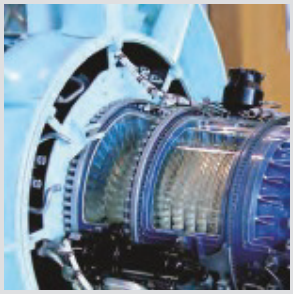
INCA

Gas analysis system for the Bio and Natural gas industries

- Modular design is ideal for customer specific solutions
- Latest sensor technologies: NDIR, electrochemical cells, paramagnetic and acoustic
- Pre-calibrated plug and play sensor modules for ease of use
- Available with/without multiple sample stream switching option for dry or saturated gases (Peltier gas cooler is available)
- Patented p ulse system proven to increase the service life of the electrochemical sensors
- Internal device communication bus with a standard interface to all sensor modules
- Measurement of gas density (flowmeter correction factor)

INCA – composition, measurement components + method of operation

Modular design

INCA (cover picture) is a modular freely user configurable measurement device for multi-component gas analysis in the Bio and Natural gas industries. The INCA concept is designed to provide an analysis system custom made for a specific application using standard modules for; sample gas supply, sample gas processing, sensor control and data processing. This approach guarantees the best possible analysis results, optimised cost items in production and operation, short delivery times and facilitates retrofitting and/or replacement of components in the future.

Only the series INCA1000 units have fixed configuration for use in pre-determined applications. The gas analysis measurement technology (figure 4) is designed as an independent unit in which all components such as sensors, pumps, valves and more, are connected to the control system via an internal device bus. The installation of sensors (sensor modules) is determined by the customers specific application. This measurement unit can be configured as a complete system in an enclosure for operation in indoor, outdoor or explosion-proof areas as well as with or without a sample gas cooler or multiple stream switching options (figure 2).

INCA1000	Compact device configured for a pre-defined application
INCA2000	In planning stage for future release
INCA3000	Use with dry gases and indoor locations With or without sample stream switching
INCA4000	Use with saturated gases and indoor locations With or without sample stream switching
INCA5000	Use with dry gases and outdoor locations With or without sample stream switching (formerly named OUTDOOR INCA)
INCA6000	Use with saturated gases and outdoor locations With or without sample stream switching (formerly named OUTDOOR INCA)
INCA7000	In planning stage for future release
INCA8000	Like INCA3000, but for use in hazardous areas (formerly named SIRA)

Figure 1: The INCA series

The modular concept results in a full range of different INCA units all designed for special applications, figure 1.
The details of the final design can be specified by using the device configurator.

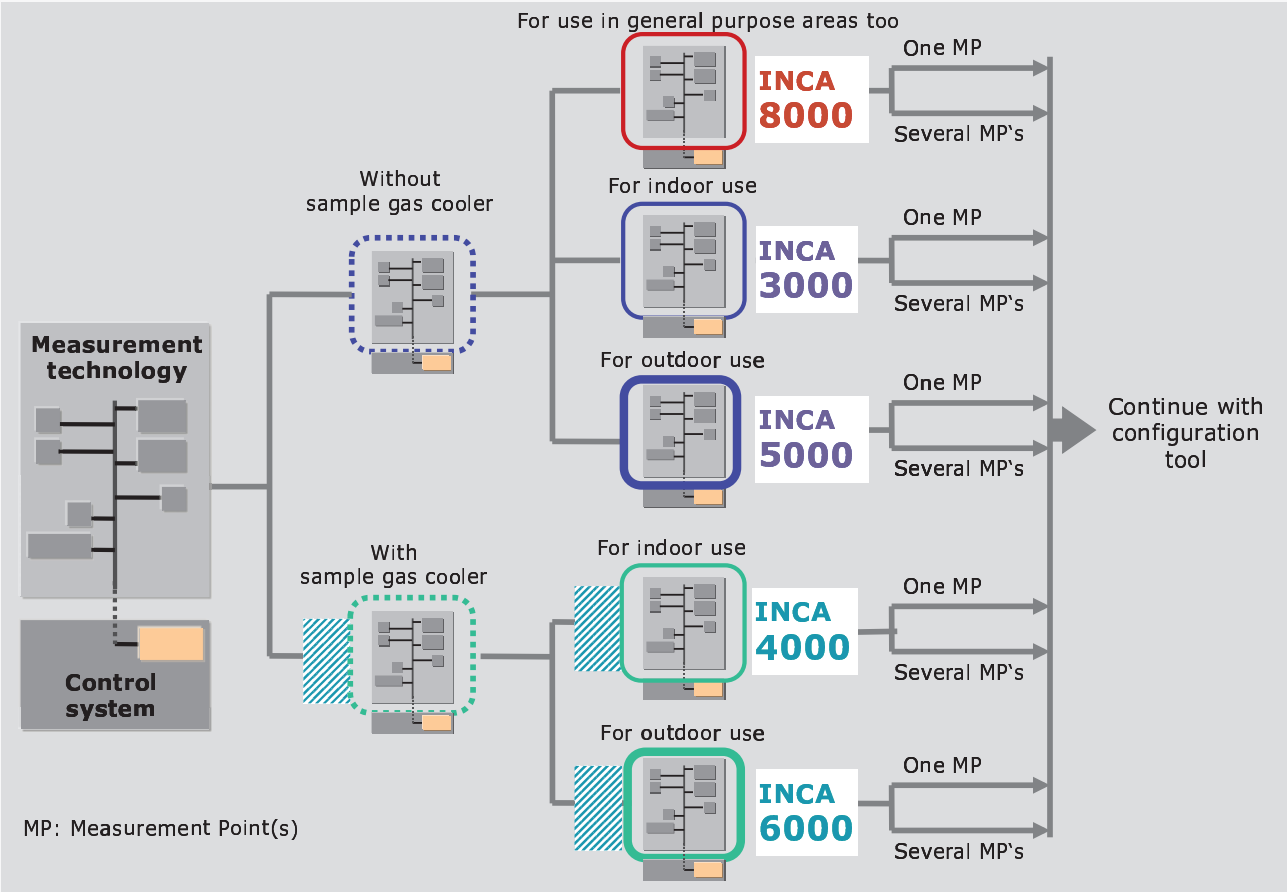


Figure 2: Schematic drawing of INCA models (INCA1000 not shown)

T087	T100	T137	T301
CH_4 0-5 Vol% CO_2 0-100 Vol%	CH_4 0-100 Vol% CO_2 0-100 Vol% H_2S 0-10000 ppm O_2 0-25 Vol%	CH_4 0-100 Vol% CO_2 0-10 Vol% H_2S 0-100 ppm O_2 0-25 Vol% H_2 0-4000 ppm	CH_4 80-100 Vol% C_2+ 0-15 Vol%
Lean gas	**Biogas**	**Biomethane**	**natural gas**

Figure 3: Different examples for available sensor systems

Sensor types (TXXX)

The INCA sensors also have a modular design. They allow for determining the concentration of gaseous components: CH_4, CO_2, O_2, H_2S and H_2 as well as the gas density, from these one can calculate characteristic values such as Wobbe index, Heating value, Calorific value, Specific Gravity and others.
In one sensor module, several sensors can be combined which can be used to determine the sample gas variables (combinations of gas components and measuring range). These **sensor types** are designated as **T**XXX; they are designed for specific applications such as the analysis of biogas or natural gas, see figure 3.
For sensor details please refer to the following page.

Modes of operation

As per function, INCA provides different modes of operation. The reasons for this are:

- Purging the electrochemical detectors with air to increase their service life
- Stream switch for several measuring points
- Protection of wetted parts, e.g. pumps

Continuous (online) operation
The mode of operation to determine CH_4 and CO_2 by using NDIR as well as O_2 by paramagnetic or electrochemical detector without any multi stream switching. In view of the sensors used in this mode an intermediate purge process is not required and this allows continuous online operation.

Quasi-continuous (cycled) operation
Online operation as described above, but with a cycled measurement of approximately 15 minutes because of the sensor air purge that is used in between cycles to condition them. Used to determine H_2S and H_2 with electrochemical sensors or in general to preserve the working life of parts like the pumps. For particularly critical measurements (H_2S) the patented **P ulse procedure** is also used which further increases operating time, measuring range and measuring accuracy of the (EC) electro chemical sensors.

Operation with measuring point switching
Sequential switching of the measurement technology to different sample gas flows e.g. in fermenter groups in biogas plants with several outputs or alarm warning devices.

Quasi-continuous operation
Measurement of several sample gas flows like above, but with a preferred "process stream". A changeover to other streams can be activated externally (e.g. via Profibus) is only done if irregularities in the process stream occur and needs to be verified as well as for control purposes.

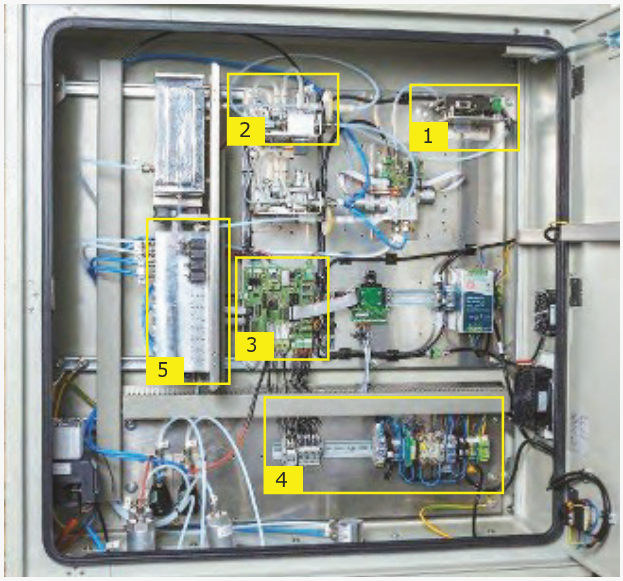


Figure 4: INCA analysis technology
1: Optical sensor
2: Pump for process gas
3: I/O card
4: wiring terminals
5: Gas cooler

INCA – Detectors and Sensors

Sensors are modular in design

INCA detectors are the real component-selective receivers with light source (in optical procedures), measurement chamber, filter + IR sensitive element. INCA **sensors** are modules consisting of one or several detectors as well as electronics and memory storage for calibration data.

The sensor modules are designed and pre-calibrated for special components and measuring ranges or combinations thereof. Integrating them to an INCA device only requires (apart from the mechanical assembly) to connect the module via a plug through a device bus (figure 7) into the control system. This simple procedure is very useful for retrofitting, but also in case of a sensor change due to age or wear. For INCA, sensors with different physical or chemical detection procedures are available, see figure 5 and associated text box.

Multipoint calibration of the sensors

Calibrating means the determination and documentation of systematic deviations of a measurement device from a "correct" value under given set of known conditions. For gas analysis devices, calibration gases are used for this purpose and the concentration data is usually certified by the gas supplier.

INCA sensors are always calibrated prior to delivery and the results are saved directly into the sensor module as a calibration curve.
By including several measuring points over the measuring range, the data from these calibration curves is precisely controlled which facilitates subsequent user calibrations. INCA offers simple and cost-efficient post calibration routines with just ambient air.

- For Methane, H_2S and H_2 zero calibration.

- For O_2 span over the range.

The calibration gases required for INCA operation are usually provided by the user.

Detection procedure	Determinable gas components or gas properties
NDIR	CH_4, CO_2, C_NH_M
Electrochemical cell	O_2, H_2S, H_2
Paramagnetic	O_2
Acoustic	Specific Gravity (Density)

Figure 5: INCA detection procedure

NDIR sensors
The NDIR (non-dispersive infrared) technology uses the absorption properties of gases for light radiation in the infrared wavelength. Suitable filters select a specific wavelength from a broad spectrum light source that shows typical absorption behavior for the gas in question. This radiation passes a measurement cell filled with sample gas. The IR attenuation occurring during this process is proportional to gas concentration. Thermal detectors (thermopiles) are used for signal measurement.

Electro-chemical sensors
Many gases react to other substances under specific conditions. If the reaction causes the release of electrons and thus a measurable current, the corresponding arrangement is called an electro-chemical cell. It consists of at least two catalytically acting electrodes connecting in an electrically conductive medium (electrolyte) and a circuit. At the junction of the electrode, gas and electrolyte, a current generating reaction occurs where the amperage shows the degree of the gas concentration. Note: Due to process conditions, electro-chemical sensors are gradually depleted during service life.

Paramagnetic sensors
Unlike most gases, oxygen is paramagnetic and thus attracted by a magnetic field. The resulting force from placing oxygen in a magnetic field serves to analyse the oxygen concentration in gases. This force is measured and registered, by generation of a rotary movement and converted into a signal proportional to the dynomagneto component effect.

Acoustic sensors (for density measurement)
The acoustic density measurement uses the impact of the sample gas on the oscillation amplitude of an induced sound wave. The sound amplitude detected by the pressure transducer depends directly on the density of the sample gas.
A reference chamber filled with ambient air also increases measurement accuracy under all conditions.

INCA – Controlling and Operation

Control system (real time operating system)

The control system is based on an embedded real time operating system. In terms of communication, all components are connected in the Master-Slave-principle to the internal device bus which also controls the power supply (figure 6). The fan control interlock ensures that the analysis system is only supplied with power if the fan is running.
The communication module offers the future-proof ability to implement not only an RS 232 interface but also Ethernet network and USB interfaces as well. Another advantage of the bus concept lies in the fact that replacement or installation only requires a plugin bus connection to be established.

Settings with INCACtrl

For all types of settings and for alarm analysis the **PC software INCActrl** (Windows) is used on an external computer or via TCP/IP.
INCACtrl allows for

- Setting calibration, purge and measurement cycles
- Specification of operating time and calibration data
- Parameterisation of analogue outputs
- Reading and display of all measurement data

For remote internet based maintenance assitance access via INCACtr is possible e.g. for queries of status messages.

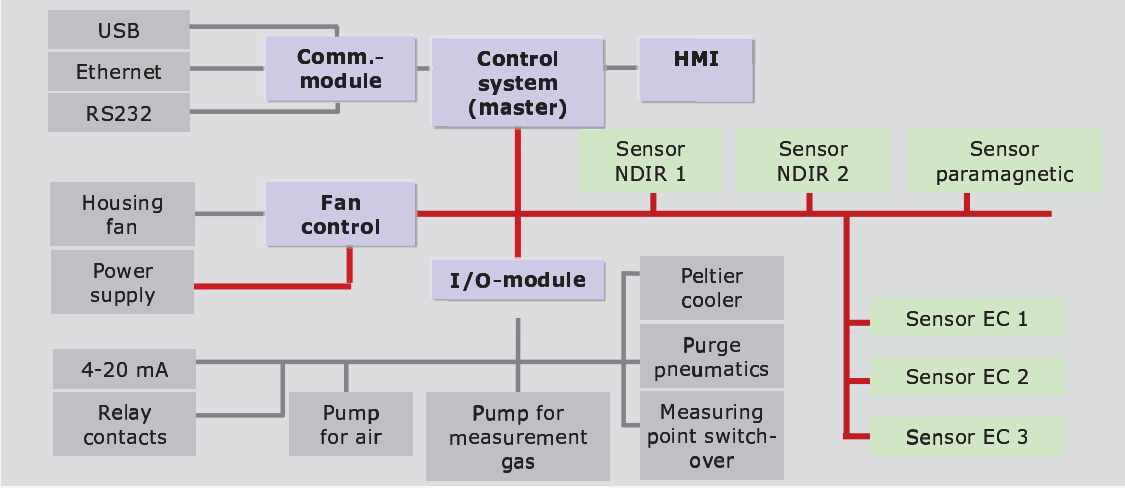


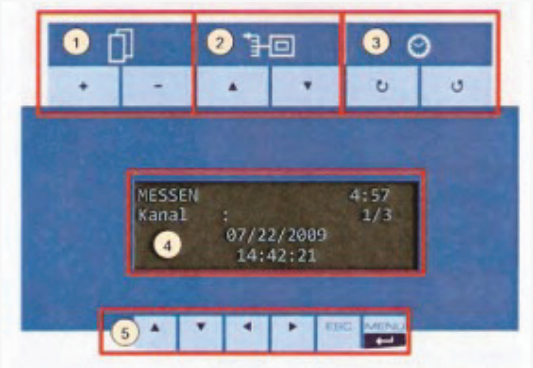
Figure 6: INCA components at the device bus

Operation

The operator panel is attached as one unit with the control system on or in the front of the enclosure. Operation is done via a membrane keyboard deliberately designed to be simple, user-friendly and always intuitive.

By consolidating basic program functions, INCA can also be used safely by less experienced persons. Figure 7 shows the operating elements (1-3 and 5) as well as the universal LC Display (4), which can be switched to show different values.

Different language versions (German, English, Italian) are available.
The operating system can be password protected against unauthorised access.



1	Display of current or saved sensor measured values
2	Display of the current measurement channel
3	Display of saved measured values (the last 10 values)
4	Display of status and channel as well as optional measured values such as temperature or pressure
5	Navigating the menu structure

Figure 7: Control panel and display

INCA – Technical data

	INCA1000	INCA3000	INCA4000	INCA5000	INCA6000	INCA8000
Weight [kg]	10	21	29	72	80	70
Dimensions (WxHxD) [cm]	48x33x25	68x65x25	80x65x25	120x110x44	120x110x44	60x48x34
IP degree of protection	IP40	IP43	IP20	IP54	IP54	IP52[1]
Setup site	inside	inside	inside	outside	outside	inside
Operating temperature	-5° - 40° C	-5° - 40° C	-5° - 40° C	-20° - 45° C	-20° - 45° C	-5° - 40° C
Gas cooler	x	x		x		x
Condensate pump	x	x	Hose or jet pump	x	Hose or jet pump	x
Inputs of process gas	1 - 2[2]	1 - 6[2]	1 - 10[2]	1 - 4[2]	1 - 10[2]	1 - 2[2]
Inputs of calibration gas	1 - 2	1 - 2	1	1 - 2	1	1 - 2
Inputs purging gas-air	1	1	1	1	1	1
Detonation protection[7]	Ex G IIC	Ex G IIC	Ex G IIC	Ex G IIC	Ex G IIC	Ex G IIC
Mains supply	100 - 240 V, 50/60 Hz					
Max. power consumption:	80 VA	100 VA	250 VA	1500 VA	1500 VA	500 VA
Storage temperature	-20° - 60° C	-20° - 60° C	-20° - 60° C	-20° - 60° C	-20° - 60° C	-20° - 60° C
CSA approval (optional)	x					x
EX approval	x	x	x	x	x	
Interfaces[2]	4-20 mA, RS232, relay contacts, Ethernet (TCP/IP), Profibus-DP, Modbus-TCP, Modbus-RTU, Profinet IO					

Measurement components[3]			
Gas component	**Measuring range**	**Measuring accuracy**	**Measuring procedure**
CH_4	0 – 100 Vol%	± 1% FS[4]	NDIR
CH_4	0 – 5 Vol%	± 3% FS[4]	NDIR
CH_4	0 – 1 Vol%	± 5% FS[4]	NDIR
CO_2	0 – 100 Vol%	± 1% FS[4] (± 1 Vol%)	NDIR
CO_2	0 – 10 Vol%	± 3% FS[4] (± 0,15 Vol%)	NDIR
CO_2	0 – 15 Vol%	± 3% FS[4] (± 0,05 Vol%)	NDIR
H_2S	0 – 10.000 ppm (µPulse)	" 25 ppm : ± 3 ppm > 25 ppm : ± 15% v. MW[5]	EC
H_2S	0 – 10.000 ppm	± 3% FS[4]	EC
H_2S	0 – 2.000 ppm	± 15 ppm	EC
H_2S	0 – 100 ppm	± 3 ppm	EC
H_2	0 – 4.000 ppm	± 5% FS[4]	EC
O_2	0 – 25 Vol%	± 0,1 Vol% at zero point ± 0,1 Vol% per 10°C ± 3% v. MW[5]	EC
O_2	0 – 25 Vol%	± 0,1 Vol% at zero point ± 0,1 Vol% per 10°C ± 3% v. MW[5]	Paramagnetic
SG (rel. density)	0,2 – 2,2	± 1% FS[4]	Acoustic
SG (rel. density)	0,5 – 2,2	± 1,5% FS[4]	calculated
HI (heating value)	0 – 11,5 kWh/m³	± 1,5% FS[4]	calculated
Wi (Wobbe index)	0 – 14,3 kWh/m³	± 2% FS[4]	calculated

[1] Not valid for 19 ″ control unit (installation in control cabinet)
[2] depending on version
[3] others upon request
[4] „FS": (Full Scale) of the measuring range end value
[5] „v. MW": of the measured value
[6] derived from earlier measured components
[7] only for biogas

Figure 8: Technical data

INCA – Application

Multifunctional applications

Devices and systems for gas analysis are required in many parts of the process and gas industry. A special application is the determination of the composition of combustible gases as required in the fields of natural gas, biogas, biomethane, liquid gas, blast furnace gas, lean gas, landfill gas and others. For such applications, INCA is particularly suitable. This does not mean that INCA cannot be used for other applications as well, provided that the task matches the gas components that INCA can detect (CH_4, CO_2, O_2, H_2S, H_2) and the measuring range required.

INCA in a biogas plant

The main application for INCA is the generation and processing of biogas. INCA provides a solution to the many different measurement tasks in a biogas plant (figure 9 to 11), thanks to its flexible design, usually just with one or two devices.
Today, UNION Instruments is one of the most successful suppliers of analysis technology in the bio-gas industry with many units in use in the world-wide market.

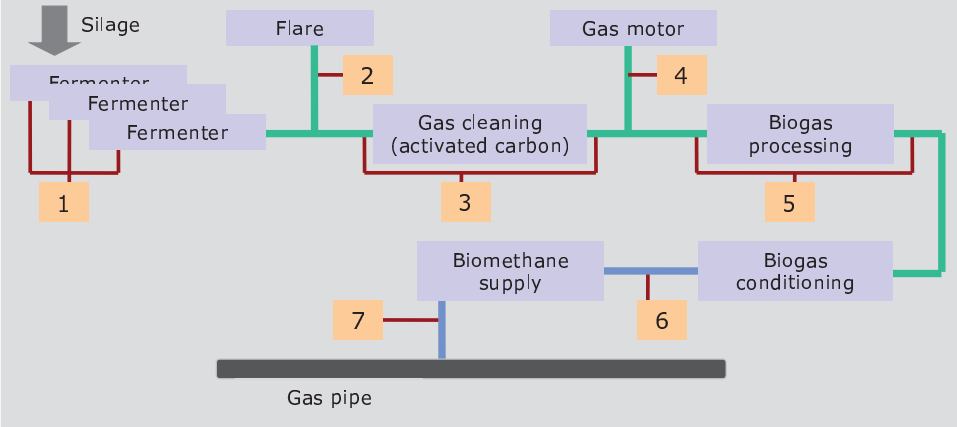


Figure 9: Use of INCA in a biogas plant

Figure 10: INCA installation

Measuring point	Position and application	Special suitability of INCA
1	At the fermenters, the composition of the saturated raw biogas is determined in different spots. This provides important information about how the process flows.	Robust stainless steel valves controlled by compressed air and a sample gas cooler with vacuum drainage allow direct sampling of the gases from the fermenters. This drainage keeps the lines clean and free from condensate.
2	At the inlet to the flare, the frequently fluctuating gas composition is determined for emission monitoring purposes and the functions and/or saturation of the activated carbon filter are monitored.	The upstream sample gas cooler ensures reliable analysis of the condensate laden (saturated) gas.
3	Upstream and downstream of the gas cleaning (removal of H_2S), the gas composition is determined and thus function and/or saturation of the activated carbon filter are monitored.	The patented p ulse function allows for precise determination of H_2S upstream and downstream the gas cleaning (with measuring point changeover) despite the high difference in concentration
4	A gas engine needs the monitoring of the gas quality to ensure the suitability of the gases before combustion.	The CH_4 determination ensures reliable start and operation of the gas engine. The H_2S determination ensures optimal protection for gas engine and its exhaust system.
5	Upstream and downstream the biogas processing, the gas composition is determined. This monitors the biogas optimisation at this critical phase.	The flexible IR measuring ranges allow adjustment of the device optimally to the different gas source (raw biogas, biomethane, offgas) as well as to the requirements of the different processing procedures (diaphragm technology, water scrubber, amine scrubber or others).
6	In the conditioning unit, the biogas is monitored for dryness, pressure and heating value to ensure that it meets the specifications required for feeding it into a natural gas network.	The selectivity of the IR measurement technology allows for continuous measurement of both methane and propane in conditioned bio natural gas.
7	At the supply point into the natural gas network, the biogas properties can be quality checked one last time.	The ATEX-approved version for use in explosive atmospheres can measure all relevant parameters in the gas supply system.

Figure 11: INCA performance in a biogas plant

Union Instruments

Corporation, presence of market, service

UNION Instruments is a German company founded in 1919 with headquarters in Karlsruhe and another location in Lübeck. Their activities are characterised by the fast pace of innovations concentrating on gas measurement technology in the process industry within the fields of calorimetry (energy content of gases) and gas analysis (composition of gases).

With sales activities in 20 countries, UNION Instruments displays a wide and ever increasing market presence. Apart from the European countries, China and the US are in our focus where we have a high market share in the pertinent market segments.
Sales is primarily done via distributors. With modern means of communication and the readiness for intensive travel, our German specialists' knowledge is available world-wide to all interested customers.

Figure 12: UNION Instruments, device calibration

Advice before procurement

The modular design of the UNION devices allows for customer-specific equipment. To use this potential to the full, we recommend clarifying the future tasks before procurement: For this purpose, UNION Instruments provides qualified specialists with years of practical experience in these applications.

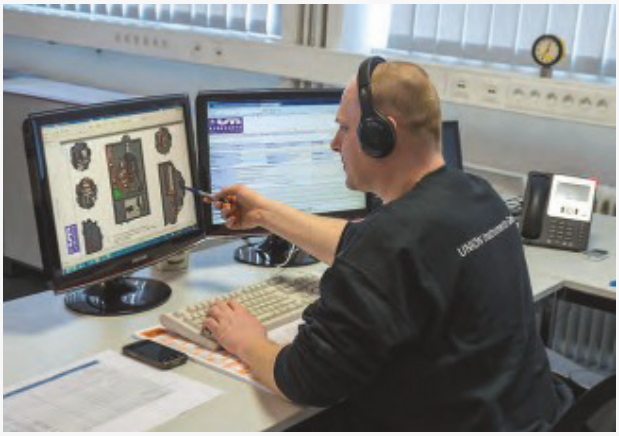


Figure 13: UNION Instruments, customer support

Support after procurement

Even the best designed technology will not survive without qualified service over its long service life. UNION Instruments offers a tiered concept:

- Service on-site by regional, well-trained technicians. The number of countries with that service is continuously expanding.
- Service from the German locations have technicians ready for by world-wide travel. Such assignments are at the same time used to support and train the regional technicians.
- Remote maintenance from Germany with modern tools per mobile telephone and/or internet.

Spare parts service is optimised for rapid dispatch and a range spare part kits and service contracts complete the service range offered by UNION Instruments.

Training at initial startup and in central courses

Even the most advanced devices can only be most useful if handled properly. The corresponding training sessions are intended to support the supplied documentation and are today part of the scope of delivery of our sophisticated measurement technology. UNION Instruments offers direct training sessions during the initial startup and addition or alternative central training courses for different specific topics.

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