ZBXYAF

Oxygen sensor control circuit board

FEATURES

- **Control circuit board for all XYA series oxygen sensors**
- **Measuring ranges 0...25 % or 0...100 % oxygen or custom adjustable range**
- **Can be calibrated in normal air or any known O_2 concentration**
- **Automatic or manual calibration**
- **Linear 0...10 V, 4...20 mA and RS232 output of measured oxygen content**
- **High accuracy**

SPECIFICATIONS

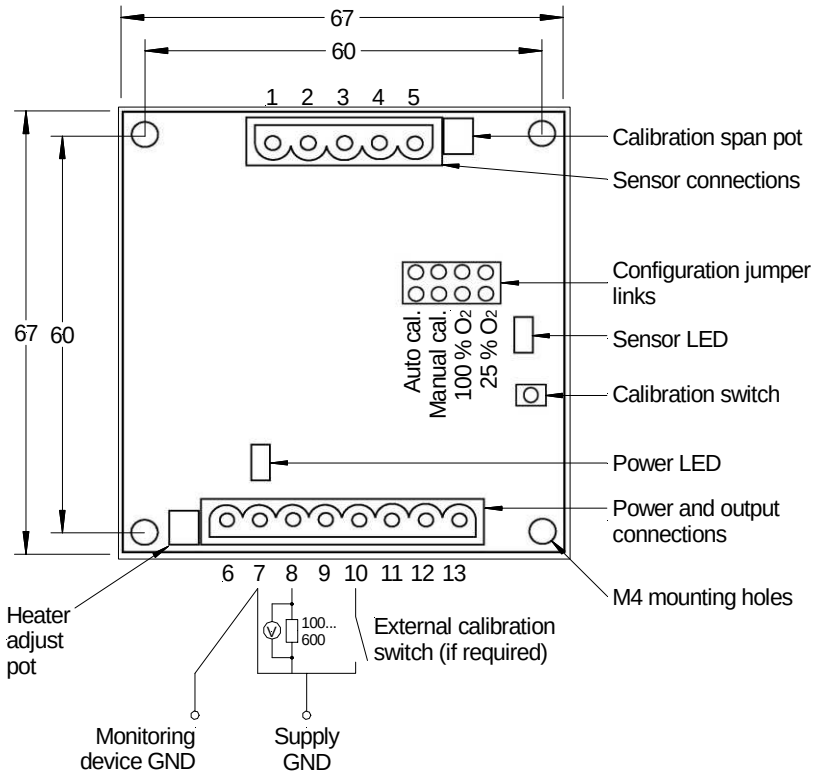
Maximum ratings

Supply voltage	24 V_{DC} ±10 %
Current consumption	600 mA @ 24 V_{DC}
Load limitation (4...20 mA)	100...600 Ω
Temperature limits	
Storage	-10...70 °C
Operating	-10...70 °C

PERFORMANCE CHARACTERISTICS (V_S = 24 V)

Characteristics		Min.	Typ.	Max.	Unit
Measuring ranges (oxygen partial pressure)[5]		1		1000	mbar
Accuracy				1	%FS
Repeatability				0.5	
Output resolution	0...10 V			0.01	V
	4...20 mA			0.01	mA
	RS232			0.01	%
Reaction time (adaptive output filtering in normal air)			1		s
Output inactive start up delay (heater warm up)			60		
Initial warm up time (till stable output)		5	10		min

OUTLINE DRAWING & ELECTRICAL CONNECTION



Pin	Connection
1	Sensor heater GND (yellow)[4]
2	Sensor heater + (yellow)[4]
3	Sensor sense (blue)
4	Sensor common (black)
5	Sensor pump (red)
6	24 V_{DC} ±10 %
7	GND[1]
8	4...20 mA output
9	0...10 V_{DC} output
10	Calibrate
11	Cycle[2]
12	RS232 Tx[3]
13	RS232 Rx[3]

Notes:
1. Due to high current flow in the supply GND, when monitoring the 0...10 V output it is recommended that a separate GND wire for the measurement system is taken from pin 7. This removes errors due to voltage drops in the power supply connections.
2. A digital 3.3 V_{DC} logic output cycles at the same frequency as the electrochemical pumping action of the oxygen sensing cell during normal operation, thus providing a real time sensor health check. If the output ceases to cycle the sensor has entered a start-up or error state. This provides fault proof operation.
3. When connecting the interface board via the RS232 connection ensure Tx goes to Rx of the PC and Rx goes to Tx of the PC. Baud rate should be set to 9600.
4. Heater coil has no polarity.
5. Prolonged operation below 1 mbar oxygen partial pressure can damage the sensing element.

OPERATING AND CALIBRATION NOTES

Heater adjustment:
Check the sensor heater settings: Using a volt meter measure the voltage across pin 1 and pin 2. The heater voltage should be 4.35 ±0.1 V_{DC} measured as close to the sensor as possible.The heater voltage is set by adjusting the HEATER ADJUST pot (see OUTLINE DRAWING on page 2).

Automatic calibration:
1. Ensure the ZBXYAF is configured for automatic calibration. See CONFIGURATION.
2. Place the sensor probe in the calibration gas, typically normal air. If automatic calibration should take place with a gas of a different known O_2 concentration see RS232 USER CONFIGURABLE OPTIONS on page 5.
3. Allow the output to stabilise for at least 5 min. (10 min. if powering from cold).
4. Apply GND to the CALIBRATE input (PIN 10) or press the on-board calibration switch for a minimum 12 s. During this 12 s the CYCLE output (PIN 11) and the green LED will go high/on, blink rapidly, go high/on, go low/off then return to cycling normally to indicate normal operation has resumed. At this point remove GND from PIN 10 or release the calibration switch.
5. The output will now track to the correct value for the calibration gas depending on the measurement range the ZBXYAF is configured for.
6. Calibration is complete and all stored memory values are retained on power loss.

If calibration is required with a different gas of known O_2 concentration and access to the RS232 menus with a PC is not achievable to change the automatic calibration percentage, a manual calibration may be performed.

Manual calibration:
1. Ensure the ZBXYAF is configured for manual calibration. See CONFIGURATION.
2. Place the sensor probe in the calibration gas, typically normal air.
3. Allow the output to stabilise for at least 5 min. (10 min. if powering from cold).
4. Apply GND to the CALIBRATE input (PIN 10) or press the on-board calibration switch for a minimum 5 s or until the CYCLE output and green LED blink at a steady 1 Hz. Remove GND from PIN 10 or release the calibration switch. Calibration is now initialised.
5. Adjust the calibrate span pot until the output equals the correct value of the calibration gas concentration (see table below for examples of calibration values).
6. Re-apply GND to PIN 10 or press the calibration switch for a minimum 5 s. During the 5 s the CYCLE output/LED will blink rapidly, go high/on, go low/off then return to cycling normally to indicate normal operation has resumed. At this point remove GND from PIN 10 or release the calibration switch.
7. The output will now track to the correct value for the calibration gas depending on the measurement range the ZBXYAF is configured for.
8. Calibration is complete and all stored memory values are retained on power loss.

O_2 concentration in normal atmosphere (1013 mbar pressure and typical humidity levels)	Calibration values			
	0...10 V output		4...20 mA output	
	0.1... 25 % Vol. O_2	0.1... 100 % Vol. O_2	0.1... 25 % Vol. O_2	0.1... 100 % Vol. O_2
20.7 %	8.28 V_{DC}	2.07 V_{DC}	17.25 mA	7.34 mA
90 %	-	9.0 V	-	18.4 mA
25 %	10.0 V_{DC}	-	20 mA	-
5 %	2.0 V_{DC}	0.5 V_{DC}	7.2 mA	4.8 mA

CONFIGURATION

The ZBXYAF boards can be user configured to measuring ranges of 0.1... 25 % Vol. O_2 and 0.1...100 % Vol. O_2. The entire measurement range is linear in both cases. Factory default is 0.1...25 % Vol. O_2. The ZBXYAF may be reconfigured at any time by adjusting the position of the header pin jumper links on the interface PCB (see OUTLINE DRAWING on page 2):

- Power down the ZBXYAF board
- Adjust the position of the jumper links to the desired configuration. Each jumper link must be placed in one of the two positions, either manual (MAN) or automatic (AUTO) calibration and 100 % or 25 % measuring range. Thin nosed pliers should be used to remove and replace the jumper links. Ensure the jumper links are correctly seated before reapplying the power.

WARNING:
Prior to re-configuration the ZBXYAF **must** be powered down. The jumper links **must** also be repositioned correctly and in the correct orientation. Failure to adhere to the above could result in product damage. Products damaged due to incorrect configuration will not be covered under warranty.

RS232 OPERATION

With the RS232 outputs connected to a PC or any other RS232 compatible device the user has the ability to access two modes of operation, continuous data streaming and the menu screens. Recommended programs for communicating via PC serial RS232 are Hyperterminal (Windows default), Teraterminal and PuTTY. A freeware PuTTY program can be downloaded from http://the.earth.li/~sgtatham/putty/latest/x86/putty.exe

Continuous data streaming

On power up, after the initial 60 s heater delay, the ZBXYAF will automatically begin outputting the measured O_2 concentration and sensor T_d as both an averaged and raw value. The averaged values give a stable output with the amount of averaging user variable whilst the raw unaveraged values allow the user to detect sudden oxygen changes. The averaged value is the measurement output on both the 4...20 mA and 0...10 V_{DC} outputs. The sensor T_d value is the measure of the partial pressure of oxygen in the measurement gas. The O_2 concentration (%) is the T_d value scaled by the stored calibration value. To stop or restart the data streaming ‘s’ (lower or upper case) should be sent to the unit. Data streaming automatically ceases during calibration.

Menu screens

If the ZBXYAF receives an enter character from the connected PC or device it automatically enters the menu password screen and stops outputting O_2 % and T_d values. After the correct password is entered followed by the enter character, the menu screens are accessed. The menu screens are primarily for diagnostics and information although there are user configurable options that may be changed. These are the automatic O_2 calibration %, the amount of output filtering (averaging) and the analog output ranges. All three processes are described below. The menu access password may also be changed by the user.

Changing the menu access password

The password is factory set to **‘default’**. This however may be changed to a user specific password.

- Connect the ZBXYAF via the RS232 interface to the PC.
- Press Enter then enter your current security password. Press Enter to access the menu screen.
- In the Configuration menu (menu 2) enter ‘3’ to access the password menu screen.
- Enter the new password then press Enter to save.
- The new password is now stored in memory and is retained on power loss.

Pressing ESC returns the screen to the previous menu.

RS232 USER CONFIGURABLE OPTIONS

Note: When navigating the menu screens pressing ESC returns to the previous screen.
Pressing ESC on the front menu screen returns the output to Continuous Data Streaming.

Changing the automatic calibration value

The system is factory set to automatically calibrate to 20.7 % O_2 to allow simple calibration in normal air. This value takes into account average humidity in the atmosphere. If calibration with a gas of a different known O_2 concentration is required the factory set value may be changed via the RS232 interface.

- Connect the ZBXYAF via the RS232 interface to the PC.
- Press Enter then enter your security password. Press Enter to access the menu screen.
- In the configuration menu (menu 2) enter the auto calibration value screen (option 1 - Enter Auto Calib).
- The number entered should be the oxygen concentration (%) of the calibration gas to 2 decimal places. Press Enter to save.
- The new automatic calibration value is now stored in memory. This value is retained on power loss.

Variable output filtering (T_d averaging)

The ZBXYAF is factory default to use adaptive output filtering to give an optimum balance between output stability and response to oxygen changes. However this balance may be altered by the customer to suit the needs of the application.

- Connect the ZBXYAF via the RS232 interface to the PC.
- Press Enter then enter your security password. Press Enter to access the menu screen.
- In the Configuration menu (menu 2) enter the Td average screen (option 2 - Enter T_d Averaging).
- The number entered should be between 0 and 200. 0 for adaptive filtering (recommended), 1 for a very fast and dynamic output response but relatively unstable to 200 for an extremely stable output but slow response to oxygen changes. Press Enter to save.
- The new averaging value is now stored in memory. This value is retained on power loss.

Adjusting a custom measurement range for analog outputs (4...20mA and 0...10VDC)

The ZBXYAF is factory default to output a range of 0.1... 25 % Vol. O_2 via its two analogue outputs. This range can be expanded to 0.1... 100 % Vol. O_2 (see CONFIGURATION above). When the unit is reconfigured to output 0.1... 100 % Vol. O_2 the user also has the option to fully customise the output via RS232. This is extremely useful in applications where the O_2 variation is within a narrow band as it allows the analog outputs to be tailored to this limited range.

- Ensure the ZBXYAF is configured for 0.1... 100 % Vol. O_2 operation (see CONFIGURATION above).
- Connect the ZBXYAF via the RS232 interface to the PC.
- Press Enter then enter your security password. Press Enter to access the menu screen.
- In the configuration menu (menu 2) enter the maximum range screen (option 3 - Enter O_2 Max Range).
- The number entered should be between 1.00 and 100.00 to represent the maximum output range.
- Press Enter to save, then ESC to return to the configuration menu.
- Enter the minimum range screen (option 4 - Enter O_2 Min Range).
- The number entered should be between 0.00 and 99.00 to represent the minimum output range.
- Press enter to save. The new ranges are now stored in memory and are retained on power loss.

The custom range adjustment does not apply to the RS232 output and is overruled if the unit is reconfigured for 0.1... 25 % Vol. O_2 operation.

ERROR CONDITIONS

If the oxygen sensor is not connected up correctly or is damaged the ZBXYAF will highlight this by blinking the CYCLE output (Pin 11) and green LED in a 3 short blinks 1 long blink pattern. An error code is also displayed on the RS232 output. If an error condition occurs the unit should be powered down and all wiring checked before reapplying the power.