Oxygen Trim Control for Modulating Burners

The RPO25... is a programmable control unit that is used for measuring and controlling the residual oxygen content ($O_2$) of flue gases.

The control unit is suited for use with modulating single- or dual-fuel burners of any capacity.

The RPO25... and this Data Sheet are intended for use by OEMs which integrate the control unit in their products.
Use

Together with the QGO… oxygen sensor, the RPO25… measures and controls the residual oxygen content of flue gases. The oxygen content is controlled by driving correcting devices on the air or fuel side. In connection with RVW2… electronic air / fuel ratio control, use of an additional correcting air damper is not required. The RPO25… can be used as a control unit with temperature compensation and as an oxygen trim controller.

Application example

Warning notes

To avoid injury to persons, damage to property or the environment, the following warning notes should be observed!

Do not open, interfere with or modify the unit!

- Before performing any wiring changes in the connection area of the RPO25…, completely isolate the control unit from the mains supply
- Ensure protection against electric shock hazard by providing adequate protection for the control unit’s terminals
- Check to ensure that wiring is in an orderly state (refer to Basic Documentation P7847)
- Fall or shock can adversely affect the safety functions. Such units may not be put into operation, even if they do not exhibit any damage
Planning notes

• For details on planning, also refer to the Data Sheets of the relevant sensors (e.g. QGO20..., QAE21..., etc.) and actuators and valves (e.g. SQN..., VKF..., etc.)
• The RESET button for the acknowledgement of faults may only be pressed after the fault has been corrected. The error code(s) must be noted down to ensure that service staff will have the information required to rectify the fault
• Only with application «Output predefined via RVW20...» may the parameters «Load0%» and «Loa100%» (programming level 8) be set to 0 V and 10 V respectively. On all other applications, the default values ex factory must be adhered to (Load0%) and (Loa100%)

Mounting notes

• Ensure that the relevant national safety regulations are complied with
• When used with the ARG61.010 housing, the RPO25... is suited for flush panel mounting; with the ARG61.040, for wall mounting. If several modules are used, it is recommended to attach them together with their clips to form a subassembly
• Various mounting accessories are available for other mounting methods, such as control panel mounting with a tilting console (several modules attached together)
• When mounting the modules in a control panel, their fronts should be visible, e.g. through a plexiglass window, so that the signal lamps and the LCD can be seen
• Mount the screw terminal base upside down with terminal «32» facing upward and terminal «2» downward
• Make wiring in accordance with the plant wiring diagram
• The AZW20.20 handheld terminal may only be connected when commissioning or service work is carried out! The RPO25... is in programming mode as soon as the AZW20.20 is plugged in

Installation notes

• Installation work must be carried by qualified staff

Commissioning notes

• Commissioning work must be carried out by qualified staff
• To commission the RPO25..., the AZW20.20 handheld terminal is required. For the connection terminals and their assignment, refer to «Connection diagram»
• Observe the «Technical data»
• For additional information, refer to the Basic Documentation P7847 and the relevant application sheets

Standards

Conformity to EEC directives
- Electromagnetic compatibility EMC (immunity) 89 / 336 EEC
- Directive for gas-fired appliances 90 / 396 EEC
- Low-voltage directive 73 / 23 EEC
Service notes

- Maintenance work must be carried out by qualified staff.
- Each time a unit has been replaced, check to ensure that wiring is in an orderly state (refer to Basic Documentation P7847).
- Oxygen trim control of the RPO25... has an impact on the air / fuel ratio. Any change to a selected parameter value represents an interference into the burner and may therefore only be made by qualified service staff! Whenever parameters are changed, the emission levels must be checked again!
- The RPO25... controls the oxygen level. For that purpose, the QGO... sensor acquires the residual oxygen content of the flue gas. Precise control depends on accurate measurements. Since the sensor is subject to wear, it should be checked at regular intervals (for detailed information, refer to the relevant Data Sheets).

Disposal notes

The unit contains electrical and electronic components and may not be disposed of together with household waste. Local and currently valid legislation must be observed.
The RPO25... is designed as a plug-in type insert with European standard printed circuit boards (100 x 160 mm) and with two 32-pin DIN connectors, design D to DIN 41612.
The PR025... is always supplied without housing.
The control unit requires housing type ARG61.010 or ARG61.040 each with a 32-pole screw terminal base. The housings must be ordered separately (refer to «Ordering»).
The ARG61... housings are made of impact-proof plastic and feature a hinged transparent front cover.
The housings must be attached together with the help of clips (refer to Mounting instructions M7850.1).

Located on the front of the unit are:
- The hinged front plate. It can be sealed to prevent unauthorized interventions via the handheld terminal
- A hole for the seal (on the front plate, to the left below the type reference)

Located behind the hinged front plate are:
- Jack for AZW20.20 handheld terminal
- Exchangeable RZD20... data carrier, located behind the plastic front; plugged in from above. To do this, the RPO25... must be removed from its housing

1. LED for status indication «Oxygen trim control released»
2. LED for status indication «Fuel 1 active»
3. LED for status indication «Fuel 2 active»
4. 7-segment display (3 digits) for the operating phases, oxygen values and fault status indication
5. Operating mode selector
   - Position O2: Oxygen trim control and ϑ-function active
   - Position ϑ-KOMP: Oxygen trim control deactivated, only ϑ-function active
   - Position OFF: Both oxygen trim control and ϑ-function deactivated
6. RESET button (refer to «Monitoring»)
Ordering

**Oxygen trim control**  
RPO25.000B27  
- For modulating burners including plugged in RZD20… data carrier  
(supplied without housing)

**Oxygen sensor QGO20...**  
refer to Data Sheet 7842  
- For combustion plants operating on natural gas or light oil

**Flue gas collector** for use with the QGO20...  
AGO20.001  
- Length 180 mm  
AGO20.002  
- Length 260 mm

**Temperature sensor (LG-Pt 1000)**  
QAE21.1(B2)  
(refer to Data Sheet 1791)

**Temperature sensor QAE22.2 (LG-Ni 1000)**  
refer to Data Sheet 1791

**Handheld terminal** for programming, commissioning and service  
AZW20.20  
- With cable of 2 m  
KF8859  
- Extension cable of 20 m for use with the handheld terminal  
KF8860

**Data carrier (EEPROM)**  
RZD20

**Housing**  
ARG61.010  
- For flush panel mounting

ARG61.040  
- For wall mounting

**Actuators SQN...** (max. 3 Nm)  
refer to Data sheet 7808  
(Actuators SQM5... (max. 40 Nm)  
refer to Data sheet 7815

**Conductive plastic potentiometers** for actuators  
(refer to Data Sheet 7921)  
- 1000 Ω / 90°  
ASZ12.803  
- 1000 Ω / 135°  
ASZ12.833

**Compatible Burner controls**  
(refer to Data Sheet 7921)  
- LAL...  
- LFL...  
- LAE...  
- LFE...  
- LGK16...  
- LEC...  
- LOK16...

**Electronic air / fuel ratio control system RVW20...**  
refer to Data Sheet 7871  
**Electronic air / fuel ratio control system RVW25...**  
refer to Data Sheet 7872  
**Electronic air / fuel ratio control system RVW26...**  
refer to Data Sheet 7873  
**Compact universal controllers RWF40...**  
refer to Data Sheet 7865
## Technical data

### General unit data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains voltage</td>
<td>AC 230 V ±15 %</td>
</tr>
<tr>
<td>Mains frequency</td>
<td>50...60 Hz ±6 %</td>
</tr>
<tr>
<td>Power consumption (without sensor)</td>
<td>15 VA</td>
</tr>
<tr>
<td>Switching capacity of relays «Q6-Q7 / H»</td>
<td></td>
</tr>
<tr>
<td>- Voltage</td>
<td>AC 24...265 V</td>
</tr>
<tr>
<td>- Current at AC 230 V</td>
<td>0.005...2 A</td>
</tr>
<tr>
<td>- Current at AC 24 V</td>
<td>0.02...2 A</td>
</tr>
<tr>
<td>Switching capacity of control outputs</td>
<td></td>
</tr>
<tr>
<td>«Y1-Y11, Y2-Y22»</td>
<td></td>
</tr>
<tr>
<td>- Voltage</td>
<td>operating voltage</td>
</tr>
<tr>
<td>- Current</td>
<td>max. 0.005...2 A</td>
</tr>
<tr>
<td>Switching capacity of triac for oxygen sensor heating «Q4-Q5»</td>
<td></td>
</tr>
<tr>
<td>- Voltage</td>
<td>operating voltage</td>
</tr>
<tr>
<td>- Current</td>
<td>max. 1.5 A</td>
</tr>
<tr>
<td>Control inputs «Q2A, Q2B, Q3, F1, F2»</td>
<td></td>
</tr>
<tr>
<td>- Power ON</td>
<td>AC 175...265 V</td>
</tr>
<tr>
<td>- Power OFF</td>
<td>&lt; AC 64 V</td>
</tr>
<tr>
<td>- Input resistance</td>
<td>100 kΩ</td>
</tr>
<tr>
<td>Power supply temperature compensation element «G2»</td>
<td></td>
</tr>
<tr>
<td>- Voltage</td>
<td>DC 10 V</td>
</tr>
<tr>
<td>- Current</td>
<td>&lt; 1 mA</td>
</tr>
<tr>
<td>Terminal «X1» (actual O(_2) value)</td>
<td>DC 0...10 V (corresponding to the programmed O(_2) range)</td>
</tr>
<tr>
<td>- Internal resistance</td>
<td>470 Ω</td>
</tr>
<tr>
<td>Terminal «X2»</td>
<td>DC 0...10 V</td>
</tr>
<tr>
<td>Terminal TxD, terminal RxD RS-232 level, 9600 Baud, 8 data bit, 1 stop bit, no parity bit</td>
<td></td>
</tr>
<tr>
<td>Degree of protection of housing with ARG61...</td>
<td></td>
</tr>
<tr>
<td>- Front</td>
<td>IP 42, DIN 40050</td>
</tr>
<tr>
<td>- Base</td>
<td>IP 10, DIN 40050</td>
</tr>
<tr>
<td>Safety class</td>
<td>II to VDE 0631</td>
</tr>
<tr>
<td>Perm. Run time of actuators</td>
<td>20...120 s</td>
</tr>
<tr>
<td>Radio interference protection</td>
<td>to EN 55011</td>
</tr>
<tr>
<td>Connection terminals for</td>
<td></td>
</tr>
<tr>
<td>2 x 1.5 mm(^2) or 1 x 2.5 mm(^2)</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td></td>
</tr>
<tr>
<td>- With housing</td>
<td>approx. 1.34 kg</td>
</tr>
<tr>
<td>- Without housing</td>
<td>approx. 0.82 kg</td>
</tr>
<tr>
<td>Mounting position</td>
<td>optional</td>
</tr>
<tr>
<td>Fuses</td>
<td></td>
</tr>
<tr>
<td>RPO25... has 4 fuses</td>
<td></td>
</tr>
<tr>
<td>- F201</td>
<td>F2.5H250V fuse of sensor heating «Q4»</td>
</tr>
<tr>
<td>- F202</td>
<td>F2.5H250V fuse «Q6»</td>
</tr>
<tr>
<td>- F203</td>
<td>F2.5H250V fuse «Y2»</td>
</tr>
<tr>
<td>- F204</td>
<td>F2.5H250V fuse «Y1»</td>
</tr>
<tr>
<td>Oxygen measurement (Applying to measurement system QGO... / RPO25...)</td>
<td></td>
</tr>
<tr>
<td>Oxygen measuring range</td>
<td>0.2...20.9 % O(_2)</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 % O(_2)</td>
</tr>
<tr>
<td>Measuring accuracy</td>
<td>±5 % of the measured value, but not better than ±0.2 % O(_2) absolute</td>
</tr>
<tr>
<td>Supply air temperature sensor</td>
<td>LG-Ni 1000 / Pt 1000 Ω</td>
</tr>
</tbody>
</table>
Potentiometer
Refer to Data Sheet 7921
Resistance 1000 Ω
Angular rotation 90° / 135°

Safety extra
low-voltage inputs
Terminal «B1»
- Voltage measurement DC –25...+125 mV
- Voltage
- Impedance 68 kΩ

Terminal «B2»
- Voltage measurement DC 0...33 mV
- Voltage
- Impedance 2 MΩ to DC +5 V

Terminal «U3»
- Current measuring range DC 223...473 µA
- Voltage
- Impedance 10 kΩ

Terminal «B3»
- Voltage DC 0...10 V
- Impedance 130 kΩ
Damper positions
- Voltage
- Impedance min. DC 0.2 V
- max. DC 9.8 V
Humming voltage max. AC 50 mV

Terminal «B4»
- Voltage DC 0...10 V
- Impedance 130 kΩ

Terminal «Z1» (setpoint shift)
- Voltage DC 0...10 V
- Impedance 170 kΩ

Safety extra
low-voltage outputs
Terminal «U10»
- Voltage DC 10 V
- Current max. 20 mA

Environmental conditions
Transport DIN EN 60 721-3-2
Climatic conditions class 2K2
Mechanical conditions class 2M2
Temperature range -25...+70 °C
Humidity < 95 % r.h.

Operation DIN EN 60 721-3-3
Climatic conditions class 3K5
Mechanical conditions class 3M2
Temperature range 0...+60 °C
Humidity < 95 % r.h.

⚠️ Condensation, formation of ice and ingress of water are not permitted!
**Functions**

**Measurement of oxygen content**

The RPO25... controls and monitors the QGO... oxygen sensor and evaluates its measuring signal. When switching the RPO25... on, the measuring function is active, provided the QGO... is correctly connected and the operating mode selector on the front of the unit is set to «OFF». The measuring transducer of the RPO25... acquires the oxygen sensor’s cell temperature and controls it to the preselected setpoint of 700 °C. The measuring transducer converts the sensor’s signal to a linear output signal, proportional to the oxygen content of the flue gas, which is then delivered via terminal «X1» as a DC 0...10 V signal. The measuring system is ready to operate when the measuring cell’s working temperature is reached. Also, in programming mode, the condition of the oxygen sensor with regard to aging can be checked. During burner off periods, the RPO25... checks the internal resistance and the measuring cell’s response at 500-hour intervals.

**Oxygen trim control**

To start oxygen trim control, the operating mode selector on the front of the unit must be set to «O2». This also activates temperature compensation provided it is switched on and a temperature sensor is connected. The RPO25... is suited for use with 2 types of fuel. The operating state of the combustion plant and the selected type of fuel are acquired with AC 230 V signals, the heat output with an analog DC 0...10 V signal. The control function is only active during burner operation, which means that the RPO25... will enable oxygen trim control on completion of the delay time. The setpoint of oxygen trim control is dependent on both the heat output and the type of fuel. The control can be deactivated below a programmable output limit. For the definition of the output-dependent oxygen setpoints, a separately programmable curve (5 or 9 points) is available for each type of fuel. The controller calculates corrections based on the control deviation and the programmed control parameters. The correction, together with the correction of the supply air temperature, is translated into a correcting signal. The correcting signal of 0...100 % is delivered as a DC 0...10 V signal either to the RVW2... electronic air / fuel ratio control system or a 3-position converter with potential-free outputs for a correcting actuator. The OPEN contact for the actuator is an N.C. contact and the CLOSE contact an N.O. contact. This ensures that — in the event of a power failure — the actuator will travel towards «excess air».

**Supply air temperature compensation (ϑ-function)**

Using the supply air temperature compensation function, adequate consideration can be given to varying physical conditions (density) of the combustion air at different temperatures (summer / winter). The function generates a correcting signal that is fed to the oxygen trim control system. If oxygen trim control is deactivated (operating mode selector set to «ϑ-KOMP»), the ϑ-function drives the air damper to a preset position, which changes as a function of the supply air temperature fluctuations. To activate the function, the operating mode selector on the front of the unit must be set to «O2» or «ϑ-KOMP». When in the latter position, only the ϑ-function is activated. When the function is activated, it starts as soon as the burner is started up. In normal control mode («O2 on»), the function is always active if «ϑ-KOMP» has been activated with the AZW20.20. In addition to general use during burner startup, this function is particularly suited for plants with preheated combustion air.

**Control of actuator**

For special applications, a load-dependent basic curve can be programmed. Control of the correcting actuator follows that curve in the event of a malfunction or when oxygen trim control and temperature compensation are deactivated. The correcting actuator must be wired such that the oxygen content will drop as the correction increases.

**Data output**

Data output is ensured via RS-232 interface.

The data are prepared in a way that they can be displayed directly on a PC.

During burner operation, a standard protocol with the following data is delivered:

- Output
- Oxygen level (% O2)
- Oxygen setpoint (% O2)
- Correcting variable (%)
The 3-digit display provides the following information:

<table>
<thead>
<tr>
<th>Selector position</th>
<th>Displayed value</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₂</td>
<td>O₂ value in %</td>
</tr>
<tr>
<td>ϑ-KOMP</td>
<td>Temperature in °C</td>
</tr>
<tr>
<td>OFF</td>
<td>O₂ value in %</td>
</tr>
</tbody>
</table>

The RPO25... is programmed (menu-driven) with the help of the AZW20.20 handheld terminal. The terminal must be connected to the RPO25... via a cable. As the AZW20.20 is connected, the programming function will automatically be activated. A flashing fuel LED (1 or 2) indicates that the programming function has been activated.

During burner operation, it is also possible to trigger a measurement to automatically ascertain the oxygen control parameters. The basic positions and control parameters must be programmed separately for each type of fuel and each output point (5 or 9). In addition, it is possible to program the oxygen setpoints and the time interval from the moment the oxygen value stabilizes to the release of oxygen trim control. All values can be programmed accurately and quickly and be stored several times in nonvolatile memory (EEPROM). When replacing the RPO25..., the programmed values can be transferred to the new unit with the help of the RZD20 data carrier.

The RPO25... continuously monitors the oxygen sensor and the operating sequence. In the event of inadmissible operating states or system malfunctions, warnings or alarms will be delivered.

The RPO25... differentiates between various types of faults and their severity:

- **Warnings (indication by error code).** Warnings are automatically cleared as soon as the cause of the fault disappears. The readiness contact remains closed (message via the data interface). Warnings can be triggered by excess air, too low a temperature of the oxygen sensor’s measuring cell, etc.

- **Alarm (indication by error code).** Depending on the severity of the alarm, the RPO25... will trigger the following actions:
  - Message via the data interface and shutdown of oxygen trim control. The readiness contact remains closed
  - Burner shutdown. The readiness contact has opened

Alarms must be cleared. This can be done either by pressing the RESET button on the front of the unit (programming mode) or by switching mains voltage off and on again.

Alarms can be triggered by the following faults:
- Wrong position of actuator
- End switch position surpassed
- Measuring cell of oxygen sensor not connected

In the event of fault, the controller will ensure the maximum amount of excess air as defined by the basic position. If this is not possible, the burner will be shut down. All faults are displayed in plain text on a special level.
Connection diagram

Viewed from the rear (wall mounting)

Mains connections

- Y22
- Q2B
- Y11
- Y1
- Q2A
- Q6
- H
- Q3
- F1
- Q7
- F2
- L
- Q5
- Q4

Low-voltage connections

- RxD
- TxD
- GND
- U3
- B2
- B1
- B4
- B3
- U1
- GND
- Z1
- X2
- X1
- M
- G2
- M
- U10
- GND

Legend

- B1: Nernst voltage of oxygen measuring cell
- B2: Thermocouple voltage
- B3: Feedback signal actuator
- B4: Supply air temperature sensor
- F1: Input fuel 1
- F2: Input fuel 2
- G2: Power supply temperature compensation element
- GND: Ground feedback potentiometer, data output, shielding «X1»
- M: Ground for «B1, B2»
- Q2A / Q2B: Redundant input, release of burner operation
- Q3: Control input burner requisition
- Q4: Sensor heating QGO...
- Q5: Sensor heating QGO...
- Q6, Q7 / H: Readiness, alarms
- TxD / RxD: Serial data output / input
- U1: Input output signal (DC 0...10 V)
- U3: Signal temperature compensation element
- U10: Power supply feedback oxygen value (DC 10 V)
- X1: Output actual oxygen value (DC 0...10 V)
- X2: Output controller variable (DC 0...10 V)
- Y1: Control output OPEN, air damper actuator
- Y2: Control output CLOSED, air damper actuator
- Y11, Y22: Power supply actuators
- Z1: Input oxygen setpoint (DC 0...10 V)

Basic diagram

- RPO25...
- O2
- QGO...
- SA2
- DC 0...10 V
- 1: Fuel
- 2: Output DC 0...10 V
- 3: DC 0...10 V
- 4: Output DC 0...10 V
- 5: 100%
Application examples

Basic diagram of a combustion plant with a modulating single-fuel burner

Legend

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>Indication of readiness</td>
</tr>
<tr>
<td>B4</td>
<td>Supply air temperature sensor</td>
</tr>
<tr>
<td>BV1</td>
<td>Fuel value</td>
</tr>
<tr>
<td>EK</td>
<td>Remote reset button for RPO25...</td>
</tr>
<tr>
<td>G</td>
<td>Fan relay</td>
</tr>
<tr>
<td>LAL...</td>
<td>Burner control</td>
</tr>
<tr>
<td>LFL...</td>
<td>Burner control</td>
</tr>
<tr>
<td>LGK...</td>
<td>Burner control</td>
</tr>
<tr>
<td>LP</td>
<td>Air pressure switch</td>
</tr>
<tr>
<td>M</td>
<td>Actuator</td>
</tr>
<tr>
<td>Mon.1</td>
<td>Display of actual oxygen value</td>
</tr>
<tr>
<td>Pot.1</td>
<td>Setpoint shift</td>
</tr>
<tr>
<td>QGO...</td>
<td>Oxygen sensor</td>
</tr>
<tr>
<td>R</td>
<td>Potentiometer</td>
</tr>
<tr>
<td>RWF40</td>
<td>Boiler controller</td>
</tr>
<tr>
<td>SA1</td>
<td>Main air damper actuator</td>
</tr>
<tr>
<td>SA2</td>
<td>Correcting air damper actuator</td>
</tr>
<tr>
<td>TK...</td>
<td>Temperature sensor (OAE21 / 22)</td>
</tr>
<tr>
<td>U1</td>
<td>Input for output signal (DC 0...10 V)</td>
</tr>
<tr>
<td>VN</td>
<td>Nernst voltage</td>
</tr>
<tr>
<td>W</td>
<td>Limit thermostat or pressure switch</td>
</tr>
<tr>
<td>X1</td>
<td>Output actual oxygen value (DC 0...10 V)</td>
</tr>
<tr>
<td>X2</td>
<td>Output controlled variable (DC 0...10 V)</td>
</tr>
<tr>
<td>ß</td>
<td>Output</td>
</tr>
<tr>
<td>ø</td>
<td>Supply air temperature</td>
</tr>
</tbody>
</table>
Dimensions

Dimensions in mm

ARG61.040

ARG61.010

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Subject to change!