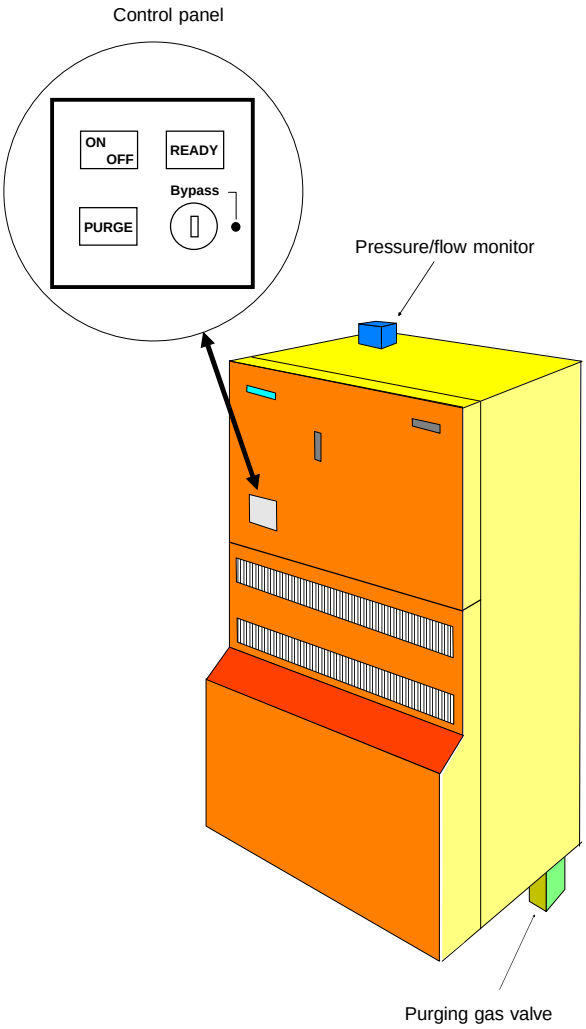
Before opening the electronics door in a division 1 area, it is essential to switch off the power supply and to then wait for at least 5 minutes.

WARNING:
An explosion may occur if the electronics door is opened too soon because of hot components and residual electrical charges in the chromatograph. An appropriate warning label is present on the door!

PRESSURIZED ENCLOSURE, SWITCHING ON THE CHROMATOGRAPH

The electronics area of the chromatograph is pressurized. It is constantly purged with a non-inflammable gas to prevent explosive gas from entering this area.

The power supply to the chromatograph must only be switched on when the electronics area has been sufficiently purged. An automatic feature ensures this is the case in a division 1 area. In a division 2 area, you must switch on the chromatograph yourself once you have assessed that the electronics area has been sufficiently purged.



Starting the automatic purging time

- Switch on the external power switch. The excess pressure is produced in the chromatograph.
- The purging time commences once the purging pressure has been produced and the flow is sufficient. The *Purge* lamp lights up while purging time.
- Once the purging time has expired and the *ON/OFF* pushbutton is at ON at the same time, the purging time controller switches the power supply to the chromatograph, to the control room panel and to the isolating relay via a contactor. The purging valve is switched over such that only losses resulting from leaks are compensated. The *Purge* lamp goes out. The *Ready* lamp lights up if the *ON/OFF* pushbutton is at OFF.
- The purging time controller switches off the power supply if the pressure in the housing becomes too low or too high. A new purging procedure commences.

Key switch, bypassing of purging time controller

For certain maintenance operations it is necessary to open the electronics door without switching off the chromatograph. You must first possess an appropriate permit. Then set the key switch to *Bypass* before opening the electronics door.

NOTE:
The power supply to the chromatograph is switched on immediately if you set the key switch to *Bypass* and then switch on the purging time controller!

WARNING:
Never activate the key switch before an expert has guaranteed that the atmosphere at the chromatograph location does not present an explosion hazard and will remain so for the duration of the maintenance work (permit!). We recommend that you install a gas warning device in the vicinity of the chromatograph during the maintenance work.

Purging time monitoring unit

The monitoring unit is fitted in the electronics area of the explosion-proof chromatograph. It has been especially adapted for this purpose. All parts are explosion-proof and must be wired according to Siemens circuit diagrams, otherwise the explosion protection is cancelled.

The set purging time is also part of the explosion protection. The explosion protection is cancelled if the settings are changed.

DESIGN OF THE CLASSIFIED PGC 302

There are three different areas in the chromatograph with respect to the explosion protection:

Pressurized area
This includes the electronics area, the mounting shaft behind the analyzer section, the connections of the oven heating cartridge and the connection cables of the FID.

Carrier gas H_2 must never be passed into this area. Switching valves for carrier gas H_2 must therefore be fitted outside this area: classified solenoid valve in the mounting area, or pneumatically-controlled slide valve.

Flameproof area
The housings can resist an internal explosion pressure. Flames are not released because they are cooled down below the ignition class temperature on their way out. These include the FID, TCD and solenoid valves.

Potentially explosive atmosphere
The surface temperatures in the oven area and the mounting area above the oven are limited to temperature class.

Degrees of protection used

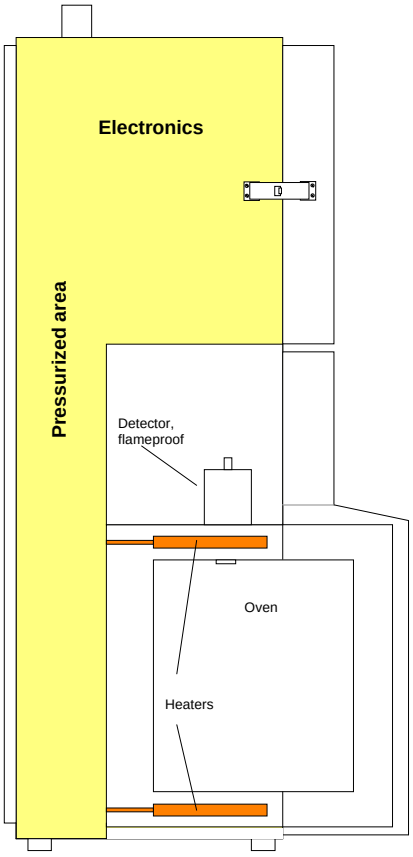
A rating plate which specifies the degrees of protection is present on the housing of your classified chromatograph:

Electronics area	EEx pe IIB+H_2
Oven heater	EEx pd IIB+H_2 T2/T3/T4
FID	EEx dp IIB+H_2 T2/T3/T4
TCD	EEx de IIB+H_2 T3/T4
FDV	EEx pd IIB+H_2 T2/T3/T4
FPD	EEx pd IIC T3/T4
Detector heater	EEx pd IIB+H_2 T2/T3/T4
Heated line	EEx p IIB+H_2 T3/T4
Solenoid valve for H_2 and flammable samples	EEx de IIB+H_2 T5
Safety monitoring unit	EEx de[ib] IIC T4

Heaters for oven, liquid injection valve and heated line

Each heater contains a temperature limiter in addition to a heating cartridge and temperature sensor. The limiter switches the heater off shortly before the ignition class temperature is violated.

The electrical connections have a pressurized enclosure. They are routed into the mounting shaft via a purged tube. Exhaust openings in the flange ensure good ventilation.



Solenoid valve for carrier gas H_2

The solenoid valve is classified. The connection cables are potted.

Classified FID

The detector has no own heater and is classified. The gas inlets and outlets act as flame barriers. They prevent sparks from passing outside the heating chamber.

The electrical connections have a pressurized enclosure. They are routed into the mounting shaft via a purged tube. Exhaust openings in the flange ensure good ventilation.

Classified TCD

The detector has its own heater and is classified. The gas inlets and outlets act as flame barriers. They prevent sparks from passing outside the measuring chamber. The electrical connections are present in a classified junction box.

A temperature limiter is fitted in the detector housing because the bridge current additionally heats the detector. The limiter switches off the bridge current shortly before the ignition class temperature is reached.

MAINTENANCE OF CLASSIFIED PARTS

According to regulations, the following operations must only be carried out by:

1 Experienced Siemens maintenance specialists on the user's premises
2 User's maintenance personnel with assessment by authorized inspector according to regulations
3 SIEMENS factory according to manufacturing diagram
4 Factory of respective manufacturer

WARNING:
The regulations must be observed during maintenance and repairs! According to the regulations for maintenance on components relevant to the explosion protection, work is only permissible in line with the table below.

Part	Adjustment			Replacement Upgrading			Repair			Limitations Notes
Purging time monitoring equipment	1	2	4	1	2				4	
Classified solenoid valves				1	2		(1)	(2)		(Clean valve)
Restrictors for protective gas			3	1	2				3	
Heater for oven, FDV, line				1	2					
Temperature limiter	1	2	3+4	1	2					
Temperature class, modify limiter type				(1)	(2)				3	(Advice from 3)
Diaphragm valve										Permissible temperature ≤ 160 °C
TCD				1	2				3	
FID				1	2		1	2		
Methanizer				(1)	2				3	(w. expert's opinion)
Window, electronics door lock				1	2					
Classified cable gland, Cassified terminals				1	2					
Purging hose for protective gas	1	2		1	2					
Gaskets for pressurized inclosure				1	2					
Fuses for classified solenoid valves				1	2					
Isolating relay: Modex, line contactor				1	2					
Isolating amplifier				1	2				4	

Numbers in brackets refer to notes in brackets.

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THE SOFTWARE

Page

BIOS (basic input output system) 2
Operating system 2
Specific software 2

Software in the chromatograph

BIOS 3
Control software, interface drivers 3

Software in the control unit

Installation program 3
Control software, interface drivers 3
Configuration 3
Screen operations 3
Supplementary software 3
Server link 3

Software in the server

Server software 4
Interface drivers for coupling modules 4

Software in the control system 4

THE IBM-COMPATIBLE PC

What happens when switching on 6
The MS-DOS operating system 6
The CONFIG.SYS file 6
The AUTOEXEC.BAT file 6
Directories 6
Working with subdirectories 7
Files 7
Path 7

The directories on the control unit

BEDI directory 8
KONFIG directory 8
METH directory 8
PGCARCH directory 8
PCPU-2 directory 9

The directories on the server

SERV directory 9
SERV\DF32 directory 9
SERV\DF32\SSnn directories 9
PCBEDI directory 9

Page

INSTALLATION OF SOFTWARE

Generation of backup copies 10
Latest information on software 10

Installation of operating software and configuration 11

Parameterization of control unit 11
Transmission rate 11
Number of chromatographs in ChromLAN 11
Use of printer on control unit for results and alarms 11
Synchronization of date and time 11
Parameterization of number of reports/chromatograms on the control unit 11

Optimizing memory in the control unit 12
Checking the memory assignments 12
The various types of memory 13
Optimization of hard disk in the control unit . . . 13

Installation of control software 14

Installation of server software 15

STARTING THE SOFTWARE

Starting the operating software or GCLAN 16
Calling the configuration 16
Starting the server software 16
A useful batch file 16
BEDI and Windows 16

PROBLEMS AND ERRORS

Faulty communication with the chromatograph 18
Testing the PCPU-2 19

NETWORKING

People use a telephone! 20
Chromatographs use interfaces 20
How are characters transmitted? 21
Parallel interface 21
Serial interface 21
Various serial interfaces 22
Various components for networking 23
Examples of networking 24
MODBUS coupling 25
TELEPERM coupling 25

THE SOFTWARE

Modern chromatographs are controlled by microprocessors which require software containing information on what they have to do. In most computers, the software is divided into several levels:

- BIOS
- Operating system
- Specific software.

BIOS (basic input output system)

The BIOS matches the processor to its respective electronic environment. It contains elementary functions which are typical for a specific application and which always remain unchanged. Examples in the case of personal computers include e.g. output characters on screen, recognize pressed keys. In the case of chromatographs, these include e.g. selftest, receive control software via interface, program flash EPROM.

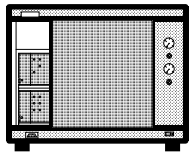
Operating system

The operating system is a collection of programs which control the more complex functions of the computer. In the case of personal computers, these include e.g. format diskettes, interface control, print.

Specific software

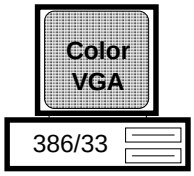
These are the functions for which you have really purchased a computer. For example, word processing with personal computers, or valve control, data processing etc. in the case of chromatographs.

Chromatographs



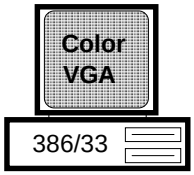
BIOS
Control software
- process
- laboratory
Interface drivers

Control-PC



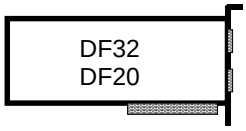
BIOS
MS-DOS 5.0
Control softw. + loader
Configuration
Operation
- ChromLAN
- Multitasking
- Printer spooler
Server coupling

Server-PC



BIOS
MS-DOS 5.0
Reduced operation with
- ChromLAN
- Multitasking
- Printer spooler
Server software with
- Settings
Interface drivers

Coupling modules for PCs



Interface drivers

Process control systems

* Teleperm M
* Simatic S5
* Honeywell TDC3000

Data address lists

SOFTWARE IN THE CHROMATOGRAPH

The chromatograph can carry out analyses automatically without a control unit being connected. To achieve this, you must

- Load the control software and interface driver
- Configure the system
- Load the methods
- Set the analysis parameters.

BIOS

The computer in the chromatograph is called PCPU-2. It has two EPROMs which contain the BIOS.

Control software, interface drivers

There are flash EPROMs on the PCPU-2 for the control software and the interface drivers. Flash EPROMs can be electrically deleted and programmed directly in the chromatograph.

The control software and the interface drivers must be loaded from the control computer into the chromatograph via a serial interface. Software updates can be carried out very simply in this manner.

SOFTWARE IN THE CONTROL UNIT

Every IBM-compatible personal computer has the BIOS in built-in EPROMs. The MS-DOS operating system must be installed on the hard disk.

Further software which is supplied on several diskettes or already installed on the hard disk is required to convert the personal computer into a chromatograph control unit:

- Installation program
- Control software and interface drivers
- Configuration
- Screen operation with ChromLAN
- If applicable, supplementary software such as GCLAN, GCARCHIV
- If applicable, further special interface drivers
- If applicable, server coupling

Installation program

The first diskette contains the installation program. This is used:

- To install the software on the control computer
- To load the control software with interface drivers into the chromatograph. You can select either laboratory or process versions, and the use of the interfaces.

Control software, interface drivers

The control software for the chromatograph is stored on the control computer in order to be able to subsequently load it into the chromatograph.

Configuration

The configuration is used to set the elementary parameters for the chromatograph. These are the parameters which are not often changed, e.g. chromatograph type, module designation or valve names.

Screen operations

Operation does not only mean the generation of colourful pictures. Programs are also required which are responsible for the invisible procedures in the control computer:

- Network software ChromLAN
- Network initialization INITCHRO
- Multitasking PGCRES
  Stores information onto the hard disk in the background. This information is obtained from the chromatographs via ChromLAN, e.g. analytical results, chromatograms, status.
- Printer spooler LPRINT or CPRINT
  Passes information on to the printer in the background. This information is obtained from the chromatographs via ChromLAN, e.g. analytical results or status information.

Supplementary software

The software packages GCLAN and GCARCHIV are supplied on separate diskettes. The installation program also copies these programs onto the control computer.

Server link

An additional interface driver is required in ChromLAN networks with servers to link the control unit to the server. The driver is called TELI and uses the D3964R protocol on ChromLAN.

SOFTWARE IN THE SERVER

Server PCs can be used e.g. to connect several control units to a ChromLAN loop. Servers can also reduce the load on the control computer if many chromatographs are connected.

At least one coupling module must be installed to convert the PC into a server, and additional software is required. This is supplied on diskettes or already installed on the hard disk:

- Server software
- Interface driver

Server software

The server software is supplied on a diskette which contains a program to install this diskette on the server.

The server software communicates with the chromatographs, control system and control unit via the interfaces of the coupling modules. The software collects data from the chromatographs and passes them on to the control unit or control system.

The server software must be assigned parameters. These settings are then stored in parameter files.

Interface drivers for coupling modules

At least one coupling module must be installed in the server. The module has two serial interfaces. Each module has a diskette with interface drivers:

- Coupling to a control unit or TELEPERM M using the D3964R protocol. This driver is called COMDRV
- Coupling to a control system with the MODBUS protocol. This driver is called UNIDRV.

The coupling module and diskette belong together and only function if they have the same serial number!

SOFTWARE IN THE CONTROL SYSTEM

The chromatograph information is stored in data structures in the control system. Data address lists must be declared when configuring so that the control system can assign these data.

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The IBM-COMPATIBLE PC

Fundamentals are handled here which must be observed when working with IBM-compatible computers. You can find further detailed information in the User's Manual of your computer and in appropriate literature.

What happens when switching on

The computer contains an EPROM (BIOS) which contains the elementary functions which must be executed when the computer is switched on. These functions are: recognition of keyboard, provision of screen output, starting of hard disk or diskette drive.

The operating system (MS-DOS) is then loaded from the hard disk or diskette. The computer then becomes a little intelligent. For example, you can now copy, delete or print files.

Special programs are additionally required for specific tasks, e.g. a text editor, a database system or the chromatograph control program.

Once the operating system has been loaded, a prompt appears on the screen, e.g.

```
C:>
```

Two files are very important whilst the operating system is being loaded: *autoexec.bat* and *config.sys*.

The MS-DOS operating system

The operating system is a collection of programs which control the basic operations of the computer. Examples of operating system files include:

COMMAND.COM	MS-DOS command processor
CONFIG.SYS	Operating system configuration
ANSI.SYS	System file
APPEND.COM	Defines file path
AUTOEXEC.BAT	Batch file for switching on
CHKDSK.EXE	Checks diskettes
DISKCOPY.EXE	Copies diskettes
EDLIN.EXE	Small editor
FORMAT.COM	Formats diskettes
MODE.EXE	Controls interfaces
PRINT.EXE	Prints in background
XCOPY.EXE	Copies directories/files

The CONFIG.SYS file

This file contains information for the operating system. You will probably never change this file. It could be the case, however, that its information is incomplete or incorrect. It should at least contain:

```
buffers=30
files=30
device=c:\dos\himem.sys
device=c:\dos\emm386.exe noems
dos=high,umb
country=001,,c:\dos\country.sys
```

The AUTOEXEC.BAT file

This file contains commands which are automatically executed as soon as the operating system is loaded. The following contents are typical, but not binding:

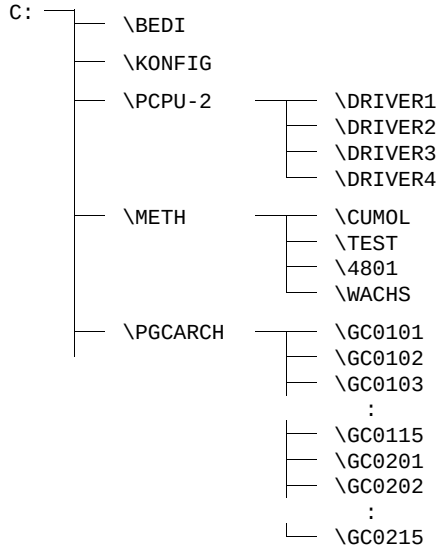
```
path=c:\;c:\dos
lh keyb us,,c:\dos\keyboard.sys
prompt $p$g
cd \bedi
```

In this case a path is generated, the American keyboard driver is loaded, and the prompt of MS-DOS emphasized. The directory *\bedi* is then selected.

You can also enter the name of your user program here at the end (e.g. BEDI). This operating software is then started automatically when you switch on your computer.

Directories

A directory structure is produced on the control computer. Directories can be compared with files in a cabinet. The filing cabinet corresponds to the hard disk *c:*. A directory can be divided into subdirectories.



When and why the chromatograph software generates the directories in this manner is explained further below.

Working with subdirectories

You must be acquainted with a number of functions so that you can organize your files meaningfully in hierarchical directories:

- Generation of subdirectories
- Deletion of subdirectories
- Changing from root directory to a subdirectory.

Generation of subdirectories
If you enter the command `MD CUMOL` in the directory *c:\meth*, for example, you generate a sub-subdirectory *cumol* in the subdirectory *meth*. The complete name of this sub-subdirectory is *c:\meth\cumol*.

Deletion of subdirectories
If you enter the command `RD CUMOL` in the directory *c:\meth*, for example, you delete the subdirectory *cumol*. Prerequisite: no files or further subdirectories may be present in the directory *cumol*. You are thus prevented from deleting files by mistake which you have forgotten.

Changing directories
If you enter the command `CD CUMOL` in the subdirectory *c:\meth*, for example, you change to the sub-subdirectory *cumol*. Please note:

- You can change forwards e.g. from the root directory to the subdirectory *c:\meth* using `CD METH` or `CD \METH`.
- You can change backwards e.g. from the sub-subdirectory *c:\meth\cumol* to the subdirectory *c:\meth* using `CD \METH` only.

You must always enter the backslash ("\") if you wish to change backwards or across from subdirectories. Because the backslash is difficult to find on some computers, here is a trick: you can also move backwards by one subdirectory at a time using the command `CD..` ! You can omit the backslash in the forward direction. Example: you can change from the directory *c:\meth\cumol* to the directory *c:\pgcarch\gc0102* if you enter:

```
c:\meth\cumol> cd..
c:\meth> cd..
c:\> cd pgcarch
c:\pgcarch> cd gc0102
c:\pgcarch\gc0102>
```

NOTE:
The bold MS-DOS prompt in the above example shows which directory you are currently in. This only functions if the command `prompt $p$g` is entered in the file autoexec.bat!

Files

Files are present in all directories and have names such as e.g. *konfig.exe*. The dot may be preceded by up to eight letters. These help the user to find his file.

The dot can be followed by up to three letters which identify the extension. These letters are used to classify the files. Certain extensions have a fixed meaning:

`.EXE` These are programs which can be called by typing their name.

Example: *konfig.exe* can be started by typing: konfig [`Return`] .

`.COM` These are programs similar to the *.exe* files.

`.BAT` These are files in which commands are stored which would otherwise have to be entered at the DOS level itself.

Example: A file *k.bat* could contain the following commands:

```
cd \konfig
konfig
cd \bedi
cls
```

The file k.bat is started by typing: `k` [`Return`]. This results in starting of the configuration software

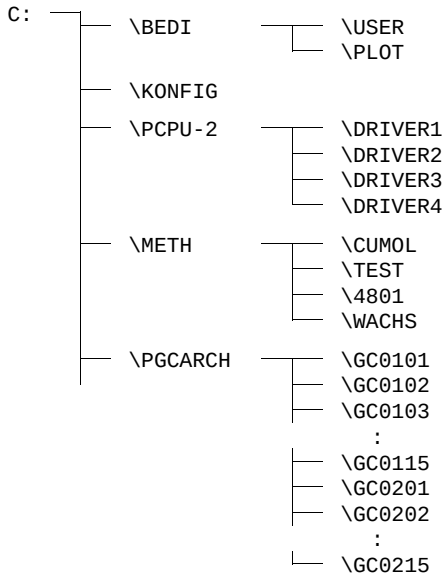
Path

Files can only be reached using their names if they are present in the current directory. For example, if you are in the directory *c:* and wish to start the file *bedi.bat* in the directory *\bedi*, you must either first change to the directory *\bedi* or enter the name with its path: *\bedi\bedi*. Examples:

`c:\`	This is the root directory
`\bedi`	This is a subdirectory, but could also be the file *bedi* in the main directory.
`\bedi\koli.dbf`	This is a file in the subdirectory

THE DIRECTORIES ON THE CONTROL UNIT

The software is always installed on the hard disk *c:*. A directory structure results with the following subdirectories:



BEDI directory

The directory *bedi* contains all files required by the operating software. These included the program files, *inter alia*:

CHROM.EXE	Chromatograph display
CHROMLAN.EXE	Communication
INITCHRO.EXE	ChromLAN initialization
LPRINT.EXE	Printer spooler
PGCREINT.EXE	Reintegration
PGCRES.EXE	Multitasking
X.EXE	User interface

Also included, amongst others, are screen drivers, display texts, info texts, working databases, databases for describing displays, and index files.

BEDI\USER directory

An item *User program* appears in the selection display if a file *USER.EXE* is present in this directory. You can start your program *USER.EXE* from there.

BEDI\PLOT directory

This directory contains files for automatic printing of chromatographs and results following every analysis.

KONFIG directory

The directory *konfig* contains all files required by the configuration software. The configuration is always effective on methods present in the directory *meth*.

METH directory

The directory *meth* contains a subdirectory for each method, e.g. *meth**cumol*. This subdirectory contains all files belonging to this method. The number of files depends on the complexity of the method. The following files must always be present:

INSTPGC.DBF	Method contents directory
INSTPU. MEM	Analysis parameters
CFAE.TXT	Configuration of A/D converter
CFG.TXT	Configuration of device type
CFGAO.TXT	Configuration of analog outputs
CFGDO.TXT	Configuration of digital outputs
CFGPRN.TXT	Configuration of printer
CFTEMP.TXT	Config. of temperature controller
TELIA.TXT	Time events program A

Usually present:

KALIA.TXT	Calibration list A
KOLIA.TXT	Component list A
REPORTx.BAS	Basic programs for report

PGCARCH directory

The directory *pgcarch* always contains 30 subdirectories *gc0101* ... *gc0215*. Report files and raw data files of the corresponding chromatograph are saved in the subdirectories, e.g. for the third chromatograph at the serial interface *com1:* in subdirectory *pgcarch**gc0103*.

In addition, the directory *pgcarch* always contains the files

ALARMREP.STA	Total status of network
GCACTPAR.DAT	Current parameters
GCPAR.INI	Initialization parameters

The number of analyses to be stored per chromatograph is defined when starting the operating software.

PCPU-2 directory

The directory *pcpu-2* contains all files required to load the control software and the interface drivers into the chromatograph.

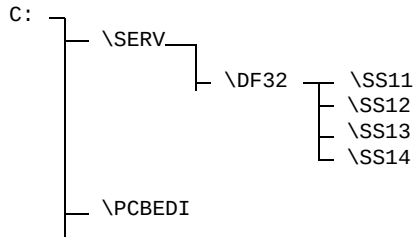
`INSTALL.EXE`	Copies files onto hard disk
`LDR.BAT`	Installs ChromLAN
`LOADER.EXE`	Programs the PCPU-2
`CHROMLAN.EXE`	Communication
`INITCHRO.EXE`	ChromLAN initialization
`PCPU-2L.HEX`	Chromatograph control software, laboratory
`PCPU-2P.HEX`	Chromatograph control software, process

The directory *pcpu-2* contains four subdirectories *driver1* ... *driver4*. These subdirectories store all interface drivers for the four serial interfaces of the PCPU-2.

`UNIDRVx.HEX`	TTY/RS232 driver
`232CLANx.HEX`	RS232 driver
`485CLANx.HEX`	RS485 driver

THE DIRECTORIES ON THE SERVER

The software is always installed on the hard disk *c:*. A directory structure results with the following subdirectories:



SERV directory

The directory *serv* contains all files required by the server software. These include the server software itself and its parameter files.

`SERV.EXE`	Server software
`SERV.BAT`	Start file for the server software
`SERVER.CFG`	Password, interface parameters
`GRAPH.CFG`	Recorder ranges for trend
`PGC_IN.CFG`	Address list of measured components

SERV\DF32 directory

The directory *serv\df32* contains the board drivers for the coupling modules.

SERV\DF32\SSnn directories

The directories *serv\df32\ss11 ... ss22* contain the respective interface drivers. The subdirectories *ss11* and *ss12* or *ss21* and *ss22* correspond to the pairs of interfaces of the coupling modules (max. 2).

`UNIDRV`	Modbus driver
`COMDRV`	D3964R driver

PCBEDI directory

The directory *pcbedi* serves as an intermediate memory for the chromatograph status, printer information and analytical results.

INSTALLATION OF SOFTWARE

Together with the chromatograph you were provided with four diskettes with 3.5" format:

- Operation BEDI V50_1 and BEDI V50_2
- Configuration KONF V50_1
- Control software PCPU V50_1

Operation and configuration contain software for the control unit, the control software must be loaded into the chromatograph.

Generation of backup copies

Produce a copy of all diskettes. The diskettes are not copy-protected. Use the copies as your working diskettes. Store the original diskettes in a safe place.

First check the file BEDI.BAT

The file BEDI.BAT is regenerated when you update the operating software. If you made changes to the old version BEDI.BAT, these changes must again be entered in the new BEDI.BAT. An example of this is our storage program for results *RPArchiv*.

The commands in BEDI.BAT

Following installation, the file BEDI.BAT appears as follows:

```
set clipper=/E:0
lh chromlan z30 a38400
initchro 1 0
if errorlevel 1 goto exit
lh pgcres c: z0 x10 y10 v0
cd c:\bedi
lh lprint c500
call lan (or call switch)
:exit
```

The meaning of the program names

ChromLAN	Resident program for communication between chromatograph and control unit
INITCHRO	Checks how many chromatographs are connected to the control unit
PGCRES	Resident program, fetches cyclically from the chromatograph: status, result and raw data
LPRINT and CPRINT	Resident program for printing result, chromatogram and BASIC texts
LAN	Produces the coloured screens for network summary and operation
SWITCH	Produces the coloured screens for operation

Latest information on software



It is often the case that changes are made to the scope of delivery or to individual program functions after editing of the manuals has been completed. Additional information may therefore be present on the installation diskettes. Please observe the message displayed on the screen at the end of the installation. It is particularly important

- if you have already used an older software version
- or if you require information on the latest software functions.

Once you have successfully terminated the installation, you should load the file README.TXT using the MS-DOS editor and read it carefully. It is advisable to print this file and to include it amongst your documentation.

INSTALLATION OF OPERATING SOFTWARE AND CONFIGURATION

Insert the diskette *BEDI V50_1* into drive *a:*, and then type

`a:install` RETURN

The installation program is then activated and expects the following inputs:

- Operating language
- Colour setting for the screen
- New installation, modify settings or install options? Select *New installation*
- The file *config.sys* is checked and modified if necessary. The old file is retained as *config.old*
- Source drive for the installation diskettes. The destination drive is always *c:*
- Also install GCLAN and GCARCHIV? Only select *YES* if you have actually purchased these programs.

The installation program then creates the directories and copies all required files into the control unit. You will be asked to insert further diskettes into drive *a:*. The installation program then expects the following inputs:

- Interface on control unit for ChromLAN
- Transmission rate for ChromLAN
- Number of chromatographs per interface
- Is the printer on the control unit to be used for results and alarms?
- Are the date and time to be synchronized automatically in the chromatograph?
- Number of reports and chromatograms on the control unit

Parameterization of control unit

You can subsequently set the parameters in the control unit. The operating software must be left in order to modify the parameters. Type:

`cd \bedi` RETURN

`install` RETURN

The installation program is activated and asks whether you wish to carry out a new installation, to modify settings or to install options. Select *Modify settings*. Modify the desired parameters, and then leave the installation program.

IMPORTANT:
The control unit must be reset when the parameters have been modified in order to activate the new parameters!!

Transmission rate

You can set different baud rates for the two serial interfaces of the control unit. Please note that it is not possible to use every baud rate for every type of interface (see *Networking*).

Number of chromatographs in ChromLAN

Each time the operating software is started, you must check the number of chromatographs which are present in the ChromLAN. The operating software can only recognize that a chromatograph is not present in that a monitoring time expires. This takes quite a time for the maximum number of chromatographs.

To avoid unnecessary waiting, enter the actual number of chromatographs in the network.

IMPORTANT:
Chromatographs must only be entered for an interface if at least one chromatograph is connected there! Otherwise the operating software is blocked.

Use of printer on control unit for results and alarms

The print information is stored in files if the printer fails e.g. because the paper has run out.

Problems may occur if you enter *Use printer* even though a printer is not present since a huge file is generated on the hard disk for each chromatograph.

Synchronization of date and time

Chromatographs with PCPU-2 no longer have a clock with battery backup! Following a power failure, the chromatograph clock is set to 1.1.1980, 0:00. The chromatograph clock can be synchronized with the clock of the control unit, however. The control unit must be permanently connected to the chromatograph in this case.

Number of reports/chromatograms on the control unit

Do not select too many files, otherwise the computer will become slow.

OPTIMIZING THE MAIN MEMORY IN THE CONTROL UNIT

In certain operating situations, the operating software requires almost the complete *conventional memory* of 640 kB. To ensure that the operating software is executed correctly, all TSR programs should be loaded into the *upper memory area* as far as possible.

> **NOTE:**
> If the space in the *conventional memory* is insufficient, the message *Not enough memory* is output if certain functions of the operating software are used, or may possibly already appear when the operating software is started.

The following steps are necessary if you wish to optimally use the memory of the control unit. Theoretical considerations are shown on the next page and in your MS-DOS manual! The measures only function with PCs with an 80386 processor or higher.

1st step: Make all types of memory available

The following lines should be present in the file CONFIG.SYS, at the beginning if at all possible:

```
device=c:\dos\himem.sys
device=c:\dos\emm386.exe noems
dos=high,umb
```

> **CAUTION:**
> If the path *\windows* is present instead of *\dos* in your file CONFIG.SYS prior to *himem.sys* or *emm386.exe*, you should not change this!
> If further parameters are present in your file CONFIG.SYS after *noems*, you should not change this!

2nd step: Load TSR programs into the upper memory area

It is necessary

- to use the command *devicehigh*= instead of *device*= in the file CONFIG.SYS
- to use the command *loadhigh* or its abbreviation *lh* in front of program names in the file AUTOEXEC.BAT!

Example of CONFIG.SYS
If your file CONFIG.SYS contains e.g. a line

```
device=c:\dos\setver.exe
```

change it into

```
devicehigh=c:\dos\setver.exe
```

> **CAUTION:**
> *devicehigh* must not be used in the lines *himem.sys* and *emm386.exe* because these lines are responsible for permitting *devicehigh* to be used!

Example of AUTOEXEC.BAT
If your file AUTOEXEC.BAT contains e.g. a line

```
keyb gr,,c:\dos\keyboard.sys
```

change it into

```
lh keyb gr,,c:\dos\keyboard.sys
```

3rd step: Reset control unit

Your modifications only become effective when the control unit is restarted! Simultaneously press and hold the keys ALT and CTRL, and then press the key DEL in addition.

4th step: Checking the memory assignments

The DOS command *MEM* indicates the current memory assignments of your control unit. Type the following command after the DOS prompt:

```
c:> mem /c /p   RETURN
```

With MS-DOS versions < 6.2, type:

```
c:> mem /c |more   RETURN
```

Please observe the vertical line (ASCII 124) in front of *more*.

How can you recognize whether your modifications were successful?
The result is correct if only a few programs are present in the *conventional memory* and many programs have been loaded into the *high memory*. The reply to the *mem* command could then appear as follows, for example:

```
Modules which use the memory below 1 MB:

Name     Total  =        Conventional +    High memory
MSDOS    15,389   (15K)  15,389   (15K)    0        (0K)
HIMEM    1,120    (1K)   1,120    (1K)     0        (0K)
EMM386   3,136    (3K)   3,136    (3K)     0        (0K)
COMMAND  3,792    (4K)   3,792    (4K)     0        (0K)
SETVER   832      (1K)   0        (0K)     832      (1K)
RAMDRIVE 1,232    (1K)   0        (0K)     1,232    (1K)
VSAFE    22,880   (22K)  0        (0K)     22,880   (22K)
SMARTDRV 29,024   (28K)  0        (0K)     29,024   (28K)
GRKBD    2,192    (2K)   0        (0K)     2,192    (2K)
DOSKEY   4,144    (4K)   0        (0K)     4,144    (4K)
LMOUSE   16,112   (16K)  0        (0K)     16,112   (16K)
EVESA    4,144    (4K)   0        (0K)     4,144    (4K)
Vacant   709,328  (693K) 631,536  (617K)   77,792   (76K)

Memory summary:

Memory type              Total =     Used      + Vacant
Conventional             655,360     23,824    631,536
High                     158,352     80,560    77,792
Reserved                 393,216     393,216   0
Expanded (XMS)           7,181,680   4,444,528 2,737,152

Total memory             8,388,608   4,942,128 3,446,480

Total below 1 MB         813,712     104,384   709,328

Maximum size for executable program  631,440   (617K)
Largest vacant block in high memory area  77,728   (76K)

MS-DOS is resident in the high memory area.
```

5th step: Changing BEDI.BAT or SIM.BAT

- Supplement your file BEDI.BAT or SIM.BAT by the following first line if it is not already present (the last character is a zero!):

```
set clipper=/E:0
```

- If your file BEDI.BAT or SIM.BAT does not contain the command *lh*, enter this for LPRINT/CPRINT, ChromLAN, PGCRES or PGCSIM and SIMRES.

You can find more details on this in this section under *Installation of software: First check the file BEDI.BAT*.

IMPORTANT:
If you change the files CONFIG.SYS or AUTOEXEC.BAT, it may be the case that your computer no longer operates correctly! You should have a boot diskette available for such a case.

Starting from MS-DOS 6.2, you can keep the key F8 pressed whilst you boot the computer. Critical commands in the modified files can then be bypassed.

Before you change anything, you should save the two files under a different name, or print them out.

If you are not quite sure:

- **Do not delete any lines**
- **Do not insert any lines**
- **Do not change any lines**
- **Only check the file CONFIG.SYS as described under *1st step***
- **Only supplement the commands *lh* and *devicehigh* in the files CONFIG.SYS and AUTOEXEC.BAT.**

NOTE:
The parameter *I* in EMM386.EXE permits additional memory areas in the UMA to be released. Please refer to your MS-DOS manual. Example: *I=E000-EFFF* works with almost all computers. The corresponding line is:

```
device=c:\dos\emm386.exe i=e000-efff noems
```

Caution: you must first determine which memory areas are actually unused in the UMA.

In exceptional cases, it is necessary to use the parameter RAM instead of NOEMS. This is necessary if older programs are used which require the expanded memory. EMM386 then simulates this type of memory.

The various types of memory

IBM-compatible computers have been subject to many years of development. It is therefore difficult to keep a track of everything. The table below is provided to help you in this respect.

The main memory in the PC

Designation	Abbreviation	Size
Conventional memory		640 kB
Programs executed under DOS normally use only this memory. They cannot recognize addresses above the 640 kB limit.		
Upper memory area	UMA	384 kB
Contains, inter alia, drivers for the screen, but memory areas are almost always still vacant. They are called UMB = upper memory blocks. Externally resident programs, and a number of programs from the operating software, can be loaded into this memory area using the command *lh*.		
Extended memory	XMS	Commences with 1 MB
Is only used by a number of programs, e.g. cache programs or Windows.		
High memory area	HMA	64 kB
This is the first 64 kB of the XMS. Parts of DOS can be loaded up into this area.		
Expanded memory	EMS	Max. 32 MB
Requires an expanded memory board and a driver which is provided with this board. Also functions with XTs because accessing is carried out using page frames of 64 kB which are inserted into the upper memory area (UMA). This is slow, however, and should only be used nowadays if an old(!) program can only use the EMS. This is hardly the case any more.		

OPTIMIZATION OF HARD DISK IN THE CONTROL UNIT

New files are constantly being stored on the hard disk of your control unit: result reports, chromatogram data and temporary files. MS-DOS Does not write these files into one block on the disk, it divides them into respectively available areas. This division increases as the operating period increases. The access to data may then become so slow that communication with the chromatograph no longer functions correctly.

It is therefore necessary to defragment the hard disk every now and then on every IBM-compatible PC. It was previously necessary to use separate programs, e.g. PCTOOLS. From version 6.2 onwards, MS-DOS contains the programs SCANDISK and DEFRAG. Following the DOS prompt, type

```
c:> scandisk c:    RETURN
c:> defrag c: /f   RETURN
```

You can find more details in your MS-DOS manual.

INSTALLATION OF CONTROL SOFTWARE

The control software of the chromatograph must first be copied onto the control computer. It can then be loaded as often as required into any number of chromatographs.

Insert the diskette *PCPU V50_1* into drive *a:*, and then type:

```
a:install   RETURN
```

The installation program is then activated and expects the following inputs:

- Operating language
- Colour setting for the screen
- Install control software on control unit or load into chromatograph (Install or Program) or both? Select *Install*. If you wish to subsequently load the control software into a chromatograph, select *Both*.

***Install* sequence**

- Process or laboratory version, select special driver
- Source drive for the installation diskettes. The destination drive is always *c:*.

The installation program then creates the directories and copies all required files into the control unit. Further diskettes with optional interface drivers may also be requested.

***Program* sequence**

Prerequisite: ChromLAN must be active on the control unit, and a contact must exist to a chromatograph. It is best to start up the operation and to immediately leave it again.

- Select which chromatograph is to be programmed in the ChromLAN network
- Select process or laboratory version
- Select interface driver

The control software is then transferred to the chromatograph and programmed into the flash EPROMs. This may take up to two minutes. The program subsequently signals whether the action was successful.

NOTE:
Once you have installed the control software, you can program further chromatographs without having to use the control software diskette. Type

```
cd \pcpu-2   RETURN
install      RETURN
```

Important advice on programming of PCPU-2

It is possible to program locally or via a ChromLAN network. An interface and a cable connection which functions correctly together with the control unit are used in both cases. ChromLAN must be loaded in the control unit!

The interface functions because standard settings are used or because meaningful settings have already been programmed.

If an incorrect drive is programmed for this interface, no further actions are carried out following programming! In this case, a meaningful setup must be produced locally using standard settings. Refer to the section *Problems and errors* for detailed information!

CAUTION:
The baud rates for the interfaces SER. 1, 3 and 4 are defined with the configuration. They only become active when a method is installed. The interface SER. 1 is set to 9600 baud immediately following programming, the interfaces SER. 3 and 4 to 38400 baud.

Our recommendation

Only program the PCPU-2 with the following setups. It is recommendable to first start up the operation and to immediately leave it again. ChromLAN is then correctly installed on the control computer.

Networked with RS485

- Interface SER. 3 or SER. 4
- Driver 485CLAN3 or 485CLAN4
- Transmission rate 38400 baud
- Participant number according to switch position on PCPU-2.

Networked with TTY

- Interface SER. 2
- Driver TTYCLAN2
- Baud rate according to switch 1 on PCPU-2
- Participant according to switch position on PCPU-2.

Locally with RS232

- Interface SER. 2
- Driver UNIDRV2
- Baud rate according to switch 1 on PCPU-2
- Participant number is 1, independent of switch position on PCPU-2.

INSTALLATION OF SERVER SOFTWARE

Please also refer to the instructions in the separate server manual!

First install the operating software on the server as described under *Installation of operating software*. The server uses the directory structures of the operating software and the functions:

`CHROMLAN.EXE`	Communication
`INITCHRO.EXE`	ChromLAN initialization
`LPRINT.EXE`	Printer spooler
`PGCRES.EXE`	Multitasking.

Now check whether you can operate the chromatograph normally.

If everything functions correctly, install the coupling modules into the server. This is described in the server manual. Then install the server software by inserting the server diskette into drive *a:* and typing

`a:` RETURN

`install` RETURN

The installation program is then activated and expects the following inputs:

- Destination drive and directory
- Interfaces used
- Error log device.

Various settings are subsequently required. These are described in the server manual.

STARTING THE SOFTWARE

Programs can be started by selecting the corresponding directory and then entering the name of the program. It is also possible to write batch files to simplify the procedure. This is described under *The IBM-compatible PC: Files*.

Starting the operating software or GCLAN

Connect the chromatograph to the control computer, and type following the DOS prompt:

C:> cd \bedi RETURN

C:\BEDI> bedi RETURN

The operation cannot be started if

- no chromatographs are connected,
- all chromatographs are switched off,
- there is a fault on the lines.

A message is output in these cases, and the DOS prompt appears again.

Calling the configuration

If you have ordered the additional software package GCLAN, start the configuration using the softkey on the GCLAN display *Measure*.

If GCLAN is not installed on the control unit: leave the operating software, and type the following after the DOS prompt:

C:\BEDI> k RETURN

or

C:\> cd \konfig RETURN

C:\KONFIG> konfig RETURN

Starting the server software

Connect the server correctly according to the circuit documents, and type following the DOS prompt:

C:> cd \serv RETURN

C:\SERV> serv RETURN .

If you have specified a different directory during the installation, select this directory instead of *\serv*.

A useful batch file

The batch file *do.bat* shown below outputs a comment menu on the screen and calls an operation or configuration without user intervention. It can be extended e.g. by a word processing call.

If you enter the command *call do* as the last line in the file autoexec.bat, the menu appears automatically when the computer is switched on. Refer to your MS-DOS manual for more details.

```
@echo off
rem Batch file DO.BAT in directory c:\
cls

if z%1z == zoz goto operation
if z%1z == zcz goto configuration
goto proceed

:operation
cd \bedi
call bedi
rem bedi is also a batch file, therefore CALL!
c:
cd \
goto proceed

:configuration
cd \konfig
konfig
c:
goto proceed

:proceed
@echo off
cls
echo Access chromatograph: Type do o
echo Configure:            Type do c
```

BEDI and Windows

The operating software can be used in a DOS window, but we cannot guarantee that no problems will be encountered. The operating software must only be started under Windows. We recommend that you boot the control unit before you call Windows. This ensures that the resident programs of the operating software are not already present in the main memory from earlier occasions.

Select the following settings for the DOS window:

- Click symbol *386 expanded* (main group, system control) and set *Never warn* for com1.
- Call the PIF editor (main group), open file *DOS_FULL.PIF* or *DOS_WIN.PIF*, select execution *Background*.

  Click *Further options* and set both the background and foreground priorities to 50.

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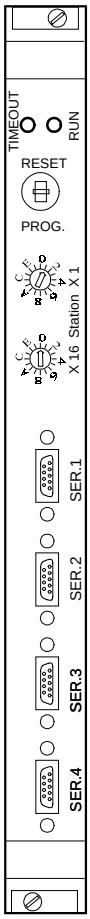
PROBLEMS AND ERRORS

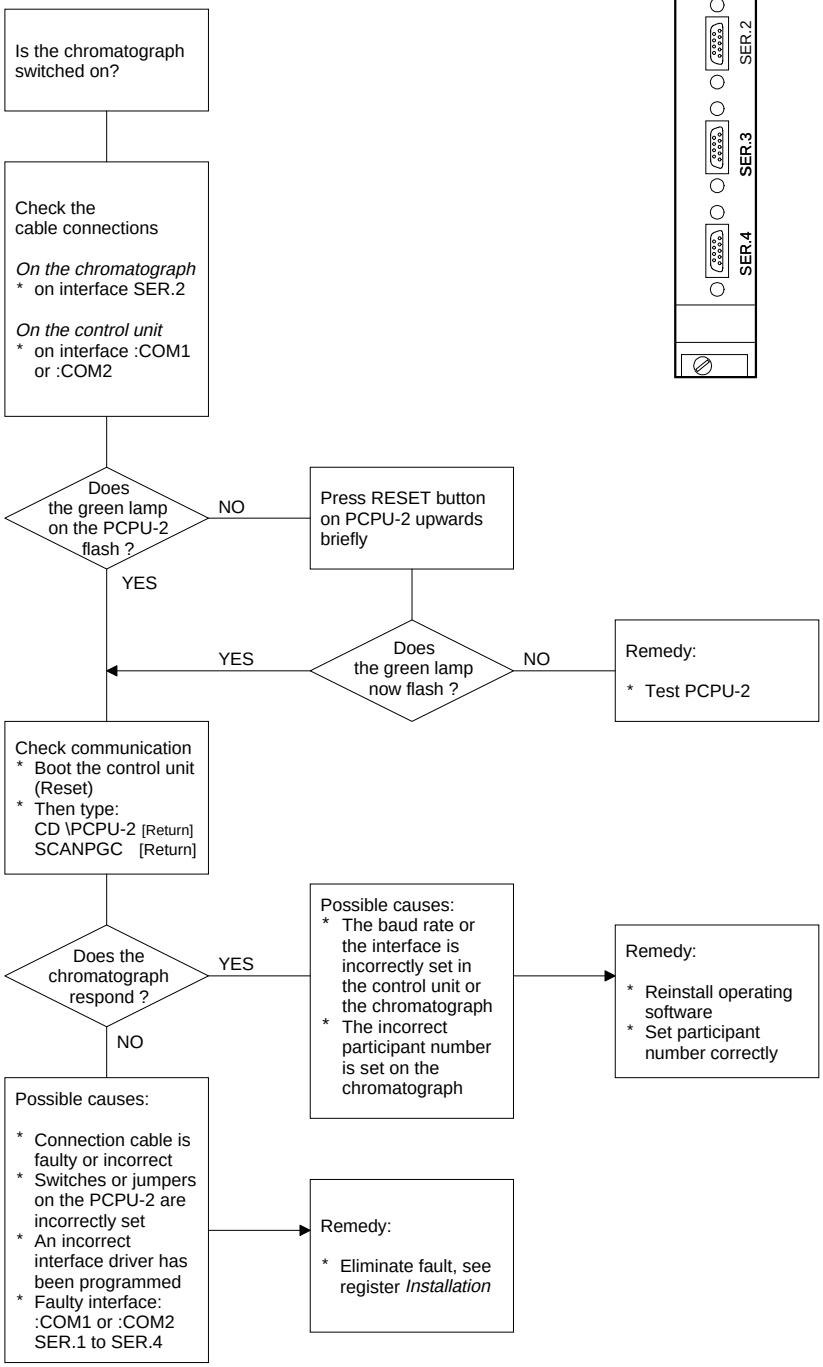
Faulty communication with the chromatograph

When an operation is started, a check is carried out to establish which chromatographs are connected and switched on. If no chromatographs reply, the message *No analyzer responding* appears and the MS-DOS prompt.

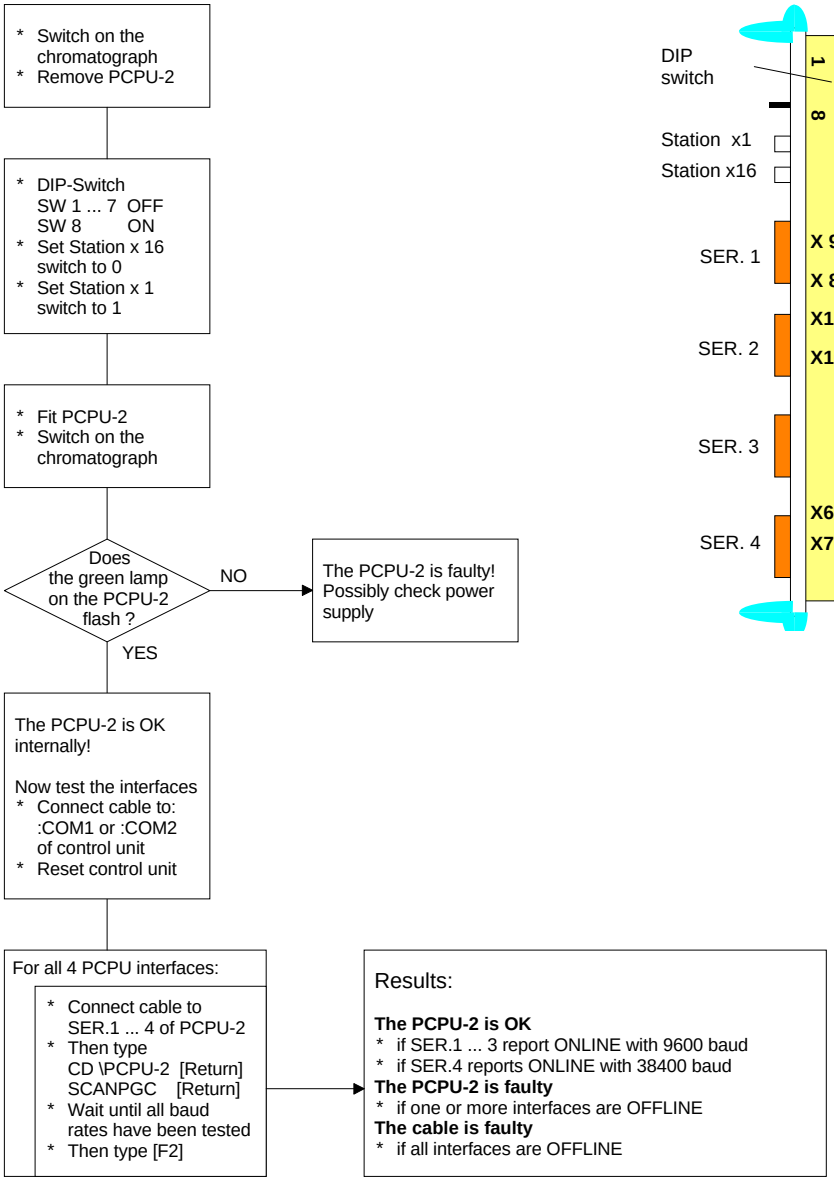
The selection display appears if at least one chromatograph responds. Select the function *Select PGC*. The display indicates for each chromatograph whether it is *online* or *offline*. Press the key [`F10: Actual. GC list`].

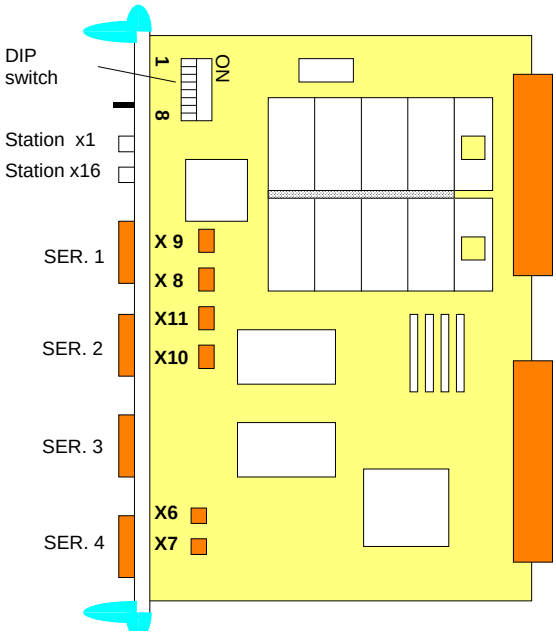
If the associated chromatograph still refuses to respond, the following checks are useful:





Testing the PCPU-2



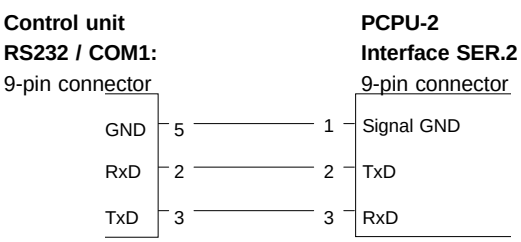


If the PCPU-2 is OK:

- Reprogram the PCPU. Use SER. 1 to 3 with 9600 baud or SER. 4 with 38400 baud. The ChromLAN must be called first! Example:

```
cd \bedi
chromlan a9600 z30
install
```

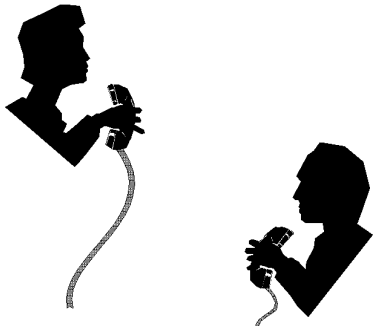
  Then follow the instructions on the screen.
- Then switch off the chromatograph and remove the PCPU-2
- Set DIP switch 8 to OFF
- Install PCPU-2



NETWORKING

The chromatograph can analyze automatically without a control unit being connected. It must first be parameterized, however. Results and status information are expected during operation.

For this purpose, the chromatograph must be able to communicate with a control unit, printer or control system. This is carried out in the same manner as when people use a telephone.



People use a telephone!

If two people in London and Munich wish to speak to one another, they use the telephone. This only functions if certain requirements are fulfilled:

Electrical connection
An electrical connection must exist between the two telephones. The electrical properties of the two telephones must be compatible. A conference circuit can be used to enable several subscribers to talk together.

Control of conversation
Courtesy rules must be observed to control the conversation, e.g. *Hello, Ron Hume here* and *Goodbye* or *What did you say* and *I see*. The partners must agree on the courtesy rules. In the case of conference circuits, everybody must be permitted to speak, e.g. *Your turn, Mr. Brown*.

Language
Both partners must speak the same language or at least be able to understand the language of the partner.

Understand what the partner is saying
The partners must understand the subject which is being discussed. They must also know what they have to do with the information.

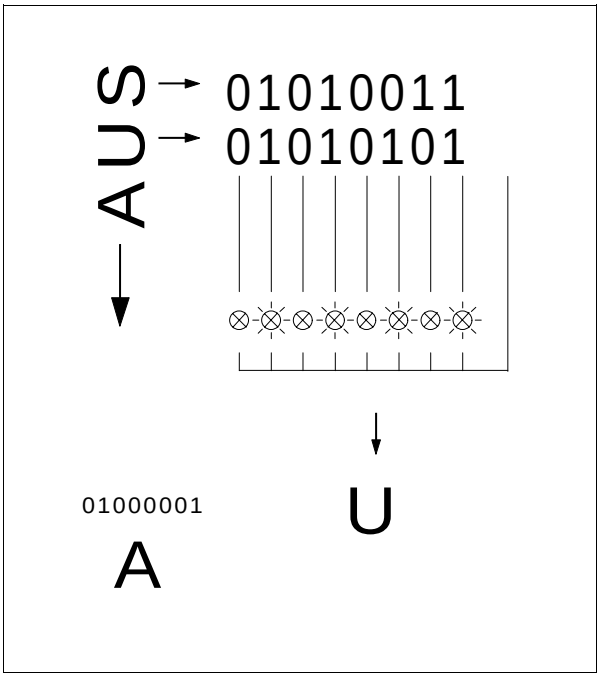
Chromatographs use interfaces

The chromatograph, control unit, printer and control system use special electronic circuits which we shall refer to as interfaces. Certain requirements must also be satisfied in this case:

Electrical connection
The device interfaces are connected together by electrical cables. The electrical properties of the interfaces are standardized, but there are different types of interface. Only identical interfaces must be connected together.

Control of conversation and language
Terms such as ChromLAN, Modbus or RK512 with D3964 incorporate courtesy rules and language.

Understand what the partner is saying
To understand the subject means in the case of chromatographs: software must be present in the chromatograph which can control it, and operating software must be present in the control unit or system which knows how a chromatograph functions and how a user thinks.



How are characters transmitted?

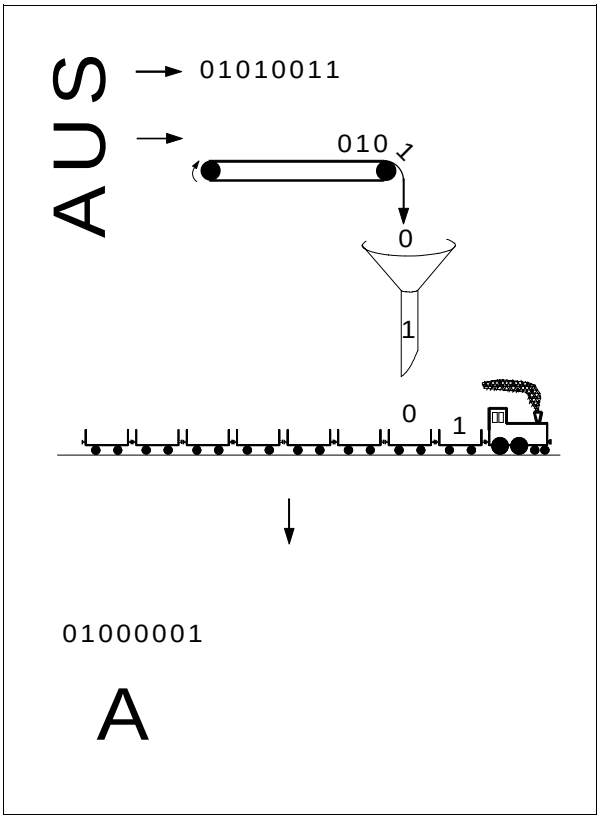
A digital computer only recognizes the states yes and no or 0 and 1. They are represented e.g. by 0 V and +5 V in a memory cell (bit).

Eight bits are combined into one byte. 256 different combinations of 0 and 1 can be generated with one byte.

An international standard (ASCII code) defines which character corresponds to which bit combination. An A is represented, for example, as *01000001* or a 5 as *00110101*.

Parallel interface

The eight bits of a byte can be transmitted simultaneously on parallel lines. This is carried out e.g. between the PC and printer via the Centronics interface. Parallel interfaces are fast, but require expensive cables with at least nine cores and often only permit short cable lengths.



Serial interface

If the eight bits are sent in succession (i.e. serially) on a line, the 0s and 1s arrive at the other end in succession. The receiver combines them into a byte again. Low-cost 2-core cables are sufficient for this type of transmission.

An understandable example of a serial transmission is the Morse code. In this case the letters are coded as a sequence of long and short signals.

Transmission rate

The receiver must know exactly how fast the 0s and 1s follow in succession. Otherwise it cannot recognize e.g. if two 0s arrive immediately in succession. The transmission only functions if the transmitter and receiver are set to the same transmission rate (baud rate). This is specified in bit/s or baud.

If the train is too fast for the conveyer belt, the wagons remain empty. If it is too slow, several digits fall into one wagon or fall under the wheels!

VARIOUS SERIAL INTERFACES

The term *Serial interface* only describes that letters are transmitted as a succession of bits. The electrical properties of the various serial interfaces are very different. The chromatograph and control unit use the following serial interfaces: TTY, V.24 or RS232, RS485.

TTY interface

The TTY interface operates with a constant current of 20 mA. There is a transmit loop and a receive loop. The partner which provides the current sources is referred to as active. The chromatograph is normally switched to passive.

The control unit requires a converter because it does not possess a TTY interface. It is switched to active.

V.24/RS232 interface

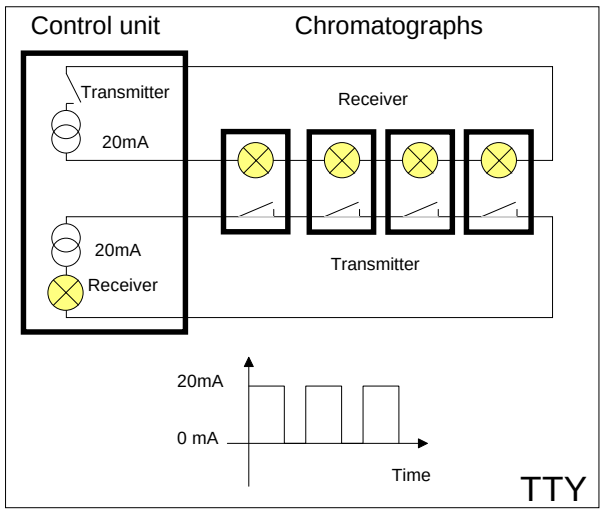
The RS232 interface operates with ±12 V voltage signals relative to ground. There is one transmit line and one receive line. The transmitter always has a voltage source.

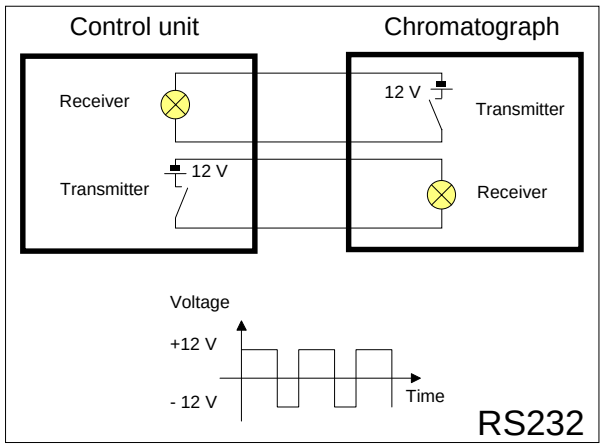
RS485 interface

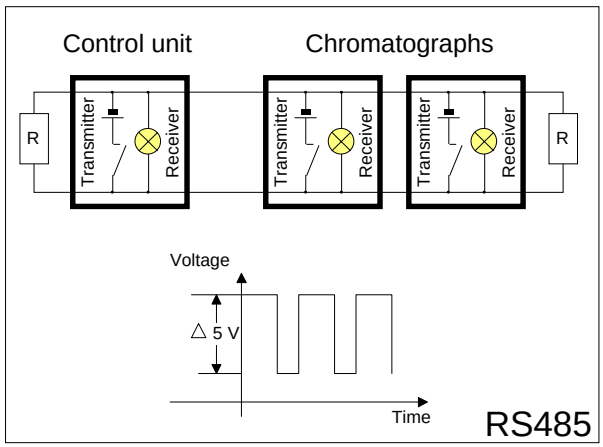
The RS485 interface operates with a 5-V differential voltage between two lines. All transmitters and receivers use these two lines: the partners must agree on who can transmit when! Each partner has a voltage source.

The control unit requires an interface converter because it does not possess an RS485 interface. This is fitted to the interface plug at the PC. It converts an RS232 interface into an RS485 interface.

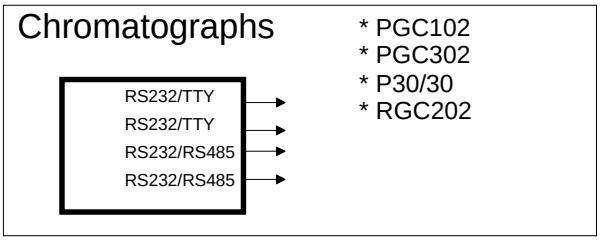
Terminators: the first and last partners must be terminated by 120 Ω (jumper on PCPU-2).

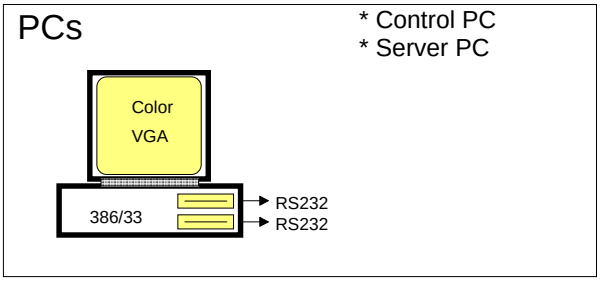


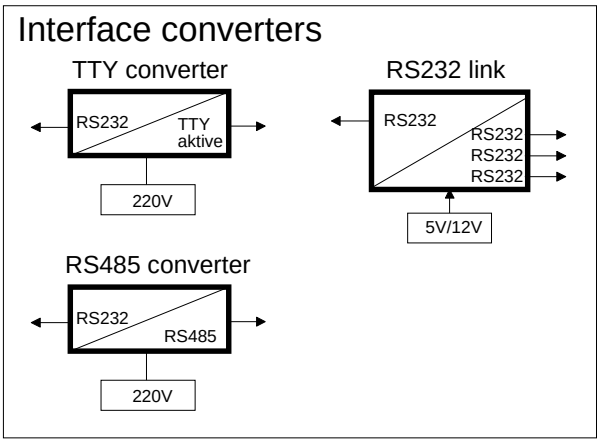


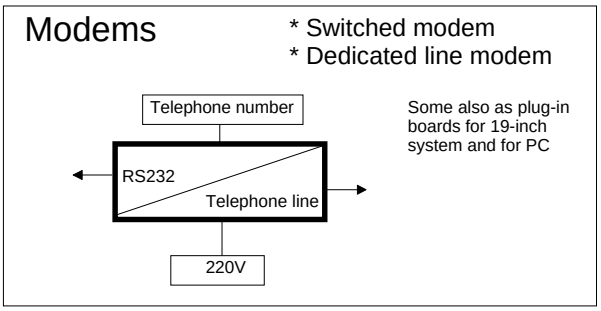


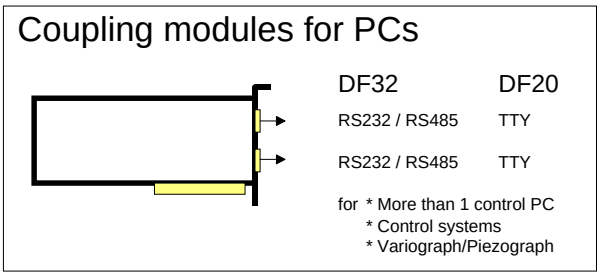
Data	TTY	RS232	RS485
Interference resistance Networking Max. number of chromatographs Max. transmission rate Max. cable length	Very good Yes 6 9600 bit/s 200 m distance	Moderate No 1 38400 bit/s 15 m	Very good Yes 32 38400 bit/s 1300 m (standard!)
Chromatograph-interface Use	SER.1 and SER.2 - ChromLAN network SER.1 - Printer	SER.2 - Local operation SER.3 and SER.4 - Control system	SER.3 and SER.4 - ChromLAN network - Control system

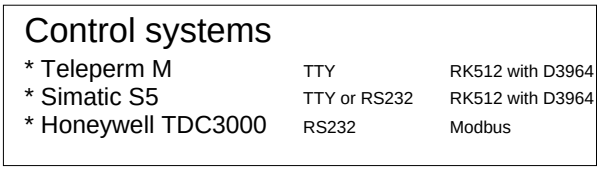












VARIOUS COMPONENTS FOR NETWORKING

Chromatographs, control units, server PCs and control systems can be combined together in numerous versions. The interconnections are described in the register *External piping and wiring diagrams*. Here we shall describe how the individual components interact.

Control units

IBM-compatible personal computers (PCs) are used as the control units. Laptops are suitable for local operation, we recommend powerful Desktops for stationary operation.

Server

It is advantageous to use server PCs if several chromatographs are to be networked. The server is connected between the chromatographs and control unit and collects all data from the chromatographs. It relieves the load on the control unit, and permits redundant networks and control system links.

We recommend particularly powerful IBM-compatible personal computers as the server.

Interface converters

Interface converters are required because PCs do not have a TTY or RS485 interface. The converters have their own housing with 230/115-V connection.

TTY repeater

Each TTY repeater extends the range of TTY cables by 200 m. It replaces one chromatograph in the current loop! The TTY repeater has its own housing with 230/115-V connection or power supply respectively.

Modems

All functions of the ChromLAN are possible via modems. Several chromatographs can also be networked to a modem using a Schniko.

Dedicated line modem
Uses the fixed telephone cables within a company. This means that repeaters are superfluous and that distances can be covered up to more than 10 km.

Switched modem
Has an unlimited range via the telephone network. A dialling procedure is required (waiting time).

EXAMPLES OF NETWORKING

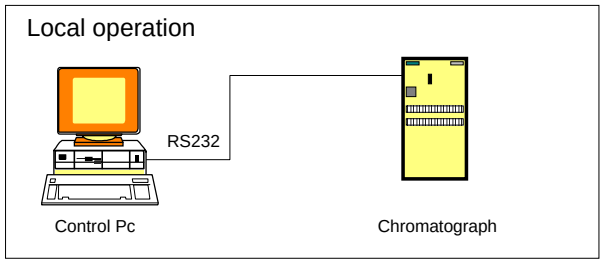
Constellations can basically be produced by connecting identical interfaces together. This functions without problems for the control unit, modems, interface converters and chromatographs. Additional software is required in certain cases:

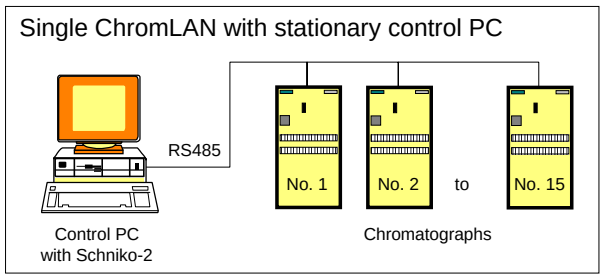
- Server software and interface drivers are required for networks with server PCs
- Interface drivers and software in the control system are required for the connection to control systems.

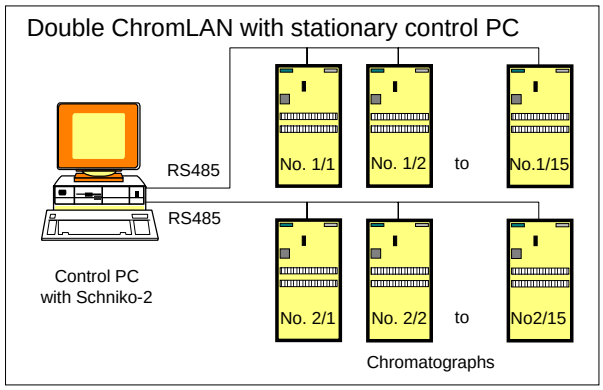
The examples on this page show a number of frequently used constellations up to a complex network:

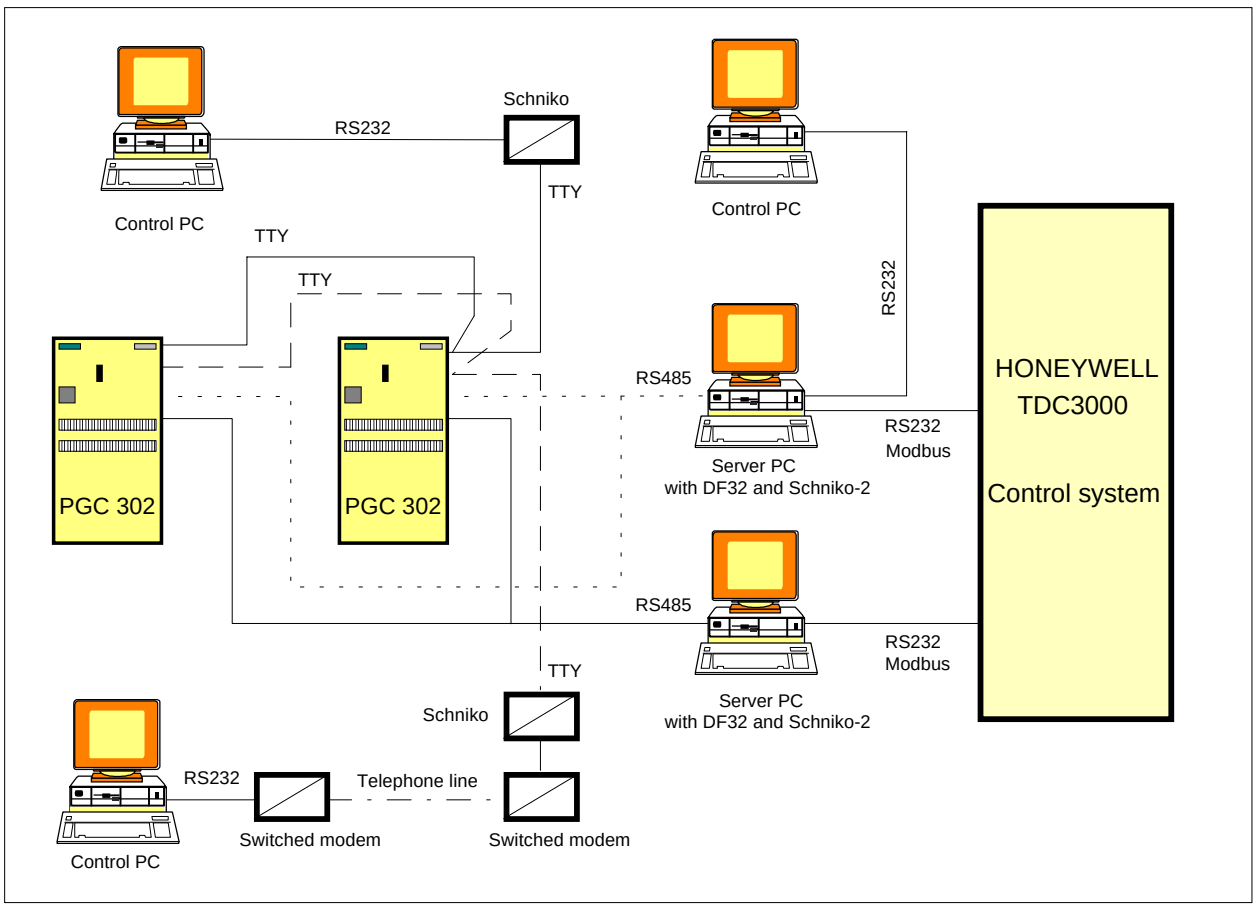
- Local operation
- Networks without server
- Networks with servers, also with modems
- Redundant networks

NOTE:
Digital and analog process signals from external devices can be networked to the chromatographs. They are connected to the chromatographs via digital and analog inputs and processed using BASIC programs.









MODBUS COUPLING

The process control system (PCS) contains a memory area into which the chromatograph can write via the MODBUS interface. The PCS software can read this information. If you write into this memory area, the information is automatically sent to the chromatograph.

Common memory area in PCS

The chromatograph and PCS thus communicate via this memory area. The memory is divided into 16-bit registers which are accessed by means of addresses. The maximum address range is 0 to 65535.

Declaration of memory distribution

The meaning of each register must be declared when configuring. The results of each component in each sample must be written by each chromatograph into a specific position in the PCS memory. The PCS can then find this data there again.

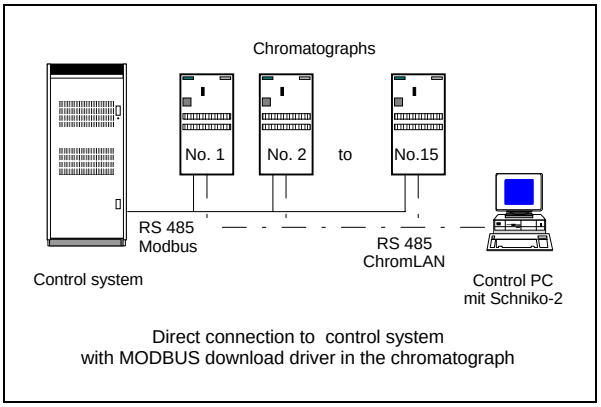
These address declarations depend on the number of chromatographs, samples and components. They are therefore redefined by us for each system.

A similar declaration is required for the status, sample sequence and sample release. In this case the standard addresses have fixed declarations.

Programming the chromatograph and PCS

The chromatograph and PCS must be programmed according to the declared memory division.

- The MODBUS download driver must be configured in the chromatograph.
- The server generates these address lists automatically, and they can then be printed.



Direct connection to control system
with MODBUS download driver in the chromatograph

TELEPERM COUPLING

The chromatograph and PCS communicate via data blocks. These data blocks must be defined in the PCS.

Interface driver

An interface driver for the TTY/TELEPERM coupling must be installed in the chromatograph. This driver is a standard, and is identical for every system. The driver in the chromatograph is initialized/configured by the PCS once or more often, e.g. with the number of samples and components. This configuration is stored by the driver in the flash EPROM of the chromatograph.

Programming the PCS

Programming is only necessary in the PCS. In this case, fixed data structures are defined for the component results similar to as with the MODBUS and dependent e.g. on the number of samples and components. Status messages, sample sequence and sample release have fixed formats.

A description for this programming is provided with the driver. There is a user interface for this in the PCS (Teleperm/Simatic).

INSTALLATION

Page

Installation location

Space requirements 2
Permissible ambient temperature 2
Permissible relative humidity 2
Power supply, power consumption 2
Gas connections, gas purity 2
Purging air, control air 2

Assembly

Gas lines 3
Sample lines 3
Exhaust gas lines 3

Power switch 4
Fitting the power cable 4
Equipotential bonding conductor 4
Lightning protection 5
Fitting the signal cables 5

Connection of local message printer 6
Connection of line recorder,
use of analog outputs 6
Connection of status messages to control room . . . 7
Connection of external status signals
and digital inputs 7
Connection of valves
and digital outputs 8

SIMATIC modules

Inserting or removing modules 10
Electrical isolation 10
Module address 11
Setting the address switches 11
32 digital outputs 0.5 A 12
16 digital outputs 2 A 13
16 digital outputs 0.5 A
and 16 digital inputs 14
32 digital inputs 15
8 analog outputs 0 to 20 mA or 4 to 20 mA 16
8 analog inputs 0/4 to 20 mA 16

Page

Connection of control unit

Local connection of control unit
using prepared RS 232 cable 18
Permanent local installation of control unit 18

ChromLAN networks

Interface converters 20
Permissible cable length 21
Pin assignments of
PCPU interfaces SER. 1 to SER. 4 21
Terminals for the interfaces
SER. 3, SER. 4 and SER.1 respectively 21
Terminating resistors 22
Participant number
of chromatograph in network 22
Loadable interface drivers 22
Setting of SER. 1 and SER. 2 to TTY or RS232 . 23
Setting of TTY to active/passive 23
Setting of SER. 1
for local printer or ChromLAN 23
Adjustment of transmission rate (baud rate) 23

Technical data

. 24

INSTALLATION LOCATION

You must observe the following information under *Technical data*.

- Permissible ambient temperature
- Permissible relative humidity
- Power supply, power consumption
- Lightning protection
- Gas connections, gas purity
- Purging air, control air

Space requirements

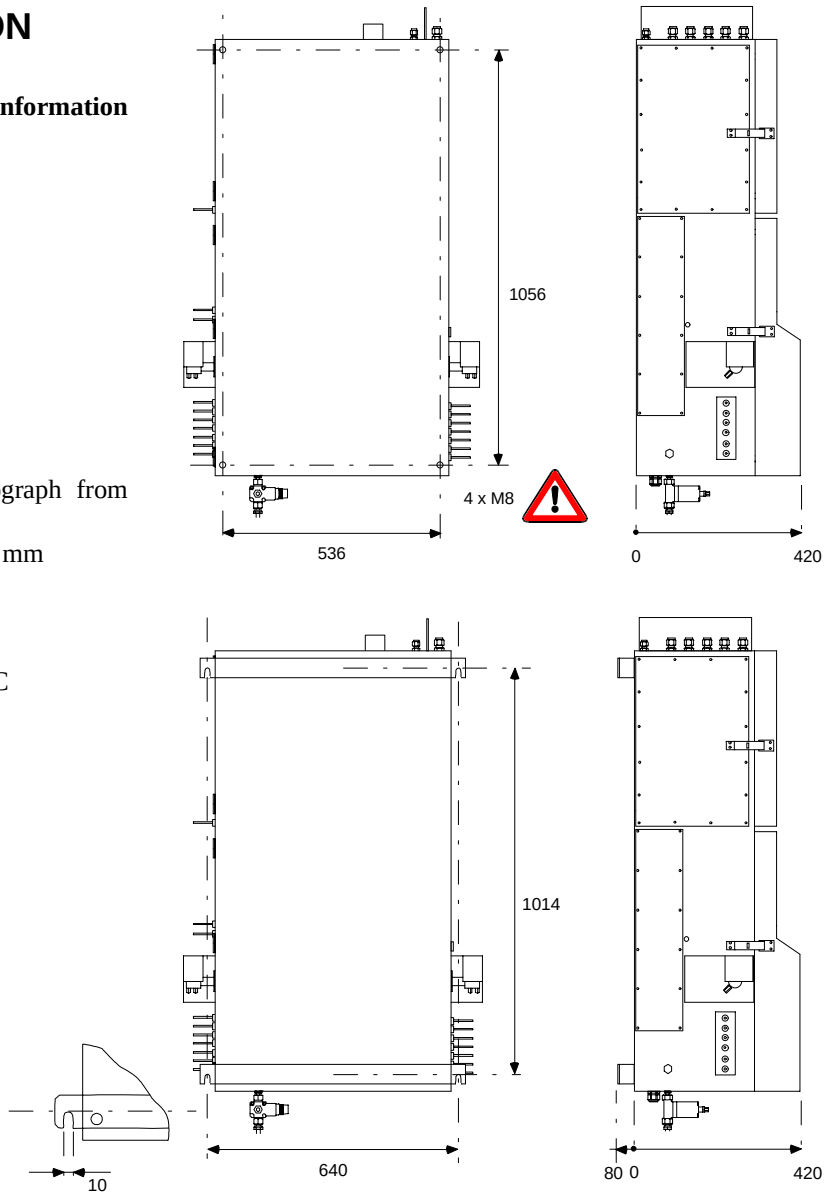
- 600 mm on both sides of chromatograph from side wall or next chromatograph
- Distance from wall at rear at least 100 mm
- Distance from ceiling at least 200 mm
- Swivelling radius of door 600 mm.

There are three manners in which the PGC 302 edition II can be mounted:

- M8 threaded holes in the rear panel.

Caution:
The max. thread depth is 10 mm!

- Mounting rails (option)
- Rack (option)



ASSEMBLY

The following assembly is always required:

- **Gas lines, Sample lines, Exhaust gas lines**
- **Power switch, Power cable**
- **Equipotential bonding conductor**
- **Signal cables**

The following assembly operations may be necessary depending on the device version:

- Message printer, Line recorder
- Valves and Status signals
- Control unit, ChromLAN
- Installation of software (see register *The software*)

CAUTION:
Leave the dummy plugs on the gas inlets until you are ready to use the chromatograph. The commissioning engineer only connects the gas lines to the chromatograph when he has checked them!

CAUTION: Gas connections
You must not shorten the gas connections on the chromatograph (3 mm pipes)! Otherwise they can become leaky because there are two pipes into one another and soldered at the end.

Gas lines

- Material: copper or stainless steel 6 mm x 1 mm (¼"). Only use very clean gas lines. Clean the lines before assembly if necessary
- Route the gas lines up to the chromatograph according to the piping diagram. Connect a shut-off valve upstream of each chromatograph.

Cleaning the lines

- Flush with a volatile solvent (acetone, hexane, do not use chlorinated hydrocarbons!).
- Then heat the lines whilst flushing with clean inert gas, e.g. five minutes at 200 °C. Purity of inert gas ≥ 99.999 %.

Gas connections on the chromatograph	
Purging gas	6 mm Swagelock gland
Liquid injection valve (FDV)	3 mm Swagelock gland
Heated gas connection	6 mm Swagelock gland
All other gas inlets	3 x 0.5 mm
All other gas outlets	3 x 0.5 mm

IMPORTANT:
All device-specific connection diagrams can be found in the register *External piping and wiring diagrams*.

Sample lines

- The sample conditioning unit must be fitted close to the chromatograph so that connection lines are short.
- The sample line to the chromatograph should have a downward gradient.

IMPORTANT:
Lifetime of injection valves decreases, if the sample contains solid particles. A filter ahead of the injection valve is essential. We recommend a filter grade
- Liquide sample: 98% for 0,3µm particles
- Gaseous sample: 99,99% for 0,1µm particles.
Siemens sample conditioning units are equipped with appropiate filters!

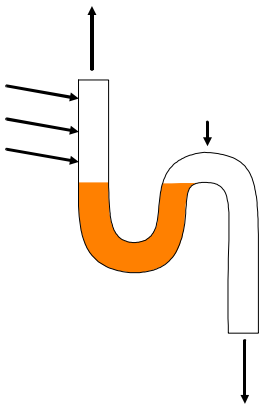
Exhaust gas lines

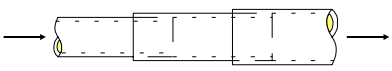
All exhaust gases of the chromatograph are routed through the housing wall and must be routed from there into a common exhaust line. The individual exhaust gas lines must have a downward gradient to the common line.

Material of common exhaust line
Stainless steel piping with i.d. of at least 12 mm (1/2") with welded-on nozzles and screwed glands. Minimum gradient 1 : 10.

Special with FID or FPD
With FID or FPD a condensation outlet or siphon is required.

For the classified FID: PTFE hose 8 mm i.d. x 1 mm (5/16"), insulated with silicon hose if necessary. Extension using PTFE hose 10 mm i.d. x 1 mm (3/8"). Exhaust gas lines must not diminish in size!





WARNING: Danger of explosion
A separate exhaust gas line is necessary when using H_2 as the carrier gas in order to prevent the constant production of an H_2/air mixture.

Power switch

The chromatograph does not have a power switch. A power switch and a fuse with a rating of 16 A/20 A at 230 V/115 V must be fitted in the building installation. The power switch should be installed close to the chromatograph.

CAUTION:
Installation regulations require the use of a ground fault interrupt (GFI) in the power supply line.

Fitting the power cable

The chromatograph is supplied without a connection cable.

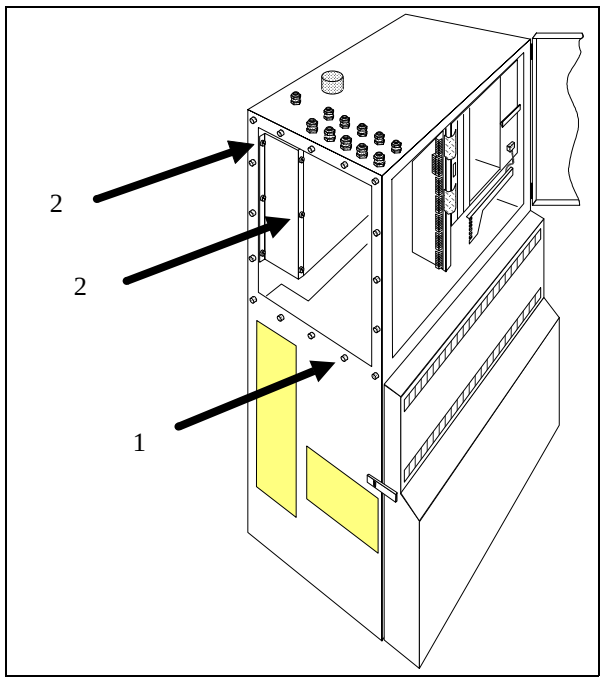
- Mains cable 3 x 2.5 □ , unscreened, permissible cable diameter 6 to 10 mm
- Loosen fifteen screws (1) and remove side panel
- Loosen six screws (2), push cover panel down and remove
- Open PG screwed gland (3)
- Push power cable approx. 15 cm into the chromatograph (3)
- Tighten PG screwed gland (3)
- With classified units: tighten the cable grip
- Connect conductors L and N to terminals L and N (4). Interchanging cancels the classification!
- Connect protective earth to earthing terminal (4).
- Refit cover and side panels.

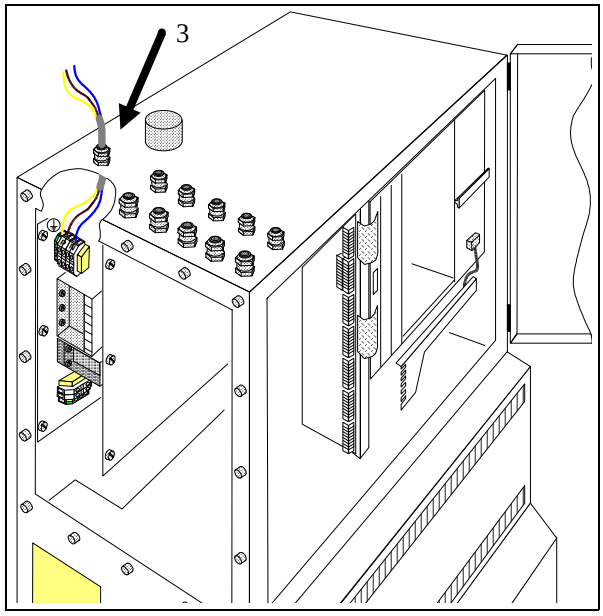
CAUTION:
Interchanging the conductors L and N cancels the classification!

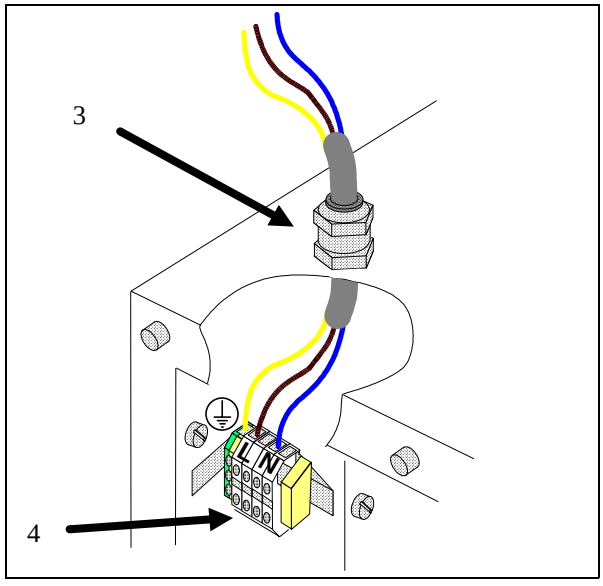
Equipotential bonding conductor

An equipotential bonding conductor is required for classified chromatographs depending on the local installation regulations.

- Connect the grounding terminal at the bottom left on the rear of the chromatograph to a central grounding point. Green/yellow cable ≥ 4 mm^2 (∅ > 3⁄32").







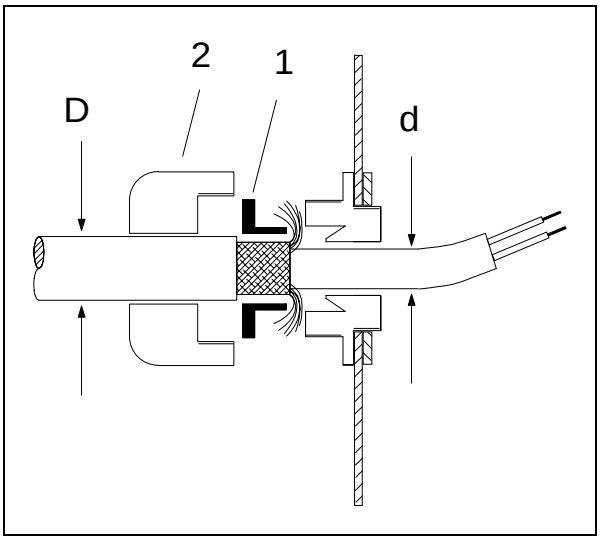
Lightning protection

To protect personnel and equipment, we recommend the installation of appropriate lightning protection equipment in areas where storms occur. Comprehensive protection necessitates the following:

- Lightning conductor
- Earthed metal belts in building to protect against electrostatic charges. This is particularly important at greater altitudes and with dry air.
- Transient suppressors in all lines leading to the chromatograph. These are available e.g. from the company Phoenix Contact.

Fitting the signal cables

All signal cables must be shielded outside the chromatograph and not shielded within the chromatograph. The shield must end at the screwed gland and is grounded there on the chromatograph housing.



- Loosen a suitable cable gland and remove the sealing gasket
- Push cable into chromatograph as far as required
- Remove insulation and screen from end of cable up to screwed gland. Expose 2 cm (1") of screen
- Connect screen around sealing ring (1) and tighten nut (2)
- With classified chromatographs: secure additional cable grip

Permissible cable diameter		
Screwed gland	D	d
PG11	6 to 10 mm	8 mm
PG16	12 to 15 mm	12 mm

Cable type

We recommend cable twisted in pairs for TTY or 20 mA-signal lines. Example: ChromLAN, printer and analog outputs.

CAUTION: Classified area:
All conductors must be connected. This means that the cable must not have more conductors than are actually required.

It is essential to refer to the connection diagram.

Connection of local message printer

A local printer can be connected to the interface *SER.1* in order to print results and/or alarms.

The driver *UNIDRV1* must be loaded for the interface *SER. 1*. DIP switches must be set on the PCPU-2. This is described under *ChromLAN with TTY*.

Your printer manual describes the interface assignment of your printer and how it is set. The printer must satisfy the following requirements:

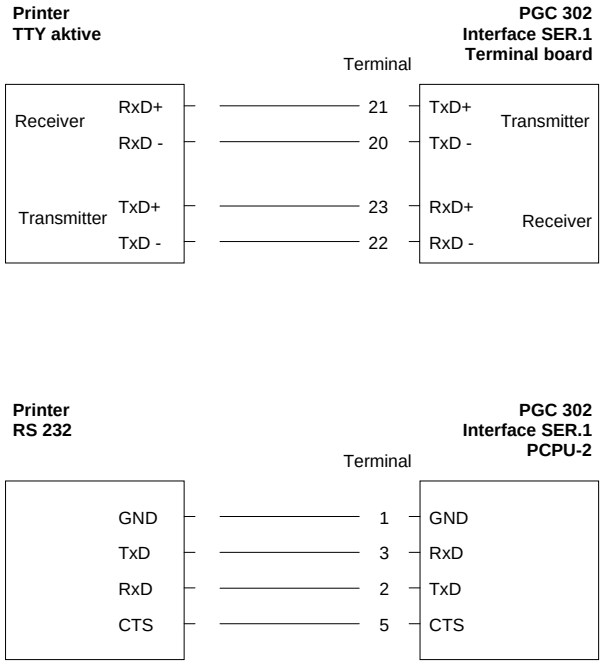
- Protocol X-ON/X-OFF
- Transmission rate 9600 baud
- Active TTY interface, i.e. the printer provides the 20-mA current loop
- Epson- or IBM-compatible

Printer with RS232 interface

If the printer only has an RS232 interface, the PCPU-2 interface *SER.1* can be switched over to RS232. The printer must be connected directly to the PCPU-2. The cable length must be less than 15 m. A DIP switch must be set on the PCPU-2. This is described under *ChromLAN with TTY*.

Printer with Centronics interface

The message printer can be connected to the Centronics interface of the control unit. It only prints if the control unit is switched on.



Connection of line recorder, use of analog outputs

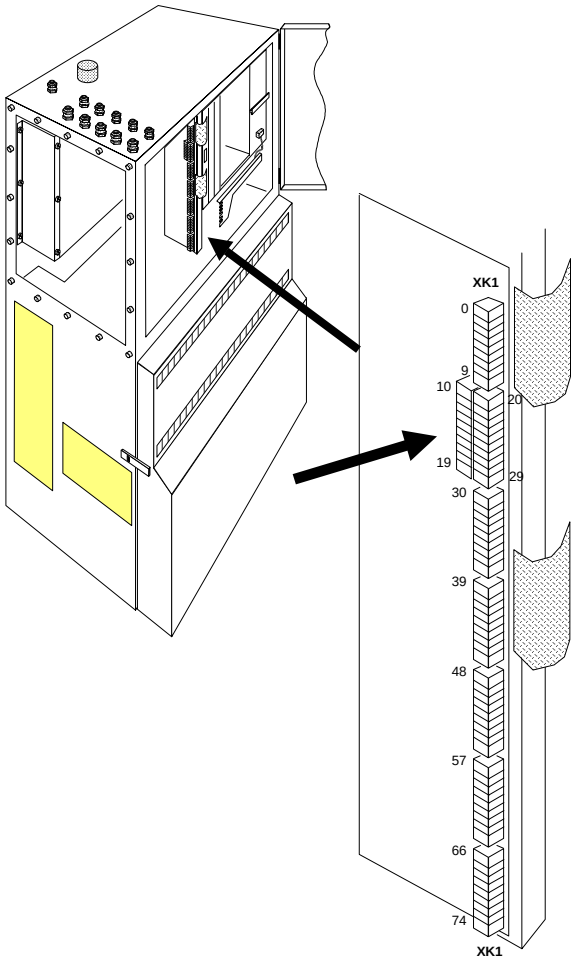
Four analog outputs are present as standard. They are connected to the terminal board, plug *X12*.

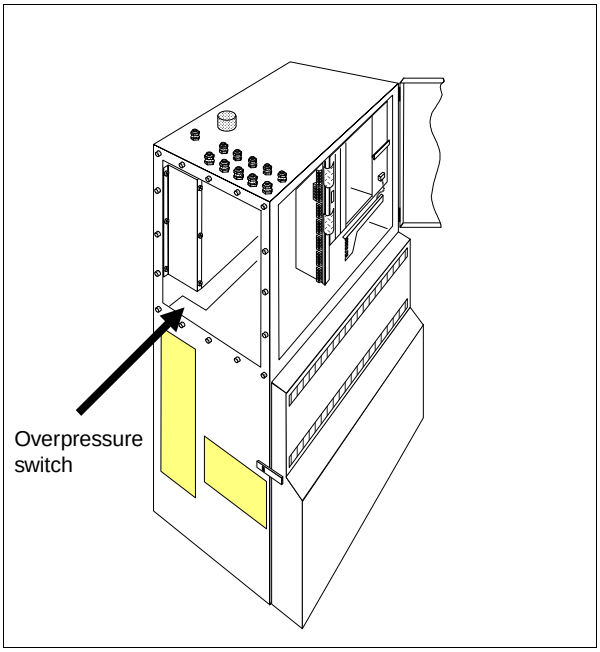
Analog output	Channel	Terminal number Output	Ground
1	A	11	10
2	B	12	10
3		13	15
4		14	15

SIMATIC modules are required for further analog outputs (4 to 20 mA). To connect these modules, refer in this register to *SIMATIC modules: Analog outputs* or in the register *External wiring diagrams*.

Setting of 0 to 20 mA or 4 to 20 mA

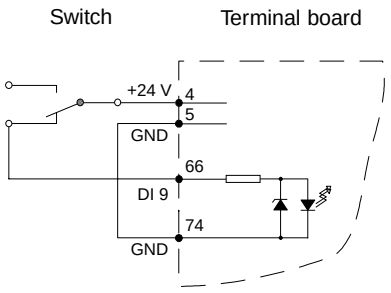
The four standard analog outputs can be converted from 4 to 20 mA to 0 to 20 mA. Plug-in jumpers must be repositioned on interface module 3. This is described in the register *Function description of electronics*.





Digital input	Use + 24 V means	Terminal on terminal board
1	Peripheral boards faulty	57
2	Housing purging o.k.	58
3	Housing temperature o.k.	59
4	Gas supply o.k.	60
5	External unit A not ready	61
6	External unit B not ready	62
7	Reserved	63
8	Reserved	64
	Ground 1 to 8	65
9	Not used	66
10	Not used	67
11	Not used	68
12	Not used	69
13	Not used	70
14	Not used	71
15	Not used	72
16	Not used	73
	Ground 9 to 16	74

Connection of digital inputs



Connection of status messages to control room

Several status messages of the chromatograph are connected as digital signals to the terminal board. More details can be found in the register *External wiring diagrams.*

Analyzer failure
The signal *Analyzer failure* of the chromatograph is connected to the terminal board as digital output 1. 24 V signal at terminal 30, ground e.g. at terminal 38.

In addition there is a relay contact connected to the terminals 8 and 9. Contact opened means: Analyzer failure.

Maintenance request
The second digital output has the meaning *Maintenance request*. You can connect this signal to a lamp or horn in the control room (see *Operation using keyboard and screen: Status)*. 24 V signal at terminal 31, ground e.g. at terminal 38.

Purging pressure, zone 2
An excess pressure switch is fitted in chromatographs for zone 2. It is closed if the purging pressure is o.k. It is possible to monitor the purging pressure, e.g. from the control unit, if 24 V are routed to digital output 2 via this switch.

Connection of external status signals and digital inputs

The chromatograph monitors the following status signals:

- Carrier gas pressure or supply gases
- Start delay by external device A
- Start delay by external device B

Further monitoring functions can be carried out using BASIC programs.

The status signals must be present as floating contacts. They are wired directly to the terminal board.

16 digital inputs are present on the terminal board. The first 8 are for internal purposes. This is shown in the following table.

SIMATIC- modules are required for further digital inputs. To connect these modules, refer in this register to *SIMATIC modules: Digital inputs* or in the register *External wiring diagrams*.

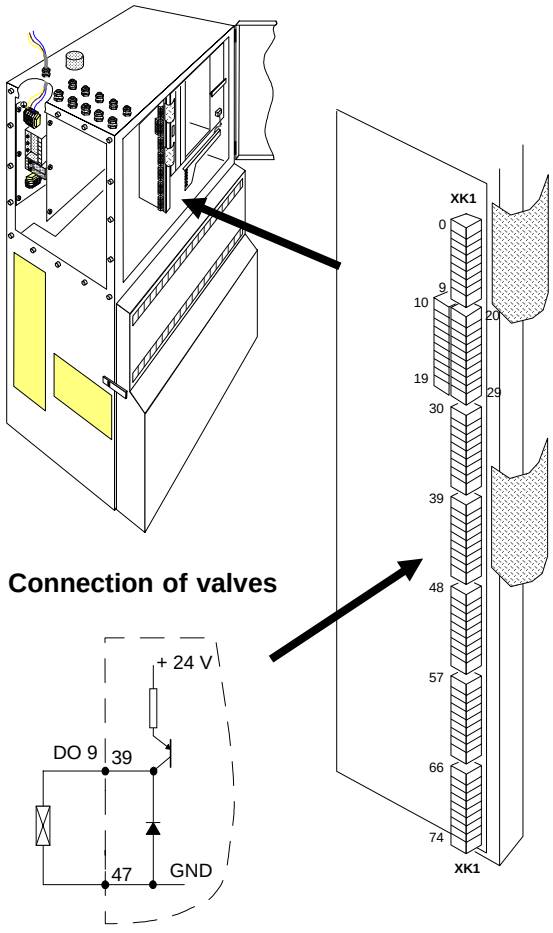
Connection of valves and digital outputs

The stream selection valves must be connected to the digital outputs. 24 digital outputs are present on the terminal board. The first 8 are for internal purposes. This is shown in the following table.

SIMATIC- modules are required for further digital outputs. To connect these modules, refer in this register to *SIMATIC modules: Digital outputs* or in the register *External wiring diagrams*.

CAUTION: Classified area
The solenoid valves must be fused according to the manufacturer's instructions.

Digital output	Use + 24 V means	Terminal on terminal board
1	No device failure (ready)	30
2	No maintenance request	31
3	Run A	32
4	Run B	33
5	Cooling on *1	34
6	Air flaps moving *1	35
7	Air flaps, direction: open *1	36
8	Heater enable	37
	Ground 1 to 8	38
9	Available for valves	39
10	Available	40
11	Available	41
12	Available	42
13	Available	43
14	Available	44
15	Available	45
16	Available	46
	Ground 9 to 16	47
17	Available	48
18	Available	49
19	Available	50
20	Available	51
21	Available	52
22	Available	53
23	Available	54
24	Available for streams	55
	Ground 17 to 24	56
*1 = Available with PGC 302		



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SIMATIC modules

We additionally use SIMATIC modules in the chromatograph as signal converters for analog and digital signals. The chromatograph can then, for example:

- **Switch valves via digital outputs**
- **Scan the switches of pressure monitors via digital inputs**
- **Display results in the control room via analog outputs**
- **Calculate values from a scale with the analytical result via analog inputs.**

The following modules can be used in our chromatographs:

■ 32 digital outputs 24 V/0.5 A	6ES5 451-4UA12
■ 16 digital outputs 24 V/2 A	6ES5 453-4UA12
■ 16 digital outputs and 16 digital inputs 24 V/0.5 A	6ES5 482-4UA12
■ 32 digital inputs 24 V	6ES5 430-4UA12
■ 8 analog outputs 0 to 20 mA	6ES5 470-4UA12
■ 8 analog outputs 4 to 20 mA	6ES5 470-4UC12
■ 8 analog inputs	6ES5 460-4UA12

All modules occupy one slot in the chromatograph computer, apart from the module 453 which requires two slots.

IMPORTANT:
SIMATIC-modules only function if they are correctly addressed and if their enable input is correctly connected. The following pages show how you must wire the modules.

Inserting or removing modules

Only insert or remove SIMATIC modules with the chromatograph switched off. You thus avoid damaging the modules. In addition, SIMATIC modules do not function if they are inserted when the chromatograph is on.

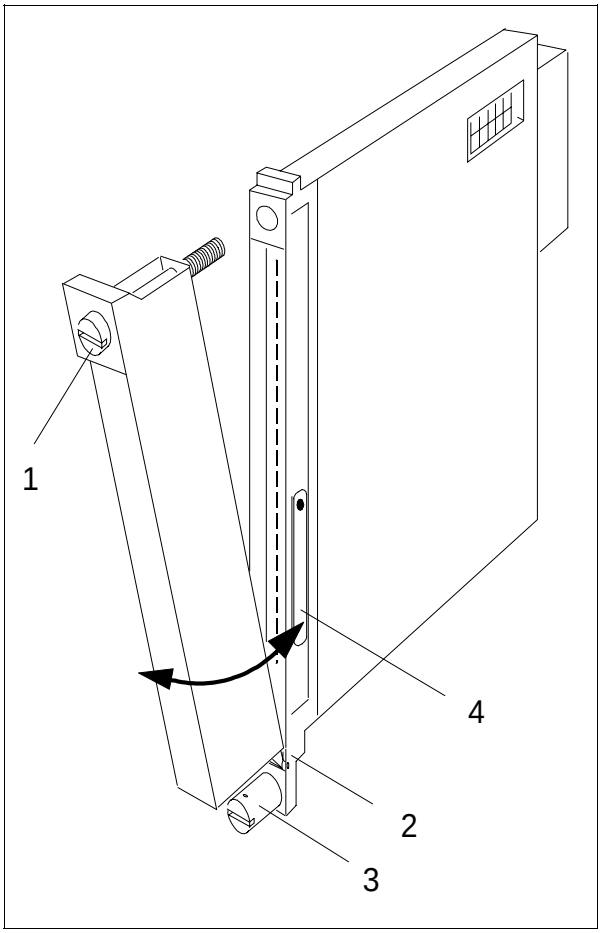
- Loosen the screw (1) on the front plug
- Swing out the top of the front plug and lift out of the bottom bearing (2)
- Rotate locking screw (3) by 90°
- Pull out the module using the handle (4). This handle is hidden. It can be extracted from below using a pointed object.

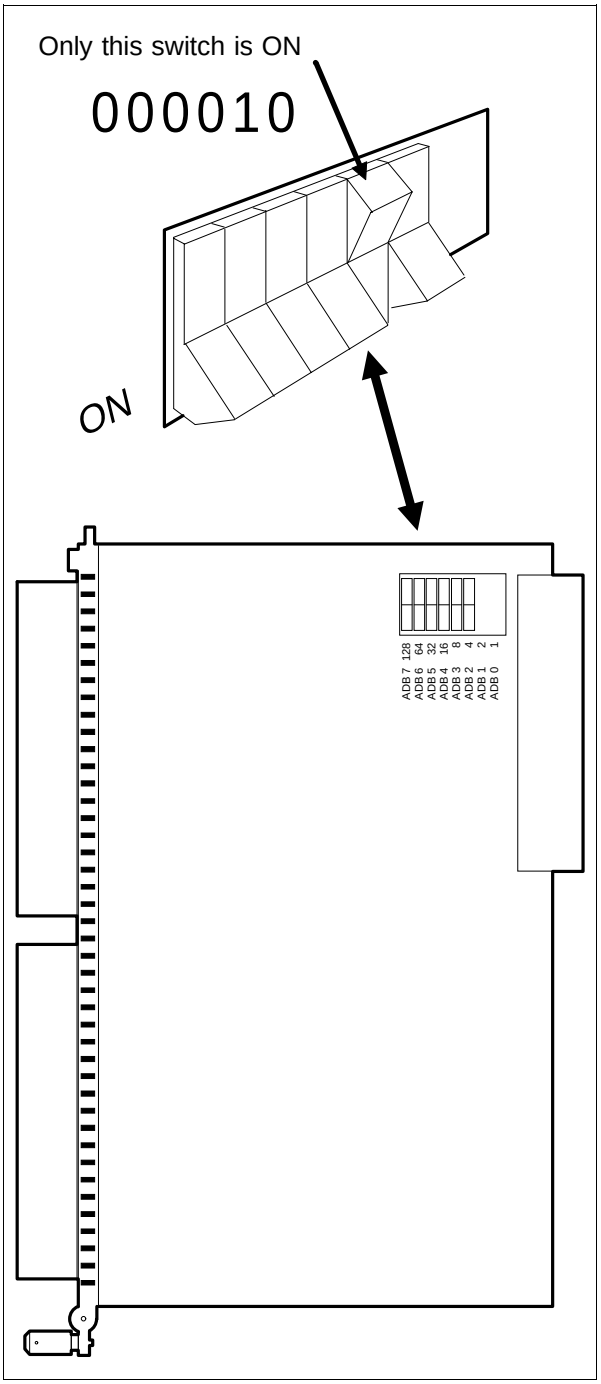
Install in the reverse order.

Electrical isolation

All inputs and outputs are electrically isolated from the module power supply which is applied at the rear. The inputs and outputs are nevertheless not electrically isolated in the chromatograph because the 24 V comes from the chromatograph power pack and all SIMATIC modules are connected to one another via their front panels.

If electrical isolation is required, use a separate module and provide an external voltage of 24 V. Individual floating digital inputs or digital outputs can be implemented using relays.





Module address

The chromatograph computer (PCPU-2) expects SIMATIC modules in a particular address area. The addressing enables several identical SIMATIC modules to be used. The computer identifies the separate modules by means of the set addresses. In addition, output modules only react to write processes and input modules to read processes.

Setting the address switches

All SIMATIC modules have an address switch. The module address is set there according to the following rules:

Address	Address switch (1 = ON, 0 = OFF)	
4	000001	First digital output module
8	000010	Second digital output module
12	000011	Third digital output module
4	000001	First digital input module
8	000010	Second digital input module
12	000011	Third digital input module
128	100000	First analog output module
144	100100	Second analog output module
160	101000	Third analog output module
176	101100	Fourth analog output module
128	100000	First analog input module
144	100100	Second analog input module
160	101000	Third analog input module
176	101100	Fourth analog input module

- Press the switches with a pointed object, but never with a pencil! Pencils leave behind conductive powder.
- The specified addresses apply to all modules, even if they are not fully configured.
- Identical modules must never be set to the same address. On the other hand, inputs are set to the same address as outputs (see table).
- Special case with module with 16 digital outputs and 16 digital inputs: no other module must have its address. This module responds like one digital output module and one digital input module where the inputs 1 to 16 and the outputs 17 to 32 are faulty.

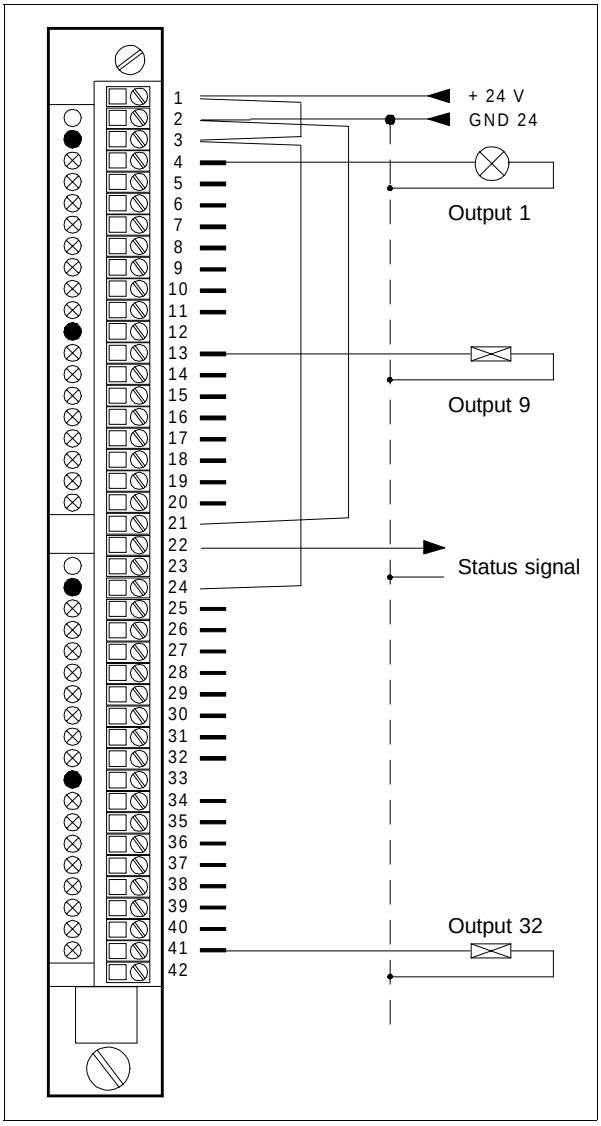
All addresses are already set if the chromatograph application has been prepared by us.

IMPORTANT:
This description does not apply to chromatographs which have at least one SIMATIC module as standard.

32 digital outputs 24V/0.5 A 6ES5 451-4UA12

The chromatograph already has internal digital outputs on its terminal board. The SIMATIC digital outputs commence with the number 33. In the adjacent Fig., *Output 1* means the first output on this module.

Green lamps indicate when an output is switched on.



Connection of valves

Connect one line directly to the front plug of the digital output module, and the return line to the central ground terminal block.

> **CAUTION with classified valves**
>
> A fuse is required in the positive line. Refer to the conformity certificate of the valve.

Short-circuit/alarm

All outputs are electrically protected against short-circuits. A red lamp lights up if an output is short-circuited, and the module outputs an alarm. This alarm can generate the signal *Device failure* in the chromatograph (see register *Operation with keyboard and screen: Status*).

Technical data

If you require detailed technical data, refer to e.g. Catalog *ST 54.1 SIMATIC S5.*

Permissible current	5 mA to 0.5 A
Residual current with OFF	< 0.5 mA
Residual voltage with OFF	< 3 V
Voltage with ON	> U_{24} - 1.5 V
Permissible cable length	< 400 m
Slots required	1

Do not connect digital outputs in parallel!

Digital outputs must not be connected in parallel if you wish to switch valves which require more than 0.5 A. A more powerful module must be used.

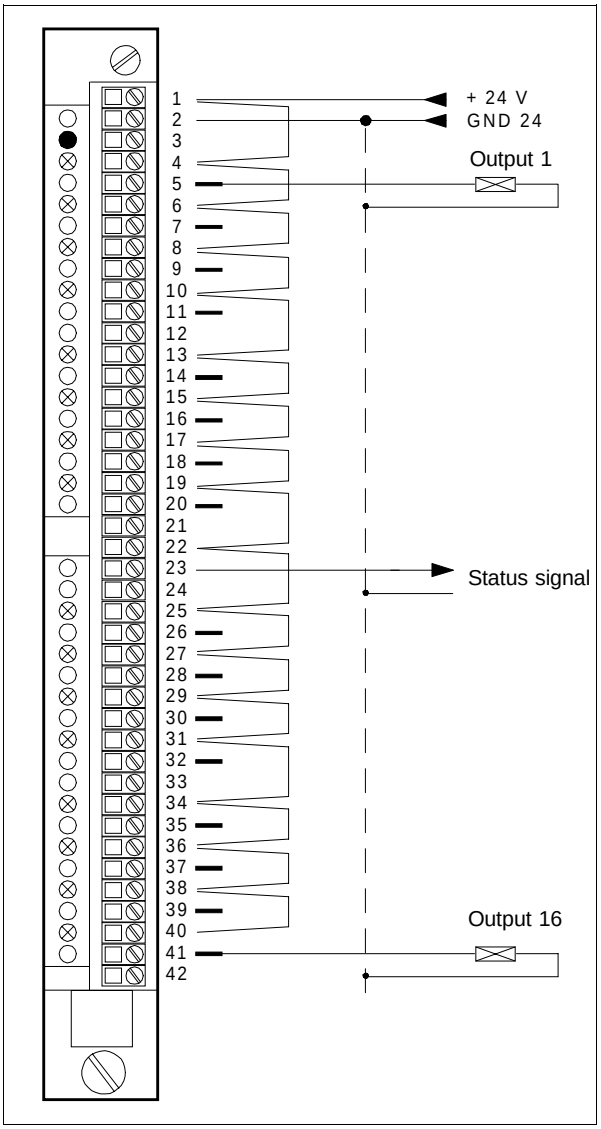
16 digital outputs 24V/2 A 6ES5 453-4UA12

Apart from the technical data, the same comments apply as to the module 6ES5 451-4UA12.

Technical data

If you require detailed technical data, refer to e.g. Catalog *ST 54.1 SIMATIC S5*.

- Permissible current 10 mA to 2 A
- Residual current with OFF < 1 mA
- Residual voltage with OFF < 3 V
- Voltage with ON > U_{24} - 2.5 V
- Permissible cable length < 400 m
- Slots required 2



16 digital outputs 24V/0.5 A 16 digital inputs 6ES5 482-4UA12

This module responds like one digital output module and one digital input module where the inputs 1 to 16 and the outputs 17 to 32 are faulty.

IMPORTANT:
In addition to the address switch, the module contains a plug-in jumper X20 and a slide switch S2.

Switch S2 must always be in position 1. It switches over between the local bus (position 2) and the S5 bus (position 1).

If the jumper X20 is open, the module is enabled independent of the front plug wiring. If the jumper X20 is inserted, the connection from 1 to 2 is required in the front plug.

Connection of valves

Connect one line directly to the front plug of the module, and the return line to the central ground terminal block.

Connection of switches

Connect one line directly to the front plug of the module, and the return line to the central +24 V terminal block.

Short-circuit/alarm

All outputs are electrically protected against short-circuits. A red lamp lights up if an output is short-circuited, and the module outputs an alarm. This alarm can generate the signal *Device failure* in the chromatograph (see register *Operation with keyboard and screen: Status*).

Technical data

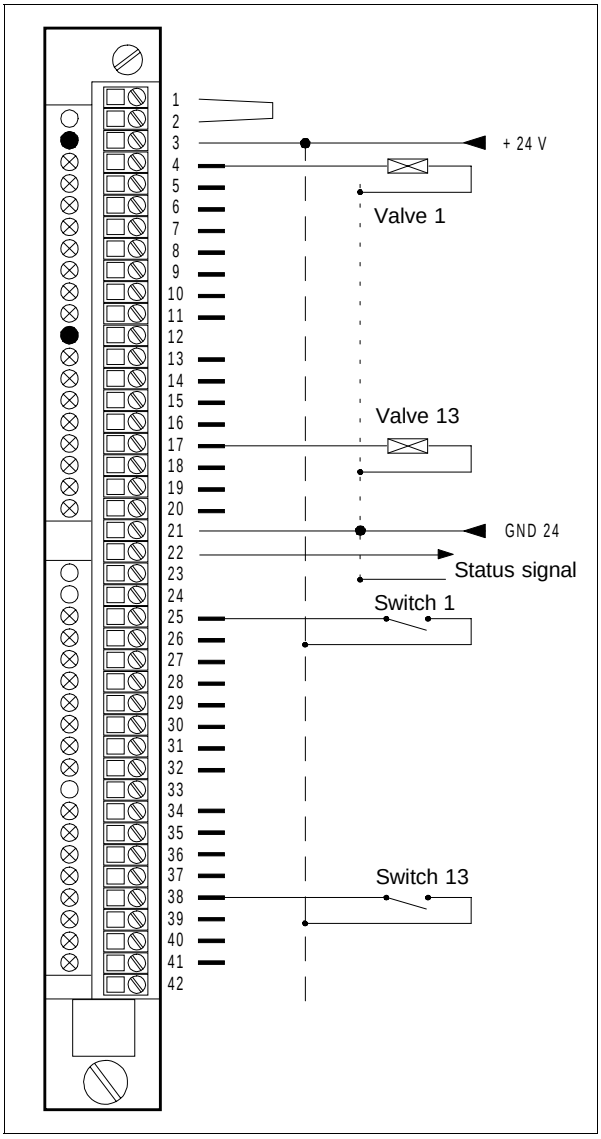
If you require detailed technical data, refer to e.g. Catalog *ST 54.1 SIMATIC S5*.

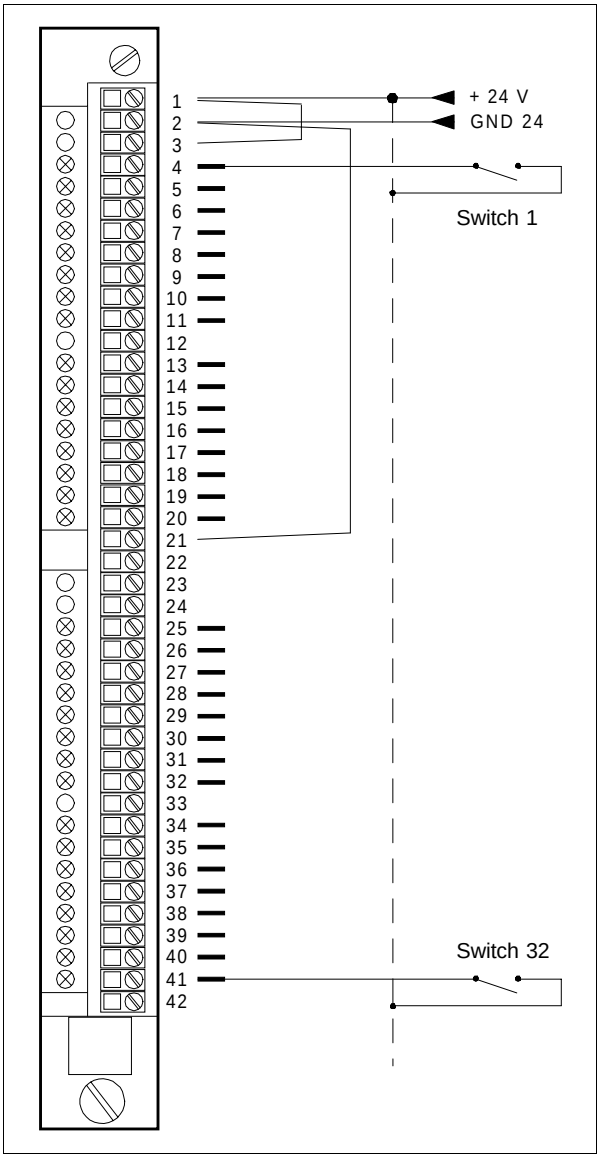
16 digital outputs

■ Permissible current	5 mA to 0.5 A
■ Residual current with OFF	< 0.5 mA
■ Residual voltage with OFF	< 3 V
■ Voltage with ON	> U_{24} - 1.5 V
■ Permissible cable length	< 400 m

16 digital inputs

■ Voltage for signal 0	33 to + 5 V
Voltage for signal 1	+ 13 to + 33 V
■ Input current with signal 1	8.5 mA
■ Permissible cable length	< 50 m
■ Slots required	1





32 digital inputs 6ES5 430-4UA12

Digital inputs can be used to import status signals into the chromatograph. Example: carrier gas pressure monitoring.

The signal status of the digital inputs is identified by green lamps on the module.

Connection of switches

Connect one line directly to the front plug of the module, and the return line to the central +24 V terminal block.

Technical data

If you require detailed technical data, refer to e.g. Catalog *ST 54.1 SIMATIC S5*.

32 digital inputs

■ Voltage for signal 0	33 to +7 V
Voltage for signal 1	+13 to +33 V
■ Input current with signal 1	7 mA
■ Permissible cable length	
Unscreened	< 600 m
Screened	< 1000 m
■ Slots required	1

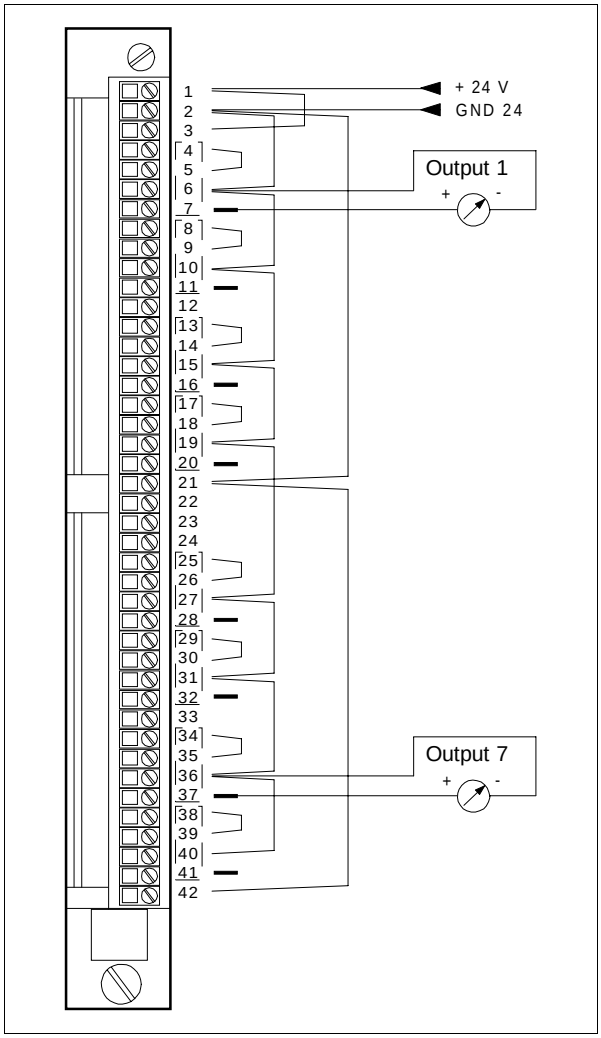
8 analog outputs
0 to 20 mA: 6ES5 470-4UA12
4 to 20 mA: 6ES5 470-4UC12

The chromatographs have two to four analog outputs as standard, e.g. for displaying chromatograms. Additional SIMATIC outputs can be used with BASIC programs, e.g. for recording the trends of component results.

Technical data

If you require detailed technical data, refer to e.g. Catalog *ST 54.1 SIMATIC S5*.

- Resolution 10 bits
- No-load voltage 18 V
- Max. load 300 Ω
- Short-circuit-proof Yes
- Permissible cable length < 200 m
- Slots required 1



8 analog inputs 0/4 to 20 mA
6ES5 460-4UA12

The analog inputs can be used to calculate process signals with the results of the chromatograph or to print them out together in a log.

Range submodules

Two range submodules are required for each group of four inputs in addition to the basic module. All unused inputs must be equipped with a range submodule! There are submodules for voltages, currents and temperatures. Only the following range submodules will be described here:

- 0 to 20 mA 6ES5 498-1AA41
- 4 to 20 mA 6ES5 498-1AA71 (four-wire!)

You can find the technical data of the other range submodules in e.g. Catalog *ST 54.1 SIMATIC S5*.

NOTE:
The 4 to 20 mA submodule is also available as a two-wire version. This is only suitable if the sensor is passive and obtains its power supply via the 20-mA line. This is usually not the case.

Setting of mode switches

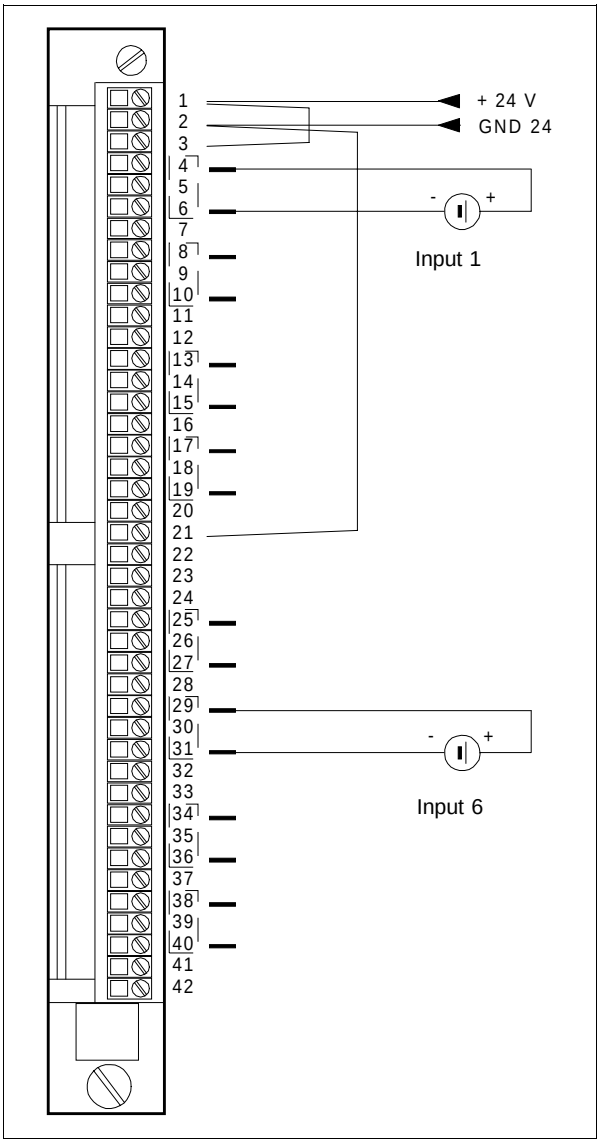
There are two mode switches on the module. The following setting applies to the current measurement. It may be necessary to set other modes when using other range submodules.

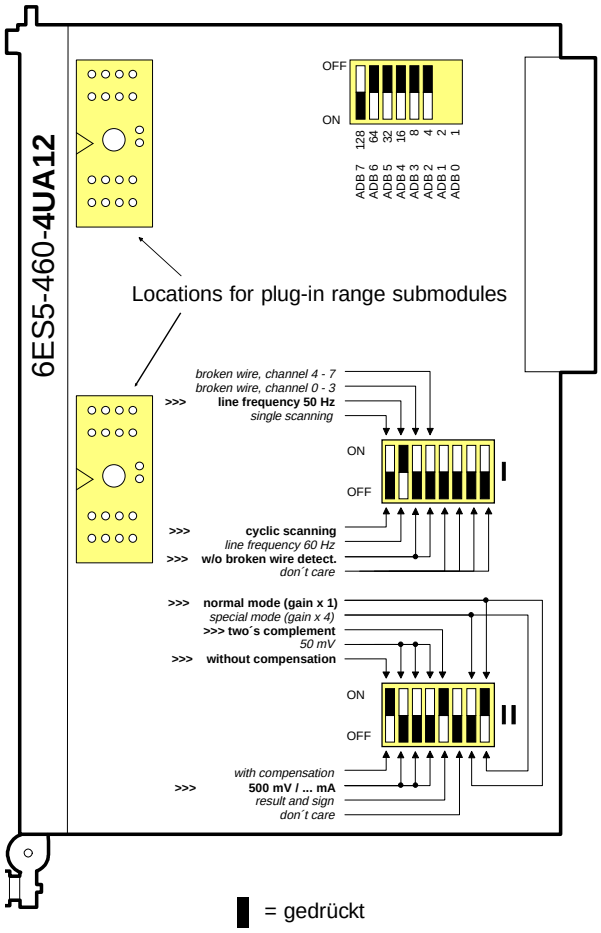
- Mode switch I
  50 Hz mains frequency `01000000`
  60 Hz mains frequency `00000000`
- Mode switch II `10001001`

1 means *ON*, `0` means *OFF*. To switch a function ON you must press the switch at ON. This may be upper or lower position depending on switch model and board version. The print on the board is only valid!

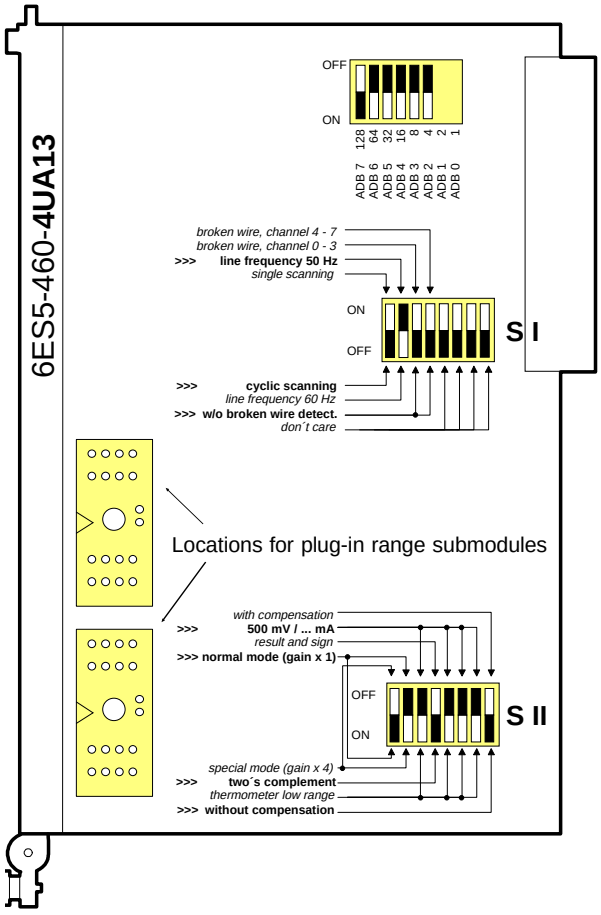
Press the switches with a pointed object, but never with a pencil! Pencils leave behind conductive powder.

IMPORTANT:
With the board -4UA13 the mode switch S II is rotated 180 ° ! So the lower position is *ON* and the pattern shown above must be reversed: `10010001`.





▮ = gedrückt



Technical data

If you require detailed technical data, refer to e.g. Catalog *ST 54.1 SIMATIC S5*.

- Rated range 0/4 to 20 mA
  Overload range 0/4 to 40 mA
- Resolution 0 mA 0 units
  4 mA 512 units
  20 mA 2048 units
- Max. input voltage 18 V
- Relay multiplexer
  Cycle time for 8 inputs 0.48 s at 50 Hz
- Integration time 20 ms at 50 Hz
  16.67 ms at 60 Hz
- Max. shielded cable length < 200 m
- Slots required 1

CONNECTION OF CONTROL UNIT

The control unit is an IBM-compatible personal computer. It can be permanently connected to the chromatograph, or it can be transported from chromatograph to chromatograph and only connected for a short time. In addition, more than one chromatographs can be operated using one control unit if they are in a network.

Every chromatograph has four serial interfaces on the PCPU-2 via which all chromatograph parameters can be accessed:

SER. 1	TTY or RS232
SER. 2	TTY or RS232
SER. 3	RS485 or RS232
SER. 4	RS485 or RS232

- With PGC 302 SER. 1 is connected as a TTY interface, SER. 3 and SER. 4 are connected as RS485 interfaces to the terminal board for fixed wiring.
- With RGC 202 SER. 2 is connected as a RS232 interface to the front of the chromatograph, SER. 3 and SER. 4 are connected as RS485 interfaces to the terminal board for fixed wiring.

Local connection of control unit using prepared RS 232 cable

Connect the plug *PCPU* to the socket *V.24* at the front of the chromatograph (RGC 202) or to the socket *SER.2* at the PCPU respectively (PGC 302). Connect the other end to the socket *com1:* of the control unit.

NOTE:
The cable is included in the delivery if you have ordered the control unit from us together with the chromatograph.

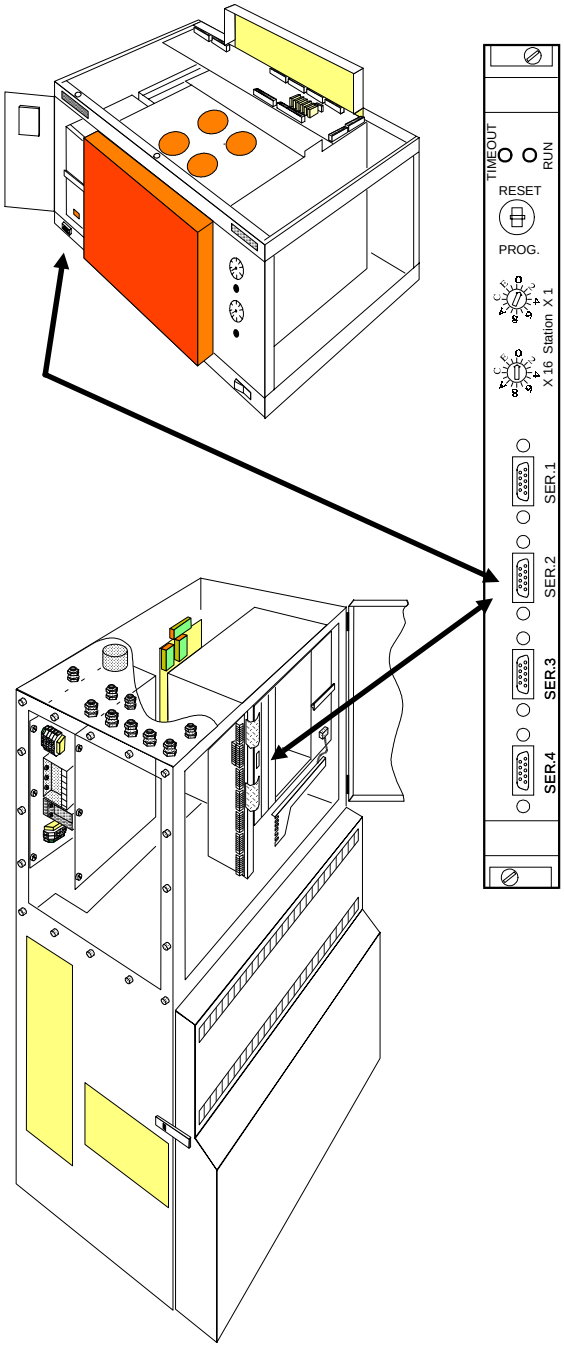


WARNING: Explosion protection

You require permission if you wish to transport a laptop through the potentially hazardous atmosphere or if you wish to open a chromatograph in a division 1 area.

Permanent local installation of control unit

The pin assignments of the RS232 interface are described in your control unit manual. Connect the cable according to the following diagram:



PGC 302
Interface SER.2
9 pin socket

Control unit
RS232 / COM1:
9 pin socket

RGC 202
Socket at front
9 pin socket

GND	5	1	Signal GND
RxD	2	2	TxD
TxD	3	3	RxD

Cable:
9 pin D-Sub female <-----> 9 pin D-sub male

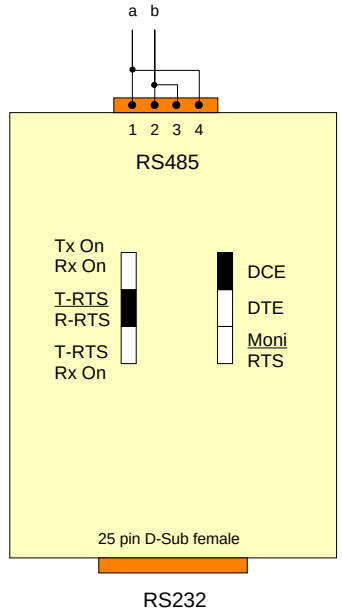
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ChromLAN networks

There are so many possibilities for generating networks with ChromLAN that no generally-applicable rules can be specified here. Anyhow we differentiate TTY networks and RS485 networks. You can find more details on the networking facilities in the register *Software and networking*.

Please also read the following topics on the next pages:

- Pin assignments of PCPU interfaces *SER. 1* to *SER.4*
- Participant number of chromatograph in network
- Loadable interface drivers
- Adjustment of transmission rate (baud rate)



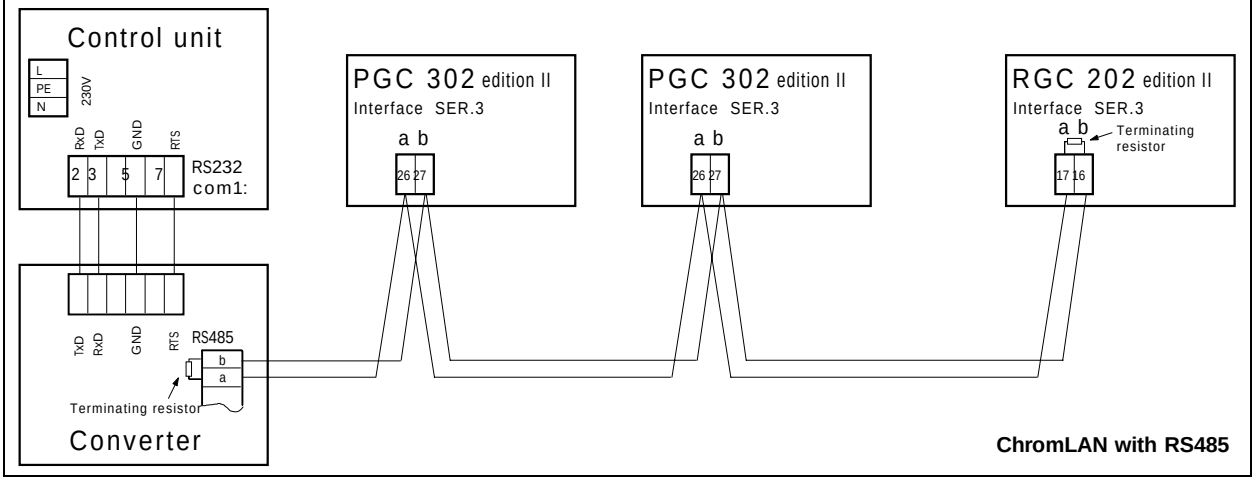
Interface converter RS232 to RS485

Interface converters

Because the control units do not have RS485 interfaces, the RS232 interface of the control unit must be converted.

- Set switches at the converter as shown in the drawing.
- Connect interface converter to socket *com1:* of the control unit. The cable is included in the delivery of the converter.
- Connect the chromatographs to the converter. The number of chromatographs connected to one converter must not exceed 15. For connection diagram please refer to register *External piping and wiring diagrams*.
- On every chromatograph: adjust rotary switch for participant number in network. All chromatographs must have different participant numbers!
- With RS485 networks: activate terminating resistor on the PCPU-2 of the last chromatograph.
- Connect power cable of the converter or power supply respectively to power socket.

Below is an example of how the control unit, interface converter and chromatographs must be connected together.

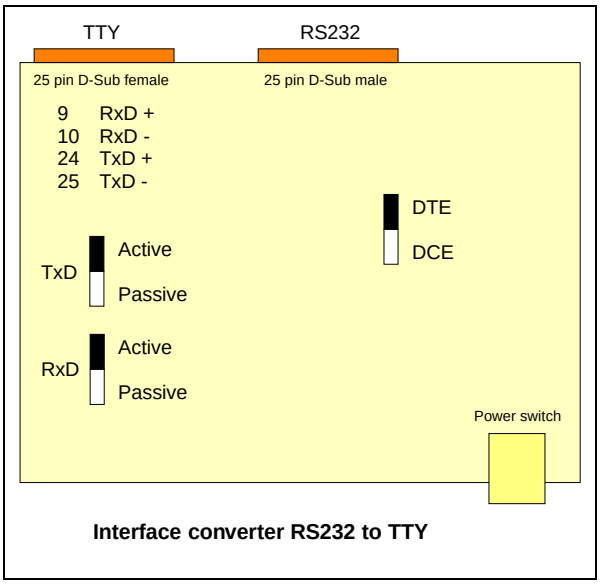


ChromLAN with RS485

Permissible cable length

	RS485	TTY
Permissible cable length	1500 m	9600 Baud: 400 m 4800 Baud: 1000 m 2400 Baud: 2500 m
Recom-mended cable	shielded, 2 x twisted in pairs 2 x 0,2□ LiFYCY	shielded, 2 x twisted in pairs 2 x 2 x 0,5□

HINWEIS:
The permissible cable length with TTY depends on the baud rate. Note that the maximum distance is only half the value because there is a forward line and a return line!



Interface converter RS232 to TTY

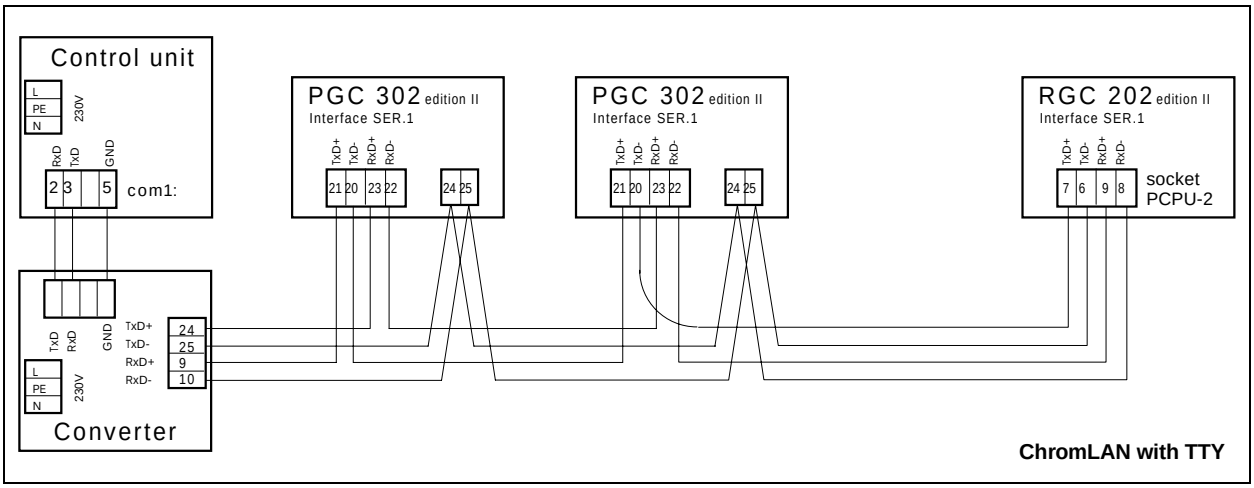
Pin assignments of PCPU interfaces SER. 1 to SER. 4

Standard	Signal	Pin number on 9-pin plug of PCPU-2 for SER.1	SER. 2	SER. 3	SER. 4
RS232	GND TxD RxD CTS DCD RTS	1 2 3 5	1 2 3 5	1 2 3 5 6 7	1 2 3 5 6 7
TTY	TxD- TxD+ RxD- RxD+	6 7 8 9	6 7 8 9		
RS485	a b			8 9	8 9
Voltage	+5V	4	4	4	4
All connectors on PCPU-2 are 9 pin D-Sub, female					

Terminals for interfaces RS485: SER. 3 and SER. 4 TTY: SER. 1 (PGC 302 edition II only)

	Signal	PGC 302 edition II Terminal board SER.1	SER.3	SER.4	RGC 202 edition II Terminal board SER.3	SER.4
RS485	a b Shield		26 27	28 29	17 16	19 18
TTY	TxD- TxD+ RxD- RxD+ Looping points	20 21 22 23 24 25				

Terminals 24 and 25 are used as connection points for cables which must be looped through.

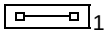


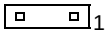
ChromLAN with TTY

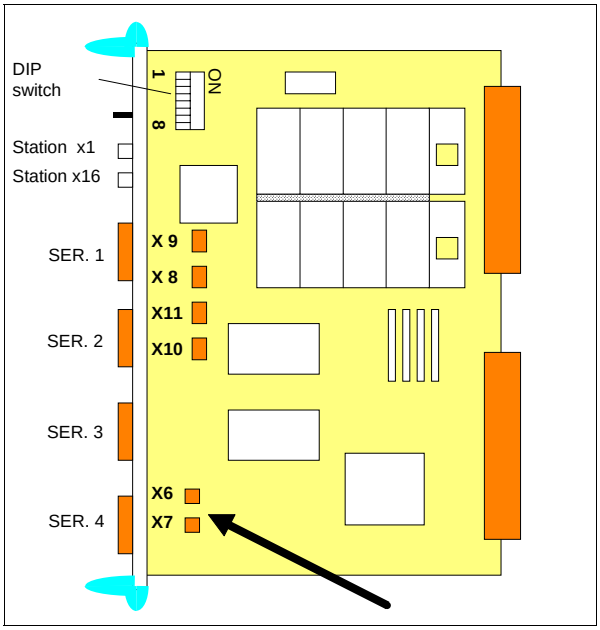
Terminating resistors

RS485 lines must be terminated at both ends with 120-Ω resistors in order to prevent reflections. These resistors are fitted on the interface converter and the PCPU-2. They must be switched on using DIP switches. This is normally carried out on the interface converter of the control unit and on the PCPU-2 of the chromatograph which is farthest away.

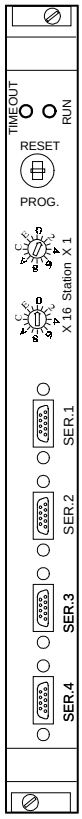
PCPU-2 interface	Jumpers
SER. 3 SER. 4	X6 X7

with terminating resistor: 

without terminating resistor: 



Participant number of chromatograph in network



There are two rotary switches *STATION x1* and *STATION x16* on the PCPU-2. The chromatograph number in the network is set on these switches. Numbers from 1 to 15 are valid.

Always set the switch *STATION x16* to 0, and set a number from 1 to 15 on the switch *STATION x1* . The letters *A, B, C, D, E, F* correspond to the numbers 10 to 15.

Local operation

The participant number in the network is also effective if you wish to operate locally with the laptop. Only exception: if a ChromLAN network is not operated on the interface *SER. 2*, the driver *UNIDRV2* is loaded there. The chromatograph then always has the participant number 1 at the interface *SER. 2*.

CAUTION:
A participant number of 00 must not be set! The PCPU-2 is in service mode if both switches are set to 0.

Loadable interface drivers

There are loadable drivers for all four interfaces. These are loaded into the PCPU-2 when the control software is programmed. Refer to *The software: Installation of software*.

- Supplied PCPU-2 status without control software:

Interface	Standard	Baud rate
SER. 1	RS232	9600 baud
SER. 2	RS232	9600 baud
SER. 3	RS232	9600 baud
SER. 4	RS232	38400 baud

- Standard drivers loaded:

Interface	Driver	Purpose
SER. 1	UNIDRV1	ChromLAN or printer
SER. 2	UNIDRV2	Laptop, participant number 1
SER. 2	TTYCLAN2	ChromLAN
SER. 3	485CLAN3	ChromLAN
SER. 4	485CLAN4	ChromLAN

With the driver *UNIDRV2*, the chromatograph always has the participant number 1, independent of the switches *Station*.

Setting of SER. 1 and SER. 2 to TTY or RS232

The interfaces *SER. 1* and *SER. 2* can be set to TTY or RS232 using DIP switches on the PCPU-2.

- Interface SER. 2

Switch	On/off	Meaning
DIP 2 DIP 2	OFF ON	TTY RS232

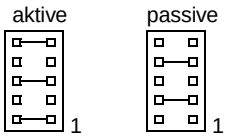
- Interface SER. 1

Switch	On/off	Meaning
DIP 4 DIP 4	OFF ON	TTY RS232

Setting of TTY to active/passive

The interfaces *SER. 1* and *SER. 2* can be operated as TTY interfaces. The plug-in jumpers *X8* to *X11* can be used to set the current source separately for the transmit and receive loops. Also refer to the register *Networking: Various serial interfaces.*

Interface		Jumpers
SER. 1 SER. 1 SER. 2 SER. 2	Transmitter Receiver Transmitter Receiver	X8 X9 X10 X11



The delivered status for both interfaces is *passive*. This setting also acts on the terminals for interfaces A and B.

Setting of SER. 1 for local printer or ChromLAN

If the driver *UNIDRV1* is loaded for the interface SER. 1, a DIP switch on the PCPU-2 can be used to set whether a local message printer is connected to this interface or whether a ChromLAN is to be operated there.

Switch	On/off	Meaning
DIP 3 DIP 3	OFF ON	Local printer ChromLAN

Adjustment of transmission rate (baud rate)

The transmission rates can be adjusted in three different manners:

Control unit interfaces

The interfaces *com1:* and *com2:* of the control unit can be adjusted using the software installation program. Refer to *The software: Parameterization of control unit.*

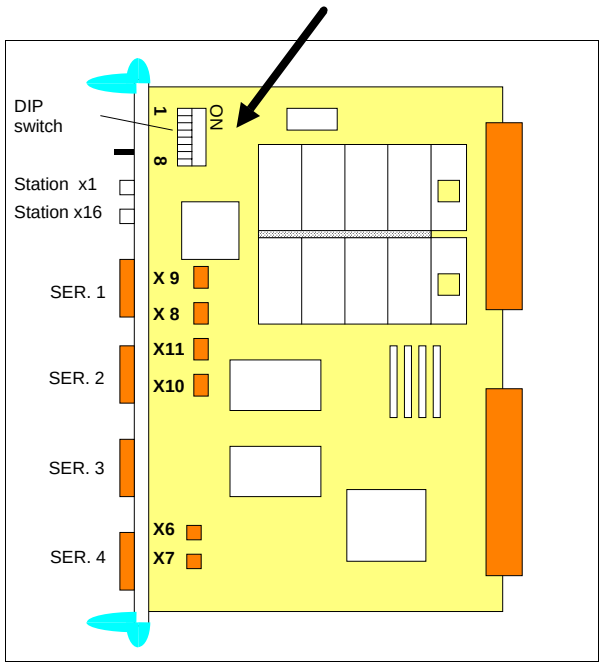
PCPU-2 interfaces SER. 1, 3, 4

The baud rates can only be adjusted using the configuration software. A matching interface driver must be programmed.

PCPU-2 interface SER. 2

The baud rate can only be adjusted on the DIP switch on the PCPU-2. The DIP switches are scanned by the driver software.

Switch	On/off	Meaning
DIP 1 DIP 1	OFF ON	9600 baud 4800 baud if TTY 38400 baud if RS232



IMPORTANT:

When delivered, the DIP switch is set to 00000000. Switches 5 to 8 must always be switched off in normal operation. Only positions xxxx0000 are permissible when operating the chromatograph.

TECHNICAL DATA

Climatic conditions

- **Permissible ambient temperature** 5 to 40 °C
  Upward or downward deviations possible depending on design
- **Permissible storage temperature** - 30 to 70 °C
- **Permissible relative humidity without purging**
  With FID, FPD, ECD Max. 80 % at 25 °C
  Max. 60 % at 40 °C
  With TCD Max. 90 %
- **Protection against dust and humidity to EN 60529 / VDE 0470, part 1 / IEC 529** IP 54

Power supply

- **Power supply** 230 or 115 V +10 % -15 %, 48 to 63 Hz
- **Power consumption** Max. 2 kVA in heating-up phase
  Approx. 0.3 / 0.5 kVA with 2 ovens and 100 / 180 °C
- **External mains fuse, for 230 / 115 V** 16 / 20 A

Dimensions and weights

- **Dimensions in mm (w x h x d)** 600 x 1200 x 420
  With FDV at side 790 x 1200 x 420
- **Weight** Approx. 90 kg

Electromagnetic compatibility

- **Radiointerference suppression**
  To VDE 0875 / EN 55011 / CISPR 11 limit class B
- **EMC** To DIN VDE 0843 / IEC 801, Part x
  Conducted interferences on AC power supply lines
  – To Part 4 (burst) 2 kV
  – To Part 5 (µs pulses), line against line 1 kV
  – To Part 5 (µs pulses), line against earth 2 kV
  Conducted interferences on signal lines
  – To Part 4 (burst) 1 kV
  Interference immunity to discharges of static electricity
  – To Part 2 (ESD) 8 kV
  Interference immunity to fields
  – To Part 3 and Part 6 10 V/m

Safety

- **Electric safety** DIN VDE 0411 / IEC 1010
- **Explosion protection** EEx pde IIB+H_2, T2, T3 or T4, division 1 or 2

Ovens

- **Number** 1 or 2
- **Air circulation** None
- **N_2 purging** Possible
- **Dimensions (w x h x d)** 220 x 260 x 195 (or 145) mm^3
- **Max. heating capacity** 800 VA
- **Temperature range** 60 to 260 °C (*1)
  with cooling unit 5 to 180 °C (*1)
- **Max. temperature difference between ovens** 100 K
- **Temperature stability** ± 0.1 K (60 to 180 °C)
- **Temperature accuracy** ± 3 K (60 to 180 °C)
- **Temperature gradient** ± 2 K (at 180 °C)
- **Variation in retention time per 10 K change in ambient temperature** Approx. -0.3 %
- **Heating-up time from 30 to 160 °C** 60 minutes

Columns and gases

- **Column type** Packed columns with 3 or 4 mm (⅛") diam.
  Capillary columns with 0.20 to 0.53 mm internal diam.
- **Column switching** Multi-dimensional chromatography with backflushing and live cutting for packed and capillary columns, or with valve switching for packed columns
- **Gas connections** Pipe 3 x 0.5 (approx. 1/8")
  except purging gas, 6 mm (¼") Swagelok
  liquid injection valve, 3 mm (1/8") Swagelok
  and heated gas connections 6 mm (¼") Swagelok
- **Gas purity (minimum requirements)** ≥ 99.999 %

Control air and purging air

- **Type of gas** Compressed air, free of oil, water and dust
- **Permissible relative humidity** Dew point more than 5 K below the lowest ambient temperature
- **Control air and purging air for Division 1** 4 to 6 bar
  Control air at least 2 bar above carrier gas pressure
- **Purging air for Division 2** restricted to 10 ... 200 l/min depending on purging situation
- **Corrosion protection purging** Approx. 2 to 10 l/min
- **Housing volume of pressure enclosure** Approx. 140 l
- **Enclosure prepurging** 130 to 200 l/min for 12 minutes
  Operating phase 8 to 12 l/min

Sample

- **Solid particles** in liquid sample < 0,3 µm
  in gaseous sample < 0,1 µm

(*1)
The following limit temperatures apply to chromatographs with explosion protection according to the following temperature class

Max. 120 °C with T4
Max. 180 °C with T3
Max. 280 °C with T2

Two-stage monitoring by Limit temperatures
Safety temperature limiter

Detectors

FID

- **Detection limit for hydrocarbons referred to carbon** 2×10^{-12} g/s
- **Dynamic response** 10^7
- **Automatic ignition**
- **Max. operating temperature** 280 °C (*1)

- **Combustion and carrier gases** 20 to 60 ml/min (H_2 , N_2 , He, Ar)
- **Combustion air** 0.4 l/min

FPD

- **Detection limit for sulphur** 2×10^{-11} g/s
- **Detection limit for phosphorus** 9×10^{-13} g/s
- **Sulphur characteristic** Approx. quadratic
- **Linear range for phosphorus** 10^5
- **Max. operating temperature, classified** 180 °C (*1)
- **Max. operating temperature, non-classified** 300 °C

- **Carrier gas** 10 to 40 ml/min (N_2, Ar)
- **Combustion gas** 60 to 80 ml/min (H_2)
- **Combustion air** 100 to 150 ml/min

TCD

- **Detection limit for ethane in H_2 at width at half peak height = 6 s** 3×10^{-9} g/ml (2 ppm)
- **Linear range** $\geq 10^4$
- **Cell volume, standard/micro** 0.35 ml / 70 µl
- **Max. operating temperature, classified** 180 °C (*1)
- **Max. operating temperature, non-classified** 200 °C

- **Carrier gas** 10 to 60 ml/min (H_2, N_2, He, Ar)

ECD

- **Detection limit for lindane** 5×10^{-14} g/s
- **Linearity** $>10^3$
- **Max. operating temperature, non-classified** 350 °C
- **Activity (Ni 63)** 370 MBq

- **Purging gas and carrier gas (N_2, 95 % argon/5 % methane)** Total 15 to 50 ml/min

Injection

Liquid injection valve

- **Injection volume** 0.6 to 9.5 µl
- **Vaporization temperature** 60 to 400 °C (*1)
- **Sample pressure** 0.1 to 50 bar abs.

Diaphragm valve

- **Injection volume** 0.2 to 2 ml
- **Max. operating temperature** 160 °C
- **Sample pressure** 0.9 bar to 2 bar abs. below control air pressure

Rotary slide valve

- **Injection volume** 0.01 to 10 ml possible
- **Max. operating temperature** 220 °C (*1)
- **Sample pressure** 0 to 20 bar abs.

Electronics

CPU

- **Microprocessor** Intel 80C186-16
- **Clock** 12.5 MHz
- **Dynamic RAM** 512 Kbyte
- **Flash EPROM** 431 Kbyte
- **Software** Loadable from control unit

Interfaces

- **Number** 2 x TTY or RS 232
2 x RS 485 or RS 232
- **Transmission rate** Up to 38400 baud, adjustable in software
- **Loadable drivers** RK512, D3964R, Modbus, message printer, local operation
- **Networking** ChromLAN, redundant also possible
- **Control system coupling** TELEPERM M (RK512)
Honeywell (Modbus)

Inputs/outputs: basic configuration

- **Digital outputs 0.5 A** 24, 16 of which for optional use
- **Digital inputs** 16, 8 of which for optional use
- **Analog outputs** 4 x 0/4 to 20 mA
750 Ω max. load, 10-bit resolution
- **Vacant slots** 5 x single width (single channel)
4 x single width (double channel)

Possible extensions with SIMATIC modules

- **32 digital outputs** 24 V / 0.5 A
- **16 digital outputs** 24 V / 2 A, double width
- **32 digital inputs** 24 V
- **16 digital outputs and 16 digital inputs** 24 V / 0.5 A
24 V
- **8 analog outputs** 0 to 20 mA or 4 to 20 mA
300 Ω max. load, 10-bit resolution
- **8 analog inputs** 0/4 to 20 mA, 12-bit resolution
Input resistance 25 Ω

Control

- **Sample streams** — Max. 32
- **Sample sequence** — 32 lines, sample enable list
- **Analytical method** — One in the chromatograph
Any number in the control unit
- **Time program** — 2 x 55 lines
- **Clock time program** — 16 lines
for valves and BASIC programs
- **Chromatogram on the recorder** — 2 channels
- **Status display** — Freely selectable using status form for digital output *Alarm*, digital output *Maintenance request* and for printer
Approx. 80 individual messages: Controllers, detectors, analysis control, gas supply, housing temperature, BASIC programs, peripherals, automatic updating
- **Ready signal** — Digital output 24 V/0.4 A
Relay contact, max. 0,5 A / 100 V / 10 W
- **Purging alarm** — Floating contact, max. 1 A

Two-channel evaluation

- **Evaluation procedure** — Area standardization
External standard
Mixed mode = area standardization and external standard
100% for all peaks in the component list
Internal standard
- **Chromatogram display** — On the screen
Mouse operation
Peak markers, names, retention times
Zoom with pilot chromatogram
- **Peak recognition** — Automatic, can be parameterized
- **Peak separation** — Perpendicular or tangent
- **Component list** — 2 x 64 components
- **Results** — ASCII file
- **Raw data** — Compressed for storage of chromatogram
Uncompressed for new calculation in control computer
- **Result log** — Optional design using BASIC
- **Trend recording** — With BASIC and analog outputs
- **Calibration** — Manual,
automatic updating
- **BASIC, possible applications** — Calculation of results, determination of status, calculation of external signals via analog and digital inputs

Recommended control unit

- **IBM-compatible personal computer** — Desktop or Laptop
- **Processor** — 80386SX or larger
- **Clock** — ≥33 MHz
- **Hard disk** — ≥ 40 MB
- **Diskette drive** — 3.5" / 1.44 MB
- **Graphic adapter** — VGA, EGA, CGA
- **Interfaces** — 2 x serial
1 x parallel
- **RAM** — ≥ 640 kB
- **Operating system** — MS-DOS 6.2
- **Mouse** — For chromatogram operations

COMMISSIONING AND SHUTTING DOWN

Page

Commissioning

Connection of gases 2
Adjustment of gases 2
Switching on the chromatograph 2
Purging the electronics area 3

Additional for service and initial commissioning

Connection of control unit 3
Connection of exhaust lines 3
Adjustment of detectors 4

Shutting down 6

COMMISSIONING

Carry out all operations in the sequence listed in these instructions to prevent damage to the chromatograph.

> **CAUTION**
>
> Carry out all operations in the sequence listed in these instructions to prevent damage to the chromatograph.

Connection of gases

- Check that all gas lines correspond to the piping diagram and that all gases and gas lines are clean
- Purge the gas lines again under high pressure
- Remove dummy plugs from the gas inlets and outlets on the chromatograph
- Connect the gas lines according to the piping diagram

Adjustment of gases

- Open up the gases in the following order: control air, carrier gas, combustion gas, combustion air, purging N_2 (ECD) and, if applicable, protective gas or purging gas

For classified PGC 302 only:
Protective gas for classification

- Check that the gas pressure corresponds to the rating plate

> **WARNING**
>
> Observe the explosion protection regulations if you are commissioning a classified chromatograph!

Carrier gas,
FID/FPD combustion gas, ECD purging gas

- Adjust the pressure on the fine pressure regulator in the chromatograph according to the application data
- Measure the carrier gas pressure and flow at the outputs *detector*, *backflushing*, *cut* and *exhaust*. The measured values should approximately correspond to the application data. Because the chromatograph is cold, the measured flows should be larger than the application data.

Switching on the chromatograph

Switch on the mains switch.

NOTE: PGC 302
The PGC 302 doesn't have a mains switch. We recommend an external master switch. The power supply for the classified PGC 302 for division 1 is connected via a safety monitoring unit. Refer to *Purging the electronics area*.

> **WARNING: Danger of explosion**
>
> Hydrogen and air can form an explosive mixture. If you switch on the FID
>
> - all gas pipes must be airtight
> - the column must be connected
> - the exhaust gas outlet must not be closed.

> **CAUTION withTCD**
>
> The filaments can burn out if you subject the TCD to improper use. Never operate the TCD without gases.

> **WARNING for ECD**
>
> The ECD must never be heated without nitrogen purging. Do not switch on the chromatograph until purging is guaranteed.

PGC 302 only: Purging the electronics area

The electronics area must be purged for corrosion protection or explosion protection in division 2 or 1 areas. Close the electronics door!

PGC 302 in division 2 area

- Adjust a suitable flow for the protective gas on the needle valve/rotameter, max. 20 l/min
- Purge the chromatograph with at least 1400 l
- Reduce the flow to 10 to 20 l/min, the pressure switch must still be activated reliably

NOTE:
The needle valve with rotameter is not part of the chromatograph. It must be mounted externally.

The pressure switch is installed in the chromatograph. Register 3: *Connection of status messages to control room* describes how it is connected. If your control unit is permanently connected to the chromatograph, you can observe the status of the purging pressure on the former.

If the control unit is not permanently connected to the chromatograph, it is possible e.g. to connect a lamp to the digital output *Maintenance request*. The status of the purging pressure must be assigned to *Maintenance request*. This is described in Register 5: *Status*.

PGC 302 in division 1 area

- Open external purging gas valve
- Switch on chromatograph using external master switch
- Press the switch ON on the control panel of the purging time controller (key switch not to *Bypass*). You can find more details in the register *Information for the user: Explosion protection*. The controller switches the chromatograph on after 12.5 minutes. If it does not, check the purging gas pressure and also for leaks. The purging gas pressure must be 4 to 6 bar.

ADDITIONAL FOR SERVICE AND INITIAL COMMISSIONING

- Only for classified PGC 302 in division 1 area: position the key switch of the purging time controller to *Bypass*. The door to the electronics area can now be opened without the chromatograph being switched off by the controller.



WARNING

You require a permit if you wish to operate the chromatograph with the electronics door open. Always refer to the information in the register *Information for the user: Explosion protection*.

- Connect the local control unit to the chromatograph as described in the register *Installation: Connection of control unit*, and start the operating software as described in the register *Software and networking: Starting the software*.

NOTE:
If you use your own applications, or if the PCPU-2 of the chromatograph has been replaced, you must first program the control software in the chromatographs and also configure the units if necessary. This is described in the register *Software and networking*.

- Now adjust the detectors as described on the next two pages. Then return to here!

Connection of exhaust gas lines

Connect the exhaust gas lines to the gas outlets of the chromatograph according to the piping diagram.

Starting process operation

- If the application is correct, switch the mode *Process operation* on. Process operation starts automatically as soon as the chromatograph signals that it is ready.
- Disconnect the cable of the local control unit from the chromatograph, and close the door to the electronics area.

Activation of explosion protection

Only with classified PGC 302 in division 1 area: switch over the key switch on the purging time controller after approx. 10 seconds. The safety monitoring function is now active again.

ADJUSTMENT OF DETECTORS

All detector parameters are adjusted using the control unit. You can find more details in Register 5: *Detectors*.

- Change to operating mode *Maintenance single run*.
- Check the analysis parameters. A method is not installed in the chromatograph if the function displays do not show any valves, detectors, temperatures, etc. You must install the methods. Refer to register *Operation with keyboard and screen*.
- Select the function *Signals* in the selection display.
  - Switch off the baseline correction
  - Select the function *Without compensation*
  - With TCD: select the polarity according to the application data

With TCD: initial adjustment

Follow the instructions under *Adjustment of TCD*: *Switching-on of bridge current* and *Adjustment of measuring bridge.*

Stabilization of operating temperatures

Please observe: With PGC 302 the FID and TCD do not have their own heaters. They are heated together with the oven. It takes 60 to 90 minutes until the oven temperature has stabilized.

Checking the gas flows

Once the oven and detectors have reached the operating temperatures, measure the carrier gas, combustion gas and combustion air exhausts at the detector output. Compare the flows with the application data and correct if necessary using the fine pressure regulator.

Adjustment of FID, FPD, ECD or HID

Now follow the complete instructions under *Adjustment of FID and FPD, Adjustment of ECD* or *Adjustment of HID*.

With TCD: final adjustment

Follow the instructions under *Adjustment of TCD: Adjustment of measuring bridge.*

Finished!!!

Adjustment of TCD

Switching-on of bridge current

Already switch the bridge current on when the oven/TCD is cold. The bridge current additionally warms up the TCD and is stabilized together with the oven temperature. Select the function *Signals* in the selection display.

- Set the bridge current according to the application data
- Switch on the bridge current. Observe the detector signal on the screen. It must change when the bridge current is switched on.

Adjustment of measuring bridge

Select the function *Autozero*. Observe the detector signal on the screen. It becomes zero.

Adjustment of bridge limit temperature

The bridge temperature is monitored by the detector electronics. If the temperature is too high, the detector electronics switches off the bridge current and signals an alarm. The bridge limit temperature can only be set in the configuration using the editor.

Adjustment of FID and FPD

Ignition of detector

Select the function *Signals* in the selection display, and observe the detector signal there. The detector signal must rise following ignition. This detector signal is the detector baseline current. Select the function *Without compensation*.

Checking of baseline current

If you are using a conditioned column, you must wait approx. 30 minutes until the column has stabilized and a stable baseline current has been set. Compare the current with the application data.

If the value is significantly larger than that in the application data, check the oven temperature and whether the gases and piping are clean (the flame should be colourless).

Compensation of baseline current

Select the function *Autozero*. Observe the detector signal on the screen. It becomes zero.

Adjustment of ECD

Adjustment of reference current

Select the function *Signals* in the selection display, and set the reference current according to the application data (standard is 100%).

The detector signal decreases and becomes constant after a while. If you put in commission the ECD for the first time this takes some hours till some days because all pipes have to become free of hydrogen and oxygen. Finally the detector signal should be less than 2 kHz.

Compensation of baseline current

Select the function *Autozero*. Observe the detector signal on the screen. It becomes zero.

Select attenuation

Select the attenuation according to the application data sheets.



CAUTION: Radioaktive!

The ECD is a radiator and is subject to governmental supervision. Observe the regulations!

Route all exhaust gases via a common line out of the chromatograph and away from the position of use.

Observe the maximum operating temperature of this detector!

Adjustment of HID

Select drain voltage

In the RGC 202 the switch for the drain voltage is located on the right, near the needle valves. Select the lower position. This corresponds to a drain voltage of 270 V.

Select attenuation 18 ... 20 and damping 4

Wait for stabilization

Depending on gas purity it takes at least 24 hours to decrease the baseline to 50 % in attenuation 15. If this cannot be reached please regenerate the gas purifier!

Increase drain voltage

In the RGC 202 the switch for the drain voltage is located on the right, near the needle valves. The upper position corresponds to a drain voltage of 300 V. Please select now 300 V. Thus the sensitivity of the HID is increased.

Compensation of baseline current

Select the function *Autozero*. Observe the detector signal on the screen. It becomes zero.

Select attenuation

Select the attenuation according to the application data sheets (usually not lower than 9).



CAUTION: Radioaktive!

The HID is a radiator and is subject to governmental supervision. Observe the regulations!

Route all exhaust gases via a common line out of the chromatograph and away from the position of use.

Observe the maximum operating temperature of this detector!

SHUTTING DOWN

The column and detector become least contaminated when the chromatograph is kept in operation. Do not switch off the chromatograph if the plant is shut down for a short period (up to 3 weeks). Also leave the flames on in the FID and FPD so that vaporized materials from the column cannot condense. Only switch off the output devices.

If the chromatograph is nevertheless to be shut down, the following sequence is recommended:

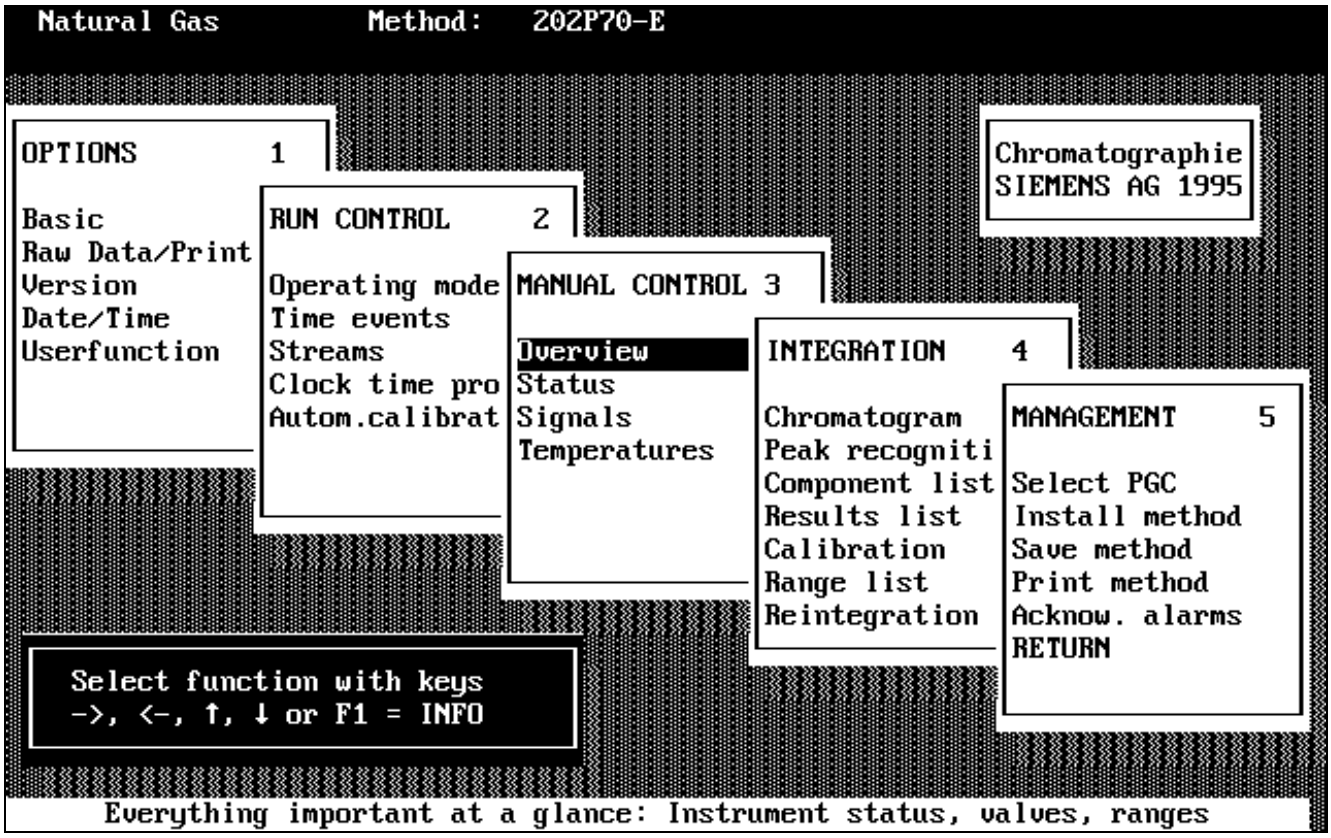
- If you have modified the original application data and wish to use the chromatograph with these data again, store them on the control unit and on a diskette. Refer to register *Operation with keyboard and screen: Saving of methods on control unit*
- Switch off all sample streams. Purge the sample lines if necessary, and blow the lines dry
- Switch off the power supply
- Switch off the combustion gas and combustion air for the FID and FPD, and the purging gas for the ECD
- Allow the detectors and oven to cool down
- Switch off the carrier gas
- Close the detector outlets using a dummy plug. This prevents contamination from entering the detectors via the common exhaust gas line.

SIEMENS

Process Gas Chromatographs, Supplement

Operation via Keyboard and Screen C79000-B5376-C526-1

This manual is valid as from software version V8.0
It contains everything that is new or has been changed compared to software version V5.0



CONTENTS

Page

DETECTORS edition II

Igniting FID/FPD, switching-on TCD 4
Switching off the TCD bridge current 5
Adjusting the detector current 5
TCD status display 5
Changing the polarity of the TCD signal 5
Compensating the baseline current
Adjusting the TCD bridge 5
Selecting the range 6
Baseline monitoring 6

CHROMATOGRAPHS edition II : CHROMATOGRAM ON THE RECORDER

Extending the analog outputs 8
Converting the analog outputs 8
Attenuation 9
Changing the polarity 10
Damping 10
Baseline offset 10
Baseline correction 11
Triggering a baseline correction 11
Cancelling the baseline correction 11

New integration procedures and other improvements

Selecting the integration procedure 12
100 % over all peaks: area standardization 13
External standard 13
100 % over all components 13
Mixed mode 14
Internal standard (only laboratory version) 14
External standard (only laboratory version) 15

Three new time events program parameters . . 16
Switching over the peak width 16
Drawing baseline from trough to trough 16
Terminate integration prematurely 16

Page

Reintegration new!

Switching the automatic raw data transmission on or off 18
Run longer than 20 minutes?
Define compression factor 18
Increasing the compression 18
Shifting the start of raw data storage 18
Selecting the run 19
Viewing the chromatogram or result 19

Optimizing the integration parameters 20
Reintegration at desk without chromatograph . . . 20
Further useful information 21

Print the chromatogram and results following each run

Installation 22
Hardware requirements 22
Switching the automatic printing on or off 22

Optimization of time events program for chromatogram printout 23
Switchover time 23
Measuring range 23
Chart drive 23
Baseline offset 23
Test printout 24

Manual printout of chromatogram 24
Faults when printing 24
Manual printing of results 25

Miscellaneous

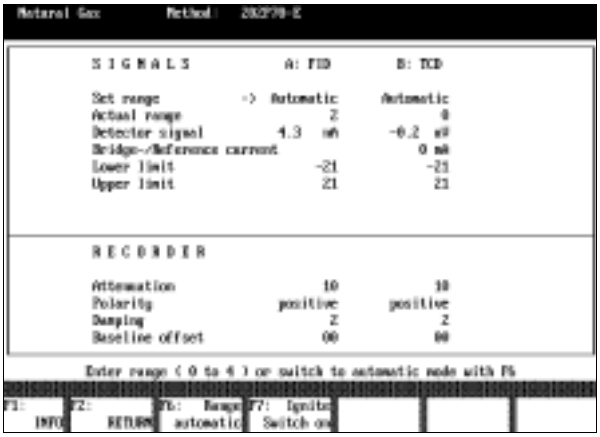
Date/time 26
Baseline monitoring 26
Temperatures and cooling 26
Analytical method 26
Analog inputs and outputs 26
Display *Peak recognition* modified 27
Display *Raw data/Print* modified 27
Correction of errors in Register 5, V5.0 28

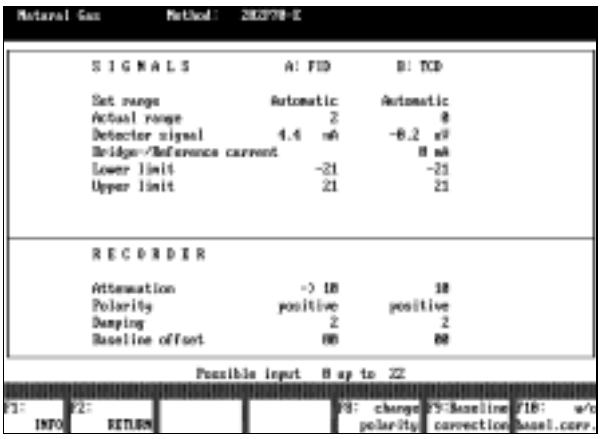
DETECTORS edition II

The chromatographs with the supplement editionII have digital detector amplifiers. These amplifiers are of double Eurocard size and are inserted next to interface module 3 in the electronics frame. The amplifiers have no control elements, all settings are made using the control unit.

Software version V8.0 or later is required in the chromatograph and in the control unit in order to operate these chromatographs. The displays *Summary* and *Signals* have been modified and adapted to the new input functions.

The chromatographs of the old generation are operated exactly as previously. Only the display *Signals* has been adapted to the new appearance. This is shown by the two Figs. on the right.





Igniting FID/FPD, switching-on TCD

Please refer to the instructions in the Register *Commissioning*: Switching on chromatograph with FID/FPD or TCD.

IMPORTANT:
Only ignite the FID or FPD when the detector temperature is higher than 120 °C, or the Ex-FID when the oven temperature is stable. This prevents the condensation of water in the detector.

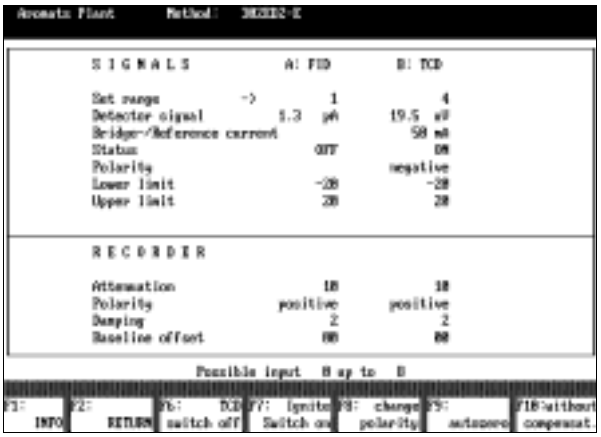
Only switch on the TCD when carrier gas has flown through the sample and reference lines for at least 5 minutes.

Select the function *Signals* in the selection display. Ensure that you select the correct channel! Position the cursor to the column of the detector you wish to switch on or ignite. Then press the key `F7: Ignite/Switch on` .

FID, FPD
The chromatograph outputs five ignition sparks to the detector. Observe the detector signal: it must increase if the detector has ignited.

TCD
The chromatograph switches the bridge current on. Observe the detector signal: it must increase when the TCD is switched on. Adjust the measuring bridge if necessary.





Switching off the TCD bridge current

Select the function *Signals* in the selection display. Ensure that you select the correct channel! Position the cursor to the column of the detector you wish to switch off. Then press the key F6: TCD switch off .

Adjusting the detector current

The TCD requires a bridge current, the ECD a reference current. Select the function *Signals* in the selection display. Move the cursor for the desired channel to the line *Bridge/Reference current.* Enter the desired value using the digit keys, and confirm with RETURN .

TCD status display

The chromatograph indicates in the display *Signals* whether the TCD bridge is switched off or on.

TCD bridge monitoring

The chromatograph switches off the bridge current if the bridge resistance becomes too large and signals *Alarm.*

The exact mode of operation of the bridge current monitoring function is described in Register 9: *TCD electronics*.

Changing the polarity of the TCD signal

Select the function *Signals* in the selection display. Ensure that you select the correct channel! Position the cursor to the column of the detector you wish to adjust. Then press the key F8: change polarity .

NOTE:
Ensure that the cursor is in the display area *Detector*. Otherwise the function acts on the recorder instead of on the detector amplifier!

The exact mode of operation of the polarity switching function is described in Register 9: *Detector electronics.*

Compensating the baseline current Adjusting the TCD bridge

Select the function *Signals* in the selection display. Ensure that you select the correct channel! Position the cursor to the column of the detector you wish to adjust. Then press the key F9: autozero .

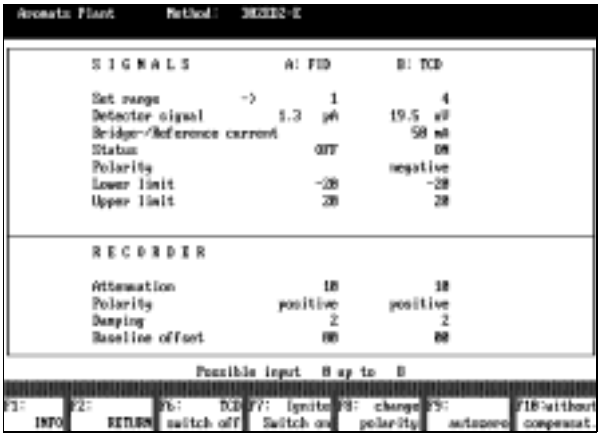
The exact mode of operation of the compensation function is described in Register 9: *Detector electronics*.

Selecting the range

The detector amplifier can be switched in a maximum of nine ranges to enable optimum processing of the large dynamic response of the detector signal. These ranges each differ by a factor of 2. The dynamic response within a range is approx. 10^6.

The range is selected once according to the measurement. It can also be switched over from the time program. Thus detector signals can be measured with a dynamic response of almost nine decades.

Select the function *Signals* in the selection display. Move the cursor for the desired channel to the line *Set range*. Enter the desired value using the digit keys, and confirm with RETURN .



Input limits for range	
FID	0 ... 8
FPD	0 ... 8
TCD	0 ... 4
ECD	0 ... 8

Baseline monitoring

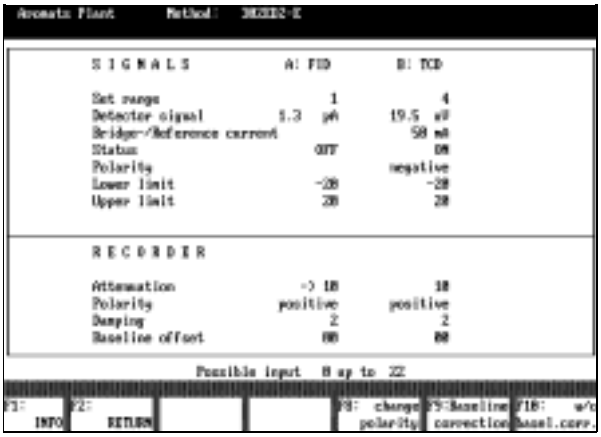
The chromatograph monitors the detector baselines. The chromatograph signals a fault if the set limits are violated (see Section *Status and alarms*).

This monitoring function can be used to determine whether e.g. the flame of the FID is still alight or whether a detector is highly contaminated.

Select the function *Signals* in the selection display, and move the cursor to the desired input field. Enter the zero limits as an attenuation (-21 to 21) which must not be fallen below or exceeded.

NOTE:
This monitoring function is only effective during the run and only in the areas in which the peak recognition does not find any peaks.

If you do not require this monitoring function, enter -21 for the lower zero limit and 21 for the upper zero limit.



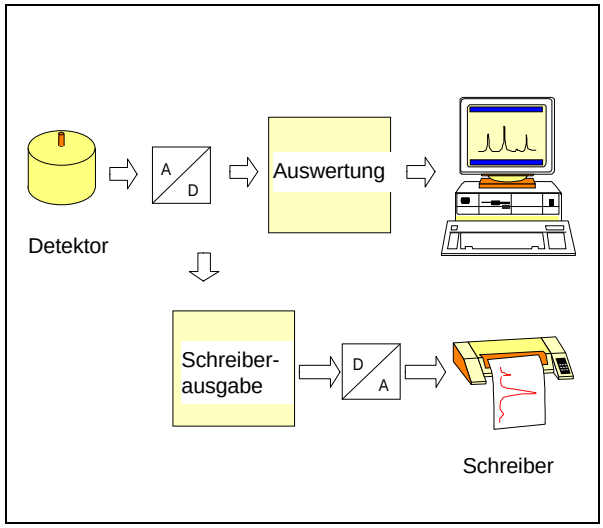
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CHROMATOGRAPHS edition II : CHROMATOGRAM ON THE RECORDER

The detector amplifiers edition II directly deliver the digital detector signal for the internal evaluation. The integration time is 40 ms as previously.

The detector signal is converted again by the chromatograph into an analog signal for the recorder output. It takes into consideration the attenuation, polarity, damping and baseline offset. These parameters thus only have an effect on the recorder. The detector signal for the integration is not influenced by them.

The chromatographs edition II have four analog outputs at terminals. The output is a load-independent current of 4 to 20 mA or 0 to 20 mA. During the configuration phase it is possible to define that the recorder signal is to be output at these analog outputs.



Extending the analog outputs

The PGC 302 edition II can be extended up to a maximum of 36 analog outputs, the RGC 202 to a maximum of 18, the PGC 102 to a maximum of 12. For this purpose there are SIMATIC modules with eight analog outputs each. These are primarily used to output component results as a trend recording (see there).

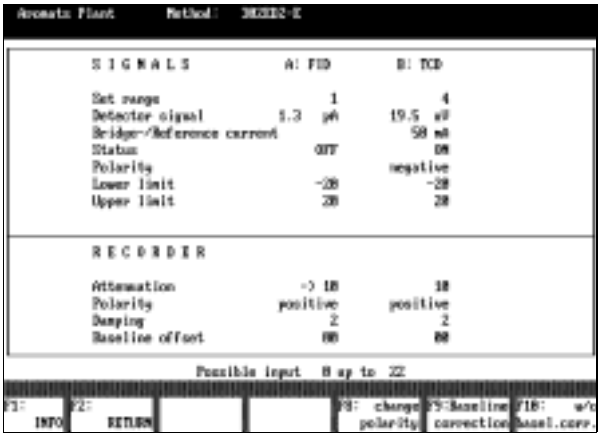
NOTE:
For compatibility reasons, the analog outputs 35 and 36 cannot be configured for output of the chromatogram on the recorder.

Converting the analog outputs

The standard analog outputs can be set to 4 to 20 mA or 0 to 20 mA using plug-in jumpers. This is described in the Register *Installation.*

NOTE:
The chromatographs of the older generation are operated exactly as previously. Only the display *Signals* is adapted to the new appearance. This is shown on the right.





Attenuation

The attenuation is the factor by which the detector signal is to be reduced (attenuated) for the recorder output. This is represented as a two's exponent 2^0 to 2^{22}.

Select the function *Signals* in the selection display and move the cursor for the desired channel to the line *Recorder/Attenuation*. Enter the desired value using the numeric keypad and confirm using RETURN .

Ionization detectors		
Range	**Detector current**	**0(4) to 20 mA in attenuation**
0	0 to 0.80 pA	0
0	0 to 13 nA	14
1	0 to 26 nA	15
2	0 to 52 nA	16
3	0 to 0.104 µA	17
4	0 to 0.208 µA	18
5	0 to 0.416 µA	19
6	0 to 0.832 µA	20
7	0 to 1.664 µA	21
8	0 to 3.328 µA	22

TCD		
Range	**Detector voltage**	**0(4) to 20 mA in attenuation**
0	0 to 30.5 µV	0
0	0 to 31.25 mV	10
1	0 to 62.5 mV	11
2	0 to 125 mV	12
3	0 to 250 mV	13
4	0 to 500 mV	14

Relationship between recorder signal and detector signal

The attenuation always refers to the direct detector signal independent of the range setting. The signal amplitude at the recorder output does not change when the range is switched over because the chromatograph takes into account the range during the digital signal processing. However, since the ranges are not calibrated with respect to one another, the signal may nevertheless differ by up to 10 %.

The tables on the left list the relationship between the detector and recorder signals for the various detectors.

Digital increments

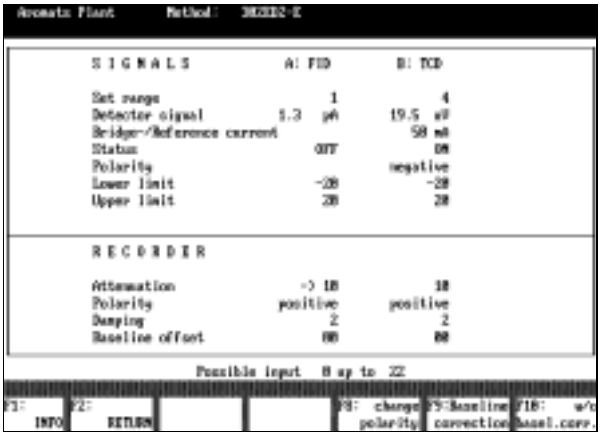
It is not meaningful to combine a large range with a small attenuation. Digital steps become visible on the recorder if the attenuation is too small. If the attenuation is too large, large peaks already reach the internal full-scale value before the recorder full-scale value has been reached.

- Largest attenuation
  The attenuation should never be selected to be larger than that which corresponds to the full-scale value in the respective range.
- Smallest attenuation
  The attenuation should always be selected larger than the value for the range.
- Example
  Range 4 with FID requires a minimum attenuation of 5 and a maximum attenuation of 18.

Changing the polarity

Negative peaks can be output as positive on the recorder by entering *Polarity negative*. Negative peaks are obtained e.g. with TCD if the carrier gas is argon, or if components are also measured in the reference branch.

Select the function *Signals* in the selection display, and move the cursor to the desired channel. Then press F8: change polarity .



Damping

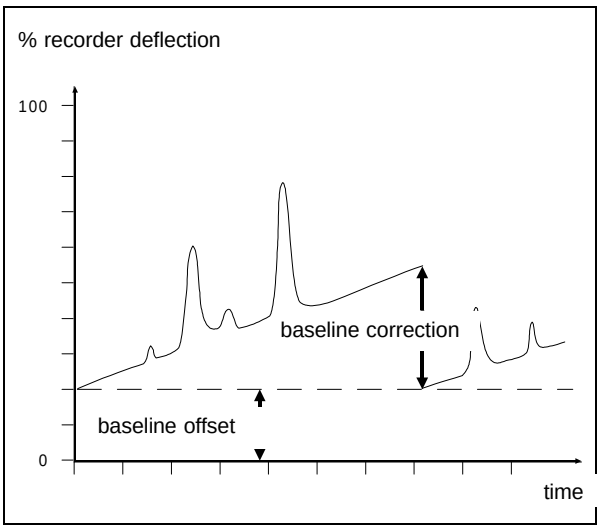
The damping of the recorder signal can be set in five steps. A damping of 0 to 4 corresponds to a time constant of 40 to 400 ms. This damping has no effect on the integration!

Select the function *Signals* in the selection display, and move the cursor for the desired channel to the line *Damping*. Enter the desired value using the numeric keypad and then confirm using RETURN .

Baseline offset

The recorder output can output negative signals down to -1 mA. If you wish to output small negative peaks on the recorder without adjusting the recorder itself, you can raise the zero line for the recorder output. This baseline offset can be adjusted to 0 to 99 % of the recorder output.

Select the function *Signals* in the selection display, and move the cursor for the desired channel to the line *Baseline offset*. Enter the desired value using the numeric keypad and then confirm using RETURN .





Baseline correction

The baseline can drift if the detector is contaminated or if the supply gases are not pure. A baseline correction can be triggered to ensure that the recorder does not run to the limit. The chromatograph stores the actual value of the signal at this moment. From now on, it subtracts this value from the detector signal. In other words: if a baseline correction is triggered, the recorder output jumps at this moment to zero or to the value you have entered as the baseline offset.

Executing a baseline correction

Select the function ***Signals*** in the selection display, move the cursor to the desired channel and press the key `F9: Baseline correction` .

NOTE:
Only carry out a baseline correction at positions in the chromatogram where no peaks are present.

Cancelling the baseline correction

Select the function *Signals* in the selection display, move the cursor to the desired channel and press the key `F10: w/o basel.corr.` .

New integration procedures and other improvements

The integration procedures have been significantly extended since the software version V1.0:

Integration procedure	Software version
External standard	V1.0 and later
100% over all peaks (area standardization) 100% over all measured components Internal standard	V5.0 and later
Mixed mode	V7.0 and later

In addition, the integration software V7.0 of the chromatograph contains the following improvements:

- Area standardization (percentage method) improved
  - Unknown peaks
  - More than 64 peaks
  - Automatic filling-in of component list
- Three new time events program parameters
  - Peak width
  - Baseline from trough to trough
  - Premature termination of integration

Selecting the integration procedure

Select the function *Integration* in the selection display, and position the cursor to the channel for which you wish to select the integration procedure. Press the space key, select the evaluation procedure using CURSOR UP/DOWN , and confirm using RETURN .



100% over all peaks: area standardization

This is the integration procedure for which the least data have to be entered. The chromatograph fills in the component list itself and calculates the peak areas according to

$$M_i = \frac{A_i}{\sum A_k} * 100$$

M_i = Concentration of components in percent
A_k = Areas of all peaks

The area standardization has been improved in software version V7.0 in three points:

Unknown peaks

- The area standardization no longer overwrites an existing component list.
- If a peak can be assigned to an existing component line, its result is entered there.
- Unknown components area appended to the known components in the component list. They can be recognized by a dash instead of a component name.
- During the next run, only those components are overwritten again whose name begins with "-" .

More than 64 peaks

- If a chromatogram has more than 64 peaks, the 63 highest peaks are entered into the component list. The areas of the remaining peaks are added as component 64 under the name "- (REST)".

Automatic filling-in of component list

- This only functions if you completely delete the component list prior to the run.
- The chromatograph automatically enters a retention time and a retention window into the component list for each peak.
- The window width is calculated by the chromatograph from the retention time and the parameter "Peak width".
- Further default settings are entered by the chromatograph into the component list.

A component list with these default settings can be easily edited and matched to the desired application.

External standard

A calibration sample with known composition is analyzed. The concentrations of the components are then entered together with a dimension into the calibration list. The chromatograph then calculates the calibration factors for each peak.

$$K_i = \frac{M_i}{A_i}$$

M_i = Concentration of components in the dimension which you entered in the calibration list

The chromatograph calculates the concentration of individual components according to

$$M_i = A_i * K_i$$

M_i = Concentration of components in the dimension you entered in the calibration list

Please also refer to Register 5 under *Calibration*.

100% over all components

This integration procedure can be used if all components of the sample are measured but their total does not result in exactly 100 % because of inaccuracies in the measurement. A quasi area standardization is then carried out, but calibration factors are taken into consideration which were previously determined according to the procedure *External standard*.

$$M_i = \frac{A_i * K_i}{\sum (A_k * K_k)} * 100$$

M_i = Concentration of components in percent
A_k = Areas of all peaks
K_k = Calibration factors of all peaks

NOTE:
The measuring error is distributed amongst all components.

Abbreviations used in all equations:

A_i = Peak area of component
K_i = Calibration factor of component
F = Scaling factor, e.g. dilution factor

Mixed mode

- This integration method is a combination of the methods *External standard* and *Area standardization.*
- It takes into account unknown components and permits response factors. This is in contrast to earlier: the component list was previously deleted, and response factor 1 used.
- This integration method can be used to represent the percentage distribution of the unknown components in a sample.

Prerequisites for the calculation

- Only peak areas are calculated, and not peak heights.
- The peak areas of known components are calculated according to the external standard method with the associated response factors. The components must therefore be previously calibrated to percentage values with an external standard.
- Response factor 1 applies to unknown components.

Calculation

- The percentage concentrations are initially calculated for those peaks which are entered in the component list.
- The total of these percentage values is subtracted from 100. This results in the percentage of all unknown peaks.
- The percentage concentration of an unknown peak is the ratio of its area to the area of all unknown peaks times the percentage of all unknown peaks.

Special case

- If, for any reason, the total of the known components is 100 %, only the results of the known components are displayed. This corresponds to the method *External standard*.

Internal standard (only laboratory version)

If an internal standard is used, an exactly known quantity of a substance is added to the sample. The chromatograph refers the concentrations of the other components to this substance. The results are thus independent of the injection accuracy.

Important: all components, including the internal standard, must first be calibrated once using the method *External standard* so that the chromatograph can determine the calibration factors.

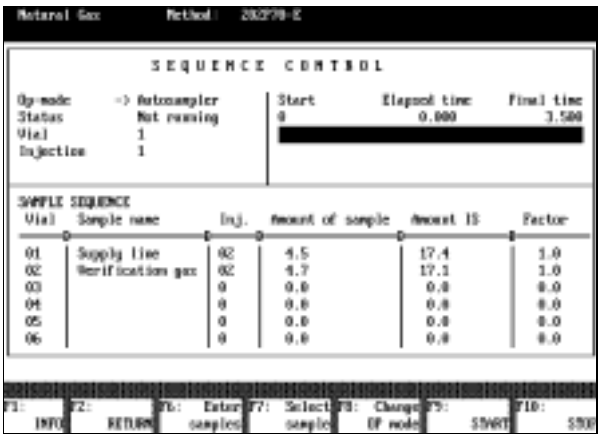
$$M_i = \frac{A_i * K_i}{A_S * K_S} * \frac{M_S}{M_p} * F$$

M_i = Concentration of component
A_s = Peak area of internal standard
K_s = Calibration factor of internal standard
M_s = Quantity of internal standard
M_p = Sample quantity without internal standard

The dimension of the result depends on how you enter the two quantities. Example: internal standard in microgram and sample in gram results in *ppm*.

NOTE:
If you enter zero for *Sample quantity*, the chromatograph does not divide by zero! The concentration of the component is then in the dimension which you have used for the internal standard. This method is only permissible if the sample quantity can be exactly reproduced.





External standard (only laboratory version)

When calculating with an external standard, it is possible to additionally specify:

- A factor, e.g. a dilution factor
- The sample quantity.

Dilution factor

A factor can be entered for every sample in the display *Start/Sequence*. The chromatograph calculates the concentration of individual components according to

$$M_i = (A_i * K_i) * F$$

M_i = Concentration of component in the dimension you have entered in the calibration list

Sample quantity

This can be used if you are working with different weighed quantities. The individual components are then referred as a percentage to the sample.

$$M_i = (A_i * K_i) * F * \frac{100}{M_p}$$

M_i = Concentration of component in percentage of the sample
M_p = Sample quantity in same dimension as the components

The chromatograph always uses this equation if you enter a value for *Sample quantity* which is different from zero.

THREE NEW TIME EVENTS PROGRAM PARAMETERS

The time events program contains three new parameters which control the evaluation:

- Switching over the peak width
- Drawing baseline from trough to trough
- Terminate integration prematurely.

Switching over the peak width

- This is an important parameter for matching the peak recognition to the separating performance of a column. It controls the bunching of the individual measured values, and thus the number of measuring points for a peak.
- This parameter is a coarse setting. It should be set such that the narrow peaks are sufficiently resolved and the wide, flat peaks are still detected.
- Practice has shown that this coarse setting is sufficient for "normal" chromatograms.

- The setting in the display *Peak recognition* is the lowest basic setting for narrow peaks. The peak width parameter in the time events program must always be larger than the basic setting.
- The time for changing parameters must be selected such that it occurs at the baseline.

Drawing baseline from trough to trough

- This is a new version of the baseline correction. In this case, the baseline is always drawn from the start of the peak to the end of the peak.
- This type of baseline correction can be useful for baselines which change rapidly (pressure surge).
- It can only be used with completely separated peaks.
- It must not be used for times overlapping with the tangent separation.
- The trough-to-trough baseline must be switched ON and OFF in the time events program for the desired areas.

Terminate integration prematurely

- Subsequent processing of the integration was previously triggered by the end of the run or the command REPORT. Subsequent operations are e.g. baseline correction of last peaks, standardization.
- It was previously impossible to access the results of the run using BASIC prior to a REPORT command. The only exception was the integration method *External standard* because the results of the integration were already available during the current run. However, the time always depended somewhat on the sequence of peaks in the chromatogram.
- The new time control command *Terminate integration* guarantees that all integration operations still present at this time are executed immediately. All results of the run are then immediately available in the component list for further processing.
- It is not essential to use this time control command. The REPORT command and the end of the run still act as previously.

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Reintegration new!

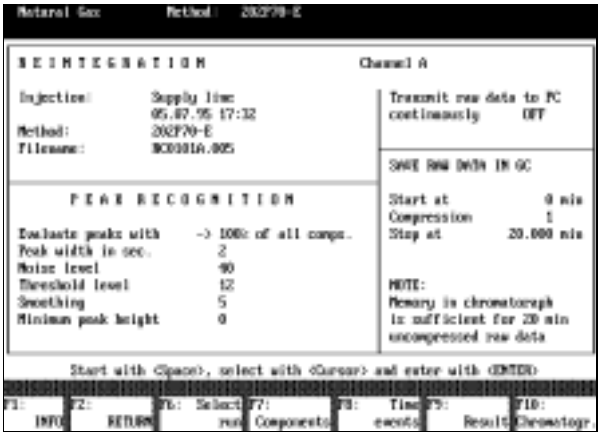
With software version V7.0 and later, the chromatograph automatically stores the raw data of channels A and B in its main memory. The main memory in the chromatograph is large enough for 20 minutes with a data acquisition rate of 40 ms. The raw data must be compressed if the run takes longer than 20 minutes.

The raw data can be selected following each run in order to reintegrate them. This is only possible if a new run has not been started, since the raw data of the previous run are deleted when a new run is started.

It is alternatively possible to switch on continuous transmission of the raw data so that the raw data from all runs are stored in the control unit.

Switching the automatic raw data transmission on or off

Select the function *Reintegration* in the selection display. The display *File selection* appears. Then press ESC , and move the cursor in the display *Reintegration* to *Transmit raw data to PC continuously*. You can now use the space key to switch between ON and OFF.



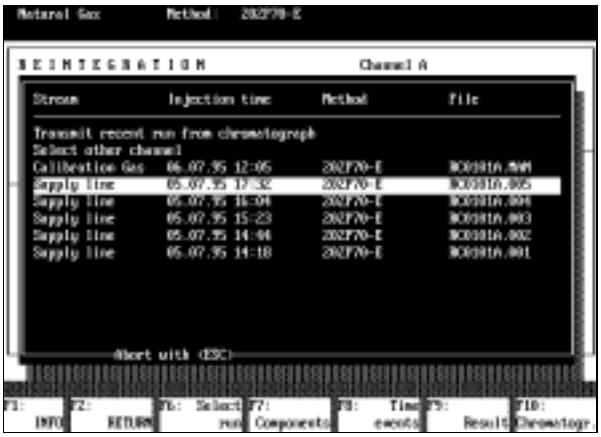
Run longer than 20 minutes? Define compression factor

Select the function *Reintegration* in the selection display. The display *File selection* appears. Then press ESC , and move the cursor in the display *Reintegration* to *Start at* or *Compression*. You have two possibilities:

Increasing the compression
If you increase the compression by one stage, a further 20 minutes of raw data fit into the main memory of the chromatograph.

This compression works independent of the parameters *Peak width* in the display *Peak recognition*. However, it is not meaningful to evaluate raw data with a peak width of 1 or 2 sec if they have been recorded with compression 3. A peak width of 1 sec corresponds to compression 1, a peak width of 4 sec corresponds to compression 4 etc.

Shifting the start of raw data storage
If the run only takes a little longer than 20/40/60 etc. minutes, it is possible to shift the start for saving the raw data. This can be applied if it is not necessary to evaluate the first minutes of the run.



Selecting the run

Select the function *Reintegration* in the selection display, or press the key F6: Select run in the display *Reintegration*. The display *File selection* appears.

From the hard disk

Raw data files are stored in the directory of the selected chromatograph on the hard disk of the control unit if you have switched on the raw data transmission. Select using the cursor and confirm using RETURN .

Changing the channel

Select *Select other channel* if you wish to select raw data files of the other channel.

Load current run from the chromatograph

If you have terminated a run in operating mode *Maintenance single run* and the raw data transmission was not switched on, you can now subsequently load the raw data of this run from the chromatograph. You must do this for both channels if you are working with two detectors.

NOTE:
The raw data loaded in this manner are stored by the control unit in the file RC0101A.MAN (for channel A of chromatograph 1/1). If you load the raw data of the current run from the chromatograph several times in succession, this file is repeatedly overwritten. This also applies if you do this for several runs in succession.

You must store the raw data file if you wish to keep it. This is described under *Data management (GCARCHIV)*.



Viewing the chromatogram or result

Select one of the keys F9: Result , F10: Chromatogr. in the display *Reintegration.* The matching result or chromatogram appears without pressing any further keys. The display *Reintegration* appears again when you leave the displays *Result* or *Chromatogram*.

Optimizing the integration parameters

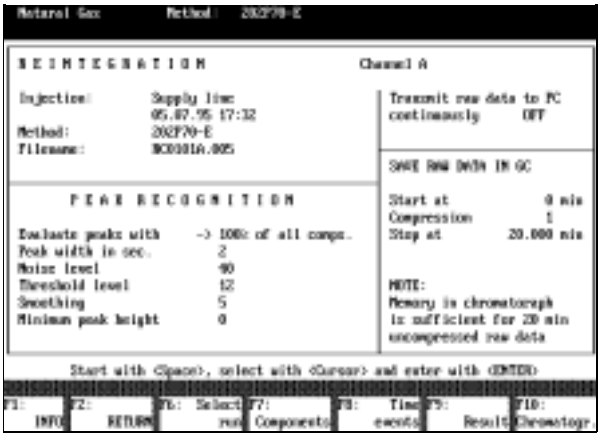
You can optimize the integration without having to leave the display *Reintegration*. All softkey functions return directly to this display so that the correct integration parameters can be found very rapidly.

Changing the peak recognition parameters
All parameters of the display *Peak recognition* can be modified directly for the selected channel in the display *Reintegration*. Details can be found in Register 5, *Integration: Peak recognition* and in this supplement under *Peak recognition*.

Changing the time program
Press the key F8: Time events in the display *Reintegration*, and select the channel. Modify the appropriate parameters in the time events program. The display *Reintegration* appears again when you leave the display *Time events program*.

Information on the integration parameters in the time events program can be found in Register 5, *Peak recognition* and in this supplement under *Improved integration: Three new time events program parameters*.

Modifying the components list
Press the key F7: Components in the display *Reintegration*. Modify the matching parameters in the component list. The display *Reintegration* appears again when you leave the *Component list*.



Reintegration at desk without chromatograph

If you possess the software packages PGCSIM and GCARCHIV, you can reintegrate at your desk without a chromatograph being connected to the PC. This functions as follows:

- For example, several analyses are run automatically at night. The control unit must be connected, and the raw data transmission function switched on.
- The results and raw data are stored on a diskette on the next morning.
- Load the runs from the diskette onto the desk PC.
- Optimize the integration (reintegrate) without a chromatograph being connected. Its function is handled by the separate software package PGCSIM.

Also read the information in this supplement in the Sections *PGCSIM* and *Data management (GCARCHIV)*.

Further useful information

It is not essential to read this page, but perhaps you wish to know more ...

Selection of the raw data file

Selection of the raw data files for reintegration is carried out e.g. from the directory *\pgcarch\gc0101* . There are many files there for each channel such as *RC0101A.004* or *RC0101B.012* and a file *RC0101A.MAN*. The latter is generated when the current chromatogram is saved from the chromatograph.

Further files are produced!

Once you have selected a raw data file, the operating software converts the selected file into *\pgcarch\RS0101A.I00* and *\pgcarch\RA0101A.I00* (the latter only with an internal standard).

The operating software then starts the reintegration. The reintegration always uses the two above-mentioned files and generates a new report file *\pgcarch\gc0101\RP0101A.I00* and a new chromatogram file *\pgcarch\gc0101\RD0101A.I00* from these. These two files are only present once per chromatograph. They are required for viewing and printing.

Save the result of reintegration?

Saving the two generated files *RD0101A.I00* and *RP0101A.I00* is really unnecessary since the raw data file already exists. This can be used to repeatedly generate a report and a chromatogram.

If you nevertheless wish to save, you must individually save the two generated files *RD0101A.I00* and *RP0101A.I00* following each reintegration.

Print chromatogram and results following each run

From software version V6.0 onwards, the chromatogram and the results can be printed together: automatically following each run or manually. It is possible to define the measuring ranges, chart drive and baseline offset for the chromatogram using a special time events program.

The result is printed with a fixed format. This has nothing to do with the BASIC program *REPORTA.BAS*. You should not use this BASIC program in the time events program of course if you have switched on automatic printing.

Installation

Printing is carried out using the TSR program *CPRINT*. The installation program enters the line

```
CPRINT
```

into the file *BEDI.BAT* if you define that you wish to automatically print the chromatogram and results.

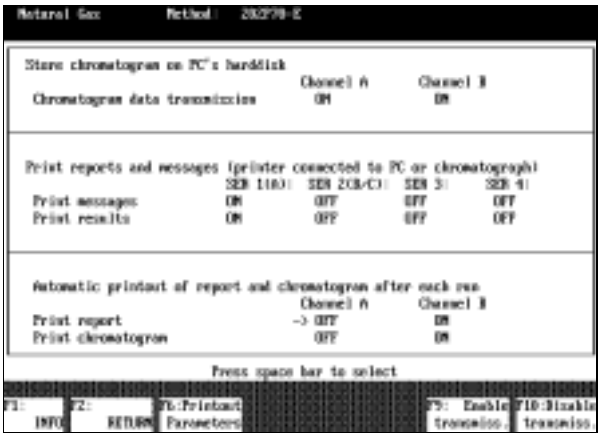
Hardware requirements

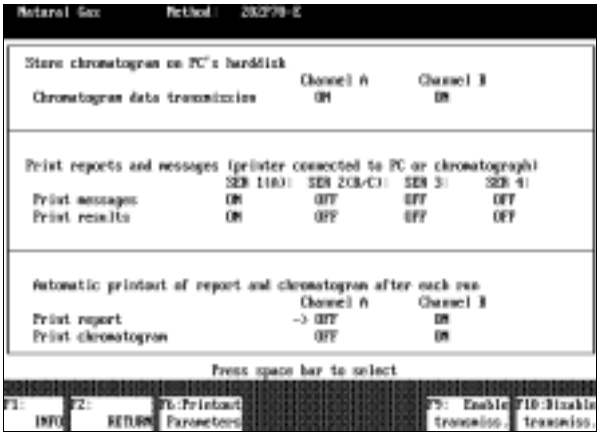
- 386 computer or better with 25 MHz and 1 MB main memory
- Printer with IBM-compatible character set. Use a high-speed printer for several chromatograms or a fast chart drive.

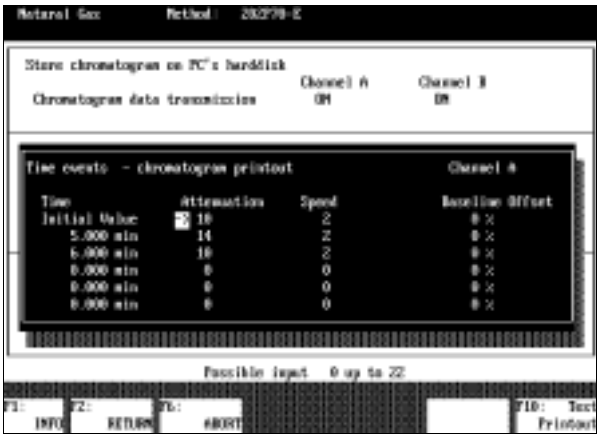
Switching the automatic printing on or off

Select the function *Raw data/Print* in the selection display. Move the cursor to *Print result* or *Print chromatogram* for the desired channel. Press `F9: Enable transmiss.` or `F10: Disable trasmiss.` .

NOTE:
Chromatograms can only be printed together with the result. If you switch on *Print chromatogram*, *Print results* is also switched on! Vice versa, *Print chromatogram* is also switched off if you switch off *Print results*.







Optimization of time events program for chromatogram printout

In a maximum of six time events program lines it is possible to modify the measuring range, baseline offset and chart drive.

These parameters only have an effect on the chromatogram printout. They have nothing to do with the parameters for displaying the chromatogram on the recorder.

NOTE:
The time events program is a part of the method.

Select the function *Raw data/Print* in the selection display. Move the cursor to *Print results* or *Print chromatogram* for the desired channel. Press `F6: Printout parameters` .

Switchover time
The parameters in the line *Start value* become active when printing is started. *Switchover time* is the respective time at which the new parameters are to apply. Time 0 means that the complete line is ineffective.

Measuring range
The measuring range from 0 to 22 is the same as with the recorder display.

Chart drive
The chart drive can be set in seven steps. Step 1 prints approx. 30 minutes of chromatogram on one page, step 7 prints approx. 30 seconds.

The parameter *Peak width* in the display *Peak recognition* influences the print result. Steps appear in the chromatogram if the peak width is selected too large. The following applies:

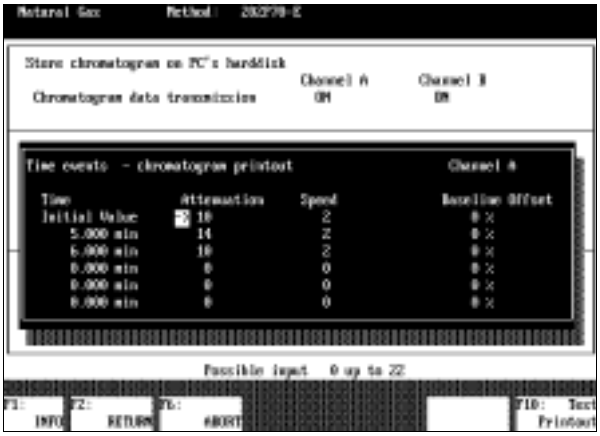
Chart speed	Max. bunching	Minutes per page
1	60	30
2	30	15
3	20	10
4	10	5
5	5	2
6	2	1
7	1	0,5

IMPORTANT:
When printing automatically following each run, the printout must be completed during the run. Not all chromatograms are otherwise printed out!

Baseline offset
The baseline offset from -99 to +99 % has the same effect as with the recorder display. The percentage value always refers to the full-scale value in the selected measuring range.

Test printout

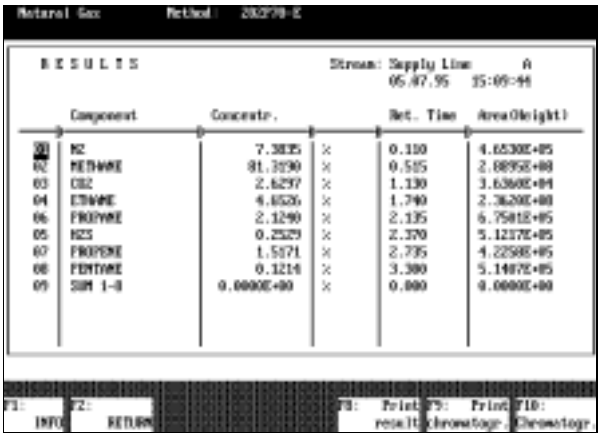
You can request a test printout once you have optimized the time events program. Press F10: Test printout . The display *Time events program* appears again following printing.



Manual printing of chromatogram

Select the function *Result list* in the selection display, then select the desired run using the cursor keys, and confirm using RETURN . The display *Results* appears.

Press F9: Print chromatogr. . The time events program for the chromatogram printout appears. Refer to *Time events program for chromatogram printout* for what you can set here. Then press F2: RETURN to start printing.



Abort

If you do not wish to print, press F6: ABORT .

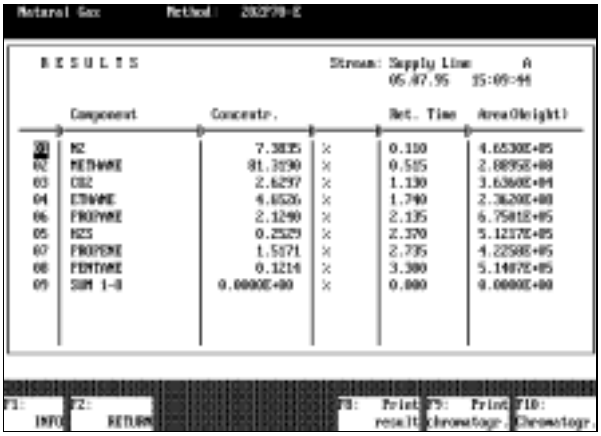


Faults when printing

Printing is carried out using the TSR program *CPRINT*. The following problems may occur:

- Printer is not connected or not ready
- Insufficient memory in control unit.

Information text then appears on the screen. Read it and continue.



Manual printing of results

Select the function *Result list* in the selection display, select the desired run using the cursor keys, and confirm using RETURN. The screen *Results* appears.

Press F8: Print result. You can find further information on this subject in Register 5, *Printing the result list.*

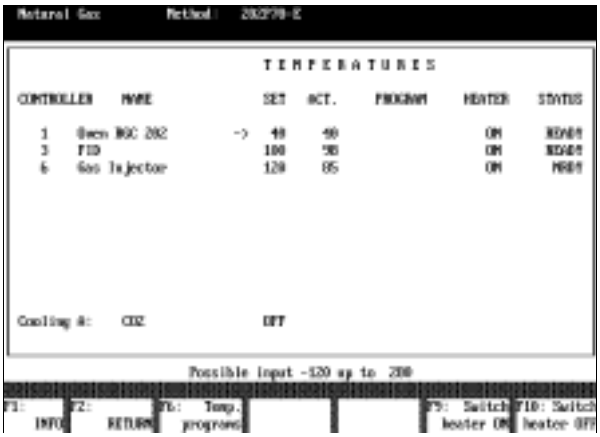
Date/time

- The clock has a battery backup in chromatographs fitted with a PCPU-1.
- Chromatographs with a PCPU-2 no longer have a backup battery. Following a power failure, the clock is set to 1.1.1980, 0:00 hours.
- From software version V7.0 onwards (operation and control software!) the clock in the chromatograph can be synchronized with the clock in the control unit. This must be selected during installation. The time of the control unit is then sent to all connected chromatographs approx. once a minute.

Baseline monitoring

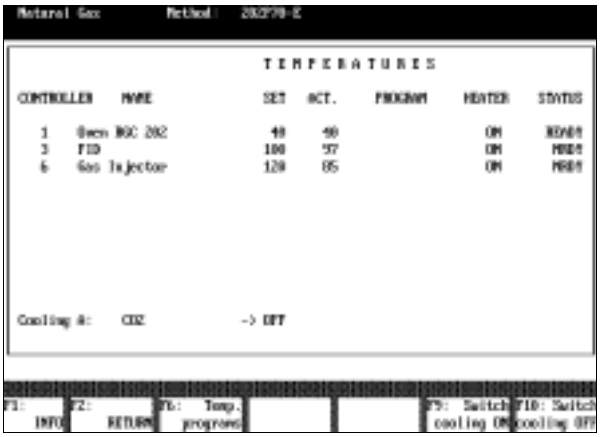
- The baseline of the FID can be monitored. An alarm is output if the FID flame is extinguished in process operation. The chromatograph becomes *Not ready*, and never *Ready* again; process operation is blocked! The only remedy is to reset the chromatograph.
- Cause: the baseline monitoring function only operates whilst a run was being carried out. From control software version V6.0 onwards, the baseline alarm is reset when the FID is ignited.

Detailed information on the baseline monitoring function can be found in Register 5 under *Baseline monitoring*.



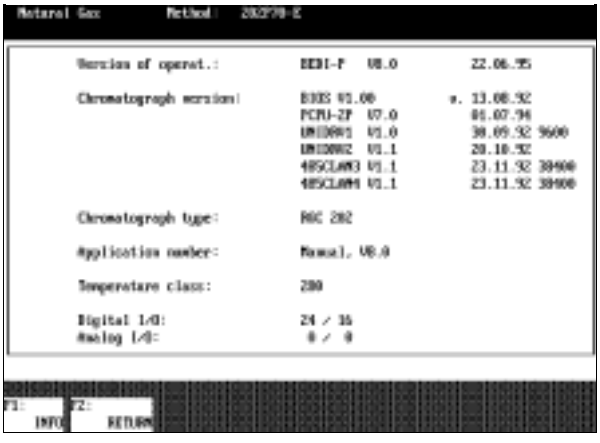
Temperatures and cooling

- Only those controllers are now listed in the display *Temperatures* which are fitted.
- Cooling with cryostat, N_2 or CO_2 can be adjusted in the display *Temperatures*.



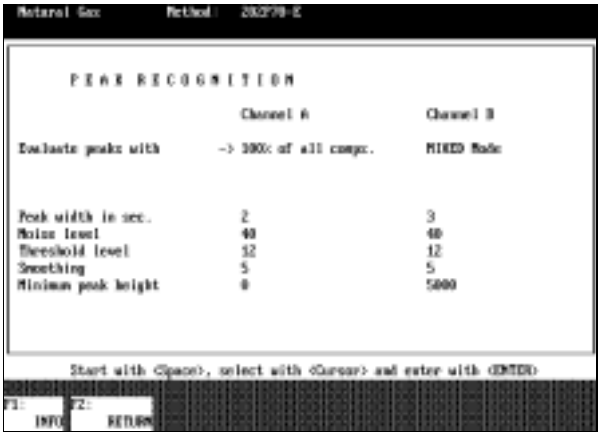
Analytical method

- The header displays the name of the method which is loaded in the chromatograph.



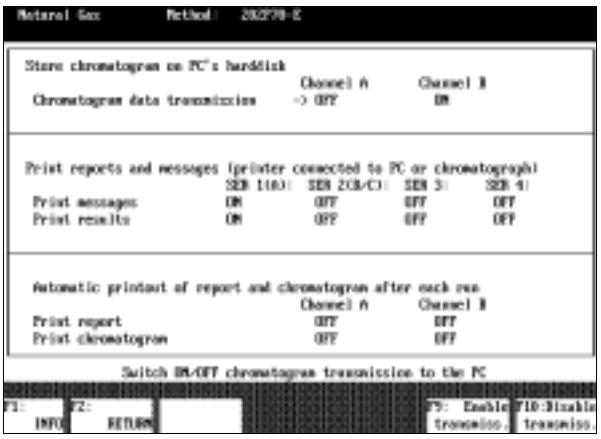
Analog inputs and outputs

- The display *Software version* additionally indicates how many analog inputs and outputs are present in the chromatograph.



Screen *Peak recognition* modified

- The parameter *Dynamic peak threshold* can no longer be modified in the display *Peak recognition*. It can only be specifically used in the time events program. More details can be found in Register 5 under *Dynamic peak threshold ON/OFF*.



Screen *Raw data/Print* modified

- The display *Raw data/Pressure* has been extended by the function *Automatic printout of report and chromatogram after each run*. Its appearance is therefore somewhat different to previously. The other functions have not been changed.

Correction of errors in Register 5, V5.0

Register	5
Concerns	All chromatographs
Chapter	Detectors
Section	Baseline monitoring
Paragraph	Third

This should read:

... Enter the zero limits as an attenuation (-21 to 21) which must not be fallen below or exceeded.

The subsequent note must then read as follows:

... If you do not require this monitoring function, enter -21 for the lower zero limit and 21 for the upper zero limit.

Register	5
Concerns	All chromatographs
Chapter	Integration
Section	Two chromatograms simultaneously on screen
Paragraph	

This paragraph should start with:

Whilst the chromatograph is displaying the list of stored chromatograms, press the key [F9: Two chromatograms]. Select the first chromatogram using ...

Register	5
Concerns	All chromatographs
Chapter	Integration
Section	Enlarging a section (zoom)
Paragraph	Third (Abort)

This should read:

You can abort marking of the section at any time by pressing the key [ESCAPE] (right mouse button).

Register	5
Concerns	All chromatographs
Chapter	Appendix A: All BASIC commands
Section	Command IF...THEN...ELSE
Paragraph	First

This should read:

```
20 IF C<20 THEN DO(1)=1 ELSE DO(1)=0
30 C = C + 1
```

Register	5
Concerns	RGC 202, process and laboratory versions
Chapter	Operation from where
Section	Complete page
Paragraph	

We do not use the interface designations A to E any more! Furthermore, switching over of interface B from TTY to V.24 via interface C no longer exists.

Please read Register 3, *Connection of control unit* and possibly the following pages for the current arrangement.

Register	5
Concerns	RGC 202, Laboratory version
Chapter	Appendix C, Parameterization of autosampler
Section	Position of solvent vial in belt
Paragraph	Last sentence

This should read:

The solvent vial (purging solution) must always be inserted into position *S* (at the second position *A* with the AS 32).

Register	5
Concerns	RGC 202, process version
Chapter	Updating of retention window
Section	Viewing corrected retention times
Paragraph	

The key F7 must read:

[F7: correc. Ret.Time] instead of
[F7: currrent Ret.Time]

The corrected retention times can also be reset by pressing [F8: Reset ret.time]. The retention windows which you have entered in the component list are then effective again.

Register	5
Concerns	RGC 202, process version
Chapter	Appendix A: All BASIC commands
Section	Command FOR...TO...STEP...NEXT
Paragraph	Sixth (second example)

This should read:

```
10 FOR I=5 TO 2 STEP -1
```

Register	5
Concerns	RGC 202, process version
Chapter	Appendix A: All BASIC commands
Section	Command ALA/ALB
Paragraph	Flag table

The flag table has been extended:

Flag table

Flag	Function	Flag	Function
1	Controller 1 ready	33	Temp.prog. 4 running
2	Controller 1 alarm	34	Temp.prog. 5 running
3	Controller 2 ready	35	Temp.prog. 6 running
4	Controller 2 alarm	36	Temp.prog. 7 running
5	Controller 3 ready	37	Temp.prog. 8 running
6	Controller 3 alarm	38	Temp.prog. 9...11 running
7	Controller 4 ready	39	Controller 9...11 ready
8	Controller 4 alarm	40	Controller 9...11 alarm
9	Controller 5 ready	41	BASIC alarm 1
10	Controller 5 alarm	42	BASIC alarm 2
11	Controller 6 ready	43	BASIC alarm 3
12	Controller 6 alarm	44	BASIC alarm 4
13	Controller 7 ready	45	BASIC alarm 5
14	Controller 7 alarm	46	BASIC alarm 6
15	Controller 8 ready	47	BASIC alarm 7
16	Controller 8 alarm	48	BASIC alarm 8
17	Simultaneous run	49	Detector alarm
18	Maintenance operation	50	Upper zero limit
19	Periphery faulty	51	Lower zero limit
20	Analog data output	52	Result ready
21	Gas supply	53	Analysis not running
22	Interface	54	External alarm
23	Internal temperature	55	Calibration running
24	5-V current	56	Calibration within cycle
25	24-V current	57	Calibration, last cycle
26	Memory overflow	58	Calibration, absolute
27	Leak detector	59	Updating of retention time
28	Purging pressure	60	Time events not running
29	Process operation		
30	Temp.prog. 1 running		
31	Temp.prog. 2 running		
32	Temp.prog. 3 running		

HPLC

30	Pump A alarm
31	Pump B alarm
32	Pump C alarm
33	Eluent A empty
34	Eluent B empty
35	Eluent C empty
36	Pulsation A alarm
37	Pulsation B alarm
38	Pulsation C alarm

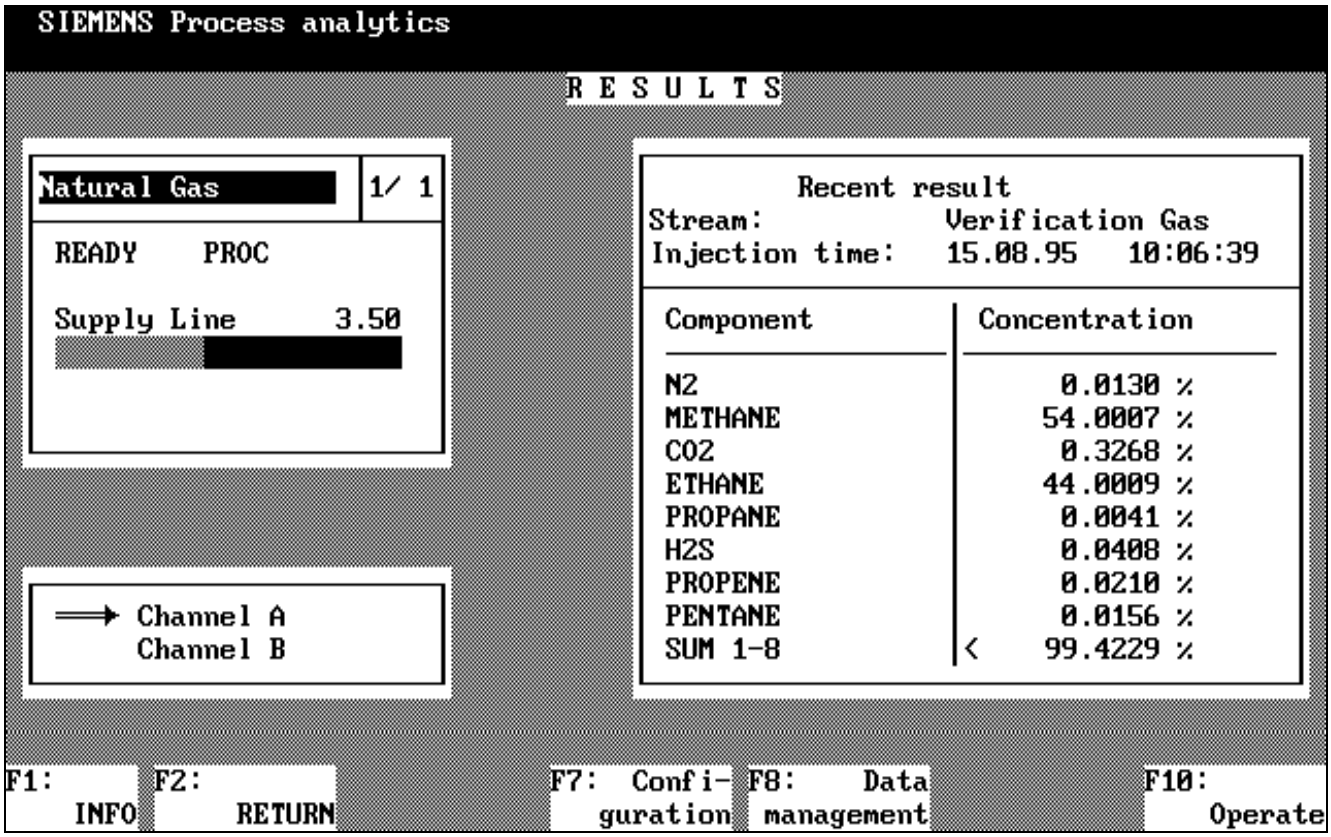
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SIEMENS

GCLAN, GCARCHIV and PGCSIM

Operation via Keyboard and Screen C79000-B5376-C521-2

As from software version 8.0



CONTENTS

Page

Installation of software 3

Network summary (GCLAN)

Starting GCLAN 4
Leaving GCLAN 4
Permanent display of last result 4

Display of a chromatograph 5
Different types of display 5
Selecting a chromatograph 5
Accessing chromatographs 6
Configuring of chromatographs 6
Data management 6

Data management (GCARCHIV)

What data have to be managed? 8
Where is the archive, and what fits in it? 8
Writing data into the archive 8
Reading data from the archive 8
Analytical method 8
Information file 8
Archive format 9

How do I proceed? 10
Select direction, select report or raw data 10
Select archive 10
Process information file 11
Generate text pattern 11
Select runs 12
Trigger storing 12
Select method 13
How can I update a method in the archive? 13
Delete archive 13

PGCSIM

Installing PGCSIM 14
Optimizing the memory 14
Checking of memory assignments 14
The commands in SIM.BAT 14
The meaning of the program names 14

Starting the simulation 14
What is simulated, and what is not? 15
Number of chromatographs 15
Alternate use of PGCSIM and BEDI 15

Installation of software

Please follow the instructions in Register 2, *The software: Installation of software*. When you install the operating functions, the installation program from version V7.0 onwards additionally asks whether you also wish to install the GCLAN or GCARCHIV.

GCLAN *Network summary* and GCARCHIV *Data management* are separate software packages. They can also be installed subsequently. The installation program is also present on these diskettes for this purpose.

Latest information on the software



Changes to the scope of delivery or to individual program functions are often carried out once the manuals have already been edited. The installation diskettes may therefore contain additional information. Please observe the message which is displayed on the screen at the end of the installation. This is particularly important

- if you have already used an older software version
- or if you require information on the latest software functions.

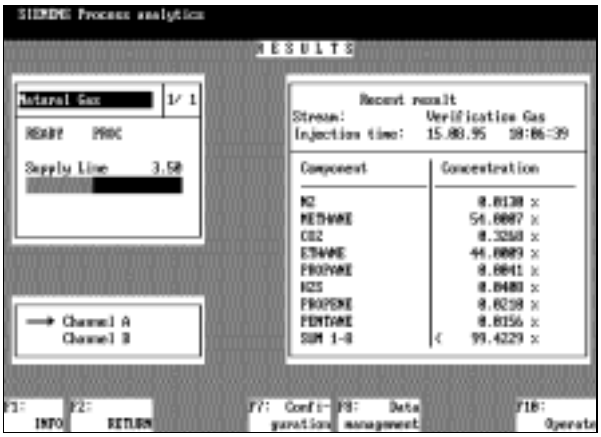
Once you have successfully terminated the installation, you should load the file README.TXT using the MS-DOS editor and read it carefully. It is best if you print out this file and enclose it with your documentation.

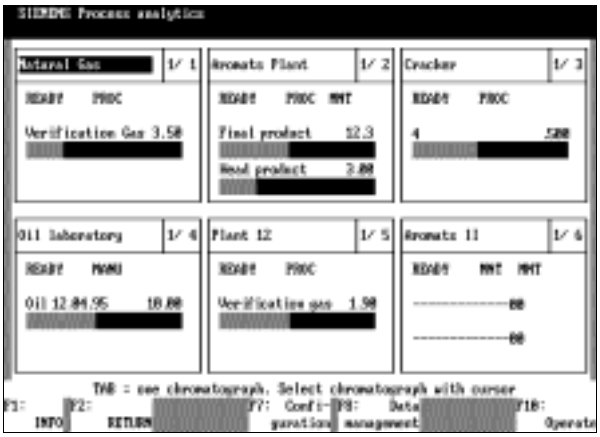
Network summary (GCLAN)

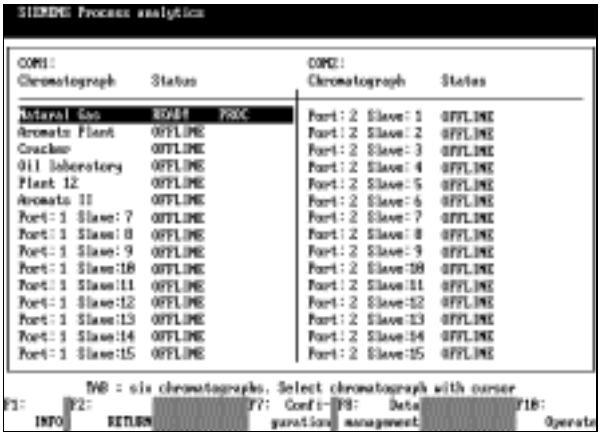
GCLAN provides a summary of all chromatographs connected to the control unit. At the same time, it summarizes operation, configuration and data management.

GCLAN shows the connected chromatographs in up to three different types of display:

- One chromatograph
- Up to six chromatographs
- More than six chromatographs.







Starting GCLAN

GCLAN enters itself into the file BEDI.BAT when it is installed. The network summary then always appears when you start operation as usual. Also refer to Register 2, *The software: Starting the operating software*.

Leaving GCLAN

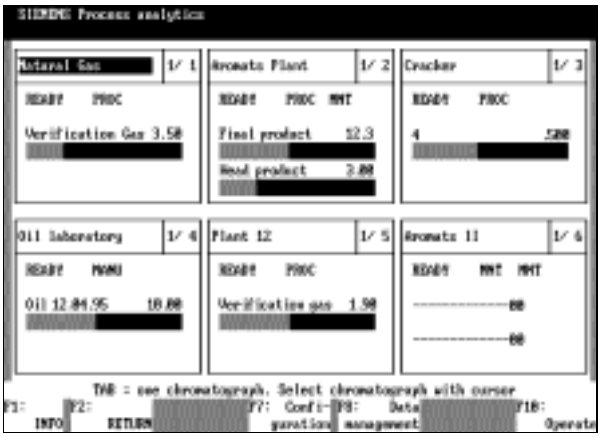
Press F2: RETURN if you wish to return to MS-DOS. The control unit asks whether you really wish to leave GCLAN. Reply using Y .

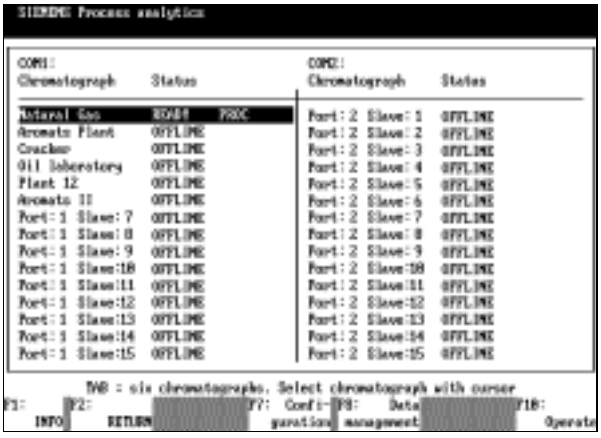
Permanent display of last result

If only one chromatograph is displayed on the screen, its last result is shown on the right. If several chromatographs are connected to the control unit, press the key TAB until the display *Results* is output.

Selection of channel A/B

If you wish to see the last result of the other channel, press one of the cursor keys CURSOR UP/DOWN .





Display of a chromatograph

The following are displayed for every chromatograph:

- Chromatograph name
- Physical address (port/slave)
- Status
- Operating mode (twice with parallel run)
- Sample stream name (twice with parallel run)
- Duration of run (twice with parallel run)
- Actual time bar (twice with parallel run)

Different types of display

The following appearances are possible depending on the chromatograph status:

Chroma-tograph	Software	Simul-taneous	Operating mode	Status
1	Process	No	Process	Device failure
2	Process	Yes	A: Process B: Maintenance	A and B ready
3	Process	No	Process	Software < V7.0
4	Laboratory	No	Manual	Ready
5	Process	No	Process	Ready
6	Process	Yes	A: Maintenance B: Maintenance	Not started

Selecting a chromatograph

If more than one chromatograph is connected to the control unit, you can switch between three types of display using the key TAB :

- One chromatograph
- Up to six chromatographs
- More than six chromatographs.

In display *One chromatograph*

Select one of the chromatographs using the cursor keys CURSOR LEFT/RIGHT .

In display *Six chromatographs*

Select one of the six chromatographs using the cursor keys CURSOR LEFT/RIGHT or CURSOR UP/DOWN .

In display *All chromatographs*

Select the desired chromatograph using the cursor keys CURSOR LEFT/RIGHT or CURSOR UP/DOWN .

NOTE:
If you subsequently switch to *Six chromatographs*, the control unit displays six chromatographs starting at the cursor position of the display *All chromatographs*.

Accessing chromatographs

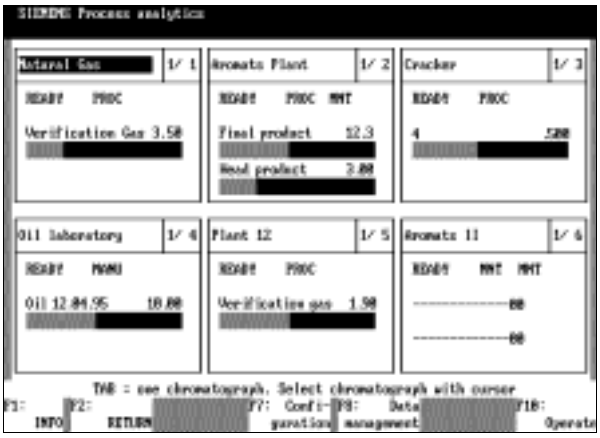
If you are not in the display *Results*, use the cursor keys to select the chromatograph you wish to access, and press F10: Operate . If you subsequently leave the operation mode, you return to the network summary.

Configuring of chromatographs

Press F7: Configuration . If you subsequently leave the configuration mode, you return to the network summary.

Data management

Press F8: Data management . If you subsequently leave the data management function, you return to the network summary. the function *Data management* is available as a separate software package. Refer in this register to: *Data management*.



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Data management (GCARCHIV)

GCARCHIV permits the storage of results, chromatograms and raw data. These stored data can be loaded again later and viewed or processed.

Possible usage: the integration can be optimized at a desk without a chromatograph being connected to the PC (reintegration). This functions as follows:

- For example, several analyses are run automatically at night. The control unit must be connected, and the raw data transmission function switched on.
- The results and raw data are stored on a diskette on the next morning.
- Load the runs from the diskette onto the desk PC.
- Optimize the integration (reintegrate) without a chromatograph being connected. Its function is handled by the separate software package PGCSIM.

What data have to be managed?

A run in the chromatograph generates three types of data:

- **Report (results)**
  This is a text file containing e.g. component names and concentrations. This file is produced with every run.
- **Chromatograms**
  These are compressed data of the detector signal with all peak detection information, e.g. start of peak, end of peak, component name. This file is only produced if transmission of the chromatogram to the control unit is switched on!
- **Raw data**
  This is a binary file. It contains the non-compressed data of the detector signal up to the duration of 20 minutes. This file is only produced if transmission of the raw data to the control unit is switched on! You can find more details in this Manual under *Reintegration*.

The storage function always handles the report and chromatogram together. This means that the associated chromatogram is always stored together with a report if it is present.

Where is the archive, and what fits into it?

Archives can be created on the hard disk of the control unit or on diskettes. Any number of archives are permissible. Each archive must have a different name.

It is possible to write in succession into the same archive, even data from different chromatographs. This is seldom meaningful, however, because of the loss of clarity. It is therefore better to create a separate archive for each chromatograph.

Writing data into the archive
An archive can contain a maximum of:

- 500 reports
- 500 chromatograms
- 500 raw data
- One analytical method
- One information file.

It is better to create several small archives with a few files than one large archive with many files.

Reading data from the archive
In order to read files stored using the operating software, it is necessary to load them from the archive. This can be carried out simultaneously for a maximum of:

- 100 reports
- 100 chromatograms
- 100 raw data
- One analytical method

A larger number would not be meaningful since selection of the file would become unclear. It is possible to repeatedly load a number of files in succession from the same archive or from different archives until 100 files are reached. It is possible to delete old files before more files are loaded from the archive, thus retaining clarity.

Analytical method
An archive can also contain an analytical method. You must know whether you wish to use the current method or the method in the archive.

Information file
Information on the files, the analytical method, the run conditions etc. are stored in this text file. This helps to subsequently retain clarity amongst the archives.

Archive format

It is not essential to know this in order to store data or read them from the archive, but it does no harm to explain it anyway:

File names

Files fresh from the chromatograph are named in \pgcarch\gc0101\	
RP0101A.001 ... 999	Reports
RD0101A.001 ... 999	Chromatograms
RC0101A.001 ... 999	Raw data
Files from the archive are named as follows in \pgcarch\gc0101\	
RP0101A.X00 ... X99	Reports
RD0101A.X00 ... X99	Chromatograms
RC0101A.X00 ... X99	Raw data
Files in the archive (e.g. \bedi\archiv\my_own.*) are named	
my_own.GCA	Info file
my_own.CRL	Management file
my_own.000 ... 499	Reports
my_own.500 ... 999	Chromatograms
my_own.V00 ... Z99	Raw data
my_own.M00 ... M99	Method
The text pattern is always present in \bedi and is named as follows	
VORLAGE1.TXT	This is the text pattern
VORLAGE1.CRL	Management file

Analytical methods

When reading from the archive, the archived method overwrites the method in the directory \meth\... if this method already exists.

Selection of runs

All files with the extensions .000 , .X00 and .I00 are available for selection of the run when storing (any number can be present instead of the 0).

Port/slave information

The port/slave information is lost in the archive. Watch out when saving files from different chromatographs into the same archive!

Current chromatograph

When reading from the archive, all files are entered into the \pgcarch\gc directory which belongs to the currently selected chromatograph. These are then again called e.g. \pgcarch\gc0103\rp0103a.x00 .

How do I proceed?

Writing into an archive or reading from an archive requires the following steps:

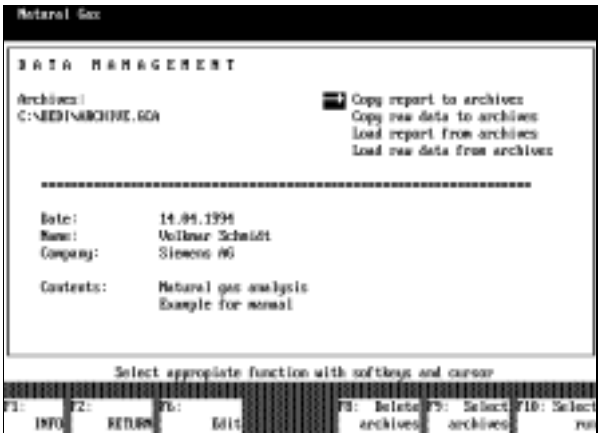
- **Select direction: write into archive or read from archive**
- **Select report or raw data**
- **Select archive**
- **Process information file**
- **Select run**
- **Trigger storing**
- **Select method**
- **Finished!!**

Select direction, select report or raw data

In the display *Data management*, you can select one of four functions using the keys CURSOR UP/DOWN

- Copy report and chromatogram into the archive
- Copy raw data into the archive
- Load report and chromatogram from the archive
- Load raw data from the archive.

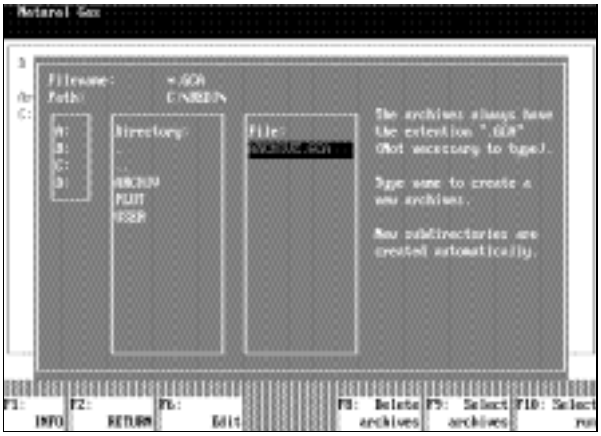
Set the cursor to the desired function.



Select archive

Press the function key F9: Select archives in the screen *Data management*. The control unit displays the selection window. Using the key TAB you can access the selection fields in succession for:

- Drive
- Directory
- Archive file
- Archive file name.



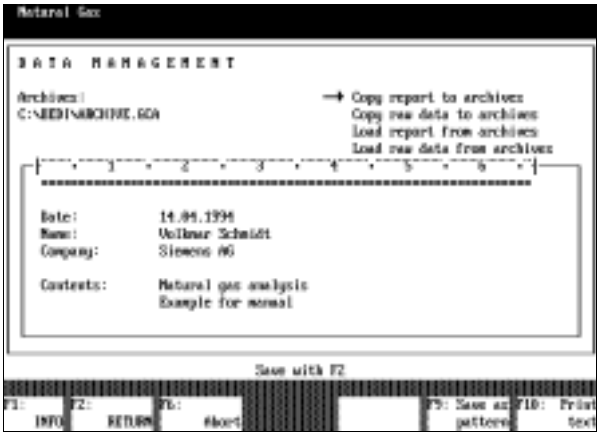
Select existing archive

Select the drive, directory and archive name using the keys TAB , CURSOR UP/DOWN , and subsequently confirm using RETURN .

Create new archive

Select the drive and directory using the keys TAB and CURSOR UP/DOWN in each case, type in the name of the new archive, and confirm using RETURN .

> **NOTE:**
> Archives always have the extension *.GCA* . You need not type in this extension.
>
> If you wish to position your archive in a new subdirectory, type in the name of the directory and the name of the archive separated by a backslash (\).



Edit information file

A text file is associated with each archive. You should save information on what you have stored, and when, in this file. You can also enter the setup of the chromatograph. You need not enter the analytical parameters here because you can store an analytical method (see below).

Press the function key `F6: Edit` in the screen *Data management*. The text editor shows the line marker and the text cursor on the first character.

Save modifications

Press `F2: RETURN` in order to save your inputs and to leave the text editor.

Reject modifications

It may occur that you do not wish to store what you have just written. Press `F6: Abort` in this case to reject your modifications and to leave the text editor.

Generate text pattern

If you wish to create several similar archives, it is recommendable to generate a text pattern for the information file. Write all texts which you require repeatedly into the information file, and then press `F9: Save as pattern` . If you then create a new archive, the information file already has these contents.

Select runs

Press the function key F10: Select run in the screen *Data management*. The control unit outputs the screen *Copy to/Load from*. Mark the desired run (see below) and then press F10: Exec . A tick in front of the run indicates that it is selected.

The right half of the display shows how many files are present in the archive, how many files you have selected, and the size of the required memory. The required memory is important if you are storing on diskette.

Selecting a number of runs
Position the cursor to the desired run and press RETURN . Repeat this for all desired runs.

Selecting many runs
If you wish to select several runs which are displayed on the screen underneath one another, proceed as follows: Position the cursor to the first run and press F8: From ... to . Position the cursor to the last run, and press F8: From ... to .

Selecting all runs
Press F9: Select all .

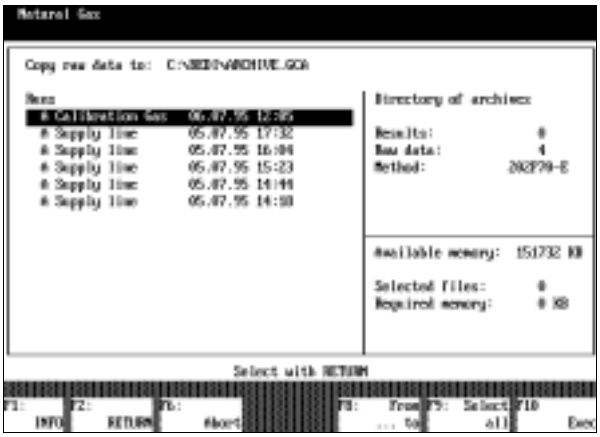
Cancelling selection of runs
Position the cursor to the desired run and press RETURN . The tick disappears. Repeat this for all desired runs.

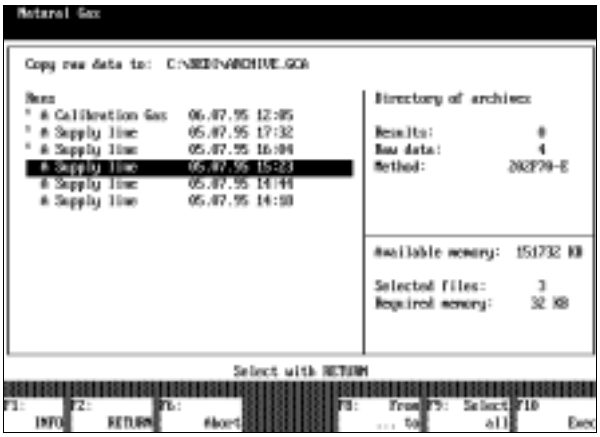
Execute storing

Once you have selected the desired runs, press F10: Exec .

> **IMPORTANT:**
> **If you are storing on a diskette and have selected too many files, the control unit signals *Diskette full* and aborts storing.**

If you load files from the archive, it is possible to previously delete all files which you have already loaded from the archive.





How can you delete e.g. all files rp0101?.x?? or rc0101?.x?? in \pgcarch\gc0101
Before storing, you should delete the *.x?? files. Selection of the runs for storing is then clearer.

Select *Load report/chromatogram* or *Load raw data*, but do not select any; then press F10: Exec . The question then appears: *Are the runs in the target directory to be deleted? A maximum of 100 files can be stored.*. The files are deleted after a short pause if you enter Y . You must subsequently reject the copying of a method.

> **NOTE:**
> The files rd0101?.x?? cannot be deleted in this manner. They are automatically assigned to the reports when storing, and you never need to occupy yourself with them.

Select method

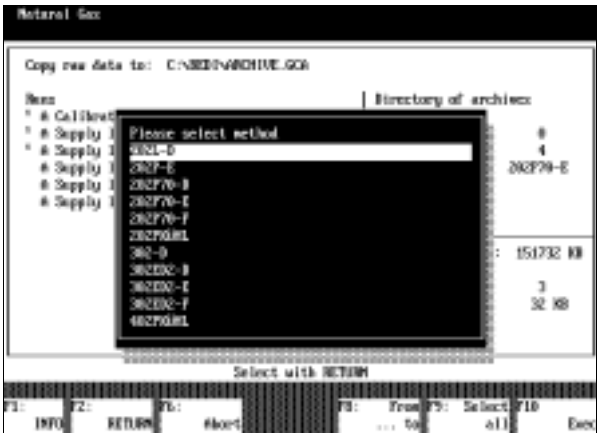
Great care is necessary when transferring analytical methods! Since only one method can be stored in an archive, it is necessary to know:

- Whether the method in the archive is the current method
- Whether all stored runs match the method.

If you load a method from the archive, you must know whether the method in the chromatograph has been modified in the meantime.

Storing of methods

Once the control unit has copied the selected run data, it asks whether it should also store a method. The method list appears if you reply with `Y` . Select the desired method using `CURSOR UP/DOWN` , and confirm using `RETURN` .



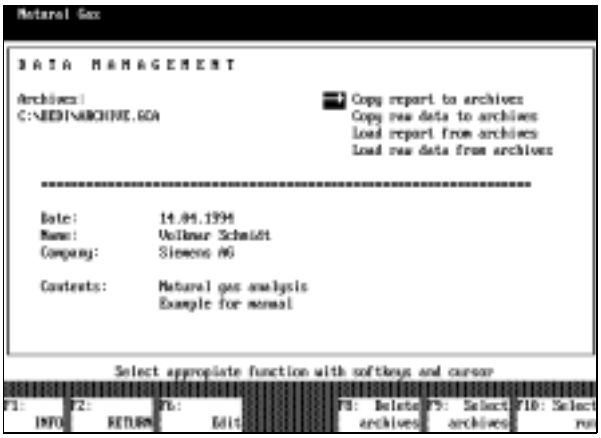
Load method from archive

Once the control unit has loaded the selected run data, it asks whether a method is also to be loaded from the archive. The method list appears if you reply with `Y` . Select the desired method using `CURSOR UP/DOWN` , and confirm using `RETURN` .

If you wish to create a new method, press `ESC` , type in the new name, and confirm using `RETURN` .

How can I update a method in the archive?

Select *Store reports*, but do not select any reports, then press `F10: Exec` . After a short pause, the question appears: *Is the method to be stored as well?*



Delete archive

Press the function key `F8: Delete archives` in the screen *Data management*. Answer the next question with `Y` . The selected archive is then deleted.

PGCSIM

The operating software for the chromatographs previously only functioned if a chromatograph was connected to the control unit. PGCSIM is a separate software package and simulates a chromatograph in the control unit. It is then possible, without a connected chromatograph, to:

- Evaluate and reintegrate runs which have been executed e.g. during the night
- Generate and optimize methods
- Demonstrate the operating software
- Practice operation.

Installing PGCSIM

Insert the PGCSIM diskette into the drive *a:* and type in:

```
a:  RETURN
install  RETURN
```

The installation generates the file *SIM.BAT*.

Optimizing the memory

In certain operation situations, the operating software requires almost the complete main memory of 640 kB. To ensure that the operating software is executed correctly, no TSR programs must be loaded in the main memory. Other TSR programs and a number of programs belonging to the operating software can be loaded into the upper memory.

If you wish to learn more on the memory in the control unit, refer to your MS-DOS manual or ask our servicing department. The following points are important in this context:

- The file CONFIG.SYS
- The device drivers HIMEM.SYS and EMM386.EXE and their parameter settings
- The commands DOS=HIGH,UMB and DEVICEHIGH for uploading programs
- The file AUTOEXEC.BAT
- The command LH for uploading programs

You should upload the following programs of the simulation software:

- LPRINT/CPRINT
- PGCSIM (this is the largest)
- SIMRES

Checking the memory assignments

The current memory assignments of your control unit are indicated by the DOS command *MEM*. Type in the following command following the DOS prompt:

```
mem /c |more
```

Please observe the vertical line (ASCII 124) in front of *more*!

The file SIM.BAT

The file SIM.BAT is regenerated when you install PGCSIM. If you have modified SIM.BAT in an old version, you must enter these modifications again in the new SIM.BAT. Use the MS-DOS editor to do this.

The commands in SIM.BAT

The file SIM.BAT appears as follows after installation:

```
PGCSIM  T2
INITCHRO  1 0
IF ERRORLEVEL 1 GOTO EXIT
SIMRES
CD C:\BEDI
REM LPRINT c500
CALL SWITCH
:EXIT
```

The meaning of the program names

PGCSIM	TSR program, simulates the chromatograph and communicates with the operating functions. Corresponds to ChromLAN. T2 = Process T3 = Laboratory T3 A = Laboratory with autosampler
INITCHRO	Normally checks how many chromatographs are connected to the control unit. It defines this during the simulation.
SIMRES	TSR program, coordinates e.g. printing processes
LPRINT	TSR program for printing of results, chromatogram and BASIC texts
LAN	Produces colored displays for network summary
SWITCH	Produces colored displays for operation

Starting the simulation

Select the directory *bedi*, and type in

```
sim  RETURN
```

The operating software is started as usual.

What is simulated, and what is not?

The simulation replies from a database. It simulates:

- All parameters present in the method, including the filling-in of the time events program, the filling-in of the temperature program etc.

It cannot

- Start runs
- Execute the temperature program
- Execute the time events program
- Execute the clock time program
- Generate actual values
- Generate measured signals
- Execute BASIC programs

Number of chromatographs

The INITCHRO command in SIM.BAT defines how many chromatographs are simulated. If you are working with more than one chromatograph, all chromatographs have the same parameter values because there is only one simulation database.

Alternate use of PGCSIM and BEDI

Both the operating and simulation functions work with TSR programs. It is therefore necessary to always reset the control unit when changing from operation to simulation or vice versa.

FUNCTIONAL DESCRIPTION OF THE ANALYTICAL SECTION

Page

Maintenance Schedule for Preventive Maintenance

What Makes Your PGC 302 Explosion Protected

Gas supply

Pressure Regulator . . . . . 1 - 1
Needle Valves . . . . . 1 - 5
Impedance Apertures . . . . . 1 - 7
2-Way-Membrane Valve. . . . . 1 - 8
Solenoid Valves . . . . . 1 - 10
- Control Valve . . . . . 1 - 10
- Switching Valve. . . . . 1 - 11
- Switching Valve for hazardeous Area. . . . . 1 - 11

Sample Loading

Liquid Injection Valve . . . . . 2 - II
6-Way-Ceramic Valve. . . . . 2 - XII
6-Way-Membrane Valve. . . . . 2 - 8
6-Way-Rotary Slide Valve . . . . . 2 - 13
Live Injection . . . . . 2 - 18
Deans Injection . . . . . 2 - 20

Separation Columns. . . . . 3 - 1

Detectors

FID. . . . . 4 - 1
FID with Methanizer . . . . . 4 - 6
TCD . . . . . 4 - 13
FPD. . . . . 4 - 21
ECD . . . . . 4 - 31

Oven . . . . . 5 - 1

Column Switching

Live Switching . . . . . 6 - 2
Switching Using Membrane Valves . . . . . 6 - 14

WARNING: **When operating electrical devices specific sections of these instruments are under dangerous voltage.**

Improper operation of these instruments can lead to death or extreme bodily harm as well as considerable property damage.

Please observe all Service Instructions on the PGC 302 and all remarks and notices listed in this chapter and on the PGC 302 itself.

- **Disconnect the PGC 302 only from the main power when disconnecting electrical cables from their terminals or when connecting them to the terminal.**
- **Always provide suffincient ventilation when operating with hydrogen. Hydrogen combined with air forms an explosive compound (oxyhydrogen gas)!**
- **Always provide sufficient ventilation when draining the sample gas line and the sample gas contains aggressive or poisenous components.**
- **Use only manufacturer authorized spare parts.**
- **Follow all specific instructions regarding repair and replacement of parts.**

Maintenance Schedule for Preventive Maintenance of the PGC 302

Specific maintenance intervals are required for the PGC 302. The following list specifies the maintenance required at specified time intervals. The operating instructions for each component contains detailed information regarding specific maintenance tasks.

Maintenance for the	day	week	month	for the following reasons
Verify **separation quality** (full chromatogram)		4		
Verify **carrier gas flow**				Error or maintenance
FID: verify basic current **TCD:** verify zero position of Verify bridge current **FPD:** verify basic and dark current Verify contamination of quartz disk/reflector			 6 6 6	Bottle change Bottle change Maintenance Maintenance Maintenance
Sample: verify flow rate and pressure	1			
Supply Gases: verify pressure	1			
Verify condensation level, exhaust gas				Installation, start of frost
Membrane valve: Verify membrane valve seal Clean membrane valve Replace switching membrane			 6 6 to 12 6 to 12	
Liquid injection valve: Lubricate O rings, verify/adjust verify spring tension Verify tightness Replace Teflon seal Clean vaporizer and sample passage Clean injection plunger			½ to 6	Depending on sample
With internal pump: Verify vacuum intake and feed performance			6 to 12	
Solenoid valves: Verify tightness and passage			6 to 12	
Pressure regulator: Verify leakage rate			6 to 12	
Temperatures: Verify desired and actual values			6	Error or maintenance
Ex-monitoring: Measure housing over pressure during pre-purging. Automatic safety monitor: clean particle filter in ex-pressure monitor (sieve at outlet)			3 to 6	

What Makes Your PGC 302 Explosion Protected

Before starting any maintenance work, please familiarize yourself with the explosion protection of your PGC 302, so that you will not void the explosion protection inadvertently during maintenance work.

WARNING: The test certificate for your PGC 302 is only valid for the original configuration. If the configuration or ignition class of one or several components is changed, the ex-protection for the instrument is no longer valid. After modification and maintenance of ex-specific parts, the PGC 302 Ex must be recertified by a specialist according to ElexV §9!

The PGC 302 Ex is available for zones 1 and 2, in the ignition classes T2 (280 °C) and T3 (180 °C). The only difference is their safety monitoring device.

PGC 302 Ex for Zone 2

- has a sealed housing,
- has a purged electronics section,
- contains the following components in ex-protected version and suitable ignition class:

Component	Ignition Class	Ex-protection through	Correct installation
FID	T2 and T3	pressure proof encapsuled combustion chamber	Exhaust gas nozzle installed with flame barrier and protected, gas connectors installed with impedance apertures and protected
		overpressure encapsuled connections	Protection tube for connection lines installed, exhaust nozzles open
Methanizer	T3	pressure proof encapsuling of the reaction zone, overpressure encapsuled connections	Gas connections installed with flame barrier, protection tube for connection lines installed, exhaust nozzles open
TCD	T3	pressure proof capsule, safety temperature limitor	Temperature limitor switched in series with bridge current
Solenoid valve for H_2 carrier gas		pressure proof encapsuled, connection terminals protected by safety fuse	Connected only to GND terminals which are protected by safety fuses (27 to 30, 57, 58)
Heating plates for - oven - liquid injection valve - heated line	T2 or T3	overpressure encapsuled heating cartridge and temperature sensor,	Safety temperature monitor installed in heating plate and switched in series with heater
		safety temperature limitor	Protection tube for connection lines installed, exhaust nozzles open

The PGC 302 Ex for Zone 1

- meets all requirements for Ex protection in zone 2 (see above,
- also has an internal, automatic purge gas monitor with power turn off. The power to the PGC 302 can be turned on o n l y via this device.

1 GAS SUPPLY

1.1 Pressure Regulator

The regulator accuracy of reduction valves on gas bottles is not sufficient for chromatographic purposes. The PGC 302 therefore contains internal proportional pressure regulators. They keep the gas pressures as constant as necessary for gas chromatography. They have the following characteristics:

- They are constructed entirely from metallic materials:
  → the gas supply system can not become contaminated by gassing softeners.
  → the desired values remain constant over a long period of time.
- The pressure regulators do not discharge into the atmosphere:
  → they can also be used to regulate poisenous gases.
- The pressure regulators are mostly temperature independent.
- Two versions are available:
  Low Pressure Regulators 0 ... 6 bar output pressure at max. 10 bar input pressure
  High Pressure Regulators 0 ... 12 bar ouptut pressure at max. 16 bar input pressure.

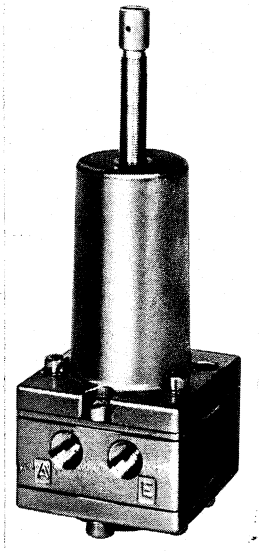


Fig. 1.1.1 Pressure regulator

Pressure Regulator Operating Principle

The regulator compares the force, which a measurement spring applies to a membrane, with the force, which the gas pressure to be regulated applies to this membrane. The resulting force is transferred to a nozzle-reflecting plate system and uses it to control the gas flow into the regulator space, so that the output pressure remains constant.

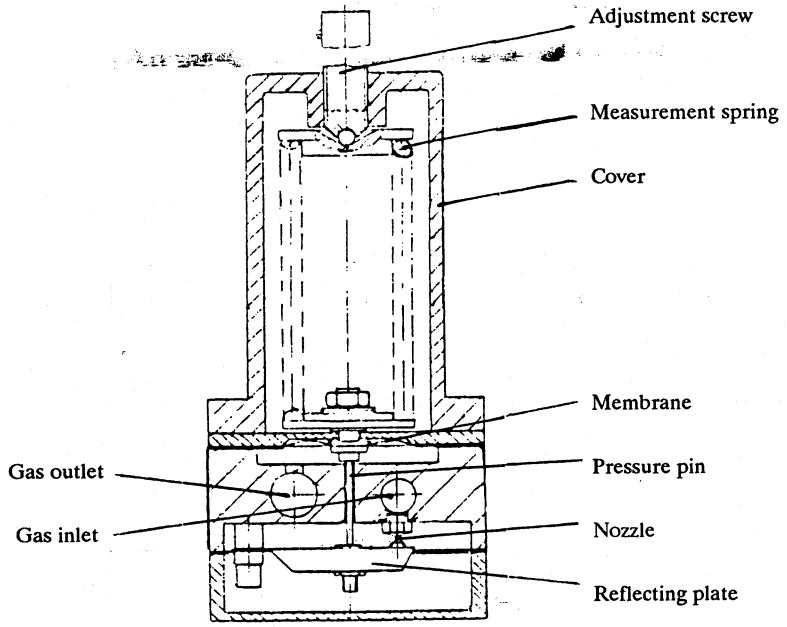


Fig. 1.1.2 Pressure regulator, sectional view

Pressure Regulator Operation

The gas, whose pressure should be regulated, flows from the regulator inlet through a dry powdered metal filter to a nozzle whose outlet opening can be closed by means of a reflecting plate. The gas pressure behind the nozzle activates a membrane. The position of the membrane is transferred to the reflection plate by a pressure pin. The opposing force to the membrane force is generated by a pressure pin which can be adjusted using the desired value adjustment screw. If the gas pressure on the membrane is lower than the desired value, the measurement pin pushes the membrane down and and thus on the reflecting plate using the pressure pin. The nozzle opening is opened. Gas flows through the nozzle into the regulator space and increases the pressure there. The pressure force lifts the membrane. The reflection plate closes the nozzle opening until the forces of gas pressure and measurement spring on the membrane are equal. The pressure regulated gas flows from the lower regulator space through the channel for the pressure pin to the membrane space and from there to the regulator outlet. Therefore the regulator has no unpurged spaces. Vibration is impeded.

Pressure Regulator Design (refer to Fig. 1.1.2)

Basic frame, cover, hood, adjustment screw and nozzle are made of brass, reflection plate spring, membrane and their limitors are made of stainless steel.

Basic frame, membrane and limitor are adjusted very accurately and secured with three screws, which may not be losened. The hood is attached to the basic frame with three additional screws; it can be removed, for example if the measurement spring of the low pressure regulator should be replaced with the one of the high pressure regulator or reverse. The only difference in the two pressure regulators is the measurement spring.

Reflection plate spring and pressure pin are adjusted very accurately to the basic frame and the nozzle. The membrane force is therefore transferred to the relection plate without friction and tilting force. A maladjusted reflection plate and pressure pin can cause a regulator deviation of several percent.

The connection threads in the pressure regulator body are suitable for G 1/8 (older version: R 1/8"), so that all commercially available 1/8" connectors with cylindrical ISO threads can be used for the gas inlet. Transition pieces must be sealed with an aluminum seal.

The basic body has two threaded holes M5. The regulator can be mounted only at this location.

Technical Data

Parameter	Low pressure regulator		High pressure regulator	Unit
Outlet pressure (p_A)	0 ... 6		0 ... 12	bar
Inlet pressure (p_E)	p_A + 1 ... 10		p_A+1 ... 16	bar
Ambient temperature	0 ... 80		0 ... 80	°C
Regulator error at 20 °C for (p_E/p_A) =	for N_2 (10/2)	for H_2 (10/0.5 ... 6)	for N_2 (16/6)	(bar/bar)
Load dependence	-60	-20 ... -50	-60	µbar/ml/min
Prepressure dependence p_A/p_E	+3	+2 ... +4	+6	mbar/bar
Leakage rate	3	5 ... 3	5	ml/min
Temperature influence	0.1	0.1	-0.25	%/10°C
Min. flow rate	2-6	2-6	2-6	ml/min
Max. flow rate	2	2	2	l/min

Load Dependence
The distance nozzle-reflection plate must vary for different gas flows; at a constant spring force this means, different position of the membrane and thus different gas pressures. The regulator deviation is considered to be the load dependence of the regulator.

Prepressure Dependence
If the inlet pressure on the regulator increases, the nozzle opening must be closed tighter, i.e. the membrane must be raised. The outlet pressure increases. This regulator deviation is considered to be the prepressure dependence.

Leakage Rate
If the pressure should be kept constant at very low flow rates, the distance nozzle-reflection plate must become zero. This means, that the reflection plate must be pressed against the nozzle by the measurement spring. This is only possible, if the membrane force (= regulator pressure) increases overproportionally. The flow rate, at which the outlet pressure increases by 1 %, is considered to be the leakage rate.

Operating Instructions

Desired Value Adjustment
Since the pressure regulator does not discharge into the atmosphere, the pressure should be increased slowly to the desired value. This prevents hysteresis errors, which could occur due to the rotation forces on the measurement spring. If the pressure is adjusted too high and only a small load flow exists, the pressure regulator outlet can be evacuated more rapidly by losening the connection on the corresponding manometer.

Gas Requirements
The pressure regulator may not be operated with aggressive gases. If damp gases (aerosols) are used, considerable regulator errors can occur. The regulator is suited for oxygen, because it is installed without oil or grease. For argon or CO_2 the regulator errors are specified somewhat higher.

Inlet Pressure
The pressure regulator operates properly only when the inlet pressure is at least 1 bar higher than the outlet pressure.

Pressure Regulator Troubleshooting

Observation	Cause	Correction
Load dependence is higher than standard value, i.e. if flow rate increases, pressure is reduced by more than 60 µbar per ml/min.	Gas path is leaky.	Seal the gas path properly.
	If observed only at flow rates below 10 ml/min, leakage rate is too high.	• Have regulator repaired. • Install load flow using T-piece and needle valve/impedence aperture.
	Friction in measurement spring, membrane and pressure pin so that pressure increases suddenly or slowly when the desired value is increased.	Have regulator repaired.
	Pressure reduction is high at a flow rate of > 0,5 l/min, because • inlet pressure is too low,	Increase inlet pressure to at least 1 bar above outlet pressure. If necessary generate additional load flow in order to be able to operated at higher inlet pressure.
	• inlet filter is clogged, • nozzle is clogged.	Remove filter and clean/replace. Have regulator repaired.
	Desired value is higher than permissible operating range.	Install high pressure regulator.
	Gas flow is blocked.	Clean clogged lines or screw connections.
Pressure is not stable.	If pressure is offset when pressure regulator is hit: friction on membrane and pressure pin	Have regulator repaired.
	Pressure offset after desired value adjustment.	20 mbar at pressures above 5 bar is considered normal.

Load flow should be used at all times when flow rates are <10 ml/min.

Note: Membrane and reflection plate of the pressure regulator must be adjusted very accurately for the regulator to operate properly. Adjustment tools are required to disassemble and repair the regulator. N e v e r disassemble the pressure regulator yourself. Return the regulator to the manufacturer for repair.

1.2 Needle Valve

Needle valves are used as adjustable flow resistors to adjust various gas flow rates. Needle valves are used primarily for the flow adjustment in separation column switching. The needle valve is available in two versions for different temperature ranges.

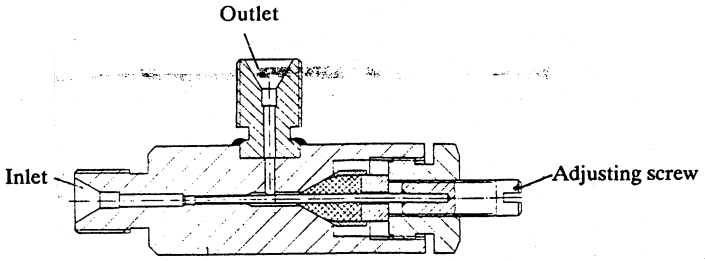


Fig. 1.2.1 Needle valve

Technical Data

	Version "T"	Version "G"
Material	Stainless steel Teflon seal	Stainless steel Graphite seal
Valve body drill hole	d_i = 0.9 mm	d_i = 0.9 mm
Needle	With cone 1°	With cone 1°
Max. operating temperature	80 °C	400 °C
Flow range	0,4 ... 500 ml/min	0,4 ... 500 ml/min
Connectors	Suited for pipes from 0.2 to 3.2 mm (1/8") outside diameter Standard size is 1.5 mm (1/16") outside diameter	

Note: **The needle valve is suitable for poisenous and corrosive gases, however, not for gas conditions near the dew point.**

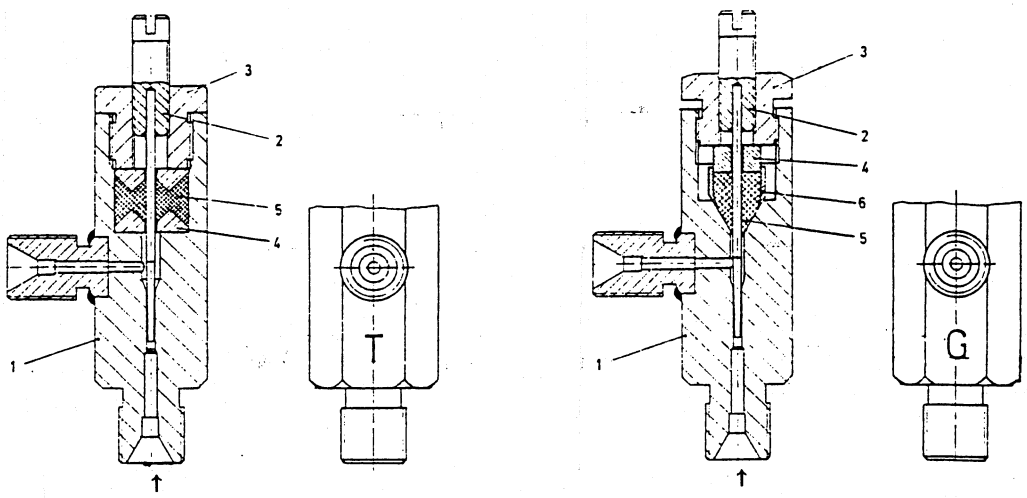
Operation

The flow rate though the needle valve is constant at constant pressures and fixed valve adjustment. The desire flow rate is adjusted using the adjustement screw. The further the neele is screwed in, the lower the flow rate.

Caution: **The valve may never be closed completely and may not be used as restrictor valve (*Minimum Flow Rate 0,4 ml/min*). If the needle is screwed in too tight, the valve body erodes and breaks when the needle is turned back. For this reason the flow must be verified when adjusting the needle valve, e.g. using a soap bubble flow meter.**

Needle Valve Troubleshooting

Observation	Cause	Correction
Flow rate decreases drastically at constant pressure.	Needle valve is contaminated, for example by solid or condensed particles in the sample or by graphite particles from the gasket.	Blow out needle valve. If no improvement, disassemble and clean needle valve.
	The stuffing box is not sealed properly.	Tighten pressure screw.
Flow rate increases irratically with depth of needle.	The needle is bent or jammed.	Replace needle valve.
Flow rate can not be adjusted.	Needle jammed in valve body and broke off when turned back.	Replace needle valve.



Version "T" (Teflon gasket)

1 Valve body
2 Adjusting screw with needle
3 Pressure screw
4 Pressure disk
5 Teflon gasket

Version "G" (graphite gasket)

1 Valve body
2 Adjusting screw with needle
3 Pressure screw
4 Pressure ring
5 Graphite gasket
6 Outer ring

Fig. 1.2.2 Needle valve

Disassemble and clean valve

- Unscrew the pressure screw and needle.
- Remove only the upper pressure disk on the valve with teflon gasket, the entire gasket on the valve with graphite gasket.
- Clean needle and valve body using a suitable solvent and dry the parts with compressed air.
- Replace the gasket as shown in the drawing for the valve with graphite gasket. For the valve with teflon gasket, replace the upper pressure disk. Manually screw the pressure screw back on.
- Insert the needle and screw in the needle approximatly five revolutions.
- Tighten the pressure screw.

1.3 Pressure Reducers

Pressure reducers define the flow rate of auxiliary gases for the detectors. If the pressure reducers are supplied with a constant pressure by means of pressure regulators, they supply a constant stream.

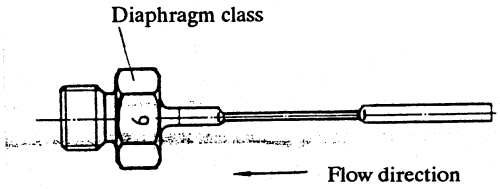


Fig. 1.3.1 Pressure reducer

Technical Data

Material	Stainless steel
Temperature dependence of flow	Approx. 1/273 per °C

The pressure reducers are available in 10 aperture classes. At an aperture pressure of 2 bar, the following flow rates are achieved at ambient temperature for nitrogen, hydrogen, air, helium and argon:

Aperture class	Flow rate at 2 bar in ml/min				
	N_2	H_2	Air	He	Argon
1	3.2	6.6	3.1	2.9	2.5
2	4.7	9.7	4.5	4.2	3.7
3	5.4	11.2	5.2 m	4.9	4.3
4	9.6	19.8	9.2	8.7	7.6
5	16.7	35.0	16.1	15.1	13.2
6	34.3	71.0	33	31	27.2
7	117	242	112	106	93
8	420	868	405	380	333
9	27.0	55.8	26.0	24.4	21.4
10	22.8	47.1	21.9	20.6	18.1

The aperture flow rate increases overproportionally with the aperture pressure. If yow wish to operate with pressures other than 2 bar, the flow rate through the pressure reducer must be defined using a soap bubble flow meter.

Pressure Reducer Troubleshooting

Observation	Cause	Correction
Flow rate reduces sharply at constant pressure.	Pressure reducer is clogged by minute particles.	Purge pressure reducer in reverse direction. If no improvement: replace pressure reducer.
Flow rate not stable at constant pressure.	Flow rate changes with pressure behind pressure reducer. The higher the inlet pressure, the more stable the flow rate.	Use a smaller pressure reducer for correspondingly higher pressure.

1.4 2-Way Membrane Valve

The 2-way membrane valve is used to pneumatically turn on or off gas streams that can contain sample or sample residue. They are used primarily for backflush in Live switching.

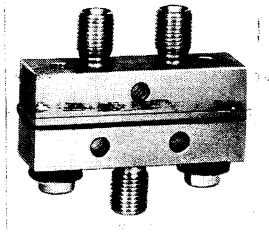


Fig. 1.4.1 2-Way membrane valve

Technical Data

Operating temp.	Max. 160 °C
Dead volume	45 µl
Control pressure	4 to 6 bar, min. 1.5 bar higher than pressure of the gas stream which should be switched
Connectors	Threads M7 x 0.75, suitable for pipes of 1.5 mm or 1/16" connectors

Operation

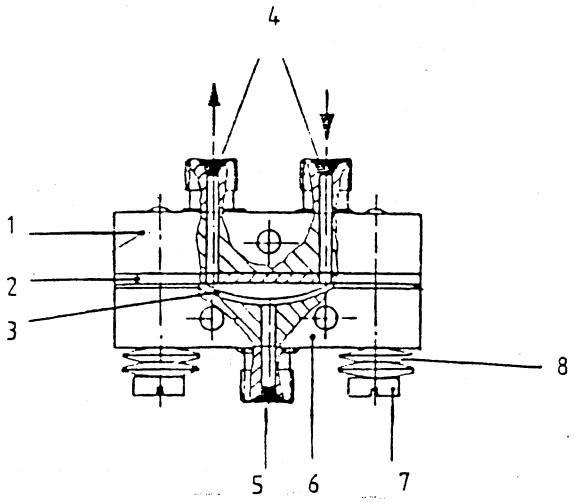
The valve is switched pneumatically. In idle condition (control pressure = 0) the two carrier gas connectors above the membrane space are connected. If control pressure is applied, a membrane closes the carrier gas connectors. This interrupts the gas flow, the valve is closed.

Valve Configuration

The valve consists of a valve plate, a membrane and a control plate. These parts are held together by two screws which are prestressed with plate springs. The inside of the valve plate containing the carrier gas connectors is teflon coated. The drill holes for the carrier gas connectors reach through the valve plate and the teflon layer. An indentation is cut into the control plate. The indentation is connected with the control air connector via a drill hole. The indentation covers the surface between the two drill holes of the valve plate. The membrane between valve plate and control plate seals the gas paths from each other and from the outside.

2-Way Membrane Valve Troubleshooting

Observation	Cause	Correction
Valve leaks or is clogged.	Valve is contaminated by dust or granular material from the separation column filling or deposits of high boiling or polymerized sample particles.	Clean valve and replace membrane.
Valve switches delayed.	The viton membrane has flowed into the drill holes of the valve plate due to excessive temperatures.	Replace membrane.



1 Valve plate
2 Teflon layer
3 Switching membrane
4 Carrier gas connection
5 Control air connection
6 Control plate
7 Tension screw
8 Plate springs

Fig. 1.4.2 2-way membrane valve

Maintenance

The valve must be removed before any maitenance and repair can be performed.

Clean valve and install new viton membrane

- Losen the tension screws and disassemble the valve.
- Clean the valve using a suitable solvent and blow dry the parts.
- Verify that the teflon surface on the valve plate is smooth. If scratches are detected, the membrane valve should be replaced.
- Insert the new viton membrane with the smooth side toward the teflon, replace the control plate and reassemble the valve. Make sure that four plate springs are placed against each other on each screw.
- Tighten the screws until the plate springs make slight contact. Tighten the screws exactly one additional revolution. The contact pressure is now adjusted properly. If some of the plate springs break when the screws are tightened, they m u s t be replaced.

Verify if the valve is sealed

The leakage rate of the 2-way membrane valve should be below 20 μl/min.

- Connect control air with 6 bar, carrier gas H_2 or He with 4.5 bar to one of the carrier gas connectors.
- Dip the valve in alcohol. If no visible bubbles appear on the entire valve after approximately one minute, the valve is sealed.

1.5 Solenoid Valves

Various valve types are used depending on the application:

- Control valves for sample stream, liquid injection valve and membrane/rotary slide valve (gas injection),
- Switching vavles for column switching technique and splitless injection.
  Switching valves are available in ex version for H_2 carrier gas in explosive areas.

All valves operate with 24 V direct voltage. One line is connected to a 24 V output of the SIMATIC digital output board, one line to a 24 V GND terminal on the terminal board. The ex-solenoid valves must be connected to the specific 24 V GND ex-connection terminals (Terminals 27 to 30, 57, 58). Each of these ex-connection terminals is protected using a safety fuse. This prevents a defective valve from pulling too much current and excess heating.

Control Solenoid Valve

Control solenoid valves are 4/2-way valves with slide and reset spring in single block configuration.

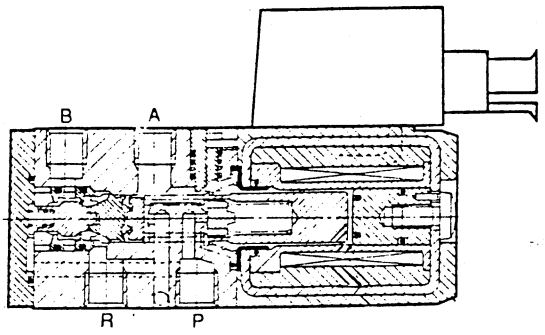


Fig. 1.5.1 Control solenoid valve

Operation:
If voltage is applied, control air inlet and outlet B are connected. If no voltage is connected, the control pressure is applied to outlet A.

Installation:
The control solenoid valves are installed on a connection plate on the installation terminal in the electronics section (refer to connection diagram). Up to four control valves can be connected on one connection plate with common pressure and discharge connector.

Technical Data

Material	Elastic mantle slide
Medium	Filtered compressed air 10 µm, unoiled
Operating pressure	1.5 to 7 bar
Operating temperature	5 to 60 °C
Connector	Pipe valve M5, connection plate G 1/8

Switching Valve

Single block configurations with ventilation as openers and closers are used as switching valves.

Installation:
The switching valves are installed on the installation terminal in the electronics sections (refer to connection diagram).

Ex-Solenoid Switching Valve

If hydrogen should be switched, an explosion protected solenoid valve must be utilized in explosive areas. The connection cable for this solenoid valve is pressed into the housing.

An ex-solenoid valve is also used as purge gas valve for the ventilation of the electronics section. The purge solution valve is connected directly to the control device of the safety monitoring device.

Installation:
The ex-solenoid valve is installed in the installation space above the oven. The purge solvent valve is installed at the purge solvent inlet on the floor of the shaft behind the oven chamber.

The solenoid valves in ex-configuration must be connected to the specific 24 V ex-GND connection terminals (terminals 27 to 30, 57, 58 on the terminal board). Each of these ex-connection terminals is protected using a safety fuse. This prevents a defective valve from pulling too much current and excess heating.

Solenoid Valve Troubleshooting

Observation	Cause	Correction
Flow rate decreases sharply at constant prepressure.	The switching valve is contaminated, e.g. by condensed sample.	Disassemble and clean solenoid valve (O rings and gaskets are made of viton). Use only hexane for ECD.
	Internal gaskets are swollen.	Replace solenoid valve.
Solenoid valve can no longer be switched.	Solenoid valve is not connected.	Connect solenoid valve to terminal strip.
	Coil is defective.	Replace solenoid valve.
	Anchor hangs because gaskets are swollen.	Replace solenoid valve.

Liquid injection valve

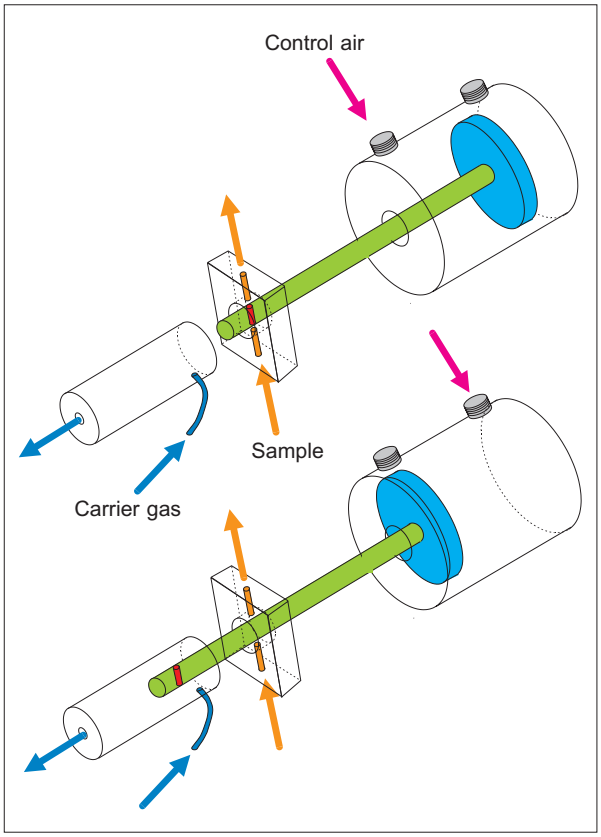
The liquid injection valve can be used to automatically inject a constant quantity of liquid sample followed by fast, complete vaporization. Small gas quantities can also be injected using the valve.



The liquid injection valve consists of three components:

- Temperature-controlled vaporization system
- Sample flow unit with seal
- Pneumatic drive

In the purging position, the sample flows permanently through the cross hole or the ring groove of the injection tappet. When injecting, the tappet is pushed pneumatically into the vaporization area. The liquid in the cross hole or ring groove is vaporized and is flushed by the carrier gas into the column. The tappet is then shifted pneumatically back into its original position. Sample then passes through the injection hole again.



Technical data

Max. vaporization temperature	60 ... 400 °C; with explosion-proof analyzers according to the temperature class
Injection volume	0.3 to 9.5 µl
Ambient temperature	-20 … +150 °C
Material of parts in contact with the sample	V4A, mat. No. 1.4571 Hastelloy, Monel or special
Control pressure	4 to 6 bar
Sample pressure	Max. 50 bar, recommended 5 ... 10 bar
Connections	For pipe with 3 mm outer diameter

Vaporization system
The vaporization tube is inserted with an aluminium sleeve into the heating plate whose temperature is regulated by a heating cartridge and a Pt100 temperature sensor.

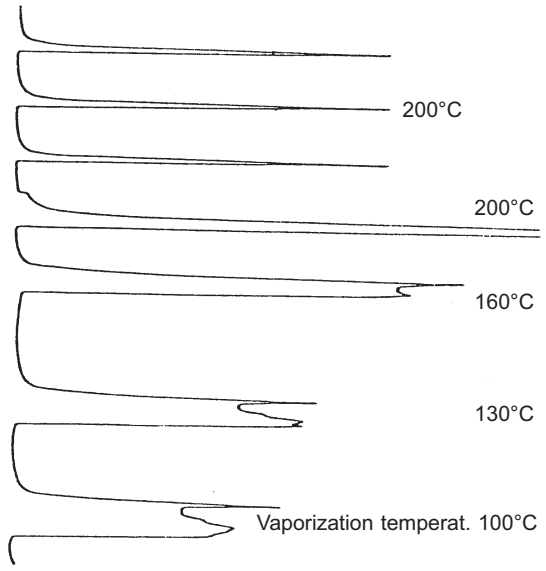
The carrier gas is routed via the pipe into the vaporizer and heated up to the vaporization temperature in the process. The vaporizer is adjusted such that the carrier gas inlet is opposite the injection hole.

Sample flow unit
The sample flow unit is isolated from the vaporizer and the pneumatic drive by lenticular Teflon gaskets. An adjustable adapter and cup springs position the Teflon gaskets with a constant pressure and compensate temperature expansion effects and gasket wear.

Classified version
In the classified version, the heating cartridges and temperature sensor are pressurized. Their lines lead directly into the venting trunking behind the analyzer area and are purged together with the electronics area. The sensor of a safety temperature limiter is additionally inserted into the heating plate and switches the heater off if the plate reaches the ignition class temperature.

Operation

Selection of vaporization temperature
The vaporization temperature can be set independent of the oven temperature. It is selected according to the sample and its boiling point. The most favourable vaporization temperature must be determined experimentally. The amount by which the vaporization temperature should be above the boiling point of the sample depends on the heat of vaporization of the sample. Samples with a high heat of vaporization, e.g. aqueous samples, only vaporize sufficiently fast for chromatographic purposes at high temperatures (above 200 °C), as shown in the Fig. below.



Temperature dependence
of vaporization speed of water

Manual injection
It is possible to inject samples manually into the vaporizer using an injection syringe. The liquid injection valve must first be adapted: remove the valve body together with the valve mechanics and the Teflon gasket in the vaporizer. Instead, insert a septum (diameter 9 mm, thickness 4 mm) into the gasket area of the vaporizer, and screw an injection syringe head with pressure washer onto the vaporizer.

DANGER: Explosion protection

What you have to observe with the classified PGC 302 so that the explosion protection is not cancelled:

The sensor of the safety temperature limiter must be inserted into the heating plate and protected from removal using a screw.

The protective tube for the heating cartridge and temperature sensor must be fitted correctly (see maintenance).

The exhaust holes in the protective tube must not be closed.

CAUTION: Filter required

The tappet and gaskets close faster if the sample contains solid particles! In this case, a filter is required upstream of the injector. We recommend a filter with a separating capacity of
- 98% for 0.3-µm particles with liquid samples
- 99.99% for 0.1-µm particles with gaseous samples

Siemens sample preparation units contain such filters!

Diagnosis and maintenance

The following factors have an influence on the maintenance frequency:

- Sample properties (with/without sliding properties, corrosive, dusty).
- Vaporization temperature
- Ambient temperature
- Sample pressure

A service life of one year is possible depending on the sample properties and the duration of the analysis.

> **IMPORTANT**
>
> To achieve a long service life, the actual state must be assessed as exactly as possible during the first maintenance operation!
>
> We recommend preventative maintenance every six weeks!

Sample residues

If, during permanent operation, products are injected which contain non-volatile or easily polymerized components (salts, proteins, monomers etc.), these components may be deposited in the vaporizer, in the injection hole and on the injection tappet. It is necessary to occasionally clean the vaporizer and the injection tappet depending on the concentration of these components in the sample and on the frequency with which such samples are injected.

If the surface of the injection tappet is attacked and roughened by the sample, it must be replaced by a tappet made of a different material (e.g. Hastelloy, Monel, tantalum, sapphire, ZrO_2).

The service life is greatly reduced if:

- The sample is corrosive
- The sample contains particles
- Salts are dissolved in the sample or if the sample contains materials which are not vaporized.

The service life is reduced normally:

- At a high vaporization temperature (gasket becomes malleable)
- With gaskets with a 25% glass filling
- At a high sample pressure (>20 bar)
- With non-volatile samples of high boiling point

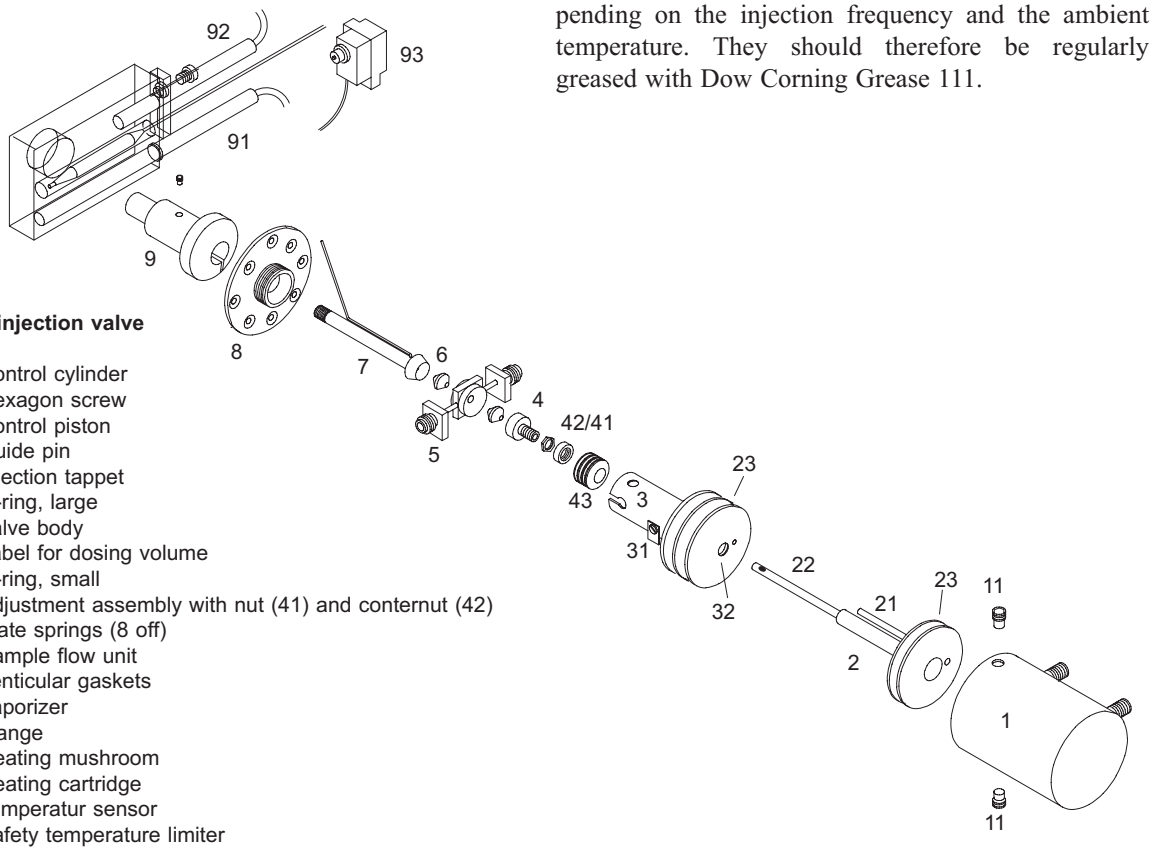
Lenticular gaskets

The sample flow unit can become blocked or is subject to wear by particles in the sample.

- The glass fibers of the filling project out of the processed surface, resulting in a low wear effect on the tappet. Pure Teflon and Rulon do not have this problem, but are not suitable for all applications.
- If gaskets are used outside their temperature class, they are either too hard or too soft. This results in a reduced service life because the malleability is too low or too high.

Pneumatic drive

The silicone O-rings of the pneumatic drive close depending on the injection frequency and the ambient temperature. They should therefore be regularly greased with Dow Corning Grease 111.



Liquid injection valve

1	Control cylinder
11	Hexagon screw
2	Control piston
21	Guide pin
22	Injection tappet
23	O-ring, large
3	Valve body
31	Label for dosing volume
32	O-ring, small
4	Adjustment assembly with nut (41) and conternut (42)
43	Plate springs (8 off)
5	Sample flow unit
6	Lenticular gaskets
7	Vaporizer
8	Flange
9	Heating mushroom
91	Heating cartridge
92	Temperatur sensor
93	Safety temperature limiter

DIAGNOSIS

Observation	Cause	Remedy
All peaks in the chromatogram are becoming smaller.	Sample flow unit is blocked. Injection hole contaminated.	Clean injection hole, vaporizer and sample flow unit. Replace gaskets if necessary.
Peaks are becoming wide and shifted to longer times. Baseline becomes neg. in pre-purging position of A column.	Vaporizer is contaminated.	
Baseline becomes pos. in pre-purging position of A column.	Leaky valve in vaporizer section.	
Interruption in chromatogram: injection occasionally missing.	Leaky pneumatic drive, grease used up, O-rings damaged, control pressure too low.	Clean pneumatic drive, replace O-rings, grease sliding surfaces and O-rings.
Peaks too small and too wide, especially those of higher boiling point.	Heating plate is faulty. Vaporization temperature too low.	Replace heating plate. Set higher equalization temperature.
Injection quantity slowly rises until a double peak results (with calibration medium). Poor peak form, platform following peak. Increase in baseline. Visible discharge of sample.	Worn gaskets and/or tappet.	Replace gaskets or tappet.
The injection tappet is matt and rough in the vicinity 3 mm around the injection volume, and often also dark. Material wear is visible using a magnifying glass. The effect is significantly less in the adjacent areas.	Corrosive sample	Possibly replace injection tappet by version made of sapphire, ZrO_2, Hastelloy or Monel.
Starting from the location of the injection volume, furrows are present in both directions, and end at the position where the tappet no longer comes into contact with the gaskets (when viewed using magnifying glass). The furrows may be very fine and distributed uniformly around the circumference or very marked and starting at the injection volume. Particles in the sample not only damage the tappet surface, they are also deposited in the hole of the soft Teflon gasket. This can be recognized by the dark gray deposit in the gasket.	Sample is contaminated by particles (most frequent case). The groove tappet is more susceptible since the sample is in contact with the gasket over a larger area.	Check filter and replace if necessary.
The space between the tappet and the inside wall of the vaporizer is filled by deposits. This can block the supply of carrier gas. In the final phase, deposits may result on the part of the tappet which protects into the vaporization area. This directly results in large sealing problems between the sample and the carrier gas. In seldom cases, these deposits may also be produced on the drive side of the injection tappet. If brown deposits are present on the vaporizer gasket at the outlet to the vaporization area, this is an indication of non-volatile components.	The sample contains dissolved salts and other non-volatile materials.	The deposits in the vaporizer must be removed mechanically (drill/reamer with 3.3 mm diameter).

Assessment of filters



IMPORTANT: Checking the filter

If the above-mentioned effects occur, it is essential to check the filter situation!

The filters must be regularly service according to the degree of contamination.

If necessary, the flow must be reduce using the filter and injection valve. Bypass operation is recommended!

Filters are required for liquid samples with a separating capacity of 98% for 0.3- µm particles.

Siemens sample conditioning units contain such filters.



CAUTION

The deposits on the tappet must be removed extremely carefully. The tappet must not be damaged. It is better to fit a new tappet.

With this type of filter, the particles are not removed by a filtering effect but are deposited on the inside of the filter assembly. The filtering effect is based on the fact that the settling forces of the particles are far greater than the pulling forces of the sample. The result is a high filtering effect and low flow resistances.

Such a filter is not blocked, but is punctured when its surface is completely full. This can be recognized in that the coloring of the filter reaches the outlet side in the flow direction.

MAINTENANCE

> **CAUTION: Hot**
>
> Before carrying out the following steps, switch off the heaters and allow the oven and liquid injection valve to cool down!

Removing the liquid injection valve

- Switch off sample flow in conditioning cabinet
- Allow sample line to empty, and purge line
- Move injection tappet to filling position (against external wall of cylinder)
- Switch off chromatograph
- Shut off carrier gas and control air
- Unscrew sample line and control line on liquid injection valve
- Only if you wish to completely remove the liquid injection valve: dismount the carrier gas inlet line and the vaporizer outlet in the oven, and then completely remove the valve.

Dismounting the liquid injection valve

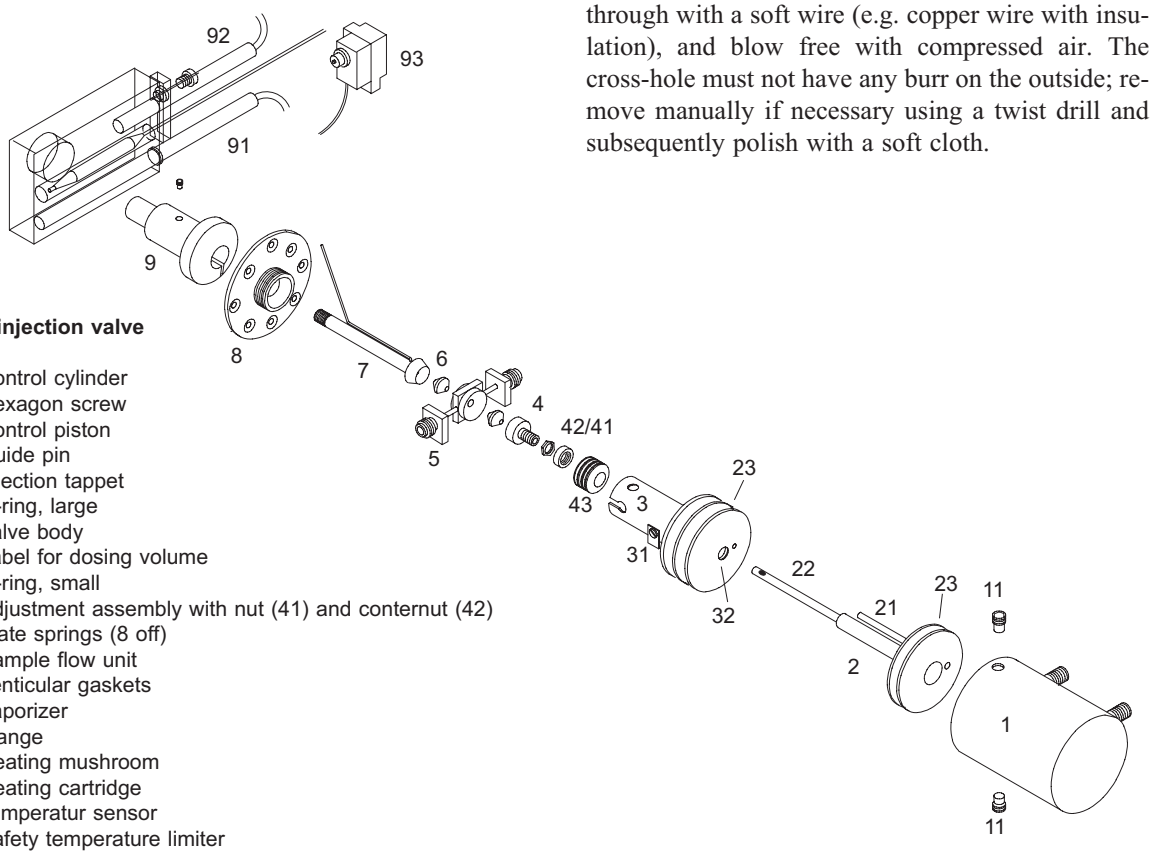
- Unscrew the valve body (3) from the flange (8) with vaporizer (7), and separate
- Unscrew the two hexagon screws (11) on the control cylinder (1), loosen the control cylinder and remove
- Lift off the vaporizer (7), sample flow unit (5) and adjustment assembly (4) from the injection tappet
- Remove the sample flow unit and the lenticular gasket (if the latter has not remained stuck in the vaporizer), allow the plate springs to drop out
- Pull the control piston with tappet (22) out of the valve body (3). Do not insert any aids such as a screwdriver into the gap between the piston and the valve body. This would damage the valve body and control piston.

Cleaning vaporizer, injection tappet, injection hole and sample flow unit

- Clean the interior of the vaporizer using an appropriate solvent. Remove insoluble components using a 3.3-mm diameter drill.

> **IMPORTANT: Internal diameter**
>
> The internal diameter of the vaporizer hole must now be 3.3 mm. Older versions have a diameter of 3.5 mm. Check using a drill/reamer!

- Clean the sample flow unit with the same solvent. Remove stubborn residues using a drill.
- Clean the surface of the injection tappet using solvent. If this is not possible, clean the tappet using a soft cloth and a little polishing paste. Make sure that the tappet is not tapered at any point.
- If the cross-hole in the dosing tappet is blocked, push through with a soft wire (e.g. copper wire with insulation), and blow free with compressed air. The cross-hole must not have any burr on the outside; remove manually if necessary using a twist drill and subsequently polish with a soft cloth.



Liquid injection valve

1	Control cylinder
11	Hexagon screw
2	Control piston
21	Guide pin
22	Injection tappet
23	O-ring, large
3	Valve body
31	Label for dosing volume
32	O-ring, small
4	Adjustment assembly with nut (41) and conternut (42)
43	Plate springs (8 off)
5	Sample flow unit
6	Lenticular gaskets
7	Vaporizer
8	Flange
9	Heating mushroom
91	Heating cartridge
92	Temperatur sensor
93	Safety temperature limiter

IMPORTANT: Do not grind!

Never treat the tappet with emery paper or a dry polishing cloth. The surface must be free of furrows to ensure that the injection volume is correctly sealed and that the piston can move smoothly.

Replacing the Teflon gasket

Replace the Teflon gaskets if collars are present as a result of deformation or wear.

- Remove the lenticular gasket (6) from the adjustment assembly and vaporizer. To do this, gently insert the tappet approx. 5 mm into the gasket and then tip to the side until the gasket is loose and can be pulled out with the tappet.
  Caution: do not damage the tappet in the process!
- Insert new lenticular gaskets into the adjustment assembly and vaporizer, and install with sample flow unit.

IMPORTANT:

Select a gasket according to the application and temperature class.

There should be no play between the new gasket and the injection tappet. It should be extremely difficult to move the gasket.

Teflon is always recommended because the gasket in the adjustment assembly is always operated below 200°C.

Rulon is better than Teflon with 25% glass filling in some cases because it does not generate as much abrasion.

Replacement of O-rings

- Remove the two large O-rings and the small O-ring out of the valve body using a small screwdriver or a needle.
- Insert new O-rings

IMPORTANT:

Only use silicone O-rings, temperature class -40 °C to +200 °C.

- Well grease the new O-rings and the sliding surfaces of the control cylinder and the piston guide. We recommend *DOW CORNING 111* with a temperature range from -40 to +260 °C or *Dow Corning 44 grease* with a temperature range from -40 to +200 °C.

Replacing the injection tappet

The injection tappet should be replaced when its surface is scratched.

Assembly of valve

IMPORTANT: Valve body

The thread for the screw and flange plate must be freely movable. Grease if necessary.

The piston guide hole must have a diameter of 5.7 mm and be smooth. Treat the hole using a drill/reamer if there are traces of wear on the piston shaft. First remove the internal O-ring and subsequently reinsert.

The adjustment assembly must slide smoothly down to the end.

The side with the O-ring seat must slide smoothly into the cylinder (without O-ring).

IMPORTANT: Grease!

Before assembling the liquid injection valve, you must apply a thin film of fresh grease to the following:
- Internal cylinder wall
- Piston shaft
- Guide hole of small O-ring
- Outside of O-rings following reassembly of valve body and piston

For appropriate types of grease, refer to *Replacement of O-rings*.

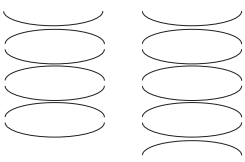
- Insert the piston with tappet into the valve body such that the tappet does not become greasy.
- Drop 8 plate springs next to one another over the tappet into the valve body such that the two outer springs support one another.

IMPORTANT: Plate springs

7 or 8 springs are permissible.

With 7 springs: support on valve body inside, on adjustment assembly outside.

With 8 springs: support on valve body and on adjustment assembly outside. This is standard with the glass vaporizer.



IMPORTANT

Check that the sample flow unit can be easily inserted into the vaporizer and the adjustment assembly and moved so that the two lenticular gaskets are subsequently subject to equal pressures when the plate springs are tensioned.

- Slide the adjustment assembly (4) with nut (41), Teflon gasket and sample flow unit onto the tappet.

IMPORTANT: Mounting position

The internal hole of the sample flow unit is tapered on the vaporizer side. Make sure that it is inserted correctly!

- Move tappet into filling position.
- Only if you have completely dismounted the liquid injection valve: fit the flange (8) over the vaporizer, and screw the valve body (3) and the flange together.
- Screw on the flange plate with vaporizer as far as possible.

Adjustment assembly

Adjust such that the spring travel is approx. 2 mm. Fix hand-tight.

Standard setting with 7 plate springs:
nut 0.5 mm above end of screw.

Standard setting with 8 plate springs:
nut 0.5 mm below end of screw. Correct if necessary when mounting.

The spring travel is not basically critical, but should be greater with a high sample pressure (20 - 30 bar) and smaller with a small sub pressure (0 - 2 bar).

- Check the spring travel, and correct using the adjustment assembly if necessary. It is correctly set if the flange can be rotated a further 2.5 rotations starting with the first pressing of the plate springs until the flange rests on the valve body. The plate springs can be viewed through a hole when pressing together. If the flange is tightened firmly, there should be a gap of 0.3 to 0.5 mm between the plate springs.
- If the pretension of the plate springs is too large or too small, loosen the flange from the valve body again, and screw the intermediate unit in or out of the nut. Then repeat the preceding step.
- Rotate the vaporizer (except the glass vaporizer) using a 6-mm fork spanner until the carrier gas inlet is parallel to the sample flow unit. The carrier gas should blow through the hole in the tappet when injecting!
- Position the control cylinder, and tighten using the two hexagon screws on the side. The screws must firmly grip the thread of the cylinder wall. If you encounter problems, rotate the screw to the outside using an Allan or Torx key.
- Connect the control lines.
- Activate pneumatically. Check the switching and movement noises.
- Connect the sample lines.

IMPORTANT: Strain relief

Hold the sample lines when connecting!

The sample lines must not be subject to strain.

Replacement of dosing tappet ONLY

We recommend that you completely remove and service the liquid injection valve when you replace the dosing tappet. If you nevertheless only wish to replace the tappet, proceed as follows:

- Execute steps as described for removal of liquid injection valve.
- Move valve to filling position. To do this, set the front connection of the control cylinder under pressure.
- Loosen the two clamping screws with which the control cylinder (1) is secured on the valve body. Lift off the control cylinder.
- Pull out the control piston (2) with the injection tappet (22) to the rear by hand. Do not insert any aids such as a screwdriver into the gap between the piston and the valve body. This would damage the valve body and control piston.
- Detension the plate springs if the dosing tappet can only be removed with difficulty and also if the tappet is to be probably removed for longer than half an hour. This prevents the Teflon gaskets from being deformed. To do this, loosen the valve body from the pressure screw with flange by two revolutions.
- Completely replace the piston with injection tappet and guide pin.

NOTE:
We recommend that you always have a piston with fitted tappet and guide pin as a spare part in stock.

Replacing heating cartridge, temperature sensor, temperature limiter

The heating cartridge, Pt100 temperature sensor and the sensor of the safety temperature limiter (with certified PFDV) are inserted into the heating plate. The parts can be replaced if faulty. The heating plate must first be dismounted. If the faulty heating cartridge is stuck in the heating plate, the latter must be replaced.

Removal of heating plate

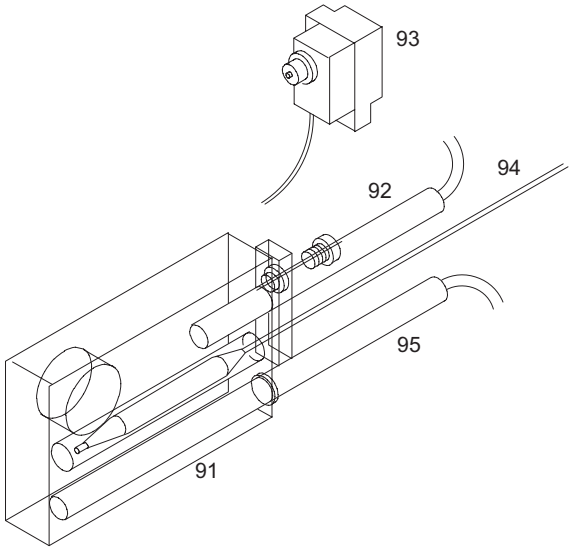
- Remove the liquid injection valve as described above.
- Remove the cover plate on which the valve was mounted.
- Remove the insulation. The heating plate is then visible.
- Unscrew the heating plate.
- Disconnect the heater and temperature sensor from the terminals in the shaft.
- For the certified version: loosen the Pg screwed gland of the protective tube, and unscrew the tube.
- Loosen the securing screws for the heating cartridge and temperature sensor, and pull out the assemblies from the heating plate.
- Replace the faulty parts, and tighten the securing screws again.

Fitting of heating plate

- Cover the top oven wall well with insulating material.
- Position the heating plate with ceramic insulators, and screw tight.
- For the certified version: route the lines for the heating cartridge and temperature sensor through the protective tube to the terminals in the shaft. Screw the protective tube onto the heating plate.
- Cover the heating plate well with insulating material and screw on the cover above it.
- Connect the heater and Pt100 temperature sensor to the terminals in the shaft. Refer to the circuit diagram for the terminal assignments.

IMPORTANT: Explosion protection

With the certified version, you must have the correct assembly the of the heating plate approved by an expert (Elex V 9) before you can use the chromatograph again.



Heater plate of certified FDV

91	Heater cartridge
92	Pt 100 temperature sensor
93	Safety temperature limiter
94	Capillary tube temperature sensor of limiter
95	Protective tube

The PFDV versions

The PFDV has already been manufactured for many years, and has been permanently improved and developed further within this time. Therefore different versions of the individual PFDV components may be encountered in different chromatographs.

Control cylinder	
Standard	Connection M7x0.75
Long penetration injection	Connection M7x0.75

Injection tappet with piston	*		*		
Transverse hole, 1.4571 for standard injection, with guide pin	0.6	1.2	2.4	5.3	9.4µl
Ring groove, 1.4571, for long penetration injection without guide	0.6	1.2	2.4µl		
Notch groove, 1.4571, for long penetration injection without guide	0.3µl				
All available in Hastelloy C, Monel * = also available in sapphire, zirconium dioxide					

Sample flow units	
M7x0.75 *	P300, P101
1/8" *	PGC 302, RGC 202, PGC 102
Nipple *	P200
* = also available in special material: Hastelloy C, Monel.	

Lenticular gaskets	Suitable for vaporization temperature
Pure Teflon	60 to 180°C
Teflon with 15% glass filling	60 to 200°C
Teflon with 25% glass filling	200 to 450°C
Rulon	200 to 400°C

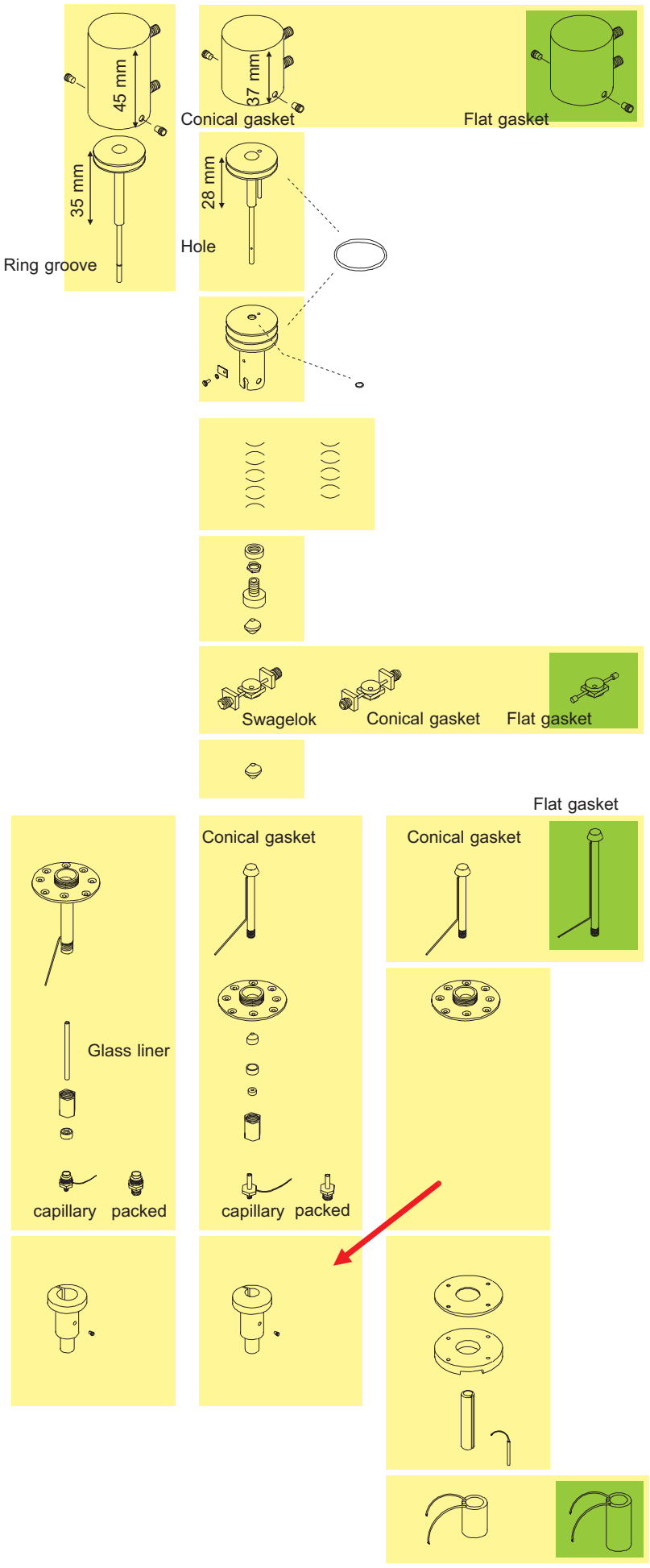
Vaporizer	
Long vaporizer M7x0.5 with sleeve 1.4571 *	P200
Short vaporizer M7x0.75 with sleeve 1.4571 *	P300, P101, RGC 202, PGC 102
Short vaporizer M7x0.75 without sleeve 1.4571 *	PGC 302
Glass vaporizer capillary with split	PGC 302
Glass vaporizer packed M7x0.75	PGC 302
* = also available in special material: Hastelloy C, Monel. Internal diameter of vaporizer hole 3.3 mm	

Heater	
Ceramic 230V, 97VA	P200
Ceramic 230V, 50VA	P101, PGC 102, RGC 202
Ceramic 115V, 50VA	P101, PGC 102, RGC 202
Ceramic 24V, 35VA	P300

Sleeve for all heaters	
diam. a 10 mm x diam. i 7 mm	P200, P300, RGC 202, PGC 102

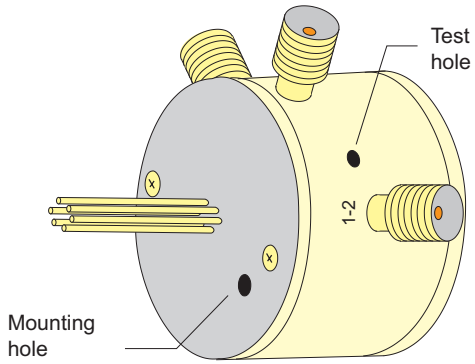
Heating mushroom or heating plate	
Standard diam. i 7 mm	PGC 302
Glass vaporizer diam. i 10 mm	PGC 302

These parts are the same for all versions
Valve body Adjustment assembly with counternut Flange plate with screw Plate springs O-rings, large and small Grease Labelling part Hexagon screw


45 mm
35 mm
Ring groove
37 mm
Conical gasket
Flat gasket
28 mm
Hole
Swagelok
Conical gasket
Flat gasket
Flat gasket
Conical gasket
Conical gasket
Glass liner
capillary
packed
capillary
packed

6-way ceramic valve

The 6-way ceramic valve can be used to inject gaseous samples onto the column.



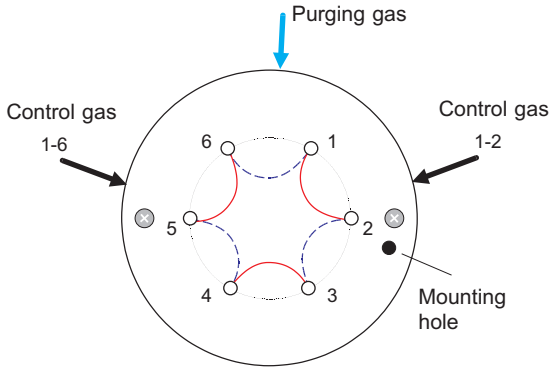
The 6 paths of the valve are pneumatically switched such that 3 paths are simultaneous open in the valve. If gas is to be injected, an injection volume assembly is present at one valve path. This is switched into the sample gas path and is filled with sample. The injection volume assembly is subsequently connected to the carrier gas path. The carrier gas flushes the contents of the injection volume assembly onto the column.

Technical data

Injection volume	80 µl … 4 ml
Control gas - Piping - Control gas pressure - Type of control - Pulse length for switchover	 2 x 0.3 mm 3 ... 6 bar Pulse 0.005 min
Max. carrier gas and sample pressure	4 bar
Max. temperature	180 °C
Number of cycles without maintenance	Typically 500 000
Connection pipes - Length - Outer diameter - Volume	 200 mm 1.0 mm 40 µl
Dead volume	2 µl
Purging gas	10 ... 20 ml/min
Leak rate: pressure drop with 4 bar H_2	< 50 mbar/sec

Linking of connections

Pressure at connection 1-2	**Pressure at connection 1-6**
1 connected to 2 3 connected to 4 5 connected to 6	6 connected to 1 2 connected to 3 4 connected to 5



Installation

The ceramic valve has one mounting hole. It is fitted in the oven using a long screw M4x50.

Operation

Changing the injection volume

- Switch off the sample stream and the injection valve. Purge the line.
- Switch off the chromatograph.
- Switch off the carrier gas and control air.
- Loose the pipe unions with which the injection volume assembly is secured.
- Remove the old injection volume assembly. The gaskets can be used several times. Only use graphite gaskets.
- Fit a new, clean injection volume assembly. Tighten the pipe unions.

Control medium

You can use clean compressed air, synthetic air or carrier gas as the control medium.

For trace analysis, we recommend that you purge the ceramic valve with carrier gas. The valve has a purging gas connection for this purpose.



IMPORTANT

The carrier gas and sample pressures must not be above 4 bar!

Injection time

The injection time span depends on the carrier gas pressure and flow. The injection volume should be purged at least twice.

$$t = \frac{2xV}{Q}$$

t = injection time span in s
V = injection volume in ml
Q = flow of carrier gas in ml/s

The minimum injection time is 0.1 min, also for capillary columns with split.

Maintenance and diagnosis

The serum valve is maintenance-free. It should be replaced after 500000 switching operations.

It is possible to check whether the valve drive is operating correctly: test holes are present next to the connections 1-2 and 1-6. A drill with a diameter of 2.5 mm must fit approx. 3 cm into the test hole if control gas pressure is present at the associated connection. It must fit approx. 2 cm into the other hole. The valve is faulty if the drill only fits 2 cm into both holes.

3 Separation Columns

This is just a brief overview of separation columns. More detailed information is available in the appropriate technical literature.

Separation columns are used to withhold the individual components from the carrier gas stream for various lengths of time and thus separate them. For this purpose the physical reciprocal actions between separation column and sample components are utilized, especially the following two characteristics:

- The components adsorb on materials with very large surfaces (pores the size of several molecular diameters) = adsorption chromatography
- The components distribute themselves dynamically between carrier gas (mobile phase) and a suitable liquid as stationary separation liquid = distribution chromatography

Adsorption Chromatography

Adsorption columns are used mainly for the separation of gases and low boiling liquids. Substances with larger molecules are mostly adsorbed and released only at very high temperatures.

Often used adsorbents are: active charcoal, molecular sieve, carbon molecular sieve, silica gel/spherosil, aluminum oxide.

The adsorbents are filled into the separation column, grain size 0.4 mm. Interfering contaminants are then removed to achieve the desired separation characteristics (conditioning). For this purpose the separation column is heated under carrier gas flow.

Distribution Chromatography

The separation phase is arranged as a thin layer with a large surface such, that it is purged evenly by carrier gas; the expansion lateral to the flow direction is very small. This is achieved almost ideally, if the inside wall of a long capillary column (inside diameter 0.3 mm) or a megaboron column (fused silica separation columns, inside diameter 0.53 mm) is coated with separation substance. Capillary columns achieve high separation action. Megaboron columns are more heavy-duty, however, they have lower separation action.

For packed columns an inert grainy material (e.g. diatomite) is impregnated with a thin layer of separation substance and filled into the separation column. The grain sizes are between 0.1 and 0.3 mm. Fine grains (e.g. 0.15 to 0.2 mm) are the usual grain sizes. This achieves even filling and thus high separation action of the separation column. The layer thickness depends on the separation substance per carrier material volume, specified in weight-%. 0.5 to 5 % is common for very high separation capacity (laboratory instruments) 5 to 25 % for columns with high durability (process chromatographs). The finer the grain size, the larger the surface, the thinner the separation phase becomes.

Influences on the Separation Characteristics

The larger the tube diameter, the more the separation column can be strained. The separation action is reduced, however, with the same amount of separation material, because the component limits swirl when the ganules are circulated. Common separation column diameters are 3 to 4 mm in process instruments. The longer the separaton column, the higher the separation action. However, the separation action increases less than proportional with the length. Therefore columns longer than 10 m (packed) are rare.

Retention times and separation action are very temperature dependent. If the temperature is increased, the retention time decreases exponentially. Separation worsens. The retention times react in the reverse proportional to carrier gas speed, i.e. the higher the gas thoughput, the shorther the retention times. Optimum flow rate ranges exist, where the separation action is satisfactory at the shortest possible analysis time.

Optimum Gas Speed

The dependence of the separation step height on the carrier gas speed shows a small optimum.

The carrier gas can be compressed. Therefore the gas speed over the entire column length can only be optimal, if the pressure reduction above the column is as small as possible. The longer the column, however, the higher the pressure reduction. The part of the column, where the gas speed is optimal, therefore decreases with increasing column length. The range with lesser separation action increases. For this reason the separation action increases less than proportionally to the column length. With long lengths the peak width dominates through cross diffusion and the separation action decreases again.

With light gases such as H_2 or He the optimum gas speed can often not be adjusted in consideration of the detector, so that the separation action appears to be smaller (less, but higher separation steps).

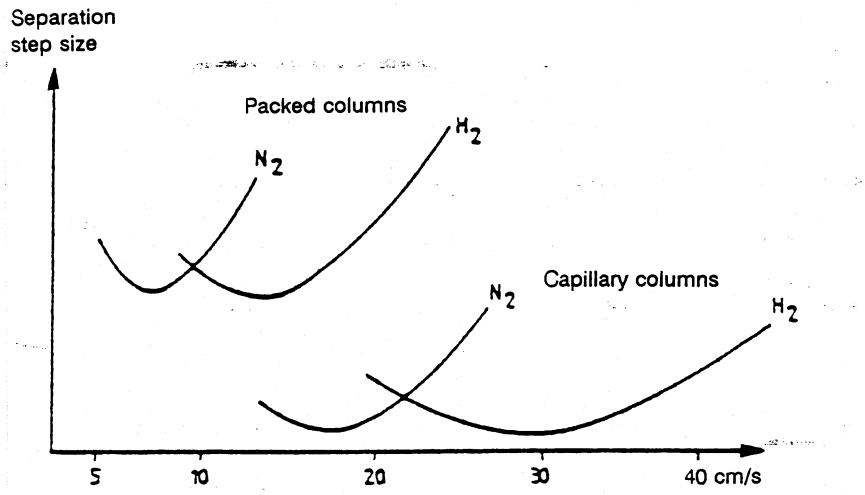


Fig. 3.1 Dependence of the separation step size on the carrier Gas Speed

Separation Action of the Separation Substance

The separation action is based on the fact, that intermolecular forces between components and separation substance are different. The individual components adhere differently to the separation substance. The Rohrschneider constant is a measure for these forces. In simple terms, the separation substances can be divided into non-polarized and more or less polarized substances after calculation of these forces. Specific polarities (e.g. for cyclic compounds containing oxygen and nitrogen) are defined by the Rohrschneider constant. The measurement components can also be divided into polarized and non-polarized substances, for example, the following applies:

Hydrocarbons with single bond	(e.g. C_2H_6 = ethane)	are non-polarized
Double bonds	(e.g. C_2H_4 = ethene)	are weakly polarized
Triple bonds	(e.g. C_2H_2 = ethine)	are highly polarized
Oxygen orientation	(e.g. C_2H_5OH = ethanol)	are very polarized.

Separation Liquids
The following table contains the commercial names of commonly used separation liquids in the sequence of increasing polarity.

Non-polarized:	**Weakly polarized:**	**Polarized:**
Squalane	Diisodecylphtalat	Carbowax 400
Siliconöl DC 200	Siliconöl DC 700	Reoplex 400
Apiezon L	Polypropylenglykol	Fraktonitril III
	Trikresylphosphat	ßß-Oxidipropionitril
	Carbowax 20000	Glyzerin
	Carbowax 4000	Diglyzerin
	Carbowax 1500	Triethanolamin

Separation substances and measurement components are combined according to the following basic rules:

- **Non-polarized column:**
  All substances are separated in the sequence of their boiling points.
- **Polarized column:**
  - Non-polarized substances are separated in the sequence of the boiling point, however, they are often held back for a shorter period of time than under the same conditions on a non-polarized column.
  - Polarized substances are held back more depending on their polarity than non-polarized substances with the same boiling point.
- Components and separation substance should have very similar chemical characteristics, in order to achieve maximum peak symmetry.

Separation column switching
When polarized and non-polarized separation columns are combined and if they are coupled and decoupled at suitable times, those substances can be separated which usually can oly be seaparated in a time consuming process. Detailed information can be found in the appropriate technical literature.

Retention Index

The retention index of the component with reference to the separation substance defines how separation substance and component interact. The retention index is the relative retention time of the component compared to two reference components. Retention time here is considered to be the net retention time, equals the measured dwell time in the column reduced by the dwell time in the gas phase. The dwell time in the gas phase equals the dwell time of the carrier gas in the gas phase and is the same for all components.

Alkanes were selected as reference components (e.g. methane, ethane, propane, n-butane, etc.). The retention index was defined as the number of carbon atoms in the molecule n x 100. The retention index for methane is therefore 100, for ethane 200, etc. The relative retention times of all components are arranged in this reference scheme. A retention index of 230 indicates, for example, that the component between ethane (I=200) and propane (I=300) leaves the separation column.

A substance can have very different retention indeces on two substances with different polarities, e.g. the retention index for acethylene on squalene is 100 and on polyethylene-glycol 330.

The connection between retention time T and the retention index I is logarithmic (I proportional log T).

Maintenance

Regularly check if the retention times and the separation action of the separation column have deteriorated. If analysis temperature and carrier gas flow rate are in order, the separation column characteristics have changed through aging. Verify, if the separation action is still sufficient at lower analysis temperatures. If yes, all control times can be redefined and adjusted in the time program and the separation column can be continued to be used. If this is not possible, the separation column must be replaced or regenerated.

- **Distribution columns**
  Distribution columns must be replaced. After installation the separation column must be conditioned to remove evaporated particles of separation substance and to achieve even cotaing:

  Conditioning before initial installation or after instrument was out of operation for a longer period of time
  Distribution columns as a rule are conditioned as follows: The columns are purged separately with carrier gas in the analyzer chamber (20 to 50 ml/min) and the columns are heated 12 to 36 hours at temperatures which are approximately 20 to 40 °C higher than the subsequent analysis temperature.

  Refer to the application documentation of your PGC 302 regarding the requirements for separation column conditioning.

- **Adsorption columns**
  Adsorption columns can be regenerated if they are not too contaminated or chemically changed. The following are causes of contamination: contamination of the supply gases or gas supply lines, adsorbed components or evaporating separation substance of distribution columns if the analysis temperature is too high.

  Conditioning before initial installation
  As a rule adsorption columns are conditioned as follows (exceptions should be requested from the manufacturer):

  Molecular sieve 6 to 12 hours at 200 to 350 °C
  Active charcoal temperature depends on type, higher temperature achieves higher activity
  Aluminum oxide temperature depends on type, higher temperature achieves higher activity
  Silica gel 12 to 24 hrs. at 150 °C
  Spherosil 48 hrs. at 80 °C

  Conditioning should occur under carrier gas flow of 20 to 50 ml/min and reversed flow direction than in the instrument.

Separation Column Connectors

A special extension piece (1.5 mm pipe) is available for FPD and ECD.

Separation columns are connected using an adapter. If purge inlet is needed, a triple adapter is necessary.

4 DETECTORS

4.1 Flame Ionization Detector

The flame ionization detector (FID) is a non-specific detector for combustable hydrocarbons. The ex-version can be operated in the PGC 302 Ex.

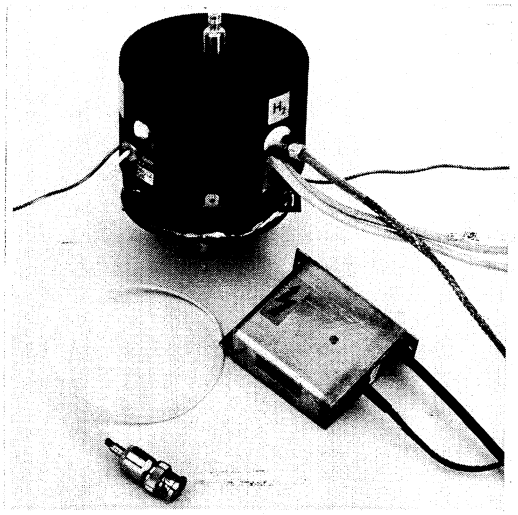
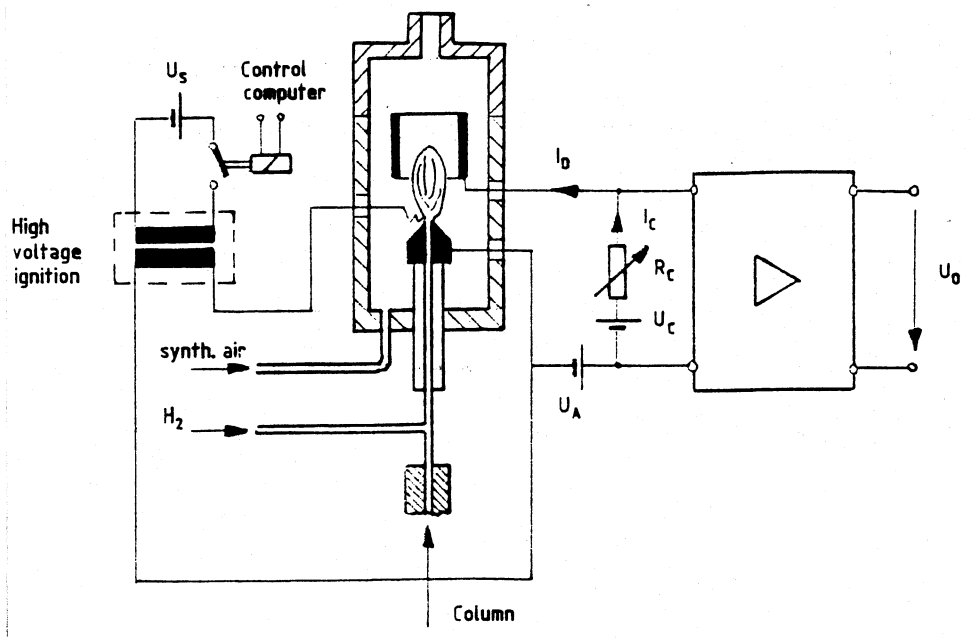


Fig. 4.1.1 FID module with ignition module

Measurement Principle

The components, which exit from the separation column, are burned in a hydrocarbon flame with the addition of combustion air. Ions are created. These are captured by the collector electrode and generate an inonization current. The measurement current I_D is converted to a measurment signal U_A in the amplifier. The basic detector current can be compensated using a compensation voltage U_K by adjusting the resistance R_K. This permits operation of the detector in sensitive measurement ranges and measurement of small concentrations.

Within the linearity range the measurement signal is proportional to the number of hydrocarbon atoms which are burned per time unit. The FID is therefore considered to be a mass detector. The measurement signal also depends on the bonding types and possible presence of heteroatoms in addition to the carbon. Detector geometry and gas supply are calibrated such that the sensitivity and structural linearity are optimal.



I_D	Measurement current of detector
I_K	Compensation current
U_K	Compensaton voltage
U_Z	Tractive force
U_V	Supply voltage
U_A	Output voltage
R_K	Adjustment potentio-meter for compensation current

Fig. 4.1.2 FID Switching principle

Technical Data:

	Non-ex-FID	Ex-FID
Detection limit	Approx. 2 x 10^{-12} g C/s	Approx. 2 x 10^{-12} g C/s
Absolute sensitivity	Approx. 2 x 10^{-3} As/g C	Approx. 2 x 10^{-3} As/g C
Concentration range	Approx. 10 ppb ... 10^{4} ppm	Approx. 10 ppb ... 10^{4} ppm
Linearity range	10^{-12} ... 10^{-5} g C/s	10^{-12} ... 10^{-5} g C/s
Basic current at 250	3 ... 7 x 10^{-12} A	3 ... 7 x 10^{-12} A
Noise at impedance 0	Approx. 10^{-13} A	Approx. 10^{-13} A
Noise at impedance 2	Approx. 4 x 10^{-14} A	Approx. 4 x 10^{-14} A
Max. operat. temperature	280 °C	180 °C (T3), 280 °C (T2)
Ignition type	High voltage spark	High voltage spark
Ignition protection	None	EEx dp IIB+H_2 T3 or T2
FID with methanizer		
Detection limit	≤ 0,1 vpm CO/CO_2	≤ 0,1 vpm CO/CO_2
Linear range	Approx. 10^{3}	Approx. 10^{3}
Dynamic range	10^{4}	10^{4}

Configuration

The FID is available in standard version as well as in ex-version. Both versions are configured the same. The ex-version is explosion protected by an additional safety device.

The FID module consists of

- **the basic body with burner nozzle, supply gas and separation column connectors**
  The supply gas connectors as configured as pressure reducer valves. This results in a constant detector gas supply at constant pressure. At the same time the pressure reducers are used as flame barriers. An 0.5 mm capillary is soldered in the separation column connector. It supplies the carrier to the burner nozzle and serves as flame barrier as well.
- **the attachment with tractive force/ignition voltage electrode and exhaust gas nozzle**
  The tractive force/ignition electrode are soldered in a ceramic disk, which is permanently welded to the attachment. Thus the two electrodes are permanently adjusted. The exhaust gas nozzle of the ex-version contains a flame barrier made of two ring slits.
- **a protection pipe for the electrode connector with traction relief**
  A pipe is screwed over the ceramic disk; it is used to lead the electrode connections out of the analyzer area. The protection pipe extends into the shaft behind the installation chamber. In the PGC 302 Ex purge gas flows from the purged shaft into the protection pipe and prevents explosive gas from reaching the electrode connectors.

The combustion chamber is pressure proof. Supply gas connector, separation column connector and exhaust gas nozzle in the ex-version have screw connections.

All metal parts are made of stainless steel (V4A, material no. 1.4571). A graphite gasket is located between base and attachment, a teflon gasket between attachment and exhaust gas nozzle. The burner nozzle consists of a quartz tube with metal cap. The nozzle drill hole is narrow enough (0.30 mm ϕ_i), that even a combustion gas mixture containing oxygen can be used without the flame backfiring.

The signal cable is connected with the measurement electrode using a 1 MΩ protective resistor; this protects the FID amplifier from high currents when the FID is ignited.

The ignition module contains a switching stage and a high voltage transformer which is used to generate the voltage for the ignition spark. The 24 V supply voltage is turned on by the computer via a relay in the FID amplifier and supplied, together with the tractive force (-300 V) over a three-wire, shielded cable. The detector receives a series of 5 ignition pulses by means of an ignition command, in order to ignite safely.

Installation Instructions

The FID does not have a separate heater. It is installed on the oven heater plate of the PGC 302 (Module slots 3 and 7).

The connection lines are plugged directly into the FID amplifier and supply board in the electronics section.

Important instructions for the ex-FID:

- **Ignition Module**
  The ignition module is installed on a plate. This plate must always be installed on the wall of the installation chamber such that the ignition module extends into the ventilated shaft.

- **Flame Barriers**
  Never install the FID in the PGC 302 Ex without internal flame barriers. Flame barriers are installed in the gas connectors, the separation column connector and the exhaust gas nozzle.

Detector Gas Supply

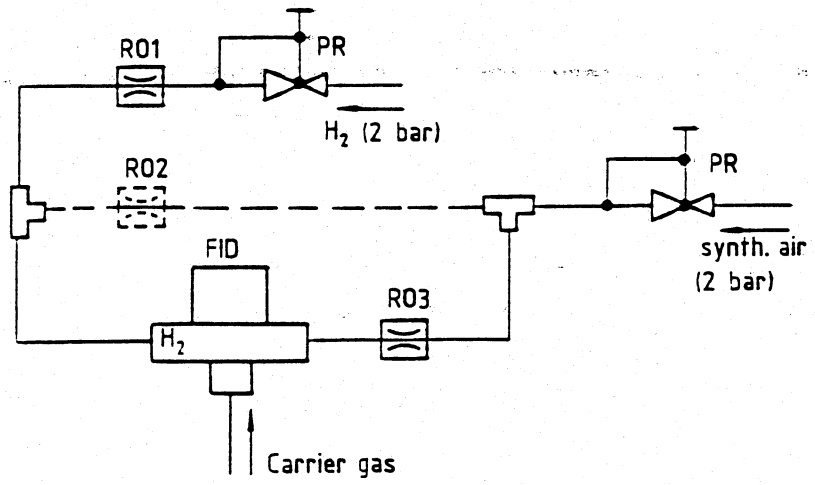
Reaction Gas
The FID requires hydrogen and combustion air (synthetic air) as reaction gas.

Carrier Gas
Hydrogen, nitrogen, argon or helium are suitable carrier gases.

Additive/Make-up-Gas
To increase the sensitivity of the FID and to improve the structural linearity, synthetic air is added to the combustion gas via DB2. When operating with N_2 as carrier gas in packed columns or Live switching, this additive is not required.

If the H_2 carrier gas stream is below 25 ml/min when operating with packed columns, we recommend the addition of H_2 combustion gas to achieve a stable flame and, if necessary, air to increase the sensitivity.

When operating with capillary columns without live switching, synthetic air is required as make-up-gas (DB2). It supplements the low carrier gas volume compared to the packed column.



Pressure reducers DB1 to DB3 are permanently installed in the exhaust gas nozzle.

Fig. 4.1.3 FID gas supply

Please observe the following when selecting supply gases:
The addition of air sometimes causes other relative response factors than are specified in the technical literature for pure H_2 or H_2/N_2 flames.

IMPORTANT: The FID is very sensitive to all types of hydrocarbons and to contamination of the gases and supply lines. If a high signal/noise ratio should be achieved, the gases must have a purity of 99.995 % and a hydrocarbon content below 2 vpm. If special detection sensitivity must be achieved, we recommend the cleaning of all supply gases using a molecular sieve filter.

The measurement characteristics of the FID are determined maily by the temperature of the detector flame and the geometry of the combustion zone. This depends on the composition and the flow speed of the gas mixture. An optimum signal/noise ratio is achieved at the following gas flow rates:

Combustion gas	25	to	45	ml/min
Combustion air	300	to	500	ml/min
Additive air	20	to	40	ml/min

Flow Rate Constant Detector Gas Supply
The detector gases are supplied to the detector by means of pressure regulators the integrated pressure reducers. This achieves constant gas flow rates. With a regulator pressure of 2 bar and ambient temperature, the standard gas flow rates listed below can be adjusted. They are suitable for most applications. The carrier gas flow rate can the be 20 to 40 ml/min, but should not exceed 50 ml/min including the additive.

	Application	Flow rate at 2 bar in ml/min
DB1	Combustion gas (hydrogen)	35
DB2	Additive (synthetic air)	33
DB3	Combustion air (synthetic air)	405

The reduced flow rates change at operating temperature (oven temperature). Depending on the oven temperature, a higher or lower regulator pressure must be adjusted. The required pressure can be calculated:

$$p = p_R \times (273\,°C + \text{oven temperature})/293\,°C$$

with p_R = pressure at ambient temperature
and oven temperature in °C

The gas flow rates can be measured at the FID exhaust gas nozzle using a soap bubble flow meter: turn off gases, completely relax measurement spring in pressure regulator and evacuate the pressure regulator on the corresponding manometer. Turn on gases i n d i v i d u a l l y and measure each gas flow rate.

Operating Instructions

Operation with highly vaporized separation column
If the FID is operated on a highly vaporized separation column (e.g. squalene at 80 °C), the detector must be supplied with gas continuously so that the flame does not extinguish. This prevents the separation phase from condensating on a nozzle head which is too cold. The condensation would cause a highly increased basic current for several hours, after the detector is reignited.

Basic Current
If the compensation voltage is 0 and the base line correction is turned off, the basic current is displayed; without separation column it is between 2 to 5 x 10^{-12} A (Measurement range 4). A packed column causes an increase to approximately 500 x 10^{-12} A depending on separation phase and oven temperature.

The basic current should not deviate significantly from the value specified in the application documentation. The FID requires maintenance if the difference is above ± 50 %.

FID Shut-Down

The FID does not contain any expendable parts and can therefore be operated continuously without problems. If the FID must be shut down for maintenance or repair, proceed as follows:

- Turn off the oven heat.
- Unplug the supply cable from the detector supply board: the tractive force is reduced within several seconds.
- Turn off all supply gases to prevent any condensation in the cold detector.

If the FID is shut down for an extended period of time, the exhaust gas nozzle should be sealed to prevent dust contamination.

FID Operation with Methanizer

When operating with packed columns, the FID can be operated with a hydration reactor (Methanizer). This permits detection of CO and CO_2, which generate virtually no signal in the FID without methanizer. In the methanizer CO and CO_2 are catalytically reduced to methane under excess hydrogen which can be detected in the FID:

$$CO + 3\,H_2 \xrightarrow{Ni} CH_4 + H_2O$$

$$CO_2 + 4\,H_2 \xrightarrow{Ni} CH_4 + 2\,H_2O$$

Other areas of application are the reduction of formic acid and formaldehyde to CH_4. This permits quantitative detection of small concentrations in the ppm range.

$$HCOOH + 3\,H_2 \xrightarrow{Ni} CH_4 + 2\,H_2O$$

$$HCOH + 2\,H_2 \xrightarrow{Ni} CH_4 + H_2O$$

If possible, the samples should not contain any halogenated or sulfurous components.

Please Note: Hydrocarbons above C_8 are partially decomposed through the catalyst. They appear with tailing and too small. The simultaneous detection of higher boiling components and CO/CO_2 is therefore not possible.

Hydration Reactor (Methanizer)

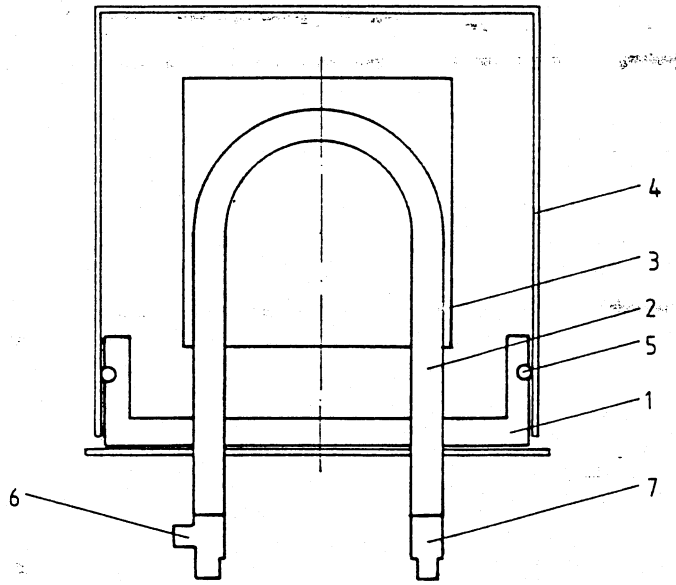
The hydration reactor consists of a stainless steel U pipe which is filled with a catalyst. A heating plate is plugged on the U pipe. Two heating cartridges and a Pt 100 temperature sensor regulate heating to 400 °C. The U pipe is installed in a base plate air tight. The gas inlets and gas outlets are configured as flame barriers. A protective cover is installed air tight over the base plate. The cover is insulated to prevent the surface temperature from exceeding 180 °C.

In the ex-version the U pipe is encapsuled and pressure proof. The base plate contains a gas connector and exhaust nozzles for purge gas. The gas connector has a pipe which extends into the purged shaft behind the installation chamber. This pipe is used to hold the connection lines for heating cartridges and temperature sensor. Purge gas flows from the purged shaft into the methanizer housing through this pipe and prevents explosive gas from reaching the heater connections.

Technical Data

	Non-ex-methanizer	Ex-methanizer
max. operat.temperature	400 °C	400 °C
Heating	2 heating cartridges 115 V each	2 heating cartridges, 115 V each
Ignition protection	None	EEx dp IIB+H_2 T3

DANGER: If the purge air supply of the PGC 302 Ex is interrupted during operation, it is i m p e r a t i v e that you keep the pressurized PGC 302 chamber closed for at least 30 minutes until the methanizer has cooled down sufficiently. If the door to the electronics section or the cover to the shaft are opened prema-



1 Base plate
2 U pipe (reactor)
3 Heater plate with heating cartridges and Pt 100 temperature sensor
4 Protective cover
5 O-Ring
6 Gas connector nozzle for carrier gas and H_2
7 Carrier gas outlet

Fig. 4.1.4 Methanizer for packed columns

Installation Instructions

The methanizer is installed on the unheated module slot on the oven. The gas connectors for the reactor extend into the oven chamber. In the PGC 302 Ex a pipe, which extends into the shaft behind the installation chamber, is screwed to the base plate at the purge gas connector. This pipe is used to hold the connection lines for heating cartridges and temperature sensor to the terminal strips in the shaft. The two heating cartridges are switched in series (refer to circuit diagram).

Gas Supply (refer to Fig. 4.1.5)
Use H_2 (35 to 45 ml/min) as carrier gas. It is used as reaction gas in the methanizer and as combustion gas in the FID. For other carrier gases, the combustion gas must be added via a pressure reducer (impedance class 5) at the methanizer inlet.

Combustion air and additive are adjusted the same as with the FID without methanizer. The hydrogen inlet on the FID must be sealed with a blind plug.

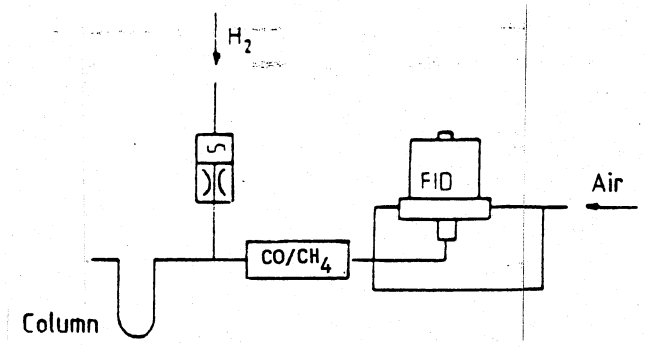
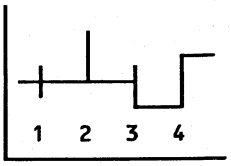


Fig. 4.1.5 Gas diagram

FID Troubleshooting

Observation	Cause	Correction
Flame does not ignite.	Combustion gas flow rates are wrong.	Adjust correct gas flow rates.
	Combustion gas flow rates lower than pressure, because integrated regulators in the gas connectors are clogged by small dirt particles.	Clean integrated regulators in gas connectors. Replace gas connectors if necessary.
	Connectors combustion gas/combustion air are reversed.	Connect H_2 to combustion gas connector.
	Ignition spark does not jump from ignition electrode to nozzle.	Check insulation of the ignition line (also in the ignition module).
	Are 24 V pulses present at amplifier terminals?	Yes: check/replace ignition module no: replace FID amplifier.
	Exhaust gas nozzle clogged by deposits.	Clean exhaust gas nozzle.
	Nozzle is • broken off; • adjusted incorrectly; • clogged.	 Replace nozzle. Adjust nozzle Puncture nozzle using ϕ 0.2 mm drill.
Pop during ignition.	Combustion air flow is too low.	Adjust correct flow rates.
Basic current is too high.	Contamination of: • supply gases • lines • detector: signal even without flame.	 Clean using filter. Anneal gas supply lines. Disassemble and clean detector.
	Combustion gas flow is too high.	Optimize volume.
	Column not suitable: basic current is in order, when detector without column.	Replace unsuited column. Anneal detector over night at 160 to 180 °C.
	Gas paths leak.	Find and correct leak.
	Insulation resistance of electrodes, nozzle and cable is less than $10^{12}\ \Omega$.	Connect cable as specified.
	Impedance is adjusted too low.	Adjust higher impedance.
	If instability is gone when measurement cable is unplugged from amplifier input: detector or measurement cable faulty.	
Base line unstable.	Detector is faulty: instability gone without flame.	Disassemble and clean detector.
	Measurement cable faulty: instability even without flame.	Properly insulate and connect measurement cable/replace measurement cable.
Base line drift if oven temperature is increased.	Separation column vaporizes too much.	Select lower oven temperature.

Detectors

Observation	Cause	Correction
Base line drifts at stable temperatures.	Less drift without carrier gas? Yes: separation column is contaminated. No: deposits in foot and nozzle of detector.	Replace separation column. Anneal detector over night at max. oven temperature.
	Supply gas bottle pressure below 5 bar.	Immediate bottle change.
Noise	Impedance is too low: amplitude to 4 pA (100 % in range 2) at impedance 0.	Enter higher impedance. When operating without normal.
	Basic current higher than measurement range 7 (100 pA): detector temperature is too high.	Adjust higher basic measurement range. Select lower oven temperature.
	Recorder drifts.	Adjust recorder impedance.
Spikes and/or offsets appear in the chromatogram.	Sprikes disappear if measurement cable disconnected, fine dust is in the gas paths.	Anneal lines, heat out detector.
	Measurement cable reacts to shocks (1): it is defective or connected wrong.	Connect cable as specified in detailed description. Replace bent or crushed cable.
	Pressure regulator is sensitive to shock. Spikes wihtout offset (2) are normal. If spikes with offset (3), pressure regulator is defective.	Have defective pressure regulator repaired or replace.
	Working environment is not stable.	Create stable working environment.
	If offset without spikes (4) when switching the amplifier range, FID amplifier is maladjusted.	Have manufacturer readjust FID amplifier.
Steps appear in chromatogram (Step recording).	High range is combined with low recorder measurement range.	Adjust lower range and/or higher recorder measurement range.
Measurement sensitivity is too low.	Leaks before and after separation column.	Find and correct leak.
	Nozzle is broken.	Replace nozzle.
	Additive air is missing. Combustion gas supply is too high or too low.	Optimize flow rates.
	Nozzle is clogged.	Puncture with steel wire or ϕ 0.20 mm drill or replace nozzle.
	Substance volume is larger than linear range.	Inject lower volumes.
	White deposit on measurement electrode (of silicon separation phases)	Brush off white deposit using glass brush, blow dustfree.
	Injection device is defective.	Maintenance of injection device.

Maintenance

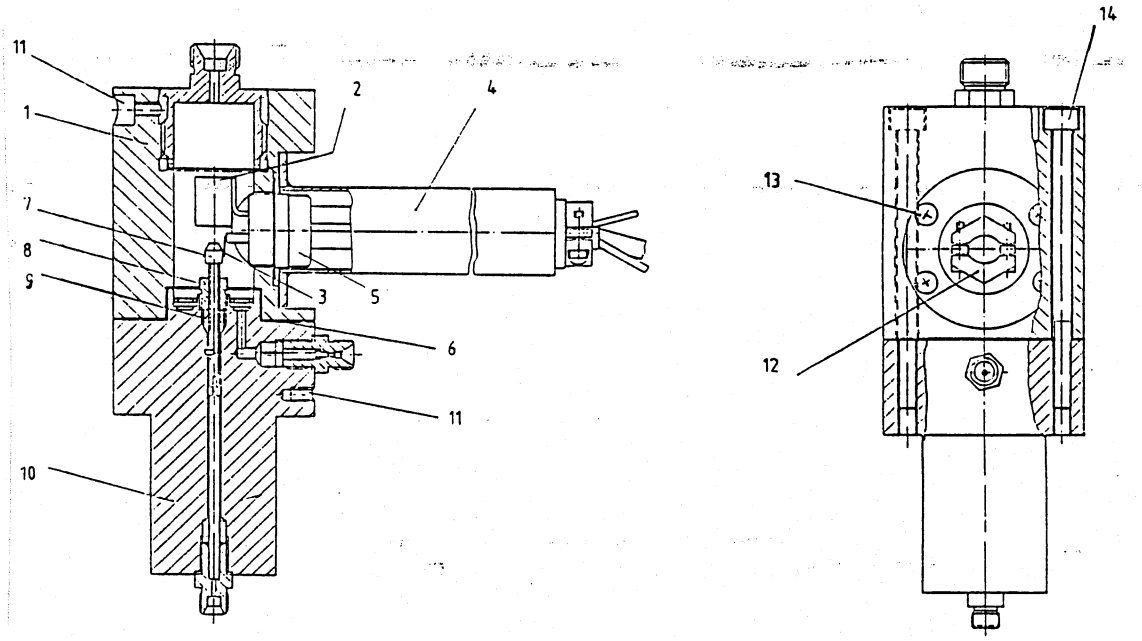
Regularly verify basic current, noise, deposits on electrodes and in exhaust gas nozzle.

Open and clean detector

DANGER: N e v e r open the Ex-FID in explosive areas with the flame burning!

Important: The ring slit between attachment and basic body in the ex-version of the FID forms the ex-slit. The ring surfaces may therefore not be scratched. Be extremely careful when disassembling the Ex-FID.

- Turn off the combustion gases.
- Remove the two screws (14). Carefully lift off the attachment with electrode and exhaust gas nozzle, so that the ring slit surfaces are not scratched and the electrodes are not bent. Be careful with the gasket (6).
- Clean the combustion chamber and the electrodes.



1	Attachment with exhaust gas nozzle	8	Pressure screw
2	Measurement electrode	9	Gasket with outer ring and pressure ring
3	Tensile/Ignition electrode	10	Basic body
4	Protection pipe	11	Protective screw connections (only Ex-FID)
5	Ceramic disk with electrode connector	12	Traction relief clamp
6	Sealing disk	13	Cylindrical screws M3 x 5
7	Nozzle	14	Cylindrical screws M5 x 60

Fig. 4.1.6 Sectional View of FID

Clean/replace nozzle

- Losen the pressure screw of the nozzle holder (8) using a 7 mm socket wrench.
- Carefully pull out nozzle (7).
- Clean the nozzle shaft. Remove deposits on the nozzle drill hole (ϕ 0.30 mm) using steel wire ϕ 0.2 mm. If the nozzle can no longer be cleaned, remove gasket and pressure screw from the nozzle and install both on a new nozzle.
- Reinstall and adjust the nozzle. The distance nozzle tip-basic body should be 10.5 mm. Manually tighten the pressure screw. Then retighten one quarter to one half rotation using the wrench. The nozzle can break if it is tightened more.

Clean exhaust gas nozzle

- Losen the mounting screw, which is used to protect the exhaust gas nozzle, on the side of the Ex-FID.
- Unscrew the exhaust gas nozzle. Please watch the gasket.
- Clean the exhaust gas nozzle with a solvent. Never disassemble the exhaust gas nozzle with flame barrier.
- Reinstall the exhaust gas nozzle. Secure it with the mounting screw if necessary.

Clean/replace gas connectors

- Losen the protective screw connections if necessary.
- Unscrew the gas connectors in sequence to prevent mixing them up. Be careful with the gasket.
- Purge the integrated regulators in reverse direction. If flow rate does not improve, replace the gas connector with the pressure reducer. Install only the prescribed gas connectors with pressure reducers in the Ex-FID, or the ex-protection becomes invalid.

Test and reassemble detector

- Install the attachment with electrodes and exhaust gas nozzle.
- Open the combustion gas supply and verify that the FID ignites.
- If the detector still has a lot of noise, extinguish the flame by briefly closing the exhaust gas nozzle (hot!). If the detector signal is then quiet, you must test if:
  - the gas paths are sealed,
  - the gases are clean,
  - the gas volumes are correct.
- If the clean detector is noisy without flame, the Koax cable must be tested.

Test coaxial cable

- If the cable is bent or crushed, it must be replaced.
- If the connector to the electrodes or the HF plug of the measurement signal cable is defective, the cable must be reconnected:

Measurement cable and tractive force/ignition voltage cable on connection nozzle in the ceramic disk
Losen the tractive force clamp (12) and then the protective pipe (4) with the screws (13) on the FID. The cables must be plugged on the electrode connection nozzle in the ceramic disk as follows:

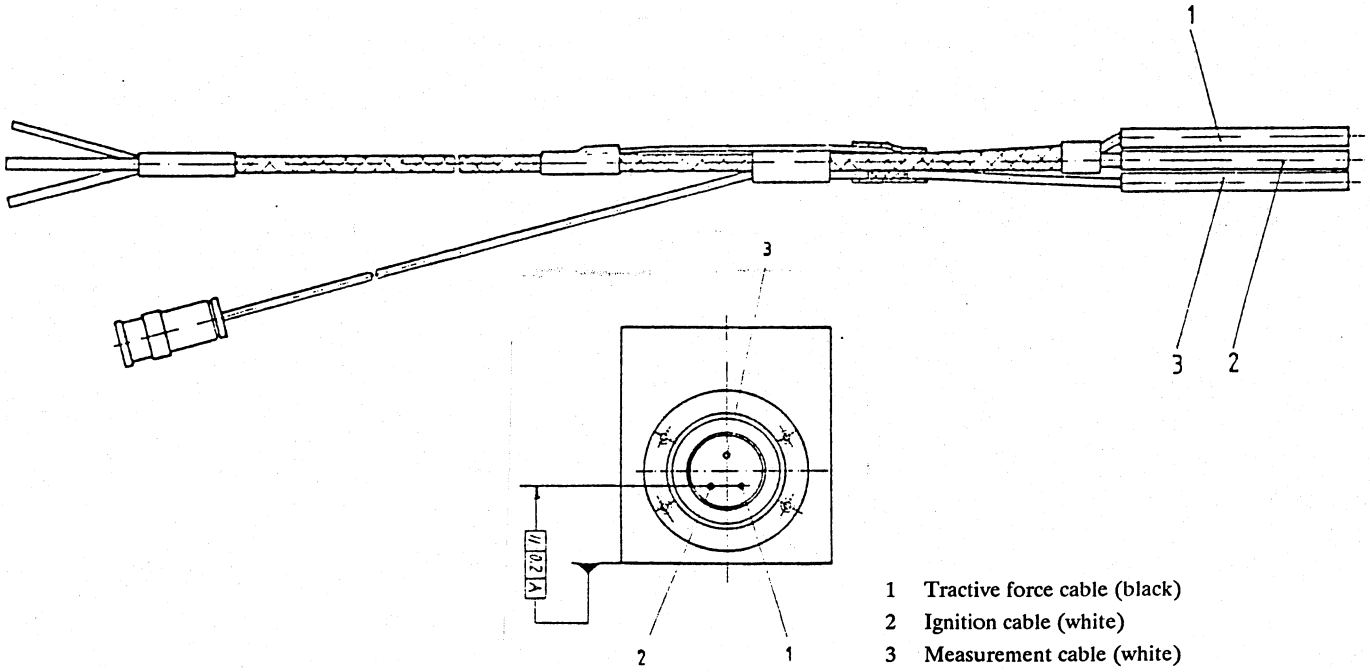
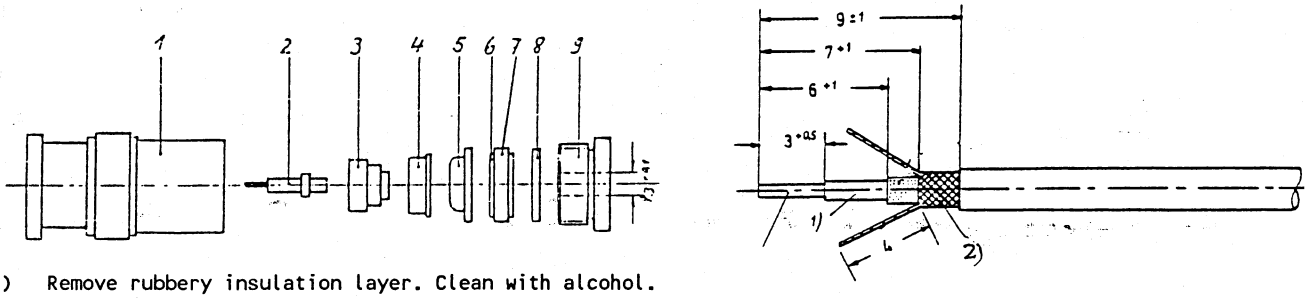


Fig. 4.1.7 Electrode connection nozzle and connection cable

Measurement signal cable high frequency plug

The measurement signal cable high frequency plug must be connected properly insulated to prevent leakage. The insulation between wire and shield contains a semiconductor layer, about 3 mm of which must be removed at the connection point (refer to drawing). Please observe the following sequence when installing the plug:

- Invert parts 10, 9, 8, 7, 6 and 5 over the cable and pull the screen meshing, drilled open if necessary, over part 5.
- Push parts 4 and 3 over the insulated cable end. Solder the cable end soft at the base of the drill hole of part 2.
- Push parts 3 to 8 tightly onto 2 and press everything into 1. Screw nut 9 into 1 until 6 is compressed such that metallic fit is ensured between 9, 8, 7, 5 and 4.
- If the screen meshing protrudes over the edge of 5, it must be trimmed. Carefully remove lose wire parts.



1) Remove rubbery insulation layer. Clean with alcohol.
2) Drill off shield after pulling back items 10, 9, 8, 7, 6, 5.

Fig. 4.1.8 Measurement signal cable with high frequency plug

Start-Up

Important: The correct installation of the FID in the PGC 302 Ex must be certified by a specialist according to ElexV §9, before the PGC 302 Ex can be restarted.

If repairs were made, the instrument must be recalibrated, because the FID may have become more sensitive.

4.2 Thermal Conductivity Detector

The Thermal Conductivity Detector (TCD) is a universal non-specific concentration detector which finds preferred use in gas analysis. The ex-version can be operated in the PGC 302 Ex.

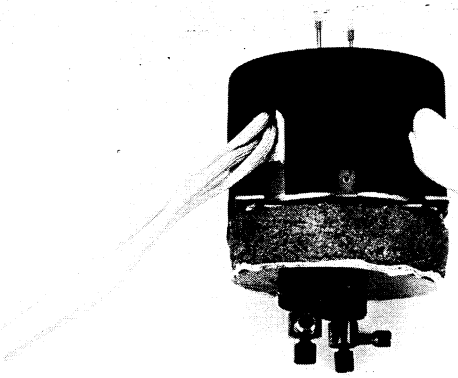


Fig. 4.2.1 TCD module

Measurement Principle

The TCD compares the thermal conductivity of the pure carrier gas with the thermal conductivity of the carrier gas containing sample components. For this purpose, the heating wires of each two measurement and reference chambers are switched to form a Wheatstone bridge (refer to Fig. 4.2.2), which is heated by means of a bridge current.

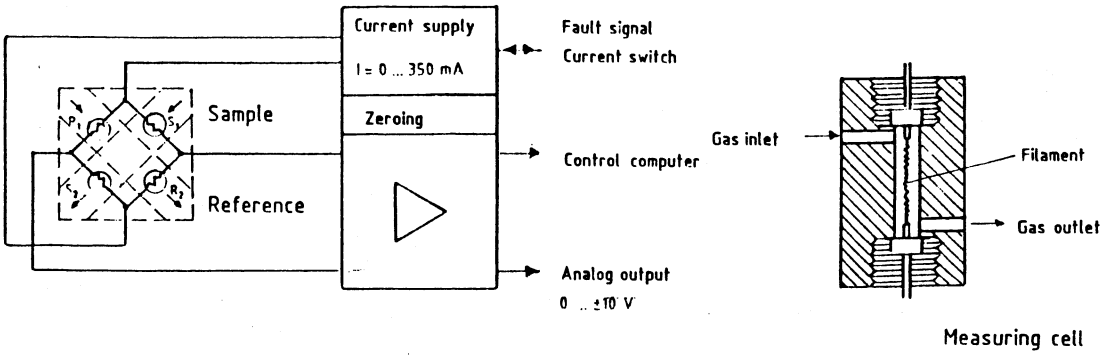


Fig. 4.2.2 TCD switching principle and configuration of a measurement chamber

When the heating wires S1, S2, R1 and R2 have the same temperature, they have the same resistance and the bridge is calibrated, i.e. the voltage between the two bridge branches is 0. If the carrier gas contains sample particles, its thermal conductivity changes and thus the temperature of heating wires S1 and S2 compared to the reference wires R1 and R2. Since the temperature of the heating wires and thus their resistance changes, the bridge becomes maladjusted and a bridge voltage is applied. It is proportional to the concentration of the components in the carrier gas.

Technical Data

The termal conductivity detector is available in two versions whose main difference is in their measurement chamber volume:

	Standard	Micro
Chamber volume	0.5 ml	70 µl
Branch volume	1.0 ml	140 µl
Heating wire material	WX by GOW-MAC	Wolfram-Rhenium
Detection limit	1.5 x 10^{-9} g/ml C_2H_6 in He	1 x 10^{-9} g/ml C_2H_6 in H_2 at $b_{0.5}$ = 6 s (2 ppm)
Sensitivity	1.2 x 10^3 mV/(mg/ml C_2H_6 in He)	2 x 10^3 mV / (mg/ml C_2H_6 in H_2)
Noise w. Carrier gas H_2	50 µ V_{SS} at 300 mA	≤ 1 µ V_{SS} at 300 mA (15 ml/min H_2, 120 °C)
Cold resistance per Heating wire	30 Ω (20 °C)	30 Ω (20 °C)
max. bridge current	300 mA	300 mA
max. operat. temperature	180 °C	180 °C
Carrier gas flow	10 to 100 ml/min	10 to 100 ml/min
Bridge	switched internally 4-wire connection	switched internally 4-wire connection

Both versions are available explosion proof, ignition protection type EEx de IIB + H_2 T3

Configuration

The TCD detector consists of the TCD measurement cell with gas connectors and connection lines.

The TCD cell consists of a massive stainless steel block with two drill holes, the measurement and reference chambers. Each chamber has a heating wire which is screwed in gas tight. The four heating wires are switched together to form a Wheatstone bridge. The two measurement chambers and reference chamber are connected with the gas connectors through cross drill holes such, that each chamber pair is purged parallel and direct.

In the ex-version the measurement cell is encapsuled pressure proof in the housing block and the gas inlets and gas outlets are designed as flame barriers. The connection lines are soldered to the measurement cell with 300 °C solder and cast in a ceramic passage.

The housing of the ex-TCD contains the sensor of a safety temperature limitor, which permanently turns off the supply voltage for the TCD power supply board and thus the bridge current, if the housing temperature exceeds the ignition class temperature, for example, if the bridge current regulator is defective.

Installation Instructions

The TCD does not have a separate heater. It is installed in the PGC 302 oven chamber.

The connection lines are fed through a PG screw connection from the oven into the shaft and are connected directly to the TCD amplifier.

What to observe with the PGC 302 to keep the ex-protection in tact

- The ex-TCD may only be installed together with a special TCD supply unit designed specifically for the ex-TCD.
- The ex-TCD may only be installed with safety temperature limitors.
- The temperature limitor must be switched in series with the 24 V supply voltage in the board the TCD supply board. The 24 V connector for the TCD supply voltage is fed via a cable from the front panel of the TCD supply board. The cable has a plug in socket where the temperature limitor is connected.

Detector Gas Supply

Carrier Gas

Hydrogen, helium, nitrogen or argon are suitable carrier gases. In this sequence the thermal conductivity of the gases decreases. The gas with the highest possible thermal conductivity difference should be used, because the TCD is then most sensitive. The following table shows the thermal conductivity of various gases with reference to nitrogen:

Gas type	Relative thermal conductivity at 300 °C
H_2	675
He	560
CH_4	170
O_2	105
N_2	100
CO_2	90
Ar	70

The flow rates through the reference branch and the measurement branch should be 10 to 100 ml/min each. The optimum carrier gas flow rate for high sensitivity and low noise is between 10 and 20 ml/min. For trace analyses the carrier gas should be selected such that the termal conductivity difference is highest between the gas and the component of lowest concentration.

When the TCD is operated at high temperature with large streams the carrier gas must contain less than 10 ppm oxygen. This prevents excess base line drift and destruction of the measurement wires. Be expecially careful when using argon as carrier gas.

The gas flow rates through the detector are adjusted with needle valves.

Operating Instructions

Bridge Current
The bridge current may not exceed specific limits to prevent destruction of the heating wires. The limit values depend on the detector temperature = oven temperature and the selected gas type. The following figure shows which currents are permissible. The values apply only to the installed measurement wires.

The limit values are only valid for short term operation. For continuous operation you must remain approximately 20 % below the specified bridge current. The signal/noise ratio is equal in both cases.

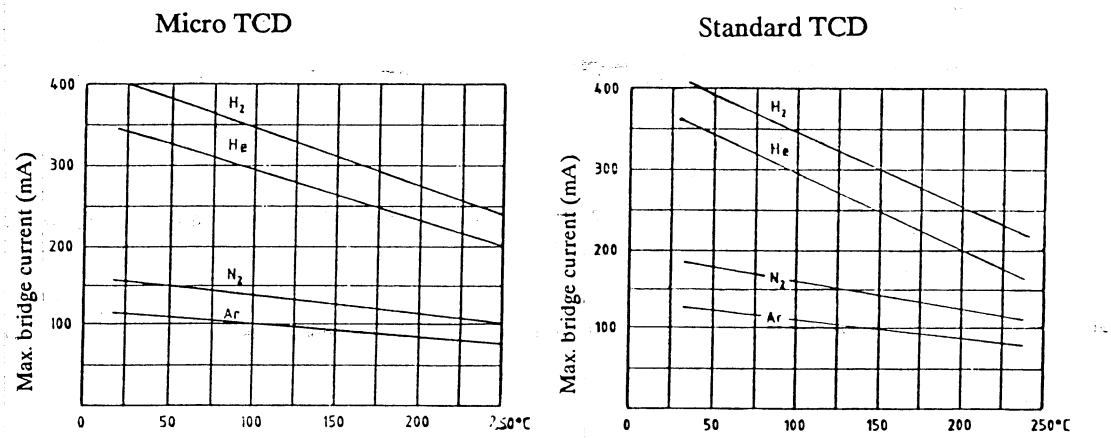


Fig. 4.2.3 Bridge current limit values

Please note: The higher the bridge current, the higher the sensitivity of the TCD. However, the heating wire life decreases with increasing bridge current, the noise increases as well. Only operate the TCD at the current required to achieve the desired sensitivity. The best signal/noise ratio for the TCD is achieved at 250 ... 300 mA with H_2 as carrier gas.

The higher the detector temperature, the higher the noise and the lower the sensitivity. Only operate the TCD at the lowest possible temperature.

The detector has less noise with dense carrier gases (CO_2, Ar) and its stability is better than with H_2.

If the sample contains oxygen or corrosive components, low bridge currents must be applied or the component must be kept from the detector by means of the "Cut Technique".

Important: Turn on the bridge current only after the TCD is purged sufficiently with carrier gas or the heating wires will be destroyed. The resistance limit may not be zero.

Measurement Signal

- **Polarity of the Measurement Signal**
  If the carrier gas is not H_2 or argon, or if components should also be measured in the reference branch, the measurement signals can alternate between positive or negative. The polarity of the peaks can be changed to achieve a "nice" chromatogram display:

  - manually at the current reverser of the amplifier,
  - manually by changing the polarity of the measurement signal in the "Signal" screen (refer to operation via Operating Device). This change only affects the recorder.
  - automatically through a time program which changes the polarity of the recorder signal.

  Since the peak recognition does not "recognize" negative peaks, the polarity of negative peaks must be changed in the component list. The peak will then be recognized and analyzed.

- **Linearity**
  The TCD operates non-linear at higher concentrations. The sensitivity as a rule decreases with increasing concentration. If higher concentrations (from approx. 10 to 20 vol%) should be measured, the injection should be small. If this is not possible, because for example low concentrations should be measured, calibration curves must be recorded for the high concentrations. Without calibration curve, the display error could be 10 to 15 % of the measurement range.

- **Dynamics**
  The dynamic range of the TCD depends on the carrier gas. For H_2 it is approximately 10^5, for Ar approx. 5×10^4. The reason is, that with H_2 measurement wires are hardly hotter than the cell block (approx. 250 °C) and, when sample flows, they take on temperatures to 500 °C for short periods of time. With argon the wire temperature is maximum (approx. 400 °C). When sample flows, the wires cool down only to the block temperature. This is why a "saturation curve" occurs much sooner when operating with argon. To improve the dynamics of the TCD with argon carrier gas, measurement wires type W2X can be used in the standard TCD. At double the measurement wire length they achieve the same noise as type WX, however, they achieve double the measurement signal.

Resistance Limit Monitoring
The PGC 302 monitors the resistance of the heating wires to prevent their destruction due to excess temperature. If the heating wire resistance exceeds the adjustable maximum value (refer to "Installation of the PGC 302 with TCD"), the bridge current is turned off automatically. If this occurs during the analysis at high peaks, the knob for the resistance limit monitor must be turned one half revolution to the left, until the turn off automatic is no longer triggered at the highest peak.

TCD Shut-Down

If the TCD should be turned off
- Set the On/Off switch for the bridge current on the supply unit to 0,
- s u b s e q u e n t l y reduce the gas supply.

TCD Troubleshooting

Observation	Cause	Correction
Bridge current can not be turned on.	Temperature limitor has turned off bridge current because ignition class temperature was reached.	Reset temparature limitor after fault is corrected (refer to Section 6).
TCD bridge current can not be compensated.	Reference gas or measurement gas are not adjusted or adjusted incorrectly.	Adjust correct gas flow rates.
	The bridge is maladjusted.	Adjust bridge as specified.
	Heating wire is defective.	Replace TCD.
Bridge is highly asymmetrical; compensation is on position 4 or 5.	Heating wires are dirty.	Reduce bridge current and heat TCD at max. temperature.
	Heating wires have aged.	Replace heating wires/have them replaced for micro TCD
	Measurement gas or reference gas flow rates are not equal.	Adjust the flow rates such that they are equal.
	Carrier gas contains oxygen.	Use oxygen free carrer gas.
	Sample contains oxygenous or aggressive components.	Keep interfering sample components from TCD using separation column switching.
Excessive noise.	Chromatographic system is leaky.	Find and correct possible leaks.
	Temperatures are not stable.	Verify oven temperature.
	Measurement and supply line connections are not tight.	Retighten connections at terminal strip.
	Flow rate is too high.	Reduce flow rate.
	Bridge current is too high.	Reduce bridge current.
	Column is filled improperly.	Use better columns.
Drift	Bridge current is too high. TCD could be damaged.	Reduce bridge current.
	Separation column bleeds.	Turn off TCD. Remove column from TCD and condition.
	Cleaning effect of the measurement cell.	Await stabilization of the zero line.
	Temperature start up phase effect.	Await stabilization of the zero line.
	Heating wires are aged due to oxygen.	Use O_2-free carrier gas.

Maintenance

CAUTION: All ex-TCD and Micro TCD with 70 µl cell may only be serviced or repaired by the manufacturer !

When replacing the ex-TCD, the PGC 302 Ex must be recertified by an expert according to ElexV §9, before it can be operated.

Check TCD (applies only to non-ex-TCD with 0.5 ml cell)
If the TCD display becomes unstable and the measurement bridge is highly asymmetrical (Zero point coarse in Position 4 or 5), the TCD should be checked as follows:

- Set the bridge current to zero.
- Disconnect the supply lines at the terminal strip.
- Measure the insulation resistance of the measurement wires against ground (cell block). If the resistance is less than 1 MOhm, the cell must be cleaned or repaired.
- Open up the paired supply lines on good insulation and measure the resistances of the four bridge branches. Depending on temperature the resistances are between 30 Ω (20 °C) and 50 Ω (300 °C). The resistances of the 1st and 2nd chamber and the resistances of the 3rd and 4th chamber are paired (refer to Fig. 4.2.5 for connections). The resistance within a pair must correspond to 0.3 Ω. The difference from one pair to the other may be maximum 1.5 Ω. If the differences between the individual resistances are higher, the measurement wires should be replaced.

Clean TCD Cell (applies only to non-ex-TCD with 0.5 ml cell)
- Turn off power. Let oven and TCD cool down if necessary.
- Remove the separation column and gas connectors and remove TCD.
- Purge a suitable solvent (acetone, methanol, ether) through the measurement cell from the exhaust gas line direction. Position the measurement cell such, that all chambers are purged.
- Heat the measurement cell under carrier gas flow to approximately 150 °C until the solvent is completely evaporated. Do not use compressed air for cleaning, because this could destroy the heating wires.
- Verify the insulation resistance and the bridge resistance. If the resistance is still not in order, replace the measurement wires.

Replace measurement wires (applies only to the non-ex-TCD with 0.5 ml cell)
Requirements: paired measurement wires, 4 graphite gaskets, 1 hooked wrench (accessory)
4 pieces teflon hose 4 x 0.5 mm, 10 mm long

- Remove the TCD cell and clamp the measurement cell tightly into a vice using protection pads.
- Untangle the connection wires and straighten the wires.
- Use the hooked wrench to losen the pressure screw of a measurement wire. Carefully pull the measurement wire with pressure screw from the cell. Avoid touching the cell wall with the measurement wire. Put the measurement wire aside and protect it.
- Remove the remaining measurement wires as described above.
- If the measurement wires are black and contaminated, they must be replaced. Gray wires can be reused if they can be paired with a resistance difference of < 0,3 Ω. If the cell block is visibly contaminated, it must be cleaned as described above.
- Insert new graphite gaskets in the cell block. Install the measurement wires with pressure screw individually such, that the wires of chambers 1 and 2 and the wires of chambers 3 and 4 are paired.
- Tighten the pressure screws using the hooked wrench.
- Pull the colored insulation holes from the disassembled measurement wires and invert them over the connection wires of the new measurement wires as shown in the Fig. The connection wires can also be coded using a colored pencil or colored tape.
- Invert a piece of teflon hose over each of the connection wires up to the drill hole of the pressure screw.
- Measure the insulation resistance and the measurement wire resistance. Again verify that the measurement wires are paired correctly.
- Connect same colored connectors using spring clips.

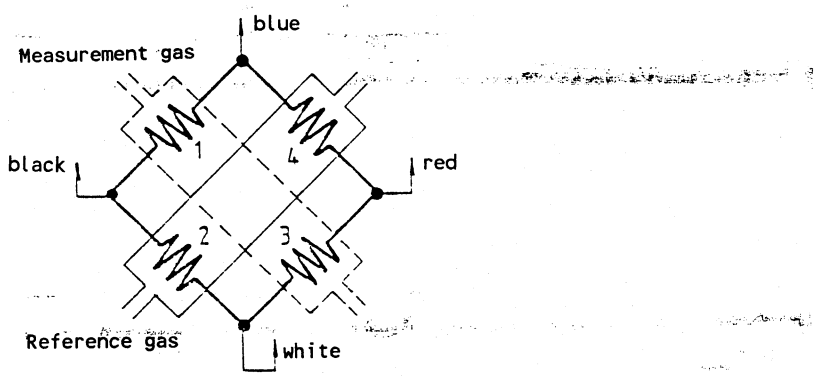


Fig. 4.2.4 Standard TCD, Connection Line Assignment

Reassemble TCD

- Replace the measurement cell in the heating pot together with a strip of fiber glass. The fiber glass prevents direct, one sided thermal contact.
- Screw the connection lines for heating cartridge/temperature sensor using traction relief.
- Bend the connection wires such that the module cover can be put in place. Grasp the wires on the cell side using adjustment jaws, so that no bending stress or rotary tension is applied to the ceramic ducts.
- Invert a fiber glass hose over the connection wires up to the measurement cell and clamp the cables under the traction relief clamp.
- Replace the module cover.

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Flame photometric detector

The flame photometric detector (FPD) is available in two versions:

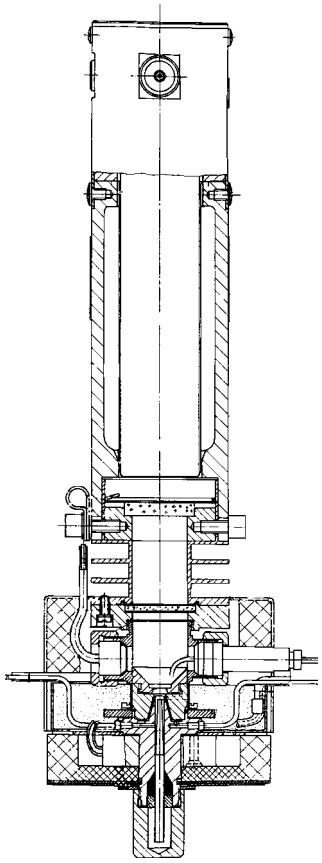
- **Explosion-proof**
- **Non-explosion-proof.**

The FPD is a selective detector. Substances containing phosphorus or sulphur can be detected depending on the filter used.

The components leaving the column are combusted in an air-poor hydrogen flame. They then generate light with wavelengths specific to the material. An interference filter only permits those wavelengths to pass on to the photomultiplier which are characteristic for phosphorus or sulphur. The photomultiplier generates an electric signal.

Technical data

Detect. limit for phosphorus Detection limit for sulphur	3×10^{-13} g/sec 2×10^{-11} g/sec
Linear range for phosphorus Characteristic for sulphur	10^5 Quadratic: $[S]^2$
Selectivity P/C Selectivity S/C	10^5 10^3... 10^6
Operating temperature range	100 °C to 150 °C Ex version 100 °C to 300 °C Non-Ex version
Ignition type	High-voltage sparks
Type of protection	EEx d II C

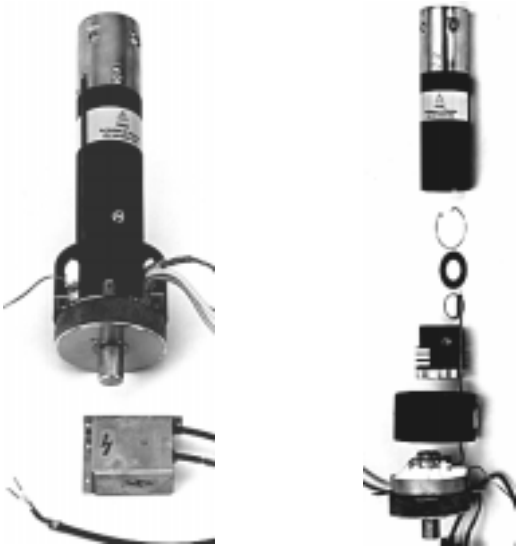


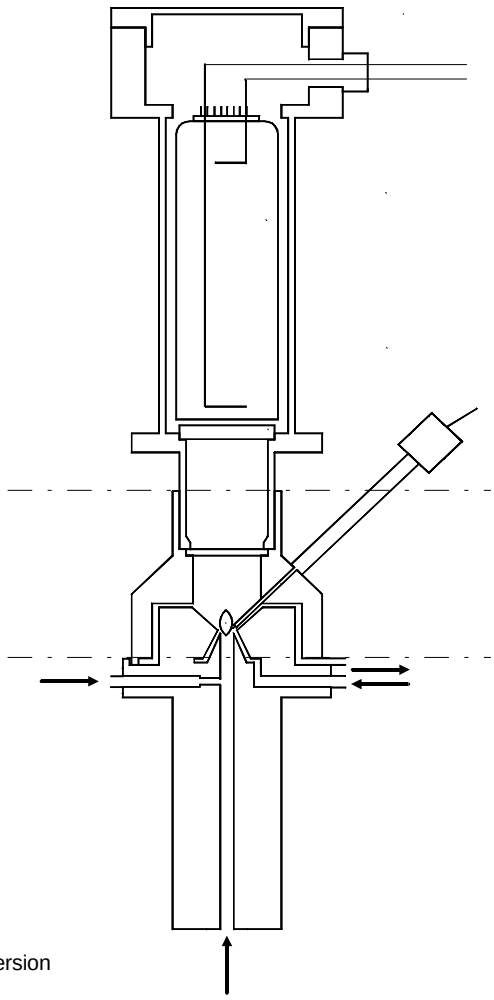
Non-Ex version

Design

The FPD comprises:

- Bottom part with connections for combustion gas, combustion air, column and exhaust, burner nozzle and reflector
- Center part with combustion chamber, ignition electrode and quartz disk
- Top part with photomultiplier, interference filter, socket for detector voltage and input signal.

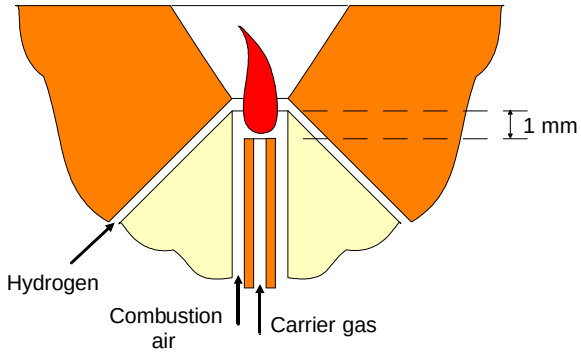




Ex version

Combustion chamber

- The burner nozzle consists of two annular gaps. The combustion gas H_2 flows out of the outer annular gap and mixes with the combustion air from the inner gap. The carrier gas flows from the quartz nozzle into the dome-shaped flame.
- The exhaust with the Ex version is output from the combustion chamber via a flameproof joint.
- The ignition electrode terminates on the side above the burner. It is adjusted such that the ignition sparks jump through the gas mixture to the housing.



Optics

- The flame burns at the focal point of a conical mirror. The light is reflected upwards by this mirror.
- A quartz disk is clamped with graphite gaskets between the bottom and center parts and seals the combustion chamber.
- The interference filter is positioned above the quartz disk, the photomultiplier is behind the former.

All connections between the combustion chamber and the photomultiplier are absolutely light-proof.

Cooling

The photomultiplier is very noisy above 50 °C. The Ex-FPD therefore has an aluminium heat sink on the top part. An explosion-proof fan is fitted in the left wall of the PGC 302 housing and blows ambient air onto the heat sink.

Cabling (Ex version)

- The ignition and signal cables of the FPD are each routed through an EEx-e cable gland into the electronics area of the chromatograph.
- Equipotential bonding of the top and center parts of the FPD is achieved for each part by an equipotential bonding conductor to the chromatograph housing.

Additional heater as option

The Ex-FPD can be supplied with an optional additional heater. Condensation would be formed in the FPD at oven temperatures below 100 °C and have a negative influence on the measuring properties. The detector must therefore be additionally heated if the oven temperature is below 100 °C.

- Without additional heater
  The FPD is screwed with an aluminium spacer onto the chromatograph oven. It then assumes approximately the same temperature as the oven.
- With additional heater
  An insulating plate and a detector heater plate are screwed between the oven and FPD. Mineral wool is positioned above the center and bottom parts of the FPD as thermal insulation.

Two temperature limiters

The Ex-FPD is available in temperature classes T3 or T4. The temperature class is defined and monitored by safety temperature limiters for the combustion chamber and the heater plate.

Heated FPD: Temperature selection

Select the detector temperature to be 20 K higher than the oven temperature, and at least 100 °C. The limit temperature or temperature class must be observed.

Installation instructions

- Capillary columns with an outer diameter < 0.3 mm can be passed through the carrier gas flame trap into the burner nozzle. Thicker columns can be pushed up to the stop.
- Exhaust gas line
  The exhaust gas of the FPD is passed with a PTFE hose through the housing wall to a condensation trap. See Register 3: *Installation*.
- See Register 9 for the electric diagrams.

DETECTOR GAS SUPPLY

The FPD requires the following gases:

Type of gas	Gas quantity
Combustion gas Hydrogen (D1)	75 - 85 ml/min
Combustion air (D2)	110 - 130 ml/min
Make-up gas Synthetic air (D3)	Approx. 10 ml/min

> **IMPORTANT**
>
> The FPD is a very sensitive detector. The gases and their supply lines must be extremely clean if you wish to achieve a high signal/noise ratio.

Selection of carrier gas

Nitrogen, helium, argon or air can be used as the carrier gas. Larger quantities of hydrogen change the flame shape and may make the nozzle glow. Hydrogen can therefore only be used with capillary columns and with carrier gas with flows < 10 ml/min.

Increasing the sensitivity

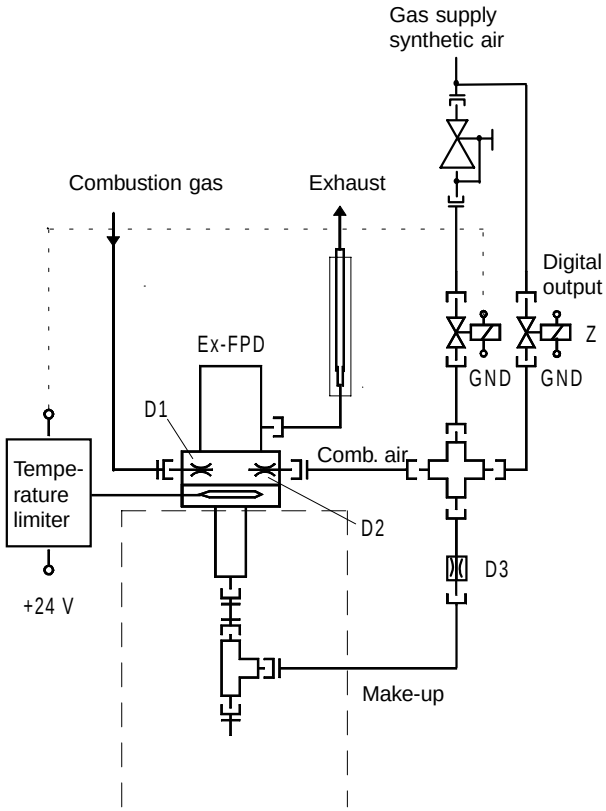
The sensitivity of the FPD can be increased by reducing the flow of combustion air. The highest sensitivity is achieved when the air flow is approximately the same as the hydrogen flow. The FPD cannot be ignited with this air/hydrogen ratio, however. Therefore initially open the solenoid valve *Z* for the higher air flow when igniting, and then close again.

Make-up gas

The addition of synthetic air supplements the small carrier gas volume of capillary columns to the value of packed columns.

Column connection

An extension piece is required in the PGC 302 for the non-Ex version.



Temperature limiter

The surface temperature of the Ex-FPD could rise above the permissible value if the combustion air controller is faulty or if the combustion air flow has been set too high by mistake. This permissible value is defined by the temperature class.

To prevent unacceptable heating-up, the temperature limiter reduces the flow of combustion air early enough by means of a solenoid valve.

> **WARNING: Ex-FPD**
>
> The restrictors D1 and D2 are screw-in parts with soldered capillaries. They are provided for explosion protection and must not be changed.

NOTE: piping diagram for non-Ex version
Deviating from the above diagram, the restrictors D1 and D2 are positioned in the gas inlet lines. The temperature limiter with solenoid valve is omitted.

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Troubleshooting

Cause	Remedy

Observation: FPD is cold:

Heater is turned off	Switch on the heater
Heater or temperature sensor not connected correctly	Connect the cables correctly. See Register 9
Fuse, heating cartridge, Pt100 or heater control element faulty	Replace faulty part

Observation: flame does not ignite

Combustion gas and combustion air connections are reversed or the flow rates are incorrect	Connect correctly or adjust correct flow rates, correct leaks if necessary
Air-poor mixture does not ignite properly	Reduce H_2 pressure before igniting, then reset old value
Ignition spark does not jump from the ignition electrode to the nozzle	Adjust ignition electrode correctly. Check insulation of ignition cable (also in ignition module)
Are 24 V pulses applied to the amplifier terminals?	- Yes: check/replace ignition module - No: replace amplifier
Exhaust gas nozzle is blocked	Clean exhaust gas nozzle
Nozzle is broken	Replace nozzle
Nozzle is incorrectly adjusted	Adjust nozzle

Observation: basic current is too high

Light enters the detector	Assemble detector and photomultiplier so that no light can enter, close oven
Detector temperature is too high	Set lower detector temperature

Observation: baseline is unstable

Damping set too low. Detector is faulty: instability disappears without flame	Set a higher damping
Signal cable defective: instability even without flame	Check as with a high basic current. Remove insulation from signal cable and connect

Observation: baseline drifts if the oven temperature is increased

Column evaporates too much	Select lower oven temperature

Cause	Remedy

Observation: baseline drifts at stable temperatures

Is drift less without carrier gas? - Yes: column is contaminated - No: deposits in foot and nozzle of detector	 - Replace column - Heat detector overnight
Column is contaminated by higher boiling components	Replace column
Cylinder pressure < 5 bar or gas(es) contaminated	Change cylinder immediately

Observation: noise

Damping is too low: amplitude up to 4 pA with damping 0	Enter higher damping Normal when operating without column
Basic current is higher than 100 pA - Detector temperature too high - Multiplier is too hot (>40 °C)	Set higher attenuation - Select lower detector temperature - Improve cooling
Recorder oscillates	Adjust recorder damping

Observation: spikes and/or offsets appear in chromatogram

If the spikes disappear when the signal cable is unplugged, fine dust is present in the gas paths or condensation in the exhaust gas path	Burn out pipes, heat detector
If the signal cable reacts to shock, it is faulty or incorrectly connected	Reconnect cable. Replace bent or crushed cable
Pressure regulator is sensitive to shock - Spikes without offset are normal - Spikes with offset: the pressure regulator is faulty	 Repair or replace faulty pressure regulator
The working environment is not vibration-free	Create vibration-free working environment
If an offset without spikes occurs when switching over the range: this is normal	

Observation: step recording in chromatogram

Attenuation and range do not match	Select smaller range or larger attenuation
Recorder is incorrectly set	Set recorder to 0 to 20 mA

Cause	Remedy

Observation: sensitivity is too low

Leak upstream or downstream of column	Find and eliminate leak
Nozzle is broken	Replace nozzle
Nozzle is incorrectly adjusted	Adjust nozzle, refer to *Replacement of quartz nozzle*
Combustion gas flow too low, combustion air flow too high	Optimize flow rates
Sample quantity too high: FPD is at saturation	Inject smaller sample quantity
Deposit on quartz window or on reflector	Clean quartz window and reflector
Incorrect interference filter fitted	Install correct filter: - appears blue for Sulphur - appears yellow for Phosphorus
Photomultiplier was exposed to daylight with detector voltage applied	Replace photomultiplier
The measured component is superimposed by an interfering component of higher concentration which is not indicated by the FPD. This changes the flame temperature and thus decreases the sensitivity (quench effect)	Improve separation such that the measured component is not superimposed

MAINTENANCE

Regularly check the module temperature, dark current, basic current, noise, sensitivity as well as contamination of quartz disk and reflector.

If the test values deviate significantly from the standard values specified in the application documents, the error must be found and eliminated.

How can I measure the dark current?

- Shut off combustion air
- Close oven
- Switch off compensation.

If the dark current is greater than 10^{-11} A, check whether light is entering somewhere on the FPD (see *Replacement of filter*).

NOTE:
The recorder deflections corresponding to these detector currents can be found in Register 5: *Attentuation* .

Check the basic current!

If you use an unconditioned column, you must wait until a stable basic current has been achieved. This should be approx. 10^{-10} A. If the basic current deviates by more than 50 % from the value in the application data, the detector is faulty or the operating parameters have changed.



IMPORTANT

Components on the Ex-FPD must only be removed or replaced by a trained Siemens maintenance engineer or by the user's maintenance personnel with subsequent evaluation by an approved expert according to §15 Elex V.

Shutting down the FPD

- Do not switch off the FPD! First permit the oven to cool down.
- Shut off the detector gases
- Allow the detector to cool down
- Close the exhaust gas nozzles if the detector is to be shut down for a longer period.

Ex version: replacing the interference filter or photomultiplier

The correct filter must be installed for either sulphur or phosphorus. The filter for sulphur (395 nm) is blue when viewed in daylight, the filter for phosphorus (525 nm) is yellow.



IMPORTANT

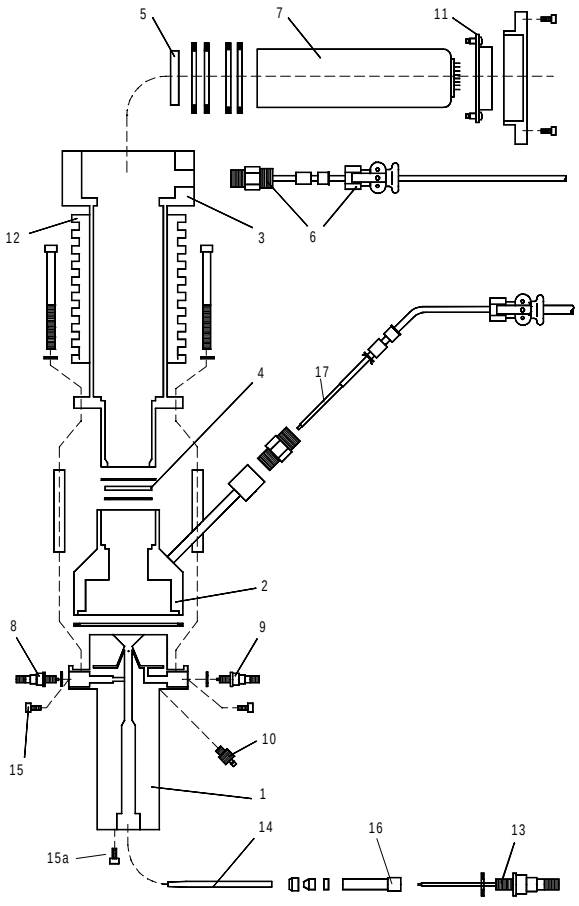
The photomultiplier in the FPD is very sensitive to light. Avoid any unnecessary influence of light on the multiplier, even in the voltage-free condition. Close the light entry window when changing the filter or removing the photomultiplier. Never subject the light entry window to a bright light source.

- Shut down the FPD
- Switch off chromatograph
- Remove metal bracket which secures the top part of the FPD to the housing
- Unscrew the heat sink
- Loosen the 4 screws on the rear metal plate with the cable inlets
- Loosen two cable clamps
- Loosen the two long cylinder head screws with which the top and bottom parts are connected
- Remove the top part from the bottom part. Position the top part horizontally in the chromatograph
- Close the bottom opening of the top part so that no light can enter
- Remove the cover from the top part (four screws)
- Loosen the two screws of the socket and pull off the socket from the tube (11)
- Remove tube from top part
- Push filter out of its seat from below (using a soft rod) and shake out of the top part
- Refit the new photomultiplier tube or the new filter in the reverse order. The reflecting side of the filter must point downwards!
- Check that the detector is light-proof: measure the basic current. The basic current must not become smaller when you cover the FPD with a dark cloth
- Check the measuring sensitivity and selectivity using a test mixture.

NOTE
The basic current and sensitivity of the new photomultiplier may deviate significantly from the values of the old multiplier. A factor of 2 is normal. The detection limit (signal/noise ratio) must only differ slightly, however.

Ex version: cleaning the quartz disk, combustion chamber, reflector

- Remove top part as described under *Replacement of interference filter or photomultiplier*
- Remove center part and push out quartz disk from below
- Wipe quartz disk using a damp cloth. Use alcohol if necessary. CAUTION: do not scratch the quartz disk!
  Replace the quartz disk if it is dull. Take care with the graphite gaskets
- Unscrew the cable inlet and remove the ignition cable. Clean the insulating shaft
- Wipe the inside of the center part and the reflector of the bottom part using a damp cloth
- Adjust the ignition electrode on the side above the combustion chamber. The spark path should be approx. 5 mm long.
- Reassemble detector and start up. Check the dark current, basic current and sensitivity.



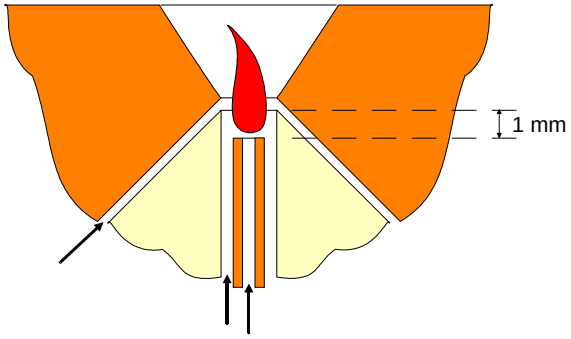
1 Bottom part
2 Center part
3 Top part
4 Quartz disk
5 Interference filter
6 Cable inlet
7 Photomultiplier
8 Combustion air restrictor
9 Combustion gas restrictor
10 Exhaust gas connection
11 Socket
12 Heat sink
13 Column inlet
14 Burner nozzle
15 Anti-rotation element
16 Pressure screw
17 Ignition electrode

Ex version: replacement of quartz nozzle

The top and center parts should be removed in order to check correct installation.

- Unscrew column
- Completely remove anti-rotation element (15a)
- Unscrew the column connection from the bottom part (13)
- Remove pressure screw (16) (hexagon socket SW 4)
- Pull out burner nozzle 20from the oven chamber and pull off the graphite gasket

- Burn out a new quartz nozzle in a flame
- Slide the graphite gasket onto the quartz nozzle
- Introduce the quartz nozzle into the bottom part and adjust: the tip of the nozzle must end 1 mm below



  the annular gap.
- Screw the column connector (13) tight. Make sure that the nozzle is no longer moved.
- Screw in the anti-rotation element (15a)
- Start up the detector and check the dark current, basic current and sensitivity. If the dark current is correct but the basic current is too high, the nozzle has been inserted too high and glows.

Ex version: replacing the heater cartridge and temperature sensor

This is described for all heating elements in a separate section in this register.

Non-Ex version: replacement of interference filter

- Shut down the FPD
- Disconnect two plugs from the multiplier housing: first the detector voltage, then the signal cable
- Loosen two M4 Allen screws
- Place a sack or a large dark cloth over the multiplier housing
- Carefully remove the housing and immediately cover the light entry window with the sack or cloth



IMPORTANT

Never carry the protective pipe with the opening pointing down. The photomultiplier could loosen itself from the socket and be broken.

- Press the two ends of the spring wire ring together using tweezers and lift off the ring
- Remove the cover disk and filter using tweezers
- Insert new filter and cover disk
- Secure the filter using the spring wire ring
- Replace multiplier housing and tighten the two Allen screws
- Connect the detector voltage cable and the input signal cable
- Check the dark current. If it is too large, light is probably entering the FPD. Check the assembly!

Non-Ex version: replacement of photomultiplier

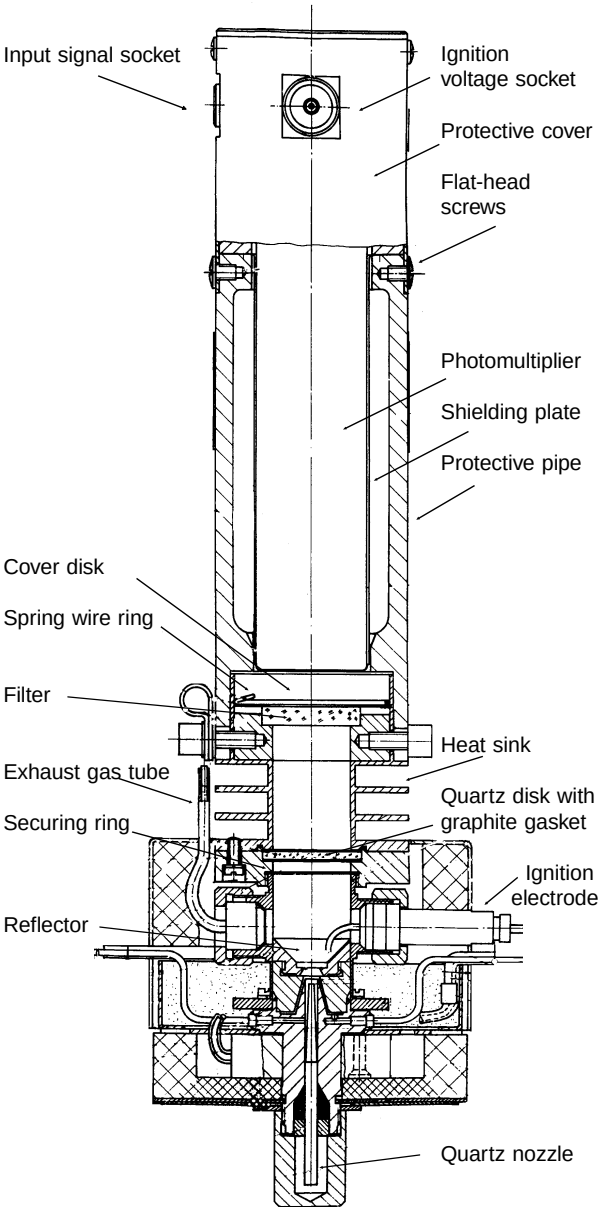
- Remove the multiplier housing as described in *Replacement of interference filter*
- Loosen the two flat-head screws
- Carefully pull the protective cover and the protective pipe apart
- Pull back the shielding plate by 5 cm and pull the photomultiplier tube out of the socket.
- Tilt the shielding plate to the side and pull the photomultiplier tube out of the shielding plate
- Insert new photomultiplier tube in reverse sequence. Avoid bright light
- Insert the grounding cable of the shielding plate completely between the photomultiplier tube and securing ring such that the shielding plate is flush with the securing ring
- Push the protective pipe over the photomultiplier and shielding plate. Make sure it is centered.
- Screw on the protective pipe and protective cover
- Measure the resistance of the detector voltage socket against the housing: setpoint 11.5 MΩ. Eliminate a short-circuit if present before connecting the detector voltage
- Push the photomultiplier with protective pipe onto the heat sink as far as possible and screw tight
- Connect the detector voltage and input signal cables
- Check whether the detector is light-proof: the basic current must not be smaller than when the FPD is covered with a dark cloth
- Check the measuring sensitivity and selectivity using a test mixture

Non-Ex version: cleaning the quartz disk, combustion chamber, reflector

- Shut down the FPD
- Remove the photomultiplier as described under *Replacement of photomultiplier*
- Unscrew heat sink from center part and lift up module cover
- Wipe quartz disk using a damp cloth. Use alcohol if necessary. CAUTION: do not scratch the quartz disk!
  Unscrew zhe holder and replace the quartz disk if it is dull. Take care with the graphite gasket
- Unscrew ignition electrode and clean shaft
- Unscrew the exhaust gas line
- Wipe the center part and reflector using a damp cloth. If stubborn dirt remains on the parts, remove the parts and soak them in solvent or a pickling solution. Polish the reflector. Rinse with methylene chloride and dry the parts in a compressed air stream
- Refit the reflector and center part, install the exhaust gas line and ignition electrode. Adjust the ignition electrode on the side above the combustion chamber. The spark path should be approx. 5 mm long.
- Reassemble detector and start up as described above. Check the dark current, basic current and sensitivity.

Non-Ex version: replacement of quartz nozzle

- Remove photomultiplier as described above
- Unscrew the column connector from the oven chamber
- Pull the quartz nozzle of the oven chamber out of the graphite gasket
- Burn out a new quartz nozzle in a flame
- Insert the quartz nozzle into the graphite gasket and adjust such that the tip of the nozzle ends 1 20mm below the annular gap.
- Screw the column connector tight. Make sure that the nozzle is no longer moved
- Adjust the ignition electrode
- Fit the heat sink and photomultiplier as described above
- Start up the detector. Check the dark current, basic current and sensitivity. If the dark current is correct but the basic current is too high, the nozzle is inserted too high and glows.



Non-Ex version: replacement of heater cartridge and temperature sensor

The heater cartridge and temperature sensor are plugged into an aluminium heating plate. In order to replace them, the detector must first be removed from the chromatograph.

- Switch off the chromatograph and permit the detector to cool down
- Remove the column and the column connector from the oven chamber
- Remove the detector with carrier plate from the chromatograph
- Remove the two screws used to secure the heating plate to the module. Remove the heater plate
- Pull the heater cartridge or temperature sensor from the heating plate. If the parts are tight, punch them out using a 6 mm or 3 mm diam. punch. If the FPD has always been operated at high temperatures, the heater cartridge may be fused to the heating plate. In this case the complete heating plate must be replaced
- Spray the new heater cartridge with graphite spray as lubrication, and insert
- Insert a fiber-glass hose as additional insulation over the connection wires up to the plate, and screw tight with the cable group.

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4.4 Electron Capture Detector

Uhe Electron Capture Detector (ECD) is very sensitive to substances with high electron affinity. It is used primarily for the analysis of halogenated hydrocarbons. The ECD may not be operated in the PGC 302 Ex.



Fig. 4.4.1 ECD module

Measurement Principle

Beta particles escape from an Ni^{63} foil. They hit the carrier gas molecules and generate free slow electrons through shock ionization. Sample substances with high electron affinity capture part of these electrons. The captured electron volume is proportional to the substance volume present. The electron concentration in the ECD measurement chamber decreases accordingly.

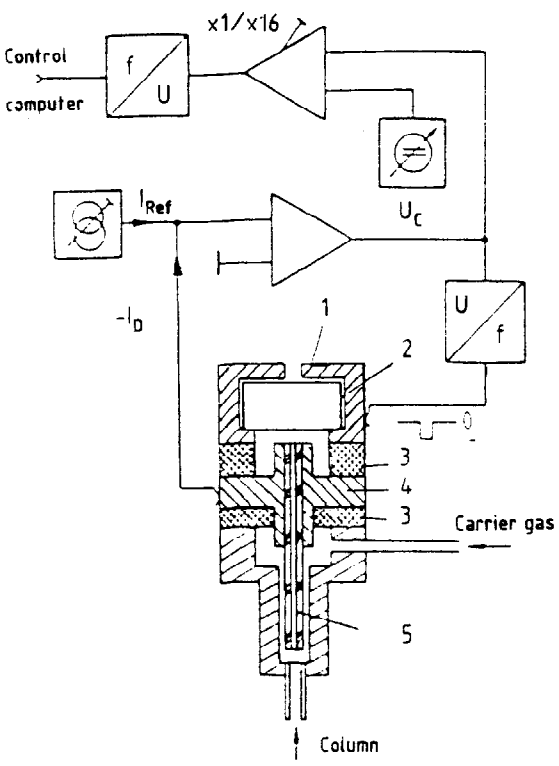


Fig. 4.4.2 Principle circuit diagram of the ECD

A pulsing square voltage of constant amplitude and constant pulse width is applied at the electrodes of the measurement chamber. It periodically collects the free electrons. This creates current pulses, which are proportional to the charge carrier concentration in the measurement chamber. To achieve a high linear range, the pulse frequency is regulated such that the resulting current is constant and equal to the reference current. This means:

The higher the substance volume with high electron affinity, the lower the electron concentration in the measurement cell and thus the current pulses. To achieve a constant measurement current, the pulse frequency must be increased. The amplifier output signal increases proportionally with the pulse frequency and thus with the substance volume.

1	Cathode (ionization chamber)
2	Radioactive foil
3	Ceramic insulators
4	Anode
5	Glass nozzle
I_D	Detector current (average value from the current pulses)
I_{Ref}	constant reference current
U_K	Compensation voltage

Technical Data

Detection limit	< 5 x 10^{-14} g Lindan/s
Linear range	10^3 to 10^4 (substance dependent)
Selectivity	Approx. 10^6 : 1 Lindan to n-hexane
Maximum operating temperature	350 °C
Activity	10 mCi = 3.7 x 10^8 Bq
Ignition protection	none

WARNING: **You may n e v e r open the ECD !**

According to Radiation Protection Regulations, the ECD is considered an open emitter and subject to government control. Please observe the existing regulations and requirements of your user authorization

Configuration

The ECD module consists of the ECD in a heating pot, a carrier plate and a heating plate. A heating cartridge is plugged in the heating pot and heating plate; they are switched in series. A Pt 100 temperature sensor is plugged in the heating plate. The three parts are screwed together to form one unit and covered by an insulated cover. The detector can be heat regulated to 350 °C.

The ECD consists of:
- a lower section with connectors for the separation column, welded connection pipe for additive/purge gas, glass nozzle,
- upper section with measurement cell, measurement electrode and pulse cable,
- the cover with exhaust gas nozzle.

All metal parts are made of stainless steel (V4A, material no. 1.4571). The ionization chamber is made of ceramic.

Installation Instructions

The ECD is installed on the unheated module slot on the oven. To connect the separation column in the oven chamber, an extension piece must be screwed to the screw connector for the separation column connector on the detector. A special adapter can be used to connect the separation column. If an additive gas is required (when operating with capillary columns), a triple adapter is necessary.

Connection terminals for heating cartridge, temperature sensor and detector power supply and signal socket for the signal cable are located on the connector board behind the detector. The connections are detailed in the circuit diagrams in Section 9.

The connection lines for heating cartridge and temperature sensor are encased in white fiber glass hose. The cable for the heating cartridge is marked red.

Detector Gas Supply

Additive/Purge Gas
The ECD requires nitrogen or a mixture of argon and 5 - 10 % methane for the ionization. One of these gases is supplied as additive via needle valve NV, independent of the carrier gas stream. It is also used as purge gas for the ECD cell.

The outer purging is used as oxygen barrier to the atmosphere. It is supplied via a pressure reducer, Class 6 (= 35 ml/min N_2 at 2 bar). The outer purging discharges through a ring slit between ionization chamber and protective cover.

Carrier Gas
Nitogen or argon-methane are used as carrier gas as well. When operating with capillary columns, helium or hydrogen can also be used as carrier gas.

Please Note:
- If nitrogen is used as carrier gas as well as additive, the sensitivity and the linear range of the ECD are highest.
- If the argon-methane mixture is used, the basic current is lower, however, the sensitivity of the detector as well.
- When operating with capillary columns helium or hydrogen as carrier gas can decrease the sensitivity to one third compared to nitrogen.

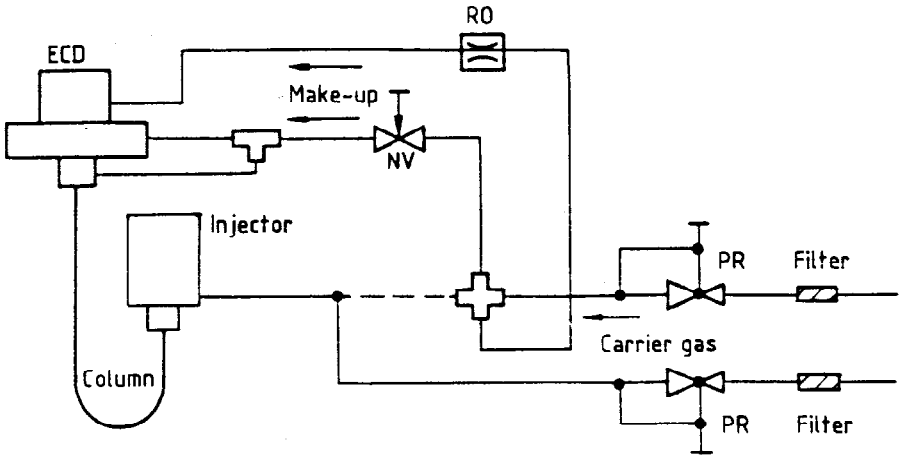


Fig. 4.4.3 ECD gas supply

The ECD can be supplied with gas in two ways (refer to Fig. 4.4.3):
1. Carrier gas and aditive are supplied via various pressure regulators. In this case, capilarry columns can be operated with helium or hydrogen as carrier gas.
2. Carrier gas and additive are supplied via o n e pressure regulator and are therefore the same. In this case, only nitrogen or argon-methane can be used as carrier gas.

Required Gas Flow Rates
The efficiency of the ECD depends on the gas stream through the measurement cell. The total gas flow through the ECD measurement cell should be 15 ... 50 ml/min. The optimum value lies at 35 ml/min.

If the column flow is too low, a gas must be added via needle valve NV. Adjust the valve such that the total gas flow at the ECD outlet at the module head is approximately 35 ml/min.

When operating the ECD with packed column, make sure, that at least 5 ml/min gas flows through the needle valve (NV), because the additive is also used as purge gas.

Supply Gas Purity
The ECD is a high sensitivity detector. It reacts very sensitively to contamination. Especially water and fluoro-chloro-hydrocarbons inhibit the ECD operation significantly. The supply gases must therefore meet the following requirements:

The gases must be highly pure. They may not contaminated by substances which have a high electron affinity. Nitrogen must have a purity degree of at least 5. Several gas suppliers offer specific ECD nitrogen, which is especially halogen and O_2 poor (fluoro-chloro-hydrocarbon content $\leq$ 10 vpb).

Supply Line Requirements
The gases must be supplied to the detector dry and free of oxygen. Therefore d o n o t use hose connections. Use o n l y cleaned steel or copper pipe for the supply gas lines. We recommend to anneal the pipes in an inert gas stream.

Exhaust Gas Line
A 2.4 x 0.4 mm Teflon hose is connected to the exhaust gas nozzle on the ECD head. This should be connected with an exhaust gas connector or discharged to the outside to discharge micro particles in a controlled manner. It is imperative to follow the regulations in your user authorization.

Operating Instructions

Separation Column
Use only well annealed separation columns!

N e v e r connect an unconditioned or contaminated separation column to the ECD. Part of the stationary liquid bleeds during conditioning. This would contaminate the radioactive foil. Therefore fewer primary electrons would be available for shock ionizytion which would cause the base line to rise. For the same reason, do not use separation columns containing oxygenous phases or phases with high electron affinity.

Detector Temperature
Select the detector temperature as high as possible to prevent condensation of contaminants on the radioactive foil or the ceramic insulation. The basic current would increase or a leakage could occur (negative display).

Set the detector temperature to 280 °C. If necessary, higher temperatures can be used. The detector temperature should be at least 20 °C higher than the highest analysis temperature, however, no higher than 350 °C. At higher temperatures the ceramic becomes conductive enough to cause interfering leakage.

Reference Current
The reference current influences the relative response factor of various components. Please adjust the value as close as possible to the specifications in the application documentation.

A low reference current causes a low basic current, but also low sensitivity and dynamics. The reference current should therefore always be at least 1 nA. The optimum sensitivity for many components is at 1 to 1.5 nA. If the detector is contaminated, an excessive reference current can cause a basic current which is so high, that is can no longer be compensated.

ECD Shut-Down

When turning off the ECD heat and removing the column, seal the separation column connector on the ECD and ECD outlet with an annealed blind plug. Follow the instructions "Operation with ECD" when the ECD should be operated again.

ECD Troubleshooting

Observation	Cause	Correction
Module remains cold.	Heater is turned off.	Turn on heat.
	Heating cartridge/temperature sensor not connected/defective.	Connect/replace heating cartridge/temperature sensor.
Basic current is too high.	Oxygen enters, leaks in • Measurement chamber • Separation column connector • Solvent vapors diffuse into carrier gas path.	Have ECD repaired. Seal separation column connector using aluminum gasket. If connector still leaks, check sealing surface in detector foot and separation column connector, rework if necessary.
	Measurement electrode does not make contact.	Have ECD repaired.
	Ceramic insulators of inonization chamber are conductive, because • Leak test foam has entered. • Vapors of the separation column have condensated in the ECD. • Detector temperature is too high.	 Have ECD cleaned. Have ECD cleaned. Select lower detector temperature.
	Supply gases are contaminated by fluoro-chloro-hydrocarbon, H_2O, O_2.	Only use ECD quality N_2.
	Separation system is contaminated.	Partial cleaning or general cleaning as described in maintenance section.
	Dirty graphite gaskets in Live-T piece, screw connections contaminate ECD.	Anneal graphite gaskets and prepressed devices before installation.
	Wrong purge gas	Use N_2 or Ar/CH_4.
	Gas flow rates incorrect.	Optimum flow volume 35 ml/min.
	Detector temperature too low, condensate on radioactive foil.	Adjust higher temperature, max. 350 °C.
	Reference current too high.	Set lower reference current, 1 to 1.5 nA .

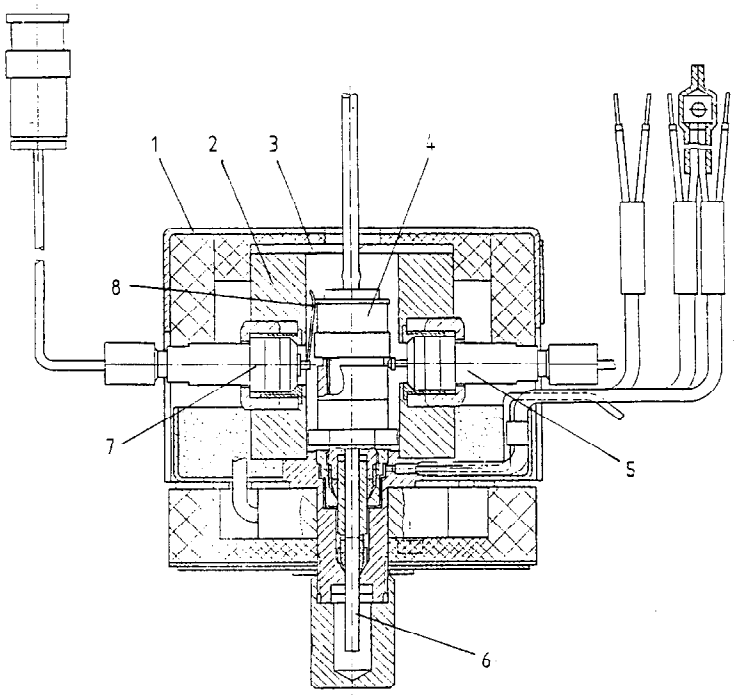
Detectors

Observation	Cause	Correction
Base line drift.	Contamination in separation system.	Correction as described under basic current.
	System leaky, fluoro-chloro-hydrocarbon or O_2 diffuses into the system.	Correct leaks.
	Carrier gas and purge gas volumes not optimal.	35 ml/min is optimal.
	Detector temperature not high enough.	Set higher detector temperature, max. 350 °C.
Sensitivity is too low.	Screw connection column connector leaks.	Tighten screw connection, replace gasket for separation column connector if necessary.
	Injection device contaminated.	Perform maintenance on injection device.
	Leak in system.	Find and correct leak.
	Glass tube too far in ionization chamber because it is not secure.	Pull glass tube down from detector foot direction using tweezers. If glass tube is loose, have ECD repaired.
	Glass tube is broken.	Have ECD repaired.
	Capillary column too deep in detector: ionization path is too short.	Insert column max. 15 mm.
	Purge gas/carrier gas not suitable.	Refer to detector gas supply.
	Wrong gas flows through the ECD.	Optimum 35 ml/min.
	Detector temperature is too low.	Increase detector temperature.
	Reference current is too low.	Increase reference current.
Basic current is negtive.	Reference current is too low.	Adjust 1 to 1.5 nA.
Linear range is too low.	Reference current is too low.	Adjust 1 to 1.5 nA.
	Glass tube is offset.	Pull down from detector foot direction using tweezers.
	Glass tube is lose/broken.	Have ECD repaired.
	Wrong carrier gas for packed columns	Use N_2 or Ar/CH_4.
	Gas flow not optimal.	35 ml/min is optimal.
	Basic current too high (> 4 oder 5)	Lower basic current than specified under basic current.

Maintenance

Important: The ECD contains a radioactive foil. It may therefore only be opened by expert and authorized personnel. You may perform the following work on the ECD yourself (refer to Fig. 4.4.4):

- **If the detector signal has increased noise, the electrode connections should be checked and cleaned. The contact spring to the measurement chamber must retain its position.**
- **If the contact spring no longer has contact to the measurement chamber, the cover plate of the heating pot can be removed and the contact spring readjusted.**



1 Protective cover
2 Heating pot
3 Cover plate of the heating pot
4 Measurement chamber
5 Pulse electrode
6 Glass tube
7 Measurement electrode
8 Contact spring

Fig. 4.4.4 Sectional view of the ECD

Observe the following during leak tests:
N e v e r test the entire ECD separation system using soap solvent, Nekal, Snoop, etc. The graphite gaskets would saturate and could pass it on to the carrier gas. If foam enters the ECD and deposits on the ceramic insulators of the ionization chamber, the insulators become conductive and can no longer be used.

Clean Separation System

- **General Cleaning**
  Remove all pipes and anneal the pipes under gas flow (H_2). Heat the pressure regulators over night at 80 to 100 °C. Disassemble the needle valve for purge gas, heat the housing, needle and gas distributor, replace the Teflon gasket or heat it, anneal the graphite gaskets. Anneal the purge gas line of the ECD under flow. Heat the ECD 1 to 2 days under H_2 flow at 350 °C. Heat the injector without separation column 1 to 2 days under flow at maximum injector temperature. Adjust the maximum possible oven temperature (160 °C for membrane valves, 200 to 250 °C for rotary slide valves).

- **Partial Cleaning**
  Heat the purge gas line under flow. Anneal the separation column connector with graphite gaskets. Install purge gas line and column connector. Heat the ECD over night under (H_2) flow at 350 °C and the maximum possible oven temperature.

5 OVEN

The PGC 302 is available with one or two separate ovens. Each oven contains all elements that must be heated to analysis temperatures for chromatographic reasons:

- Separation columns
- Gas injection valve (6-way membrane valve, rotary slide valve)
- Thermal conductivity detector, TCD
- Membrane valves for separation column switching
- Live-coupler for separation column switching in Live technique
- Needle valves for flow adjustment

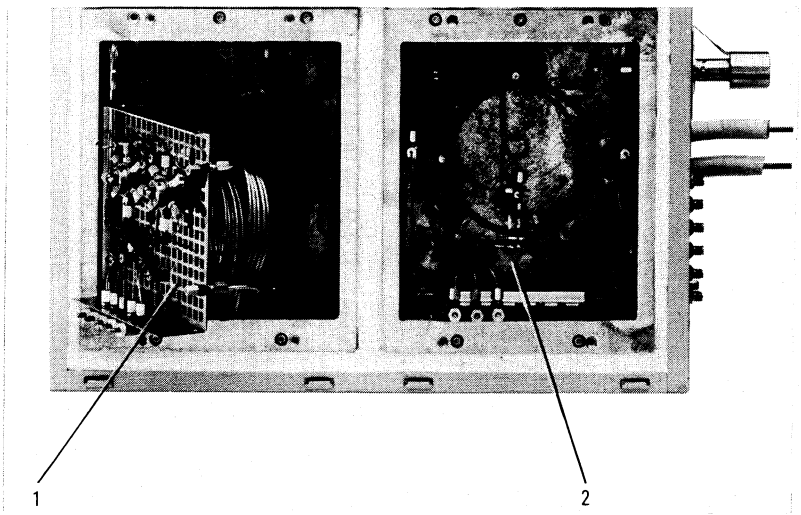
Configuration

The oven is a cubic aluminum case. One side is open. An aluminum cast box is connected as oven door. The oven is heated by two heating plates which are screwed to the floor and oven ceiling from the outside. The heating plates are permanently attached to the front cross piece, which is twice as thick as the oven wall. The oven door rests on this cross piece of the oven chamber. This ensures optimum thermal transfer between oven wall and oven door. Oven chamber and door are insulated with ceramic glass wool.

The lower heating plate spans over the entire oven width, the upper heating plate over 2/3 of the oven width. The upper heating plate has a heated module installation slot for the FID, which does not have a separate heater. Next to it is an unheated installation slot for modules with separate heaters, such as liquid injection valve, FPD and ECD.

The inside contains installation slots for needle valves, membrane valves and thermal conductivity detector (TCD). If the membrane valves should be installed in the oven, a lattice door is installed in the oven. The mounting strip for needle valves is secured to this lattice door; the needle valves are otherwise secured directly to the oven wall. The membrane valves are installed on the front of the lattice door. The lattice door with installation parts extends into the door chamber. This frees the oven chamber for separation columns and TCD.

The oven door has drill holes for the adjustment spindles of the needle valves. This permits adjustment of the needle valves with the oven closed.



1 Right oven
2 Left oven

Fig. 5.1 Oven chambers, doors removed, on the left with lattice door

Maintenance

Open and close oven

- Open the lower door of the chromatograph.
- Losen the four inbus screws in the oven door. This losens the door insert which is attached to the cross piece on the oven chamber.
- Remove the screw used to secure the door to the housing.
- Lift the door plate from the guides.
- Close the oven in reverse sequence. Do not forget to screw the door insert securely to the cross piece of the oven.

Replace heating cartridge, temperature sensor

Heating cartridge and Pt 100 temperature sensor are plugged into the heating plate. If they are defective, the parts can be replaced. The heating plate must be removed for this purpose. If the heating cartridge is fused to the heating plate, the heating plate must be replaced.

Remove heating plate (refer to Fig. 5.2)

Steps marked with * apply only to the PGC 302 Ex !

- **Remove upper heating plate**
  - Turn off the power on the main switch.
  - Open the oven and let it cool.
  - Remove the modules on the oven with the defective oven heating plate.
  - Remove the securing plate for the modules. Remove the insulation material. The heating plate is now visible.
  - Disconnect heater, temperature sensor from the connection terminals in the shaft.
  - From the front, losen the screw used to secure the heating plate to the cross piece.
  - From the top, losen the screws used to secure the heating plate to the oven.
  - Remove the heating plate.
  - * Losen the screw connection of the protection pipe. Unscrew the protection pipe.
  - Losen the securing screws for heating cartridge, temperature sensor and pull the defective inserts from the heating plate.
  - Replace the defective parts and tighten the securing screws.

- **Remove Lower Heating Plate**
  - Open the oven and let it cool.
  - Disconnect the heating cartridge, temperature sensor from the connection terminals in the shaft.
  - Unscrew the floor plate from the PGC 302 housing. Remove the insulation material. The heating plate is now visible.
  - From the front, losen the screw used to secure the heating plate to the cross piece.
  - From below, losen the screws used to secure the heating plate to the oven.
  - Remove the heating plate.
  - * Losen the screw connection of the protection pipe. Unscrew the protection pipe.
  - Losen the securing screws for heating cartridge, temperature sensor and pull the defective inserts from the heating plate.
  - Replace defective parts and tighten the securing screws.

Install Heating Plate

- Remove all of the ceramic insulation from the contact surface of the oven.
- Lubricate the heating plate with thermal conductivity paste and place the plate on the blank oven wall.
- Lightly secure the heating plate to the oven wall using the four screws.
- * Guide the supply lines for heating cartridge and temperature sensor through the protecton pipe to the connection terminals in the shaft. Secure the protection pipe to the heating plate.
- Secure the heating plate, from the front, to the cross piece using two screws.
- Tighten the four screws used to press the heating plate to the oven wall.
- Connect heating cartridge, temperature sensor to the connection terminals in the shaft. The connections are specified in the circuit diagram.

Temperature Regulation

Each heating plate contains two heating cartridges and one Pt 100 temperature sensor. Their temperature is regulated separately for the desired oven temperature. The desired temperature for the oven temperature, however, is entered simultaneously for the two regulator paths of an oven (refer to "Operation via Keyboard and Monitor: Temperatures").

PGC 302 Ex

The heating plate is encapsuled and pressure proof. The connection lines for heating cartridges and Pt 100 temperature sensor are fed into the pressure encapsuled chamber through a protection pipe and connected. The protection pipe is screwed to the heating plate and sealed at the separation wall to the ventilated shaft. The protection pipe has cross drill holes for purge gas discharges.

The temperature of each heating plate is monitored by a safety temperature limitor. The capillary tube sensor of the temperature limitor is inserted in the oven heating plate, the switching contact of the temperature limitor is switched in series with the heater.

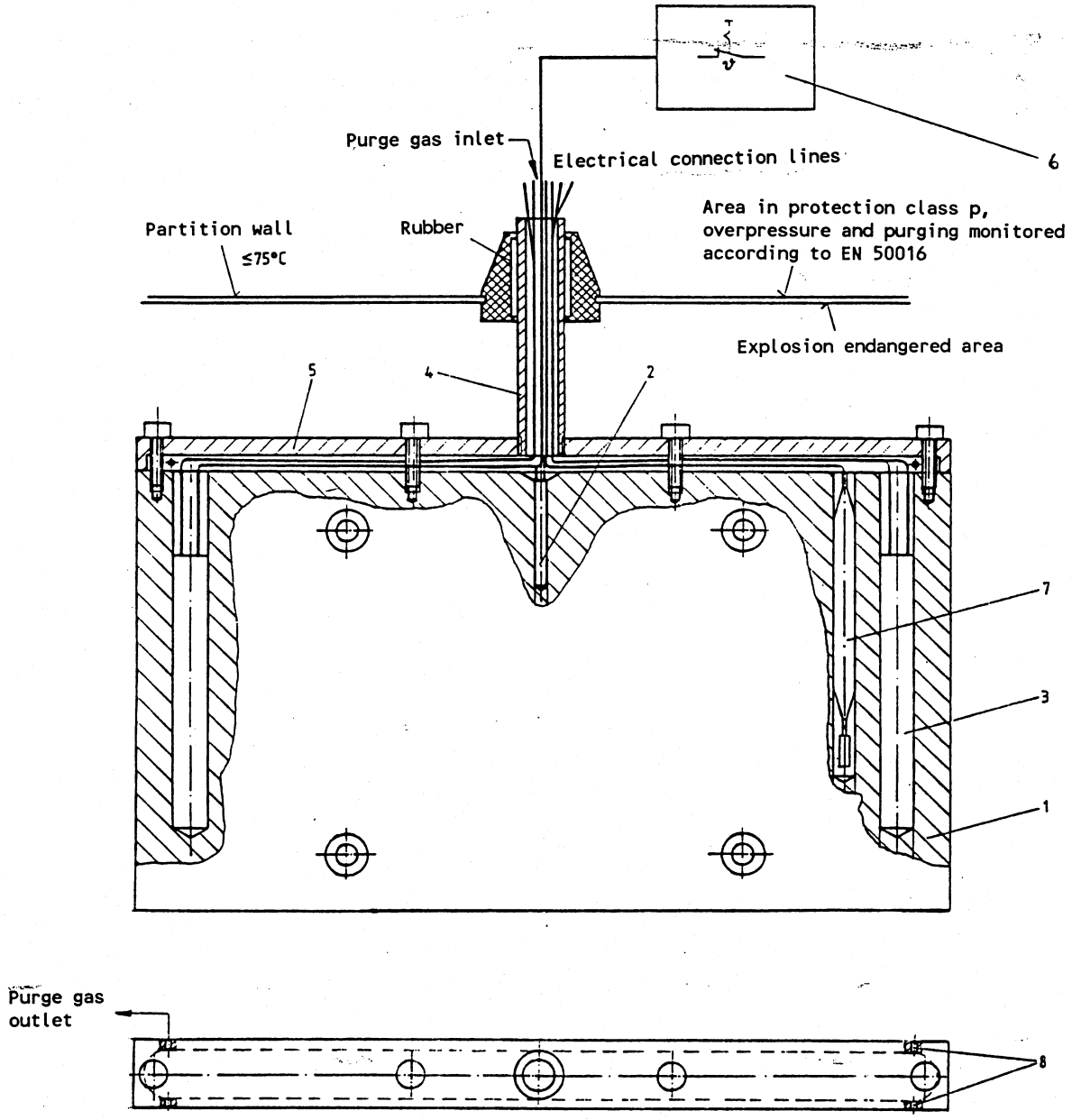
Safety Temperature Limitor

The temperature limitor has a capillary tube sensor which is filled with liquid. If the temperature of the heater exceeds the permissible ignition class temperature, the liquid in the capillary presses on the membrane of a membrane switch and turns the heater off. If the capillary of the sensor breaks, the membrane switch turns the heat off as well. The membrane switch is installed in the ventilated shaft behind the oven. The heater is released again only after the reset switch on the membrane switch is depressed.

Technical Data

Dimensions in mm (W x H x D)	224 x 262 x 214
Heating capacity per oven	2 x 500 W
Temperature gradient in oven	±2 °C at 180 °C
Temperature stability at constant ambient temperature	±0,1 °C
Adjustable oven temperature	60 to 180 °C (T3) 60 to 280 °C (T2)
with cooling accessory	5 to 180 °C
Heat up time from 20 to 180 °C	Approx. 60 min
Double Oven Instrument	
Temperature of the colder oven, if the hotter oven has 200 °C	≥80 °C

Important: After a new heating plate has been installed, the PGC 302 Ex must be recertified by an expert according to ElexV §9, before it can be restarted.



1 Heating plate
2 Pt 100 temperature sensor
3 Heating cartridge, connection line marked red
4 Protection pipe
5 Cover
6 Safety temperature limitor (only with PGC 302 Ex)
7 Capillary tube sensor of temperature limitor (only with PGC 302 Ex)
8 Discharge openings for purge gas

Fig. 5.2 Lower oven heating plate

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COLUMN SWITCHING

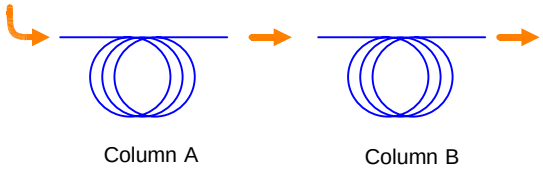
Column switching provides many advantages with its various operating modes *Straight, Backflush, Cut.*

Two columns are usually connected in series. The columns have e.g. different separating characteristic or different temperatures.

More complex switching is possible depending on the problem. The type of switching used in your chromatograph can be found in the application documents.

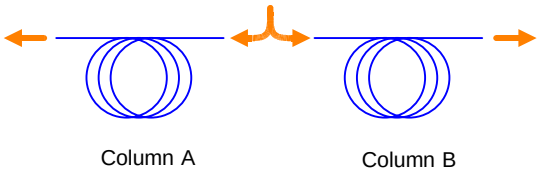
Straight

The components pass through columns A and B in succession.



Backflush

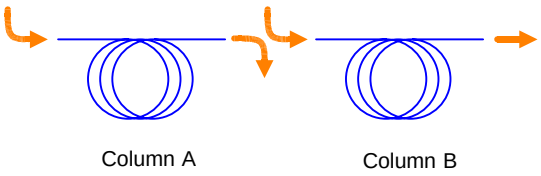
Once a number of components have passed through column A, the flow direction in this column is reversed. The components which are still present in column A are collected again at the beginning of this column and flushed out into the open air via the backflush outlet or as a backflush total to a detector.



This permits the analysis cycle to be drastically shortened: higher boiling components which only pass through column A slowly need not be removed at a higher temperature, a process which often requires a long time.

Cut

Once a number of components have passed through column A, they are flushed out through the cut outlet. They never reach column B.



This method is used

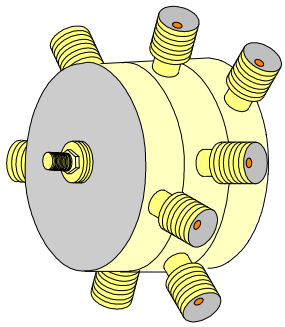
- to keep components away from column B which cannot be backflushed because they are followed by components which are still of interest
- if components falsify the result or damage column B
- to directly pass components onto a further detector, e.g. in order to shorten the duration of the analysis
- to divide components further on a third column (distribution).

Live switching or diaphragm valve?

The columns can be connected using the live T-piece or diaphragm valves.



Live T-piece



Diaphragm valve

Advantages of live switching

- The sample only comes into contact with metal parts in the live T-piece
- There are no temperature imitations because the switching valves are mounted outside the oven
- Maintenance-free since there are no moving parts
- Minimum dead volume, highly suitable for capillary columns.

Disadvantages of diaphragm valve switching

- The sample comes into contact with plastic components in the valve (Viton/Teflon)
- Influence of diffusion through the diaphragm
- Dead volume too high for capillary columns
- The maximum analysis temperature is 150 °C.

Live switching

The two columns are connected by the live T-piece. The sample then only comes into contact with a platinum-iridium capillary, but not with valves. The various operating states of the live switching are activated using solenoid valves in the gas supply line.

To make live switching function correctly, you must first adjust the flows using needle valves. This description includes:

- 4 pages: How live switching functions
- 2 pages: Adjustment of live switching
- 2 pages: Fault diagnosis.

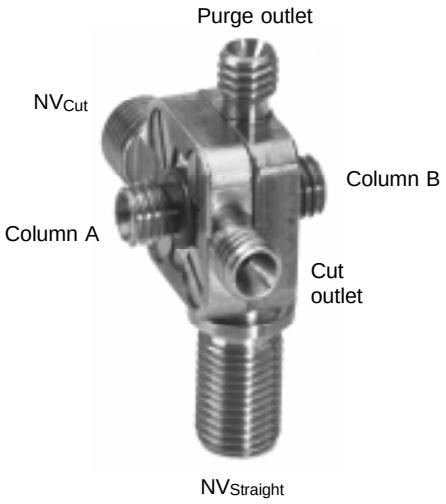
Mounting of columns on the live T-piece

- The side with the long, thick connection is always the column B side. The figure shows the assignment of the connections.
- Insert column into live T-piece as far as possible, and then pull back by 1 mm
- Tighten screwed gland. Do not move the column in the process. This can be guaranteed if you previously compress the gasket such that it can just still be moved on the column.

CAUTION

Do not insert the column next to the coupling capillary! It will otherwise break off.

For capillaries with a solid stationary phase (plot columns): first scratch clear the end of the column using a drill and with the carrier gas flowing. Contamination may block the coupling capillary or the clearance!



Live T-piece for capillary columns

Selection of live T-piece

Different live T-pieces are required for the different column diameters. The following table lists all live T-pieces. Ideal for capillary columns: the internal diameter of the column should be 20% greater than the outer diameter of the coupling capillary.

Columns Internal diameter [mm]		Coupling capillary Outer diameter [mm]
Packed	3	2.8
	2	1.8
Capillary	0.2 ... 0.22	0.17
	0.25	0.20
	0.32	0.27
	0.53	0.43

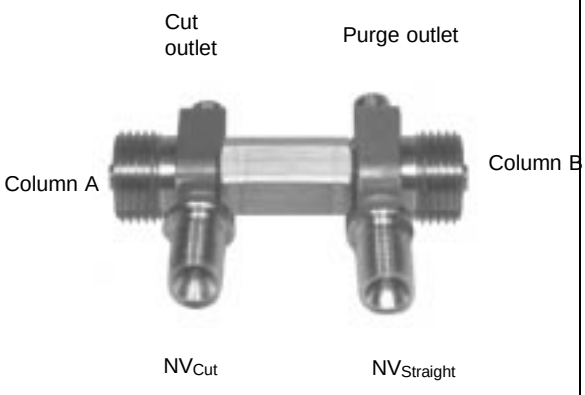
Identification of coupling capillary diameter

The small metal plate of the coupling capillary is bent on the side of the live T-piece. The exact outer diameter of the coupling capillary is printed on this.

Column diameter

Column A and B usually have the same diameter. The following applies if columns A and B have different diameters: selection of the appropriate coupling capillary depends on the thinnest column.

Golden rule: good functioning is always achieved if the diameter of column A is smaller than that of column B. You can expect problems if the reverse is the case!



Live T-piece for packed columns

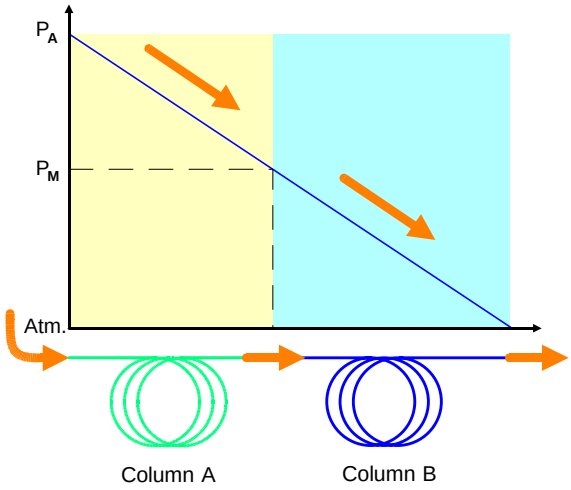
Four pages ... - and you know how live switching functions!

Pressures and flows are important

Two columns are connected in series, and a pressure of P_A is connected to the beginning. Atmospheric pressure is present at the end. The pressure distribution and flows are then as shown on the right.

Conclusion:
In the straight operating mode shown here, the pressure P_M is present in the middle between the two columns.

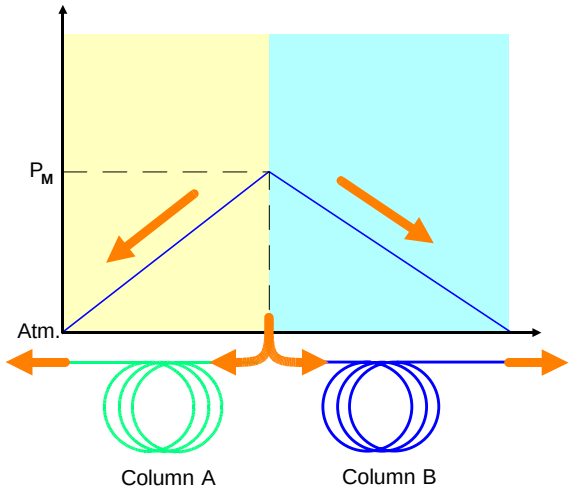
NOTE:
In reality, the pressure drops are not linear, they are curved.



Time for reflection

The pressure P_M read on the Y-axis in the above figure is now applied between the two columns. The input of column A is left open. This results in a pressure distribution and flows as shown on the right.

Conclusion:
Backflushing is now being carried out in column A.

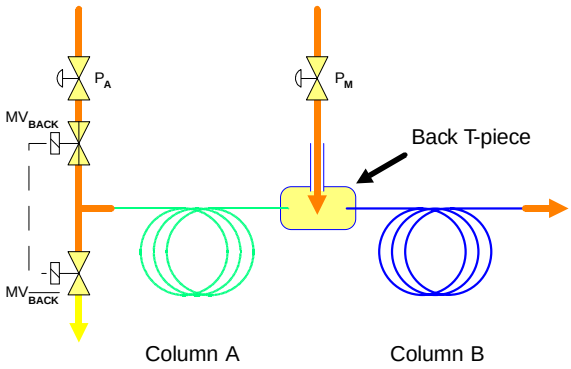


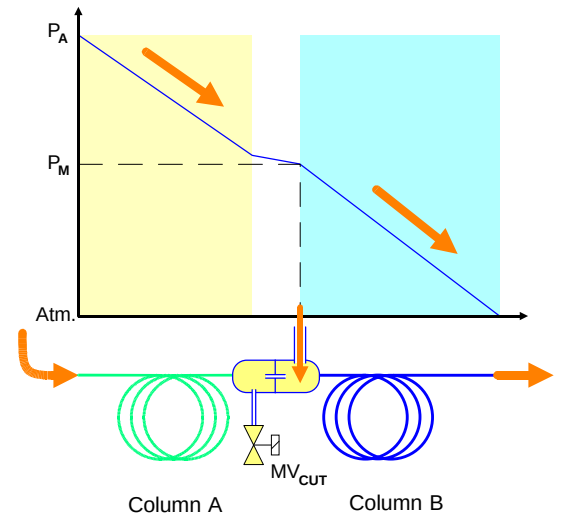
The solution: the back T-piece

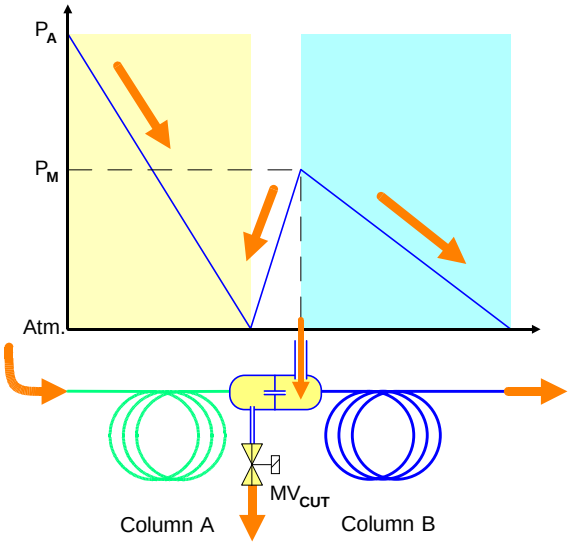
If we connect the two columns using the back T-piece and add the two solenoid valves MV_{Back} and $MV_{\overline{Back}}$ we have completed the backflush circuit!

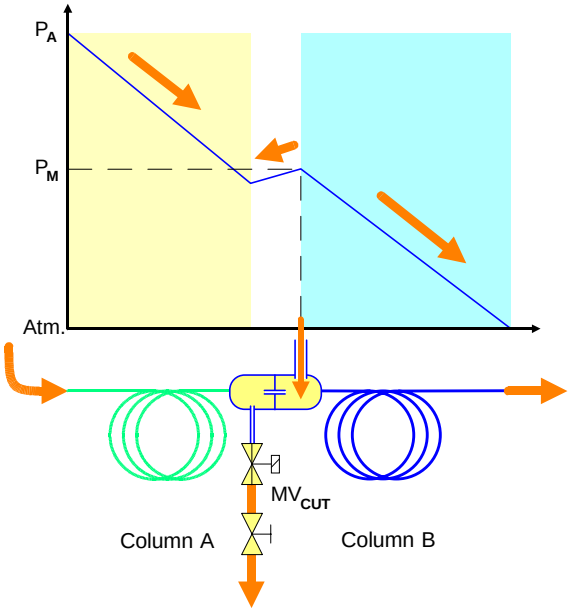
Straight operating mode
MV_{Back} is open, $MV_{\overline{Back}}$ closed. The figure at the top fits again.

Backflush operating mode
MV_{Back} is closed, $MV_{\overline{Back}}$ open. The center figure fits here.









What we don't know yet

If we wish to prevent a specific peak from disappearing into column B once it has passed through column A, we need a separation between the two columns and also an outlet for the cut. The solution is the live T-piece.

We can imagine two combined back T-pieces with a coupling capillary in their common center wall.

Straight: new pressure conditions

The coupling capillary in the live T-piece has a higher flow resistance than a section of column of the same length. Our pressure response therefore has a kink.

That doesn't worry us because solenoid valve MV_{Cut} is closed. The result is initially the same as for straight operating mode on the previous page.

And now the cut

We open the solenoid valve MV_{Cut}. The result is shown on the left. The components are flushed into open air as soon as they leave column A.

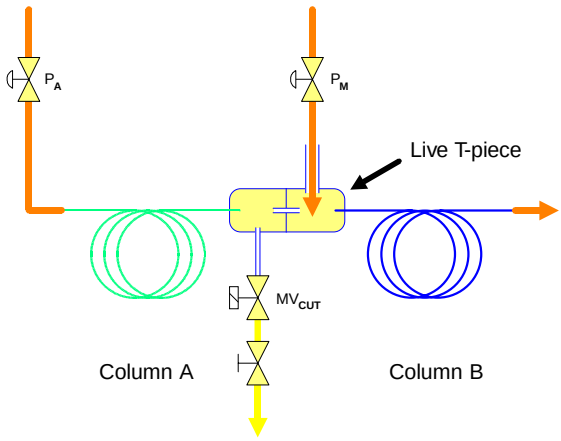
What we don't like

If we open the solenoid valve MV_{Cut}, the pressure there drops to atmospheric. That is not what we want. We therefore fit a resistance, e.g. a needle valve, downstream of the solenoid valve.

The pressure on the solenoid valve then only drops a little when we open it. But the cut functions nevertheless: because the pressure to the left of the coupling capillary is lower than on the right, all gas from column A must pass to the cut outlet!

Resulting design of switching

This switching is known as Deans switching.



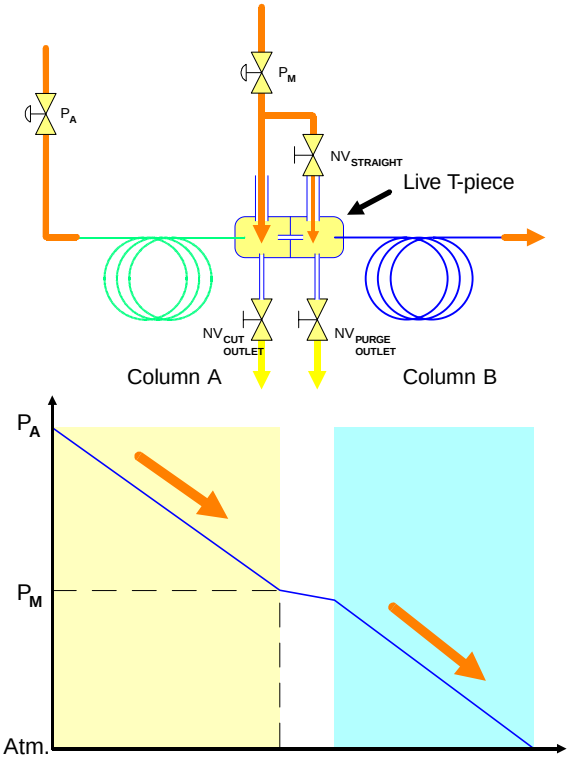
Away with the solenoid valve!

A significant advantage of live switching should be that the sample does not come into contact with valves. We must therefore find another way of controlling the pressure difference via the coupling capillary.

We need another two connections on the live T-piece with associated needle valves, and also the needle valve $NV_{Straight}$.

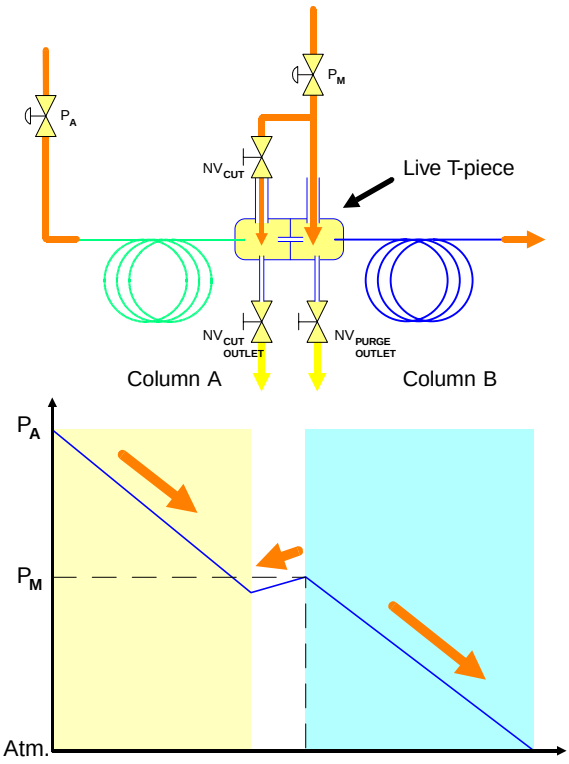
Straight

We connect P_M on the left of the T-piece, and restricted via $NV_{Straight}$ on the right. The pressure on the right is approx. 20 mbar lower than on the left. The pressure profile already appears as at the top on the previous page for *Straight: new pressure conditions*, i.e. switching also functions!



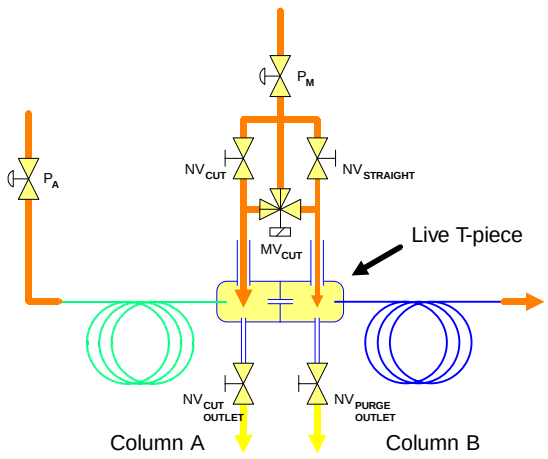
Cut

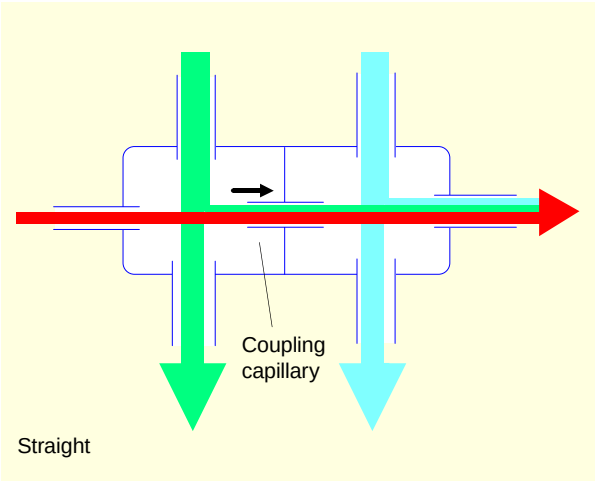
If we connect P_M on the right of the T-piece and restricted via NV_{Cut} on the left, the pressure on the left is approx. 20 mbar lower than on the right. The pressure profile then appears as on the previous page under *What we don't like*, i.e. this switching also functions!



The solenoid valve must return!

But at a position where no sample passes by. We use this solenoid valve to switch back and forth between straight and cut by bypassing one of the needle valves in each case. The same pressure profiles result again as shown on the right.





If it really were that simple ...

... then we would be finished. Why does live switching therefore have to the adjusted?

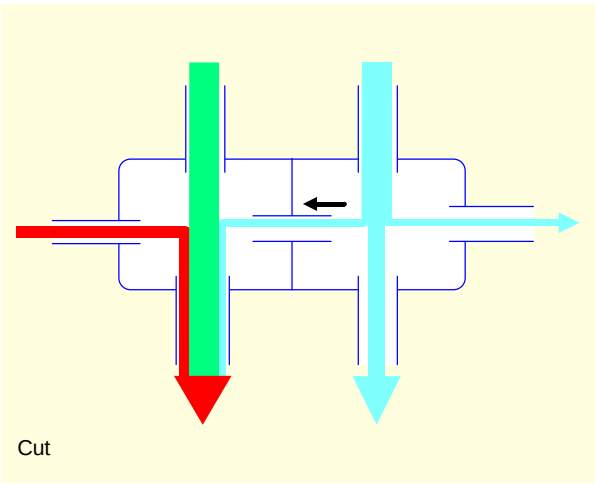
The live T-piece has 6 connections, of which 3 can be outputs. This means that a peak can be divided simultaneously amongst 3 outputs. And we can do without that!

We can understand this better if we consider the flows in the live T-piece.

Straight

Everything from column A must enter the coupling capillary, and everything from the coupling capillary must enter column B. This functions reliably if the flow is supplemented by the flows of the auxiliary inlets.

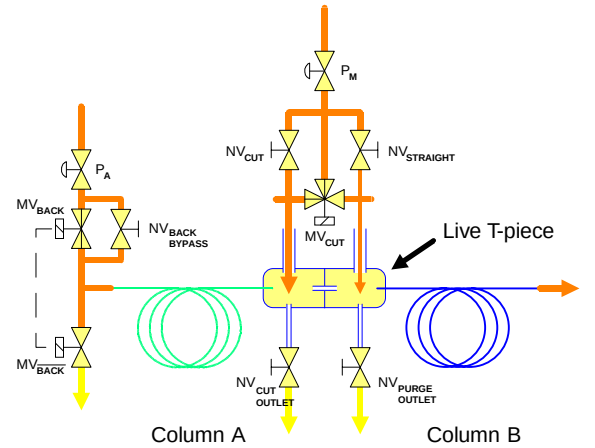
The flow in the coupling capillary is from left to right.



Cut

Everything from column A must pass on to the cut outlet. This functions reliably if the flow is supplemented by the flows of the auxiliary inlets.

The flow in the coupling capillary is from right to left.



Backflush

Backflushing functions exactly as described previously under *The solution: the back T-piece*. The position in which the live T-piece is currently being operated is irrelevant.

NOTE:
The needle valve $NV_{Back\ bypass}$ is required so that the pressure regulator is always loaded by a flow to prevent a sample from diffusing into the carrier gas line during backflushing.

Adjusting the live switching

IMPORTANT

For safety reasons the function *Backflush* was previously switched on if the solenoid valve MV_{Back} was OFF! The same applies to MV_{Cut}. In other words: MV_{Cut} ON = straight, MV_{Back} OFF = straight!

We have retained this so that you need not be concerned with different versions.

However this can be changed in two manners using the configuration software:
- The valves can be configured as inverted
- The names of the valves can be changed, e.g. into *No backflush*.

In this description we consider the non-modified version!

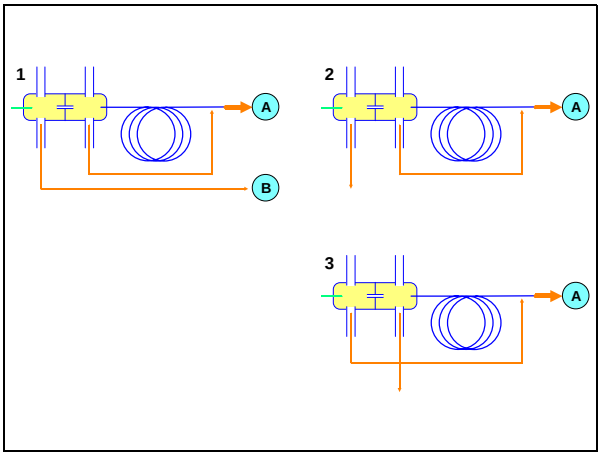
There are three outlets!

During the adjustment, peaks cab be output from the live T-piece via three outlets:

- Cut outlet
- Flushing outlet
- Column B outlet.

Therefore all three outlets must be observed! This is easiest using monitor detectors (version 1).

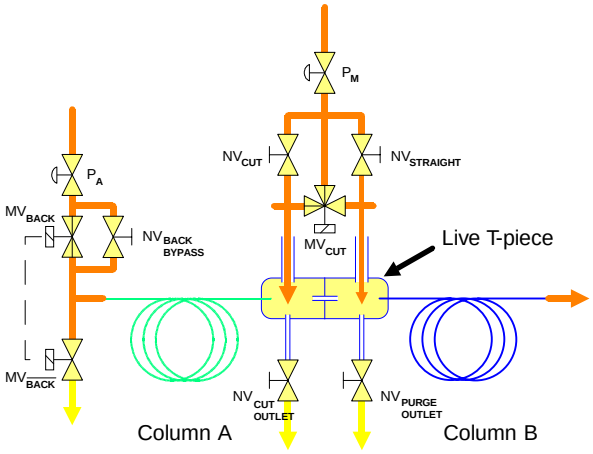
If you do not have a monitor detector, the outlet *Purge outlet* must be routed to the main detector in straight operating mode (version 2), or the outlet *Cut outlet* in cut operating mode (version 3). To do this, connect the respective capillary from the outlet of needle valve $NV_{Cut\ outlet}$ or $NV_{Purge\ outlet}$ to the detector.



The following applies in all cases: the peak via column B always arrives later than the peaks via the cut or purge outlet. Therefore: detailed consideration is necessary, especially with versions such as *Distribution*!

The suitable test substance

The test substance for the adjustment should generate only one peak without a short retention time. An alkane with approximately the same boiling point as the measured component is appropriate. Example: methane for gas injection or hexane for liquid injection.



NOTE:
The solenoid valve $MV_{\overline{Back}}$ is usually replaced by a needle valve in the case of capillary switching!

Off we go!

Install columns. See *Installation of columns on live T-piece.* Check everything for leaks.

1. Adjustment of flow through column B

- Measure flow at outlet of column B
- Set P_M
  - according to the application data
  - or look up the optimum flow in the tables provided by the column manufacturer, measure and set P_M accordingly
- Set P_A according to the equation

$$P_A = P_M + \frac{Length_{Column_A}}{Length_{Column_B}} \times P_M$$

- Set initial temperatures

2. Adjustment of needle valves

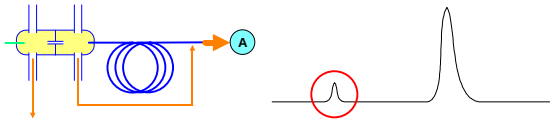
- Set split. See *Injectors*.
- Completely open NV_{Cut} and $NV_{Straight}$
- Set $NV_{Cut\ outlet}$ and $NV_{Purge\ outlet}$
  - according to the application data
  - or to 10 ... 70 ml/min at the outlet *Cut outlet* (optimum, approx. 5 * $flow_{A\text{-}column}$) and 10 ... 30 ml/min at the outlet *Purge outlet*

NOTE:
If you use a monitor detector, it is connected to the outlet *Cut outlet* using a capillary. The needle valve $NV_{Cut\ outlet}$ is not present in this case. The flow is adjusted by shortening the capillary.

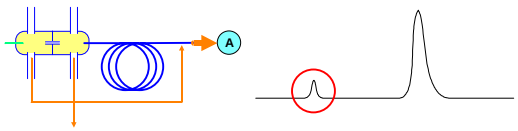
3. Preadjustment of differential pressure

If possible:
Set the differential pressure to 20 mbar using the capillary. To do this, switch MV_{Cut} ON and connect a pressure gauge to the four-way distributor (on left and right of MV_{Cut}). Your advantage: you need fewer attempts in the next step.

4. Adjustment of flow through the coupling capillary in position *Straight*

MV_{Cut}	ON	MV_{Back}	ON
Target	To pass the measured peak completely via column B to the detector, and just no longer to the outlet *Purge outlet*.		
			
Measure	Increase the flow in the coupling capillary until it no longer completely passes into column B. Then close $NV_{Straight}$ in steps of e.g. 1/2 revolution until a peak appears at the outlet *Purge outlet*. Then open $NV_{Straight}$ again carefully until the peak just disappears.		

5. Adjustment of flow through column A in position *Straight*

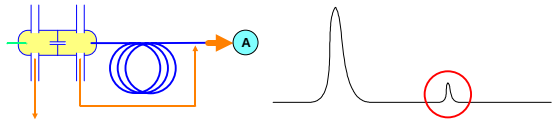
MV_{Cut}	ON	MV_{Back}	ON
Target	To pass the measured peak completely to the detector via column B, and just no longer to the outlet *Cut outlet*.		
Note	If you do not have a monitor detector, you must replace the capillaries here as described in *There are three outlets*!		
			
Is there a peak at the outlet *Cut outlet*?			
YES		NO	
P_A is too high, and thus also the flow through column A. Not everything passes into the coupling capillary. Reduce P_A until the peak just disappears.		This is right! But the flow through column A could be smaller than necessary. Therefore test: Increase P_A until a peak appears at the outlet *Cut outlet*. Then reduce P_A again carefully until the peak just disappears.	

6. Adjustment of flow through the coupling capillary in position *Cut*

It is also useful to adjust the differential pressure to -20 mbar prior to this step. You then need fewer attempts in this step.

IMPORTANT

From now onwards: don't touch P_A, P_M, $NV_{Straight}$

MV_{Cut}	OFF	MV_{Back}	ON
Target	The measured peak should just no longer arrive at the detector following column B; it should be completely at the outlet *Cut outlet*.		
			
Is there a peak at the detector via column B?			
YES		NO	
The flow through the coupling capillary is too small, sample is still coming through! The differential pressure must therefore be increased. To do this, close NV_{Cut} in steps of e.g. 1/2 revolution until the peak just disappears.		This is right! But the flow through the coupling capillary could be higher than necessary. Therefore test: Open NV_{Cut} in steps of 1/2 revolution until the peak just appears. Then carefully close NV_{Cut} again until the peak just disappears.	

NOTE:
If you are working with a temperature program, you should adjust step 5 *Straight* at the lowest temperature, but step 6 *Cut* at the highest temperature!

If you do not have a monitor detector and have therefore replaced the capillaries in step 5, you must now change them back again!

7. Adjustment of position *Backflushing*

MV_{Cut}	ON	MV_{Back}	ON
Target	Measured peak must not arrive at the detector, it must pass completely into open air via the backflushing outlet.		

- Adjust $NV_{Back\ bypass}$ to 5 ... 10 ml/min at the outlet, but at least a little more than flows through column A.
- Inject test substance. A peak must not appear on the detector!

Faults which may occur during startup

With *Straight*: Peak on monitor detector and preliminary peak on main detector even though the differential pressure is very low and P_A this greatly reduced	
Cause	**Remedy**
The annular clearance is too large	Use a column with a smaller internal diameter or use a coupling capillary with a larger outer diameter

With *Straight*: No peak or too small peak on main detector	
Cause	**Remedy**
The input of column B is blocked	Check flow through column B, possibly break off approx. 15 mm from beginning of column B

With *Straight*: Differential pressure required during adjustment is very high	
Cause	**Remedy**
The coupling capillary is squashed or blocked	Blow through coupling capillary or replace live T-piece

***Straight* can be adjusted well, but *Cut* and *Backflush* poor: In *Cut operating mode*: Peak on main detector although the differential pressure is very high**	
Cause	**Remedy**
The annular clearance between the coupling capillary and the column internal diameter is too small. A smaller differential pressure is present at the ends of the coupling capillary than the measured differential pressure	Use column with larger internal diameter or use coupling capillary with smaller outer diameter
Column A has been inserted too far into the live T-piece. The internal gasket does not seal the column outlet	Pull back column A by 1 to 1.5 mm
Contamination from the stationary phase may reduce the annular clearance with plot columns	Scratch end of column free using a drill

NOTE
The needle valves $NV_{Cut\ outlet}$ and $NV_{Purge\ outlet}$ can be replaced in the case of critical components or laboratory operation by capillaries with a corresponding flow resistance.

The differential pressure is reduced at high temperatures.	
Cause	**Remedy**
The flow is reduced in the capillaries because the viscosity of the gas increases with temperature. The pressure drop across the currently selected needle valve NV_{Cut} or $NV_{Straight}$ is reduced, the differential pressure becomes smaller, and the flow in the capillary as well	Adjust the differential pressure in position *Cut* at a higher temperature Adjust the differential pressure in position *Straight* at a lower temperature

FID response factors are changed during the temperature program, the baseline drifts downwards	
Cause	**Remedy**
The flows via the capillaries act like a make-up gas. The flow changes during the temperature program because the viscosity of the gas changes	Use an additional constant flow as the make-up gas, and keep the flows through the capillaries as low as possible, e.g. using temperature-independent auxiliary flows

With *Cut operating mode*: Peak tailing on monitor detector	
Cause	**Remedy**
Tailing is caused by the sample injection or by column A	Connect column A directly to a detector. If the tailing disappears, check the live T-piece
Graphite particles are present in the ducts of the live T-piece. The flow in the capillary *Cut outlet* is then too low	If the tailing is reduced at higher temperatures, the cause is adsorption on the graphite in the live T-piece - in the ducts of the live T-piece - or on the gaskets
Column A has been inserted too far into the live T-piece	Pull back column A a little
The capillary *Cut outlet* has been inserted too far or not far enough into the live T-piece	Shift the capillary *Cut outlet*

With *Cut operating mode*: Some of the main components arrive at the main detector, the smaller peaks are cut directly to the monitor detector	
Cause	**Remedy**
The flow in the capillary *Cut outlet* changes because the carrier gas with sample has a different viscosity to pure carrier gas	Increase differential pressure in position *Cut*. This increases the flow in the capillary, and the main component is diluted

Faults which may occur after a certain period

Peak areas become smaller, calibration factors larger	
Cause	**Remedy**
Live switching is maladjusted	Readjust the live switching
The solenoid valve MV_{Cut} does not close properly in one or the other position (aging). The differential pressure is then too low	Replace solenoid valve MV_{Cut}

Peaks appear at positions where they do not interfere	
Cause	**Remedy**
Live switching is maladjusted	Readjust the live switching
The solenoid valve MV_{Cut} does not close properly in one or the other position (aging). The differential pressure is then too low	Replace solenoid valve MV_{Cut}

Peaks superimposed on one another	
Cause	**Remedy**
Live switching is maladjusted	Readjust the live switching
The solenoid valve MV_{Cut} does not close correctly in one or the other position (aging). The differential pressure is then too low	Replace solenoid valve MV_{Cut}

The cut time is suddenly poor	
Cause	**Remedy**
Aged columns, blockages or leaks are present	Readjust the live switching, replace columns if necessary

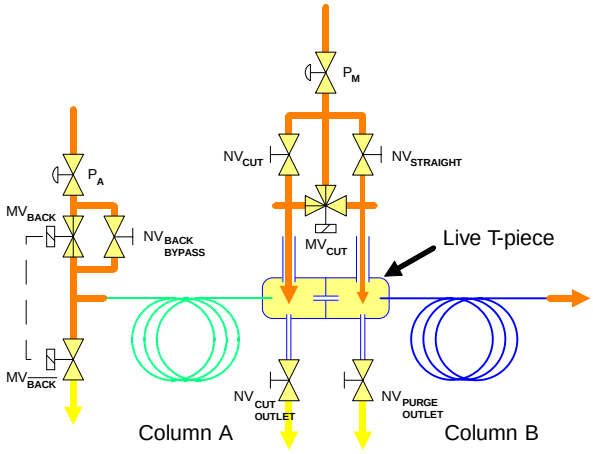
Maintenance of live switching

The live T-piece is maintenance-free. However, packing material may block the coupling capillary or the annular clearance between the coupling capillary and the column. The live T-piece must then be replaced.

Always recommendable: compare with calibration analysis from time to time!

The other way: flow diagrams

The following two tables show all possibilities for the positions *Straight* and *Cut*. Please note that the target is always the left-hand (bright) path.



Position *Straight*

Repeatedly inject test substance until only 1 peak appears optimally from column B

How many peaks ?				
1 peak		**2 peaks**		**3 peaks**
From column B	**From the cut outlet**	**From the cut outlet and from column B**	**From the purge outlet and from column B**	**From all three outlets**
This is right! But perhaps more is flowing through the coupling than is necessary	We have cut operating mode. Possible faults: -MV_{Cut} is OFF instead of ON -Capillary is blocked	We have partial cut operating mode. Cause: P_A is too high or Δp is too low	Δp via the coupling capillary is too large, i.e. more comes out of the coupling capillary than passes into column B	This is a mixture of both situations for "2 peaks". Rotating $NV_{Straight}$ no longer helps in this case!
Open $NV_{Straight}$ by e.g. 1/4 revolution until a peak also appears at the cut outlet. Then close again until this peak just disappears!	Normally only the pressure at the right auxiliary inlet is too high. Therefore close $NV_{Straight}$ by e.g. 1/2 revolution	Normally the pressure at the right auxiliary inlet is too high. Therefore close $NV_{Straight}$ by e.g. 1/2 revolution	Open $NV_{Straight}$ by e.g. 1/2 revolution	Reduce P_A by 0.1 bar

If you are working with a temperature program repeat everything at the final temperature

Position *Cut*

Repeatedly inject test substance until only 1 peak appears optimally from the cut outlet

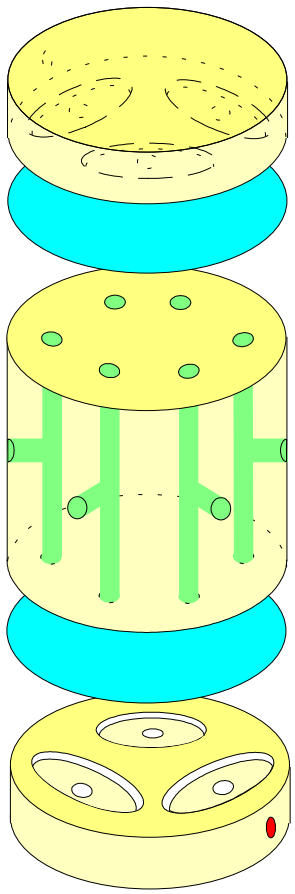
How many peaks ?		
1 peak		**2 peaks**
From the cut outlet	**From column B**	**From the cut outlet and from column B**
This is right! But perhaps more is flowing through the coupling than is necessary	We have straight operating mode	This is a mixture of both situations for "1 peak"
Open NV_{Cut} by e.g. 1/4 revolution until a peak also appears at the outlet of column B. Then close again until this peak just disappears.	The pressure at the left auxiliary inlet is therefore too high. Close NV_{Cut} by e.g. 1/2 revolution	The pressure at the left auxiliary inlet is therefore too high. Close NV_{Cut} by e.g. 1/2 revolution

If you are working with a temperature programrepeat everything at the final temperature

This page is intentionally empty!

Column switching with diaphragm valves

The columns are connected via 6-way diaphragm valves. These valves are installed in the oven. The flows are adjusted with needle valves such that the flow through the detector is influenced as little as possible by the valve switching. Valve switching is only conditionally suitable for capillary columns, we recommend live switching.



How a diaphragm valve functions

Valve position *Straight*

- The valves "Back" and "Cut" are switched such that columns A, B and C are connected in succession. Carrier gas flows through the injection valve *Inj.* to column A, from there via valve *Back* to column B, and then on via valve *Cut* to column C
- Column A is often filled with a nonpolar substance. The uninteresting components with a higher boiling point are retained there, the interesting components are passed on to column B.

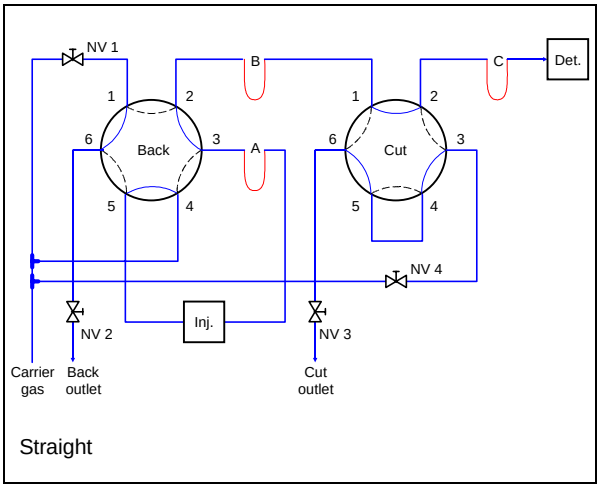
Valve position *Cut*

- As soon as a component which is not of interest or which interferes has left column B, the cut valve is switched over. This component is then flushed into open air via *Cut outlet*
- Shortly before a component of interest reaches the outlet of column B, the cut valve is switched over again. The component is passed on to column C

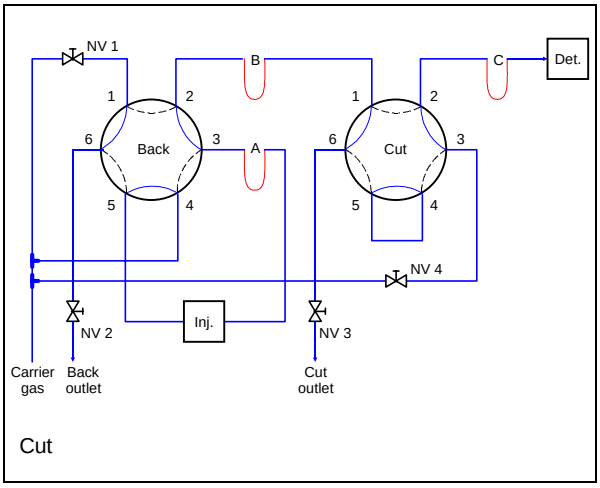
NOTE:
The cut can also be used for distribution onto another column.

Valve position *Backflush*

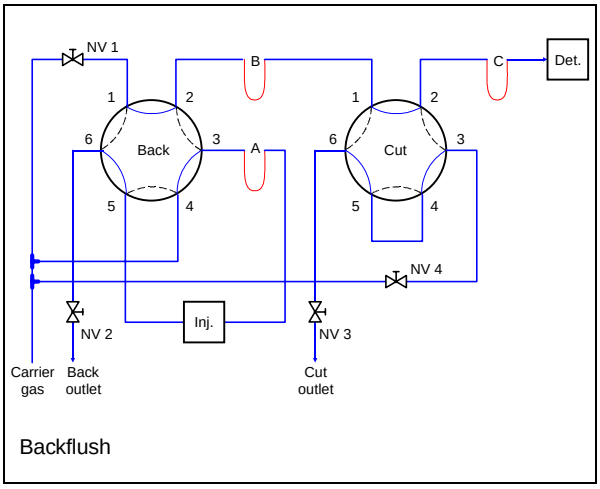
- Once the last component of interest as left column A, the backflush valve is switched over
- Carrier gas flows backwards into column A via the valve *Back* and also via the needle valve *NV 2* into open air through the backflush outlet *Back outlet*. All components still present in column A are flushed backwards out of the column
- Carrier gas flows via needle valve *NV 1* and via the backflush valve to column B.



Straight



Cut



Backflush

Adjustment of flow

The required flow is specified in the application documents. The following rule applies:

> **The same quantity of gas must flow through the detector, out of the backflush outlet, and out of the cut outlet. This must always remain the case, even when the valves are switched over!**
>
> Exception: A greater amount may occasionally flow through the backflush outlet as this does not influence the retention times.

Adjustment of position *Straight*

- Switch the backflush valve (Back) and the cut valve (Cut) such that columns A, B and C are in series
- Measure the flow of carrier gas at the detector outlet, and adjust to the required value using the carrier gas pressure regulator

Adjustment of position *Cut*

- Switch over the cut valve
- Adjust the flow through the detector using needle valve *NV 4*. *NV 4* now replaces columns A and B.
- Adjust the flow at *Cut outlet* using needle valve *NV 3*. *NV 3* now replaces column C.

Adjustment of position *Backflush*

- Switch back the cut valve
- Switch over the backflush valve
- Adjust the flow through the detector using needle valve *NV 1*
- Adjust the flow at the backflush outlet *Back outlet* using needle valve *NV 2*

IMPORTANT with FID/FPD:

- **Turn off the combustion air and combustion gas prior to the adjustment**
- **Switch on the combustion air and combustion gas again following the adjustment.**

Maintenance

Depending on the sample and the purity of the used gases, the injection valve and the switching valves may become contaminated. Clean and service the valves as described under *Sample injection: Diaphragm valves*.

FUNCTION DESCRIPTION OF ELECTRONICS

Page

Summary of electronics

All fuses 2
Block diagram 3

Detector electronics

Signal flow 4
Electronics for FID and FPD 5
TCD electronics 6
ECD electronics 8
Interface amplifier 9

Control electronics

Interface board 3 10
PCPU-2 11
Terminal board 12
Heater control board 13
Power pack 14

Circuit diagrams

SIMATIC boards

You can find information on the SIMATIC boards e.g. in the Catalog *ST 54.1 SIMATIC S5* and in this manual, Register 3: *SIMATIC modules*.



WARNING

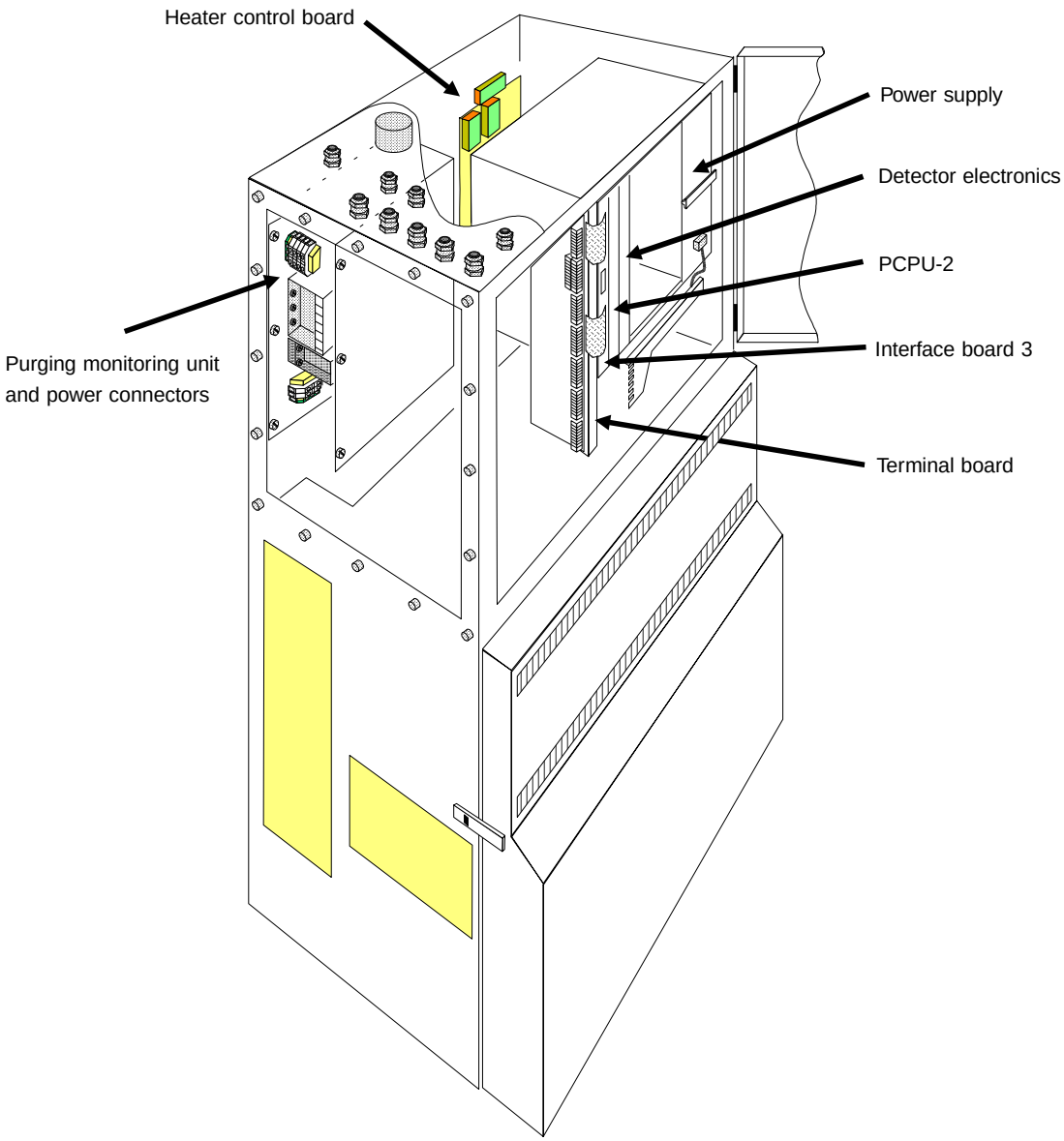
Certain parts in these electrical devices contain dangerous voltages during operation.

Improper use of these devices could therefore result in death or severe personal injury as well as extensive damage to property.

When carrying out repairs on the chromatograph you should therefore observe all information in this section and also that printed on the chromatograph itself.

- Disconnect the chromatograph from the power supply before you remove or insert electronic modules.
- Only use spare parts approved of by the manufacturer.
- Exactly observe the instructions for repair and replacement.

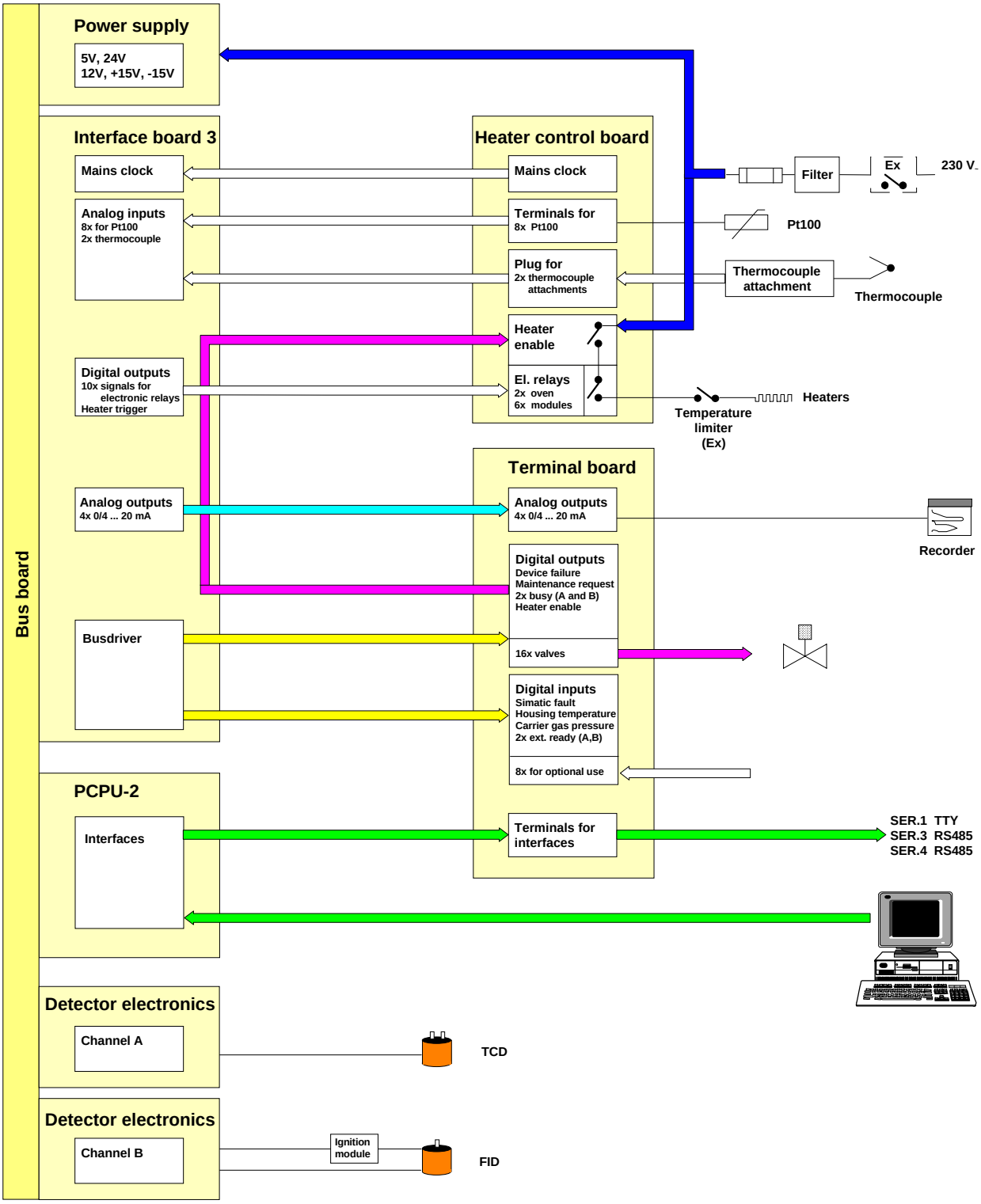
Summary of electronics



All fuses

Location	Designation	Type	Purpose
Above the heater control board	F 1 F 2 and F 3	T 4 A (230 V) T 6.3 A (115 V) FF 10 A	Main fuse for electronics Heaters
Power supply	F 1 and F 2	T 4 A (230 V) T 6.3 A (115 V)	Mains
Purging monitoring unit		M 160 mA	Ex solenoid valve for purging
SIMATIC digital output (option) Standard, 24 V, 0.5 A Option, 24 V, max. 2 A	 F 1 to F 4 F 1 to F 16	 T 5 A F 2.5 A	 1 fuse for every 8 outputs Each output fused separately

Block diagram



DETECTOR ELECTRONICS

There is a separate double-height Eurocard for each type of detector. The module contains all power supplies, amplifiers and compensating circuits where required. Two modules are inserted for channels A and B in the electronics frame on the right of the PCPU-2.

All electronic modules are maintenance-free. In the event of faults, please contact our service technicians.

Signal flow

The detector signal is applied on the detector module to a precision analog-to-digital converter with a resolution of 20 bits. This corresponds to a dynamic range of 10^6. The converter can be operated in up to 9 ranges depending on the type of detector. The ranges result in an attenuation of 2^0 to 2^8.

The detector modules have their own microcontroller. This receives its parameters from the controller (PCPU-2) via the bus board and delivers its results to the controller.

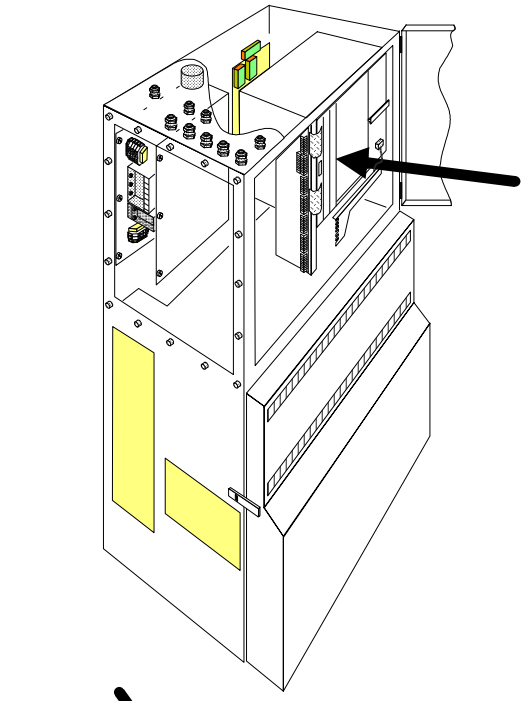
The controller uses these digitized measured values for peak recognition and evaluation. At the same time, it converts them into an analog recorder signal of 0 to 20 mA. Further details, on e.g. the relationship between detector input signal and recorder signal, can be found in Register 5: *Chromatogram on the recorder*.

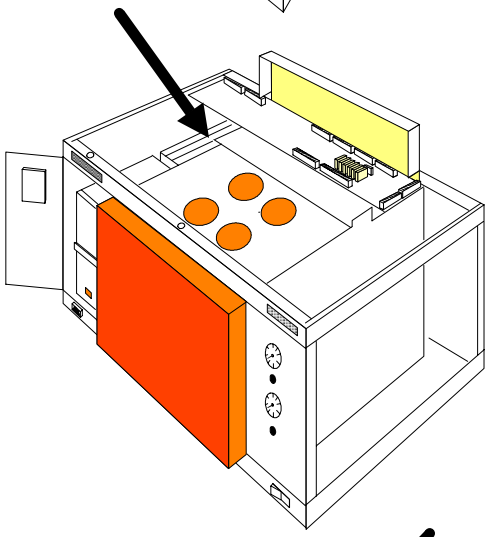
Compensation

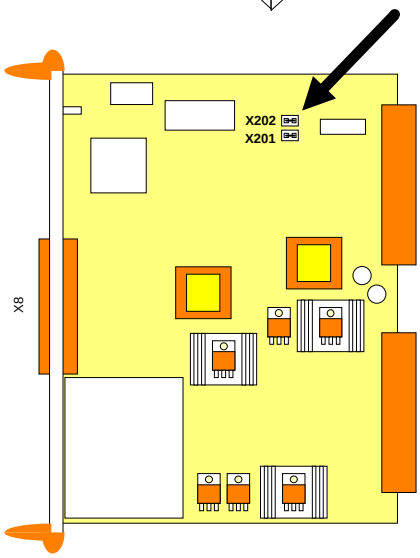
The detector boards have no control elements. The microcontroller on the detector board carries out the zero adjustment. To find out how this is carried out, refer to Register 5: *Detectors: Adjustment of zero.*

Setting of channel A or B

The jumpers X201 and X202 on the detector boards select whether a detector is channel A or B.







	Detector A	Detector B
X 202	▬	□
X 201	▬	▬

Electronics for FID and FPD

The FID signal is applied directly to a precision analog-to-digital converter for extremely small currents in the pA range.

Operating voltage

The operating voltage is 300 V for the FID and 600 V for the photomultiplier of the FPD. The voltage is generated on the detector module from +24 V and is electrically isolated.

Ignition

The ignition command resulting from an operator input or a time program is converted in the detector module into five 24-V pulses. These are converted in the ignition module into high-voltage sparks.

Range

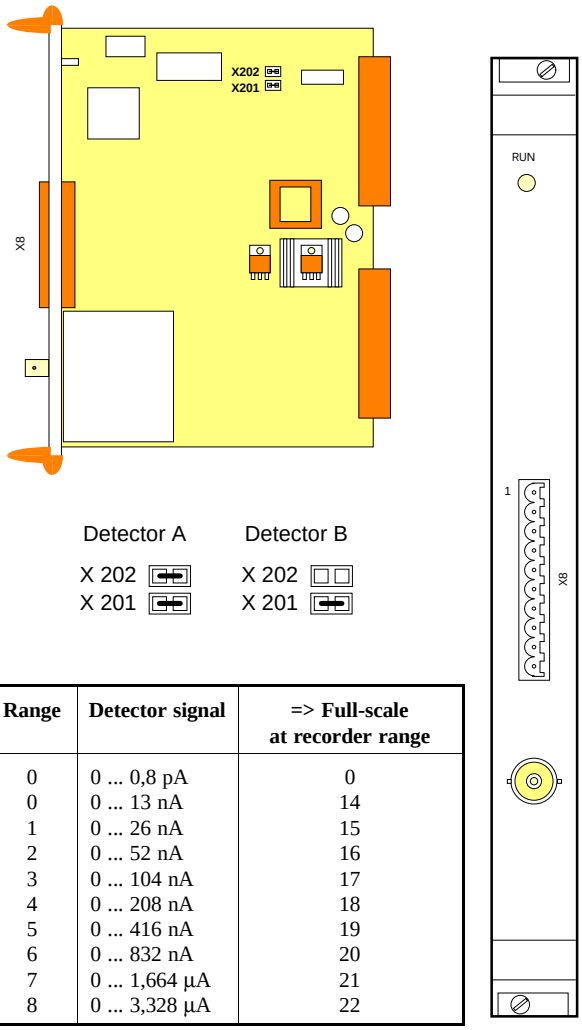
Each range has a dynamic response of 10^6. Nine ranges can be selected for the FID. The ranges result in an attenuation from 2^0 to 2^8. The table lists the maximum detector current in each range.

Zero adjustment

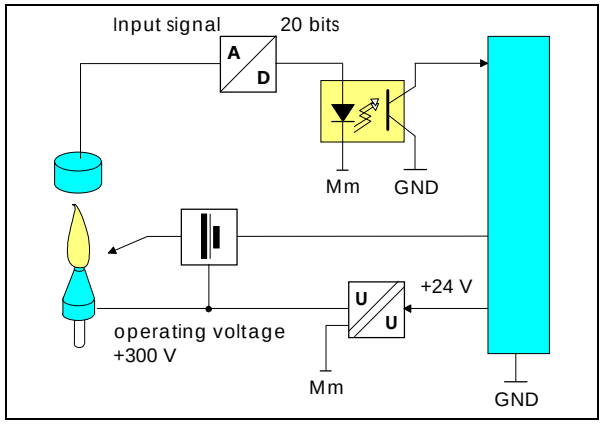
The microcontroller on the detector module adjusts the zero using software functions if an *autozero* is triggered manually or by a time program.

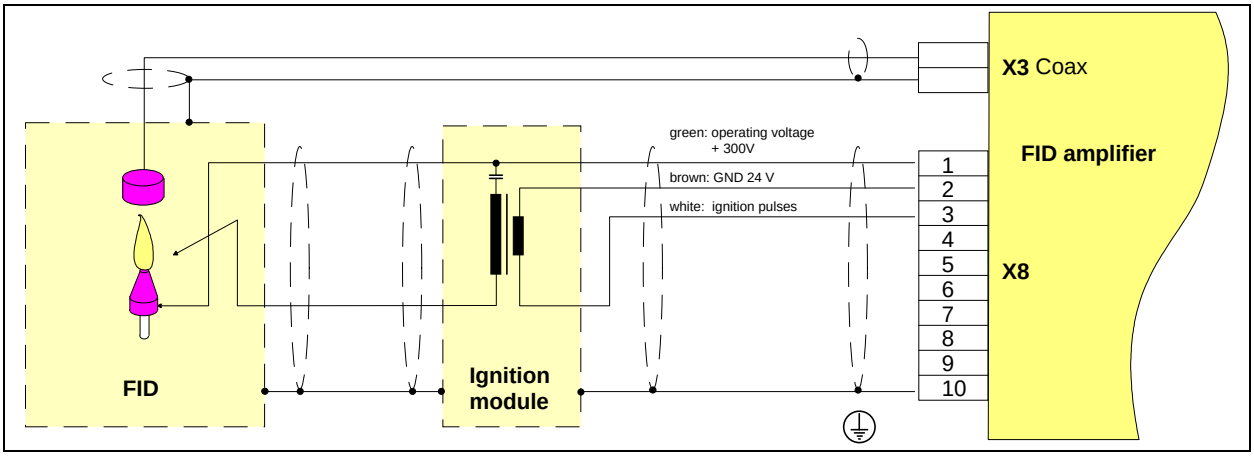
Connection of detector

Refer to the connection diagram below.



Range	Detector signal	=> Full-scale at recorder range
0	0 ... 0,8 pA	0
0	0 ... 13 nA	14
1	0 ... 26 nA	15
2	0 ... 52 nA	16
3	0 ... 104 nA	17
4	0 ... 208 nA	18
5	0 ... 416 nA	19
6	0 ... 832 nA	20
7	0 ... 1,664 µA	21
8	0 ... 3,328 µA	22





TCD electronics

The TCD is a heated resistance measuring bridge. The sample gas changes two of the bridge resistances if components dissipate heat better or worse than the carrier gas. The bridge offset is amplified and is used as the input signal.

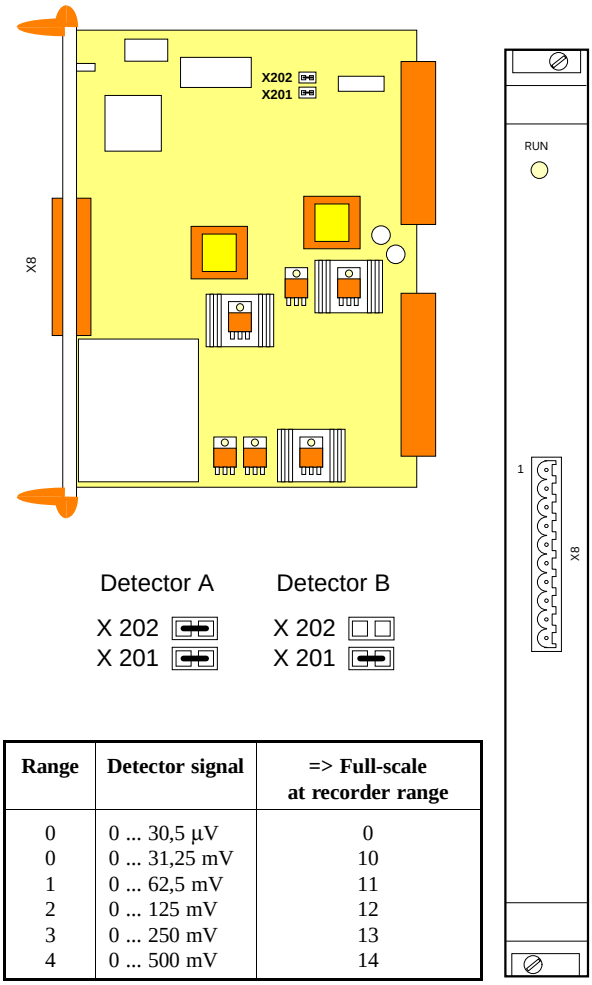
Monitoring of bridge current

The bridge current is held constant by a controller. It can be adjusted from 0 to 350 mA by the microcontroller. The voltage on the bridge is monitored by a comparator. The microcontroller switches the bridge current off if the resistance of the TCD bridge becomes too large. The resistances increases e.g. if the carrier gas fails.

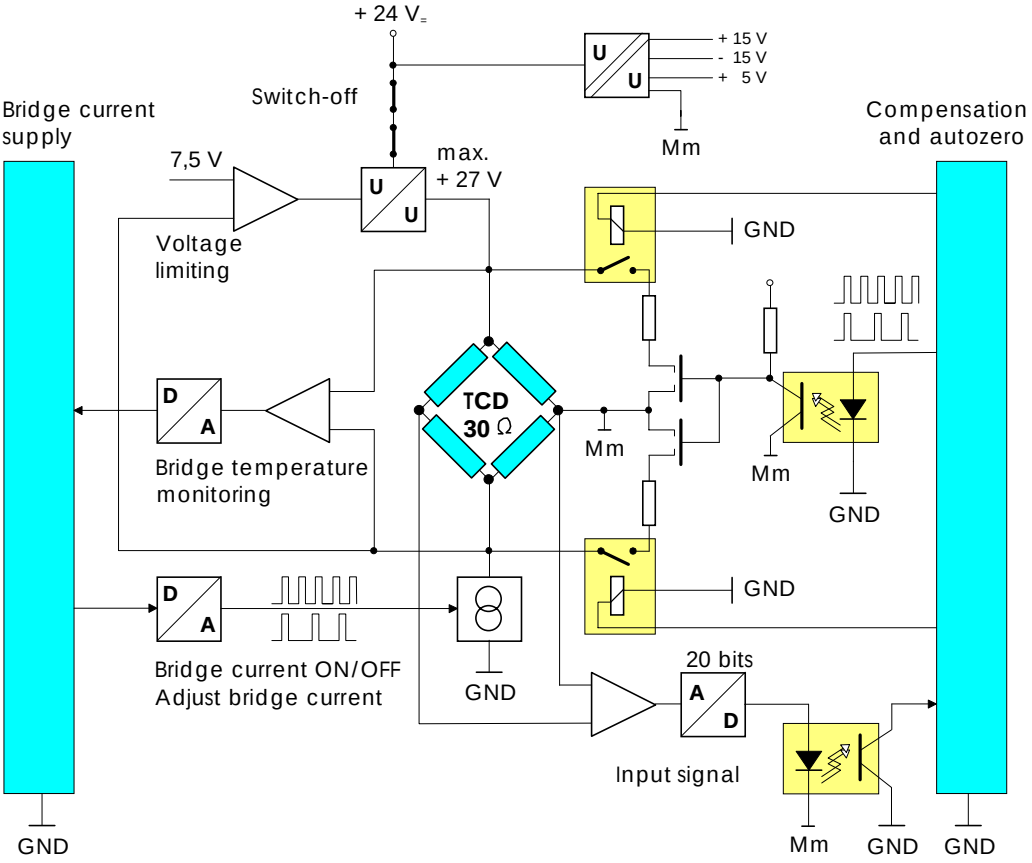
The bridge current is also switched off if the carrier gas monitoring function or the Ex overtemperature switch is triggered.

Range

Each range has a dynamic response of 10^6. Five ranges can be selected for the TCD. The ranges result in an attenuation from 2^0 to 2^4. The table lists the maximum detector signal in each range.



Range	Detector signal	=> Full-scale at recorder range
0	0 ... 30,5 µV	0
0	0 ... 31,25 mV	10
1	0 ... 62,5 mV	11
2	0 ... 125 mV	12
3	0 ... 250 mV	13
4	0 ... 500 mV	14



Zero adjustment

If an *autozero* is triggered manually or by a time program, the microcontroller compensates the bridge offset. To do this, it determines an appropriate number of pulses per unit in time. It passes these pulses on to the bridge via field-effect transistors. It switches the two relays according to the required polarity.

Polarity

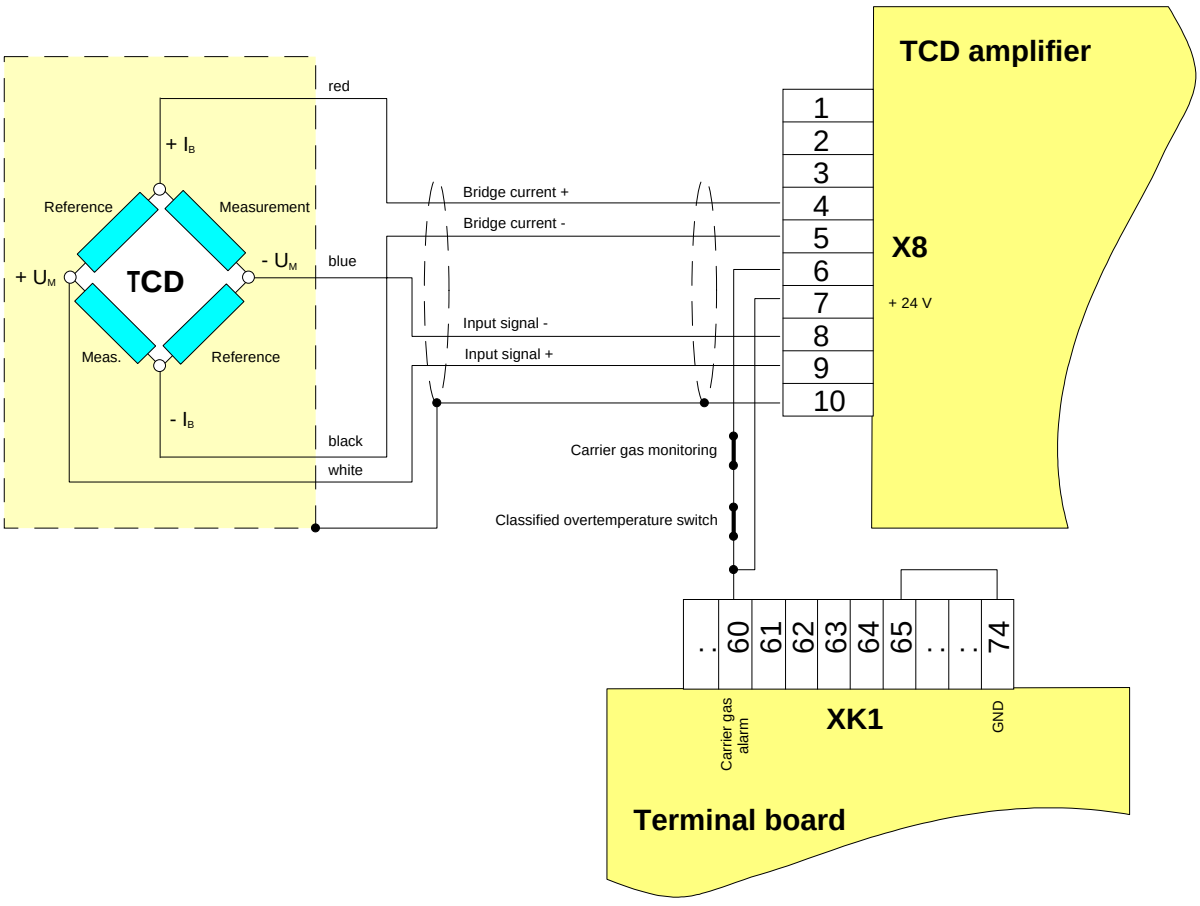
Peaks can be positive or negative depending on the carrier gas and the components. The polarity of the signal can be switched over in the detector electronics by the software. To find out how this is carried out, refer to Register 5: *Detectors: Changing the polarity.*

Status

The TCD signals *Alarm* if the bridge current monitoring function switches off the bridge current.

Connection of detector

Refer to the connection diagram below.



ECD electronics

A ß-radiator in the ECD ionizates the carrier gas. The pulsed operating voltage forces a current. This current decreases when components appear and catch electrons.

This current is supplied by the detector electronics as rectangle pulse with constant amplitude, 1µs pulse width and 0,3 ... 300 kHz

The pulses are integrated and compared with the adjustable reference current (0 ... 400% => 0 ... $4x10^{-9}$A). The amplifier adjustes the pulse frequency so that measuring current equals reference current.

If the sample in the measuring chamber catches electrons the measuring current decreases. Thus the pulse frequency increases till measuring current and reference current are equal again.

Reference current

The reference current of 100% = 1nA is optimum for carrier gas nitrogen with a flow of 30 ml/min.

Range

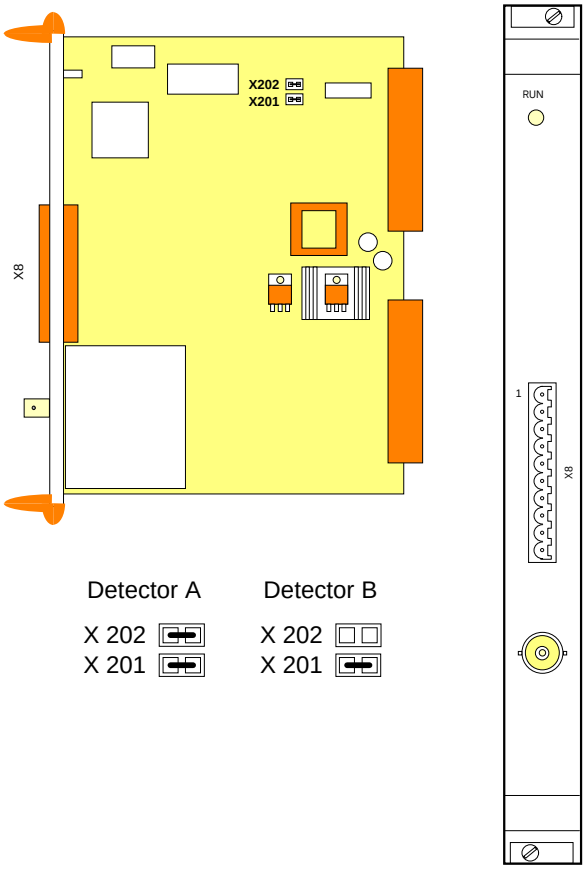
Die Dynamik des ECD ist $2x10^{4}$. Weil der Detektorverstärker in einem Range eine größere Dynamik hat, gibt es für den ECD keine Range-Einstellung.

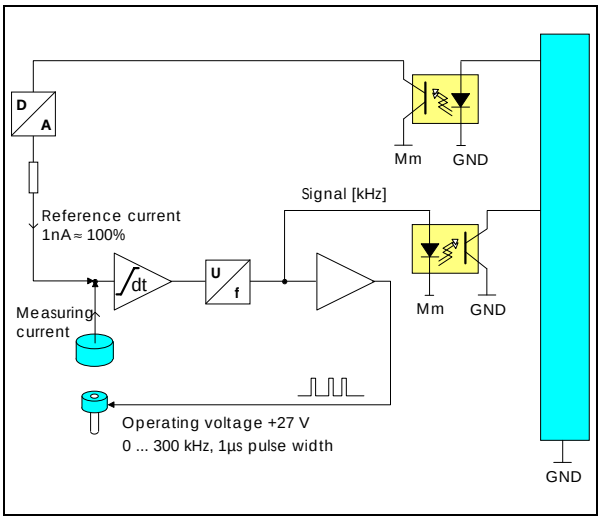
Zero adjustment

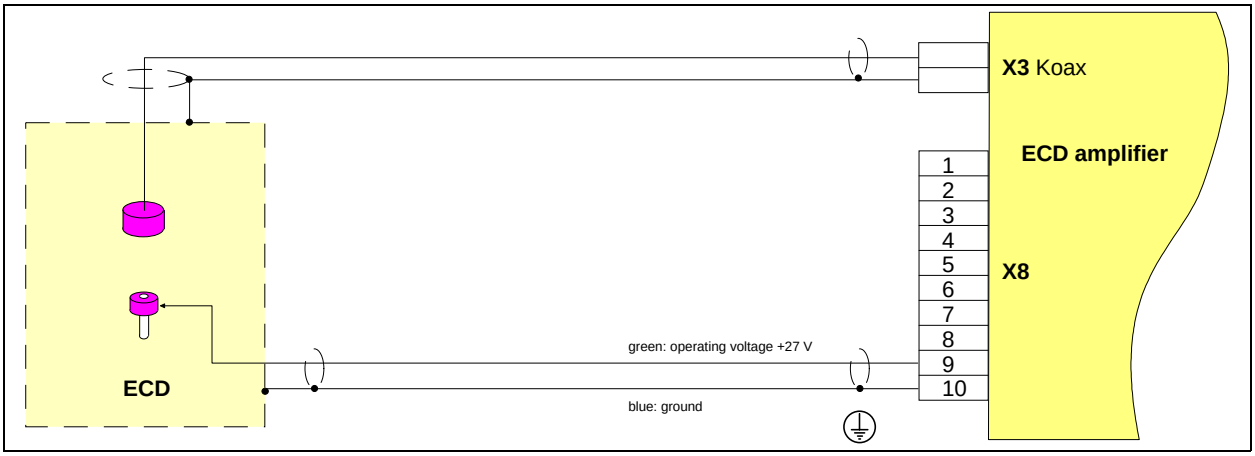
The microcontroller on the detector module adjusts the zero using software functions if an *autozero* is triggered manually or by a time program.

Connection of detector

Refer to the connection diagram below.







Interface amplifier

To the interface amplifier you can connect signals that you want to process like detector signals in the chromatograph. The interface amplifier is identically with the TCD amplifier.

Input sensitivity

The interface amplifier covers three ranges dependent on terminals used.

Input	Range	Impedance
green	0 ... 280 mV	1 kΩ
brown	0 ... 1 V	2,7 kΩ
white	0 ... 10 V	34 kΩ

Range

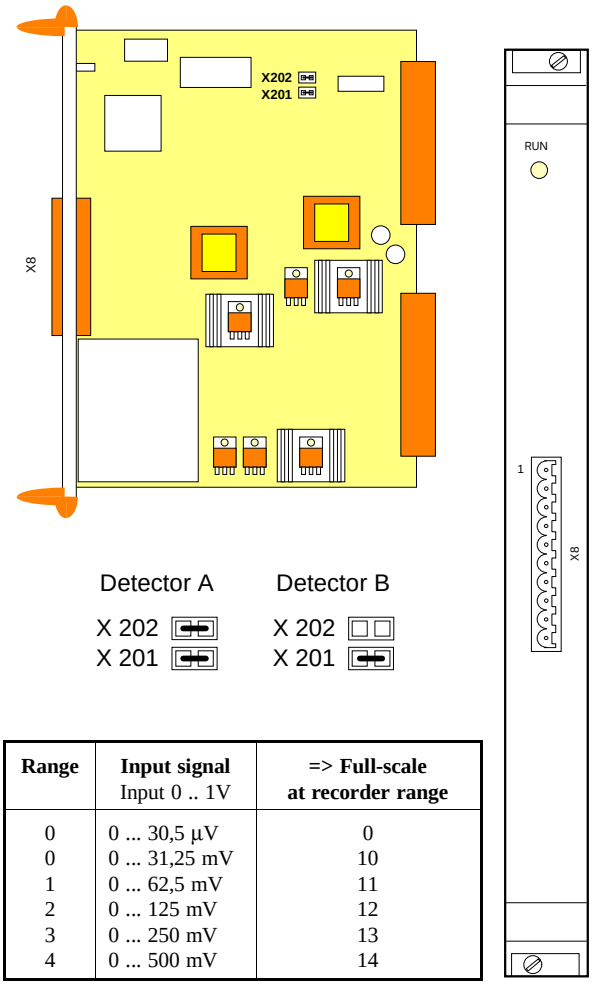
Each range has a dynamic response of 10^6. Five ranges can be selected for the interface amplifier. The ranges result in an attenuation from 2^0 to 2^4. The table lists the maximum detector signal in each range.

Zero adjustment

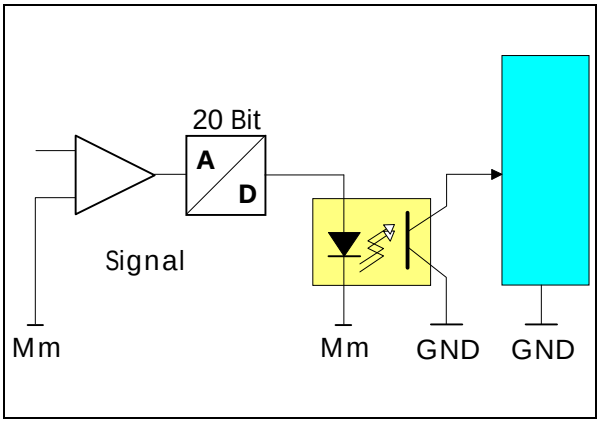
The microcontroller on the detector module adjusts the zero using software functions if an *autozero* is triggered manually or by a time program.

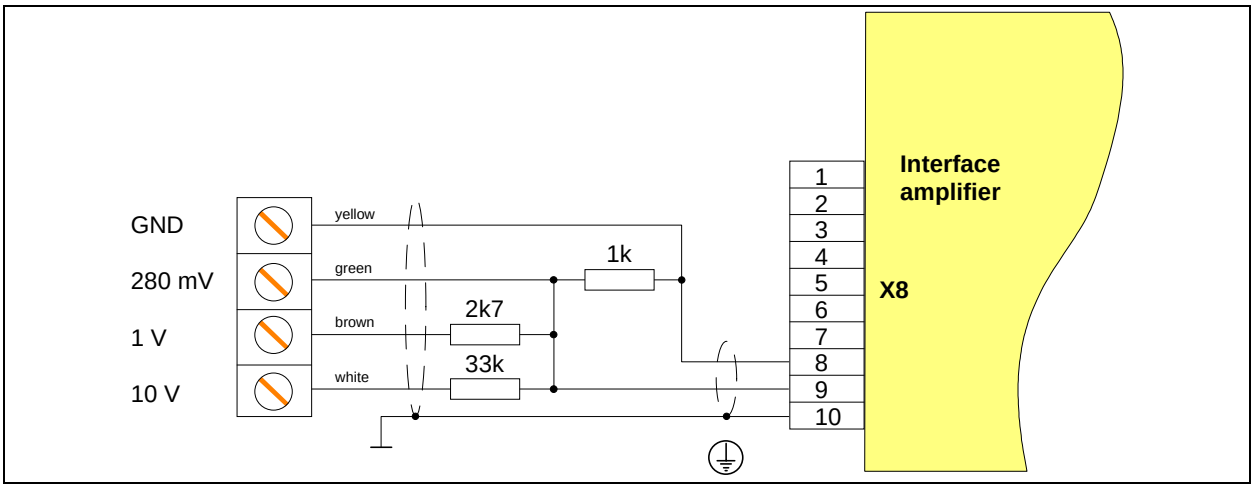
Connection of signals

Connect the signal to the terminal block. Refer to the connection diagram below.



Range	Input signal Input 0 .. 1V	=> Full-scale at recorder range
0	0 ... 30,5 µV	0
0	0 ... 31,25 mV	10
1	0 ... 62,5 mV	11
2	0 ... 125 mV	12
3	0 ... 250 mV	13
4	0 ... 500 mV	14





CONTROL ELECTRONICS

The boards of the control electronics are of double-height Eurocard format. They are plugged next to one another in the electronics rack. Sequence from left to right: interface board 3, PCPU-2, detector amplifier, options, power supply.

All electronic boards are maintenance-free. In the event of faults, please contact our service technicians.

Interface board 3

Interface module 3 is the link between the *PCPU-2* controller and the terminal board or the heaters of the chromatograph. The functions:

- Analog-to-digital converter with multiplexer in bridge circuit for 8 temperatures measured using Pt100
- Optional analog-to-digital converter with multiplexer for voltages: 2 temperatures measured using thermocouple
- Processing of mains interrupt for temperature control
- Digital outputs control the electronic heater switches
- Control of the terminal board with digital outputs, digital inputs and analog outputs.

Pilot lamps for temperature controller

The lamps indicate how the heaters are operating. The AC heater voltages are switched at the passage through zero. The heating power results from the time between two 20 ms pulses. The lamps 1 to 10 are assigned to the temperature controllers 1 to 10.

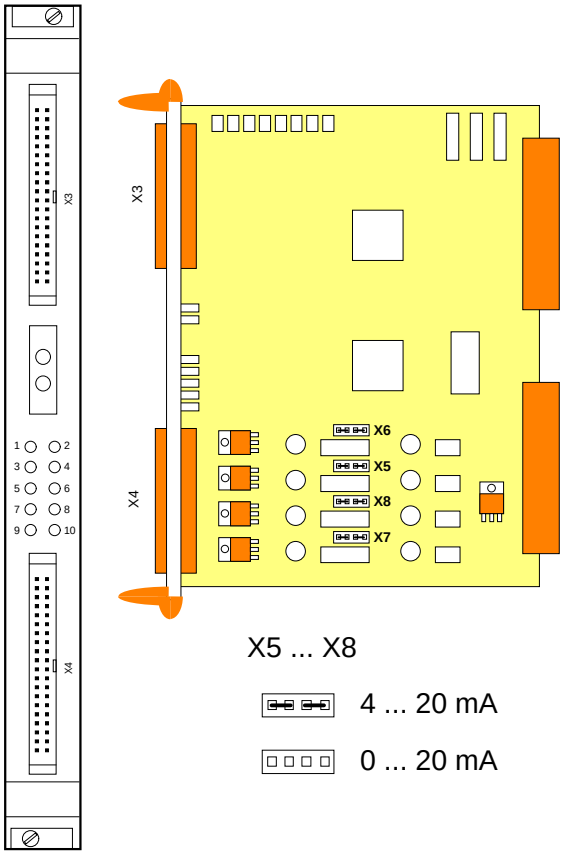
Pilot lamps ready/not ready

The green lamp indicates that the chromatograph is *ready*, the yellow lamp signals *not ready*. Refer to Register 5: *Status* to find out how the statuses are defined and how they can be influenced.

Plugs X3 and X4

All signals for the digital outputs, digital inputs and analog outputs from and to the terminal board are via plug *X3* .

Plug *X4* connects the interface board 3 to the heater control board for the temperature controllers: temperature measurements, mains interrupt and control signals for the heaters.



Conversion of analog outputs

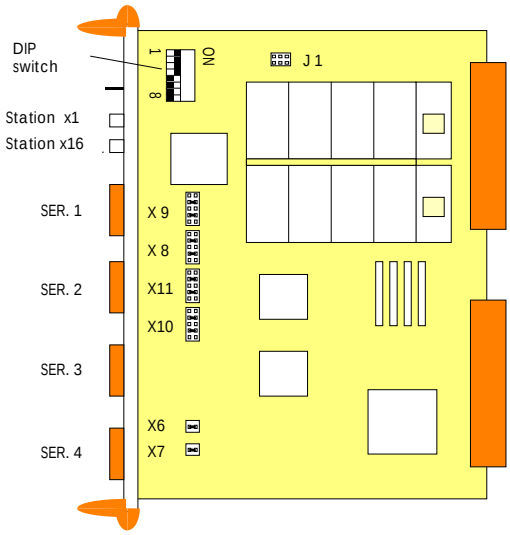
The four analog outputs can be converted from 0 to 20 mA to 4 to 20 mA. The table shows the plug assignments.

Analog output	Plug
1	X6
2	X5
3	X8
4	X7
Jumpers inserted: 4 to 20 mA, jumpers open: 0 to 20 mA Maximum load: 750 Ω	

PCPU-2

The adjacent drawing shows the standard setting of a PCPU-2 when delivered. You need only make changes in the following cases:

- If TTY interfaces are to be active (seldom the case), change *X8* to *X11*
- If several chromatographs are used in the Chrom-LAN network, change station *x1/x16*
- If the chromatograph is not the last participant in the RS485 ChromLAN network, change *X6* or *X7*.



Meaning of control elements

Station x1 + x16	Participant number in ChromLAN network, Standard is number 1
X6 X7 X8+X9 X10+X11 J1	RS485 terminator for SER.3 RS485 terminator SER.4 TTY active/passive for SER.1 TTY active/passive for SER.2 Only for test purposes

Further information

Setting instructions for the eight DIP switches, the jumpers X6 to X11 and the two station switches can be found Register 3: *ChromLAN networks with TTY* and *ChromLAN networks with RS485*. Useful information on troubleshooting on the PCPU-2 can be found in Register 2: *Problems and faults*.

Pin assignments of interfaces SER. 1 to SER. 4

		Pin number on 9-pin plug of PCPU-2 for			
Standard	**Signal**	**SER.1**	**SER. 2**	**SER. 3**	**SER. 4**
RS232	GND TxD RxD CTS DCD RTS	1 2 3 5	1 2 3 5	1 2 3 5 6 7	1 2 3 5 6 7
TTY	TxD - TxD+ RxD - RxD+	6 7 8 9	6 7 8 9		
RS485	A B			8 9	8 9
Voltage	+5V	4	4	4	4

Factory setting without control software:

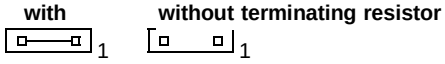
Interface	Standard	Transmission rate
SER. 1	RS232	9600 baud
SER. 2	RS232	9600 baud
SER. 3	RS232	9600 baud
SER. 4	RS232	38400 baud

DIP switches

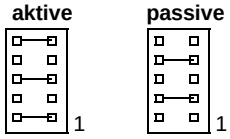
Switch	On/off	Meaning
DIP 1 DIP 1	OFF ON	SER.2 9600 baud SER.2 4800 baud if TTY 38400 baud if RS232
DIP 2 DIP 2	OFF ON	SER.2 TTY SER.2 RS232
DIP 3 DIP 3	OFF ON	SER.1 Local printer SER.1 ChromLAN
DIP 4 DIP 4	OFF ON	SER.1 TTY SER.1 RS232
DIP 5,6,7		No significance
DIP 8 DIP 8	OFF ON	Normal mode PCPU in programming mode

Jumpers

PCPU-2 interface	Jumpers
SER. 3 SER. 4	X6 X7



Interface		Jumper
SER. 1 SER. 1 SER. 2 SER. 2	Sender Empfänger Sender Empfänger	X8 X9 X10 X11

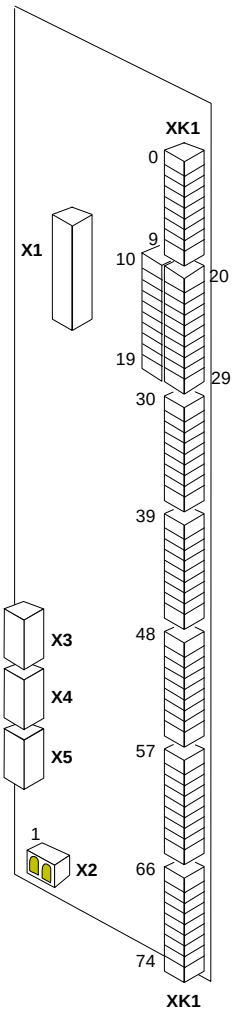


Terminal board

The terminal board connects the interface board 3 to the valves, switches, recorders etc. It has terminals for the following functions:

- 24 digital outputs
- 16 digital inputs
- 4 analog outputs
- Power supplies
- Serial interfaces 1, 3 and 4

You can find detailed information on these subjects in Register 3.



CAUTION

To prevent interferences, all external cables must be screened. The screen must be connected to the chromatograph housing in the cable gland.

Terminal assignments

Terminal	Group	Application
1	Power supply	-15 V
2		GND 5 V
3		+15 V
4		+24 V
5		GND 24 V
8	Failure relay	Relay contact, max. 0,5A/100V
9		Contact open = Analyzer Failure
10	Analog outputs	Ground
11		Analog output 1
12		Analog output 2
13		Analog output 3
14		Analog output 4
15		Ground
20	Serial interfaces	SER.1 TxD -
21		SER.1 TxD +
22		SER.1 RxD -
23		SER.1 RxD +
24		Looping point
25		Looping point
26		SER.3 a
27		SER.3 b
28		SER.4 a
29		SER.4 b
30	Digital outputs	24 V = Ready / 0 V = Not ready
31		24 V = Maintenance request
32		24 V = Run A
33		24 V = Run B
34		Cooling
35		Air flaps moving
36		Air flaps, direction: open
37		Heater enable
38		GND 24 V
39 ... 46		Digital outputs 9 to 16
47		GND 24 V
48 ... 55		Digital outputs 17 to 24
56		GND 24 V
57	Digital inputs	Short-circuit signal
58		Housing purging o.k.
59		Housing temperature o.k.
60		Carrier gas pressure o.k.
61		External device A not ready
62		External device B not ready
63		Reserved
64		Reserved
65		GND 24 V
66 ... 73		Digital inputs 9 to 16
74		GND 24 V

Cable connections

Cable	Application
X 1	To interface board 3, bottom
X 2	1 = 24 V; 2 = GND, comes from bus board X 18
X 3	To PCPU-2, SER.1
X 4	To PCPU-2, SER.3
X 5	To PCPU-2, SER.4

Heater control board

The heater control board connects interface board 3 to the heaters, temperature sensors and temperature limiters, and also has terminals for the power supply.

Plugs and cable connections

Plug	Application
X2	Temperature sensors for controllers 1 to 8
X3 to X5	Heaters for controllers 1 to 8
X6, X7	Overtemperature limiters for controllers 1 to 8
X8	Power supply
X11	Protective earth
X12	N, mains zero conductor
X13	L0, mains to power pack
X14	L1, mains to right oven
X15	L2, mains to left oven
X16	Control signal for heater enable
X17	Control signal for heater enable
X18	Protective earth
X1	Cable to interface board 3, top
X9	Cable to low-voltage power supply, controller 9 connects controller 9 to electronic relay 8
X10	Cable to low-voltage power supply, controller 10 connects controller 10 to electronic relay 7

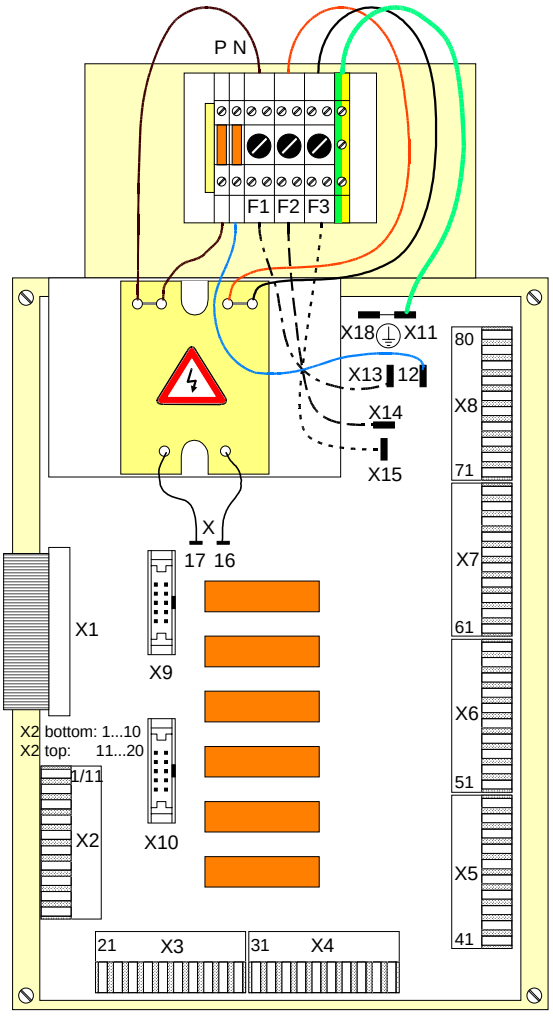
Temperature controllers

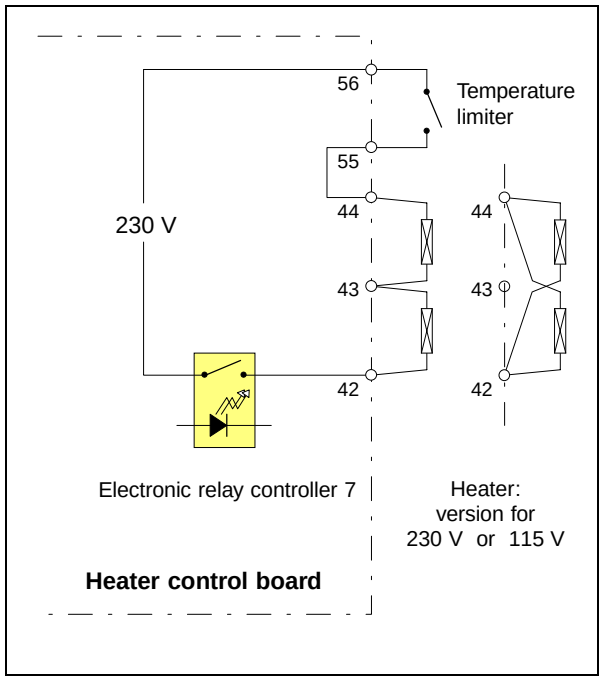
No.	Application	Heater X3 to X5	Temperature limiter X6, X7	Pt100 X2
1	Top right oven	27, 28, 29	65, 66	5, 6
	Bottom right oven	30, 31, 32	63, 64	
2	Top left oven	21, 22, 23	69, 70	7, 8
	Bottom left oven	24, 25, 26	67, 68	
3	Right detector	36, 37, 38	59, 60	9, 10
4	Left detector	33, 34, 35	61, 62	11, 12
5	Right injector	48, 49, 50	51, 52	13, 14
6	Left injector	45, 46, 47	53, 54	15, 16
7	Right heated line	42, 43, 44	55, 56	17, 18
8	Left heated line	39, 41, 40 !	57, 58	19, 20

Heater 230 V or 115 V?

Ovens have two double 115-V heater elements, hydrogenation reactors and heated gas connections have two 115-V heater elements.

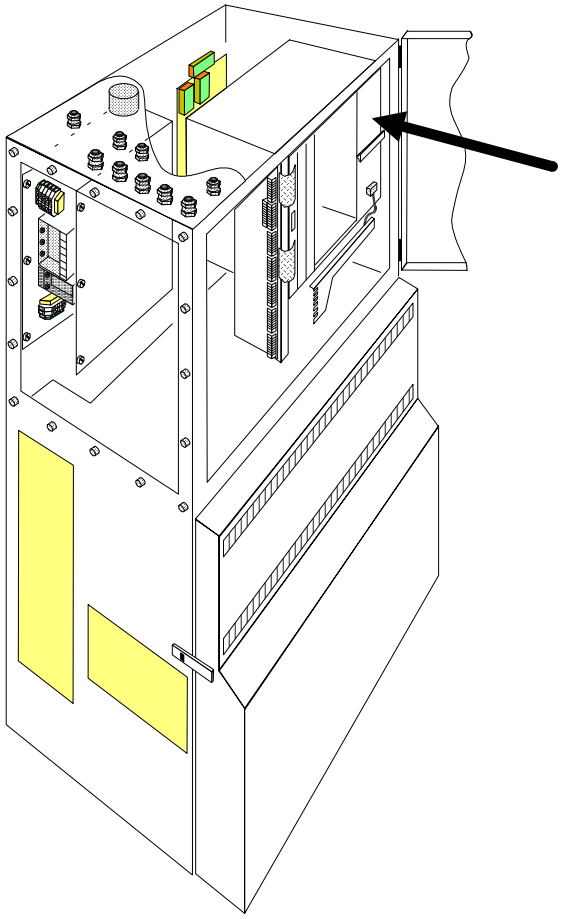
- 230-V operation
  Pairs of heater elements are connected in series. The center terminal serves as a looping point.
- 115-V operation
  Pairs of heater elements are connected in parallel. The center terminal is unused.





Heater control board (continued), power supply

Terminal	Application
75	N Spare
76	L Spare
77	PE Spare
78	PE To power supply
79	L To power supply
80	N To power supply



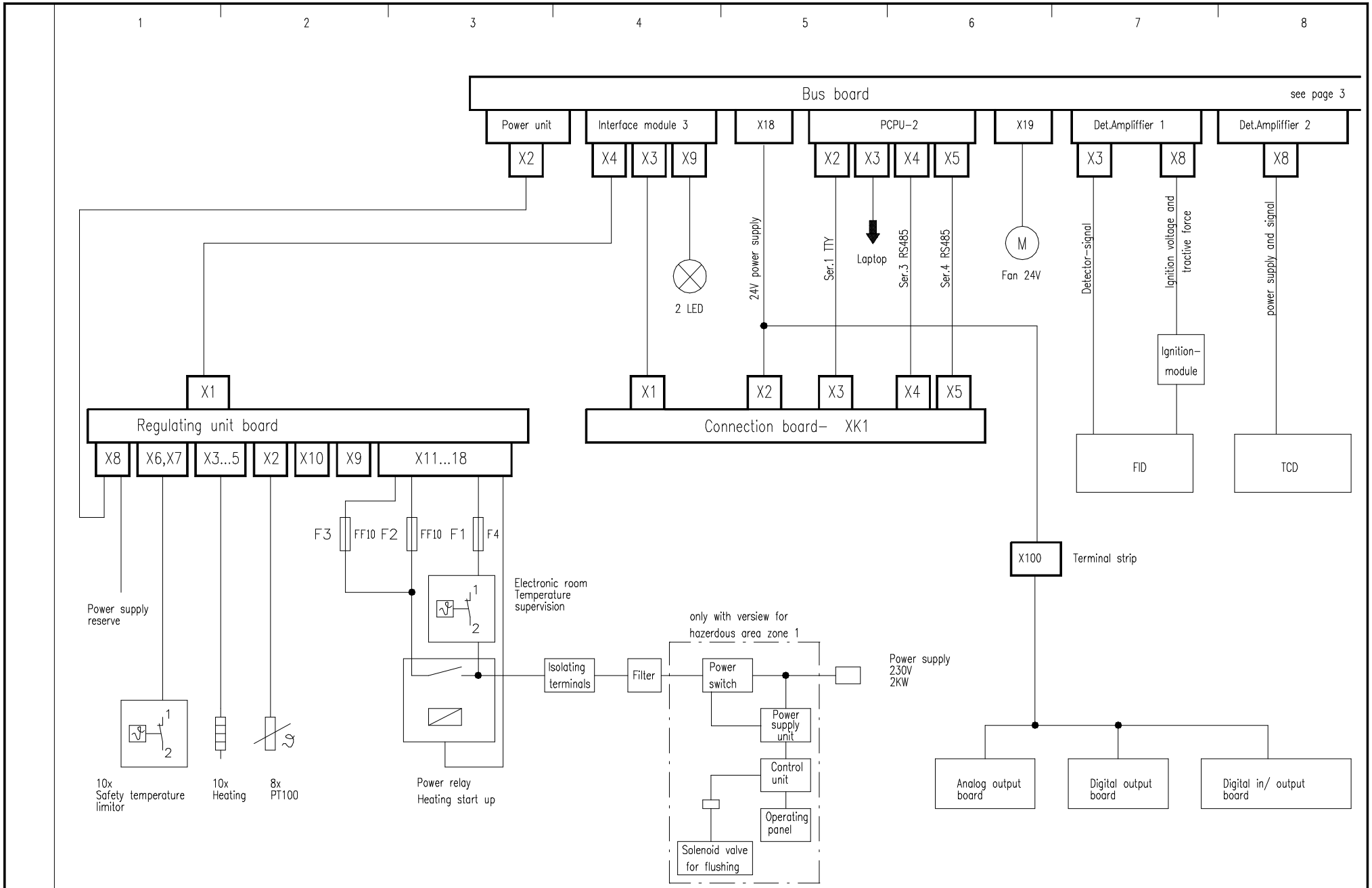
Power supply

Two ratings of the switched-mode power supply are available. Version 6815 is fitted as standard. The power supply provides the following voltages and currents:

Voltage	Current (type 6815)	Current (type 7750)
24 V	4 A	8 A
5 V	5 A	12 A
+15 V	0.2 A	0.2 A

Fuses

Voltage	Current (type 6815)	Current (type 7750)
230 V	2 x 1.25 A slow-blow	2 x 4 A slow-blow
115 V	2 x 2.5 A slow-blow	2 x 6.3 A slow-blow



	Revision	Date	Name		Date	Name
a				Desig.	23.10.00	Hirn
b						
c				checked		
d						

A&D PI25

SIEMENS

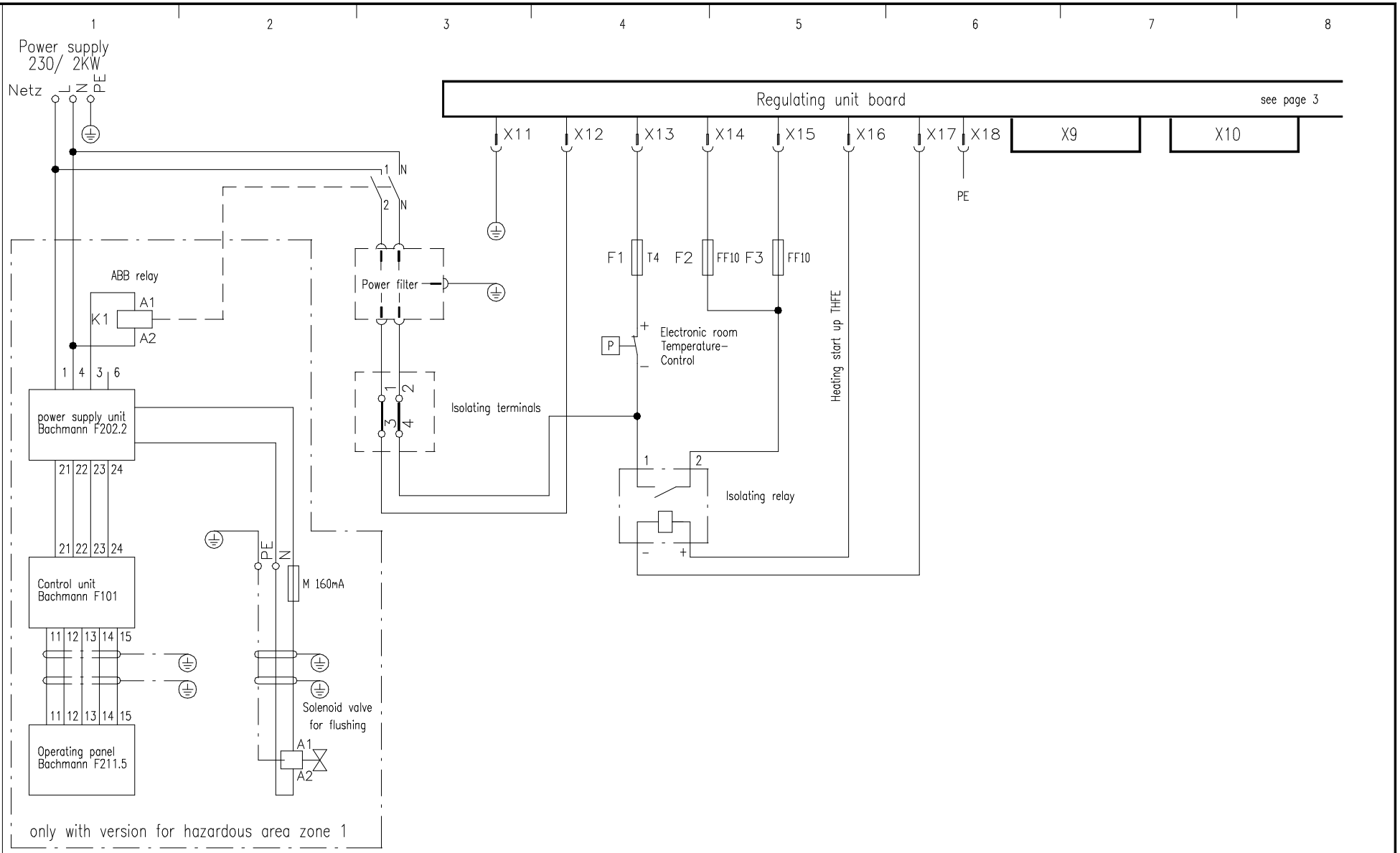
Blockdiagram P302 internal

Project No.

Order No.

Drawing No. C79451-A3404-X1-*-11

Page 1 13 P.



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c				checked		
d						

A&D PI25

SIEMENS

Wiring diagram
P302 internal

Project No.

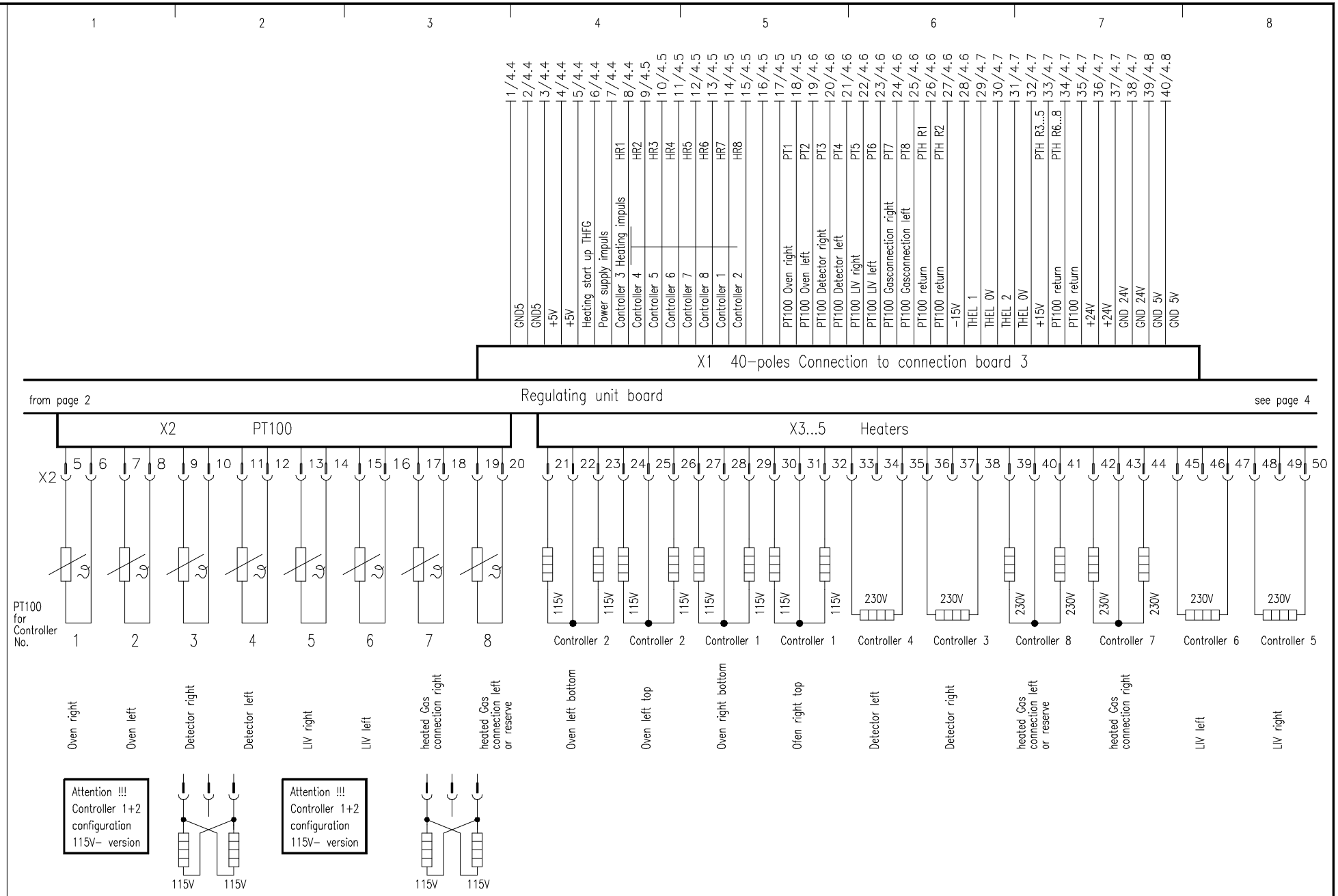
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Order No.

Drawing No.
C79451-A3404-X1-*-11

Page 2
13 P.



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c				checked		
d						

A&D PI25

SIEMENS

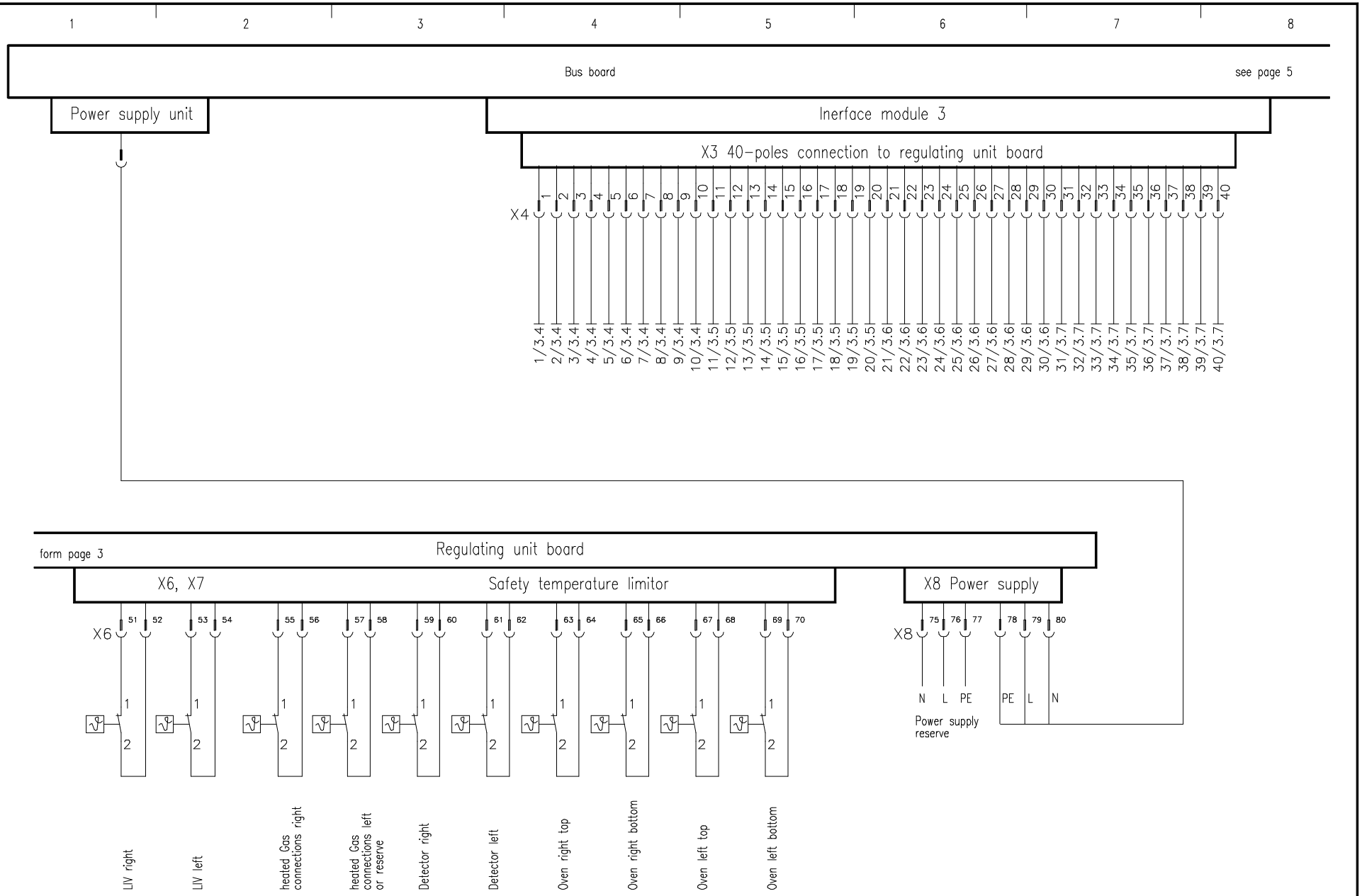
Wiring diagram
P302 internal

Project No. =
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Order No.

Drawing No. C79451-A3404-X1-*-11

Page 3
13 P.



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b						
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A&D PI25

SIEMENS

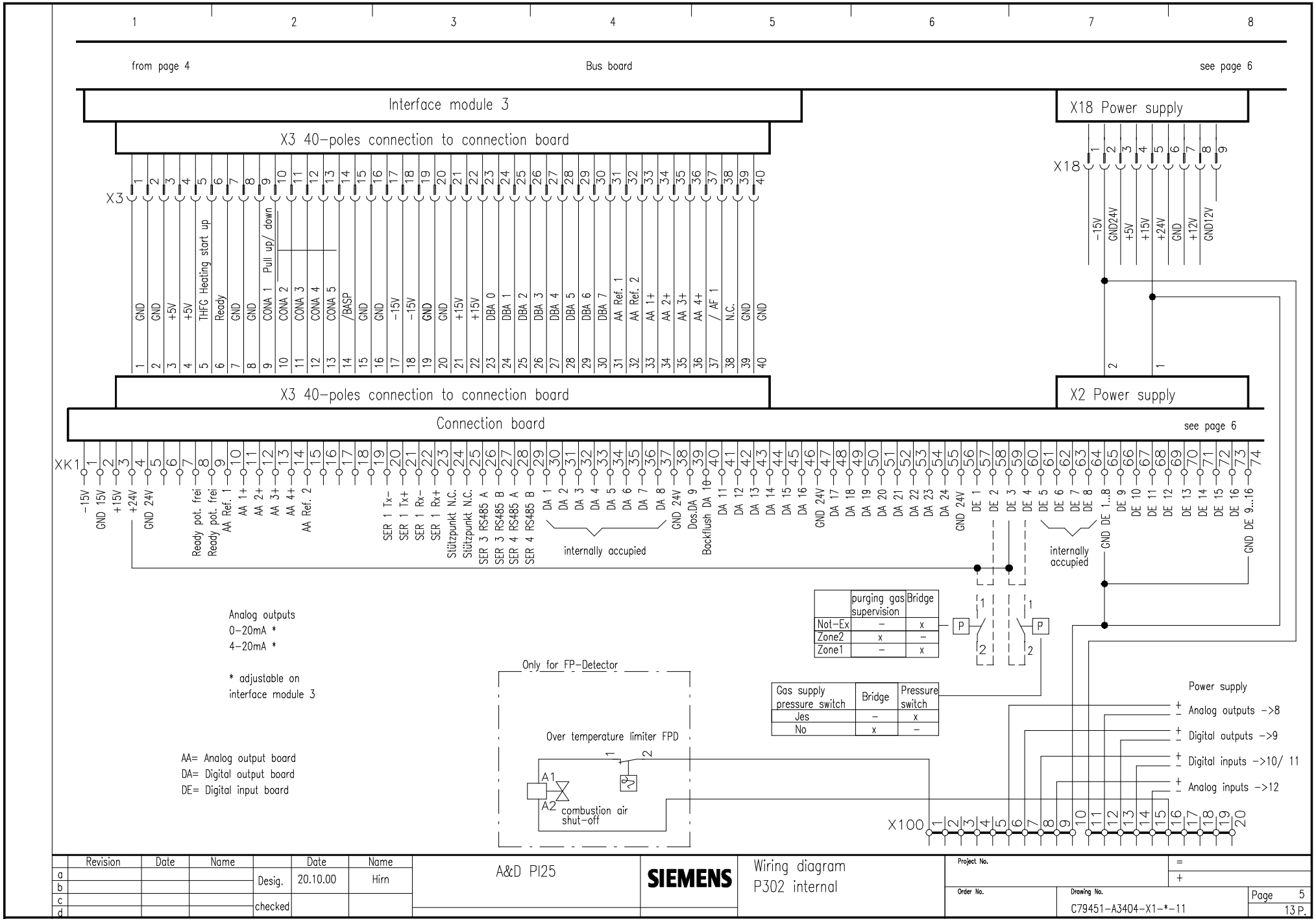
Wiring diagram
P302 internal

Project No. =

Order No. +

Drawing No. C79451-A3404-X1-*-11

Page 4
13 P.



	Revision	Date	Name		Date	Name
a				Desig.	20.10.00	Hirn
b						
c				checked		
d						

A&D PI25

SIEMENS

Wiring diagram
P302 internal

Project No. =

Order No. +

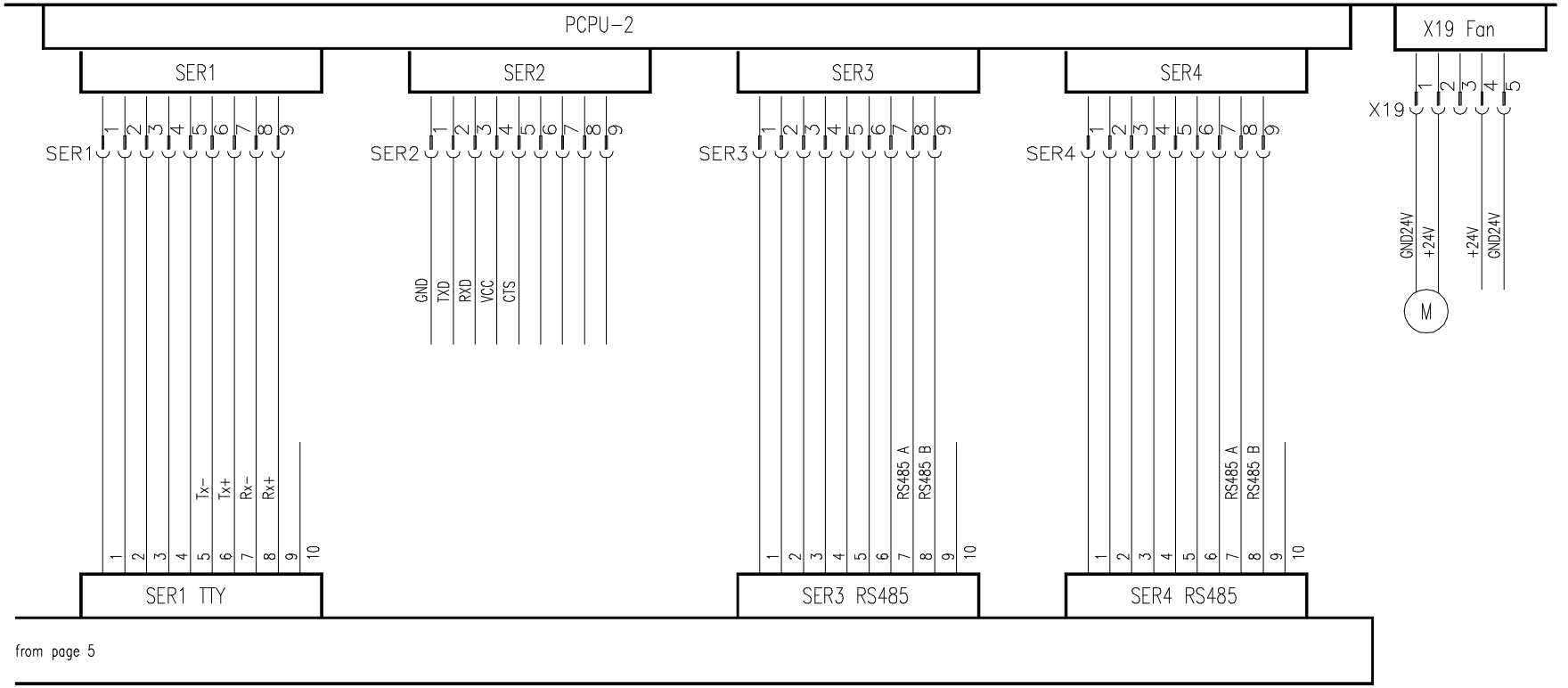
Drawing No. C79451-A3404-X1-*-11

Page 5
13 P.

from page 5

Bus board

see page 7



from page 5

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A&D PI25

SIEMENS

Wiring diagram
P302 internal

Project No.

Order No.

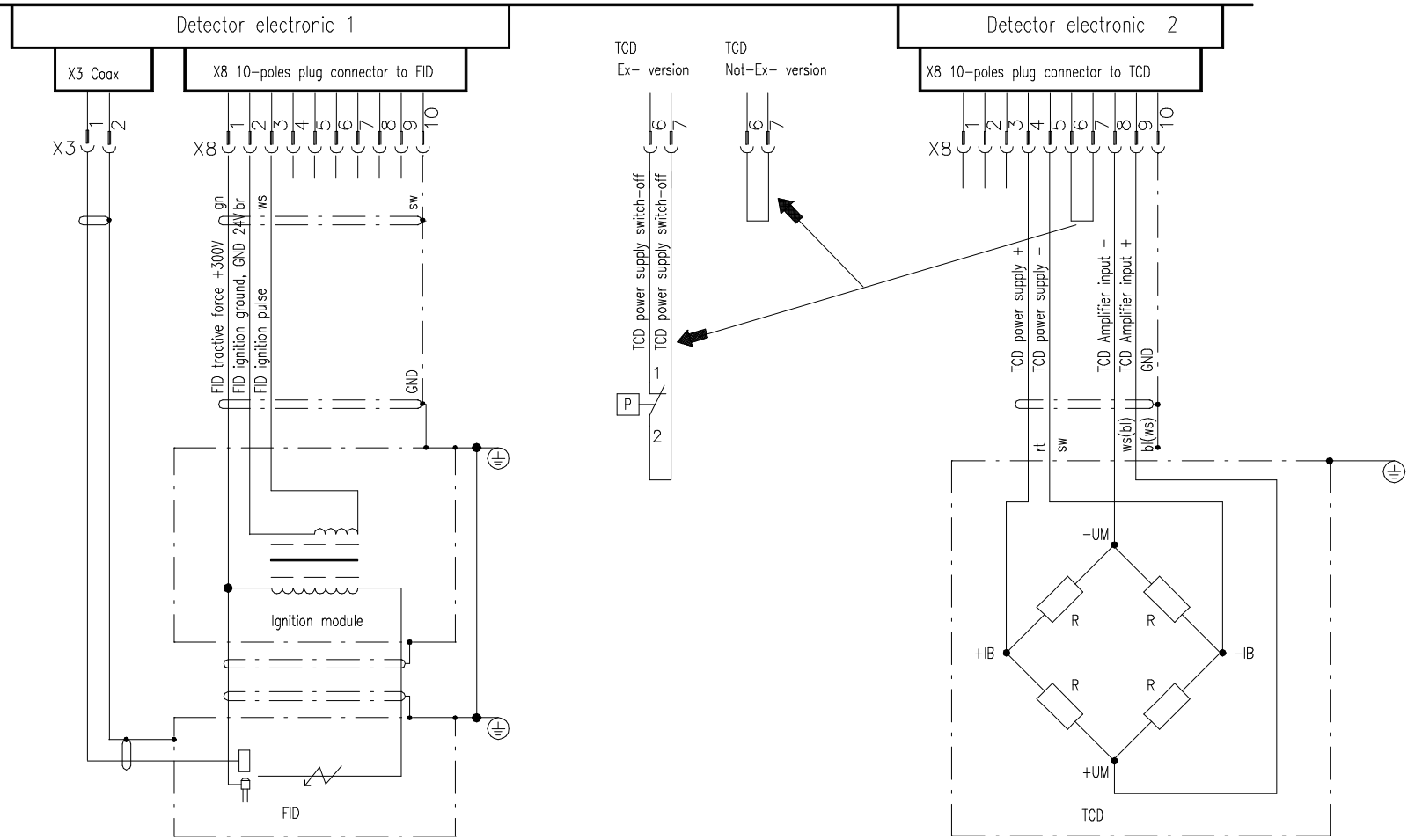
Drawing No.
C79451-A3404-X1-*-11

Page 6
13 P.

from page 6

Bus board

see page 8



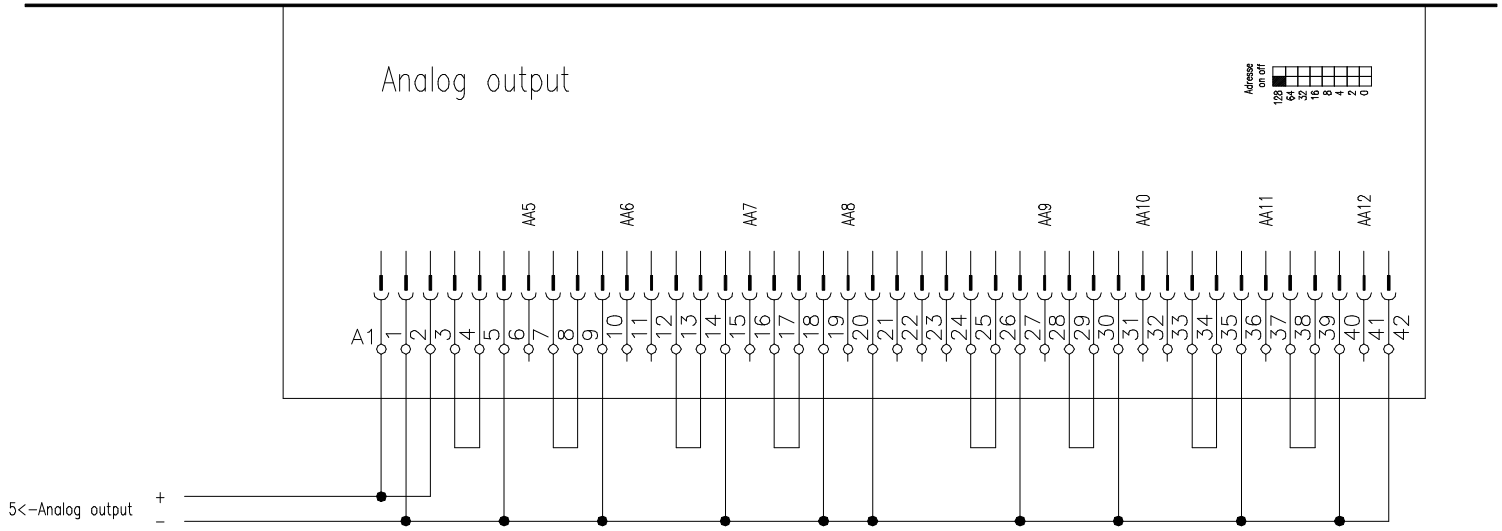
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Order No.	Drawing No. C79451-A3404-X1-*-11
	Page 7 / 13 P.

from page 7

Bus board

see page 9



AA = Analog output

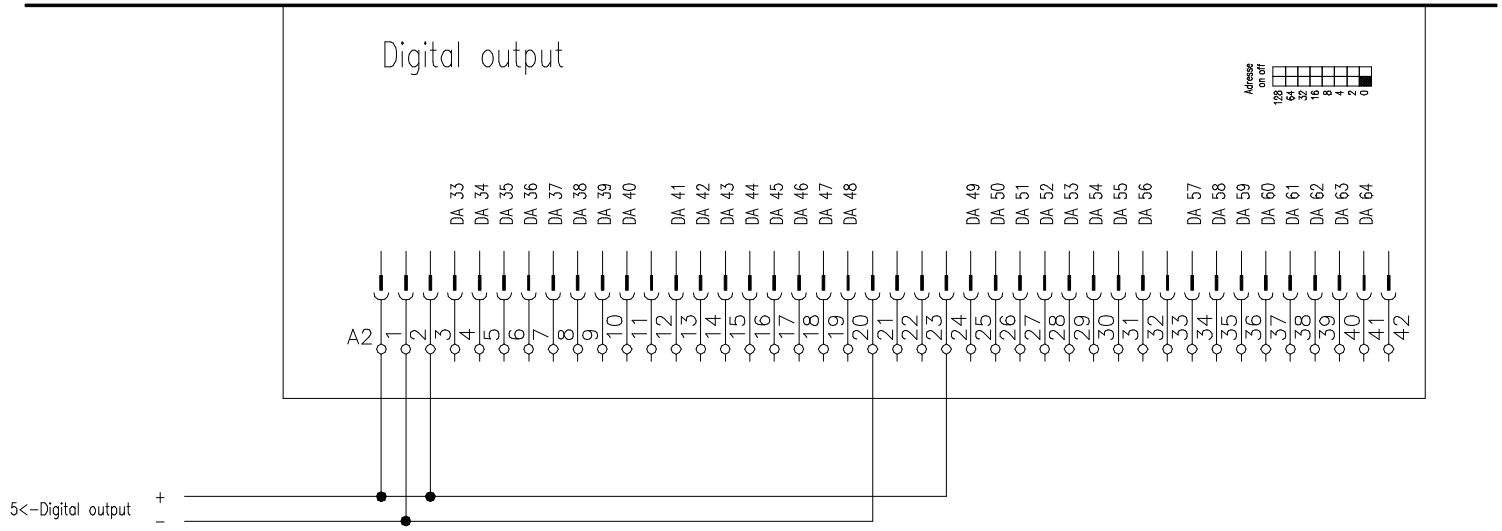
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Project No.	=
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Order No.	Drawing No. C79451–A3404–X1–*–11
	Page 8 / 13 P.

from page 8

Bus board

see page 10

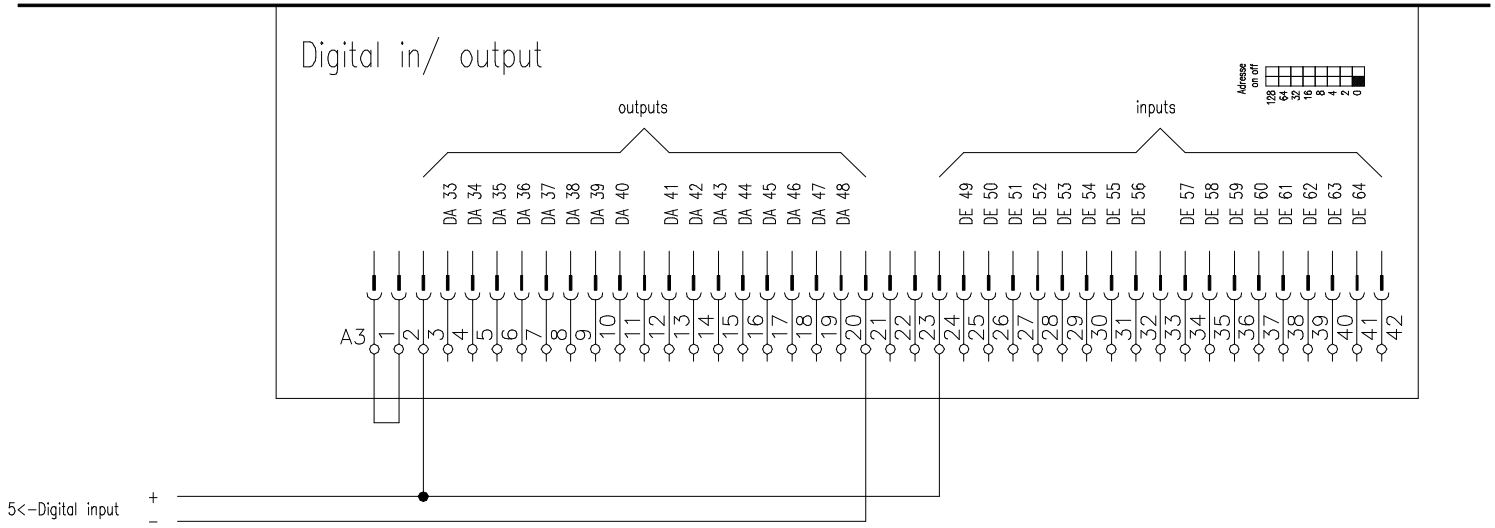


DA = Digital output

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Order No.	Drawing No. C79451–A3404–X1–*–11
	Page 9 / 13 P.

from page 9 Bus board see page 11

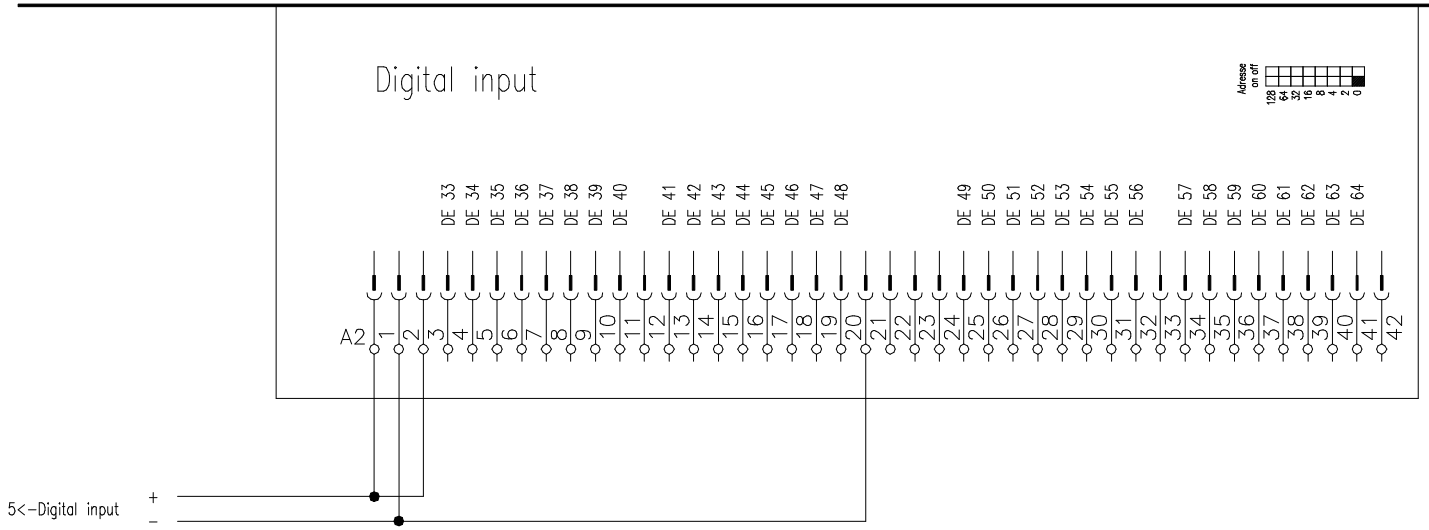


DA = Digital output
DE = Digital input

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Order No.
Drawing No. C79451–A3404–X1–*–11
Page 10
13 P.

from page 10 Bus board see page 12



DE = Digital input

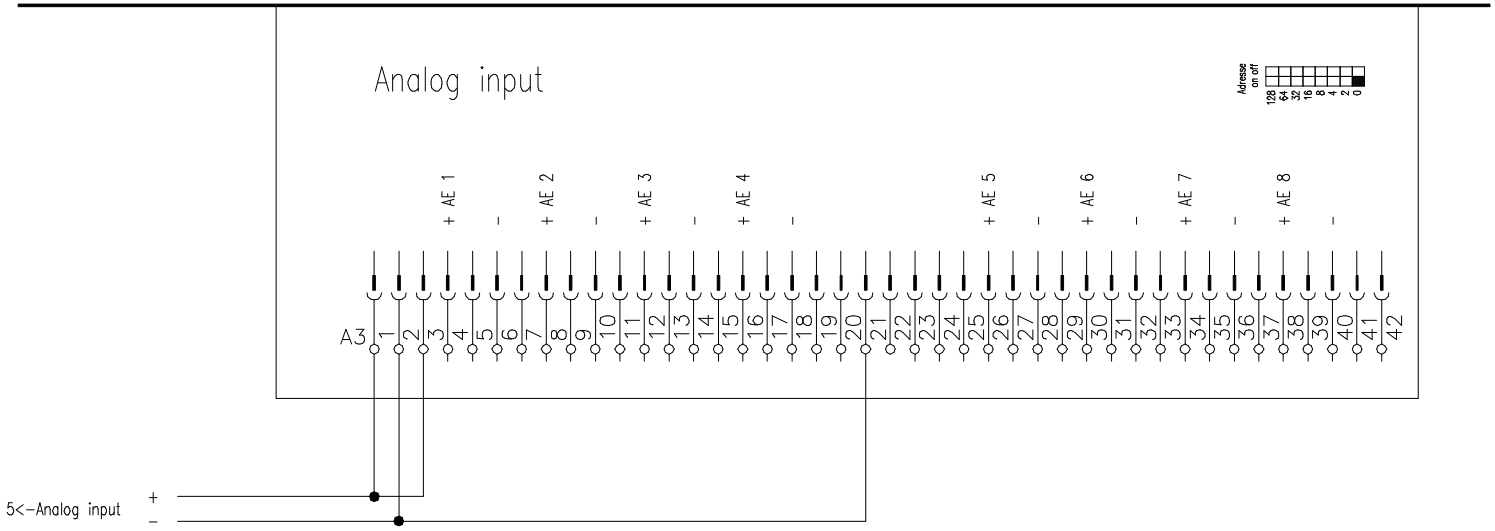
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Order No.	Drawing No. C79451–A3404–X1–*–11
	Page 11 / 13 P.

from page 11

Bus board

see page 13

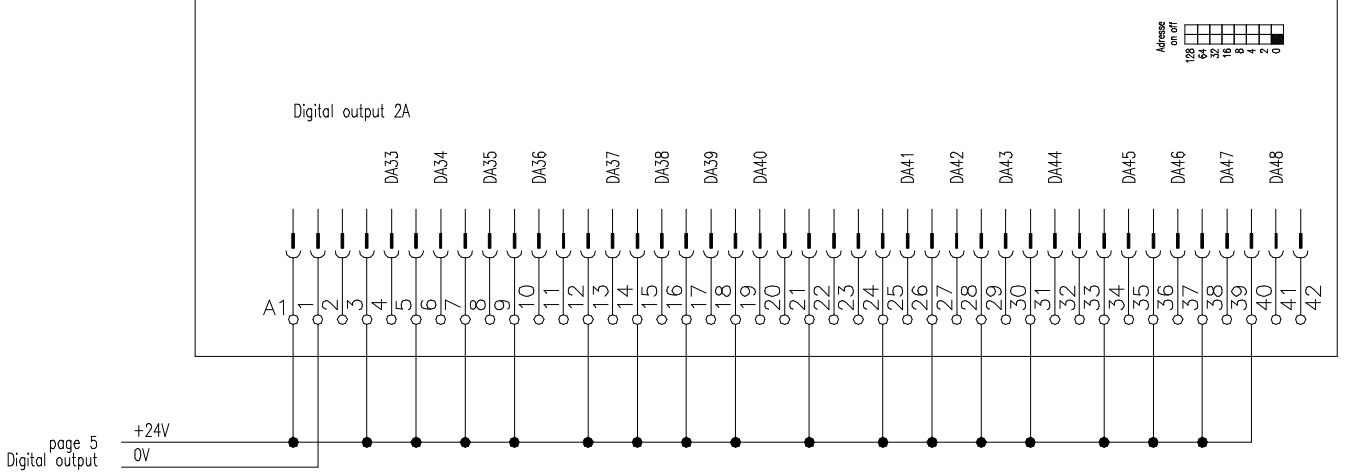


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d									

Project No.	=
	+
Order No.	Drawing No. C79451-A3404-X1-*-11
	Page 12 / 13 P.

from page 12

Bus board



	Revision	Date	Name		Date	Name
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b						
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A&D PI25

SIEMENS

Wiring diagram
P302 internal

Project No. =

Order No. +

Drawing No. C79451-A3404-X1-*-11

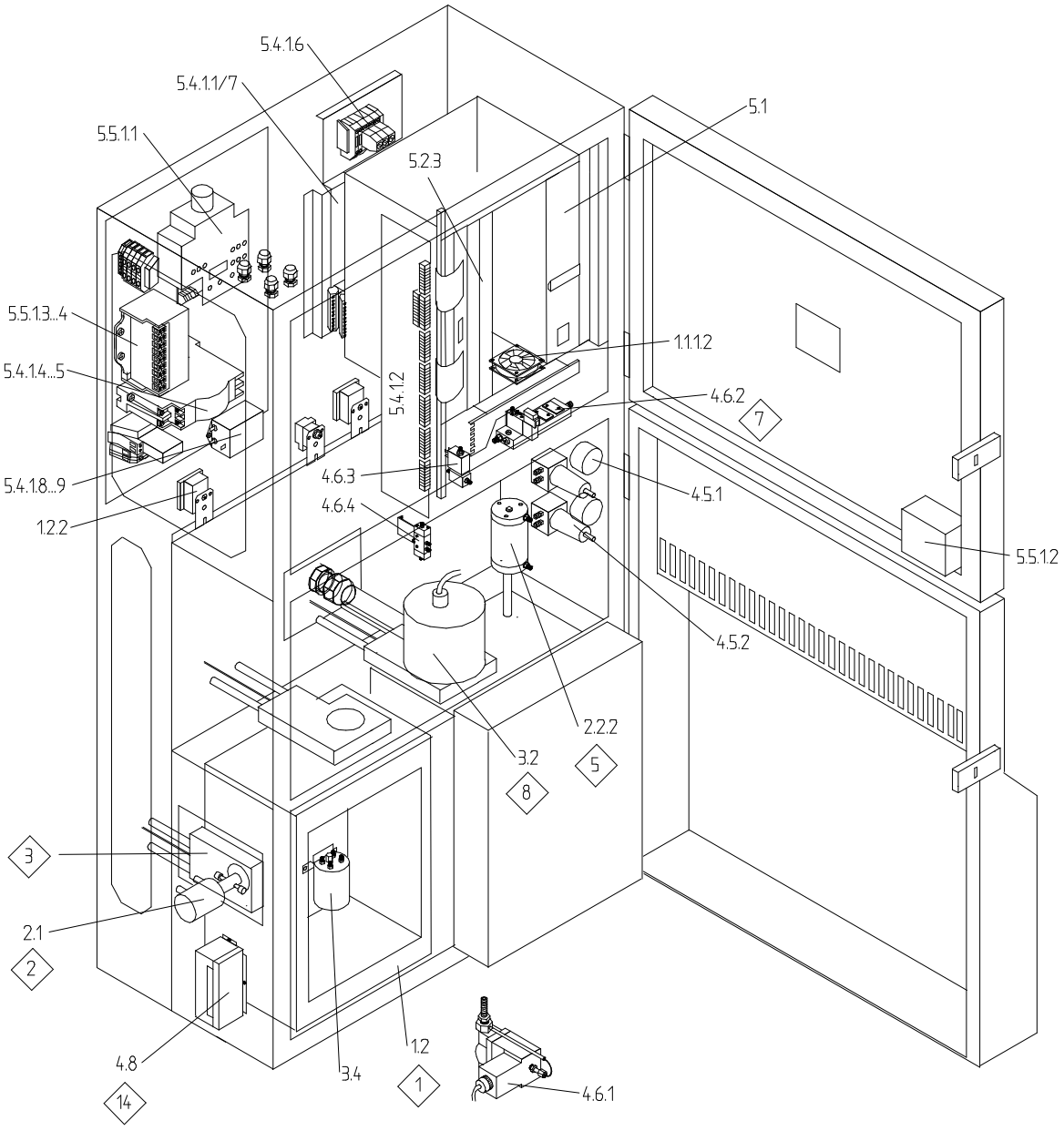
Page 13
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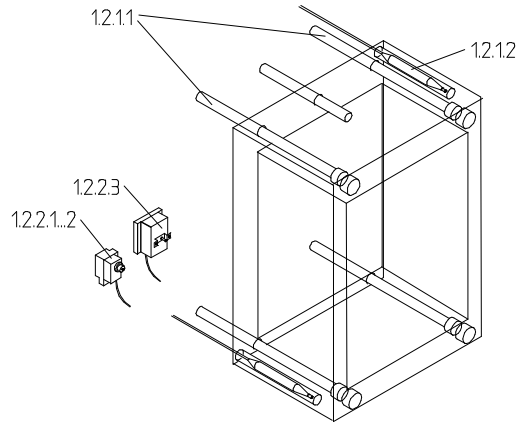
SIEMENS

Process Gas Chromatograph PGC 302 edition II

Spare parts list C79000-E5376-C524-1







1 s. Bild 1

Bild 1
Ofen

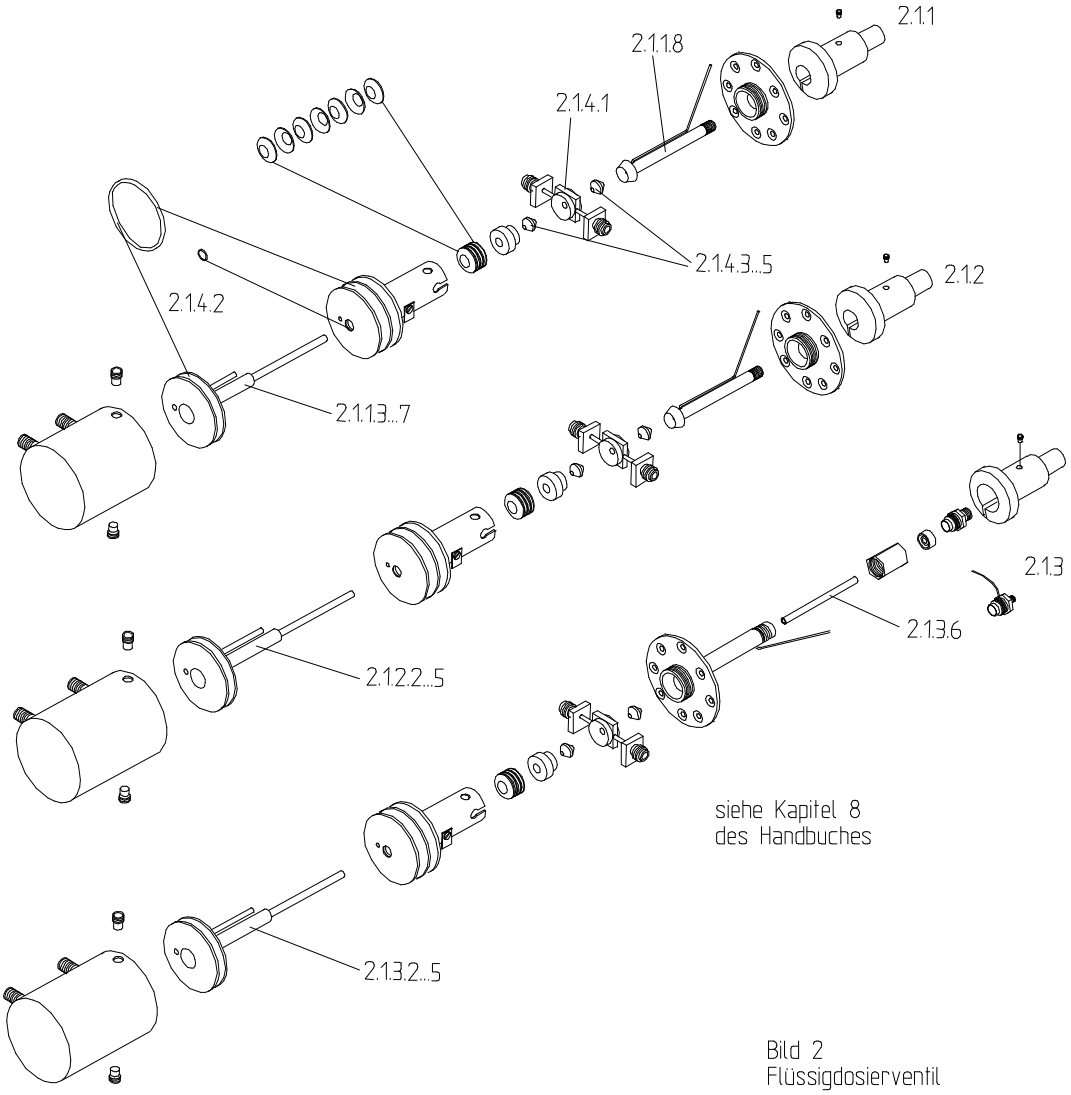


Bild 2
Flüssigdosierventil

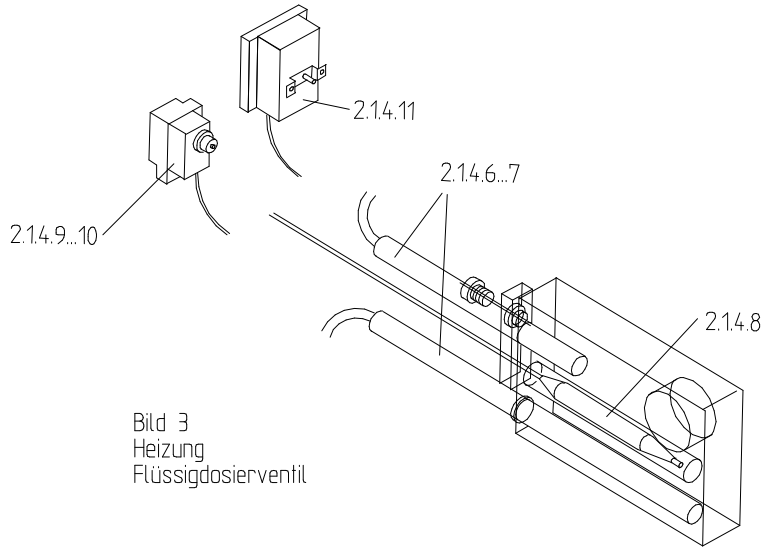


Bild 3
Heizung
Flüssigdosierventil

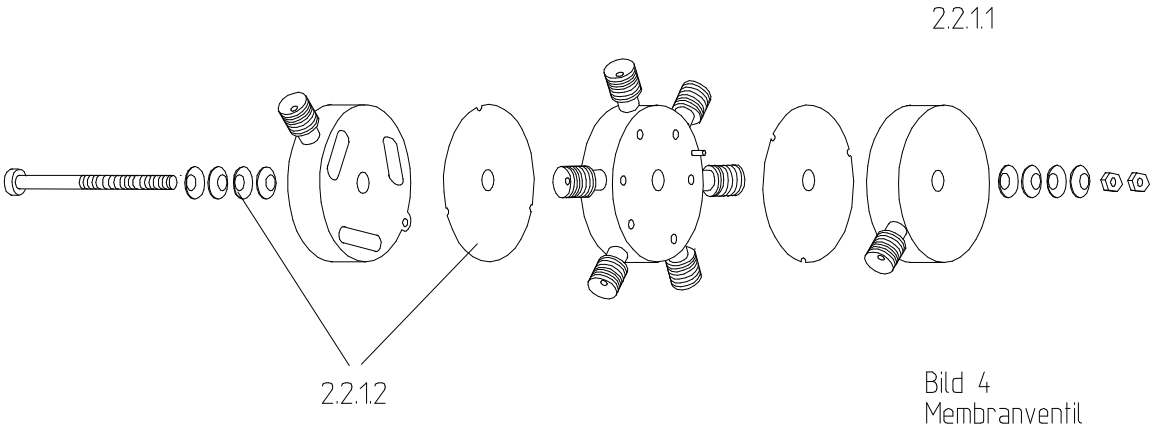


Bild 4
Membranventil

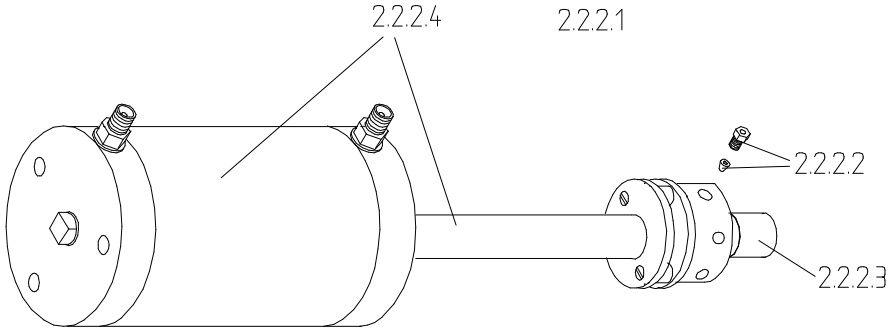


Bild 5
Drehschieberventil

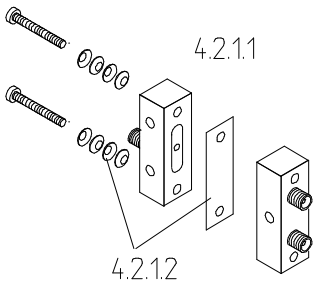


Bild 6
2-Wege-Membranventil

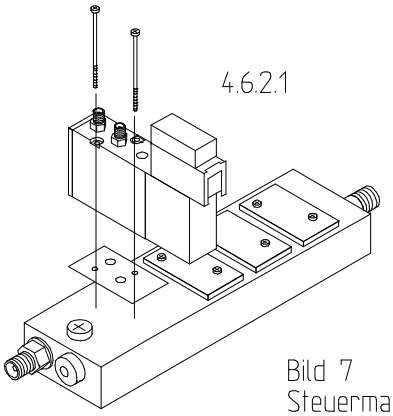


Bild 7
Steuermagnetventile

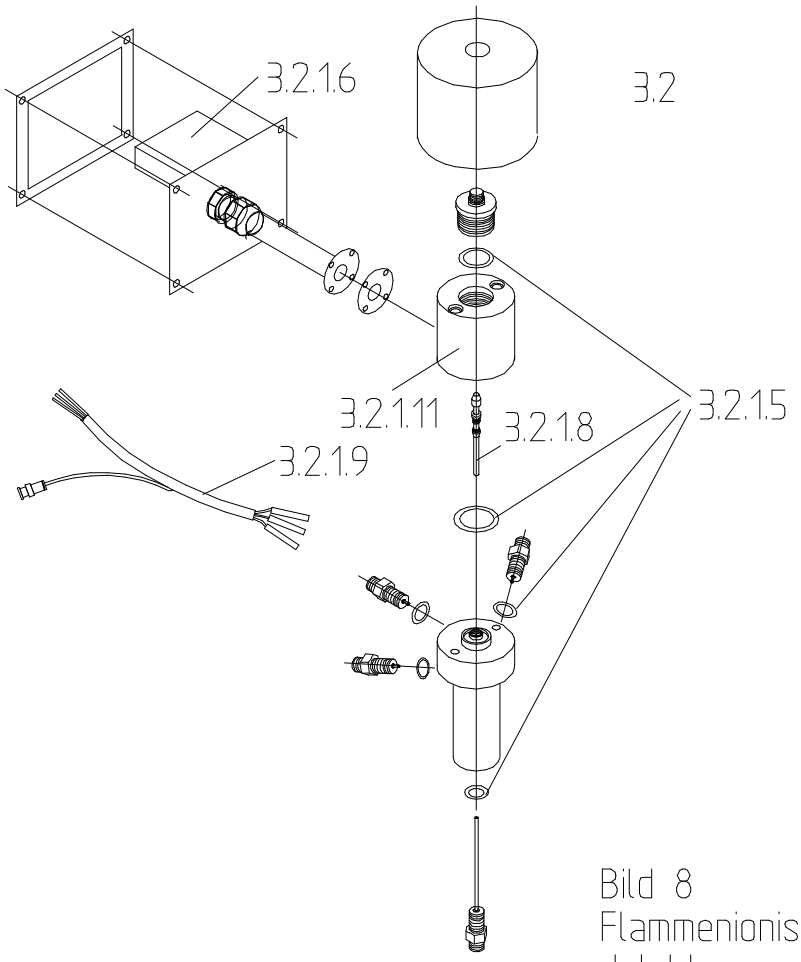


Bild 8
Flammenionisations-
detektor

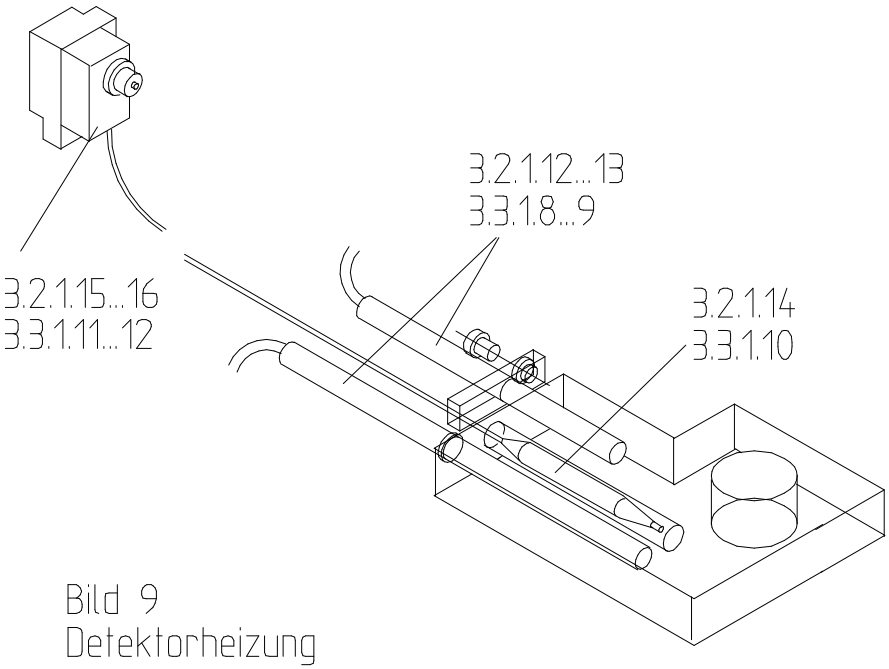


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Detektorheizung

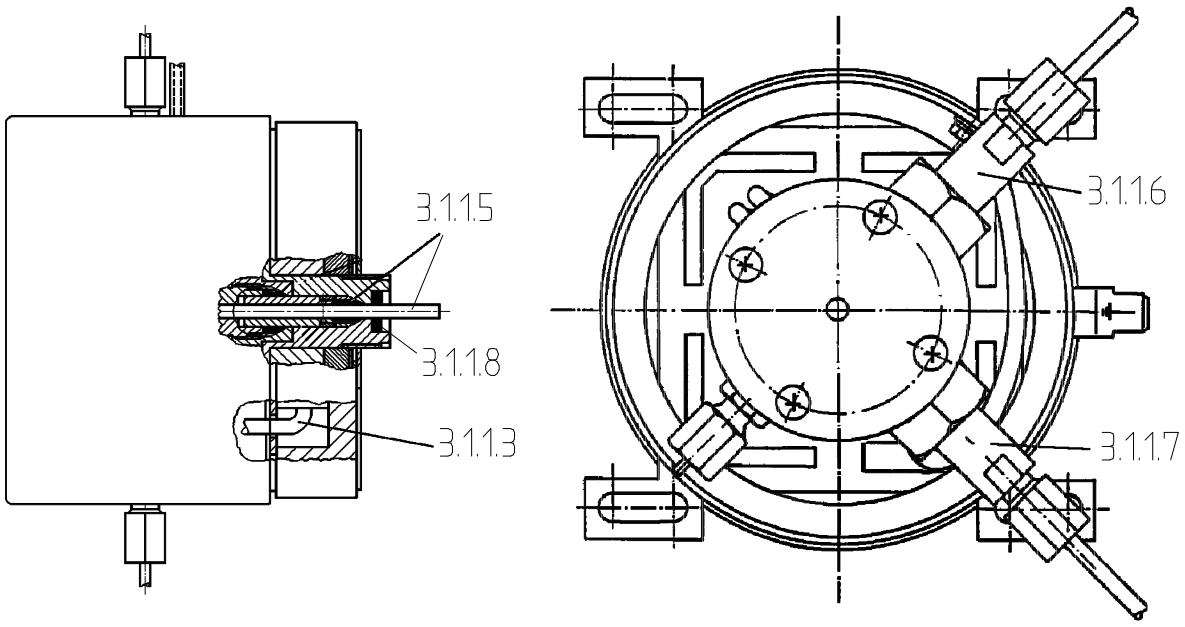


Bild 10
Elektroneneinfangdetektor

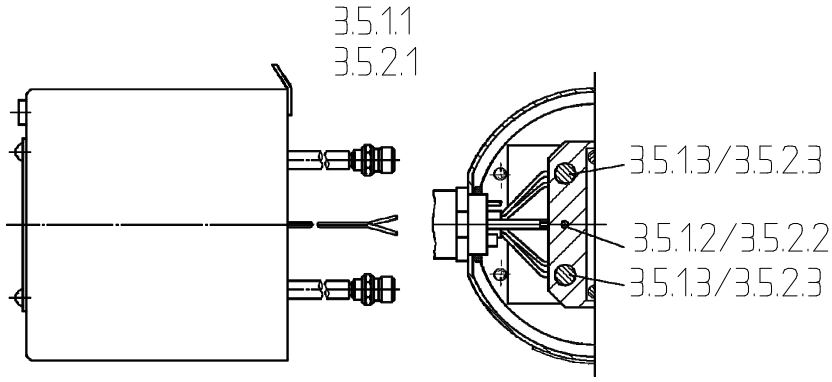
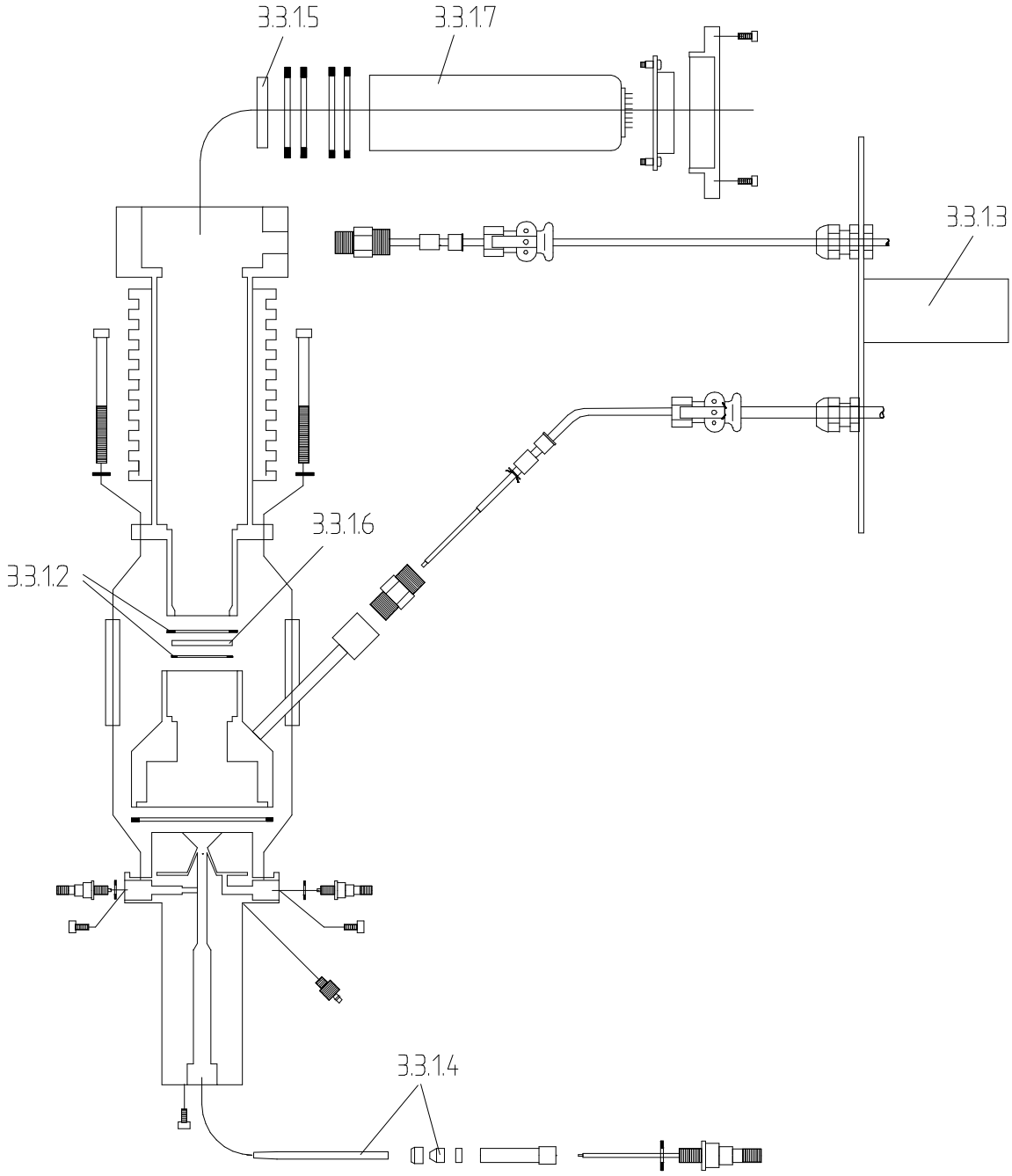


Bild 11
Hydrierreaktor



Heizpatronen
Pt100
Temperaturbegrenzer

s. Detektorheizung
Bild 9

Bild 12
Flammenphotometer-
detektor

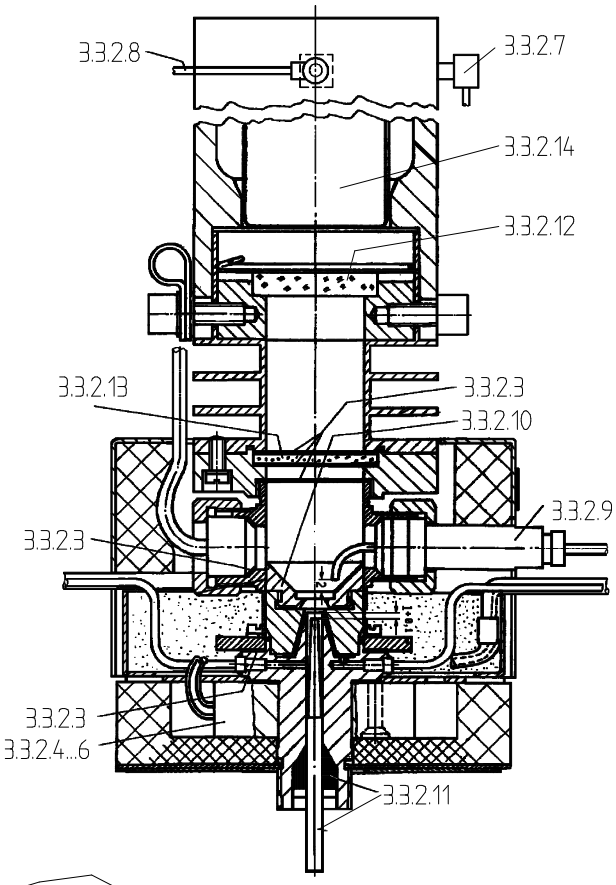


Bild 13
Flammenphotometer-
detektor (Nivht-Ex)

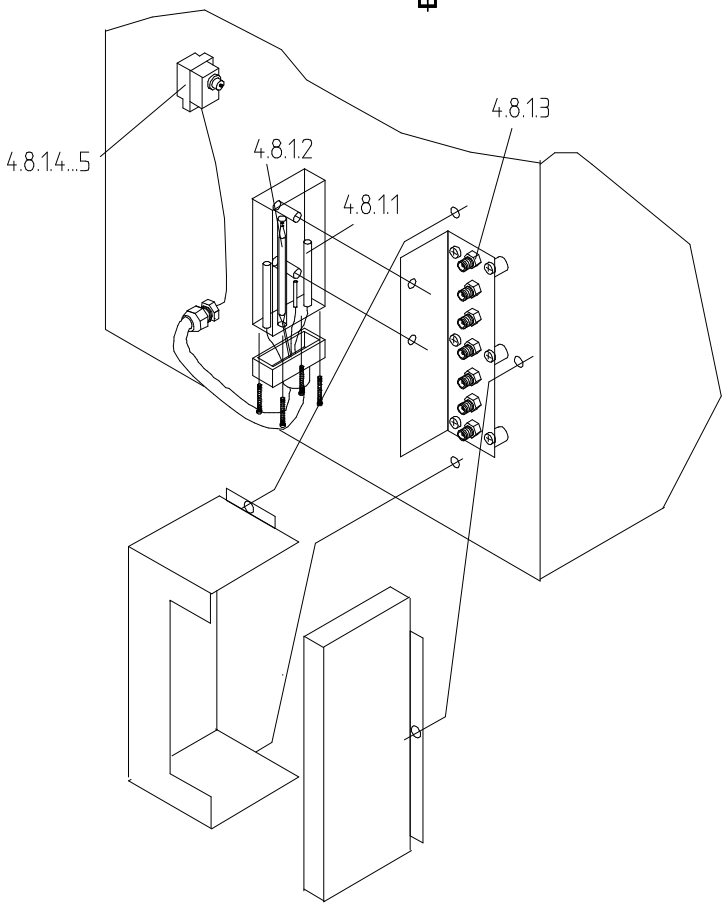
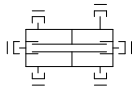
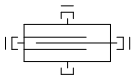
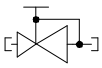
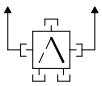
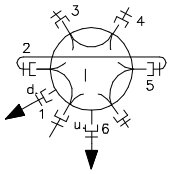


Bild 14
beheizte
Durchf?hrungen

Symbol Verrohrungsplan	Bezeichnung	Pos. Nr. Ersatzteilliste
	Live-T-St?ck	4.1.1.1..4 4.1.2.1...2 4.1.3.1...2
	Back-T-St?ck	4.2.1.1...2 4.3.2.1
	Nadelventil	4.3.1.1...2
	Drosselblende	4.4.1.1...7
	Fused Silica	4.4.2.1
	Manometer	4.5.1.1...2
	Druckregler	4.5.2.1...4
	Magnetventil	4.6.3.1...2
	pneumat. Ventil	4.6.4.1
	Geradeaus- verbinder	4.7.1.1...4
	3fach- Verteiler	4.7.2.1
	4fach- Verteiler	4.7.2.2...3
	6fach- Verteiler	4.7.2.4
	6-Wege- Membranventil	2.2.1.1..2 s. Bild 4
	2-Wege- Membranventil	4.2.1.1. s. Bild 6

	Description	Order no.
1.	**Basic equipment**	
1.1	**Housing**	
1.1.1.1	Temperature limiter, 60°C	W79086-D3-A60
1.1.1.2	Axial fan, 24V	C79451-A3404-B218
1.2	**Oven**	
1.2.1	**Heating of oven**	
1.2.1.1	Heating cartridge 115V :˝230V: 2 in serie 115V: 2 in parallel	W75083-A1001-F115
1.2.1.2	Measuring resistor Pt100	W75085-C1011-X
1.2.2	**Temperature limiter**	
1.2.2.1	Temperature limiter, 120°C	W75086-D1-A120
1.2.2.2	Temperature limiter, 185°C	W75086-D1-A185
1.2.2.3	Temperature limiter, 280°C	W75086-D1-A280
2.	**Injection valves**	
2.1	**Liquid injection valve**	
2.1.1	**Liquid injection valve (LIV) standard version**	
2.1.1.1	Liquid injection valve, standard type,˝injection volume 0,6µl	C79451-A3114-B33
2.1.1.2	Liquid injection valve, standard type,˝injection volume 2,4µl	C79451-A3114-B34
2.1.1.3	Piston with injection tappet, stainless steel,˝with bore 0.6µl	C79451-A3114-B40
2.1.1.4	Piston with injection tappet, stainless steel,˝with bore 1.0µl	C79451-A3114-B42
2.1.1.5	Piston with injection tappet, stainless steel,˝with bore 2.4µl	C79451-A3114-B43
2.1.1.6	Piston with injection tappet, stainless steel,˝with bore 5.3µl	C79451-A3114-B44
2.1.1.7	Piston with injection tappet, stainless steel,˝with bore 9.5µl	C79451-A3114-B45
2.1.1.8	Vaporizer for liquid injection valve	C79451-A3114-B26
2.1.2	**Liquid injection valve (LIV) for deep injection**	
2.1.2.1	Liquid injection valve, deep injection,˝SS, injection volume 0,6µl	C79451-A3364-B27
2.1.2.2	Piston with injection tappet, deep injection˝SS, with grooved ring 0.6µl	C79451-A3114-B47
2.1.2.3	Piston with injection tappet, deep injection˝SS, with grooved ring 1.5µl	C79451-A3114-B48
2.1.2.4	Piston with injection tappet, deep injection˝SS, with grooved ring 2.4µl	C79451-A3114-B49
2.1.2.5	Piston with injection tappet, deep injection˝SS, with notch 0.4µl	C79451-A3364-B44
2.1.3	**Liquid injection valve with deep injection and glass vaporizer**	
2.1.3.1	Liquid injection valve, deep injection,˝glass vaporizer 0,6µl	C79451-A3364-B27
2.1.3.2	Piston with injection tappet,˝SS, with grooved ring 0.6µl	C79451-A3114-B47
2.1.3.3	Piston with injection tappet,˝SS, with grooved ring 1.5µl	C79451-A3114-B48
2.1.3.4	Piston with injection tappet,˝SS, with grooved ring 2.4µl	C79451-A3114-B49
2.1.3.5	Piston with injection tappet,˝SS, with notch 0.4µl	C79451-A3364-B44
2.1.3.6	Glass vaporizer tube	C79451-A3364-C67
2.1.4	**Spares for all liquid injection valves (LIV)**	
2.1.4.1	Sample passage part,˝connector: Swagelok 1/8"	C79451-A3114-B46
2.1.4.2	Set O-rings for liquid injection valve : 10off small, 20off large	C79304-A3000-D3
2.1.4.3	Set: 20 lenticular gaskets for LIV, up to 60°C	C79304-A3000-D4
2.1.4.4	Set: 20 lenticular gaskets for LIV, 60 - 200°C	C79304-A3000-D5
2.1.4.5	Set: 20 lenticular gaskets for LIV,˝200°C - 450°C	C79304-A3000-D6
2.1.4.6	Heating cartridge, 230V	W75083-A1001-D230
2.1.4.7	Heating cartridge, 115V	W75083-A1001-D115
2.1.4.8	Measuring resistor Pt100	W75085-C1010-X
2.1.4.9	Temperature limiter, 120°C	W75086-D1-A120
2.1.4.10	Temperature limiter, 185°C	W75086-D1-A185
2.1.4.11	Temperature limiter, 280°C	W75086-D1-A280

Description	Order no.
2.2 Gas injection valves	
2.2.1 6-way diaphragm valve	
2.2.1.1 6 way diaphragm valve	C79450-A3014-A1
2.2.1.2 Set: 20 Diaphragms and 8 plate springs ˝for 6 way valve	C79304-A3000-D7
2.2.2 Slide vane rotary valve, up to 220°C	
2.2.2.1 Slide vane rotary valve, up to 220°C, complete	C79211-A3022-B10
2.2.2.2 Set: 6 fittings for slide vane rotary valve	C79304-A3000-D8
2.2.2.3 Slide vane rotary valve 220°C˝without pneumatic drive	C79211-A3022-B12
2.2.2.4 Pneumatic drive for slide vane rotary valve	C79211-A3022-B13
3. Detectors	
3.1 Electron capture detector (ECD)	
3.1.1.1 Elektron capture detector (ECD), 230V	C79211-A3009-A3
3.1.1.2 Elektron capture detector (ECD), 115V	C79211-A3009-A5
3.1.1.3 Heating cartridge	C79211-A3005-B14
3.1.1.4 Measuring resistor Pt100	C79211-A3005-B15
3.1.1.5 Nozzle with pressed-on conical gasket	C79211-A3009-B15
3.1.1.6 Supply cable ECD	C79211-A3009-D2
3.1.1.7 Measuring cable ECD	C79211-A3009-D3
3.1.1.8 Sealing washer ECD-nozzle 1set = 5off	C79304-A3000-B1
3.2 Flame ionization detector (FID)	
3.2.1.1 Flame ionization detector (FID),˝explosion-proof	C79451-A3404-B91
3.2.1.2 Flame ionization detector (FID),˝without EX protection	C79451-A3404-B90
3.2.1.3 Flame ionization detector (FID),˝explosion-proof , without ignition module	C79211-A3023-A1
3.2.1.4 Flame ionization detector (FID),˝without EX-protection, without ignition module	C79211-A3023-A2
3.2.1.5 Set of gaskets for FID	C79304-A3000-D20
3.2.1.6 Ignition module	C79211-A3023-B20
3.2.1.7 Filter for FID	C79211-A3023-C12
3.2.1.8 Nozzle (quartz-glass) for FID	C79211-A3023-C19
3.2.1.9 FID-cable, complete	C79211-A3023-B13
3.2.1.11 FID upper part with electrodes	C79211-A3023-B7
3.2.1.12 Heating cartridge, 230V	W75083-A1001-D230
3.2.1.13 Heating cartridge, 115V	W75083-A1001-D115
3.2.1.14 Measuring resistor Pt100	W75085-C1010-X
3.2.1.15 Temperature limiter, 120°C	W75086-D1-A120
3.2.1.16 Temperature limiter, 185°C	W75086-D1-A185
3.3 Flame photometric detector (FPD)	
3.3.1 FPD with EX-protection	
3.3.1.1 Flame photometric detector complete, explosion-proof	C79211-A3026-A1
3.3.1.2 Set: Gaskets for EX-FPD	C79304-A3000-D21
3.3.1.3 Ignition module for FID / FPD	C79211-A3023-B20
3.3.1.4 Nozzle, Quartzglass for FPD including conical gasket	C79211-A3026-B13
3.3.1.5 Filter, 399nm (sulphur) for FPD	C79285-F1252-F1
3.3.1.6 Quartz disk for FPD	C79285-Z184-C1
3.3.1.7 Photomultiplier for FPD	W79045-A4000
3.3.1.8 Heating cartridge 230V	W75083-A1001-D230
3.3.1.9 Heating cartridge 115V	W75083-A1001-D115
3.3.1.10 Measuring resistor Pt100	W75085-C1010-X
3.3.1.11 Temperature limiter, 120°C	W75086-D1-A120
3.3.1.12 Temperature limiter, 185°C	W75086-D1-A185

Description	Order no.
3.3.2 **FPD without EX-protection**	
3.3.2.1 Flame photometric detector complete,˝without EX-protection, 230V	C79211-A3006-A1
3.3.2.2 Flame photometric detector complete,˝without EX-protection, 115V	C79211-A3006-A9
3.3.2.3 Set: Gaskets for Non-EX-FPD	C79304-A3000-D9
3.3.2.4 Measuring resistor Pt100	C79211-A3005-B15
3.3.2.5 Heating cartridge 230V	C79211-A3005-B16
3.3.2.6 Heating cartridge 115V	C79211-A3005-B17
3.3.2.7 Supply cable FPD	C79211-A3006-B17
3.3.2.8 Measuring cable FPD	C79211-A3006-B18
3.3.2.9 Ignition cable FPD	C79211-A3006-B24
3.3.2.10 Reflector, FPD	C79211-A3006-C3
3.3.2.11 Nozzle, Quartzglass for FPD˝including conical gasket	C79304-A3000-D22
3.3.2.12 Filter, 399nm (sulphur) for FPD	C79285-F1252-F1
3.3.2.13 Quartz disk for FPD	C79285-Z184-C1
3.3.2.14 Photomultiplier for FPD	W79045-A4000
3.4 **Thermal conductivity detector (TCD)**	
3.4.1.1 Thermal conductivity detector (TCD)˝without EX-protection, chamber volume 70µl	C79211-A3005-A13
3.4.1.2 Thermal conductivity detector (TCD)˝without EX-protection, chamber volume 350µ	C79211-A3005-A14
3.4.1.3 Thermal conductivity detector, (TCD)˝explosion-proof design, chamber volume 7(	C79211-A3005-A11
3.4.1.4 Thermal conductivity detector, (TCD)˝explosion-proof design, chamber volume 3ᵹ	C79211-A3005-A12
3.4.1.5 Temperature limiter, 120°C	W75086-D1-A120
3.4.1.6 Temperature limiter, 185°C	W75086-D1-A185
3.5 **Hydrogenation reactor**	
3.5.1 **Hydrogenation reactor without EX-protection**	
3.5.1.1 Hydrogenation reactor , complete	C79211-A3024-A2
3.5.1.2 Measuring resistor Pt100	C79211-A3024-B9
3.5.1.3 Heating cartridge 1set = 2off	C79451-A3358-B94
3.5.2 **Hydrogenation reactor explosion-proof**	
3.5.2.1 Hydrogenation reactor, explosion-proof	C79211-A3024-A1
3.5.2.2 Measuring resistor Pt100	C79211-A3024-B9
3.5.2.3 Heating cartridge 1set = 2off	C79451-A3358-B94
4. **Gassupply and column switching**	
4.1 **Live T-pieces**	
4.1.1 **Live-T-piece for capillary columns**	
4.1.1.1 Live-T-piece for columns I.D.= 0,2mm	C79450-A3012-B1
4.1.1.2 Live-T-piece for columns I.D.= 0,25mm	C79450-A3012-B2
4.1.1.3 Live-T-piece for columns I.D.= 0,32mm	C79450-A3012-B4
4.1.1.4 Live-T-piece for columns I.D.= 0,53mm	C79450-A3012-B5
4.1.2 **Live-T-piece for packed columns with inner diameter 2mm**	
4.1.2.1 Live-T-piece for columns I.D.= 2mm	C74304-A16-B321
4.1.2.2 Coupling capillary for Live-T-piece˝(Columns I.D. = 2mm)	C74304-A16-B323
4.1.3 **Live-T-piece for packed columns with inner diameter 3mm**	
4.1.3.1 Live-T-piece for columns I.D.= 3mm	C74304-A16-B293
4.1.3.2 Coupling capillary for Live-T-piece˝(Columns I.D. = 3mm)	C74304-A16-B318
4.2 **Backflush valve**	
4.2.1 **Diaphragm 2-way backflush valve**	
4.2.1.1 Diaphragm 2-way backflush valve	C74402-A2244-A3
4.2.1.2 Set: 10 Diaphragms and 4 cup springs for˝2-way backflush valve	C79304-A3000-D11

	Description	Order no.
4.2.2	**Back-T-piece for packed columns**	
4.2.2.1	Back-T-piece for columns I.D.=1/8"	C79304-A3000-B7
4.2.2.2	Back-T-piece for columns I.D.=4mm	C79304-A3000-B8
4.2.3	**Back-T-piece for capillary columns**	
4.2.3.1	Capillary Back-T-piece	C79304-A3000-C54
4.3	**Needle valve**	
4.3.1.1	Needle valve, graphite	C74402-A2246-A6
4.3.1.2	Needle valve, PTFE	C74402-A2246-A7
4.4	**Restriction orifices**	
4.4.1	**Restriction orifices**	
4.4.1.1	Restriction orifice, class 1	C74302-A32-B611
4.4.1.2	Restriction orifice, class 4	C74302-A32-B614
4.4.1.3	Restriction orifice, class 5	C74302-A32-B615
4.4.1.4	Restriction orifice, class 6	C74302-A32-B616
4.4.1.5	Restriction orifice, class 7	C74302-A32-B617
4.4.1.6	Restriction orifice, class 8	C74302-A32-B618
4.4.1.7	Restriction orifice, class 9	C74302-A32-B619
4.4.2	**Fused Silica**	
4.4.2.1	Restriction, fused silica˝I.D.=0,15, O.D.=0,3mm length=6m	C74304-A16-B305
4.5	**Pressure gauges and controllers**	
4.5.1	**Pressure gauges**	
4.5.1.1	Pressure gauge, 2.5 bar	C79402-F779-A1
4.5.1.2	Pressure gauge, 6 bar	C79402-F779-S1
4.5.2	**Pressure controllers**	
4.5.2.1	Pressure controller, 6bar	C79450-A3006-A3
4.5.2.2	Difference pressure controller	C79450-A3006-A5
4.5.2.3	Filter frit for pressure controller	C79450-A3006-C18
4.5.2.4	Connection, G1/8 -> 1,5mm	C74304-A16-C299
4.6	**Solenoid valves and slider valves**	
4.6.1	**Solenoid valves for purge of Zone1-instruments**	
4.6.1.1	Solenoid valve 230V	C79402-Z1010-A23
4.6.1.2	Solenoid valve 115V	C79402-Z1010-A25
4.6.2	**Solenoid valve for control gas (SMC)**	
4.6.2.1	Solenoid valve for control gas,˝including connectors	C79304-A3000-D15
4.6.3	**Solenoid valves for Live-Switching all instruments besides EX with carrier H2**	
4.6.3.1	Solenoid valve 24V, for Live-injection˝without current : 1-2 connected	C79304-A3000-D13
4.6.3.2	Solenoid valve 24V, for Live Back and Cut,˝without current: 1-2 interrupted	C79304-A3000-D14
4.6.4	**Pneumatic valve for Live-Switching in EX-Instruments with carrier H2**	
4.6.4.1	Slider valve	C79304-A3000-D12
4.7	**Pipes and fittings**	
4.7.1	**Adaptors**	
4.7.1.1	Adaptor, 4mm -> 1,5mm	C74304-A16-C290
4.7.1.2	Adaptor, 1,5mm -> 1,5mm	C74304-A16-C291
4.7.1.3	Adaptor, 1,5mm -> 1/8"mm	C74304-A16-C452
4.7.1.4	Adaptor, 4mm -> 4mm	C74304-A16-C474

	Description	Order no.
4.7.2	**Distributors**	
4.7.2.1	3 fold distributor, 1,5mm -> 1,5mm	C74304-A16-C449
4.7.2.2	4 fold distributor, 1,5mm -> 1,5mm	C74304-A16-C450
4.7.2.3	4 fold distributor, 1mm -> 1,5mm	C79304-A3000-C26
4.7.2.4	6 fold distributor, 1,5mm -> 1,5mm	C74304-A16-B286
4.7.2.5	Injection split	C74304-A16-C475
4.7.2.6	Nut M7 x 0,75	C74304-A16-C293
4.7.3	**Fittings, Tube**	
4.7.3.1	Set: Fittings for capillary columns	C79304-A3000-D17
4.7.3.2	Set: Fittings for 1,5mm and 3mm tubes	C79304-A3000-D18
4.7.3.3	Set: Fittings für 4mm tubes˝(packed columns)	C79304-A3000-D19
4.7.3.4	Tube 1,5mmx0,25mm 6m	C74304-A16-B304
4.8	**Heated gas connection**	
4.8.1.1	Heating cartridge 115V,100W,˝115V: 2 in parallel 230V: 2 serial	C79451-A3358-B94
4.8.1.2	Measuring resistor Pt100	C79451-A3358-B96
4.8.1.3	Connection piece, l=1200mm , 6mm Swagelok connector , with safety ring	C79304-A3000-D16
4.8.1.4	Temperature limiter, 120°C	W75086-D1-A120
4.8.1.5	Temperature limiter, 185°C	W75086-D1-A185
5.	**Electronic boards and components**	
5.1	**Power supply**	
5.1.1.1	Power supply unit 230V -> 24V / 4A	C79451-A3410-B20
5.1.1.2	Power supply unit 115V -> 24V / 4A	C79451-A3410-B21
5.1.1.3	Power supply unit 230V -> 24V / 8A	C79451-A3324-B61
5.1.1.4	Power supply unit 115V -> 24V / 8A	C79451-A3324-B62
5.2	**Detector boards**	
5.2.1.1	TCD-board	C79458-L2428-A1
5.2.1.2	FID-board	C79458-L2426-A1
5.2.1.3	FPD-board	C79458-L2426-A2
5.3	**PCPU, Interface module, Simatic I/O**	
5.3.1.1	P-CPU-2	C79458-L2232-A3
5.3.1.2	Interface module 3	C79458-L2430-A1
5.3.1.3	Digital input/output module 16/24 inputs , 16/8 outputs	6ES5482-4UA11
5.3.1.4	Analog input module 8 inputs	6ES5460-4UA13
5.3.1.5	Digital input module 32 inputs 24V	6ES5430-4UA12
5.3.1.6	Analog output module 8 outputs 0-20mA	6ES5470-4UA12
5.3.1.7	Analog output module 8 outputs 4-20mA	6ES5470-4UC12
5.3.1.8	Digital output 16 x 2A	6ES5453-4UA12
5.3.1.9	Digital output 32 x 0,5A	6ES5451-4UA13
5.3.1.10	Screw connector	6ES5497-4UB31
5.4	**Components in the terminal compartment**	
5.4.1.1	Heater control board	C79451-A3404-B806
5.4.1.2	Terminal board	C79451-A3404-B801
5.4.1.4	ABB contactor, 115V	W75053-C1001-D112
5.4.1.5	ABB contactor, 230V	W75053-C1001-E112
5.4.1.6	Fuse unit	W75078-D4-X
5.4.1.7	Power relay	W79024-B9281-B253
5.4.1.8	Mains filter, 115V	W79041-E4203-K2
5.4.1.9	Mains filter, 230V	W79041-E4163-B1
5.5	**Components in the explosion-proof controller**	
5.5.1.1	Controller for EX-protection, Bachmann	C79451-Z1453-U2
5.5.1.2	Control unit to operate EX-protection,˝Bachmann	C79451-Z1453-U1
5.5.1.3	Mains component 115V	C79451-Z1453-U3
5.5.1.4	Mains component 230V	C79451-Z1453-U4

Description		Order no.
5.6	**Software**	
5.6.1.1	Software (Operation program "Bedi",˝Configuration "Konfig", PCPU-2-Software)	S79610-S12-A88