TREMON

PGA

MULTI-CHANNEL PROCESS NDIR GAS ANALYZER

TRM-PGA

TRM-PGA-R 19" 3 U rack · TRM-PGA-W IP66 wall enclosure · 1–7 channels · heated stainless cuvette · Modbus RTU / TCP

WARNING Strictly follow these Instructions for Use. Personnel who install, use or service this analyzer must fully understand and observe the instructions.

CONTENTS

1 PHYSICAL PRINCIPLE

1.1 NDIR MEASUREMENT

Non-dispersive infrared analysis (NDIR) is based on resonant absorption of gas at the wavelengths corresponding to the vibrational excitation energies of the target molecules in the mid-IR range. Absorption follows the Lambert–Beer law:

$$A = (I_0 - I_1) / I_0 = 1 - e^{-\varepsilon(\lambda)\cdot\rho\cdot l}$$

where A — absorption; I_0 — incident intensity; I_1 — exiting intensity; ε(λ) — absorption coefficient of the medium; ρ — gas density; l — path length.

The relation between gas density and concentration:

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

with ρ_0, p_0, T_0 at normal conditions (1013 hPa, 0 °C). The volume concentration therefore depends on pressure and temperature — both are controlled in the TRM-PGA.

> **NOTICE**
> NDIR cannot detect monoatomic (inert) gases and symmetric molecules — N_2, O_2 and H_2.

1.2 CONSTRUCTION OF THE MEASURING SYSTEM

The TRM-PGA is an optical system with a broadband solid-state emitter and a multi-channel receiver. Main components: broadband IR emitter · multi-channel receiver · optical cuvette · cuvette heater.

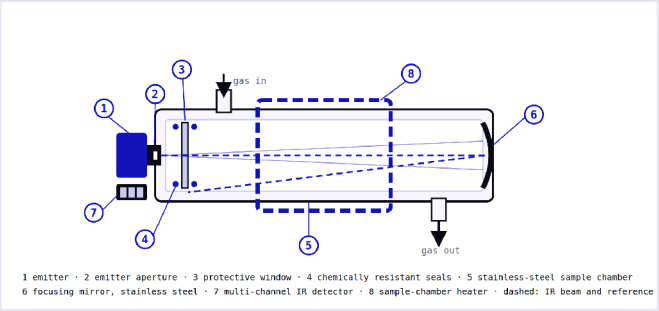


Fig. 1.1 — Measuring system: 1 emitter · 2 emitter aperture · 3 protective window · 4 chemically resistant seals · 5 stainless-steel sample chamber · 6 stainless-steel focusing mirror · 7 multi-channel IR detector · 8 chamber heater

1.3 IR EMISSION · MECHANICS · CUVETTE · DETECTOR

- **IR emission** — generated by a solid-state broadband source; the beam passes the sample cuvette and is absorbed by the gases inside, the reference wavelength passes unchanged; all channels are measured simultaneously.
- **Mechanics** — solid-state electronics and mechanics without moving parts.
- **Sample cuvette** — stainless steel, chemically resistant version; all seals are resistant to aggressive media and temperatures up to 250 °C.
- **IR detector** — multi-channel detector with double thermal compensation (internal and external). The detector is extremely sensitive to sudden temperature changes: do not expose it to open flame or direct sunlight.

2 FACTORS AFFECTING MEASUREMENT ACCURACY

2.1 INTERFERING GASES

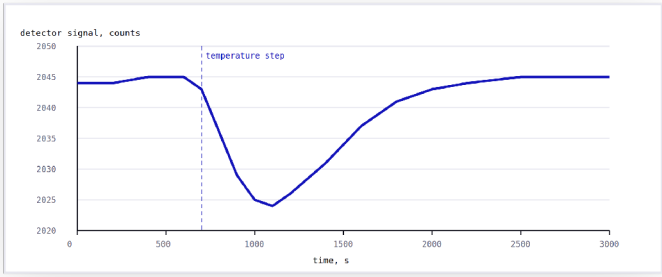
An accompanying gas affects the measurement if its absorption energy coincides with or overlaps the wavelengths of the detected gas. The design uses wavelengths not overlapped by accompanying gases; where a free range cannot be chosen, additional channels are fitted to correct the reading of the target gas. Cross-sensitivity is corrected in software.

2.2 PRESSURE & FLOW

Pressure has a direct influence on accuracy (see the formulas above), so the pressure of the supplied mixture must be controlled. One solution is throttling the flow to **300–500 sccm**: such a flow leaves the cuvette freely without creating excess pressure. Keep the flow within 300–500 sccm; otherwise excess pressure in the cuvette increases the measurement error.

2.3 TEMPERATURE

Temperature affects the measurement — avoid sudden temperature changes. A 10 °C change increases the measurement error by 3 %. The system uses a heater that thermostats the whole measuring system; control is by three temperature sensors on the heater and on the IR detectors.



Graph 1.2 — Response to a sudden temperature change (detector signal vs. time, s)

3 SYSTEM COMPOSITION

3.1 COMPONENTS & CONFIGURATIONS

- Measuring channels from 1 to 7
- 1 or 2 broadband IR emitters
- Up to two IR detectors per cuvette
- Fitted regardless of configuration: sample cuvette · cuvette heater · signal-acquisition board · motherboard (processing and output to the upper level) · 3 temperature sensors

Special versions:

- High-temperature version — cuvette heated to 200 °C
- 2–3 optical cuvettes connected in series
- Other wetted materials
- ¼" Swagelok-type compression connection, stainless steel / PTFE

3.2 ENCLOSURE VERSIONS

The analyzer module is supplied in two Rittal enclosures. The module itself — plate, cuvette, heater, boards and power supply — is identical; both versions carry a 7" touch-screen with the same readings / log / calibration pages as the GDC cabinet.

TRM-PGA-R — Rittal Ripac Vario 3 U, 482.6 × 132.5 × 245 mm; 7" touch-screen and lamps POWER · STATUS · SERVICE · ALARM on the front panel; all connections at the rear

TRM-PGA-R rear panel — sample fittings, RS-485 / DO terminal, Modbus TCP, USB service, IEC mains inlet

TRM-PGA-W — Rittal AX compact enclosure 500 × 500 × 210 mm, IP 66; touch-screen and lamps in the door; bulkhead fittings and cable glands on the bottom wall

VERSION	TRM-PGA-R — 19" RACK	TRM-PGA-W — WALL-MOUNTED
Enclosure	Rittal Ripac Vario 3 U subrack, 482.6 mm (19"), RAL 7035 sheet steel; front panel with two rack handles	Rittal AX compact enclosure, sheet steel RAL 7035, single door with two cam locks, galvanised mounting plate
Dimensions (W × H × D)	482.6 × 132.5 × 245 mm (3 U)	500 × 500 × 210 mm
Ingress protection	IP 20 (indoor, cabinet-mounted)	IP 66 (IEC 60529) · NEMA 4 / 12
Display & operation	7" colour touch-screen on the front panel (readings, log, calibration); lamps POWER · STATUS · SERVICE · ALARM	7" colour touch-screen in the door (readings, log, calibration); four door lamps: 3 × status, 1 × alarm; audible-signal acknowledge
Sample connections	rear panel — SAMPLE IN · SAMPLE OUT · PURGE / ZERO, 6 mm stainless compression bulkhead fittings	bottom wall — SAMPLE IN · SAMPLE OUT, 6 mm stainless compression bulkhead fittings
Electrical connections	rear panel — IEC C14 inlet with switch and fuse, RS-485 A/B/GND + DO1/DO2 pluggable terminal, RJ45 Modbus TCP, USB-B service	bottom wall — two cable glands (mains, signal); internal terminals and circuit-breaker Q1 on the mounting plate
Mounting	19" rack, 4 slots; rack slides optional	4 wall fixings; min. 700 mm above floor; service access ≥ 800 mm
Mass	≈ 7 kg	≈ 21 kg (enclosure 15 kg + module)

3.3 GAS CONNECTIONS

Sample supply connection: **6 mm compression fitting** (Swagelok-type), tube outer diameter 6 mm. The module is supplied with a 90° elbow fitting; if necessary the elbow is replaced by a straight fitting. **Each flange can be either inlet or outlet.** In the R version the module flanges are piped to bulkhead fittings on the **rear panel** (SAMPLE IN · SAMPLE OUT · PURGE / ZERO); in the W version to bulkhead fittings on the **bottom wall** of the enclosure.

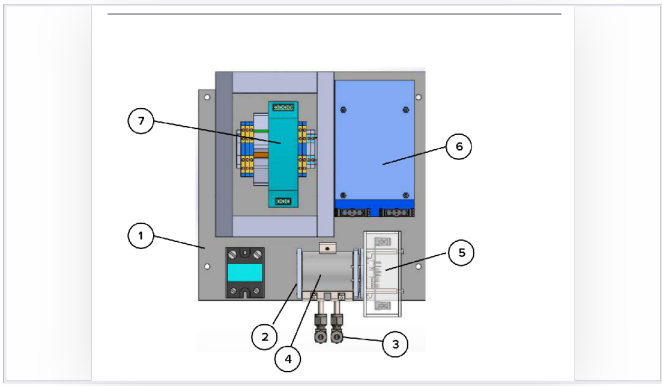


Fig. 2.1 — Analyzer module: 1 mounting plate · 2 optical cuvette · 3 gas inlet / outlet flanges · 4 heater · 5 signal-acquisition board · 6 motherboard · 7 power supply

3.4 CUVETTE · DETECTOR BLOCK · MOTHERBOARD · HEATER · COVER

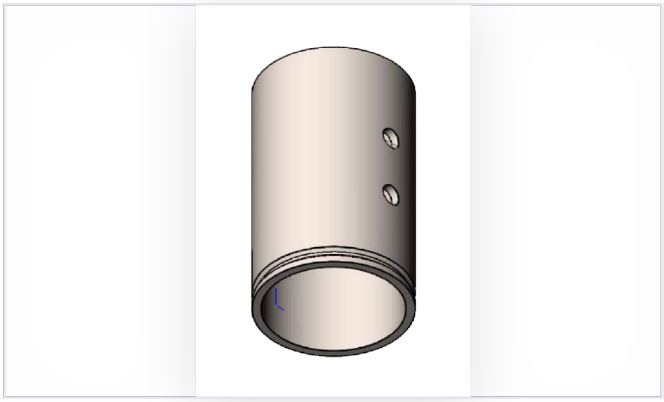


Fig. 2.3 — Cuvette

Cuvette. The cuvette is the load-bearing body of the optical system; the other components are mounted on it. It is a tube with two welded stainless-steel sample tubes; one end is closed by a stainless-steel focusing mirror, the other by the IR window. The inner wall carries a cylindrical insert faced for the sealing rings. Purpose — load-bearing body centring the optical components.

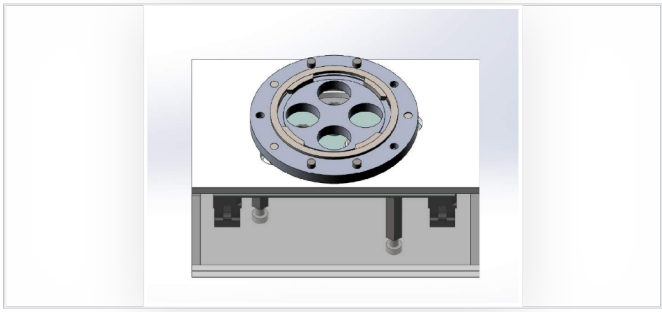


Fig. 2.4 — Receiver-emitter block

Receiver-emitter block. Mounted on the end face of the cuvette body: a board with the receivers and emitters, a protective housing and a metal flange for mounting on the cuvette. It contains the apertures for emitting and receiving IR radiation with primary electronic processing and output to the motherboard.

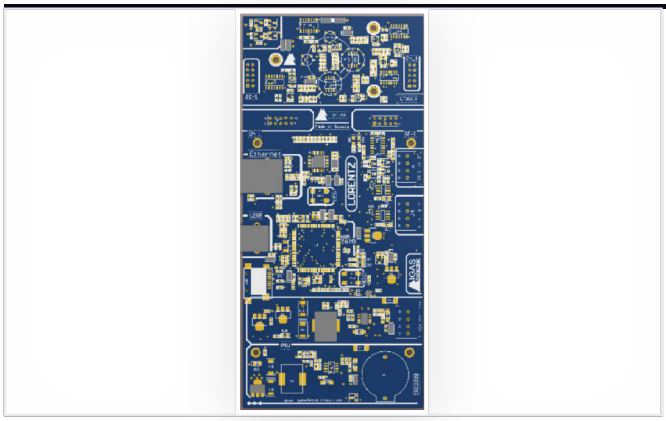


Fig. 3.1 — Motherboard and signal-acquisition board

Motherboard. Located next to the acquisition board under a protective acrylic panel; carries the CPU and connectors for peripherals. Functions: processing of acquisition-board signals · USB connection of the service utility · supply of the processor and actuators · RS-485 Modbus RTU and Ethernet Modbus TCP · SD card for configuration and event logging · battery compartment for the RTC · two open-collector digital outputs · PID control of the solid-state relay · RTD signal processing · X2X bus for Tremon extension modules.

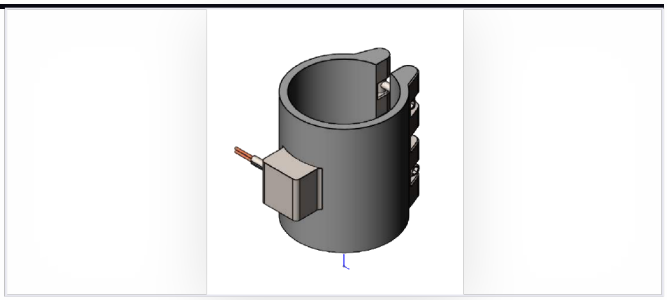


Fig. 3.2 — Heating element

Heater. Resistive clamp heater, stainless steel, fitted over the cuvette body; keeps the cuvette at the set temperature, preventing condensation on the optics and keeping the device at a stable temperature.

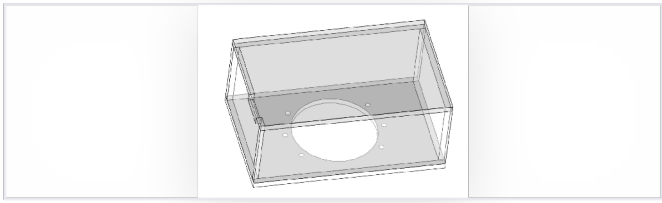


Fig. 3.3 — Acquisition-board cover

Cover. Shielding acrylic housing protecting the board and sensitive elements from external influences, radiation and noise.

4 TECHNICAL DATA

4.1 ANALYZER

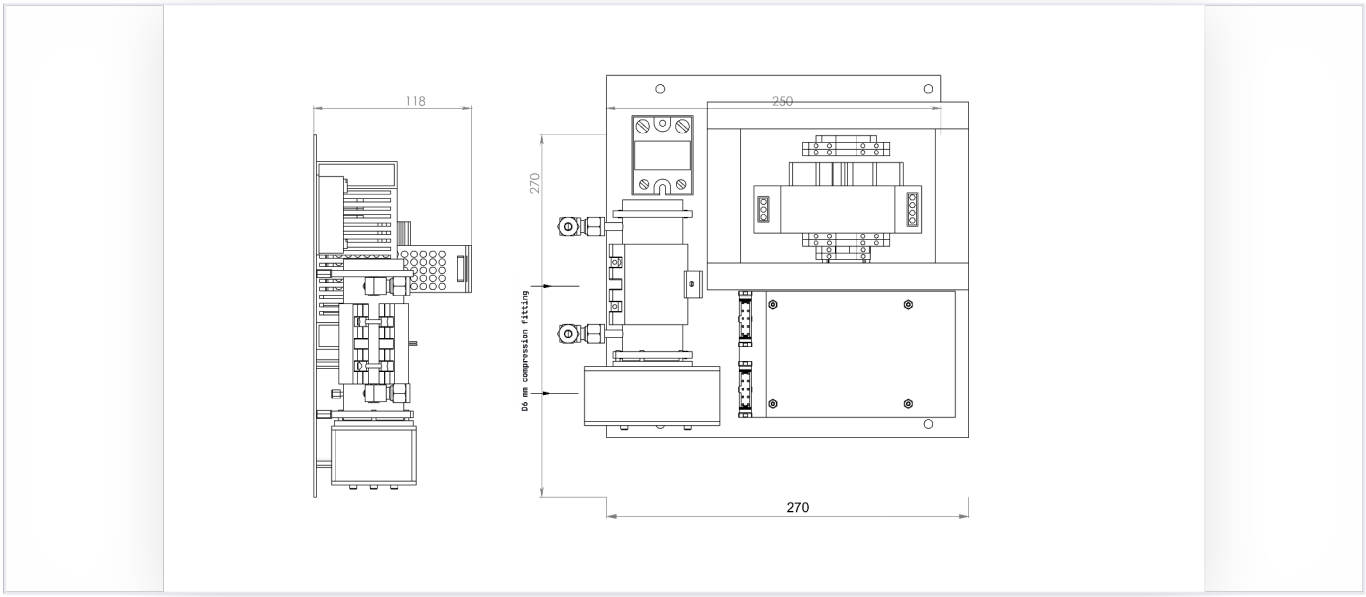
Measuring principle	NDIR — non-dispersive infrared absorption, mid-IR; broadband solid-state emitter, multi-channel detector
Measuring channels	1 to 7 gas channels per cuvette (up to 8 registers); 1 or 2 IR emitters, up to 2 detectors per cuvette
Optical cuvette	stainless steel, chemically resistant seals to 250 °C; heated, thermostatted (3 temperature sensors)
Sample connection	6 mm compression fitting (Swagelok-type), stainless steel; 90° elbow supplied, straight on request; either flange may be inlet
Sample pressure	0.9 – 1.1 bar abs
Sample flow	300 – 600 sccm (recommended 300 – 500 sccm)
Sample temperature	< 90 °C, stable within 3 °C
Sample quality	ISO 8573-1:2001 class 2 — particles ≤ 5 µm, ≤ 10 particles/m³; oil ≤ 0.1 mg/m³; dew point −40 °C
Detection limit	< 2 % of range
Cross-sensitivity	< 4 % (software-corrected; free wavelengths or extra correction channels)
Linearity	≤ ±2 %
Response time	T90 < 30 s (NH_3: T90 < 40 s)
Temperature influence	< 3 % of range per 10 °C (thermostatted cuvette)
Zero drift	automatic periodic purge and zero recommended (every 2 weeks)
Interfaces	RS-485 Modbus RTU (slave, 9600 bd, 8N1, addr. 1) · Ethernet Modbus TCP · USB-B service port · µSD (configuration & log)
Outputs	2 open-collector digital outputs · PID-controlled solid-state relay for heater · X2X bus for Tremon extension modules
Power supply	220 V AC ±10 %, 48 – 62 Hz, single-phase; internal 24 V DC supply
Power consumption	max. 250 W with heater on
Operating temperature	+10 … +30 °C (electronics); storage −25 … +60 °C
Relative humidity	< 75 %
Special versions	high-temperature — cuvette heated to 200 °C · 2–3 cuvettes in series · alternative wetted materials · ¼" Swagelok / PTFE

4.2 MEASURING RANGES

Standard full-scale ranges per channel (smartGAS FLOWEVO-compatible catalogue, September 2026); other gases and ranges on request. Gas-to-register assignment is marked on the device.

GAS	NAME	STANDARD MEASURING RANGES (FULL SCALE)
CO_2	Carbon dioxide	100 · 500 · 1000 · 2000 · 5000 · 10 000 ppm · 2 · 5 · 10 · 20 · 30 · 50 · 100 vol%
CO	Carbon monoxide	2000 · 5000 · 10 000 ppm · 2 · 5 · 10 · 15 · 20 · 30 · 50 · 100 vol%
CH_4	Methane	2000 · 5000 · 10 000 ppm · 2.5 · 5 · 10 · 15 · 50 · 100 vol%
SF_6	Sulfur hexafluoride	50 · 1000 · 2000 · 5000 ppm · 100 vol%
N_2O	Nitrous oxide	500 ppm
SO_2	Sulfur dioxide	2000 ppm
C_2H_4	Ethylene	2000 ppm
SO_2F_2	Sulfuryl fluoride	100 ppm · 4 · 6 vol%
CH_3Br	Methyl bromide	5.8 · 35 vol%
NH_3	Ammonia	200 · 1000 ppm
CO_2 in Ar	Carbon dioxide in argon	30 · 50 vol%
Biogas	CH_4 / CO_2	CH_4 5 · 50 · 100 vol% · CO_2 5 · 50 · 100 vol%

4.3 DIMENSIONS



General view of the analyzer module — plate 270 × 270 mm, module height 118 mm, length 250 mm; D6 mm compression fittings

5 OPERATION

5.1 CONTROL & START-UP

The analyzer module itself has no local controls; the 7" touch-screen of the R and W versions shows readings, the event log and the zero / span calibration pages, and all data are available over RS-485 or Ethernet. The analyzer switches on when the circuit-breaker (W) or the rear switch (R) is closed and starts automatically. Boot sequence:

- All LEDs on the motherboard light for 0.5 s.
- Configuration is read from the SD card; on successful access the SD LED lights green.
- After successful boot the CPU LED lights green.
- Normal operation is indicated by periodic blinking of the two green LEDs next to connector SE-1.

5.2 RS-485 CONNECTION

PARAMETER	VALUE
Protocol	Modbus RTU
Device type	Slave
Baud rate	9600 bd
Address	1
Interface	RS-485, two-wire
Functions	03 read registers · 06 write register · 16 write multiple
Registers per frame	max. 20
Parity / data / stop	none / 8 bit / 1 bit

> **CAUTION**
> Do not connect the analyzer to the mains until all cables are routed and checked. In the W version the internal circuit-breaker Q1 feeds the 24 V DC supply and the heater SSR; in the R version the IEC inlet on the rear panel (switch and fuse) carries the mains.

5.3 MODBUS REGISTER MAP

REGISTER	TYPE	DESCRIPTION	R / W
1 … 8	int	Gas concentration, channels 1–8, in calibration units	R
101 … 108	byte	Signal gain coefficients, 1 ... 252	W
109	bool	Store gain coefficients to non-volatile memory	W
111 … 118	byte	Signal gain coefficients (readback), recommended 1 ... 252	R
120	int	IR source duty cycle, recommended 35 ... 350	W
121	int	IR detector duty cycle, recommended 150 ... 900	W
122	int	Detector sampling period, ms, recommended 1 ... 3	W
123	byte	Device address on RS-485 network	W
124 / 125	int	Cuvette temperature set-point (write / read)	W / R
126	bool	Heater on / off	W
129	bool	Store parameters to non-volatile memory (cycle time, sampling, address, heater set-point, heater switch)	W
130 … 133	int / byte	Readback: source duty, detector duty, sampling period, RS-485 address	R
141	byte	Current SSR state (open / closed)	R
143 … 150	bool	Write 1: bring detector signal to reading 200 (= zero)	W

REGISTER	TYPE	DESCRIPTION	R / W
152	bool	Store the signal-to-200 coefficients	W
158	bool	Reset calibration curve to factory on selected channel	W
159	bool	Store calibration curve to non-volatile memory	W
160	bool	Set zero on selected channel	W
161	int	Set span with calibration gas on selected channel (write concentration)	W
541 … 548	int	Raw detector signal	R
561 … 568	int	Averaged signal	R
581 … 588	int	Signal after noise filter	R
621 … 628	int	Signal normalised to 200	R
641 … 648	int	Concentration	R
721 … 732	int	Signal delta in noise filter	R
741 … 752	int	Signal smoothing coefficient (typ. 4 ... 15)	R
941 … 952	int	Reserved	R / W
961 … 972	int	Number of measurements before processed output	W
1000	byte	Select channel number for zero / calibration operations	W
1001 … 1008	int	Calibration curve — detector-signal axis	R
1011 … 1018	int	Calibration curve — concentration axis	R
1999	byte	Motherboard restart command	W
2000	int	System status bits (1 = OK): b0 IR source 1 · b1 IR source 2 · b2 detector 1 · b3 detector 2 · b4 optics clean (0 = cleaning required) · b5 RTD OK · b6 zero calibration not required (0 = required) · b7 heater OK	R

6 SOFTWARE

6.1 READING CONCENTRATIONS · ZERO · SPAN

Concentrations: read registers 2 ... 8 with function 03; gas-to-register assignment is marked on the device.

Zero:

1. Select the channel — write the channel number to register 1000.
2. Purge the analyzer with nitrogen.
3. Set zero — write 0 to register 160.
4. Store to non-volatile memory — write 0 to register 159.

Span with calibration gas:

1. Select the channel — write the channel number to register 1000.
2. Feed the calibration mixture to the analyzer.
3. Wait until the reading in the channel register 581–588 stabilises.
4. Write the concentration of the calibration mixture to register 161.
5. Store to non-volatile memory — write 0 to register 159.

6.2 TREMON TGA SERVICE SOFTWARE

Visualisation, service settings, calibration and diagnostics use the **Tremon TGA** software (PC with Windows 7 or later; connection via RS-485 or USB A-B cable). Before connecting to the motherboard the buttons on the left of the start window are inactive; a demo mode is available without connection. Select the port, refresh the port list and press Connect.

Settings tab: change the RS-485 device address · switch from User to Engineer mode · enable data logging to a file on the PC.

Calibration tab: zero and span with calibration gas, with step-by-step instructions on the page.

Readings tab: the 8 channels in numeric and graphic form.

Service (Engineer mode, password). Four tabs:

1. **Signal processing** — electronic gain per channel. Emission and reception intensity differ per wavelength; to avoid clipping and to obtain maximum resolution set the intensity to about 3300. Recommended gain up to 252 (under some conditions the recommended intensity may not be reached at 252).
2. **Noise filter** — gain also amplifies noise; filtering is set per channel, smoothing coefficient typically 4 … 15. A higher coefficient slows the response but avoids false trips on temperature jumps or mechanical shock to the optics.
3. **Calibration file** — keep copies of the SD card (it holds the whole configuration); previously saved calibration files can be loaded per channel; the tab also resets the calibration curve to factory. The Restart button reboots the motherboard.
4. **Heater** — detector and cuvette temperatures in graphic and numeric form; cuvette set-point; heater on/off. **PWM** — synchronous emitter/receiver duty: a lower duty reduces noise and speeds the response but lowers resolution and loads the emitter.

> **NOTICE**
> Signal after switch-on settles within ~20 s. Example from the factory record: intensity 780 at gain 200; gain raised to 235 gives intensity 3416.

7 DIAGNOSTICS

7.1 LED INDICATORS & STATUS REGISTER

The system continuously self-diagnoses its units. LEDs on the motherboard allow a first visual check; the status is also available over the digital link.

LED	MEANING
1	IR emitter activity — blinks in normal operation
2	RS-485 data transfer
3	X2X bus data transfer to extension modules (optional)
4	S1 — PWM heater supply · S2 — RTD connected and OK · S3 — optical cuvette needs cleaning
5	Processor supply OK
6	IR-source and digital-communication supply OK
7	CPU running normally
8	SD card initialised, data available

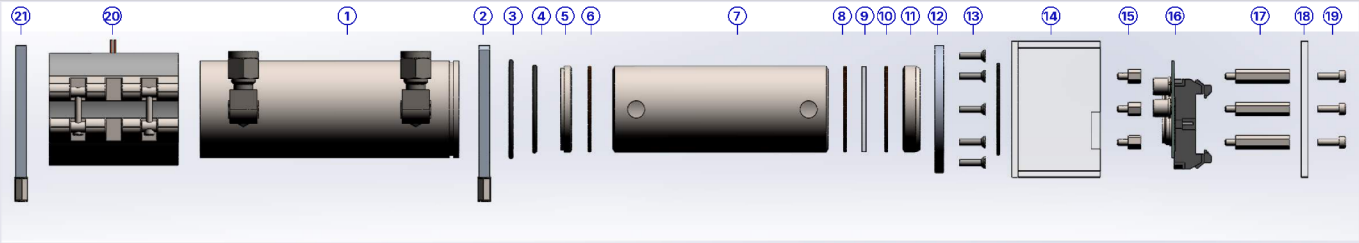
Register 2000 carries 8 status bits (1 = no error):

- IR emitter 1 OK
- IR emitter 2 OK
- IR receiver 1 OK
- IR receiver 2 OK
- Optics do not need cleaning (0 — cleaning required)
- RTD OK
- Zero calibration not required (0 — required)
- Heater OK

7.2 FAULTS AND REMEDIES

FAULT	ACTION
No LED lit on the motherboard	Check 220 V at the input breaker and 24 V at the power supply; check the supply reaches the board, no open circuits.
SD-card LED blinking	Check the card is seated correctly; if so, check the card is readable on a PC.
One of the two supply LEDs off	Contact Tremon service.
RTD LED off	Check the RTD connection to the motherboard; sensor resistance 1000 Ω.
No communication with the motherboard	Check the connection; confirm the CPU LED is green; restart the board with the Reset button.
IR source not working (LED lit)	Check ribbon cables between motherboard and signal board; emitter resistance 47 Ω; is the emitter LED blinking?
Detector fault	Make sure nothing in the cuvette blocks the beam completely; contact Tremon service.
Cuvette cleaning required	Disassemble the cuvette and clean the mirror, protective window and inner sleeve; replace the window if its thinnest point is < 1.5 mm.
Heater fault	Check wiring integrity; control signal reaching the SSR; supply leaving the SSR to the heater; heater resistance.

7.3 CUVETTE DISASSEMBLY FOR CLEANING



Assembly / disassembly — callouts 1–21: 1 cuvette body · 2 body stand · 3 external circlip · 4 mirror circlip · 5 mirror · 6 seal mirror/tube · 7 protective tube · 8 seal tube/window · 9 window · 10 seal window/ring · 11 centring ring · 12 clamping flange · 13 flange screws · 14 board housing · 15 board stand-offs · 16 acquisition board · 17 cover stand-offs · 18 housing cover · 19 cover screws · 20 heater · 21 free-mounting stand

CAUTION

Work in gloves and a mask. The protective IR window is fragile.

1. Shut off the sample supply to the cuvette.
2. Disconnect the power supply.
3. Wait until the cuvette has cooled to room temperature.
4. Remove the plate with the mounted components and place it on a flat, stable surface.
5. With a hex driver loosen the heater clamp (20).
6. Disconnect the RTD from the motherboard.
7. Disconnect the ribbon cables from the motherboard.
8. Undo the screws of stands 2 and 21 holding the tube.
9. Remove the stand from the tube on the mirror side (opposite the acquisition board).
10. Slide the heater (20) off away from the board, guiding the RTD leads carefully.
11. Undo screws 19 and remove cover 18.
12. Remove the ribbon cables from the acquisition board.
13. Put on gloves and undo stand-offs 17. Do not touch the optical windows of the detector and emitter.
14. Remove board 16; fit stand-offs 17 and screws 19 so that the board stands with the emitters facing down.
15. Undo stand-offs 15 and remove housing 14; take the seal out of flange 12.
16. Undo screws 13 and remove flange 12.
17. Remove centring ring 11.
18. The protective IR window is fragile — use no metal tools and no pressure on the window surface.
19. Carefully remove seal 10.
20. Lay a soft pad (foam, bubble wrap) on the surface.
21. Turn the cuvette window-end down onto the pad; if the window does not drop out (stuck to the seal), tap the cylindrical surface with a mallet until it does.
22. Remove seal 8.
23. Remove the inner sleeve 7 and seal 4.
24. Clean: mirror with isopropyl alcohol; window with a dry cloth and compressed air (clouding is not a reason for replacement — the system compensates and signals when replacement is needed; window thickness at the thinnest point ≥ 1.5 mm); unpolished internal metal surfaces with abrasive pads (Scotch-Brite type).
25. Reassemble in reverse order; inspect the O-rings before assembly and replace if necessary.

8 SPARE PARTS

ITEM (CALLOUT)	PART NO.	QTY PER KIT	DESCRIPTION
6, 8, 10	17-SPL01001	3 pcs	Chemically and heat-resistant seals
9	17-SPL01002	1 pc (2 in HT version)	Protective IR window
16	17-SPL01003	1 pc	Signal-acquisition board
–	17-SPL01004	1 pc	IR source
–	17-SPL01005	1 pc	IR detector, 2-channel
–	17-SPL01006	1 pc	IR detector, 4-channel
–	17-SPL01007	1 pc	Motherboard
–	17-SPL01008	1 pc	Power supply
–	17-SPL01009	1 pc	Solid-state relay
–	17-SPL01010	1 pc	Heater
–	17-SPL01011	1 pc	RTD PT1000

NOTICE

Order spare parts with the analyzer serial number. Seals, window and acquisition board are the consumables of the optical path; the IR source and detectors are matched to the channel configuration.

CONTACT

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