EnCal 3000
Gas Chromatograph
Hardware Manual

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Safety Information

Electrical Safety

The EnCal 3000 is a gas analyser designed to be installed in hazardous areas. For this purpose it is certified according to:

ATEX II 2 G Ex d IIB T4 Gb and IECEx Ex d IIB T4 Gb

In compliance with:

IECEx:
IEC 60079-0: 2011 Sixth edition
IEC 60079-1:2014 seventh edition

ATEX:
EN 60079-0: 2012
EN 60079-1: 2014

Detailed information on this certificate can be found in APPENDIX

The operation and maintenance of such equipment should only be performed by qualified personnel.
Fuse replacement must only be performed by Elster GmbH authorized personnel.
The following basic rules must be observed in all circumstances:

The flameproof enclosure may not be opened when an explosive gas atmosphere may be present. The process pressure shall be limited to 2 MPa to ensure that the pressure rise inside the flameproof enclosure remains below 10 kPa. The functional pressure must be lower see chapter 3 and section 5.1.4 containing the specifications. Before any start-up, verify all connections of the unit for tight sealing.
For information on the dimensions of the flameproof joints the manufacturer shall be contacted.

WARNING! ELECTROSTATIC HAZARD!
Because of the potential electrostatic charging of the paint layer, the housing should only be cleaned by using a moist cloth to prevent charging
CASE MUST BE EARTHED!

Important disclaimer:

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Installation instructions mentioned in this manual are intended for information only. The installation of this equipment must conform to any national, local, or company codes applicable to the location. Elster-Instromet assumes no responsibility for compliance with these requirements. It is suggested that a review of the codes be made prior to installation.

Gas quality measurement system EnCal 3000

The gas quality measurement system EnCal 3000 consists in its basic configuration of a measuring unit and an optional Encal3000 controller.

The measuring unit is the real gas chromatograph. It performs the analysis by measuring technology autonomously.

It is configured with the PC program "RGC 3000". It is possible to install an additional optional Encal3000 controller. The subsystems communicate with each other via Modbus (see Figure 1).

This manual describes the Hardware of the Encal3000 gas chromatograph (measuring unit). The other subsystems are described in separate manuals.

Basic configuration EnCal 3000 (Measuring unit and an optional Encal3000 controller)

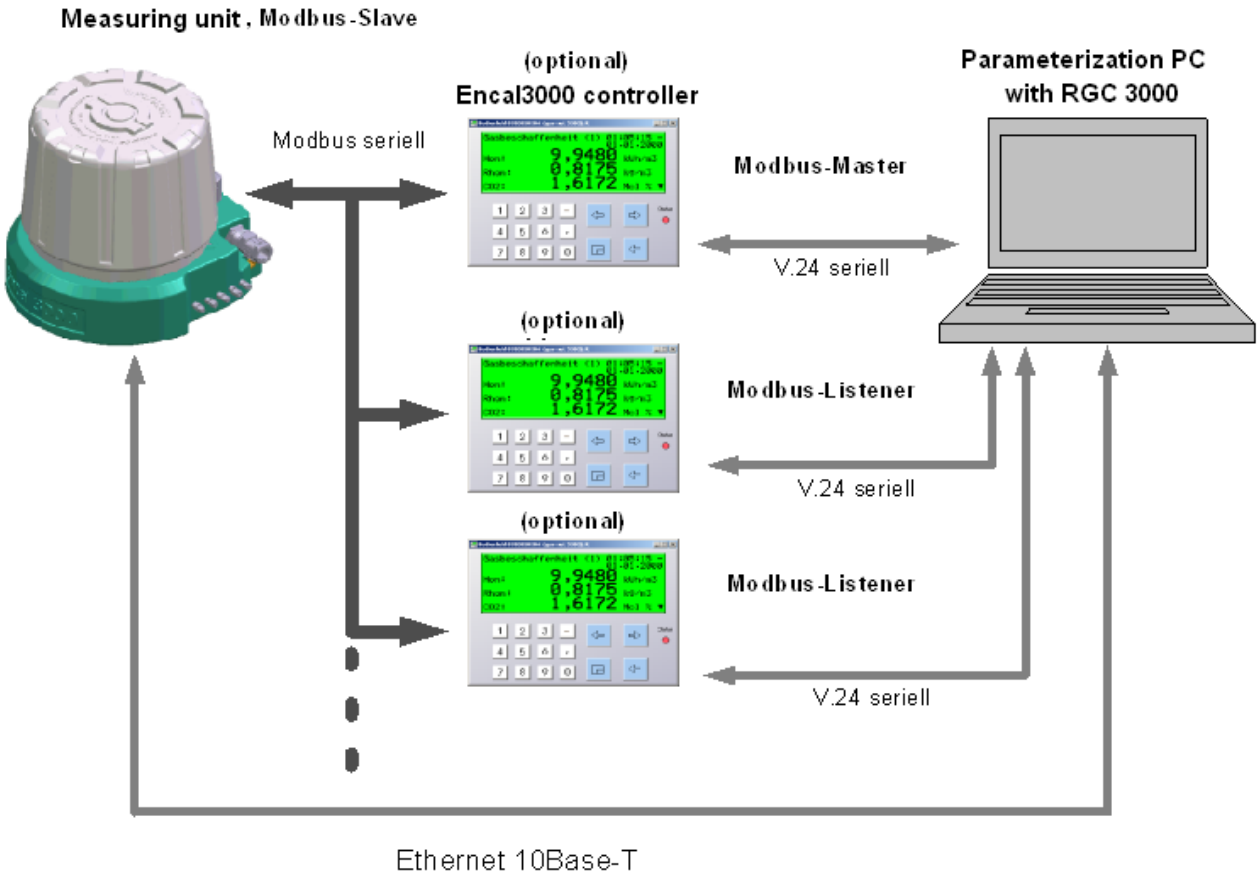


Figure 1

1 Process Gas Chromatography – General Introduction

1.1 Analytical Principle

Gas chromatography in general is an analytical technology which is used to analyse gas mixtures, i.e. to measure the concentrations of the different components of a gas.

The analytical principle is shown in fig. 1-1:

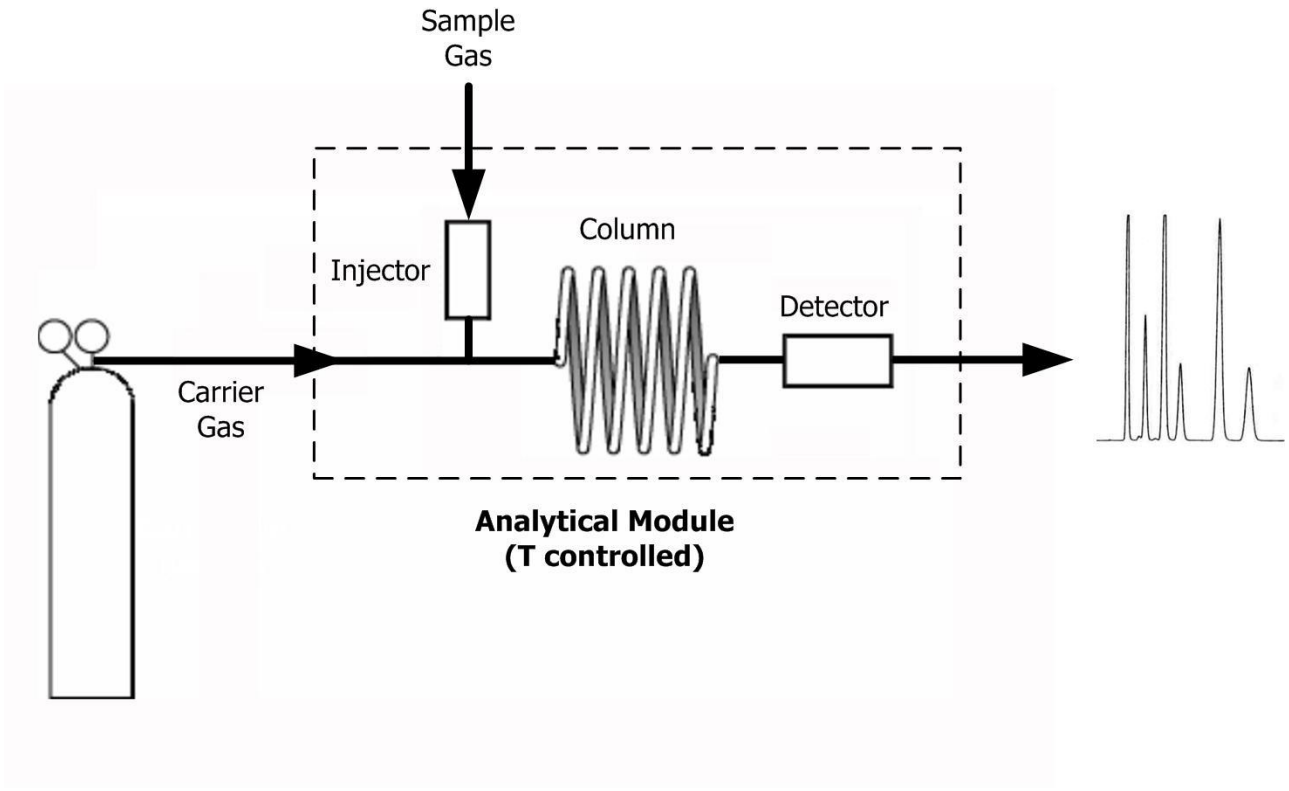


fig. 1-1 Principle of a Gas Chromatography

A very small volume of sample gas (typically much less than 1 ml), which is a mixture of several components, is injected into a stream of carrier gas, which takes the sample gas through the column. This column acts as a separator through the difference in absorption rate of the different components of the sample gas, they are separated from each other during their passage through the column and elute as individual components. The concentration of each component is then measured at the end of the column by a detector. From the knowledge of the concentrations of each component, any property of the gas can be calculated.

1.1.1 Column

A GC column is a relatively long spiral of tubing with very small internal diameter. Typical dimensions of the used columns in the Encal3000 have a length of several meters and internal diameters of <0.1 mm. They are made of inert materials like fused silica and stainless steel. Every GC column has a so-called stationary phase inside, which acts as an absorption layer for the gas molecules flowing through the column.

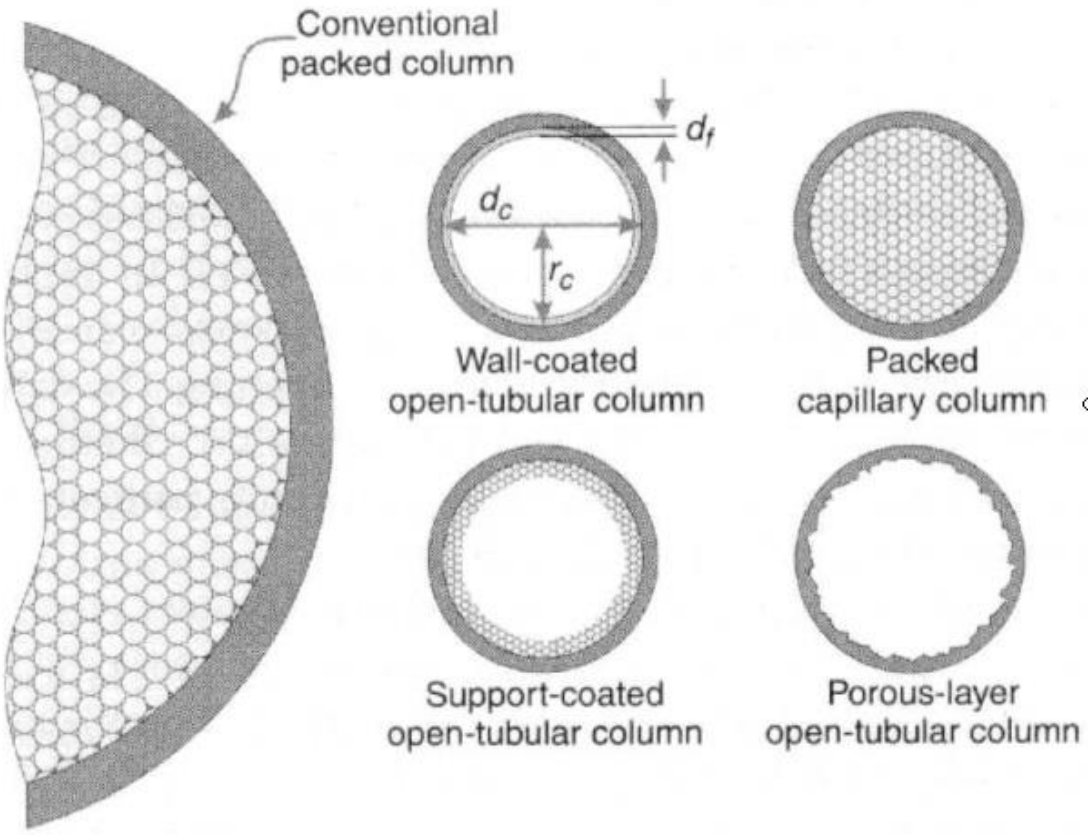


fig. 1-2 Different types of gas chromatographic columns

Various configurations exist:

- Wall coated open tubular column: the stationary phase is a thin liquid layer coated on the inner wall of the column (for example type 5CB)
- Packed column: the stationary phase is coated on a packing, which is equally distributed throughout the column (for example type HSA)
- Support coated open tubular column: the stationary phase is a coated packing, which itself is coated on the inner wall of the column (for example type M5S mole sieve)
- Porous layer open tubular column: the stationary phase is a porous layer on the inner wall of the column (for example type PPU)

1.1.2 Detector

In the natural gas industry, the most popular detector is the TCD: Thermal Conductivity Detector. It's a relatively simple, very efficient and very robust detector.

Another reason for the popularity of the TCD in the natural gas industry is the fact that gas chromatographs are used mainly for the measurement of gas properties like heating value, Relative density and Wobbe index. The calculation of these parameters is based on the concentrations of the main gas components.

TCDs newer design in MEMS technology (MEMS = Micro-Electro-Mechanical System), which are also used in the Encal 3000 are much smaller in terms of volume. The components can be integrated at the same time much more accurately, so that the analytical precision is for example 1 ppm for n-pentane.

Traditionally the two TCD's (reference + measurement detector) are integrated in a so-called Wheatstone configuration, which increases significantly the signal-to-noise ration of the measurement.

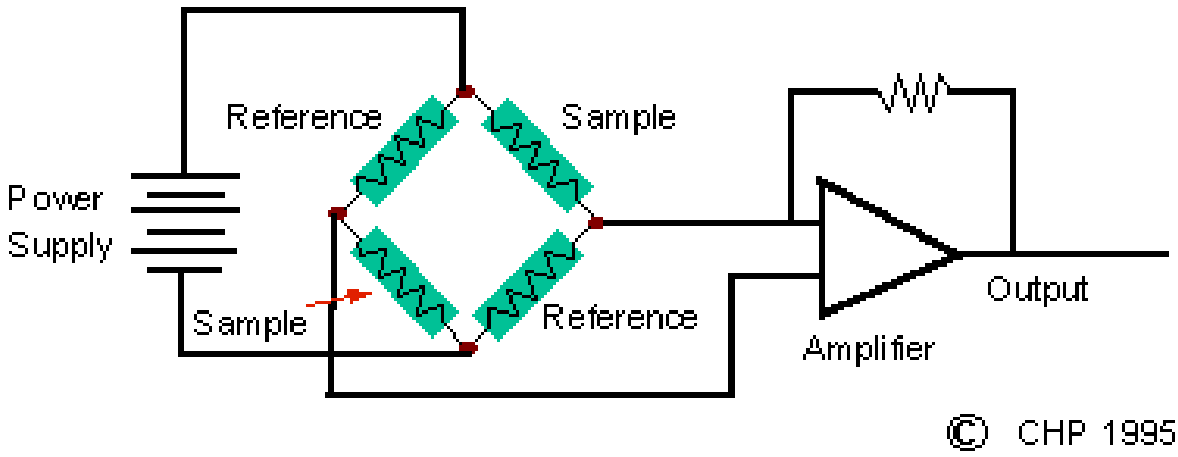


fig. 1-3 Typical electrical TCD circuit

1.1.3 Sample Injector

The sample injection must assure a precise injection of sample into the flow of the carrier gas.

In principle the amount injected must be very precisely controlled, both in volume, pressure, temperature and flow (to avoid viscosity effects) to guarantee a high level of repeatability of the analytical results, but in practice the normalisation of the measured concentrations will compensate for a large part of the fluctuations of these parameters.

However, to reach repeatability for the heating value below 0.01 %, these parameters do have effect and need to be controlled to a high degree.

The used MEMS technology allows a fundamental improvement of the sample injection quality compared to the traditional fine-mechanical technologies used for most of the current process GC's on the market. The picture below shows a typical MEMS sample injector, etched in silicon channel, with membrane valves to control flow directions.

This injector allows for a very precise control of the injection volume and temperature, on a remote base.

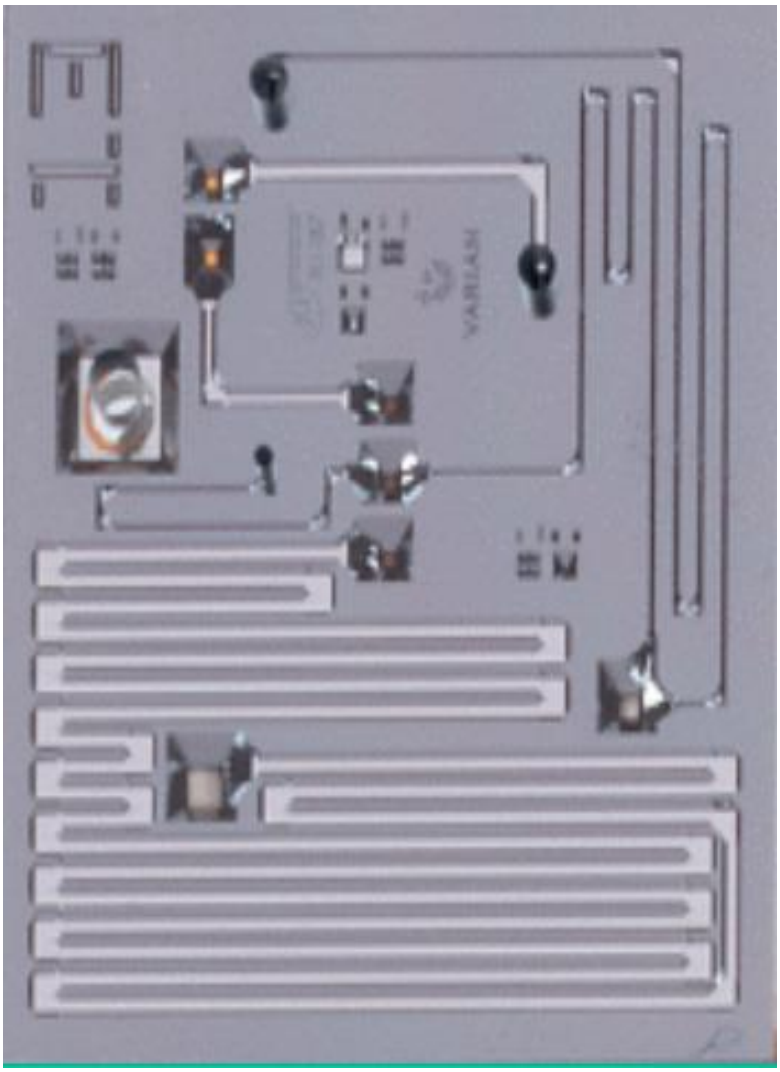


fig. 1-4 MEMS Sample Injector

1.2 Process Gas Chromatography

The Encal 3000 Process Gas Chromatograph (PGC) transfers the core laboratory technique to process conditions. Apart from the analytical performance specifications, a PGC therefore needs to be designed to match the following specifications:

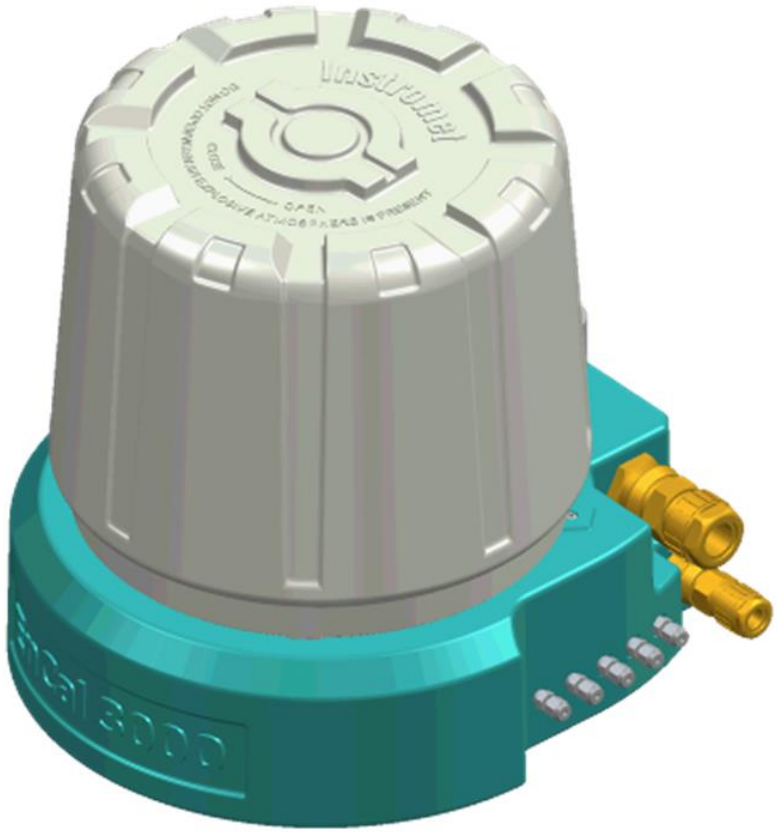
- Explosion safety.
- Extreme environmental conditions:
  - High and low temperatures
  - Dust and precipitation
  - Electro-magnetic influence
  - Wind
  - Corrosive atmospheres
  - Vibrations and shocks
- Complete stand-alone operation, no operator interference during normal operation:
  - Automatic and continuous analysis of different streams
  - Control and processing of analytical measurement executed internally, no peripheral device needed
  - Automatic calibration and verification
- Standard maintenance limited to yearly intervals, without need for specifically trained people
  - High reliability of the components
  - High degree of protection to any contaminant (liquids, vapour or particles) in the sample gas
- Analytical results available in industrial formats (for natural gas industry serial ModBus or ModBus TCP/IP)
- Internal data storage of all data, including averages, calibration data, events and alarms, during the last 35 days, to permit the operator to retrieve data in the past in case the continuous analysis was interrupted for any reason.

The EnCal 3000 is designed to meet or exceed all of the above requirements. At the same time the unit uses analytical technology which can compete with the highest standards used in the laboratory world, surpassing any PGC currently used in the natural gas industry.

2 Functional Design

2.1 Introduction

The EnCal 3000 is an on-line gas chromatograph that is housed in an EX-proof housing. In the housing is place for up to two analytical channels that are controlled by one processor board.

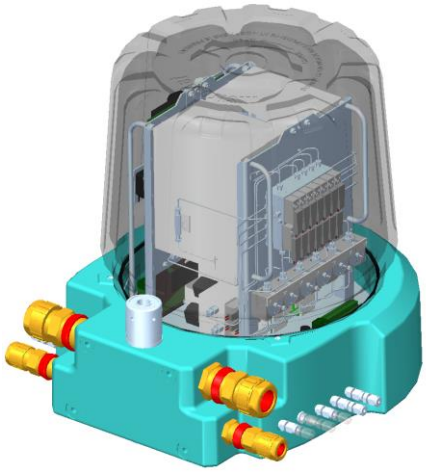


The most important features are:

- Compact EX-d design
- Complete stand-alone operation
- Capillary and micro packed columns in combination with MEMS analytical components
- Fast analysis (C_{6+} in less than 3 minutes)
- High analytical performance :
  - Uncertainty < 0.1 % for a wide range of gases
  - Repeatability < 0.01 %
- Up to 5 sample streams sequential without external stream selection
- Integrated sample system
- Internal data storage for the last 35 days of all data
- Suitable for extreme environmental conditions

The following paragraphs give a general description of the main parts of the unit.

2.2 Enclosure



The enclosure of the EnCal 3000 is a custom EX design, with various specific features.

Essentially the explosion proof enclosure consists of a low base, to which a relatively high cap is attached through a screw connection. Once the cap is removed from the base, almost all the internal components are directly reachable:

- Two analytical modules (which do each a part of the total analysis, in parallel)
- Processor board
- Internal sample system (stream selection and pressure regulation)
- All electrical field connections (Ethernet, ModBus, analogue IN, digital I/O, solenoid drivers), fuses, switches and jumpers

Only if the Interconnection Board, which connects the analytical channels and the Processor Board, has to be exchanged, the unit has to be taken apart. For all other check or maintenance procedures, only the cap has to be removed.

The compactness of the unit (installation clearance Ø 55 cm x 70 cm height, weight <30 kg) allows it to mount the device on a platform, a pole or to the wall. Mounting holes at the back (M8) and in the bottom (M5) allow for fixation.

All gas tubing (sample lines, cal. gas, vent line, helium in and out) and all electrical connections can be directly connected to the unit.

The design of the enclosure allows for the harshest conditions imaginable in natural gas applications:

- Explosion proof certified for ATEX II 2 G Ex d IIB T4 Gb and IECEx Ex d IIB T4 Gb (equivalent FM approval pending) ATEX (EN 60079-0 : 2012/EN 60079-1 : 2014) IECEx (IEC 60079-0 : 2011 Sixth edition / IEC 60079-1 :2014 seventh edition)
- IP 66 ingress protection against dust and precipitation (suitable for offshore applications)
- Standard temperature range: 0 to +55 ° C (32 to 130 ° F), optional extension with internal heating to -20 ° C (-4 ° F), with internal heating and external insulation to -40 ° C (-40 ° F)
- EMC certification according to EN 61000-6 - 2/4 (Industrial devices)
- Vibration and shock test according to OIML D11 11- 1/2
- Coating according to Shell specifications DEP 40.4800.30 for off-shore applications

2.3 Assembly of major components and internal components

fig. 2-1 shows the exploded view of the different internal components of the Master Unit of the EnCal3000

The frame is used for mounting the components. It allows the removal of all the direct and individual components, with the exception of the interconnection board. The components can be removed directly and individually by unscrewing just a few screws.

If the Interconnection Board must be removed (bottom), the frame has to be removed from the enclosure base first. This arrangement permits the service engineer to easily review the board in case malfunctions would occur.

The detailed description of the functionalities of each component will be done in the following paragraphs.

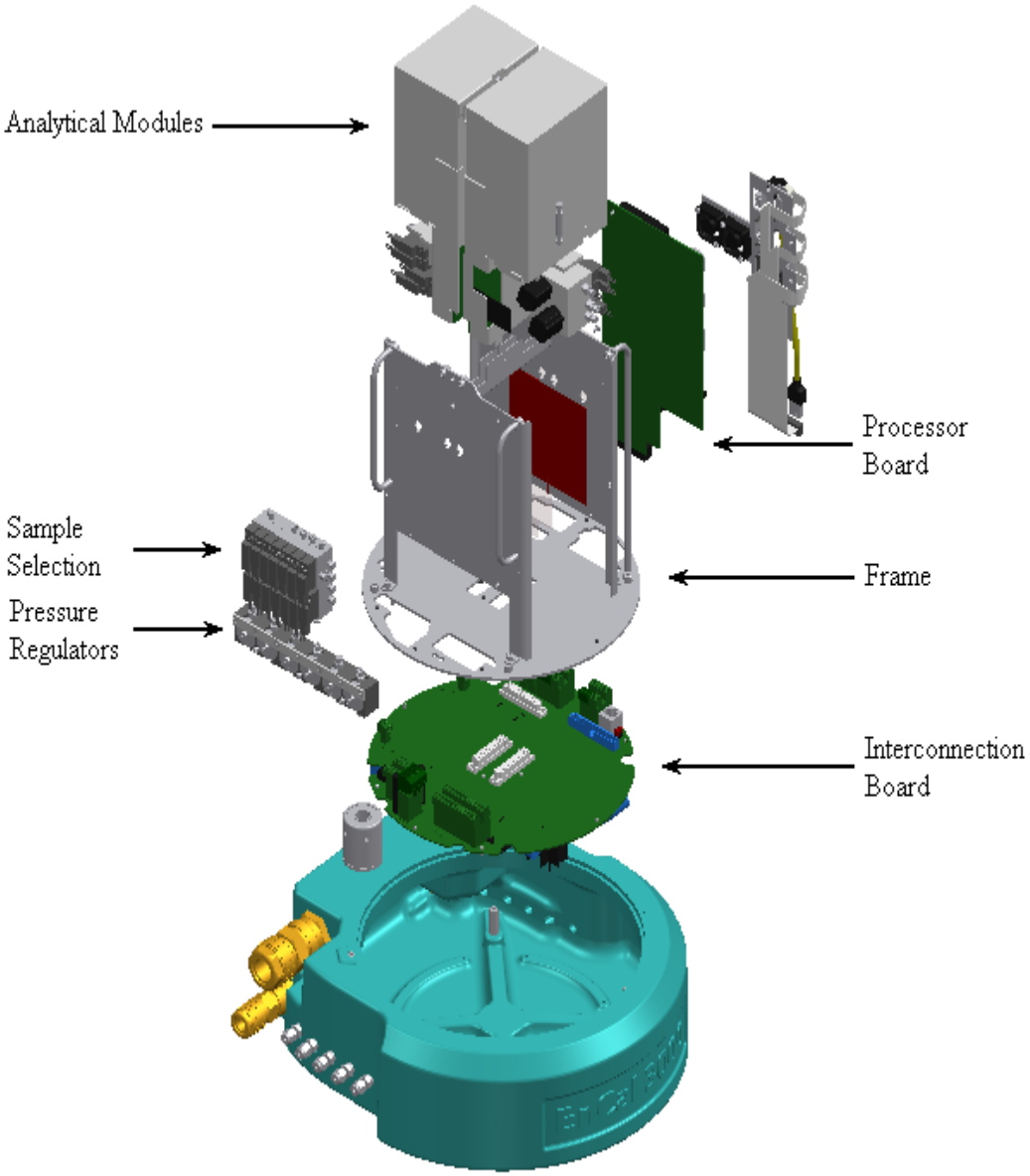


fig. 2-1 Exploded View on the Internal Parts of the EnCal 3000

2.4 Channel

A channel consists of the following subcomponents:

- Analytical Module: This is the heart of the EnCal 3000: it contains the column, sample injector, detector and the heaters for the columns and the injector
- AMI (Analytical Module Interface): electronic circuit which controls the analytical components of the Analytical Module. It has its own EDS (Electronic Data Sheets) which stores the local configuration parameters
- EPC: Electronic Pressure Control for adjusting the pressure of the analytical column
- Channel Controller: electronic circuit which controls the communication between AMI and Processor Board, and also controls the EPC (Electronic Pressure Control) and valves needed for the control of the internal gas flow circuit.

Both AMI and Channel Controller have their own EDS (Electronic Data Storage) which stores the local configuration parameters. This enables to swap to channels without a need for reconfiguration, uploading the internal settings is sufficient to fully install a new channel in an existing unit.

The Analytical Module uses different columns for different applications. In the EnCal 3000 two columns are used:

- HSA column (HaySep), for the analysis of N_2, CH_4, CO_2 and C_2H_6
- 5CB column 4m or 8m, for the analysis of the higher hydrocarbons (C_3H_8 up to C_8H_{18} or up to C_9H_{20})

For devices build before 2008 the 5CB-4m channel was used for the analysis up to C6+ and the 5CB-8m channel just for the analysis up to C9. Since 2008 the 5CB-8m becomes used for both options, the main reason for this change is that the separation of the peaks especially for n-butane and neo-pentane is better for the 8m long column.

Another possible Channel configuration for the special application biogas is:

- M5A column (molesieve), 10m long, for the analysis of H_2, O_2 and N_2.
- PPU column, 10m long, for the analysis of the hydrocarbons (CH_4 up to n-C_4H_{10}) and CO_2

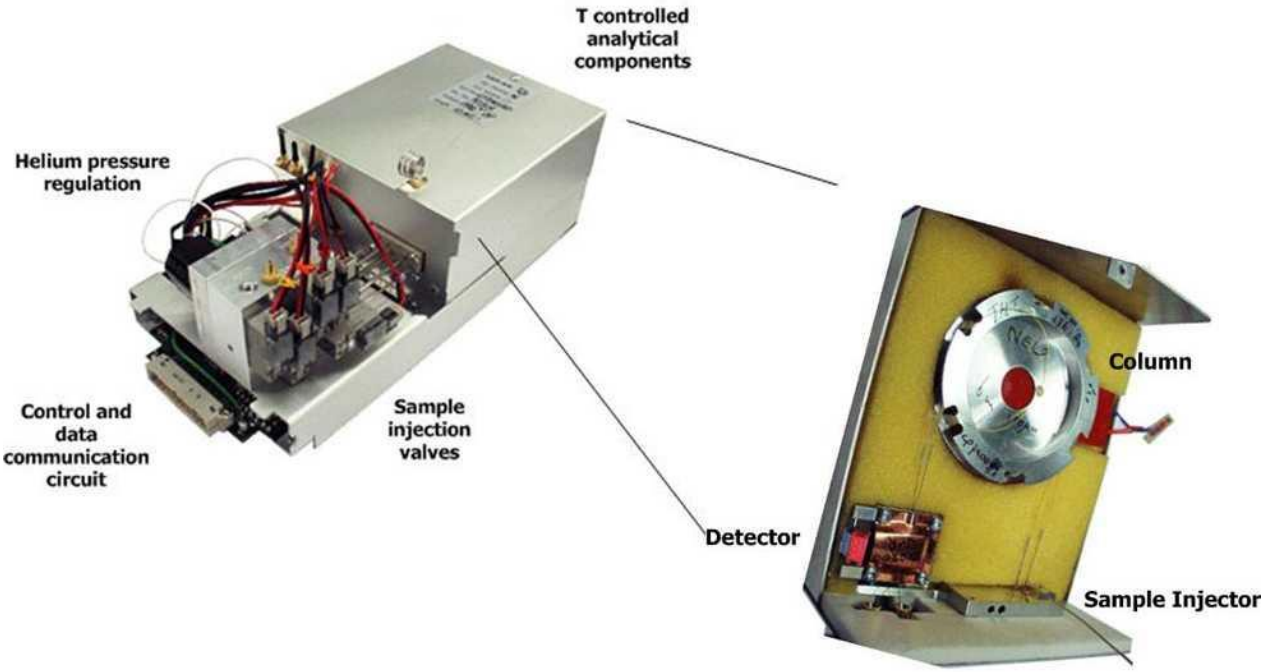
Another possible Channel configuration for the analysis of hydrogen and natural gas is:

- COX column, 1m long for the components (He), H2, N2, CH4, CO2 and C2H6
- 5CB column, 8m long for the higher hydrocarbons (C3H8 to C9H20)

In the biogas-application for the M5A column, two additional internal humidity filters are required, which are mounted on the module. These filters are used to reduce humidity to a minimum. Humidity can penetrate by diffusion of air into the analytical column.

Without the filter, this humidity would reach the analytical module and be absorbed by the column material. Therefore, the retention times of the measured components would reduce always so that the separation of the measured components is deteriorated and a heating up of the column would be required after about 3 months.

With the filters ensures that a heating up of the M5A column is not necessary within a year (calibration cycle). As the capacity of the attached filter is very low, the filter should be changed with each recalibration. For the carrier gas argon always an additional external humidity filter should be used.



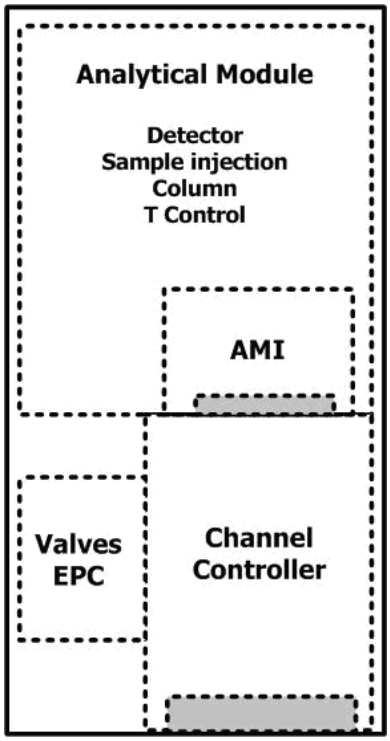


fig. 2-2 Overview of Channel Components

The next page shows the internal gas flow configuration of the channels.

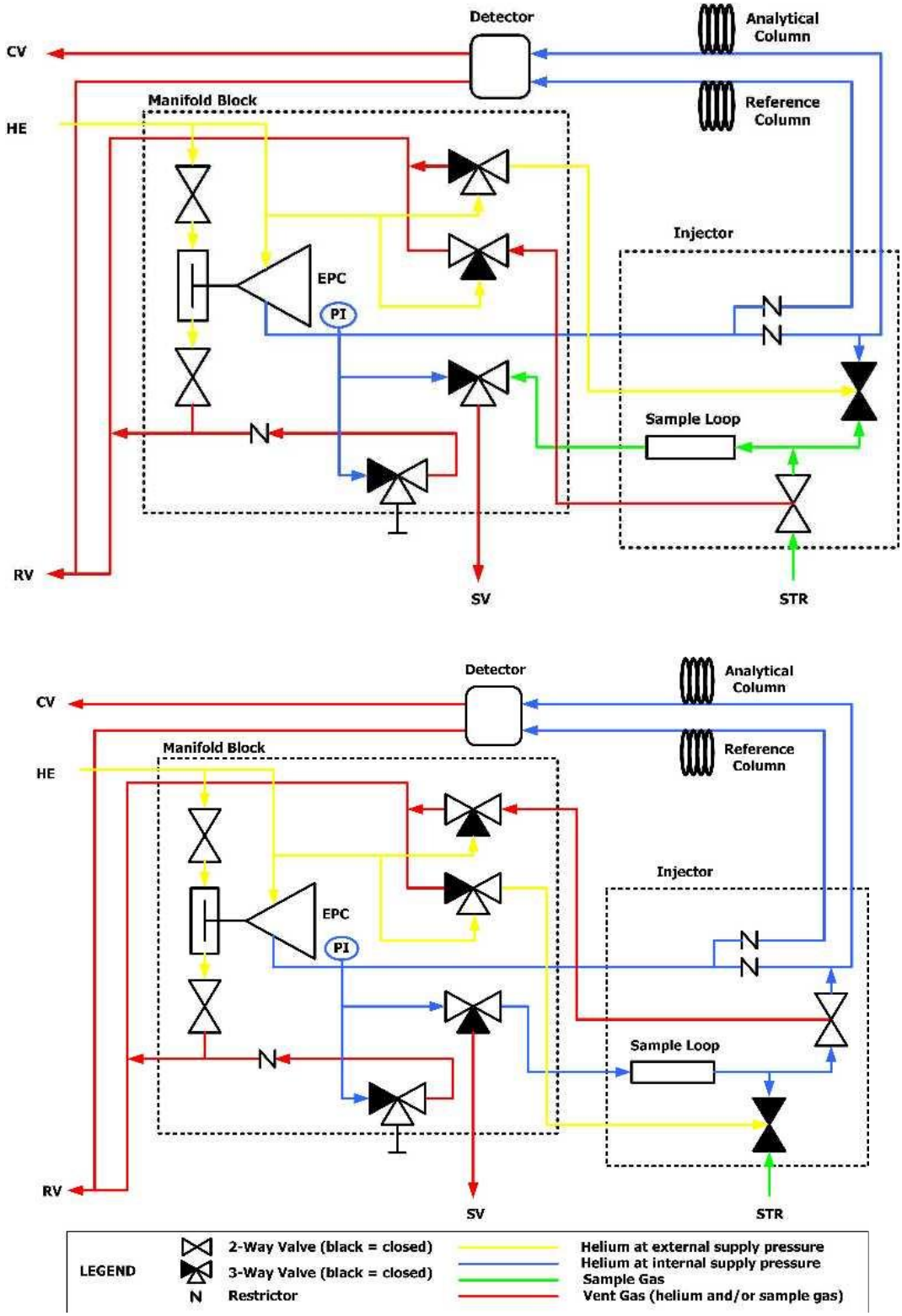


fig. 2-3 Internal Gas Flow Circuit for each Analytical Channel of the EnCal 3000, during Normal Operation (top) and sample Injection (below)

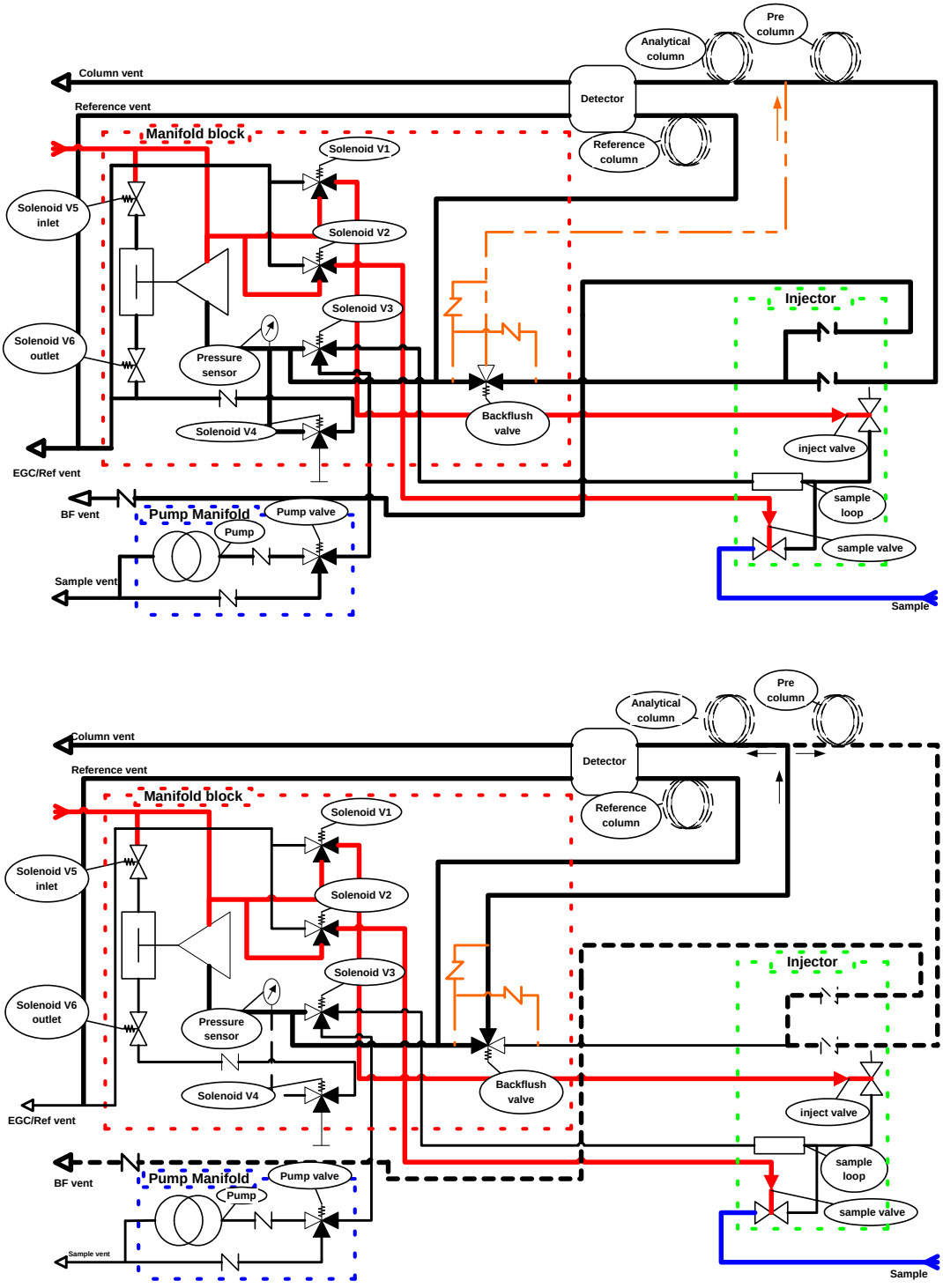


fig. 2-4 Internal Gas Flow Circuit for each Analytical Channel with backflush of the EnCal 3000, before activating backflush valve (top) and after activating backflush valve (below)

2.5 Processor Board

The main components of the board are:

- Arm9 Processor
- A Flash-Memory 32 MB for local data storage
- The Ethernet-Port
- Data communication ports (COM1-4) for serial Modbus, Analogue and Digital I/O
- USB Port
- I/O Controller for Communication to the analytical channels
- Pressure- and Temperature Sensor

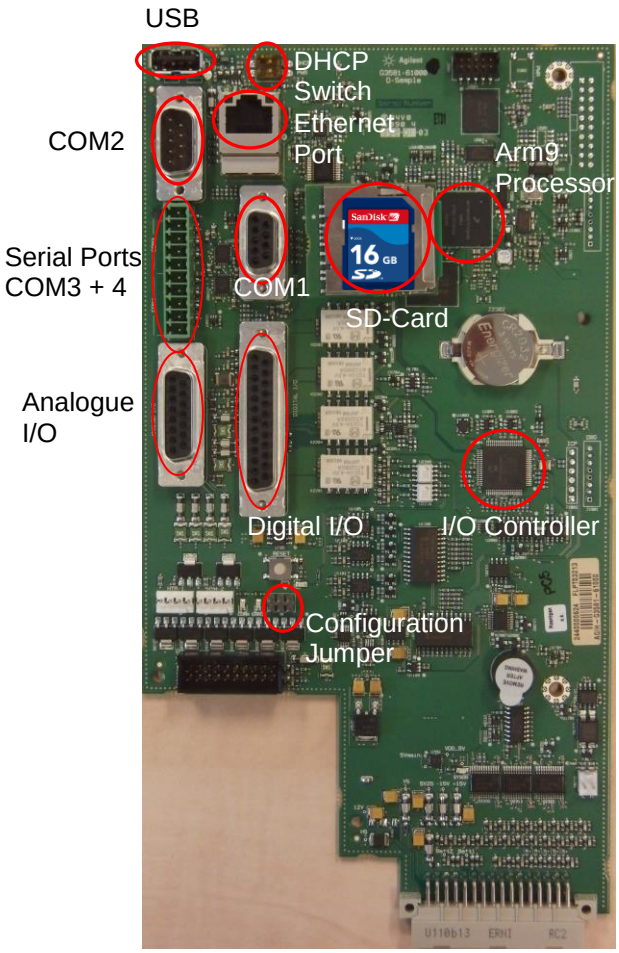


fig. 2-5: Processor Board connections

Save parameters in the measuring unit

Setting the "Configuration Jumpers" can protect the parameters on the measuring unit computer witch was loaded by using the software RGC 3000. This configuration Jumper is at the same position for the old and the new mainboard.
If the jumper is set, the parameters inside the measuring unit cannot be override.
Changes in the parameters can only be transferred to the measuring unit, if the jumper is not set. The setting of the jumper can be checked on the display of the “instrument status” page. See Section 3.2 of the software manual. How to set the jumper is shown in Figure 2.6.

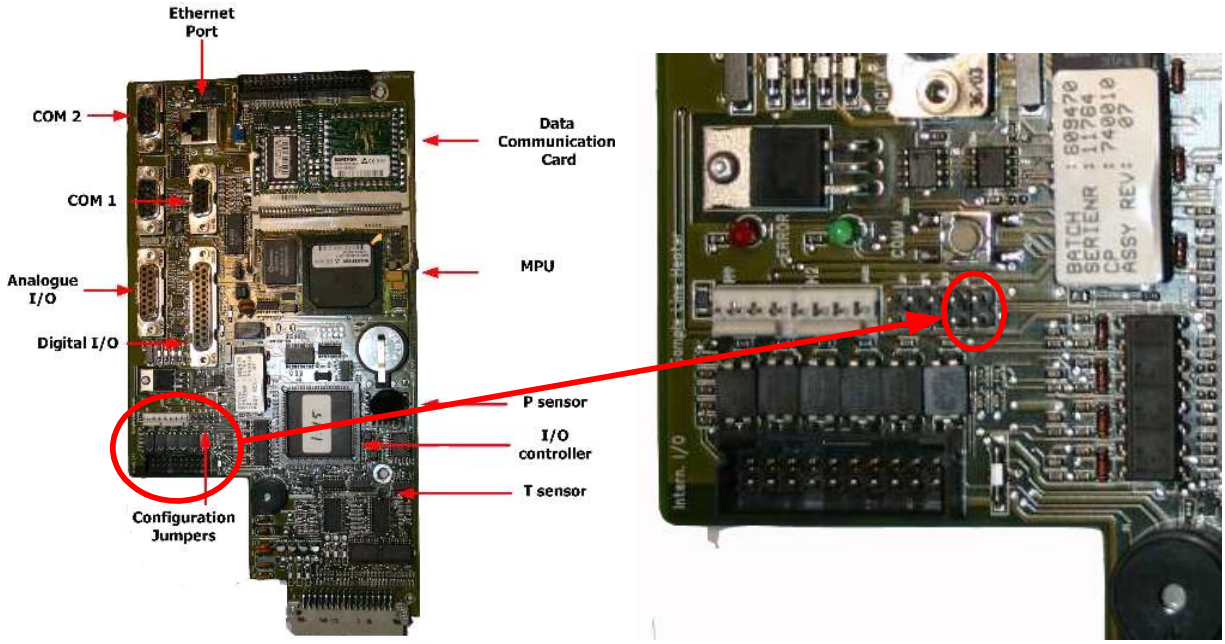


fig. 2-5 Save parameters in the measuring unit

.
When installed in the EnCal 3000, a flat cable makes the connection between the communication ports of the Processor Board and the Interconnection Board, which provides field connections (Phoenix connector) for the data communication signals. Also 2 fans are mounted to cool the processor in case of elevated ambient temperatures.

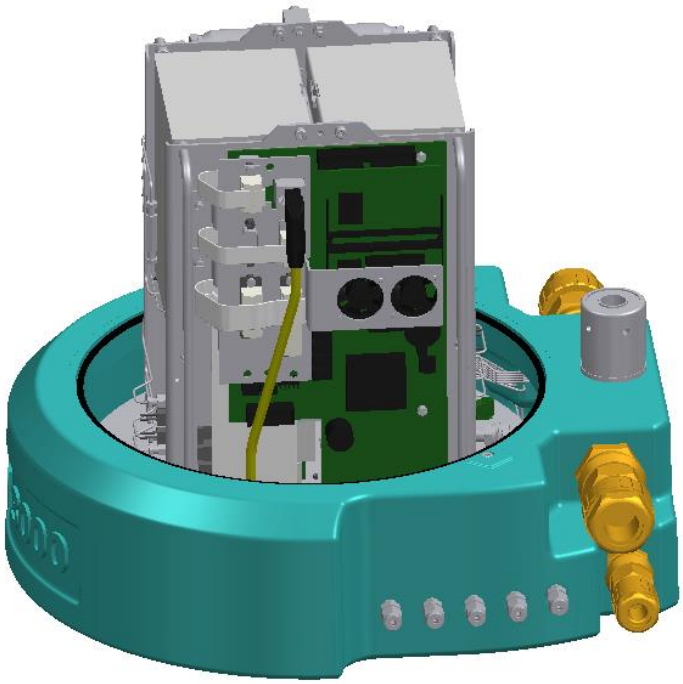


fig. 2-6 Processor board with ribbon flat cable and fans mounted in the EnCal 3000

2.6 Interconnection Board

This board has the following functions:

- Power supply input (24 VDC)
- DC/DC converter (18 – 36 VDC)
- Connection of Processor Board with Analytical Modules
- Field data communication connectors
- Actuation of stream select solenoids
- Enclosure temperature regulation
- Internal DC/DC conversion for various circuits

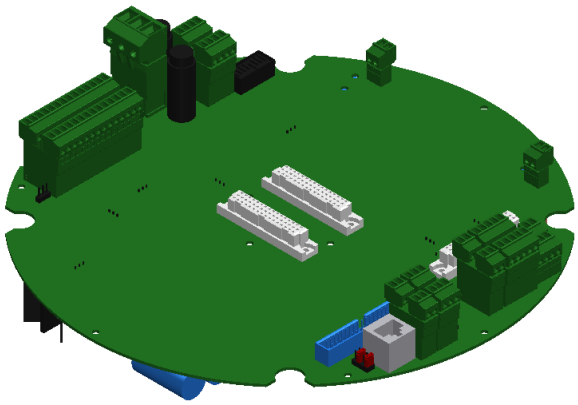


fig. 2-7 Interconnection Board

The following diagram shows the overall electrical configuration EnCal3000 in a rough overview.

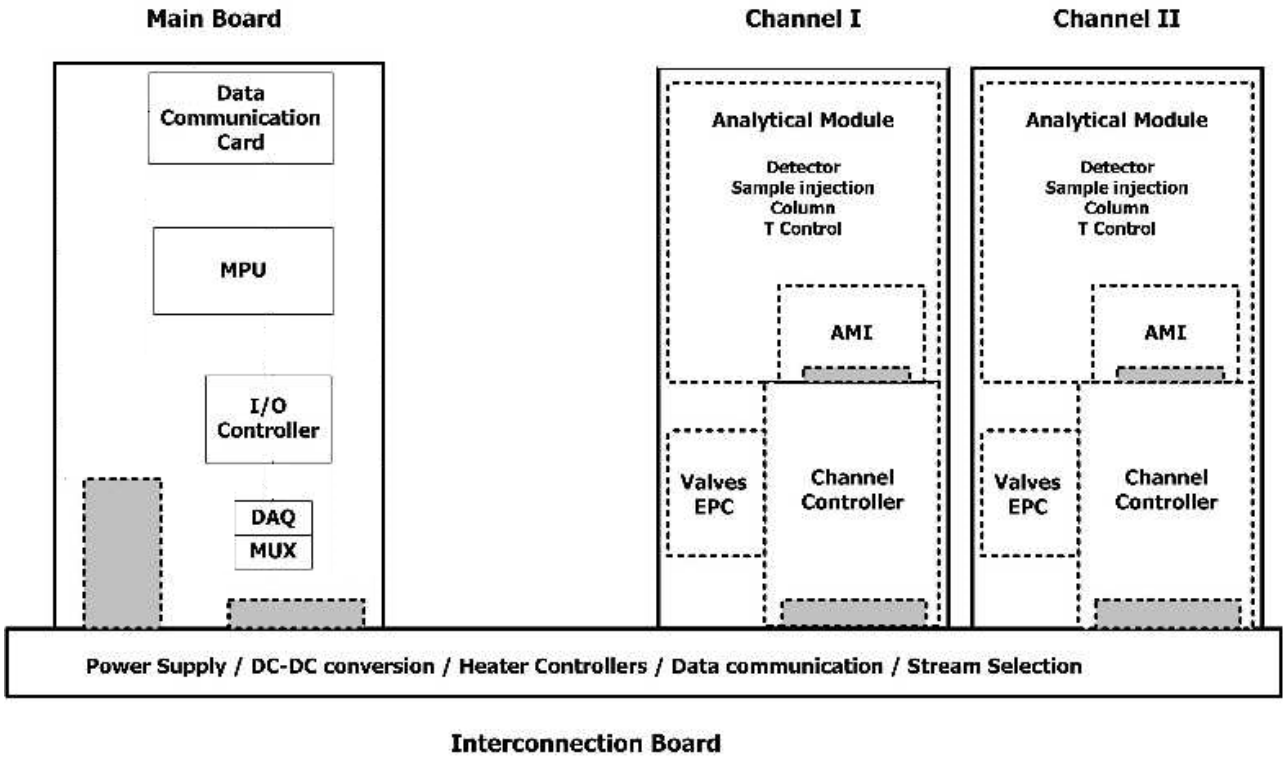


fig. 2-8 Overall Electrical Configuration of the EnCal 3000

2.7 Cabinet Heaters

The cabinet heaters are used for frost protection. They are attached directly to the mounting plates and provide additional heat when the internal enclosure temperature goes below 10 °C (50 °F). Figure 2.10 shows the location of the cabinet heaters.

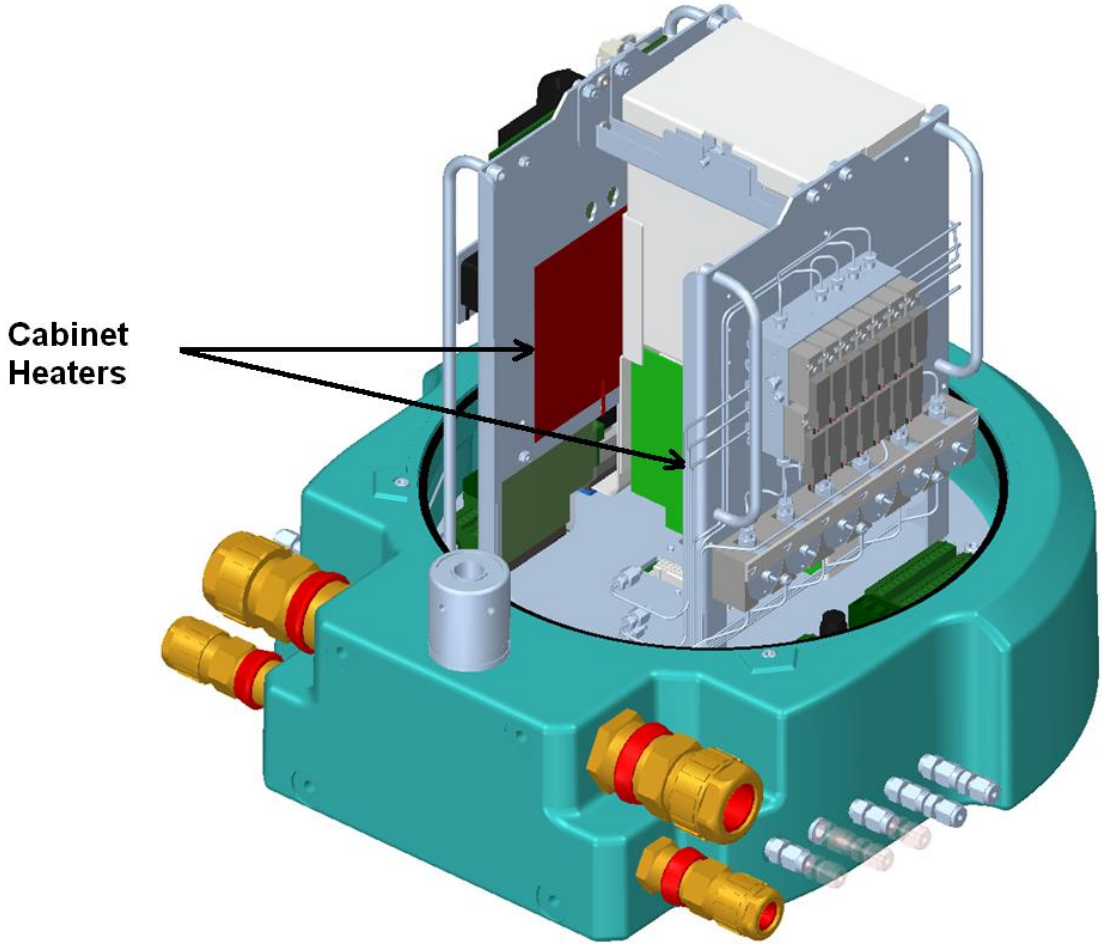


fig. 2-9 Cabinet heaters location in the EnCal 3000

For the regulation of the heaters standard thermostats with a fixed setting are used. These thermostats are connected to the interconnection board close to the connectors for the power supply of the heaters (see also fig. 5.5, connectors J12 and J13).

2.8 Internal sample system

The internal sample system has the following functions:

- Double block and bleed stream selection (up to 5 streams / 1 cal)
- Pressure regulator. Advised input pressure is 2 barg. Input pressure range is 1 to 5 barg
- Split of the helium and sample gas to the 2 analytical columns
- Combination of the vent lines of the 2 modules
- Purge of the cabinet with Helium (optional)
- Integrated fast loop function (stream purge)

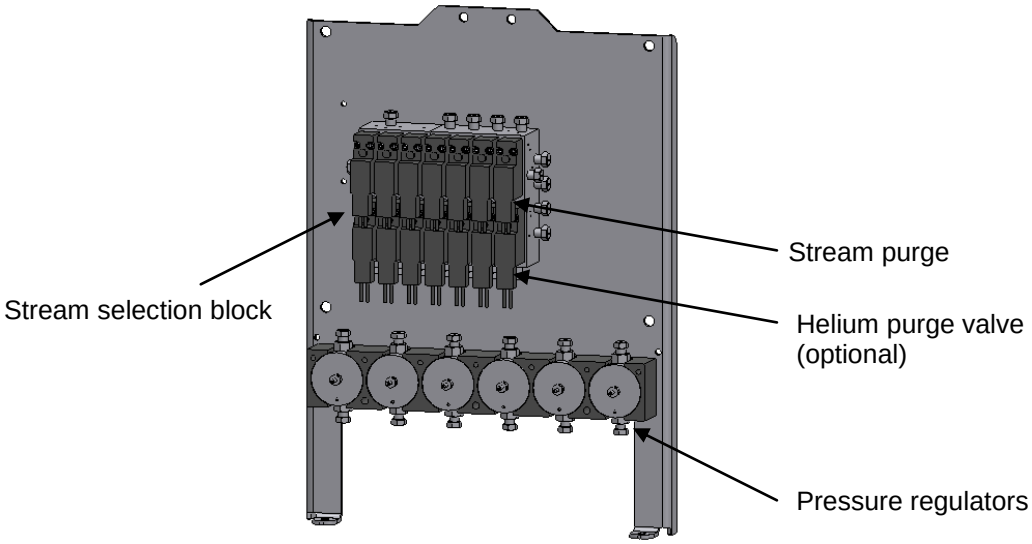


fig. 2-10 Front view of the internal sampling/stream selection system

Helium Purging (optional)

Helium enters the manifold and is split to both analytical modules. Through a purge valve the helium can be vented into the housing, to expel the air in the housing (activated by time relay 3). Additionally to this the column vent is released into the housing which is nearly pure helium. If there is a leak in the housing no combustible mixture can be formed because of the absence of air. The housing withstands the pressure of an explosion but by purging the housing with Helium the chance of internal damage is also reduced significantly. The purge and the small amount of helium that is vented into the housing also protects the internal components against moisture or other aggressive components entering the housing through the breather.

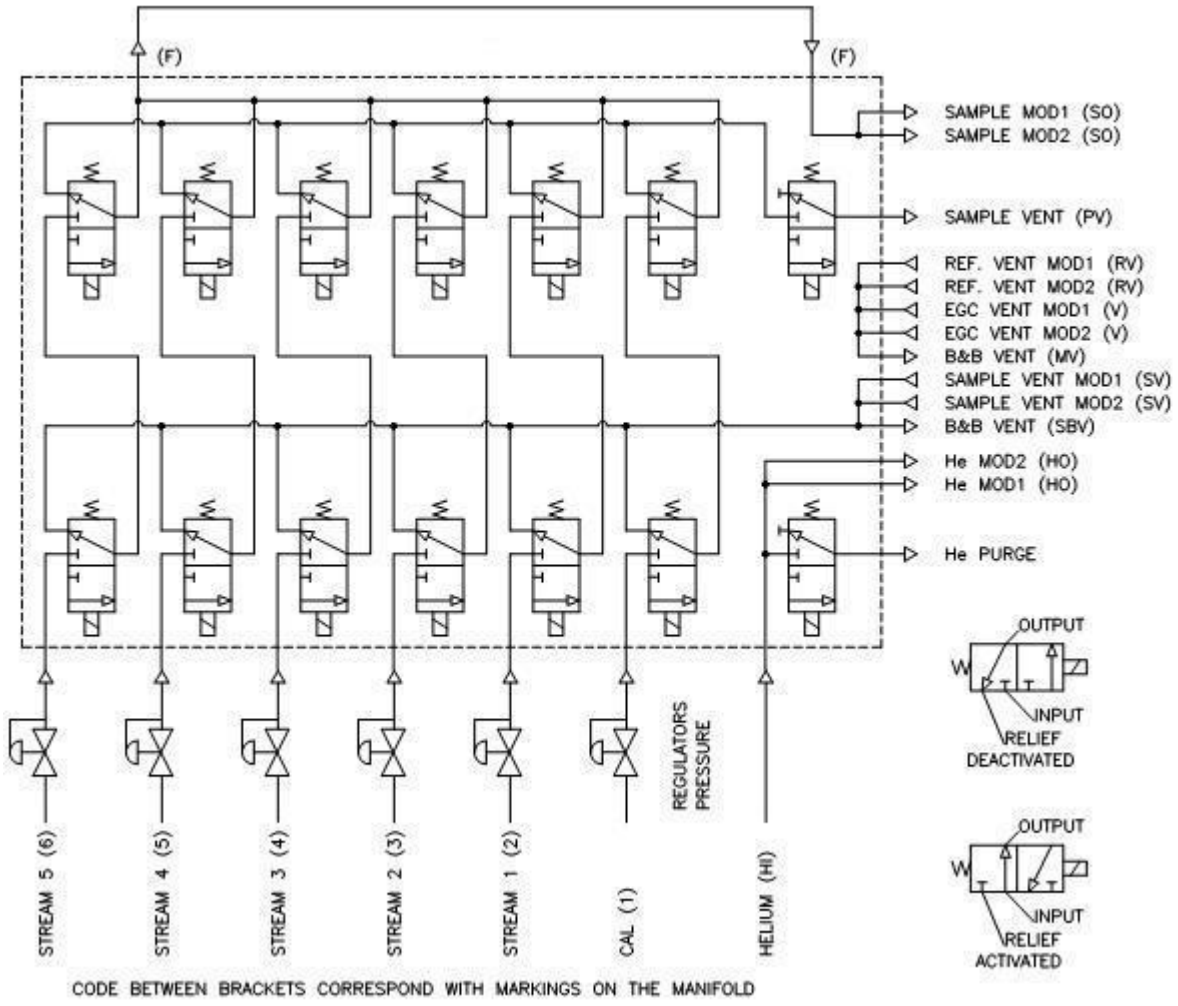


fig. 2-11 Flow diagram Sample Conditioning and Selection System

2.8.1 Double Block and Bleed Function

After small particles are filtered out by the inlet filters in the inlet couplings, the pressure is reduced to approximately 0.8 barg. From the pressure regulators the gas will flow to the manifold. There are several valves mounted on the manifold.

The two most right valves are purge valves. The upper purge valve is the sample bypass valve (Activated by timed relay 2). The lower is a helium purge valve and activated by timed relay 3.

The stream and calibration valves form pairs that are actuated at the same time.

The valves left from the purge valves are used for the calibration. Next to the calibration valves there are 1 up to 5 pairs used for the streams. Depending on the configuration the manifold can support up to 3 or up to 6 streams (including the calibration gas stream). Unused positions on the manifold are blocked.

Gas will enter at the first (lower) valve which will guide the flow to the second (upper) valve in actuated situation. The second valve guides the flow into a common channel. In deactivated situation, the input from the first valve is blocked and the output is linked to the relieve port of this valve, which vents to the SBV vent. The input of the second valve is also blocked so it is not possible to build up pressure between both valves. In case one or both valves would leak, the pressure between the valves won't rise above the pressure that is present in the common channel because of the vent to the SBV vent, so mixing up the streams is not possible.

2.8.2 Internal Sample Bypass

The output from all second valves is combined on the common channel. Depending on which channel is activated, a section of this channel and the deactivated valves, form a dead volume. The outputs from deactivated valves are therefore relieved to a second common vent channel, which is blocked by the sample bypass valve. Activating this valve will result in a flow from the activated valves, through the deactivated valves, to the bypass valve. This refreshes all second valves and the common channels with the new gas, so all dead volumes are refreshed. Actuating the bypass valve results in a flow that is approximately 15 times higher than the normal flow. The purge valve should be activated for a short period (±30 seconds default) when a new stream is selected.

If there is a long sample line between the sample point and the Encal, or there is a relatively high pressure in this line the bypass time can be increased up to 150 seconds. The new stream is selected one analysis prior to the injection, so during the analysis the new sample is already flushed through the manifold. The best moment to activate the sample purge is ending 10 seconds before the injection and then extended to the front depending on the purge duration.

Keep in mind the purge time also applies to the calibration gas which must be purged, but larger purge times and frequent purging will deplete the bottle faster. Further information for the needed setting in the software can be found in the software manual.

The flow through the analytical modules will be reduced during the activation of the bypass, but will continue. Closing the bypass valve will restore the normal flow to the analytical modules. After the sample gas has passed the manifold it becomes split for the transport to the two analytical channels. The vent outputs from both modules return to the manifold and are combined to two venting outputs.

2.9 Gas Connections

Each gas connection consists of:

- Male Connector 1/8” with internal particle filter 2µ (adapter in following figure) and adaptation to 1/8” or 3 mm for the carrier gas, calibration and sample gas inlets. This can be replaced without removing the cap of the analyser.
- Male Connector 1/8” with optional adaption to 3mm for output gas. Outlet connectors do not have a filter.
- Adapter, fixed to the housing
- Tubing 1/16”, soldered to the adapter and connected at the other end with the internal sampling system. This tubing serves as flame arrestor. Its length has to be bigger than 25 cm (19") and should not be shortened by the customer

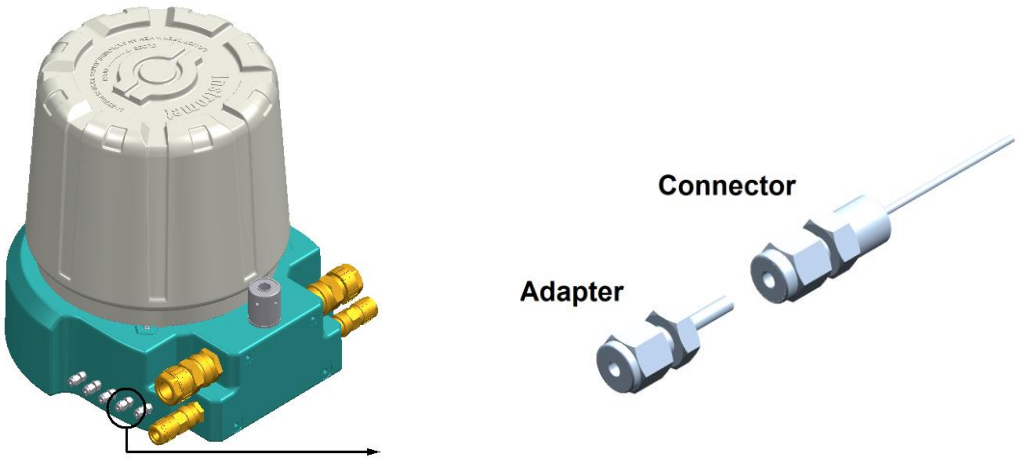


fig. 2-12 Gas Connection of the EnCal 3000. Adapter includes 2µ filter.

WARNING! DO NOT LOOSEN THE CONNECTORS (AS DESCRIBED ABOVE) FROM THE ENCAL 3000 HOUSING. THE SOLDERED TUBE WILL BE DAMAGED! THE JOINT BETWEEN CONNECTOR AND HOUSING IS AN INTEGRAL PART OF THE ENCAL 3000’s SAFETY APPROVAL. IF THE CONNECTOR IS ACCIDENTALLY LOOSENED PLEASE SWITCH OF THE ENCAL 3000 AND CONTACT THE MANUFACTURER OR YOUR LOCAL ELSTER-INSTROMET AGENT.

To prevent loosening the connectors use a second key wrench to prevent the coupling from turning.

2.10 Breather

The breather at the back of the enclosure is needed to comply with the ATEX rule which restricts the pressure in the enclosure to 100 mbar overpressure, in case of total leakage, i.e. if all gas inlet tubing would be internally disconnected at the same time.

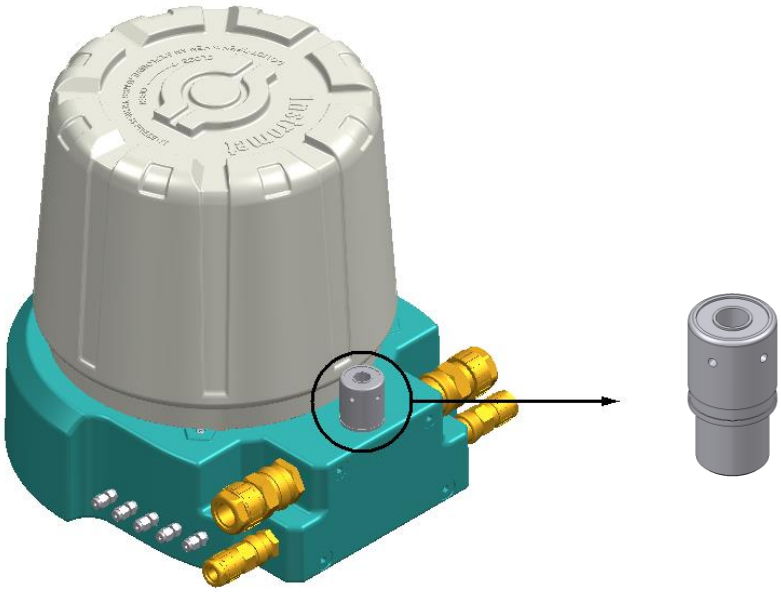


fig. 2-13 EX breather as required by ATEX directive

The breather used on the EnCal 3000 is an Ex- d certified device with IP 65 rating, and a vent flow of about 600 l/h at 100 mbar overpressure in the enclosure. It is sealed with Loctite to prevent loosening by unauthorised persons.

When installed outside it should be protected against dirt and rain, i.e. by connecting a swan neck tube to it, the breather has a 3/8 NPT connection. Any tube connected should have an internal cross section of at least 28mm² 3/8" tube or larger.

The breather should always vent atmospheric without large pressure fluctuations. The output of the breather must not be blocked because the valve would not function properly otherwise!

2.11 Cable Glands

Up to 4 cable glands can be connected to the enclosure base: 2 M25 and 2 M20 cable glands. For the standard configuration see chapter 5 "Hardware Installation".

Most installations will only need 2 cable glands, one for data communication cable (TCP-IP and/or Serial ModBus) and Power Supply (24 VDC). Additionally entrance for signal cables (such as alarm contacts, carrier gas control, etc) might be needed.

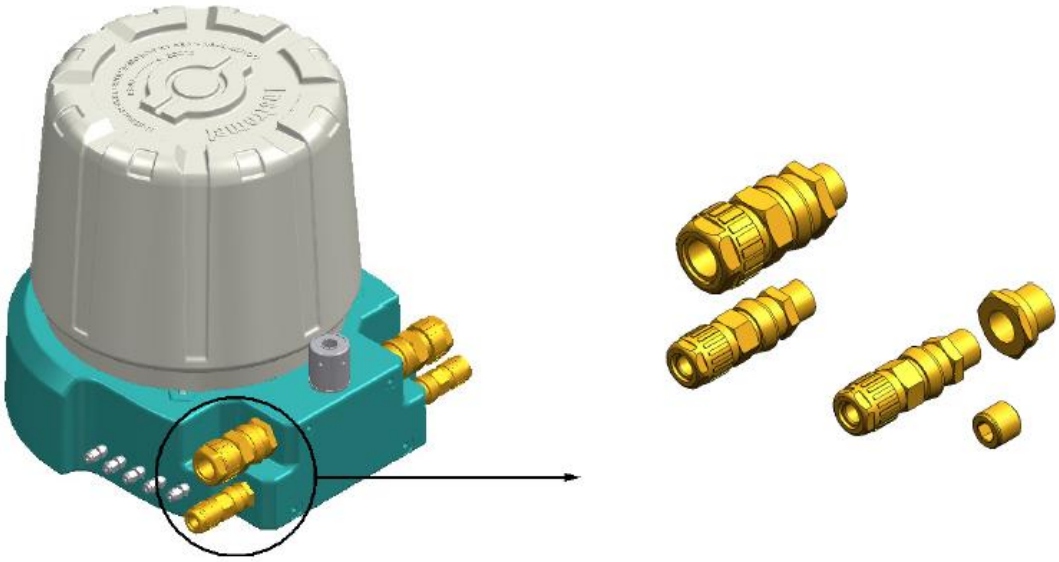


fig. 2-14 Location of Cable Glands at the Back of the Enclosure Base

Cable glands with a sealing system are typically required. To fulfill the FM regulations **seal all conduits within 18 inches**. Installation directive EN 60079-14 recommends for Ex-d devices with an internal volume > 2 dm3 the so-called "Barrier Glands", incorporating compound filled seals around the individual cores or other equivalent sealing arrangements. The cable entry devices and blanking elements of unused apertures shall be of a certified flameproof type, suitable for the conditions of use and correctly installed. For connection of an external earthing or bonding conductor a cable lug shall be used. The conductor shall be mounted so that it is secured against loosening and twisting and that the contact pressure is permanently maintained.

2.12 External Switch

To comply with Electrical Safety Standards IEC 60947-1 and IEC 60947-3, an external switch has to be located close to the analyser, enabling an operator to close down the unit in case of emergency. It has to be marked with "Disconnecting Device". Practical implementation of this requirement will differ from site to site. In any case the external switch installation has to comply with all national, local, and company codes applicable to the location.

2.13 Configuration with two Carrier Gases

For some applications like the analysis of biogas a use of different carrier gases for the two analytical modules can be an advantage. In the application Biogas for the module from type mole sieve Argon is used as carrier gas and for the second module from type PPU Helium is used as carrier gas. In the following picture this configuration is shown. The two connections for the two different carrier gases are marked on the housing.

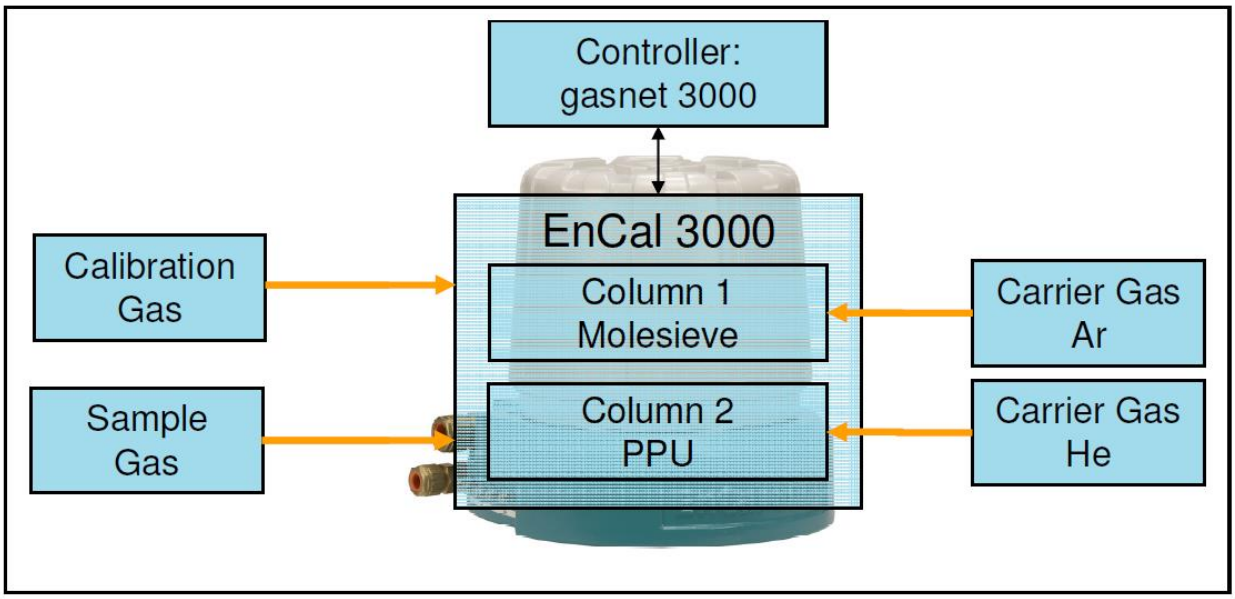


fig.2-16: Configuration with two Carrier Gases

3 Technical Specifications

See below the main technical specifications.

Mechanical

Dimensions	Base Ø 37 cm x Height 37 cm (Ø 14" x Height 14")
Installation Clearance	Ø 55 cm x Height 70 cm (Ø 20" x Height 28")
Weight	<30 kg
Approvals	ATEX II 2 G Ex d IIB T4 Gb and IECEx Ex d IIB T4 Gb ATEX (EN 60079-0: 2012/EN 60079-1: 2014) IECEx (IEC 60079-0: 2011 Sixth edition / IEC 60079-1:2014 seventh edition) NEC Class I, Div. I, Groups A, B, C & D (pending)
IP 66	Vibration and shock test acc. IEC 60068-2-31 and 64

Electrical

Power Supply	24 VDC, 50W nominal non-heated and 120 W nominal heated version (ambient < 0 °C) Created with Quint-PS-100-240AC / Quint-PS-24DC/24DC/10 / Siemens PSU / Siemens Logo or equivalent power supplies. The power will be lower once the unit has reaches its operation temperature depending on the ambient temperatures.
Interfaces	Ethernet UTP 10 Base-T for ModBus TCP/IP and PC link Two RS 232/485 ports (user selectable) for ModBus RTU 3 analogues I/O for local sensors (4-20 mA or 0-10 VDC)
Battery back-up	Button battery, Panasonic Type BR 2032 3V
EMC	according to EN 61000-6-2 and EN 61000-6-4

Software

Analyser	Pro™: complete stand-alone operation, inclusive all calculations and generation of report formats, without need for operator intervention. Calculations acc. to ISO 6976, GPA 2172 or GOST 22667
PC	RGC 3000: Windows based program for configuration, diagnostics and report generation (Compatible with Windows XP/Vista/7)
Data Logging	History Log: local storage of last 35 days of all analytical data (analysis, events, alarms, averages, last chromatogram, calibration data) according to API Report 21.1. All data available on remote workstation in XML format
DCS	Remote monitoring and trending of the system as an integral part of the Instromet Supervisory Suite

Analytical

Hardware	2 parallel isothermal GC modules with narrow-bore capillary column technology in combination with MEMS based analytical components
Analysis Output	Full composition of any natural gas up to C_{6+} (standard) or C_{9+} (optional) Heating Value, Density, Wobbe Index

Component Range

for natural gas		for biogas	
N_2	: 0.005 – 20 %	N_2	: 0.005 – 15%
CH_4	: 55 – 100 %	CH_4	: 60 – 100%
CO_2	: 0.001 – 20 %	CO_2	: 0.001 – 10%
C_2	: 0.001 – 14 %	C_2	: 0.001 – 14 %
C_3	: 0.001 – 6 %	C_3	: 0.001 – 6 %
C_4	: 0.001 – 3 %	C_4	: 0.005 – 3 %
Neo-C5	: 0.005 – 0.25 %	H_2	: 0.001 – 5 %
C_5	: 0.001 – 0.25 %	O_2	: 0.005 – 4%
C_6	: 0.001 – 0.1 %	H_2S	: 0.0002 – 1%
C_7	: 0.001 – 0.05 %	COS	: 0.0001 – 1%
C_8	: 0.001 – 0.05%		
C_{9+}	: 0.001 – 0.05 %		

Concentrations outside this scope might be possible, but verification with Elster-Instromet is needed.

Performance	Uncertainty < 0.1 % for all calculated properties Repeatability < 0.005 % (RSD) for all calculated properties Detection limit for C_5: 1 ppm; Detection limit for C_9: 2 ppm Analysis time 3 minutes for C_{6+} analysis, 5 minutes for biogas or C_9 analysis
Temperature range	0 °C to 55 °C (-10 to 130 °F), extendable to -40 °C to 55 °C (-40 to 130 °F)

Analytical

	Special application "analysis of hydrogen in natural gas"	
Hardware	2 parallel isothermal PGC modules in close capillary column technology in combination with analytical MEMS components components	
Analysis Output	Full composition of any natural gas up to C_{6+} (standard) or C_{9+} (optional) Heating Value, Density, Wobbe Index; Methane number, incl. Hydrogen	
Component Range	Component	technical / mol%
	C1	55 – 100
	N2	0 – 22
	CO2	0 – 20
	C2	0 – 14
	C3	0 – 10
	i-C4	0 – 1,8
	n-C4	0 – 1,8
	neo-C5	0 – 0,25
	i-C5	0 – 0,25
	n-C5	0 – 0,25
	C6, C6+	0 – 0,1
	C7	0 – 0,1
	C8	0 – 0,1
	C9+	0 – 0,1
	H2	0 - 10
	Concentrations outside this scope might be possible, but verification with Elster-Instromet is needed.	
Performance	Uncertainty < 0.15 % for all calculated properties Repeatability < 0.02 % for all calculated properties Detection limit for C_5: 1 ppm; Analysis time: 5 minutes	
Temperature range	0 °C to 55 °C (-10 to 130 °F), extendable to -40 °C to 55 °C (-40 to 130 °F)	

Gas Cylinders

Helium / Argon	Quality 5.0 or better Optional 2 bottles with automatic change system Supply pressure 5.5 barg Flow ± 4 ml/min per column (max. 8 ml/min with 2 columns)
Calibration gas	Composition preferably close to pipe line composition Quality 2.0 or higher (with a maximal uncertainty of 1% relative deviation for each component) Supply pressure 1 to 4 barg nominal Pressure peak protection up to 4 barg Flow ± 30 ml/min

Installation

Location	Outdoor installation, close to sample point. Only sun shade required
Mounting	Table or platform by preference, pole or wall mounted
Gas connections	Swagelok 1/8”

Electrical connections

Power Supply	M20/M25 cable gland for armoured cable Ø 11-17 mm / 17-26 mm
Data Communication	M20/M25 cable gland for armoured cable Ø 11-17 mm / 17-26 mm
Ext. sensors (optional)	M20 cable gland (2) for armoured cable Ø 6-12 mm

4 Data Communication

4.1 Local TCP/IP Data Communication

The main Data Communication Port of the EnCal 3000 is the TCP/IP port, although 2 serial ModBus ports are also available (see next paragraph). The TCP/IP Port (Ethernet UTP 10 Base-T) is necessary for connection with RGC 3000 (Windows based interface for configuration, diagnostics and report generation), but is also used by preference for ModBus communication with Flow Computers, DCS systems, PLC and other ModBus hosts, if they are able to handle ModBus TCP/IP. If not, ModBus serial to TCP/IP are easily available nowadays. For existing systems the 2 serial ModBus ports can of course also be used.

The picture below shows a typical set-up:

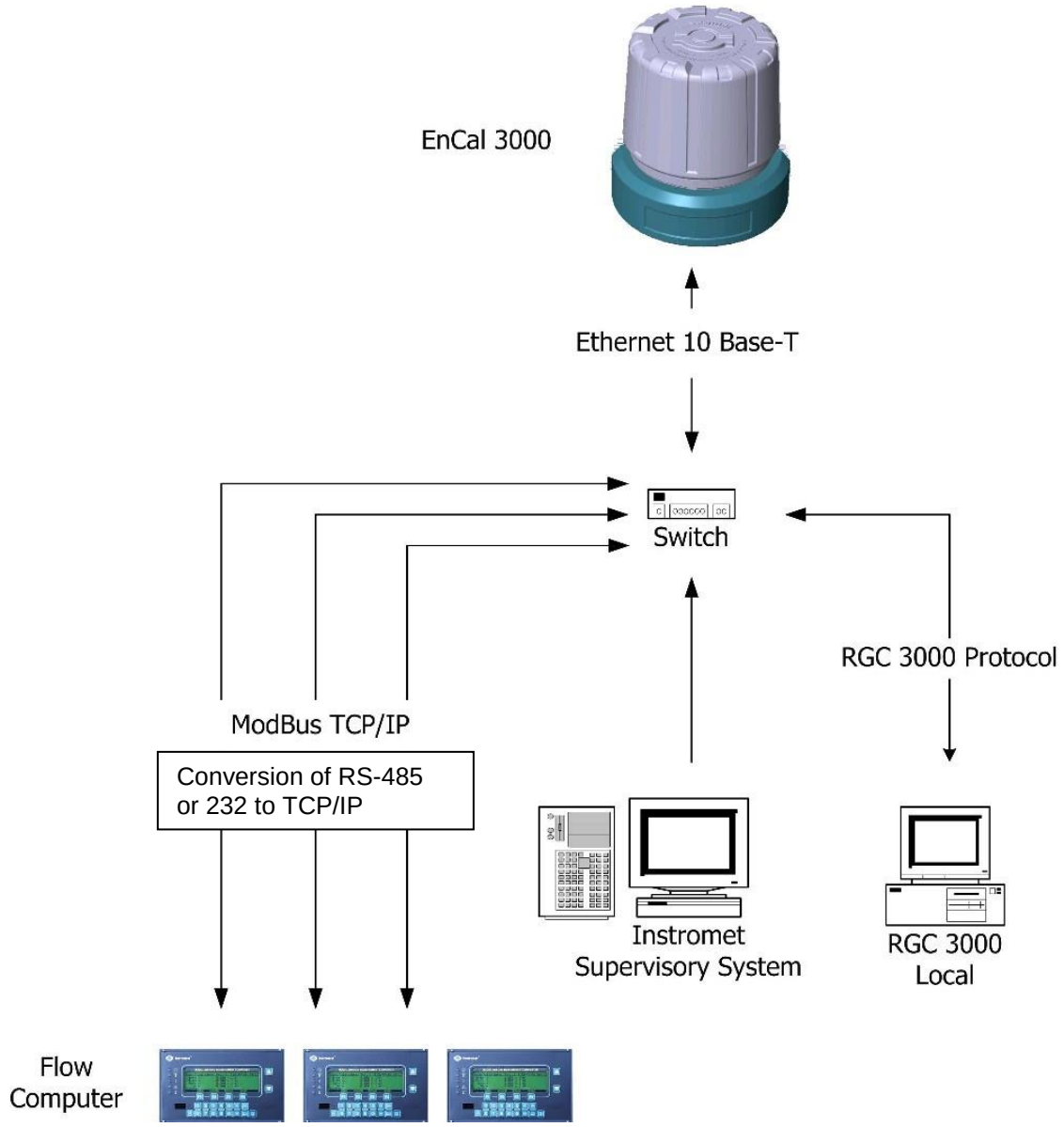


fig. 4-1 Typical Data Communication Set-up for Ethernet Communication with the EnCal 3000

4.2 Local Serial ModBus Data Communication

Flow computers or another ModBus host could also be directly connected to one of the 2 serial ModBus ports internally integrated in the EnCal 3000.

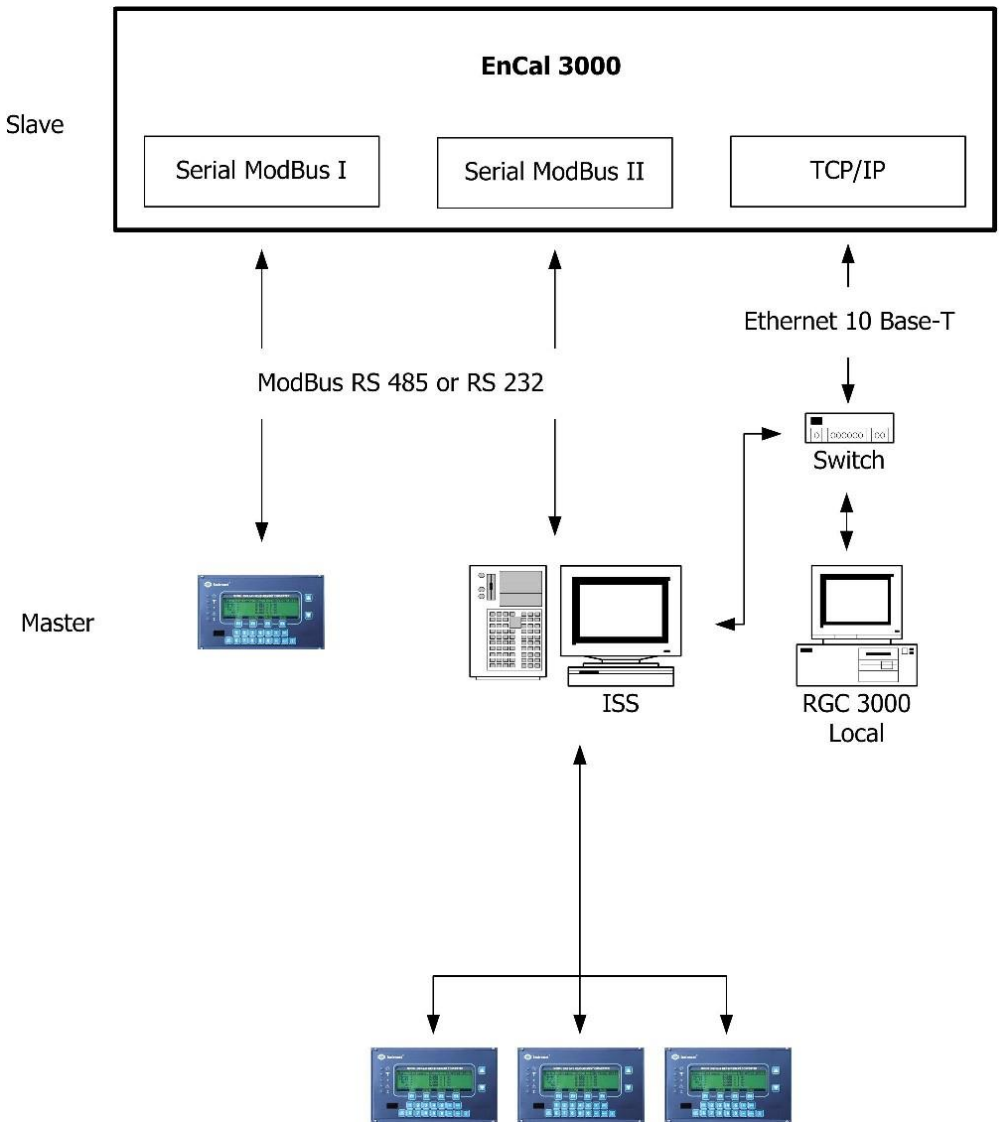


fig. 4-2 Typical Data Communication Set-up for TCP/IP combined with Serial ModBus Communication with the EnCal 3000

4.3 Remote Access

The schematic below shows the different options for remote access to the EnCal 3000:

Through Internet:

- Or through a direct connection of the Ethernet switch with Internet (through cable or ADSL modem, or wireless)
- Or through a VPN connection with the customer's network, if the Ethernet switch or the local PC is integrated in this network. In this case the customer has to give (if required only temporarily) a User Account and Login ID to the remote PC.

If network connection is not available, telephone line connection is also possible:

- Or by using an Ethernet modem with dial-in capability
- Or by using the internal modem of the local PC, and a remote access program like PC Anywhere.

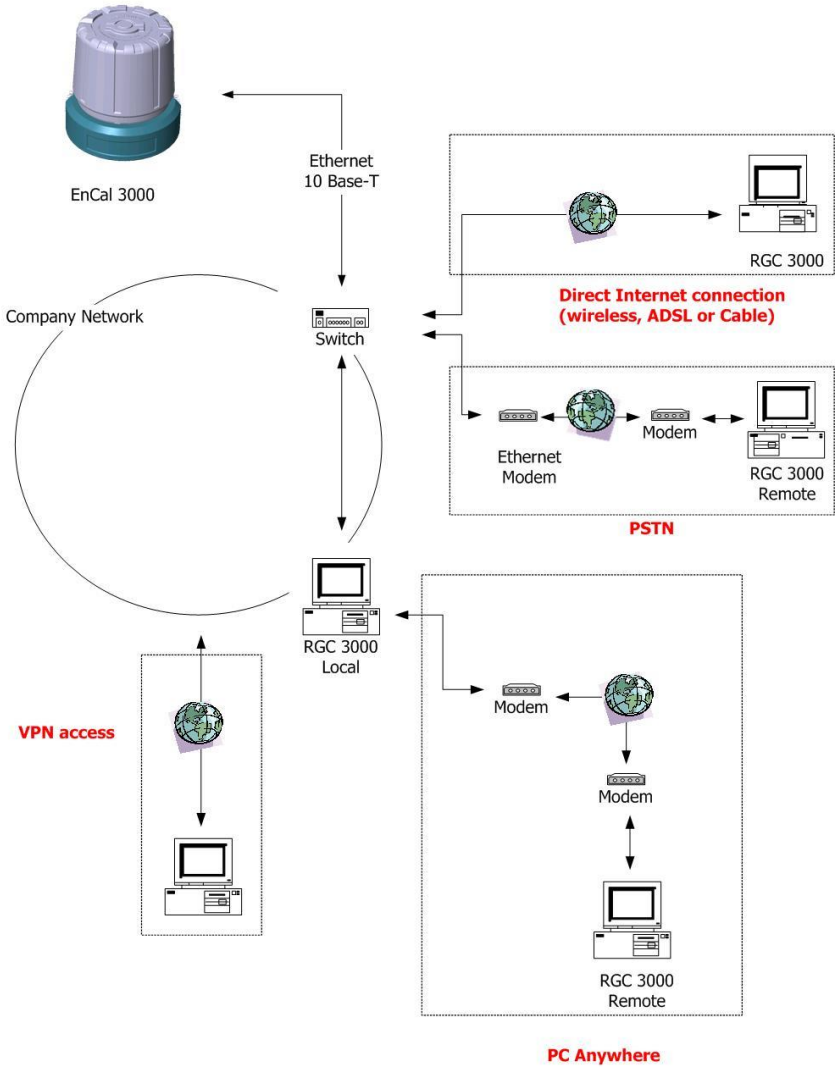


fig. 4-3 Remote Access to the EnCal 3000

4.4 ModBus Communication

The picture below shows the ModBus Configuration screen for the EnCal 3000 (see also Software Manual)

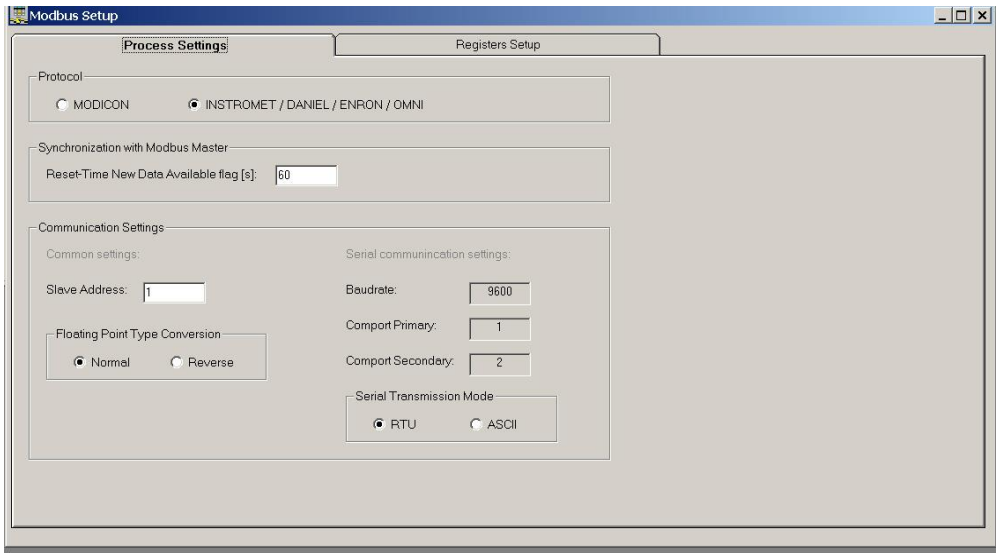


fig. 4-4 ModBus Configuration Screen

The ModBus registers are user configurable:

fig. 4-5 ModBus Register Details

- Register Type: Either Read Only (R) or Read/Write (R/W), and either bit (Status) or register size
- Register #: User selectable. For the Instromet protocol be aware of the following restrictions:
  - 0 – 4999 : 2 bytes per Registers
  - 5000 – 6999: 4 bytes Integers
  - 7000 – higher: 4 bytes Floating Point

  The Modicon protocol always uses 4 registers
- Data Type: Bit when Status is defined, Integer (16 bit or 32 bit) or Float when Register is defined
- Parameter ID: Instruction set which is available in EnCal 3000.
- Channel: This column is reserved to define channel # or stream #, depending on the type of Parameter ID defined
- Peak #: Component number, if applicable

For further details concerning the Modbus communication please refer to the Software Manual of RGC 3000.

5 Hardware Installation

5.1 Installation specifications

5.1.1 Weight and Dimensions

Weight:	< 30 kg	
Dimensions:	Analyser	: Ø 37 x H 37 cm (Ø 14.5" x H 14.5”)
	Installation Clearance	: Ø 50 x H 70 cm (Ø 20" x H 28”)

5.1.2 Installation clearance

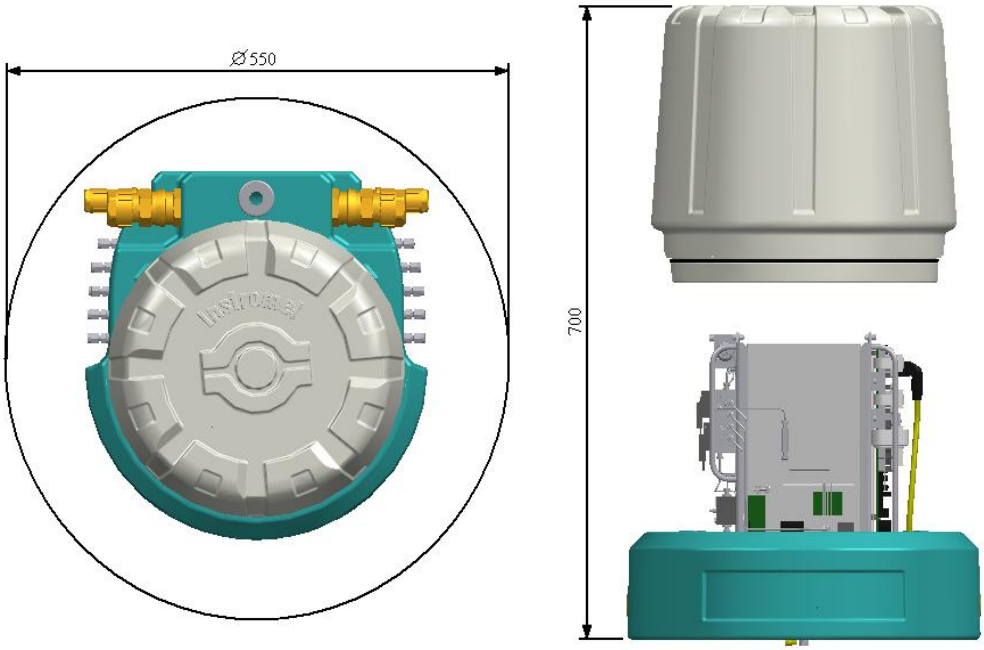


fig. 5-1 Mounting Dimensions and Installation Clearance

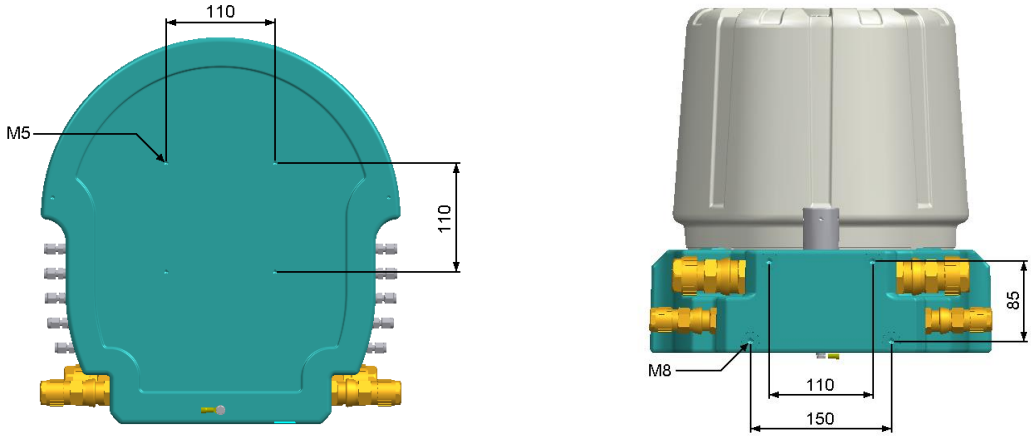


fig. 5-2 Mounting Holes EnCal 3000 Housing

5.1.3 Wall mounting

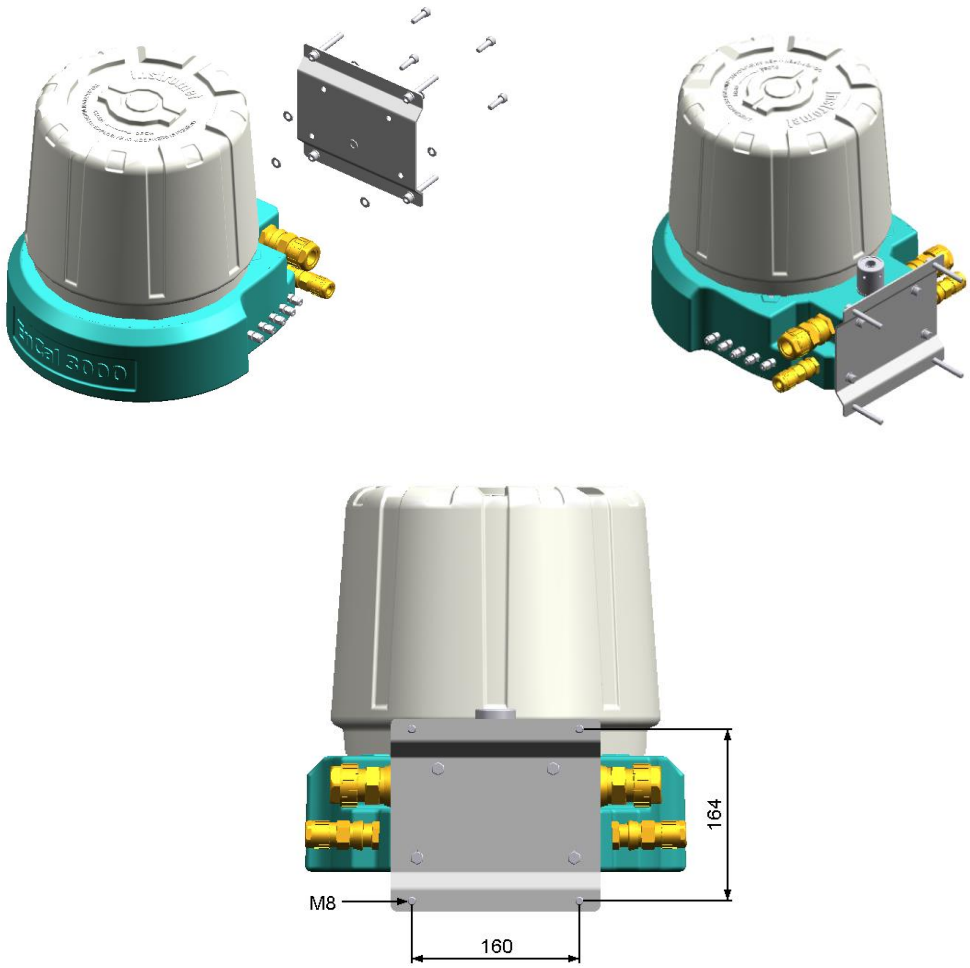


fig. 5-3 Wall Mounting Bracket Dimensions

Depending on local regulations, the weight of the EnCal 3000 (±28kg) may exceed the allowable manual lifting limit for one person. Be sure the appropriate manpower or lifting equipment and protective equipment such as safety shoes are available.

5.1.4 Connection of utilities

Gas lines:	HE	Helium	5-6 barg (71-86 PSIg) Recommended pressure 5.5 barg
	AR	Argon	5-6 barg (71-86 PSIg) Recommended pressure 5.5 barg (Second carrier gas only needed to analyse biogas or hydrogen in natural gas. In standard applications this connection is not used and closed without piping inside.)
	STR1	Stream 1	1-4 barg (15-57 PSIg)
	STR2	Stream 2	1-4 barg (15-57 PSIg)
	STR3	Stream 3	1-4 barg (15-57 PSIg)
	STR4	Stream 4	1-4 barg (15-57 PSIg)
	STR5	Stream 5	1-4 barg (15-57 PSIg)
	CAL	Calibration Gas	1-4 barg (15-57 PSIg)
	PV	Purge Vent	
	SBV	Sample + Block and Bleed Vent	

All gas and vent lines do have a 1/8" Swagelok connection to the EnCal 3000. On request also 3 mm connections are available.

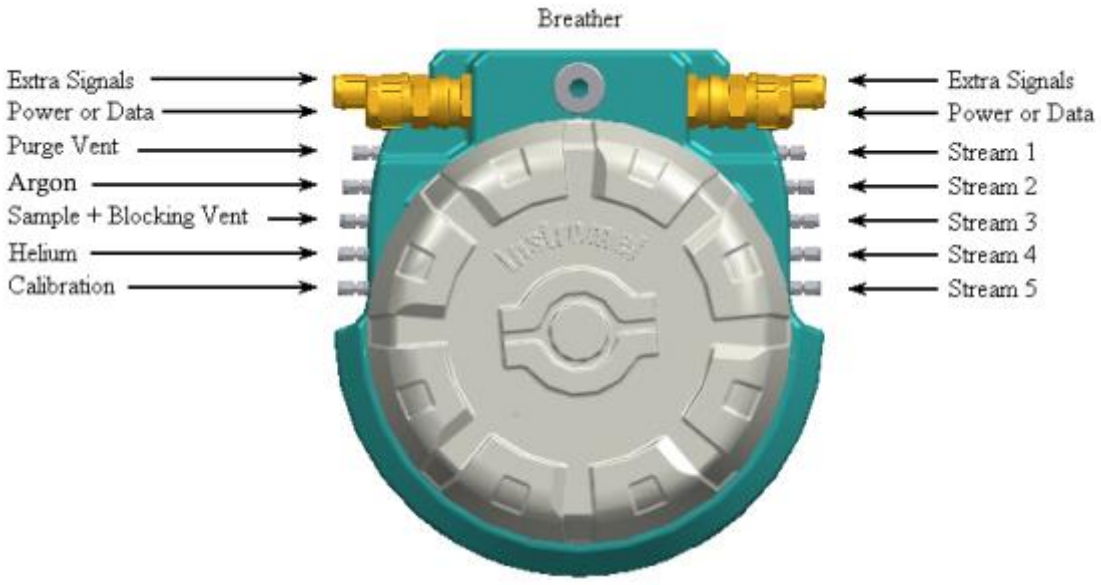


fig. 5-4 Connections to the EnCal 3000

Power Supply cable

24 VDC / 120 W max
Conductor cross section: AWG 12-13 (2.5 - 4 mm²)
Armoured cable required for outdoor installation – OD between 12 and 25 mm

Data Communication

Ethernet : shielded twisted 4 wire cable or industrial CAT5
ModBus Serial : shielded twisted pair

⚠	All input, output signals and power connections shall be of non-hazardous voltage and reinforced isolated from main.

5.1.5 Connections to the EnCal 3000 Interconnection board

The drawing below shows the top lay-out of the Interconnection Board at the bottom of the unit. It contains all the connectors for external cables (marked with grey). For flame retardant wiring use cables according an ISO norm. To fulfill the FM regulations always use cables / wiring according to UL94 V-1 or better for installation. All the wiring with the other electronic boards is done in the factory, and may not be changed during field installation.

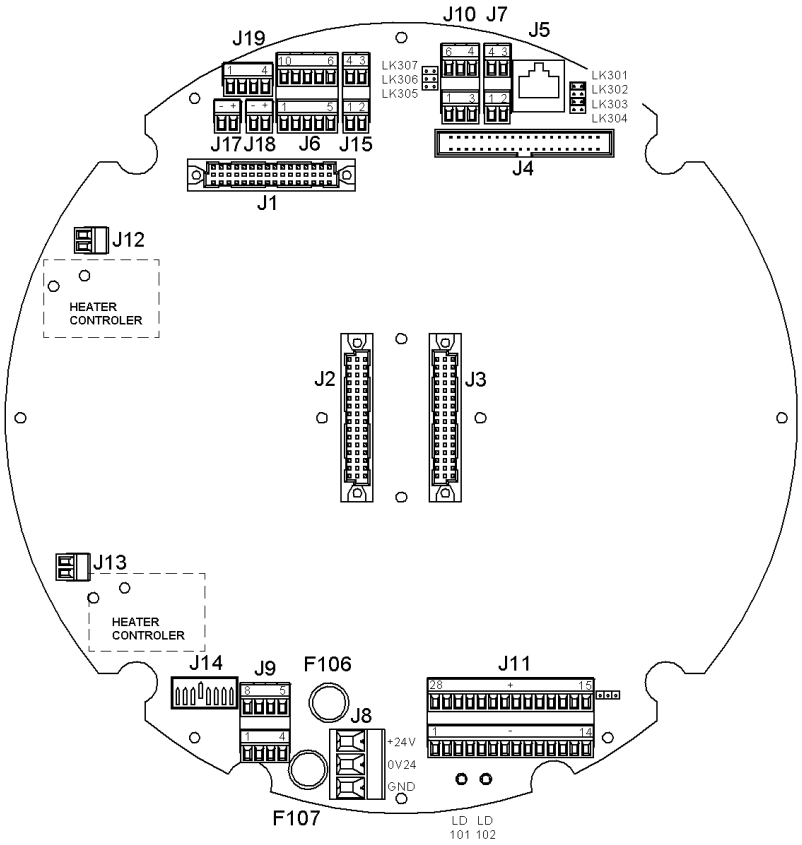


fig. 5-5 Interconnection Board: top view lay-out

J1	Processor board connection
J2	Channel 1 Connector
J3	Channel 2 Connector
J4	I/O Flat cable to Processor board
J5	TCP/IP connection between Inter-connection board and Processor board
J6	Modbus RS485/232 connections
J7	Ethernet connection
J8	Solenoids terminal power suppl. 24 V DC
J9	Power supply out (12 VDC / 24 VDC)
J10	Analogue inputs (0-10 V DC)
J11	Solenoids terminal for valves of stream selection (0-12 V DC)
J12	Power supply heater 1 (24 V DC)
J13	Power supply heater 2 (24 V DC)
J14	Dip Switch Power supply valves (internal current supply circuit)
J15	Digital Inputs (passive contact)
J17	Fan1 power supply connection (12 V DC)
J18	Fan2 power supply connection (12 V DC)
J19	Input
F106	Fuse analytical channels Module (6,3A)
F107	Fuse additional cabinet heaters (5A)
LD101	LED (internal 12 V- circuit)
LD102	LED (activation valves stream selection)
LK 301-304	4 jumper for selection between RS232 and RS485
LK 305-307	**3** jumper for selection of analogue input (4-20 mA or 0-10 V)

Power Supply Connection:

Power Supply is 24 VDC (tolerance band 18 – 36 VDC), with conductor size AWG 12-13 (2.5 – 4 mm²). The cable has to be connected to connector J8. See picture below and fig. 5-6 for location and polarity. Just a two wire connection for + and – is required, don't connect a third wire for the ground. Instead of that the device should be grounded at the bottom of one housing at a M5 connection or at a free M8 connection at the mounting plate.

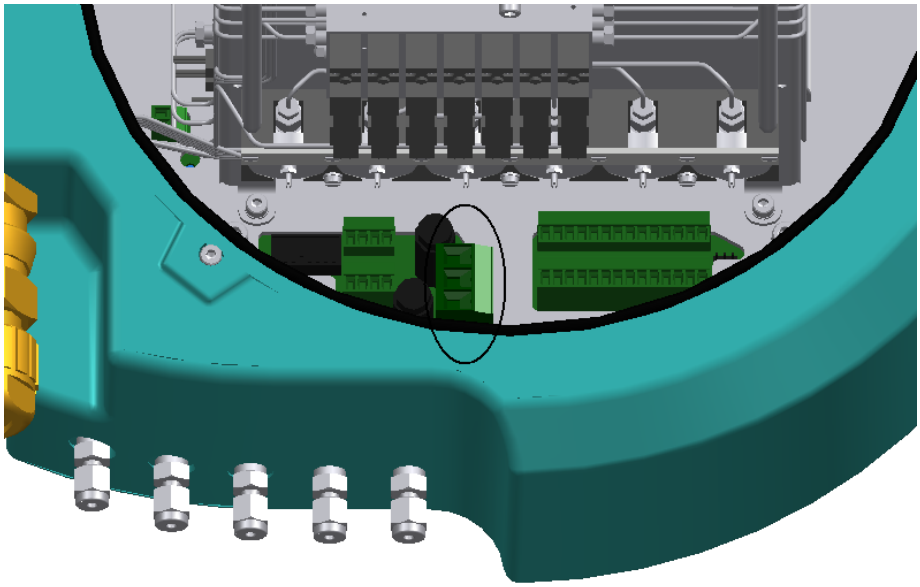


fig. 5-6 Location of Power Supply connector (J8)

Ethernet connection:

The Ethernet connection is used for connection with a PC or ModBus TCP/IP clients. It uses 4 wires, connected to connector J10. See picture below for location and wiring scheme.

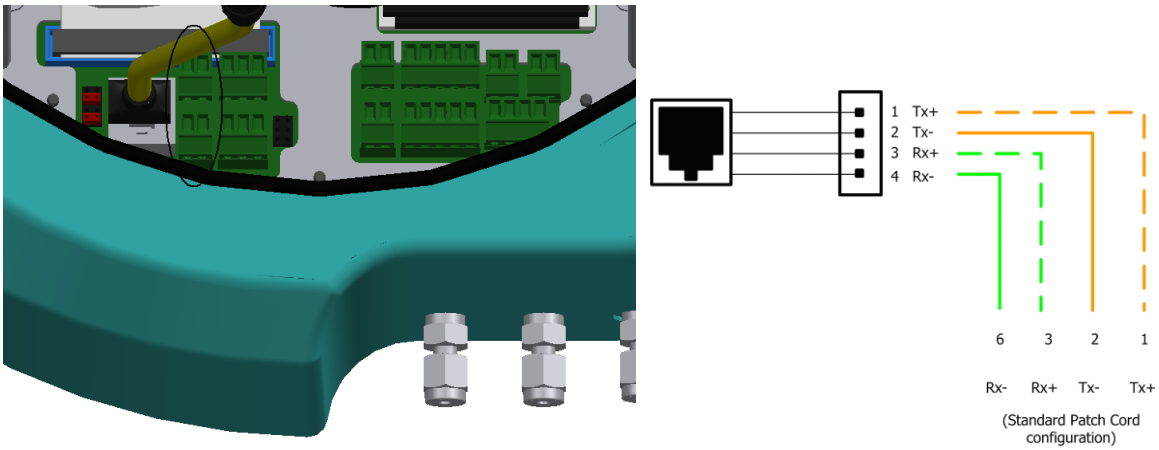


fig. 5-7 Location of Ethernet connector (J10) and wiring scheme

Serial ModBus connection

The Serial ModBus connection is used for connection with Serial ModBus clients like for example Flow Computers. The EnCal features 2 Serial ModBus ports with identical output. They are both independently configurable for RS232 or RS485 communication through link settings 301 to 304 (see pictures below for location, wiring scheme and link settings).

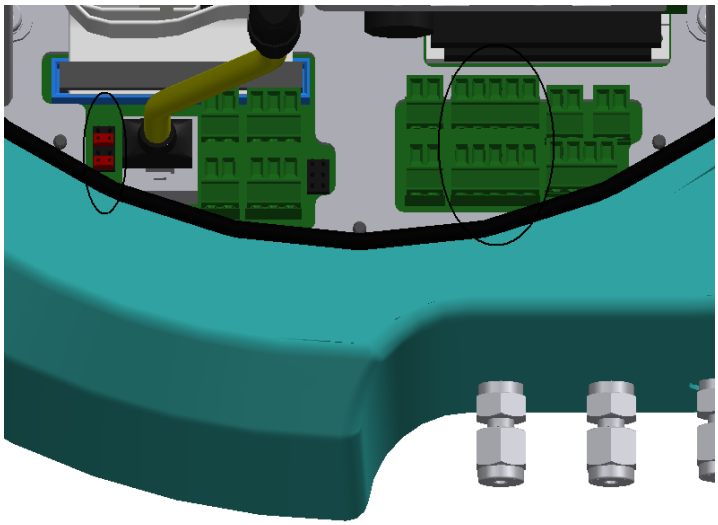


fig. 5-8 Location of Serial ModBus connector (J6)

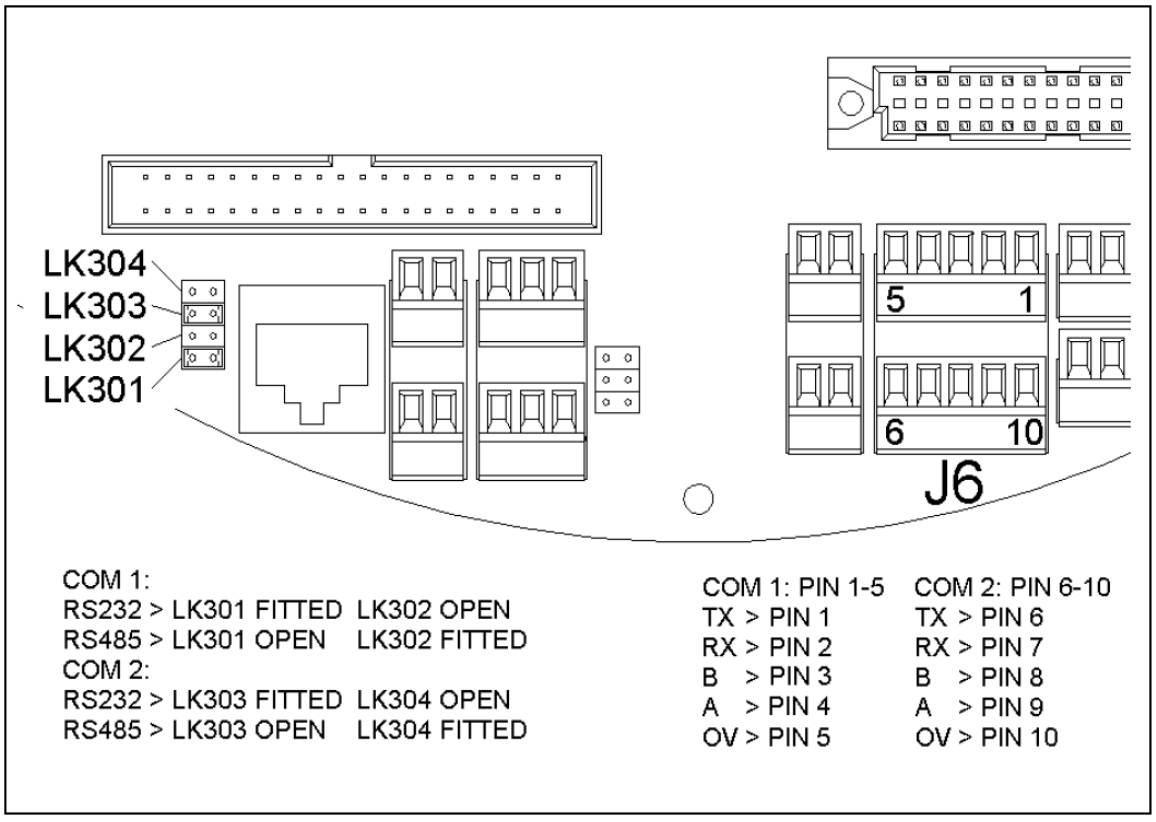


fig. 5-9 Modbus Connection and Link settings

5.2 Hardware Start-up

Electrical Installation in Hazardous Areas

The start-up should be done by an experienced technician, with a proven knowledge of electrical installations in explosion proof areas. Always remember to make sure there is no hazardous condition present during installation. Follow the instructions below carefully and make sure you have fulfilled all necessary safety steps before powering up the EnCal 3000.

Gas connections:

- Make sure the helium cylinder is tightly secured to the wall and the regulators are tightly mounted on the cylinder. Check the helium and Argon quality (5.0 – equivalent to Zero Grade classification - or better). Do not connect yet the tubing to the helium inlet at the EnCal 3000. Open carefully the helium regulator and check the helium pressure at the outlet of the regulator. Adjust to 5.5 barg (80 psig). Purge the tubing before connecting to the EnCal 3000 for about 30 s. Make the connection with Helium inlet. Check for leaks.

- Make sure the cal. gas cylinder is tightly secured to the wall and the regulators tightly mounted on the cylinder. Check the cal. gas certificate. The tube should be flushed once before it is connected to the Encal3000 with a non-flammable gas like the carrier gas Helium. Open carefully the cal. gas regulator and check the cal. gas pressure at the outlet of the regulator. Adjust to 1-4 barg (15-57 psig). Purge the tubing before connecting to the EnCal 3000 for about 30 seconds. After the connection a check for leaks is required.

- Check the stream gas pressure at the connection point with the EnCal 3000. Adjust to 1-4 barg (15-57 psig). Purge the tubing before connecting to the EnCal 3000 for about 30 s. Make the connection with inlet STR1. Check for leaks. (calibration is already connected in the section above)
- Make a careful leak check of the total system.

Power Supply cable:

- Standard industrial 2-wire cable.
  (The use of an external junction box is responsibility of the customer / installer)
- Power rating 3A x 24V nominal (ambient T > 0 °C or >32 °F). The cable cross-section must be chosen sufficiently large.
- For the location of the internal connector see figure 5.6.

Data communication cable:

- Ethernet cable (PC and/or ModBus TCP/IP clients) :
  Standard straight cable, shielded twisted 4 wire cable or industrial CAT5 quality. For the location of the Ethernet connector see figure 5.7.

- Serial Modbus :
  - Standard industrial data communication cable twisted pair
    - 3-wire for RS 485 communication
    - 3-wire for RS 232 communication
  - 2 serial ModBus ports are available, each of them independently user configurable into RS 232 or 485 (Pin lay-out and link locations see figures 5.8 and 5.9)

Mount the cap on the unit, hand-tight fixed. The marked screws in the following figure are security screws. Screw out the security screws to prevent removing of the cap by accident or ignorance.

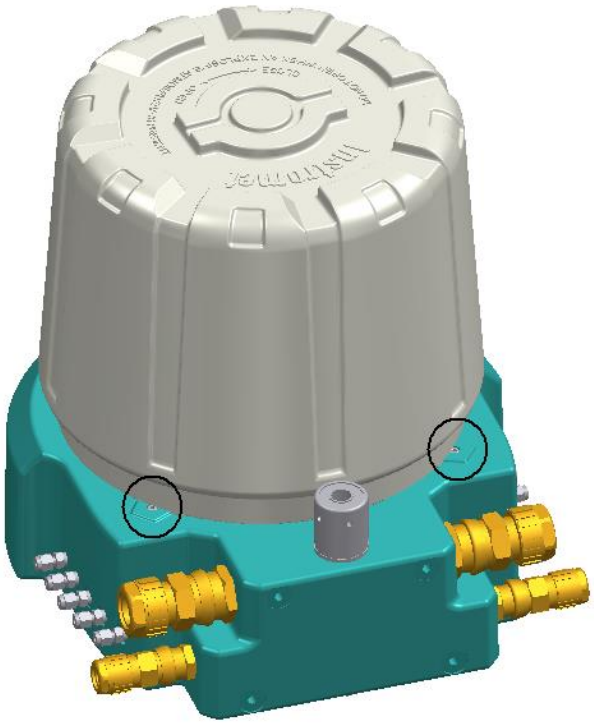


fig. 5-10 Location of security screws to fix the cap after mounting on the base

Check one more time if all gas connections are leak tight connected and all cable glands for electrical connection are securely tight. Check also one more time the different gas pressures for correct settings

Apply power to the unit (24 VDC) by turning on the external switch.

The unit will automatically start-up. The start-up sequence takes about 5 minutes, including temperature and pressure stabilisation, and system flushing. After this sequence the unit is ready for the software configuration.

APPENDIX 1: CERTIFICATE EC-Type Examination

CERTIFICATE

EC-Type Examination

(1)

(2) Equipment and protective systems intended for use in potentially explosive atmospheres - Directive 94/9/EC

(3) EC-Type Examination Certificate Number: **KEMA 05ATEX2191 X** Issue Number: **4**

(4) Equipment: **Gas Analyzer type ENCAL 3000**

(5) Manufacturer: **Elster-Instromet GmbH**

(6) Address: **Steinern Straße 19 – 21, 55252 Mainz-Kastel, Germany**

(7) This equipment and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

(8) DEKRA Certification B.V., notified body number 0344 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres given in Annex II to the directive.

The examination and test results are recorded in confidential test report number 212675200/3

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 60079-0 : 2012 **EN 60079-1 : 2014**

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-Type Examination Certificate relates only to the design, examination and tests of the specified equipment according to the Directive 94/9/EC. Further requirements of the directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate.

(12) The marking of the equipment shall include the following:

II 2 G Ex d IIB T4 Gb

This certificate is issued on 23 April 2015 and, as far as applicable, shall be revised before the date of cessation of presumption of conformity of (one of) the standards mentioned above as communicated in the Official Journal of the European Union.

DEKRA Certification B.V.

T. Pijpker
Certification Manager

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DEKRA Certification B.V. Meander 1051, 6825 MJ Arnhem P.O. Box 5185, 6802 ED Arnhem The Netherlands
T +31 88 96 83000 F +31 88 96 83100 www.dekra-certification.com Registered Arnhem 09085396

(13) **SCHEDULE**

(14) to EC-Type Examination Certificate KEMA 05ATEX2191 X Issue No. 4

(15) **Description**

The Gas Analyzer type ENCAL 3000 is used to measure the concentrations of the different components of a gas.

Ambient temperature range -40 °C to +55 °C.

Electrical data

Power supply ..... 24 Vdc, max. 170 W

Installation instructions

The instructions provided with the equipment shall be followed in detail to assure safe operation.

(16) **Test Report**

No. 212675200/3.

(17) **Specific conditions of use**

The flameproof enclosure shall not be opened when an explosive gas atmosphere may be present.

The process pressure shall be limited to 2 MPa to ensure that the pressure rise inside the flameproof enclosure remains below 10 kPa.

For information on the dimensions of the flameproof joints the manufacturer shall be contacted.

(18) **Essential Health and Safety Requirements**

Covered by the standards listed at (9).

(19) **Test documentation**

As listed in Test Report No. 212675200/3.

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Form 100
Version 5 (2013-07)

APPENDIX 2: DECLARATION OF CONFORMITY ENCAL 3000

CE

Declaration of Conformity
Konformitätserklärung

elster

Product
Produkt

Gaschromatograph
Gas Analyzer

Type, Model
Typ, Ausführung

ENCAL3000

	EMC	ATEX
Product marking *Produkt-Kennzeichnung*	N.A.	Ex II 2 G Ex d IIB T4 Gb Kema 05ATEX2191 X CE 0044
EC-Directives *EG-Richtlinien*	**2004/22/EC, 2004/108/EG** *2004/22/EG, 2004/108/EG*	**94/9/EC** *94/9/EG*
Standards *Normen*	EN 61000-6-2:2005 EN 61000-6-4:2007	EN 60079-0:2012 EN 60079-1:2014
EC Type-Examination *EG-Baumusterprüfung*	**E145203E1**	**KEMA 05ATEX2191 X**
Surveillance Procedure *Überwachungsverfahren*	N.A.	**Notified Body 0044** 94/9/EC Annex IV+VII *94/9/EG Annex IV+VII*

We declare as manufacturer:

Products labelled accordingly meet the requirements of the listed directives and standards. They correspond to the tested type samples. The production is subject to the stated surveillance procedure. If alterations are made to the product or it is modified, this declaration becomes void with immediate effect.

Wir erklären als Hersteller:

Die entsprechend gekennzeichneten Produkte sind nach den aufgeführten Richtlinien und Normen hergestellt. Sie stimmen mit dem geprüften Baumuster überein. Die Herstellung unterliegt dem genannten Überwachungsverfahren. Bei Umbau des Produkts oder Änderungen am Produkt verliert diese Erklärung mit sofortiger Wirkung ihre Gültigkeit.

07.05.2015

Dr. Harald Dietrich, Managing Director

Elster GmbH, Postfach 1880, D – 55252 Mainz-Kastel, Steinern Straße 19-21 05.2015 Rev. 2

APPENDIX 3: IECEx Certificate ENCAL 3000

IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification Scheme for Explosive Atmospheres

for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.:	IECEx KEM 10.0094X	Issue No: 1	Certificate history:
Status:	**Current**	Page 1 of 4	Issue No. 1 (2014-03-21)
Date of Issue:	**2014-03-21**		Issue No. 0 (2010-12-31)
Applicant:	**Elster-Instromet B.V.** Munstermanstraat 6 7064 KA Silvolde **The Netherlands**		
Electrical Apparatus:	**Gas Analyzer type ENCAL 3000**		
Optional accessory:			
Type of Protection:	**Ex d**		
Marking:	Ex d IIB T4		

Approved for issue on behalf of the IECEx Certification Body: R. Schuller

Position: Certification Manager

Signature:
(for printed version)

Date: 2014-03-21

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting the Official IECEx Website.

Certificate issued by:

DEKRA Certification B.V.
Meander 1051
6825 MJ Arnhem
The Netherlands

DEKRA

IECEx Certificate of Conformity

Certificate No:	IECEx KEM 10.0094X	Issue No: 1
Date of Issue:	**2014-03-21**	Page 2 of 4

Manufacturer:

Elster-Instromet B.V.
Munstermanstraat 6
7064 KA Silvolde
The Netherlands

Additional Manufacturing location(s):

Elster GmbH
Steinern Straße 19-21
55252 Mainz-Kastel
Germany

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements. This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended.

STANDARDS:

The electrical apparatus and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards:

IEC 60079-0 : 2004 Edition:4.0	Electrical apparatus for explosive gas atmospheres - Part 0: General requirements
IEC 60079-1 : 2007-04 Edition:6	Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"

*This Certificate **does not** indicate compliance with electrical safety and performance requirements other than those expressly included in the Standards listed above.*

TEST & ASSESSMENT REPORTS:

A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in

Test Report:

NL/KEM/ExTR10.0103/00

Quality Assessment Report:

DE/TUN/QAR11.0003/01 NL/DEK/QAR12.0007/00

IECEx Certificate of Conformity

Certificate No:	IECEx KEM 10.0094X	Issue No: 1
Date of Issue:	**2014-03-21**	Page 3 of 4

Schedule

EQUIPMENT:

Equipment and systems covered by this certificate are as follows:

Description

The Gas Analyzer type ENCAL 3000 is used to measure the concentrations of the different components of a gas.

Ambient temperature range -40 °C to +55 °C.

Electrical data

Power supply : 24 Vdc, max. 170 W.

CONDITIONS OF CERTIFICATION: YES as shown below:

The flameproof enclosure shall not be opened when an explosive gas atmosphere may be present.

The process pressure shall be limited to 2 MPa to ensure that the pressure rise inside the flameproof enclosure remains below 10 kPa.

For information on the dimensions of the flampeproof joints the manufacturer shall be contacted.

IECEx Certificate of Conformity

Certificate No:	IECEx KEM 10.0094X	Issue No: 1
Date of Issue:	2014-03-21	Page 4 of 4

DETAILS OF CERTIFICATE CHANGES (for issues 1 and above):

Addition of production location