aeroqual

SM50

USER GUIDE

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1. Description

The Aeroqual SM50 range of gas sensor modules provides state of the art gas measurement in a flexible cost effective package. They utilise Aeroqual's GSS Technology to provide reliable and sensitive measurement for a wide range of gases. There are two gas response specifications available - "Standard" for industrial process control or leak detection applications and "High Spec" for low level ambient gas measurements. Furthermore the modules are available in diffusion, fan and pump sampling versions. Please consult your Aeroqual Business Development Manager for further information.

Each SM50 module is calibrated to give a linear output with gas concentration. There are multiple outputs fitted as standard including diagnostic LEDS, 0-5V signal, relay, RS232, and RS485 digital communications. I2C is available as an option.

Standard inputs include dipswitch settings for the relay and calibration buttons. Optional inputs include two analog voltages.
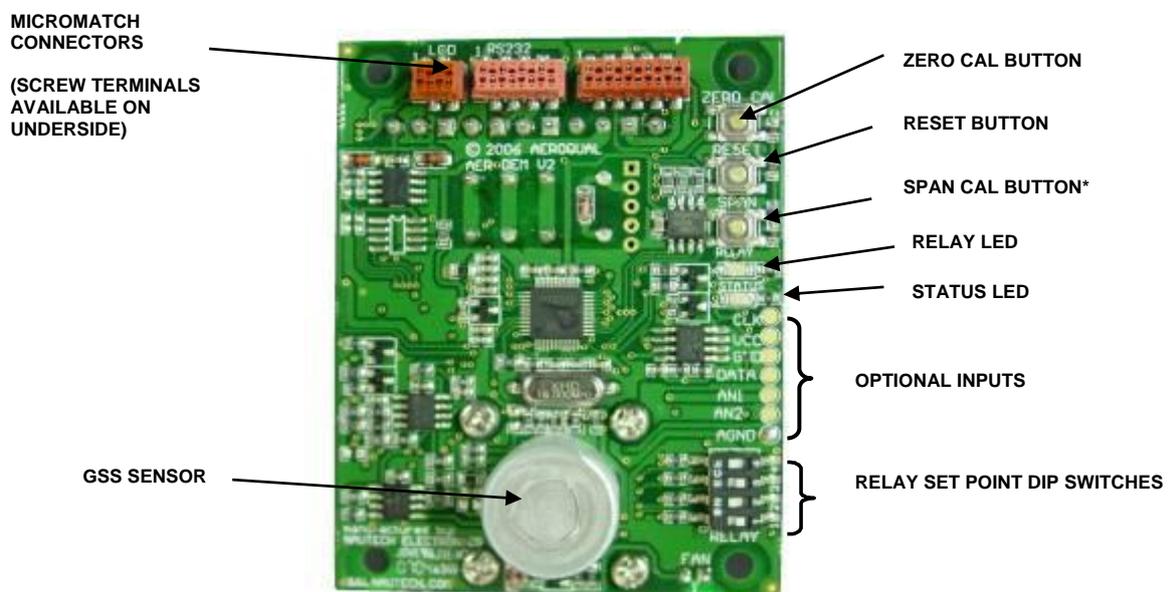
* This button will change the span calibration of the SM70 and **should not be activated for any reason**

2. Operating Instructions

2.1.   Power

The SM50 module will run off a DC input voltage in the range 11 - 24 VDC. Connect power to the V+ and GND screw terminal connectors or to the VIN and GND pins on the micromatch connectors. Power consumption varies depending on the SM50 sensor in the range 2.5 to 6W.

2.2.   Warm Up

The SM50 module is designed to run continuously. On first time use or after a period of non-use the SM50 module should be run for a couple of hours to burn off contaminants on the sensor. When power is switched on the SM50 will warm up for 3-10 minutes before full operation.

2.3.   Input and Output signals

The SM70 sensor board contains a number of buttons, LEDs and a dipswitch.

2.3.1. ZERO CAL

This button activates a zero calibration routine on the sensor. It should only be pushed when you are performing a zero calibration.

2.3.2. RESET

This button resets the SM50 without needing to remove the power from the SM50.

2.3.3. SPAN

This button will change the span calibration of the SM70 and **should not be activated for any reason**.

2.4. Using the Relay Output

The SM50 sensor module can be used as a simple gas sensitive relay switch to control devices or activate alarms using the on board relay. Three relay control software options are available: **AA, AB, C10**. The user should specify the software prior to delivery. The relay logic of the three software versions is described below. External equipment connected to the on-board relay should be wired appropriately to the normally open or normally closed contacts

AA Alarm-Above: the relay is programmed to energise or activate above the selected set point. Typical applications are health and safety alarm/warning systems or switching external equipment on and off. **This is the default software.**
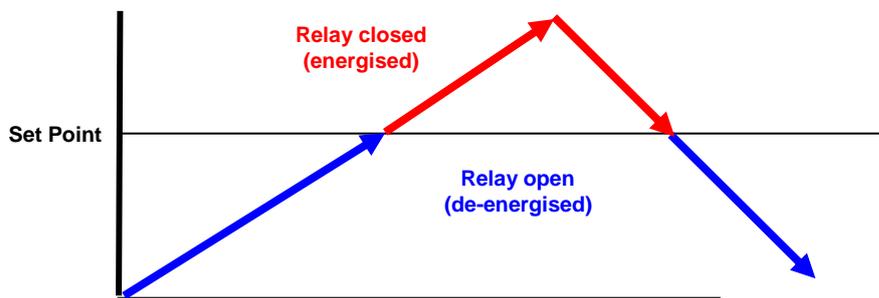
- When gas concentration is rising from below the "Set Point", relay de-energised (relay NO=open, NC=closed)
- When gas concentration rises and reaches the "Set Point", relay is energised (relay NO= closed, NC = open)
- When gas concentration drops and reaches the "Set Point", relay de-energised (relay NO=open, NC=closed)

AB Alarm-Below: the relay is programmed to energise or activate below the selected set point. Typical applications are fail safe warning systems or controlling a gas generator.
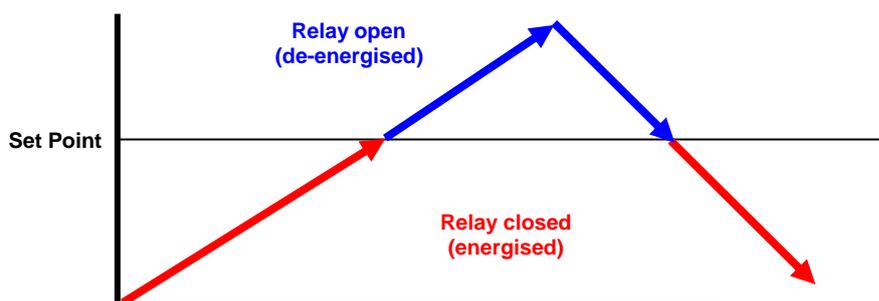
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- When gas concentration is rising from below the "Set Point", relay energised (relay NO= closed, NC = open)
- When gas concentration rises and reaches the "Set Point", relay is de-energised (relay NO= open, NC = closed)
- When gas concentration drops and reaches the "Set Point", relay energised (relay NO=closed, NC=open)

C10 The relay is programmed to open and close around the selected control set point ±10% to create a "control band". Typical application is for maintaining a specific gas concentration between user defined levels through the control of an external device e.g. ozone generator.
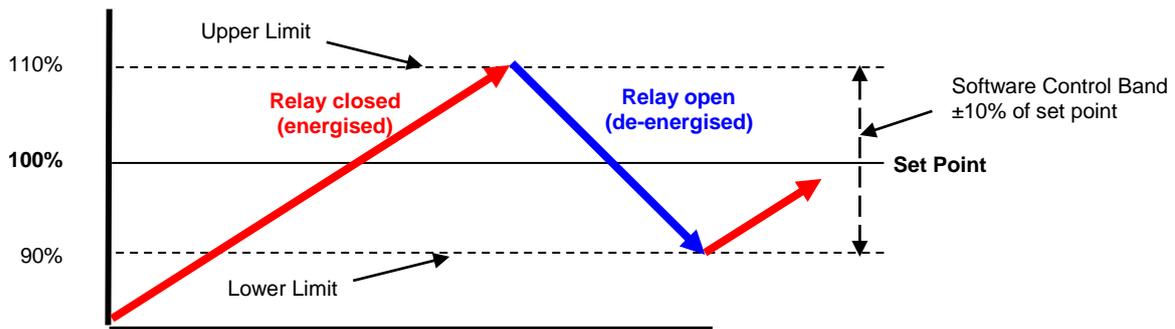
- When the gas level is rising from below "Lower Limit" to "Upper Limit", relay is energised, (NO=closed, NC = open)
- When gas level is falling from above "Upper Limit" to "Lower Limit", relay is de-energised (NO=open, NC = closed)

2.4.1. Setting the Relay and Alarm Set Point

The Relay Set Point can be altered by adjusting the set-point dip-switches as shown below. The Relay Set Point is factory set (unless otherwise specified) to OFF-ON-OFF-ON. The set point levels for different dipswitch settings are provided below for some sensors. Contact Aeroqual if your sensor is not listed.

Note: The relay and sensor diagnostics are inactive during the warm up period.

| Relay dipswitch (1 2 3 4)	O3 0-0.150 (ppm)	O3 0-0.500 (ppm)	O3 0-10 (ppm)	VOC Isobutylene (ppm)
on on on on	0.000	0.000	0.00	0
off on on on	0.010	0.025	0.50	1
on off on on	0.020	0.050	1.00	2
off off on on	0.030	0.075	1.50	3
on on off on	0.040	0.100	2.00	4
off on off on *	**0.050**	**0.125**	**2.50**	**5**
on off off on	0.060	0.150	3.00	6
off off off on	0.070	0.175	3.50	7
on on on off	0.080	0.200	4.00	8
off on on off	0.090	0.225	4.50	9
on off on off	0.100	0.250	5.00	10
off off on off	0.110	0.300	6.00	12
on on off off	0.120	0.350	7.00	14
off on off off	0.130	0.400	8.00	16
on off off off	0.140	0.450	9.00	20
off off off off	0.150	0.500	10.00	25

* Factory default setting

2.4.2. Connecting to the Relay Outputs

The relay output is a set of volt-free contacts that can be used to trigger an external device directly (max. 24V @ 2A) or for a higher voltage and current loads via a secondary relay. A typical external device is an alarm bell, siren, extractor fan, etc.

When the relay is energised (the red relay LED will light up) the normally open (NO) will short to common (COM) and the normally closed (NC) will be open with respect to COM.

Connect the desired external device to the normally open (NO), normally closed (NC) and COM contacts on the screw terminal as shown below.
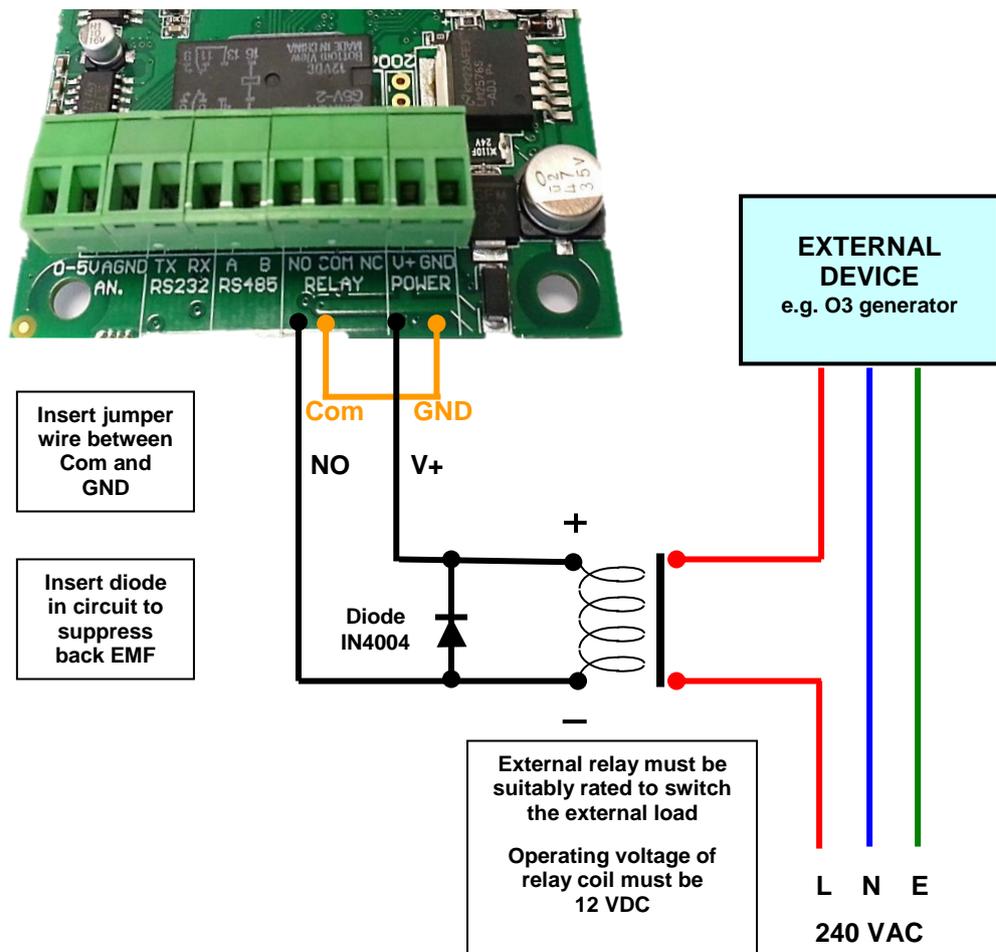
2.5. Status LED (Normal and Failure modes)

The status LED glows green and is located on the Sensor board. At start up, the Status LED will flash 2 to 6 times at an interval of 0.5 seconds. During the 3 to 10 minute warm-up time, the Status LED will flash at an interval of 2 seconds.

Normal status: Constant on
Sensor Failure: Flashes quickly at an interval of 0.3 seconds.

2.5.1. Relay LED

The relay LED glows red and is also located on the Sensor board. This LED comes on when the relay is energised.

2.6. Using the Analog 0-5V Output

The gas concentration is available as a 0-5V signal at the 0-5V and AGND connectors on the screw terminal block. 0 volts = zero ppm and 5 V = designated range of sensor (for example, a 0-0.5 ppm O_3 SM70 module would output 5V at 0.500 ppm ozone). The resolution of the analog signal is 8 bit.

Note: The 0-0.150ppm O3 sensor analogue output is 1.5V at 0.150ppm (full scale). All other sensors output 5.0V at full scale.

2.7. Using the Serial Digital Communications

Gas concentration data is available on the RS232 and RS485 digital communication channels. The RS485 channel is 2-wire, the RS232 is 2-wire plus GND. Connection is via the screw terminal connectors on the sensor board. The communication protocols for these serial interfaces are provided in the Appendix. Please note: the RS232 serial protocol is a proprietary format and is not ASCII. Hence a terminal program cannot be used to communicate with the SM50.
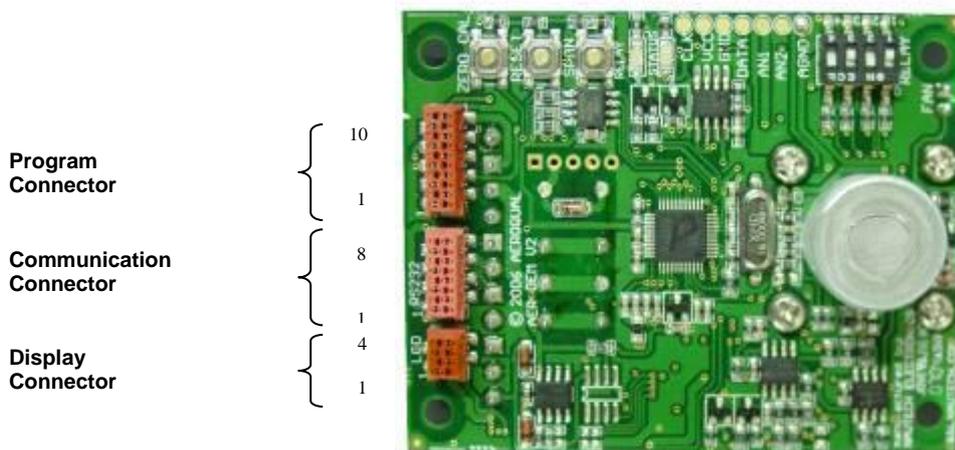
Program Connector

PIN	1	2	3	4	5	6	7	8	9	10
CONFIG.	VCC (5V)	BUSY	CLK	R x D RS485	GND	RESET	CNV	T x D RS485	N/A	VIN (11-24V)

Communication Connector

PIN	1	2	3	4	5	6	7	8
CONFIG.	VIN (11-24V)	GND	METER_TX (RS232)	METER_RX (RS232)	SPAN	ZERO	0-5V OUT (analog)	AGND (analog GND)

Display Connector

PIN	1	2	3	4
CONFIG.	VCC (5V)	SCL (clock)	SDA (data)	GND

3. Specifications

Power
Input	11 - 24 VDC
Consumption	2.5 - 6 W max

Outputs
0-5V analog	8 bit
Relay	Onboard 24VDC / 2A, NO, NC, COM
2 x LED indicators	Relay status Red = activated
	Sensor status Green = normal
	Green slow flash (2 seconds) = warming up
	Green fast flash (0.3 seconds) = failure
RS232	2-wire proprietary protocol (not ASCII)
RS485	2-wire proprietary protocol (not networkable)

Inputs
Relay set points	4-way dip switch
Zero calibration	Auto-calibration zero button
Reset	Microprocessor reset button
Span calibration	Factory use only
Analog inputs	2 Voltage (optional)

Diagnostics

If sensor failure then:-
Status LED	fast green flash
Relay	AA version (energised) LED red
	AB version (de-energised) LED off
	C10 version (de-energised) LED off
0-5V analog output	5V

Mechanical
Board Size	60 mm x 75 mm
Mounting	Screw or extrusion slot
Fan (if required)	On-board ball-bearing 50,000 hours
Sensor filter	On-board

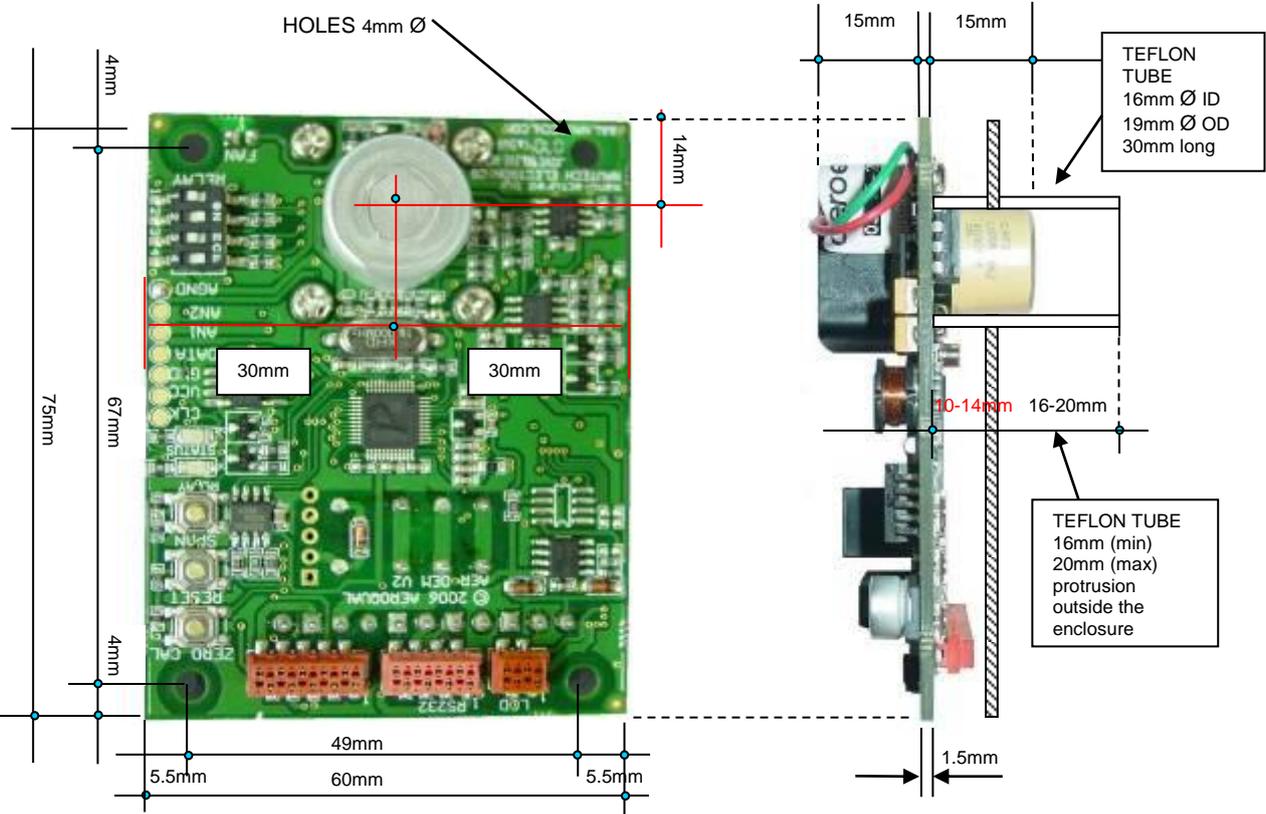**Environmental**
Operating temperature	0ºC to 50ºC (-20ºC to 50ºC if enclosed)
Operating humidity	5% to 95% RH (non-condensating)

Approvals

4. Mounting Dimensions

The mounting points and dimensions are given below for an SM50 ozone sensor. Individual SM50 modules may differ slightly to that shown.

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5. Appendix

5.1. RS232 Protocol

The Aeroqual OEM sensor's digital information output is based on the following RS232 protocol. These command protocols are specified by Aeroqual Limited, all rights reserved. Aeroqual reserves the right to change the protocol without notification.

Version 2.2
Date: 23-09-2009

* Added zero calibration function.
* Combined with temperature and relative humidity sensor data.

Section 1.

Descriptions of communication commands (for data format and representations please refer to section 3). Comma and spaces are not applied for every command and reply data stream, they are just used for clearly specifying data stream:

1. OEM sensor regular data report command; the data report interval varies with sensor.
  It is 15 bytes data stream:

SENSOR, DATA_REPORT, DATA1, DATA2, DATA3, RESERVED2, STATUS1, STATUS2, CHECKSUM

* SENSOR - 1 byte monitor reply data stream header, see section 2 for its value.
* DATA_REPORT - 1 byte data report command, see section 2 for its value.
* DATA1 - 4 bytes floating point data, gas concentration value.
* DATA2 - 2 bytes unsigned int used for optional sensors of temperature reading, its value scaled up by 10.
          that means if the reported value is 256, then the actual reading is 25.6 Celsius degree.
* DATA3 - 2 bytes unsigned int used for optional sensors of relative humidity reading, its value scaled up by 10.
          that means if the reported value is 515, then the actual reading is 51.5%.
* RESERVED2 - is 2 bytes reserved.
* STATUS1 - 1 byte sensor status indication, refer section 3 for details.
* STATUS2 - 1 byte sensor status indication, refer section 3 for details.
* CHECKSUM - 1 byte the data stream's check sum - that makes the command stream total sum is zero.

2. OEM sensor information request command:

Command   RECEIVER, SENSOR_INFO, RESERVED1, CHECKSUM

Reply   SENSOR, SENSOR_INFO, VERSION_NO, DISPLAY, NMAE_LENGTH, SENSOR_NAME, RESERVED2, CHECKSUM

* RECEIVER - 1 byte information request command header, see section 2 for its value.
* SENSOR - 1 byte monitor reply data stream header, see section 2 for its value.
* SENSOR_INFO - 1 byte command see section 2 for its value
* VERSION_NO - 1 byte sensor version number, see section 2 for its value.
* DISPLAY - 1 byte, gas concentration value display format type, see section 2 for its value.
* NAME_LENGTH - 1 byte specify the sensor name byte length
* SENSOR_NAME - 7 bytes, the gas sensor name ASCII code, its valid bytes are specified by NMAE_LENGTH
* RESERVED1 - 1 bytes reserved use value 0x00.
* RESERVED2 - 2 bytes not used.

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* CHECKSUM - 1 byte the data stream's check sum - that makes the command stream total sum is zero.

3. OEM sensor concentration ppm to mg/m3 conversion factor request command:

Command   RECEIVER, CONVERT_FACTOR, RESERVED1, CHECKSUM

Reply   SENSOR, CONVERT_FACTOR, FACTOR, RESERVED8, CHECKSUM

* SENSOR - 1 byte monitor reply data stream header, see section 2 for its value.
* CONVERT_FACTOR - 1 byte command see section 2 for its value
* FACTOR - 4 bytes floating point conversion factor value, see section 3 for details.
* RESERVED1 - 1 bytes reserved use value 0x00.
* RESERVED8 - 8 bytes reserved.
* CHECKSUM - 1 byte the data stream's check sum - that makes the command stream total sum is zero.

4. OEM sensor zero calibration command, 4 bytes:

Command   RECEIVER, ZERO_CAL, RESERVED1, CHECKSUM

* ZERO_CAL - 1 byte (0x12) command to start zero calibration for the sensor, see section 2 for its value.
* RESERVED1 - 1 bytes reserved use 0x00.
* CHECKSUM - 1 byte the data stream's check sum - that makes the command stream total sum is zero.
* During zero calibration OEM status LED will slowly flash, once the flash finished, zero calibration
* finished too.

Section 2.

Protocol command values:

RECEIVER   = 0x55   //header command used for receiver command
SENSOR   = 0xAA   //header command used for monitor reply
DATA_REPORT   = 0x10   //regular data report command
ZERO_CAL   = 0x12   //zero calibration command
SENSOR_INFO   = 0xFB   //parameters upload command
CONVERT_FACTOR   = 0x2A   //update monitor real time clock
RESERVED   = 0x00   //the byte not been used for information transfer

CHECKSUM   a data stream's check sum - that makes the command stream total sum is zero.
DISPLAY display format can be following:

        = 0x01 - 1 digit int, 3 decimal points, eg. 0.500 ppm

        = 0x02 - 2 digits int, 2 decimal points, eg. 12.20 ppm

        = 0x03 - 3 digits int, 1 decimal point, eg. 126.8 ppm

        = 0x04 - 4 digits int, no decimal point, eg. 2888 ppm

STATUS1 8 bits monitor and sensor status information
        SS0   * b0 \ 00 sensor working fine,
        SS1   * b1 / 01 sensor failure,
        11 sensor aging (for O3 LOW sensor only).
                        Reserved1   * b2 Reserved not been used
                        Reserved2   * b3 Reserved not been used
                        Reserved3   * b4 Reserved not been used
                        Reserved4   * b5 Reserved not been used

STATUS2   8 bits monitor and sensor status information

Reserved0	* b0 Reserved not been used
Reserved1	* b1 Reserved not been used
Zeroing	* b2 = 0 sensor normal working mode
	* b2 = 1 sensor zeroing
Reserved2	* b3 Reserved not been used
Reserved3	* b4 Reserved not been used
Reserved4	* b5 Reserved not been used
Reserved5	* b6 Reserved not been used
Reserved6	* b7 Reserved not been used

Section 3.

Data value format representation:

The floating point data values use IEEE754 32 bits floating point little ending representation. They are:

DATA1 and FACTOR

Section 4.

Data transfer mechanism

1. Due to the monitor main chips feature, 4 bytes floating point data and 2 bytes int data
   send sequence are low byte first, high byte last, such as section 3 data
   DATA1, DATA2, ADAT3 and FACTOR.

2. For regular data report:

The OEM sensor will automatically send out a measured data result to the RS232 serial port according
to sensor type. The data report interval will vary with different sensors. The longest report interval is about 2 minutes, the shortest one is only 2 seconds. Please ask Aeroqual for this information
when needed.

Section 5.

RS232 communication port settings:

Baud rate:	9600
Data bits:	8
Stop bits:	1
Parity:	none
Flow control:	none

5.2. RS485 Protocol

The Aeroqual OEM sensors digital information output is available on RS485. These command protocols are specified by Aeroqual Limited, all rights reserved. Aeroqual keep the rights to change the protocol without notification.

Version 1.0
Date: 05-12-2008

Section 1.

Descriptions of communication commands (for data format and representations please refer to section 3). Comma and spaces are not applied for every command and reply data stream, they are just used for clearly specifying data stream:

Aeroqual OEM sensor module RS485 protocol is a slave mode. Master receivers need send request command to get response.

1. OEM sensor data request command, it is 4 bytes data stream:

  BASE, DATA_REQUEST, RESERVED, CHECKSUM

  example: 0x55, 0x1A, 0x00, 0x91

  Reply data stream is 15 byte.

SENSOR, DATA_REPORT, DATA1, DATA2, RESERVED, STATUS1, STATUS2, CHECKSUM

The second byte (DATA REPORT) will be either 0x1A or 0x0F or 0x10.   Only if DATA REPORT = 0x10 will DATA1 be a valid concentration reading.

  * SENSOR - 1 byte monitor reply data stream header, see section 2 for its value.
  * DATA_REQUEST - 1 byte heater data report, see section 2 for its value.
  * DATA_REPORT - 1 byte gas concentration data report command, see section 2 for its value.
  * DATA1 - 4 bytes floating point data, when command reply is DATA_REPORT, this value is gas concentration in ppm,
  * DATA2 - reserved
  * RESERVED - is 2 bytes data space reserved.
  * STATUS1 - 1 byte monitor and sensor status indication, refer section 3 for details.
  * STATUS2 - 1 byte reserved.
  * CHECKSUM - 1 byte the data stream's check sum - that makes the command stream total sum is zero.

2. OEM sensor information request command:

  Command
BASE, SENSOR_INFO, RESERVED, CHECKSUM

  Reply
SENSOR, SENSOR_INFO, VERSION_NO, DISPLAY, NMAE_LENGTH, SENSOR_NAME, RESERVED, CHECKSUM

  * BASE - 1 byte information request command header, see section 2 for its value.
  * SENSOR - 1 byte monitor reply data stream header, see section 2 for its value.
  * SENSOR_INFO - 1 byte command see section 2 for its value
  * VERSION_NO - 1 byte sensor version number, see section 2 for its value.
  * DISPLAY - 1 byte, gas concentration value display format type, see section 2 for its value.
  * NAME_LENGTH - 1 byte specify the sensor name byte length

* SENSOR_NAME - 7 bytes, the gas sensor name ASCII code, its valid bytes are specified by NMAE_LENGTH
 * RESERVED - 1 byte
 * CHECKSUM - 1 byte the data stream's check sum - that makes the command stream total sum is zero.

Section 2.

Protocol command values are in hexdecimals not ASCII:

BASE = 0x55   //header command used for receiver command
SENSOR = 0xAA   //header command used for monitor reply
DATA_REPORT = 0x10   //regular data report command
DATA_REQUEST = 0x1A   //heater data request/report command
SENSOR_INFO = 0xFB   //parameters upload command

RESERVED = 0x00   //the byte not been used for information transfer

CHECKSUM * a data stream's check sum - that makes the command stream total sum is zero.
DISPLAY * display format can be following:
 = 0x01 - 1 digit int, 3 decimal points, eg. 0.500 ppm
 = 0x02 - 2 digits int, 2 decimal points, eg. 12.20 ppm
 = 0x03 - 3 digits int, 1 decimal point, eg. 126.8 ppm
 = 0x04 - 4 digits int, no decimal point, eg. 2888 ppm

STATUS1 * 8 bits monitor and sensor status information
SS0 * b0 \ 00 sensor working fine,
SS1   * b1 / 01 sensor failure,
11 sensor aging.

Reserved1   * b2 Reserved not been used
Reserved2   * b3 eserved not been used
Reserved3   * b4 Reserved not been used
Reserved4   * b5 Reserved not been used
Reserved5   * b6 Reserved not been used
Reserved6   * b7 Reserved not been used

Section 3.

Data value format representation:
The floating point data values use IEEE754 32 bits floating point little ending representation.
They are: DATA1, DATA2

Section 4.

Data transfer mechanism

Due to the monitor main chips feature, 4 bytes floating point data and 2 bytes int data send sequence are low byte first, high byte last, such as section 3 data DATA1 and FACTOR.

Section 5.
RS485 communication port settings:
Baud rate: 4800
Data bits: 8
Stop bits: 1
Parity: none
Flow control: none

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