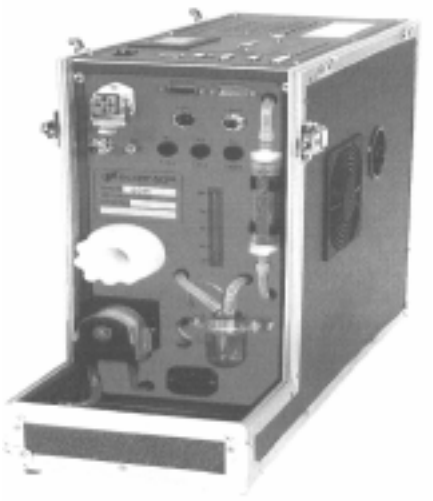
Instruction manual



Emission Analysing System

rbr-ecom-SG PLUS

rbr-ecom®

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Dear User,

Please receive our congratulations concerning your decision to use the emission analysing computer rbr-ecom-SG Plus, a device of highest quality.

The rbr-ecom-SGPlus is a compact emission analysing system and especially designed for quasi-continuous use. A multi-point temperature compensation method and furthermore leading technique for diminution of cross-sensitivities offer a high rate of security for the analysis of pollutant emissions. A gas processing system especially tuned for electrochemical sensors guarantees long-time stability and accuracy of measurement.

In connection with the integrated software for measurement data recording and evaluation, substantial criterions of the TA-Luft can be integrated into the automatic function. Mean values determination with freely programmable integration times, the consideration of minimum times for measurement data recording, freely eligible O2-min limits as well as individual programming of limit values belong to the standard functions of this allround device software.

So as to avoid losses, especially with gases such as sulphur dioxide and nitrogen oxids, the use of a more costly technique for gas sampling and gas processing is necessary. The optional gas sampling system consists of a stainless steel tube, a robust installation flange, a heated probe head with integrated filter and a heated sampling hose. Probe pipe and sampling hose can be delivered in different lengths. According to the demands of a compact measuring system the gas processing technique of the emission analysing system is integrated into the housing of the analysing computer. It consists of transport, filtering, cooling and drying of sampled gases as well as of the adjustment for the heated sampling gas line and the probe head.

The emission analysing system rbr-ecom-SG Plus can work on up to ten different temperatures or other analog input signals at a time.

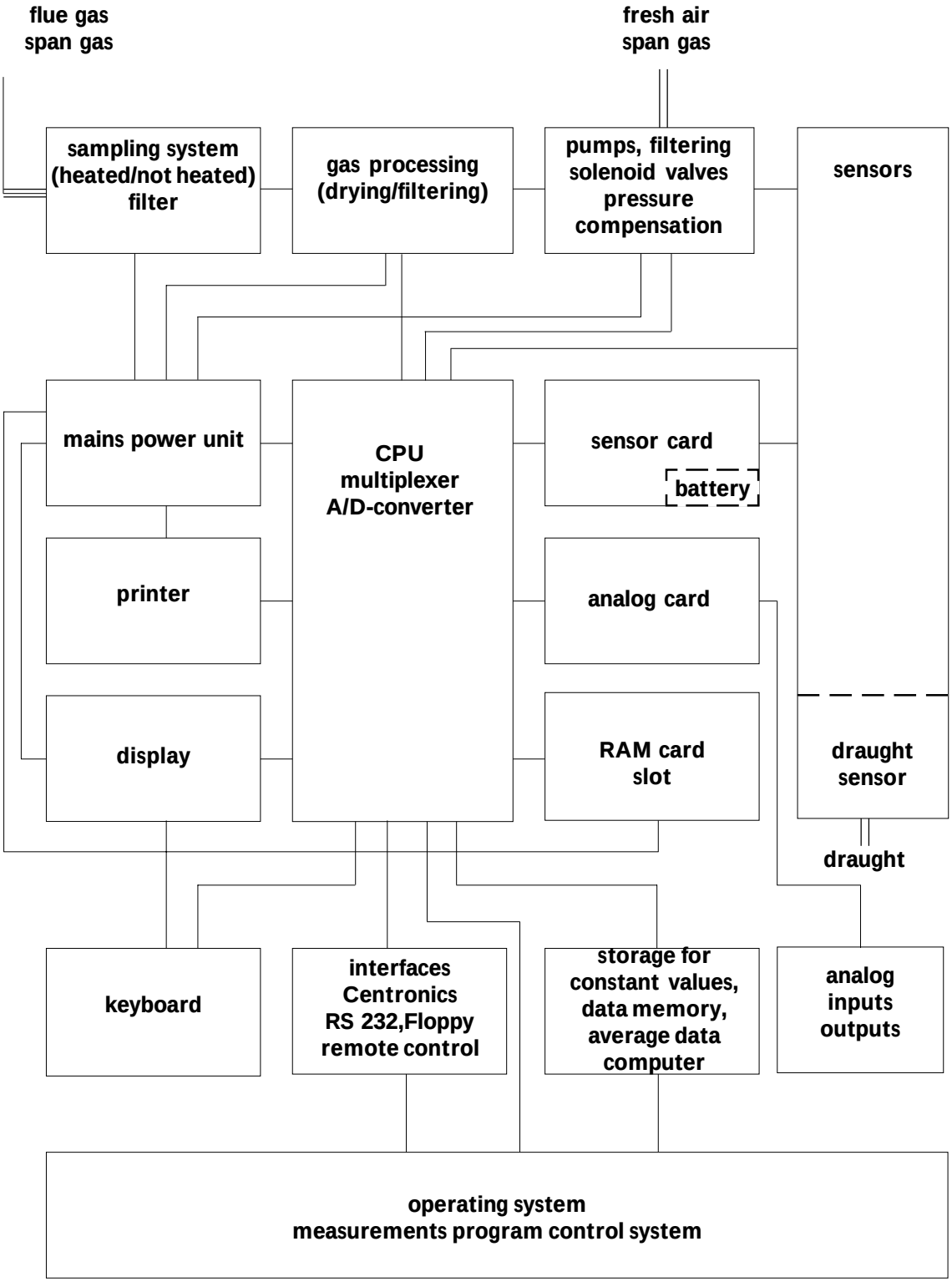
With its extraordinary features of performance this analysing system offers - with simultaneous mobility - speedy set-up times and a low expenditure on maintenance.

The system rbr-ecom-SG Plus can thus be used for multiple applications for the fully automatic analysis of toxic emissions. It combines a maximum rate of accuracy with high operating comfort and is an economical and flexible alternative to in-situ installations.

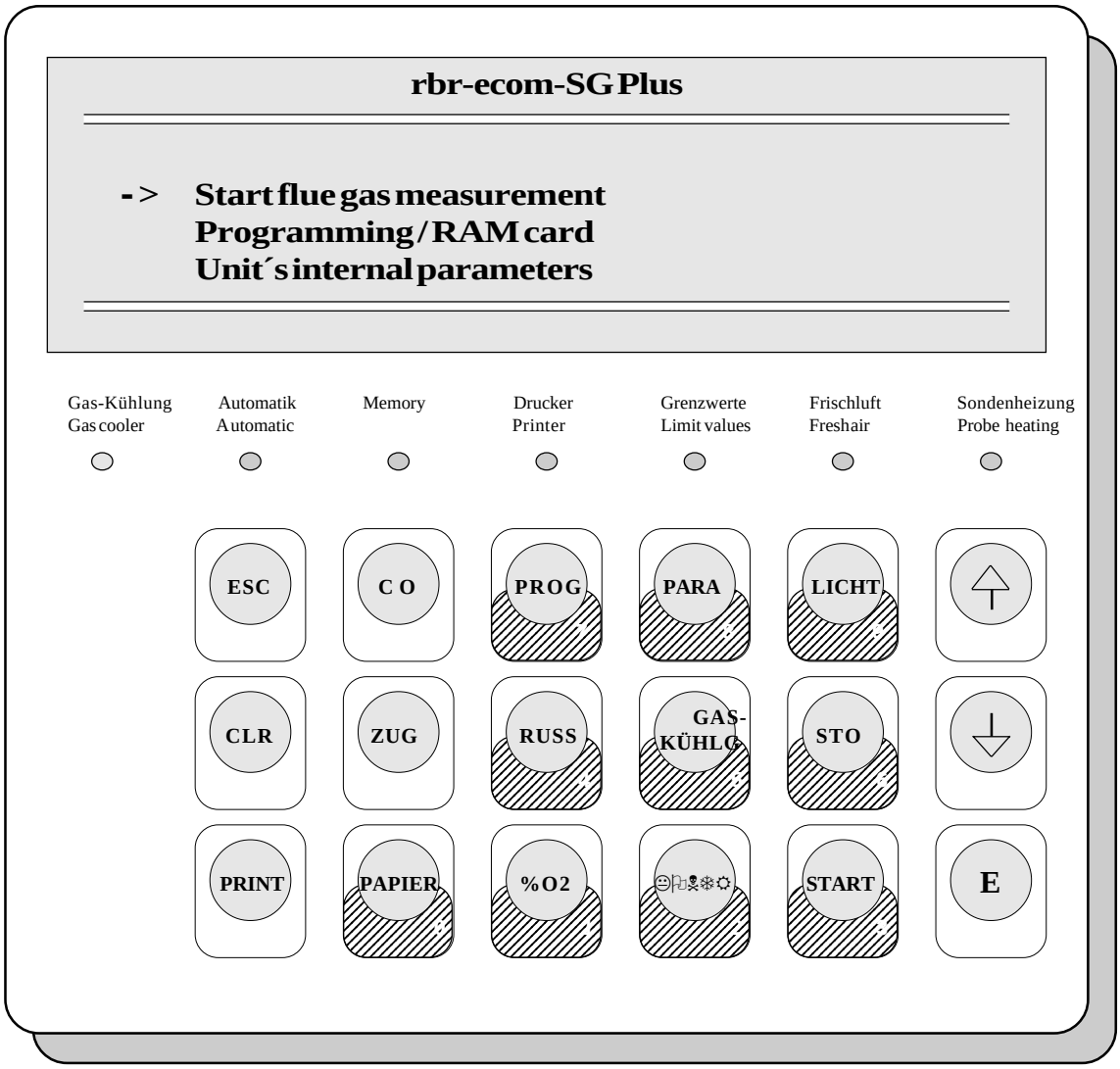
Sincerely Yours,

INDEX

Block diagram ecom®-SG PLUS



Display and keyboard unit - Front view



The emission analysing system rbr-ecom-SG Plus has a 8-line backlit LCD-display with each 30 characters a line.

7 LEDs under the display are designed for the status and control indication of the unit´s functions. The LED for "Automatik = automatic", "Memory" and "Drucker = printer" are only effective in automatic operation.

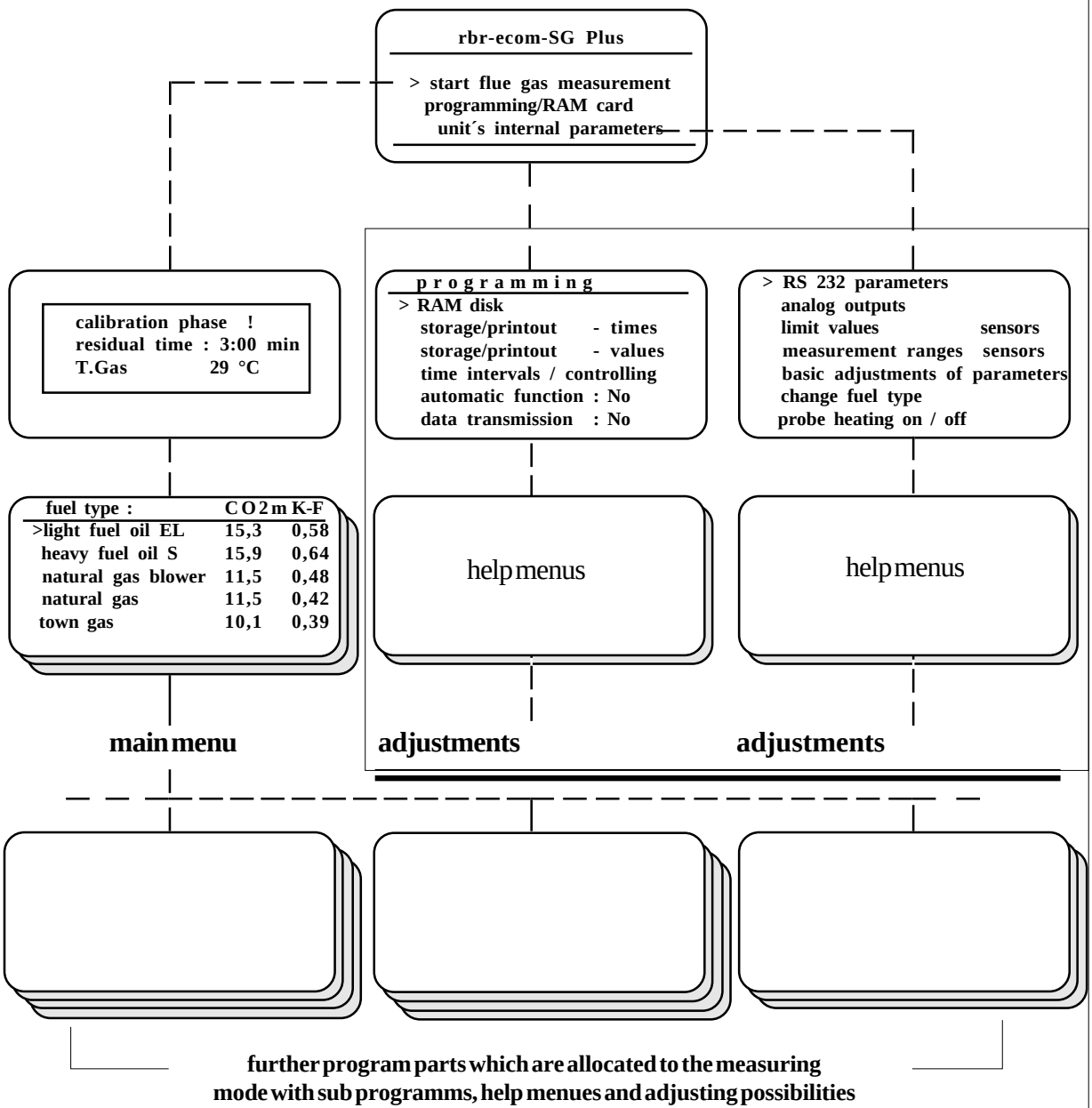
The input field is a 18-key key pad with short-stroke keys. It is differentiated between keys with a control function (<ESC>, <CLR>, <E> and keys with arrows) and keys with program functions (all others). In their second function, some keys offer the possibility of numerical input. The program of the SG-Plus differentiates between the numerical and the functional input according to the program control section.

Erratic keyboard inputs will not be accepted or just be ignored, a damage of the instrument will thus not occur.

Program Structure of the ECOM-SG-Plus

The emission analysing system rbr-ecom-SG Plus has of an intensively structured internal program which branches several times. The single program parts are allocated to several levels so that these can each be quit again by single or repeated use of the key <ESC> and a return to the main menu will follow.
A numerical input is always only possible in the lowest level of the corresponding program control section and is confirmed with <E>.

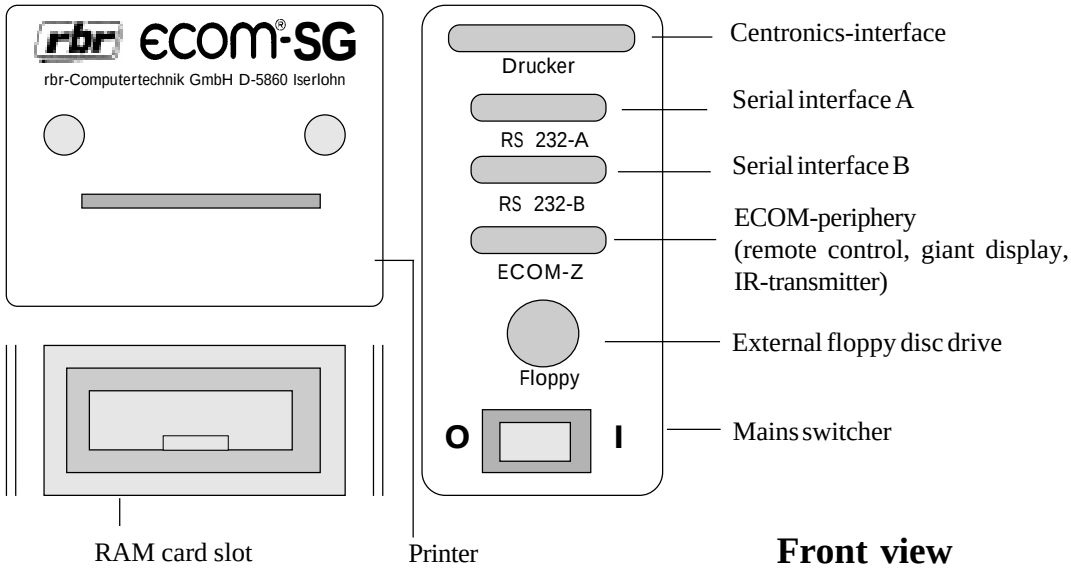
After switch-on parameters and basic adjustments can be performed even before measurement. A change over to measuring function is here always and only possible by means of the calibration



All program parts can be accessed directly with the operational keys as <ZUG>, <RUSS>, <PROG> and others. Further branching is then menu-controlled.

Interfaces and Peripheral Connection Possibilities

Besides the values measured and calculated by the emission analysing system rbr-ecom-SGPlus, further values which have to be entered over the analog input can be handled and integrated into the data record.
2 serial and 1 parallel interface allow the access to data already during measuring operation (online), a 8-channel measuring data recorder can be connected by means of the analog output.
The connections on the front and side board of the device have the following structure/purpose:



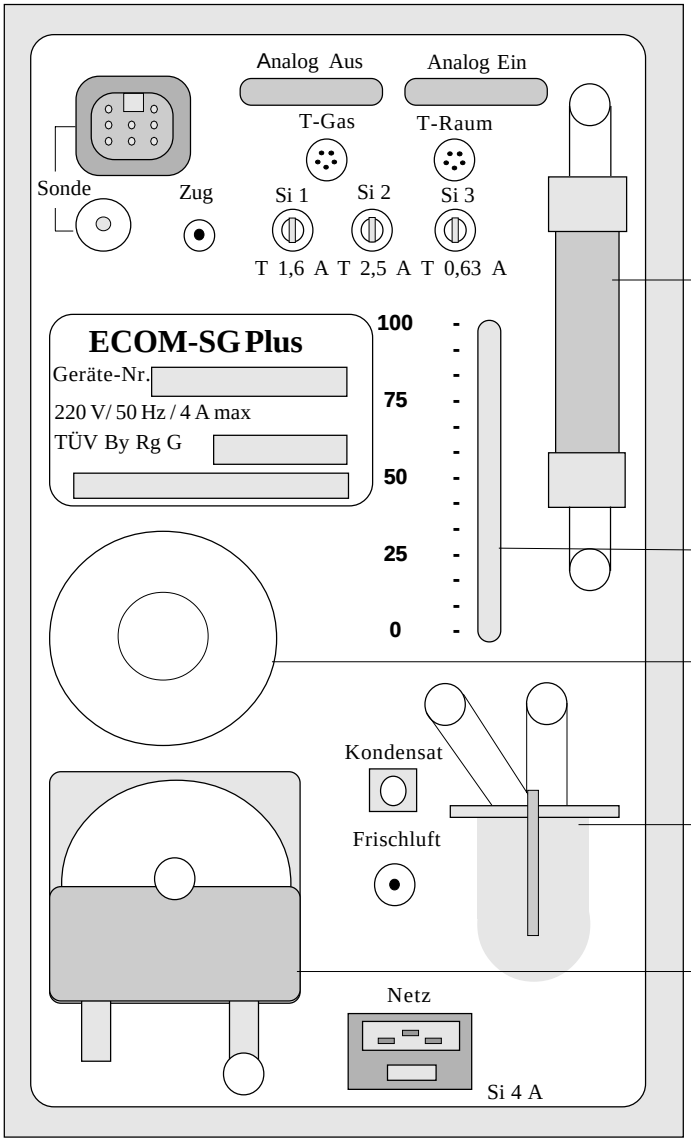
Front view

Parallel and serial interfaces as well as the connecting socket for accessory rbr-ecom devices are constructed as standardized SUB-D-connections (Centronics = 25-channel socket, serial A and B = 9-channel socket). A detailed description of the accessory devices is to be found in chapter "Additional Devices for the rbr-ecom-SG Plus" (page 36).

The printer integrated into the instrument is a matrix printer with 58 mm width of paper. The paper box is designed for currently available printer rolls of 58 mm x 25 m.

The emission analysing system rbr-ecom-SG Plus has been equipped with a RAM card slot for a secure and shock independent recording of data. The RAM card writing and reading system can work with memory cards of 8 kB up to 4 MB and is furthermore able to format RAM cards and delete these completely or partially. The minimum interval rate of data memory is 1 second.
For data read-out for subsequent processing on a PC, rbr Computertechnik GmbH offers an external memory card reader which enables a transfer of data from the RAM card by means of the serial interface when connected with the PC.

Generally all data sent and stored have ASCII-format so that further processing can be universally done with a large number of existing standard software.
Furthermore a software especially developped for the rbr-ecom-SG Plus belongs to the standard delivery package.



Si= fuse 1 - probe heating
Si= fuse 2 - heatable hose
Si= fuse 3 - heated head of the sampling system

SO2/NOx-filter
(is only located in the gas path of the CO-sensor)

Electronic flow indicator

Particle filter
(micro glass fiber or PTFE)

Condensation trap with liquid detector

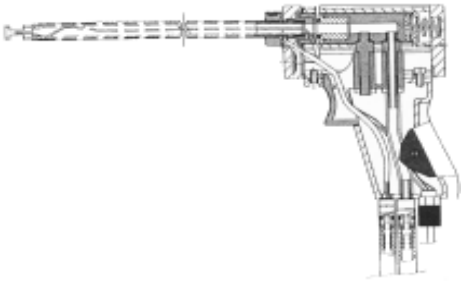
Peristaltic pump for continuous condensate evacuation

Side view

The connections for the analog channels (analog out = 15-channel SUB-D-socket, analog in = 15-channel SUB-D-plug) as well as for the sampling system are located on the side board. To avoid confusion, the connections for the flue gas and room temperature sensors are designed as 5-channel diode socket or plug. The mains power supply connector is designed as appliance tip jack with integrated time-lag fuse (4 A).
The collecting pot of the condensation trap is equipped with a liquid detector which reacts when the filling height reaches appr. 1/3 of the pot. This detector is connected with the connection "Kondensat = condensate".
During the calibration and purging phases, the analyser sucks in ambiant air by means of the connection "Frischluft = fresh air". This connection can be fed with external fresh air in case of need (e.g. if surrounding air is polluted and would cause erratic results).
The connecting branch "Zug = chimney draught" is directly led to the draught sensor (expansion measuring bridge) and can only be used for draught measurement. When operating the heated sampling system, a separate sampling tube has to be used.

Sampling System and Gas Processing

The sampling system serves for the transport of sampled gas from the collection place to the analyser. According to the measurement requirements, different sampling systems can thus be used.



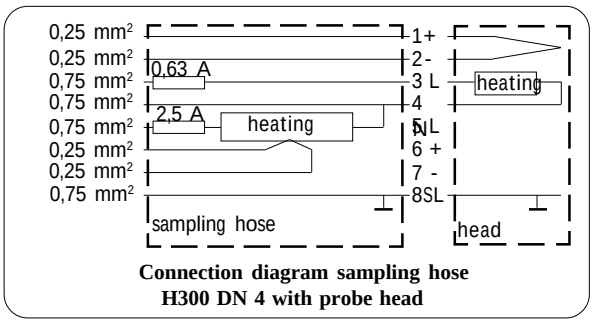
A measurement without gas processing is possible for spot analysis of emission concentrations of the CO, CO2, O2 values as well as of the calculated efficiency, losses and excess air values.
The pistol grip probe with 3-chamber sampling hose is the suitable sampling tool for this application.
It fits as well for a chimney draught measurement, as it fea
for gas analysis, 1 tube for draught measurement and 1 tube with cable for the electrical connection of the probe heating".

With this sampling technique no gas processing is performed.
Condensate will form within the sampling hose of the probe which will be removed by the constantly working peristaltic pump.
But, as there is no regulation of the complete sampling system by the gas heat exchanger, condensate may drop into the water catchpot due to the suction of the pump. The pump is automatically switched off by a level sensor when a certain quantity of condensate (appr. 1 cl) has been collected in the water catchpot, as otherwise it cannot be guaranteed that the sensors are carefully protected against humidity (drops and aerosoles). Signalling and advice are simultaneously displayed. The water catchpot has then to be emptied and screwed on again. After a delay time of appr. 10 seconds, the pump will be swiched on again.

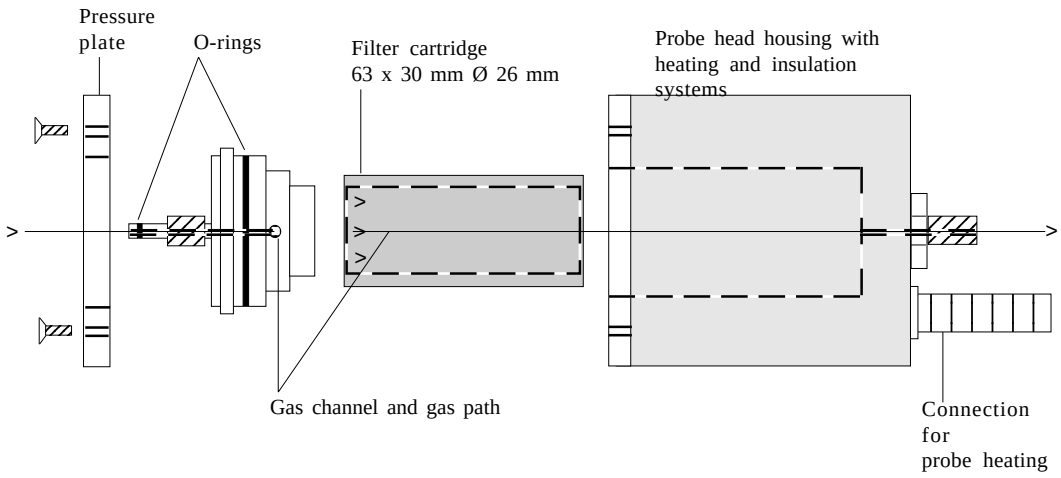
The main application purpose of the emission analysing system rbr-ecom-SG Plus is **the gas analysis with gas processing**. This guarantees constant conditioning of the sampling gas on its way to the sensor and thus stable measurement results. Losses by washing out, especially for the substances NO, NO_2 and SO_2, can consequently be avoided.

The heated sampling system is an optional accessory and will be delivered according to your requirements.
The standard length of the heated hose is 3 m (alternative 4 m, 5 m, 6 m and 10 m), the probe tube for the heated head is to be screwed on the head and is delivered in the standard length 300 mm, Ø 8 mm (alternative 500 mm, 700 mm, 1000 mm and 1500 mm).
A norm flange of 160 mm (DIN 2527, version B) serves for fixing at the sampling place.
A preliminary filtering of the measurement gas is performed in the heated probe head by means of a micro glass fiber filter (standard for particle size 20 µm). Alternatively as PTFE filter available.
The sampling system can be heated up to + 170 °C, thus separately for sampling hose and for the probe head.

The heating is pulsed by the mains power unit of the analyser and supervised by Ni-Cr/Ni temperature sensors. The connections hose/analyser and hose/probe head are made of quality stainless-steel (1.4305) with crimp threaded joint. (Swagelok 14 mm on analyser, 15 mm on probe head). For cleaning purposes and change of filter, the probe head can be dismantled. Through release of the hexagon socket screws on the connection side of the probe pipe, the filter adaptor piece can be removed from the probe head. The hexagon socket screws on the connection side of the heated hose allow the access to the probe head heating and to the heat insulation system of the head.



Connection diagram sampling hose H300 DN 4 with probe head

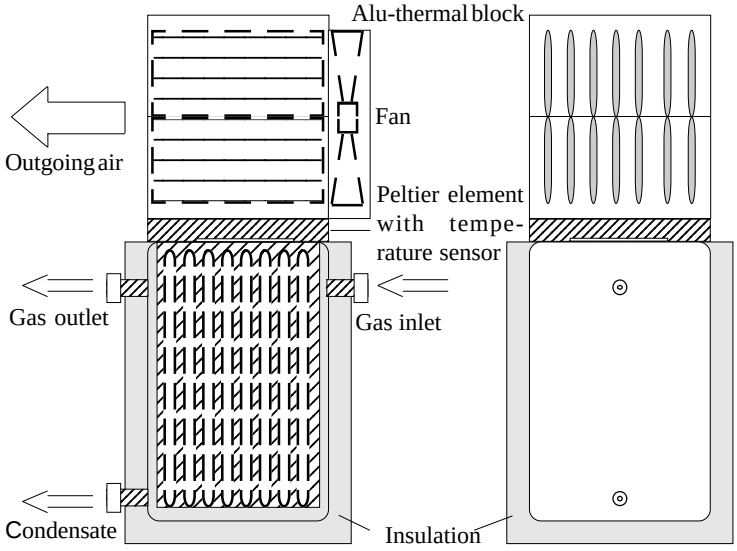


Heated probe head (partially dismounted)

The above picture illustrates the main parts of the probe head which have to be maintained more frequently. Besides the optical check of the filter cartridge, the flow indicator located at the side part of the measuring instrument serves as indicator for the wearing state of the filter.

Immediately after inlet into the measuring system, the sampled gas is led into the gas cooler. A reduction of gas temperature and dew point to a range of 5 - 10 °C is performed in the gas heat exchanger. This range is fixed and cannot be changed. A temperature control is made by the device itself. The LED "Gas-Kühlung = gas cooling" under the display flashes yellow when the gas cooler regulates, it flashes green when the gas cooler is regulated. The actual regulating status is as well indicated in the menu "Gas-Kühlung = gas cooling" (which can be entered while pressing the key <GAS-KÜHLUNG>).
The gas cooler is made of PVDF and heat insulated. It has a small dead volume (50 cm^3) by a large surface. Besides an efficient cooling capacity, the condensate formation is aided by a large number of turbulence points due to the gas channel path in meander form.

The heat draining is made by means of a Peltier element (np-change over from warm to cold) onto an aluminium thermal block with exhaust ventilation. The condensate is permanently sucked off by a peristaltic pump. The suction capacity can be adjusted by change of the number of revolutions per minute of the pump. The cooling capacity of the gas cooler is ascertained by surrounding temperatures of up to 35 °C.



Gas cooler (schematic), side and front view

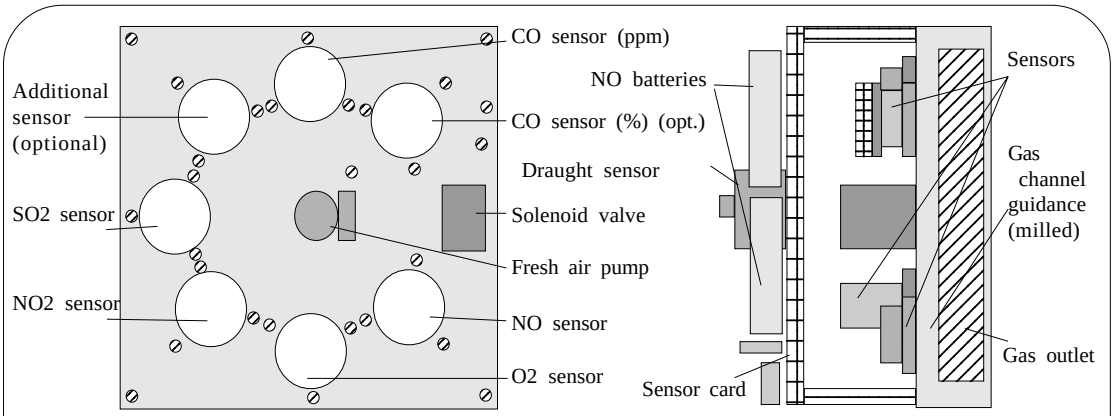
By means of further filters (micro glass fiber standard 2 µm, on request PTFE; in the gas path of the CO sensor through a chemical filter for binding SO_2 and NOx), the sampled gas is then led to appliances for gas distribution and pressure compensation. The electrochemical sensors used in the instrument are flown with sampled gas either separately or in groups. The change-over or switch-off of single sensors is made manually (key <CO> for the CO-sensor) or automatically according to presetting, limit values and ratings for the sensors. After switching off one or several sensors, the latest receive fresh air by means of a separate pump and are freed from gas.

Sensor Technology and Recording of Measured Values

Gas sensors

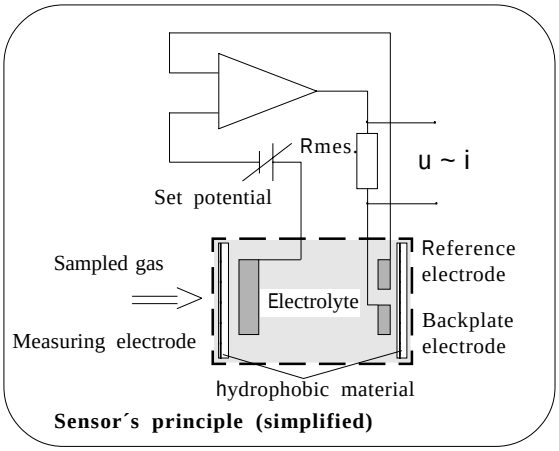
Different transducers are used in the emission analysing system rbr-ecom-SG Plus.
Core piece is the sensor bench with electrochemical cells for gas analysis. In its standard version, the instrument has 5 electrochemical sensors and can, optionally, be enlarged by two further sensors (both for other gas types as well as for other measuring ranges). For determination of the oxygen concentration in the measurement gas, a sensor is used which in its functional principle is similar to a diffusion restricted metal/air-battery. The rate of the existing oxygen concentration to be measured defines the reaction velocity and the rate of the output signal of the measuring cell. Natural wear and tear and loss of capacity limit the life span of the cell to appr. 1 - 1 ½ years (dependent on measurement time, concentration and purity). The functional principle of the toxic sensors for CO, NO, NO2 and SO2 is somewhat different. These sensors are made as 3- or 4-electrode sensors at the minimum in order to compensate falsification of measurement data through cross-sensitivities and other disturbance sources. Furthermore, the current temperature of the sensor bench´s surroundings is noted and serves as base for the compensation of temperature sensitivities of the sensors. The analog output signals corresponding to the concentration (current signal or voltage level over multiplier) are callipered at the sensor and converted in the analog-digital converter.

Plausibility check and linearisation are permanently made by the software and this specifically corresponding to the concrete characteristic curve of the sensor. Hereby the consideration of the current signals of the other sensors is secured so that the adjustment of the complete sensor bench has to be made even if only one single toxic sensor is exchanged.
The toxic sensors themselves do not consume own stuff components for the electrochemical analysis reaction. The reduction of water used at the measuring electrode (anode) is performed



Sensor bench (simplified), top and side view with sensor

at the backplate electrode (normally the cathode) so that, totally, a Redox reaction occurs. Because of this, these sensors reach a longer life span (appr. 3 years). The life span is mainly dependent on the concentration of the sampled gas (consequence: current conduction at the electrodes), on the soiling of the sampled gas (consequences: impurity of the capillaries) and on the general storage and operating conditions of the sensor (consequences: drying out). Controlled by the electronics, a reference electrode guarantees constant conditions between measuring and backplate electrode. As electrochemical sensors mostly do not work exactly in a selective manner, reactions to others than the gas to be measured can result in signal variations (cross sensitivities). By some sensors, these can be registered by means of a secondary electrode. Together with the signal behaviour of the neighboured sensors, an efficient compensation of those cross-sensitivities can herewith be secured.



Sensor´s principle (simplified)

The complete sensor bench including the control electronics can be replaced for service and repair purposes. The batteries for the current supply of the NO sensor which has to be secured permanently to avoid a drift of the NO sensor are as well located on the sensor bench. The complete sensor module is mounted in a separate casing. The measuring sensors for the determination of the real sensor temperature are sticked directly onto the sensors.

Draught sensor

An extension measuring bridge for the measurement range -20 hPa < chimney draught/ pressure < + 20 hPA is used as draught sensor which -in this range- shows a very exact and linear measuring function course. Any exceeding of the measurement range results very quickly in the mechanical destruction of the sensor! This sensor receives its measuring signal

by means of a separate channel without intermediate switch of piece parts, so that either the current sampling probe or a simple probe pipe with hose has to be used to perform a draught measurement.

Temperatures
The temperature measurement is performed by thermoelements. A PTC element (0-99 °C) is used for the T-room measurement, a Ni/Cr-Ni temperature probe (0 - 1200 °C, limited by the software to 999 °C) is used for the T-gas measurement.

Further measurements
Besides these measured values determined by the rbr-ecom-SG Plus itself, up to 8 further series of measurement as analog signals (0 - 10 V; 0 - 20 mA) can be input by means of the 8-channel analog input, which then will be integrated into the data record of the instrument and into the calculation of mean values.

Storage for Constant Values, Data Memory and Timing

The emission analysing system rbr-ecom-SG Plus has several internal memories which, according to their application, have different data stocks.
The system itself has no measurement data memory where these would remain stored after switch-off. The comprehensive periphery instrumentation is dedicated to the external storage.

The storage for constant values covers the characteristic curve data in one range and, in another range, the adjustment data of the complete system. By means of a special technology, the sensor technique is prepared for the measurement work in a climatic chamber and the characteristic curves of the single sensors are recorded. The results of this procedure lasting several days serve as base for the measuring behaviour and for the subsequent adjustment of the sensors by means of test gas. They are recorded into the storage for constant values. Users have no access to this storage.

The values for the zeroing of the sensors (fresh air => 20.93 % oxygen and zero concentration for the toxic gases) after the calibration phase are recorded as reference values into the range of adjustment data after each switch-on of the analyser. These values can be called up and checked (key <KONTR>) but not altered. You can alter data for the adjustment of the values in the middle and upper range of the characteristic curve which are determined by means of test gas in a special adjustment mode and record them into the memory as new values. As user you have herewith the possibility to prepare the system or single sensors to their measuring work within their measurement range respectively to control the measurement accuracy at any time by means of test gas. Further explanations are to be found in chapter “Operating Instruction” and “Maintenance and Calibration” (page 33).
Measured values determined by the analyser can be stored into a temporary memory (key <STO>) where they remain available for a printed report by the integrated data printer until the analyser is switched off. In automatic operation, the mean value calculator is available with its own temporary memory. Here all instantaneous values are collected and used for mean value calculation during the integration time. The size of this storage is fixed. In dependence on the integration time, the system calculates in which pulse period measured values are taken over out of which the mean value is calculated over the integral. The shortest time pulse is 1 second.

Especially for the automatic operation, the analyser needs several time settings to control the recording of measured values and the calculation of mean values.
These times or time intervals are:

Automatic time	- time period from one calibration phase to the next in automatic operation (after reaching tAutom. a calibration phase is performed, then the next automatic period)
Measuring time	- period of recording of measured values within an automatic time (tMeas </= tAutom; when reaching tMeas the system switches over to the purging and stand-by phase until tAutom is reached)
Integration time	- time period in which the integral (mean value) should be determined (tInteg < tMeas)
Minimum time	- period of the integration time in which at the minimum plausible (realistic) measured values have to be presented so that the mean value is accepted (normally 2/3 of integration time)
Delay of integration	- period of delay time of the recording of measured values to avoid falsification of measured data by dilution of measurement gas during former calibration phases. This time corresponds to the duration of sampled gas transport to the sensor and can be altered in dependence on the length of the sampling system.

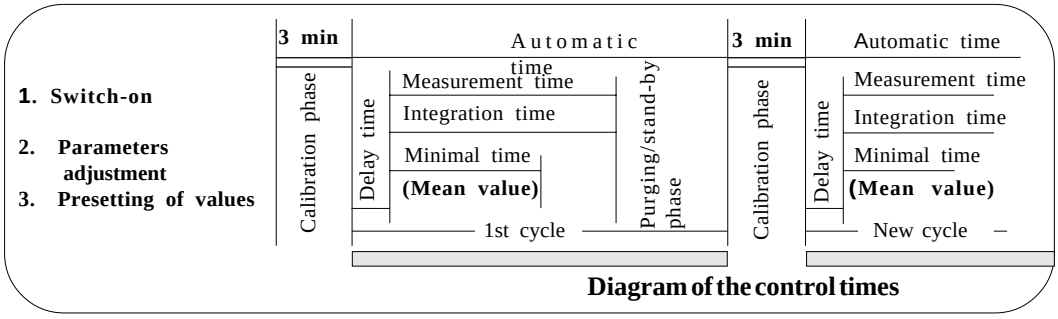


Diagram of the control times

A basic adjustment orientated towards the TA-Luft requirements is stored in the instrument. This can be called up and activated at any time by means of the RESET-function.

The menu-controlled program guidance enables an access to all adjusted parameters and values during a measurement action without interrupting the measuring operation. Thus with exception of the keys “ZUG” and “RUSS”.

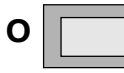
An alteration of the parameters and adjustments for the automatic operation is only effective if an eventual working automatic period is or has been finished.

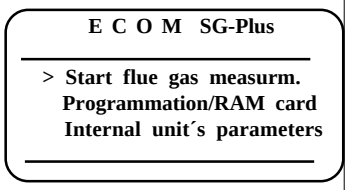
Operation of the rbr-ecom-SG Plus

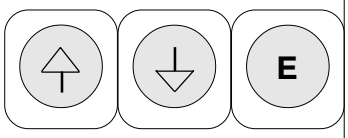
The preparation of the emission analysing system for measuring work is done by installing the sampling system required for the corresponding measuring work (pistol grip probe, heated sampling system) at the measurement point and performing all necessary connections to the analyser. T-Gas and T-Room sensors must be connected, otherwise no calculation of efficiency and losses can be made and the program announces an error
Shouldn't you need these calculation values, so dummy plugs can be used instead of temperature sensors which simulate the temperature recording.

The following connections must be performed:
- mains power 220 V ~
- condensate
- probe
- T-Gas
- T-Raum

Switch on the analyser and select out of the menu the desired operation mode with the cursor. Confirm this selection with <E>. After switch-on, both the gas cooler and the peristaltic pump work constantly, thus regardless of the selected operation mode. The use of the key <E> starts the measuring gas pump. In the operation mode "Flue gas measurement", suctioning is performed over the fresh air inlet during the calibrating phase. Any change over to the measuring mode is only possible by means of the calibration phase of the menu "Flue gas measurement".

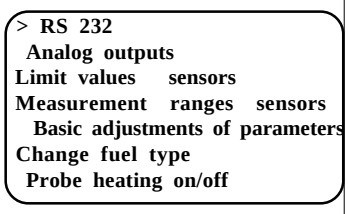






1. Internal Unit´s Parameters

This program branch enables the preadjustment of some unit´s parameters prior to a measurement or the reset of selected adjustments to the standard values. In detail you can call up each line with the cursor and activate the adjusting mode by the key <E>.



1.1. RS 232

By means of the integrated RS 232 interface, the data transmission is performed with the standardised options:

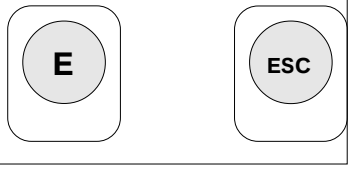
The transmission rate can be changed in the steps:

-300	- 4800
-600	- 7200
-1200	- 9600
-1050	- 38400
-2400	

- 8 Bit
- 1 Stopbit
- no parity

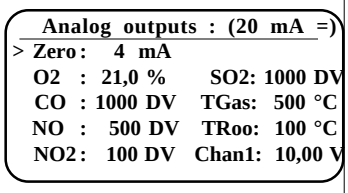
The adjustment is altered with <E>. <ESC> returns to the menu.

Please consult the technical documentation enclosed to the periphery to be connected with the RS 232 to select the parameter you will need. Basic adjustment is 9600 Baud.



1.2. Analog Outputs

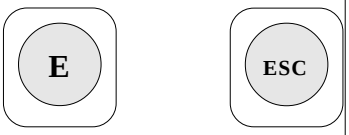
A measurement data recorder for analog signal recording can be connected by means of the 8-channel analog output at the side of the analyser. The output signals for O_2, CO, NO, NO_2, SO_2, T-Gas, T-Room are transferred in the options 0-20mA/0-10V and one free channel. Within these limits the transmission conditions can be adjusted by yourself, the "Zero" in the first line is the offset.
The adjustment is performed by selecting the line with the cursor, input of the corresponding digits by means of the numerical keyboard and confirmation with <E>. With <ESC> you change over again to the upper menu level.

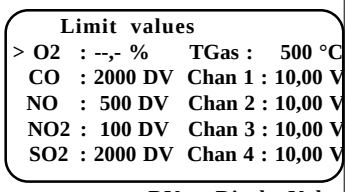


DV = DisplayValue (ppm or mg/m3)

1.3. Limit Values of Sensors

The electrochemical sensors are designed for a maximum measurement range (see § 1.4. Measurement Ranges of Sensors) which should not be exceeded. Within this range, you can preset limit values for each sensor as well as for 4 free channels where an optical and acoustical alarm will be released when these are exceeded.
The limit value for the oxygen sensor is a "low limit" one. An alarm for O_2 is released when the value is not reached. The recording of measured values will hereby not be interrupted, there will only follow a signalisation. The display indication of the sensor or channel for which the limit value has been exceeded flashes (for O_2 = low limit). The signalisation can be stopped by purging the sensor or increasing its limit value. The adjustment of the preset values is made according to the same principle as already described: with the cursor you select the place of input, overwrite the digits via the numerical keyboard and terminate the input with <E>.
<ESC> leaves this section and turns back to the upper menu level.

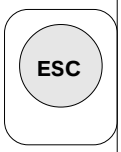


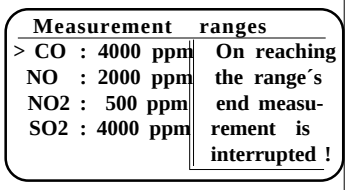


DV = DisplayValue (ppm or mg/m3)

1.4. Measurement Ranges of Sensors

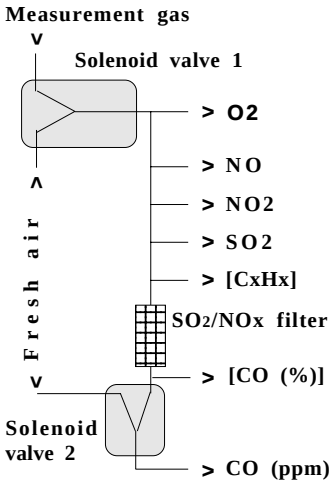
The adjustment menu "measurement ranges" enables a range limitation within the technically given maximum measurement range of the sensor. The sensor is switched off from the sampled gas flow and is supplied with fresh air (purging phase) if one of the adjusted value is reached.
An exception is here to the CO sensor. The analyser has in its standard version a CO sensor with a measurement range up to 4,000 ppm. Is this value (or a smaller value preset in the menu) exceeded, so this sensor is purged with fresh air without measurement interruption. Solenoid valve 2 is switched on. The CO sensor has a separate gas channel through which it can be switched on or off independently on the sensor bench (see key <CO>). The display only shows dashes after switching off the CO sensor.





The analyser can furthermore optionally be equipped with an additional CO sensor (0-6.3 % measurement range).
In this case, the measured value of the %sensor is displayed in after the ppm-sensor has been switched off. The indication is in ppm (1 % = 10.000 ppm). The resolution of the sensor is 0,1 % (1.000 ppm). For this sensor, the indication of measurement values is extrapolated by the software so that the indication is more differentiated than the real resolution of the sensor. For the CO sensor, the measurement range can be adjusted to max. 6.3 % (63.000 ppm). This should only be a theoretical possibility as the adjustment value should be used as switching value for switching over from ppm to %.

The change-over from the indication of the ppm-sensor to that of the %sensor is fluent as the %sensor already receives sampled gas before use of its output signal. Is the CO concentration decreasing from the %-range into the ppm-range, a short-time discontinuity in the determination of measured values will occur.
The ppm sensor is purged with fresh air during the operation of the % sensor (purging to a threshold value of <2.000 ppm) respectively it is cut off from the gas flow if this threshold value and the % sensor is still working. If the CO concentration as well falls down to the threshold value of 2.000 ppm, a solenoid valve switches on the ppm sensor into the gas path and the indication of the % sensor is switched off. In the switch moment of the solenoid valve, the ppm sensor is flown for a short time with diluted or enriched sampled gas (according to the tendency of the CO concentration) from the gas channel and the filter chambers. After a short adjustment period, the real momentaneous gas concentration can be found in the gas path of the ppm-sensor and is then displayed.



Is one of the other adjusted values of the sensors exceeded by the real gas concentration, the solenoid valve 1 switches on and purges the complete sensor bench with fresh air.

The purpose of this measurement range limitation is the possibility to protect the sensors against too high concentrations due to sudden and short time operating conditions of the installation to be checked.

1.5. Basic Adjustments of Parameters

This menu includes the RESET function for backspacing of all presettings of times and values for the program flow of the emission analysing system. A list of all basic adjustments is to be found in the appendix to this operation instruction manual.

1.6. Fuel Types

15 fuel types at a total can be stored in the storage for constant values. These factors serve as base for the calculation of the CO_2 concentration as well as for the losses/efficiency.
Hereby 2 groups of fuel types are generally differentiated:
- 10 fuel types with a calculation according to the SIEGERT formula (K-factor)
- 5 fuel types with a calculation according to BImSchV (instead of the K-factor the factors A1, A2 and B are used)

Among the 10 fuel types according SIEGERT, one free choice capability for CO_{2max} and K-factor is offered which enables emission measurements by installations fired with extra fuel types. Just the input of the CO_{2max} value is necessary, the K-factor is then extrapolated and suggested. It can thus be confirmed or - when the specific K-factor is known as well and differs from the suggested one - be changed.

A list of the most important formula used can be found in the appendix.

Fuel types and factors

SIEGERT

	CO2max	K-factor
Liquid gas	13,8	0,52
Hard coal	19,5	0,68
Coke	18,8	0,75
Wood (dry)	20,9	0,69
Light f. oil EL	15,3	0,58
Heavy f. oil S	15,9	0,64
Nat. gas bl.	11,5	0,48
Natural gas	11,5	0,42
Town gas	10,1	0,39
Free choice	< >	< >

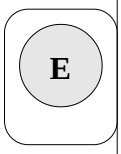
BImSchV

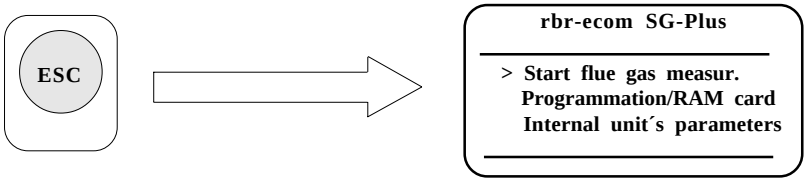
	CO2max
Light fuel oil (B)	15,4
Natural gas	11,8
Town gas	11,7
Coke oven gas	10,2
Liquid gas	14,0

1.7. Probe Heating On/Off

This display line is only dedicated to a switch function for the heating of the pistol grip probe, it does not cover any further submenu.
The key <E> activates the switch function, the current status is shown by the LED <Sondenheizung = probe heating> above the keyboard.
The power supply (30 V) for the probe heating is performed via the connector <T-Gas>.

With <ESC> you can leave this program branch and turn back to the main menu.





2. Programmation/RAM card

The second program branch after switch-on of the instrument is dedicated also to the presetting of some options for the automatic function of the emission analysing system rbr-ecom-SG Plus. While, as described in the previous chapter, the analyser with its switches has been prepared for the measuring work in the menu "Internal unit´s parameters", the data output and data storage are adjusted through external data carriers in this program branch.

```
P r o g r a m m a t i o n
> RAM disk
  Storage/printout     - times
  Storage/printout     - values
  Time intervals/controlling
  Automatic operation: No
  Data transmission  : No
```

The following apparatus can be used for the data output and the data storage:

- RS 232	- personal computer in online operation
	- giant display
- Centronics	- printer in online operation
- external floppy	- 3.5 " diskette drive (720 kB)
- analog outputs	- 8-channel measurement data recorder
- RAM card-slot	- RAM card (8 kB up to 4 MB)
- integral printer	

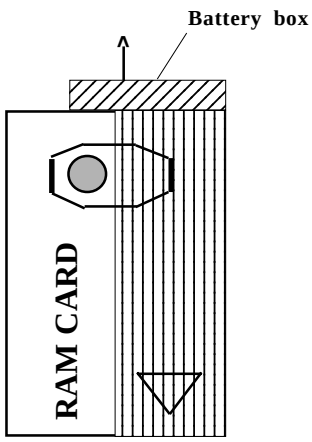
One or several of these data carriers can be used according to the needs. The options for controlling the data transfer can be adjusted in the following menues.

2.1. RAM disk

A RAM card (memory-card) is ideal for a troublefree data recording without additional device. In automatic operation, the storage of each one complete data record is made in a time pulse to be set by the user. A complete data transfer consists of an initialisation file, per time pulse each a values file and a termination file. A standard RAM card of 256 kB storage capacity can accept appr. 2.500 files of values which corresponds to appr. 7 hours recording of measured values by a 10-seconds. time pulse.

```
R A M  d i s k
> Storage R-Disk     : ------
  Format RAM disk
  Delete RAM sector
  RAM disk --> RS 232
  RAM R.  2   Occup.: 1,0  kB
  Batt.   OK  Card: 256  kB
```

"Format RAM disk" deletes all data on the RAM card and prepares the card for storage in case of first use. The formatting information needs appr. 1 kB storage place.
"Delete RAM sector" deletes the last written sector of the card.
The two lower lines of the display show the status lines for the RAM card which inform you about the number of reserved sections, allocated storage location, size of the card and state of the card battery.
With an external RAM card reader (ECOM-RL) the data can be transmitted from the RAM card into a PC by means of the serial interface or be sent to the PC over the slot of the analyser by means of the option RAM disk > RS 232.



The software necessary to read the data into the PC is standardly delivered with the rbr-ecom-RL. Already during reading, the data format can be converted into the necessary structure for further work (ECOM-software, currently available graphics software, ASCII-set of characters)

2.2 Storage/Printout - Times

In this menu the output pulse for the data output is selected:

```
Storage/printout
> Storage disk          : -----
  Output RS 232         : -----
  Printout Centronics   : -----
  Printout SG-P meas.v. : -----
```

- Storage disk = output pulse to diskette (3.5 “, 720 kB, DOS format) over the floppy

  Recommendation: >/= 20 seconds

- Output RS 232 = output pulse over the RS 232 to the periphery (e.g. PC)

  Recommendation: > /= 2 seconds

- Printout Centr. = output pulse for output to an external printer

  Recommendation: > /= 10 seconds

- Printout SG-P meas. values = output pulse for the integrated printer for output of a measurement data report

  Recommendation: > /= 1 minute

2.3 Storage/Printout - Values

```
Storage/printout
> Printout centr. mean values : No
  Printout centr. CO2... :      No
  Printout SG-P mean v.:        No
  Printout SG-P CO2... :        Yes
  Printout analog inputs :      No
  Storage analog inputs:        No
```

CO2... = momentaneous values of measured and calculated values of the SG-Plus

Here you make the presetting which data shall be printed through which output channels. You generally have the choice between an external matrix printer connected via the centronics interface and/or the integrated 58 mm printer of the SG-Plus. In combination of both printers, you herewith have the possibility to print transient values and mean values independently on each other, this over a fixed integration time.

The signals to be input through the 8-channel analog input can be integrated into the data record of the SG-Plus by storing them in the data output pulse by means of RAM card, external floppy or RS 232 together with the measured and calculated values of the SG-Plus. The printout of the analog signals is performed by the integrated printer.

The adjustment of the desired options is performed by selection of the corresponding line and YES/NO-adjustment with key <E>. <ESC> turns back to the upper menu.

2.4. Time Intervals/Controlling

```
Time intervals
> Automatic time      : 45:00 min
  Measurement time    : 45:00 min
  Integration time    : 30:00 min
  Minimal time        : 20:00 min
  Delay time          :  1:00 min
  O2 limit            : 10,00 %
```

Once you have selected the line “Time intervals/Control” with the cursor out of the menu “Programming/Ram card”, you will receive all interval times programmable for the SG-Plus for automatic measuring function (see as well chapter "Storage for constant values", "Data storage" and "Timing" page 13 and following ones.).
These times can be selected and adjusted individually (select with the cursor, perform numerical input and <E>) where the times depending on each other (measurement time to automatic time and minimal time to integration time) will automatically be switched when the corresponding superior time is programmed in a smaller value than the subordinate time. An exception is the adjustment of the integration/ minimal times in proportion to automatic/measurement time. It is then theoretically possible to build an integral over two or more automatic periods with exception of the times for the calibration phase.

tautom. >/= tmeas.
tinteg >/= tmin

The delay time is, as explained on page 14, the time of delay of the recording of measured values after start of the automatic period.
The O_2 limit serves as additional threshold value by the running automatic operation. Measured values are only included into the calculation of mean values if the adjusted limit value for O_2 is not reached. Otherwise the measured values are further stored or output, but they are not included into the mean value to be calculated. Consequently, it is possible to exclude short time disturbance functions as well as starting or stopping phases of an installation from the calculation of mean values.
All programmed times can be reset by means of the RESET function to the basic values as shown in above illustration.

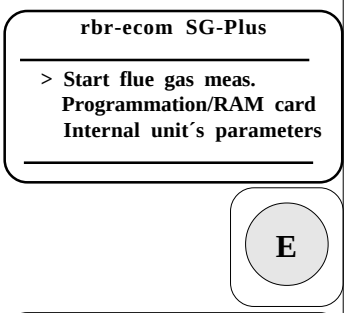
2.5. Automatic operation and Data Transfer

```
Programmation
> RAM disk
  Storage/printout    - times
  Storage/printout    - values
  Time intervals/controlling
  Automatic operation:  No
  Data transmission   :  No
```

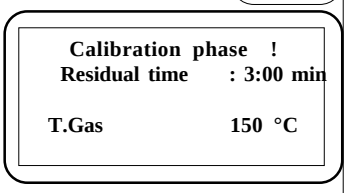
The lines “Automatic” and “Data Transfer” have no significance in this program branch as it is not possible to access the measurement function from this program branch.
Thus the switching functions “Automatic” and “Data transfer” can be performed but you will not receive an indication of measured values.
From the program branch “Start flue gas measurement” and after termination of the calibration phase of the analyser, you have access to all adjusting menues of the program branch “Programmation/RAM card”.
You can thus make a preadjustment of the variable parameters, perform the calibration phase with the necessary system check and over this menu, switch on the automatic mode and the data transfer.
Further explanations are to be found in the following chapter.

3. Flue Gas Analysis

To perform a flue gas measurement with the rbr-ecom-SG Plus, a 3-minute calibration phase has to be started in any case. The line "Start flue gas measurement" has to be selected from the adjusting menu and the fresh air phase is started with <E>.



By starting the calibration phase, the unit switches over to fresh air flow and purges the internal tubing behind the gas cooler and the complete sensor system. A control of the sensor characteristics as well as their zeroing is performed in the last seconds of the calibration phase. The signal voltage delivered by the oxygen sensor is stored as reference value at 20.93 % O_2, the signal voltages given by the toxic sensors are set to zero as fresh air does not contain any concentrations of these gases. Should the surrounding air concentration not be typical (see page 8), so the external air flow is recommended by means of a separate hose.



Fresh air:	vol.-%	mass-%
Oxygen O2	= 20,9	23,10
Nitrogen N2	= 78,1	75,55
Argon Ar	= 0,94	1,30
Carbon dioxid CO2	= 0,03	0,05

Do the sensors show signal voltages after the calibration phase which essentially exceed a fixed tolerable value, so an error message will be displayed. In case of slight deviations of the toxic sensors voltages, the repetition of the calibration phase will improve the results as these sensors are thus purged repeatedly. Does the oxygen sensor not reach its minimum set value, then it is weared out and has to be exchanged. The NO batteries are used to prevent a deviation of this sensor under normal conditions. They are automatically reloaded when the analyser is connected to mains power supply. Do the positive and negative voltage value of the battery drift substantially one from the other, this points out that one cell is defect.

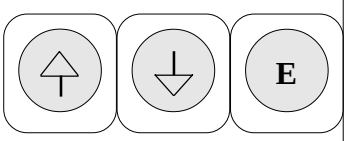
Expected sensors voltages after the calibration phase:

Oxgen-sensor	> 750 mV
Toxic sensors	0 ± 25 mV
NO batteries	> ± 1300 mV

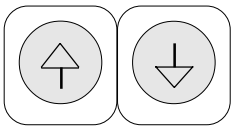
Already during the calibration phase the sampling system can be installed at the sampling place. The processing of measurement values for the gas temperature is already performed during the calibration phase.

After termination of the calibration phase, the program requests the input of the fuel type fired in the installation to be checked. This choice will determine the necessary factors for the calculation of the CO_2 content.
The selection menu consists of 3 display pictures (10 fuel types according SIEGERT, 5 fuel types according BlmSchV) which can be selected with the cursor. One fuel type is free programmable.
<E> closes the selection and switches over to the indication of measurement values.

	CO2max	K-factor
>Liquid gas	13,8	0,52
Hard coal	19,5	0,68
Coke	18,8	0,75
Wood (dry)	20,9	0,69
Light f. oil EL	15,3	0,58



The menu of the indication of measured values covers 4 display pictures which can all be scrolled by the cursor keys. The display right side is the real main menu to which you can return from each other program branch by <ESC>. It shows the momentaneous emission values, the temperatures and calculated values. The indication of the calculated values (CO_2, Lambda, ETA and losses) is only performed when the measured oxygen content is $O_2 < 20.5\,\%$ and the measured difference in temperature is Dt (T-Gas less T-Room) > 5 °C. Otherwise, the measured values are not considered as emission values typical for a com-bustion installation. Pictures 2 and 4 of the main menu show the momentaneous values of the analog channel as well as the mean values of emissions and analog signals. Mean values are only calculated and displayed in the automatic operation.



```
Time    :      12:34:56
Chan 1         : 0,00 V
Chan 5         : 0,00 V
Chan 2         : 0,00 V
Chan 6         : 0,00 V
```

```
Mean values !
O2    0,00  %  SO2    0 DV
CO      0 DV  NOx    0 DV
NO      0 DV  TGas   0 °C
NO2     0 DV
Integration time  :  30:00 min
Minimal time      :  20:00 min
```

```
  Mean values !
  Chan 1      : 0,00 V
  Chan 5      : 0,00 V
  Chan 2      : 0,00 V
  Chan 6      : 0,00 V
  Chan 3      : 0,00 V
  Chan 7      : 0,00 V
```

```
Time    :      12:34:56
O2     20,9 %  TGas  :154 °C
CO     0 ppm   TRoom:  23 °C
NO     0 ppm   CO2  :  ----- %
NO2    0 ppm   Lambda:  -------
NOx    0 ppm   Eff    :  ------ %
SO2    0 ppm   Losses:  ------ %
```

Indication of measured values of emission and variables of calculation (main menu).

All emission values are basically displayed in ppm.
This scaling can be changed while pressing the key <%O2> for conversion of the emission values to another scaling and/or setting to a free programmable residual oxygen content.
The position of the cursor shows the scaling to be output (ppm or mg/m3). By means of the numerical keyboard you input the reference oxygen content and confirm it with <E>. The key <ESC> closes this menu window.


```
> ppm related to
  mg    -------  % O2
```

If the gas concentration is to be displayed referring to the measured oxygen content, only dashes will be displayed for %O2 in the second line of this picture

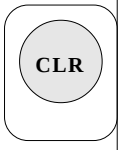
The following measurement values indications are thus possible:

1. gas concentration in ppm referring to the measured oxygen content **indication: ppm**

2. gas concentration in mg/m3 referring to the measured oxygen content **indication: mg**

3. gas concentration in ppm referring to a preset oxygen content **indication: ppmN**

4. gas concentration in mg/m3 referring to a preset oxygen content **indication: mgN**



The key <CLR> cancels the last input for the reference oxygen content.

3.1. Determination of Transient Values of an Installation

If the emission analysing system rbr-ecom-SG Plus is operated in non-automatic function, it determines the transient values of an installation according each individual operation mode (emission measurement, chimney draught measurement and soot measurement). All values can be stored in the temporary memory so that after termination of all individual measurements, the emission values, calculation values, chimney draught values and soot values can be printed on the report printout with date, time, type of installation and further indications. The printout always only covers those values which are stored in the temporary memory. If one measurement hasn´t been performed (i. e. the chimney draught measurement), this line is missing in the printout. In each operating mode, the storage has to be performed by means of the key <STO>, one exception being the soot mea-surement. Here the values are automatically stored. The repeated use of the key <STO> within an operating mode cancels the storage again.

```
**********************
*  rbr-ecom-SG Plus  *
**********************
--------------------------
      Date       Time
   12.03.99    12:34:56
--------------------------
        Fuel type
   Light fuel oil EL
--------------------------
  T.Room        20 °C
  T.Gas         95 °C
  O2            8,3 %
   CO           65 ppm
   NO           28 ppm
   NO2           8 ppm
   NOx          36 ppm
   SO2          16 ppm
   Draught   0,10 hPa
   Soot number   1,2
   Oil trace       No
------------------------------
------------------------------
-rbr-Computertechnik
 Am Grossen Teich 2
   58640 Iserlohn
 Tel. (49) 2371-945.5
```

3.1.1. Spot Measurement

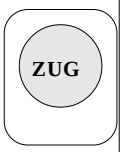
The purpose of a spot emission measurement is the momentaneous determination of emission values and fuel engineering data of an installation. The selection of the gas concentrations to be measured determines the type of sampling system necessitated.
For emission values of nitrogen oxides (NO, NO_2, NOx) as well as of sulphur dioxide (SO_2) the heated sampling system is highly recommended, for all other values the pistol grip probe is sufficient (see as well § "Sampling System and Gas Processing" page 9).
Should you require the heated sampling system, then probe head and heated hose should have reached the adjusted temperature. With the key <GASKÜHLUNG> (GAS COOLER), select the adjusting menu for gas processing. The expected values to be preset should be substantially above the dew point of water vapour and that of acid. The values for the dew points are specific for the material and are dependent on the partial pressure of the gases of the gas compound. The acid dew point of sulphureous-free fuel types is for example between 40 - 50 °C and rises to approx. 145 °C by combustion of sulphureous fuel types.
The sampled gas connection has to be fixed to the connection <Sonde = probe> of the SG-Plus and after termination of the calibration phase, the gas pump sucks the necessary gas quantities thru this inlet. The adjustment time for a stable value is mainly depending on the length of the gas channel and on the pump capacity. With a 3 m sampling hose it amounts appr. 1 minute. The current values are permanently displayed.


```
      G A S C O O L E R
                Meas.  Set
> Hose          124 °C 120 °C
  Head temp.    132 °C 140 °C
  Inner temp.   23 °C
  Cooler :      is  adjusted
```

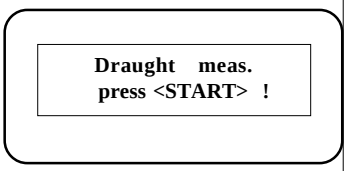
```
Time    :       12:34:56
O2    6,7 %   TGas  :154 °C
CO   78 ppm   TRoom:  23 °C
NO   21 ppm   CO2   :  9,5 %
NO2   3 ppm   Lambda   1,1
NOx  24 ppm   Eff.    : 86,6 %
SO2   8 ppm   Losses:  13,4 %
```

Is the indication stable, store these values by means of the key <STO>. The display then shows a small "m" on the upper right side to indicate the occupied storage.

3.1.2. Chimney Draught Measurement

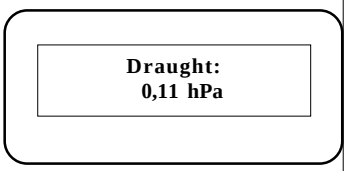


The connecting branch <ZUG> at the SG-Plus must be used for draught measurement. For transfer of the draught/pressure signal, the pistol grip probe or a current probe pipe with hose should be used. The draught measurement is prepared by pressing the key <ZUG>. The draught sensor calibrates down to zero according to the ambiant pressure. The key <START> switches the inlet of the draught sensor onto the connecting branch <ZUG>.



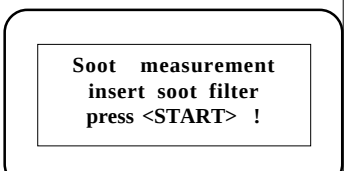
The key <STO> stores the measurement results into the temporary memory, the display shows "m".

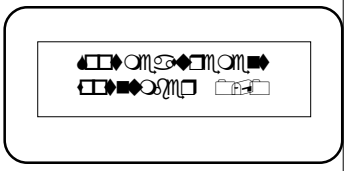
With <ESC> the measurement mode is left, the sampling pump is switched on again and the display switches over to the indication of measured values.

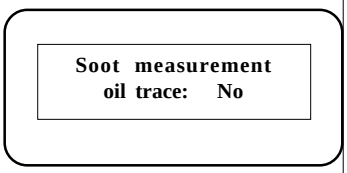


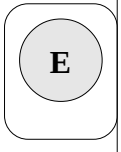
3.1.3. Soot Measurement

The soot measurement mode is started with the key <RUSS>.
The pistol grip probe is the suitable tool hereto. Its grip covers a slot in which a soot filter paper is inserted. In order to get a dry soot picture, this area is heated to appr. 60 °C.
To activate the probe heating, call the corresponding menu out of the main menu with the key <PARA>, select the line "Probe heating on/ off" with the cursor and switch with <ESC>. The LED shows the switching state. <ESC> returns back to the main menu, <RUSS> performs the soot measurement.
The sampling hose has to be connected with the connecting branch "Sonde = probe" and with key <START> the pump is switched on. The pump sucts the necessary gas volume of 1.63 l. The volume still to be suctioned is displayed. Once 1.63 l have been sucked, the pump switches off, you can take off the filter paper and compare the soot number with an optical or photo-metric device (densitometer rbr-ecom-D, see page 36) or with the soot number comparison scale. The determined value is then input by means of the numerical keyboard and confirmed with <E>. Should any oil trace be present on the filter (sign for an uncomplete combustion), so consign this with YES or NO using the key <E>.
A storage is performed automatically. Press <ESC> to quit the soot measurement mode and the instrument switches over to the main menu.



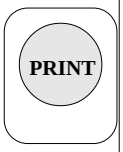




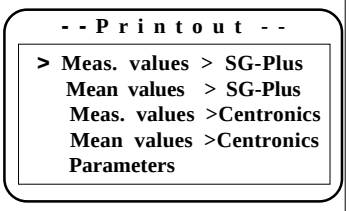


3.1.4. Printout of the Measurement Results

This can be performed by means of the key <PRINT>. The stored values can only be printed as complete report by the integrated 58 mm printer while selecting the line "> Measured values>SG-Plus". A complete report is shown on page 24.



3.1.5. Data Transfer performed during a Spot Measurement



Several data transfers for emission measurements are possible by non-automatic operation mode without storing into the intermediate memory and without the necessity to print a complete report.
The RS 232 and the Centronics interface serve for data transfer.
A PC or Laptop for online function (COM I or COM 2) can be connected with the RS 232 B.
By means of the software delivered with the instrument, the data permanently sent is read as well as their storage or output to a printer controlled by the PC is performed.
A 9- or 24-needle printer can be connected with the Centronics interface. This printer then is controlled by the SG-Plus. Data output of a complete set of emission values is subsequently performed by using the key <E> in the line "Messgrößen > Centronics = Measured values > Centronics in the PRINT-menu.

3.2. The Automatic Measurement Operation

With the rbr-ecom-SG Plus, an automatic measurement operation is possible over several hours.
After a certain period of time, electrochemical sensors nevertheless need a fresh air purging phase to control their zero point. These calibration phases last as well 3 minutes and can be preset in their time sequence. The longest possible time of permanent flow with sampled gas is 180 minutes. After each calibration phase, the automatic cycle of measurement starts again on its own (see as well "Diagram of control times" on page 14).
Comprehensive supervision and compensation functions secure the operation reliability of the sensor technique and electronics and secure measurement accuracy as well by alterations of the working conditions.

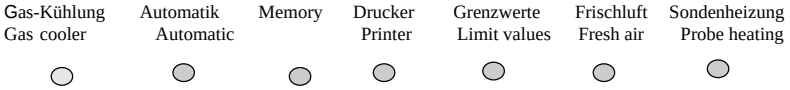
The heated sampling system is indispensable for the automatic operation mode. Sampling hose and plugs for heating (head and hose) have to be connected to the connecting combination "Sonde = probe" and the heating temperatures have to be selected in the menu gas cooling.
As described under 1. Internal Parameters of Device (page 15) and 2. Programming/RAM card, you have either preset the options for the automatic operation according to the measurement work or you do the programmation after the calibration phase has been terminated. You thus use the key <PARA> for adjustment of the internal unit´s parameters. The procedure for programming the internal unit´s parameters is explained in chapter 1 (pages 15-18).


```
G A S C O O L E R
                Meas.    Set
> Hose          124 °C   120 °C
  Head temp.    132 °C   140 °C
  Inner temp.   23 °C
  Cooler :      is  adjusted
```

For programming the time control and the data transfer, you use the key <PROG> and the same adjusting mode as described under 2 (pages 19-21) is displayed. After programmation, you start the automatic operation by selecting the line "automatic: No" with the cursor and switching to <Yes> with the key <E>. The instrument starts to work off the adjusted cycles and sends the data to the periphery according to the selected options. The data transfer is switched together with the automatic operation.
The LED row shows the active function:

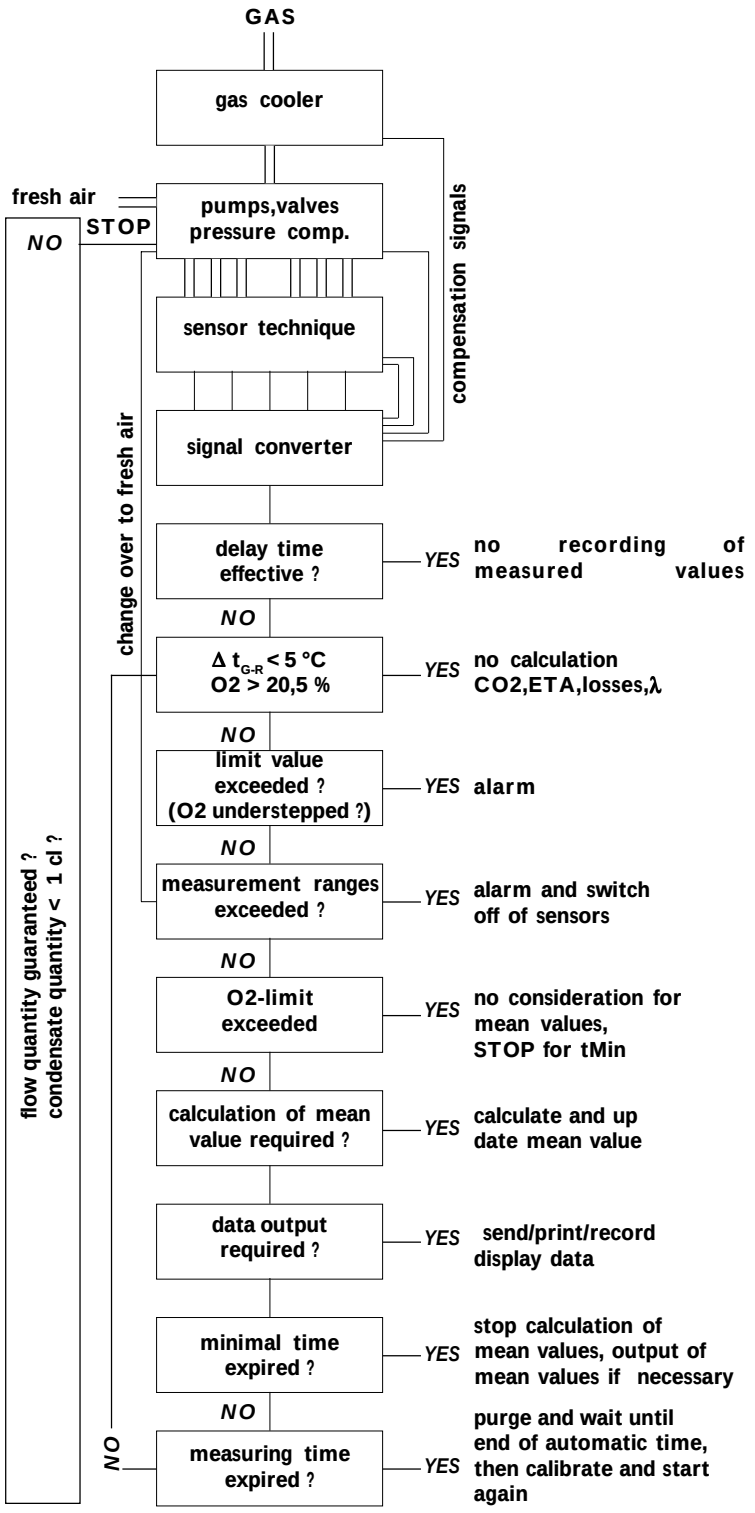

```
> RS 232
Analog outputs
Limit values                Sensors
Measurement ranges          Sensors
Basic parameters adjustments
Change fuel type
Probe heating on/off
```


```
P r o g r a m m a t i o n
> RAM disk
  Sstorage/printout   - times
  Storage/printout    - values
  Time intervals/controlling
  Automatic operation:  No
  Data transmission  :  No
```



3.2.1. Signal Flow and Supervision of Parameters in Automatic Operation

The internal program of the SG-Plus performs a permanent supervision of important parameters and characteristics to guarantee the measurement security and accuracy. You can preset the majority of the parameters according to the measurement work. Please find herewith a schematic representation of signal flow and options for presetting of the parameters.



Parameter options

Temperature of sampling hose and probe head > dew point of acid/ water vapour (> 100 - 150 °C)

Storage temp.: -5 bis +45 °C
Operation temp.:+5 bis +35 °C
Zero signals: O2 > 800 mV
toxic sensors 0 ± 20 mV

tdelay>/= 1 minute

Limit value < measurement range

Meas. range </= max. meas. range
O2 : 25 %
CO : 4000 ppm
NO : 2000 ppm
NO2: 200 ppm
SO2 : 4000 ppm
CxHx: 4 %
CO(%): 10 %
T-Gas : 999 °C
T-Room: 99 °C

Disk	**pulse >/= 20 sec.**
RS 232	**pulse >/= 2 sec.**
Centronics	**pulse >/= 10 sec.**
RAM-card	**pulse >/= 1 sec.**
Printer SG-P	**pulse >/= 1 min.**

tMin </= tInteg.
tMin > 2/3 tInteg

tMeas </= tAutom
tAutom </= 180 minuts

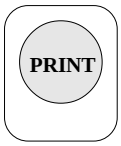
3.2.2. Basic Adjustment of Parameters in the SG-Plus (RESET)

The most important alterable data for an automatic operation are stored in a basic adjustment in the instrument.
You can call them on after having selected the RESET-function in the menu "internal unit´s parameters".
The basic adjustments of alterable parameters are:

Baud rate	9600	**Unit´s parameters**
printout of mean values	NO	
scaling	ppm	
reference oxygen	none	
fuel type counter	0 (light fuel oil EL, SIEGERT)	
CO2max	15,3 (light fuel oil)	
K-factor	0,53 (light fuel oil)	
automatic time	45:00 min	**Time intervals**
measurement time	45:00 min	
integration time	30:00 min	
minimal time	20:00 min	
delay time	1:00 min	
O2-limit	10 %	
disk(ette)	-----	
RS 232	-----	
centronics	-----	
Printer SG-P	-----	
RAM card	-----	
analog offset	4 mA	**Analog card**
analog output 1 (O2)	21 %	
analog output 2 (CO)	1000 DV	
analog output 3 (NO)	500 DV	
analog output 4 (NO2)	100 DV	
analog output 5 (SO2)	1000 DV	
analog output 6 (TGas)	500 °C	
analog output 7 (TRoom)	100 °C	
analog output 8 (Ch1)	0 V	
O2max	0 %	**Limit values**
CO	2000 DV	
NO	500 DV	
NO2	100 DV	
SO2	2000 DV	
TGas	500 °C	
channel 1	10 V	
channel 2	10 V	
channel 3	10 V	
channel 4	10 V	
cooler temperature	5 °C (cannot be adjusted)	**Gas conditioning**
hose temperature	150 °C	
head temperature (probe)	150 °C	
CO	4000 ppm	**Measurement ranges**
NO	2000 ppm	
NO2	500 ppm	
SO2	4000 ppm	
automatic	NO (Yes switches data transfer to YES)	**Activation state**
data transfer	NO (can be switched individually)	
gas cooling	YES (cannot be switched off)	
probe heating	NO	

4. Special Functions in the Instrument

Some keys are programmed with special functions for the operation as well as for the control and maintenance of the instrument.



The key <PRINT> opens a selection menu where the lowest line "Parameters" delivers a parameter report after selection by the cursor and confirmation with <E>. On this report, the values for the adjusted options for time intervals, data transfer, measurement ranges and limit values are to be found. For this function, the signal voltages of the sensors are output in their zero points, as they have been recorded into the main memory for calibration data after the calibration phase. The report is issued with date, time and serial number.
Thus you always have the possibility to adjust the same conditions of measurement in case of repetition or control measurements at one and the same installation.

Further selection functions in the <PRINT> menu have been described in the previous chapters.

The key <PAPIER = paper> has a line feed function which is necessary after replacement or as function control of the printer paper roll. The paper roll has a 58 mm width and a 25 m length. The paper roll can be replaced by opening the paper box and removing the roller on which the paper roll is placed by loosening one of the side screws. The new paper roll is to be placed on the roller so that the paper strip runs under the roll from top to bottom towards the printer drive. Cut the strip tip in cone form and insert it in the paper slot of the drive and press several times <PAPIER>=<PAPER>. Once you can catch the paper strip end, pull it slowly through the drive until you can insert it through the tear-bar edge of the paper box cover. Close the paper box.

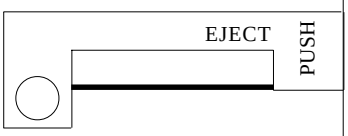
A necessary change of paper roll is signalized by a red tape on the last paper centimeters.

The ribbon band in the needle-printer of the SG-Plus is a current printer ribbon type EPSON ERC-09. For replacement, press on the right side (PUSH) of the housing and take out the cartridge.

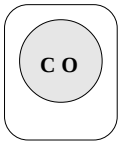
```
Date          Time
12.03.99      12:34:56
--------------------------------
Serial- nr.     0001
Time intervals :
--------------------------------
Automatic :     45:00 min
Meas. time:     45:00 min
Integral :      30:00 min
Minimal :       20:00 min
RAM disk      : -----
Diskette      : -----
RS 232        : -----
Print.-Cen    : -----
Print SGP     : -----
Meas. range !
--------------------------------
CO    : 4000 ppm
NO    : 2000 ppm
NO2   :  500 ppm
SO2   : 4000 ppm
Limit value!
------------------------------

O2    :        ------
CO    : 2000 DW
NO    :  500 DW
NO2   :  100 DW
SO2   : 2000 DW
TGas  :  500 °C
Cha1  : 10,00 V
Cha2  : 10,00 V
Cha3  : 10,00 V
Cha4  : 10,00 V
Zero point of sensors
------------------------------
O2    : 1825 mV
CO    :   -2 mV
NO    :    2 mV
NO2   :    1 mV
SO2   :    1 mV
```

Replacement of paper roll

Ink ribbon

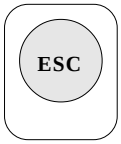


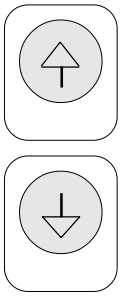
Position a new cartridge at the right side and press it at the left side until the cartridge snaps in. Stretch the ribbon by turning the tooth lock washer left hand on the ribbon cartridge.



CO-switch off (manually)

The key <CO> is an external switch for the CO (ppm) sensor. As explained in the previous chapters, the CO sensor is protected against over concen-tration by an automatic switch-off with subsequent purging with fresh air. The switching moment can be selected by presetting the maximal measurement range. Should the CO sensor not be needed during a measurement operation, it can be cut off of the gas way manually by the key <CO>. In the display, dashes are shown for the CO value and the message that the CO measurement has to be performed manually is displayed. A repeated pressure on this key switches the sensor into the gas path again.





Display lightening

Contrast adjustment

The key <LICHT> (LIGHT) switches the background lighting of the display on and off. A contrast adjustment can be performed by simultaneous pressing on <ESC> and one of the step keys.

The key <KONTR> delivers information as regarding the unit´s specific data. Besides the data for date, time, sumed operation hours and serial number you can see the present sensor voltages in the second picture (which can be reached by one of the step keys). As you can visualise this indication first after a calibration phase, the most recent sensor data will be displayed in any case. The unit´s clock can be adjusted as explained by selection of the adjusting mode with <START> and overwriting the flashing indication by numerical input on the keyboard. The key <E> writes in the value and starts the flashing of the next indication. Confirm the flashing second-indication and thus close the adjusting mode.

```
      Control          V 1.0
Date :        12.03.99
Time :        12:34:56
Operating hours:  12,34 hrs
Service tel.:  (49) 2371-44029
Serial nr.    :   0001
Adjust clock     <START>
```

```
   Control  of  s e n s o r s
O2 :  0  mV  NO :     -1 mV
CO : -2 mV   NiCd + 2709 mV
NO2:  1 mV   NiCd  - 2706 mV
SO2 :  0 mV
```

Indications concerning the set values and tolerances of sensors are to be found on pages 13 and 22 of this manual.

In the first display indication of the control menu, you can see on the upper right side the version number of the unit´s software (i. e. V1.0).

Due to reasons of further technical development, we reserve the right to make changes in the instrument as well as in the integrated software. Different versions mainly concern the selection of programmed fuel types and conversion factors, the sensors number, the accessories as well as the software language. As far as alterations concern the unit´s functions, you will receive an updated information.

Maintenance and Calibration

The emission analysing system rbr-ecom-SG Plus is designed so as to be ready for operation after a short preparation time. To secure a high accuracy of measurement and long lasting operability of the instrument, you should pay special attention to specific functions/ parts and control these regularly:

5.1. Gas Flow

Gas flow

The necessary gas quantity is provided by the gas pump and is appr. 2.5 l/min. The suctioned gas quantity is monitored by an electronic flow indicator which is placed directly before the sensor bench.

Changes in the gas flow can have the following reasons:
- failure of the gas pump (no pump noise)
- interruption of the gas path (flow indicator shows red or/and no emission value indication of the sensors)

An interruption of the gas path can be due to condensate as well as to obstructed filters. Condensate arising in the unit is possible when the gas cooler breaks down or the cooling capacity is not sufficient to dry the sampled gas sufficiently due to the operating conditions (high ambiant temperature). For this case, the condensation trap serves as further security. You should check it in case of longer operation, screw it off and empty it after measurement or if necessary during a calibration phase. Do not transport the instrument with any condensate still in the trap as this will thus penetrate into the instrument!

Particle filter

Two particle filters can be found along the gas path:
- probe head (standard PTFE 20 µm)
- side front (standard micro glass fiber 2 µm)

Should the filters be weared out, the gas flow quantity drops gradually. Replace these filters.

Compare with illustration on pages 8 and 10

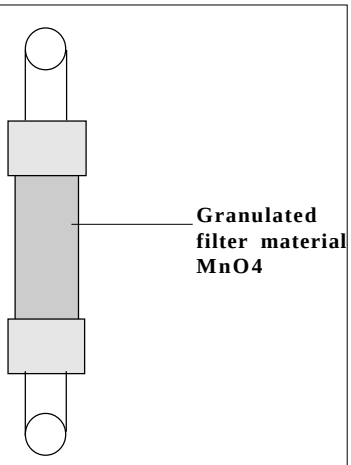
The filters can under certain conditions be reused (dependent on the type of soiling of the sampled gas) by loosening the surface tension of the dirt particles by short time heating (appr. 500 °C) or ultrasonic treatment. The filters are then to be blown through with compressed air. PTFE-filters can furthermore be treated with a slightly alkaline solution, then dried and blown through.

5.2. Filtering of Single Gas Components

SO2/NOx filter

The CO sensor is cross-sensitive to NOx and SO2 components in the sampled gas.
To prevent a falsification of measured values, this sensor receives its sampled gas (both sensors in case of equipment with the additional CO %-sensor) through a chemical filter. This SO_2/NOx filter consists mainly of manganperoxide (MnO_4) which changes its colour

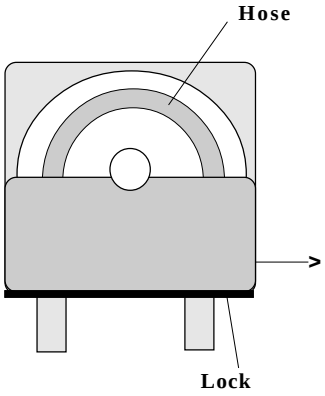
dependent on the state of reactivity.
In its original state, the granulated filter material is pink/reddish brown and changes to white over the graduations brown, black and grey. When the colour of the granulated material is light grey, it should be replaced.
In case of need, granulated material can be ordered by indicating the required quantity (one cartridge filling appr. 25 g).
The used granulated material has to be handed over to a special waste recycling company.



5.3. Pumps, Ventilators

The instrument includes 2 gas pumps (gas pump and fresh air pump), 1 hose pump (condensate evacuation) as well as 2 exhaust fans (gas cooler and ventilation of the insert card pit).
The hose pump has to be controlled regularly as it underlies a special mechanical and chemical load.
The state of the hose is controlled by turning on the lock below the pump case. Then the cover of the box can be removed and the hose is accessible.
For replacement, a new piece of hose is put onto the connectors and locked with clasps. By re-assembly, take care that the hose is not pinched and that the lock snaps in.

Hose pump (peristaltic pump)



Collecting the waste condensate is recommended in any case when the sampled gas contains a lot of sulphur hydrides as thus forms a more acid condensate.

5.4. Sampling System

Sampling system

Probe pipe, probe head as well as sampling hose are subject to a strong load by temperature and soiling of the sampled gas which cannot completely be collected by the probe head filter.
From time to time, these parts of the sampling system have to be cleaned. The dismounting procedure for the probe head can be seen in the illustration on page 10, the sampling hose can be purged with warm water mixed with some washing-up liquid and then dried.

5.5. Connecting Branchs, O-Rings

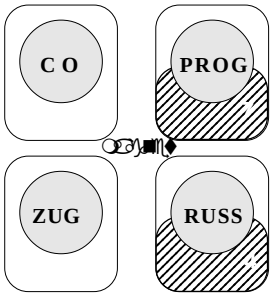
O-rings

In order to guarantee the tightness it is recommended to rub the O-rings of all connecting branches (gas, draught, fresh air) from time to time with non-corrosive grease (i.e. pump lubricating oil).

Calibration of the Sensors

As described in chapter "Storage for constant values, data storage and time control" (page 13), it is possible to change the adjustment data of the sensors in the middle or upper range of their characteristic curves and herewith specifically prepare the sensors for the requirements or just control them.
A calibration or a control of the sensors accuracy by means of test gas can be done as follows:

1. Switch on the instrument and perform the calibration phase.
2. Press <E> for confirm any fuel type and then <KONTR> to call on the control indication.
3. Place a small magnet (i. e. magnet of the T-Room sensor) between the keys <CO>,<PROG>, <ZUG> and <RUSS>. The display shows a star (*).
4. Press <PROG> the magnet being still placed. The display indication changes over to the service mode.



The service mode covers 2 display pictures in which the adjustment of some parameters of operating modes can be performed. Please only perform the adjustment/control of the sensors as the adjustment of the characteristics for the soot/ draught and temperature measurement needs special devices. Select the line "sensors" with the cursor and press <E>. The second page of the service mode where you can calibrate the toxic sensors is then displayed. By means of the fresh air inlet, flow test gas into the instrument and control the accordance of the displayed value with the real value according to the test gas certificate. After an adjustment time of 1-2 minutes, the value should be stable. Do both values not correspond, input the real value for the corresponding sensor into the memory by means of the keyboard. Store with <E>.
With <ESC> you leave the service mode.

```
Service          rbr   12.03.99
> Soot measurement
  Draught measurement
  Sensors
  TGas                 23,5 °C
  TRoom                23,5 °C
```

```
Service        O2   20,9 %
> CO :          0 ppm
  NO :          0 ppm
  NO2:          0 ppm
  SO2:          0 ppm
```

After calibration, please control the accuracy of the indication of measured value by means of a repeated admission. Use herefore the measurement mode and the measurement gas inlet. Do not admit gas onto the sensors with pressure!
Then you can check the tightness and flow rate in that you flow test gas via the connected probe and observe the operation.

Test gas concentrations used in our factory:

C O : ca. 400 ppm with and without H2 content
C O : appr. 3 % with and without H2 content
NO : appr. 100 ppm
NO2 : appr. 80 ppm
SO2 : appr. 100 ppm
CH4 : appr. 3 %
Use of mixed gas concentrations as well as undiluted gas (with and without residual O2)

Additional Devices for the rbr-ecom-SG Plus

For this instrument, rbr-Computertechnik GmbH offers a row of additional high-tech devices for an incresed operation and data processing comfort.

1.) RAM Card Reader rbr-ecom-RL

RAM card reader rbr-ecom RL

An external RAM card reader serves for reading out on the PC the data stored on the RAM card. The RL has to be connected with the serial interface of the PC and enables the reading of RAM cards of 8 kB up to 4 MB size.

Device specifications:
- 9600 Baud transfer rate
- RS 232 connector (9-channel SUB-D)
- storage size 8 kB - 4 MB
- storage info
- indication of number of data records
- delete function
- 220 V/50 Hz ~
- incl. software for data conversion

2.) Remote Control/Remote Indication

Remote control

Handy, external indication and control unit for the analyser rbr-ecom-SG Plus, either by cable or with additional infrared sender via IR with a by-pass distance of 10 m (IR) or max. 50 m (cable). Two values can be displayed simultaneously on the remote control/indication and a printed report can be activated.

3.) Densitometer ECOM-D

Densitometer rbr-ecom-D

Photometric determination of the grey scale value of a soot spot according to the BACHARACH scale with a resolution of soot number 0.1.

4.) Giant Display

Giant display

For stationary installation or when measurement and adjustment places are far away from each other, the use of a giant display with large LED (28 mm) indicating 6 measured or calculated values is highly recommended. The giant display is provided with data by means of a cable and needs 220 V/50 Hz ~.

Dimensions: (w x h x d): 620 x 500 x 65 mm

5.) Software for Recording and Processing of Measured Data

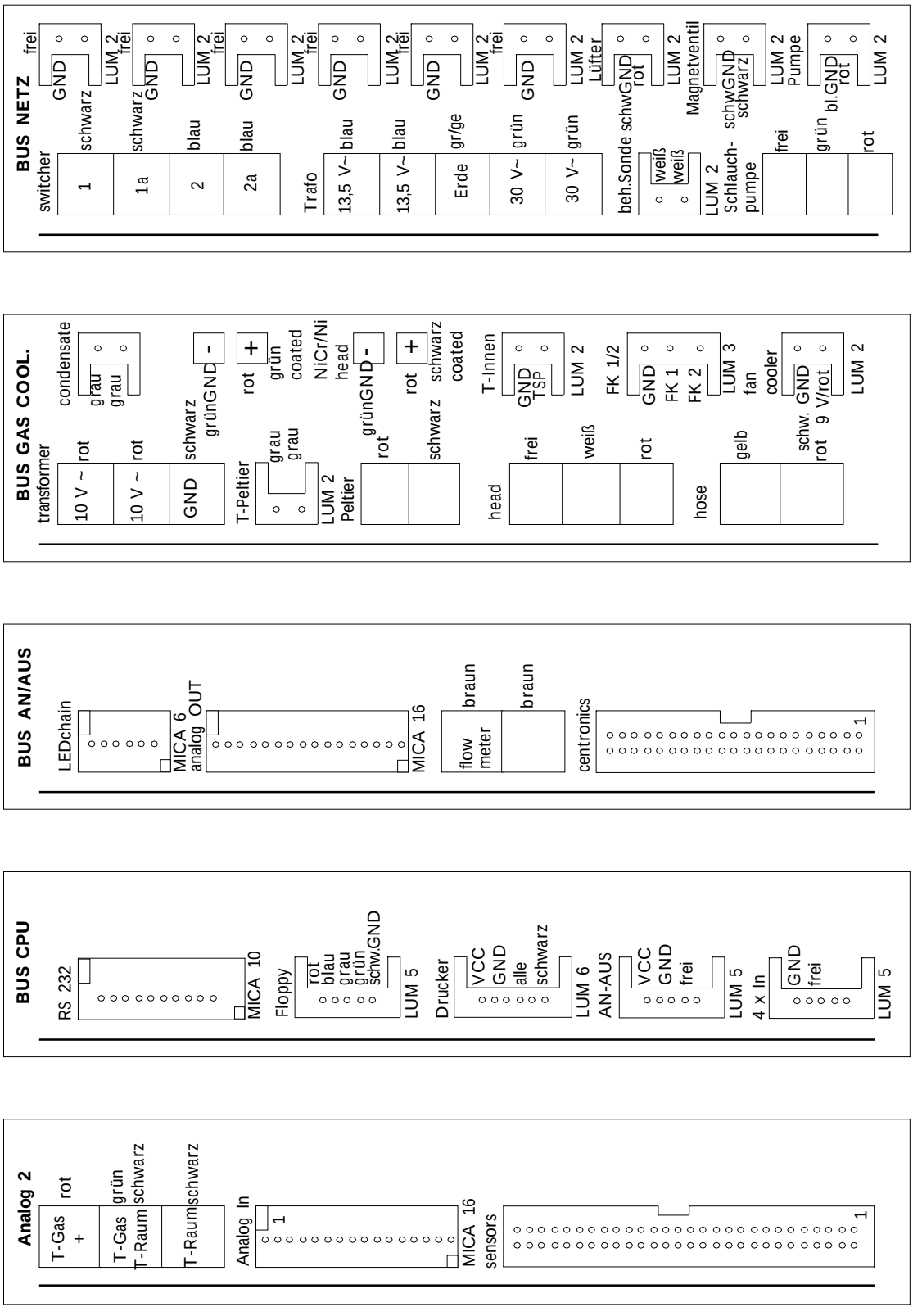
Our software offer for the rbr-ecom-SG Plus covers

- program for data transfer rbr-ecom-MCR to PC
- program for online recording of measured data and storage on a PC/Laptop as well as output of a data report
- data files processing with printer and plotter control for the graphical representation of measurement series.

We would enjoy to advise you in detail about applications and operation of the software.

Appendix

1. Pin configuration of the card pit



Technical data

1. Measurement values

Parameter	Range	Tolerance[1)] rel./abs.	Tolerance[2)] rel./abs.	Resolution
O2	0 - 25 %	5 %(1,25 %)	2 %(0,1 %)	0,1 %
CO	0 - 4.000 ppm	5 %(200 ppm)	2 %(16 ppm)	1 ppm
CO %	0 - 6.3 %	5 %(0,31 %)	2 %(252 ppm)	0,1 %(1000 ppm)
NO	0 - 2.000 ppm	5 %(100 ppm)	2 %(8 ppm)	1 ppm
NO2	0 - 200 ppm	5 %(10 ppm)	2 %(1 ppm)	1 ppm
SO2	0 - 4.000 ppm	5 %(200 ppm)	2 %(16 ppm)	1 ppm
CxHx	0 - 4 %	5 %(0,2 %)	-	0,1 %
T-Gas	0 - 999°C	2 %(20 °C)	-	1 °C
T-Room	0 - 99 °C	2 %(2 °C)	-	1 °C
Draught	± 20 hPa	1 %(0,2 hPa)	-	0,1 hPa

[1)] - referring to the range
[2)] - referring to 20 % of the range

2. Calculation values

Parameter	Calculation range	Resolution	Formula
CO2	0 - CO2max	0,1 %	$CO2 = CO2max * (1 - \frac{O2meas.}{21})$
Losses	0 - 99,9 %	0,1 %	$qA = (tG - tR) * (\frac{A2}{21 - O2} + B)$
Efficiency (η)	0 - 99,9 %	0,1 %	eff = 100 - qA
Excess air	1 - ¥	0,01	$l = 1 + \frac{O2}{21 - O2}$

3. Conversion factors

Gas	from ppm to mg/m3	from mg/m3 to ppm
O2	1,429	0,699
CO	1,25	0,8
NO	1,34	0,75
NO2	2,05	0,49
SO2	2,86	0,35
CH4	0,715	1,398

$$NOx\,(mg/m3) = NOx\,(vol.ppm) * 2{,}056 * \frac{21 - O2ref}{21 - O2meas}$$

calculated as NO2

4. Conversion from ppm to mg/kWh (not performed by the device)

CO (mg/kWh) = CO (ppm) * 1,26
NOx (mg/kWh) = NOx (ppm) * 2,03 (on 3 % O2)

5. Sampling System

- heated sampling hose	P = 270 W	Tmax = 170 °C
- heated head	P = 140 W	Tmax = 170 °C

6. Gas Processing

- gas inlet temperature (max.)	220 °C
- gas flow (max.)	4 l/min.
- dead volume	< 50 cm3
- surrounding temperature	40 °C
- cooling capacity	> 15 W (J/s)

7. Mains Power Supply

- network voltage	220 V/50 Hz ~
- battery	4 x 1.2 V/700 mAh NiCd for NO-sensor
- battery	1 x 3.6 V/60 mAh (system clock)

8. Dimensions and Weight

- basic device	
width x height x depth in suitcase:	600 x 500 x 200 mm
- weight of the basic device:	appr. 25 kg

Data sheet

for the emission analysing system rbr-ecom-SG Plus

Serial number: ..... Calibrated on: .....

Meas. var.	Unit	Adjust. val. (span gas)	Notes
O2	Vol. %	20,93 %	reference gas - fresh air
CO	ppm	396 ppm	
CO/H2	ppm	400 ppm	
NO	ppm	94 ppm	
NO2	ppm	84 ppm	
SO2	ppm	98 ppm	
T-Gas	°C	222 / 50 °C	two point adjustment
T-Room	°C	22 / 50 °C	two point adjustment
Draught/press.	hPa	..... hPa	
Soot	l	1,63 l	
Pump capacity	l/min	3,75 l/min	pump voltage: V
CO2	Vol. %	- - - - - -	calculated value
CO	Vol. %	3,01 %	optional equipment
CxHx	Vol. %		optional equipment

Sensor data

O2 : ..... mV
CO : ..... mV
NO : ..... mV
NO2 : ..... mV
SO2 : ..... mV
CO% : ..... mV
CxHx: ..... mV

Notice:

1.) The calibration of the analyser should be performed at a value which corresponds to 75 % of the max. value to be measured.

2.) The calibration of the soot measurement system is performed by presetting a time constant for the pump control (1,63 l +/- 0,07 l in </= 60 sec.).