

aeroqualTM

SM70

USER GUIDE



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1. For Your Safety

The Aeroqual SM70 Monitors are used to monitor ambient ozone gas concentrations. Aeroqual does not guarantee user safety. In hazardous environments, an appropriate Health and Safety plan should be in place. The SM70 contains no user serviceable parts. Return unit to Aeroqual or your Distributor for servicing. Use only approved accessories. When connecting to any other device, read the appropriate user guide for detailed safety instructions. Do not use the SM70 in an environment where flammable liquids, vapours, gases or combustible dusts are likely to occur in quantities sufficient to cause fire or explosion.

2. SM70 Components

The following components are supplied with the SM70 Monitor:

- SM70 Monitor
- 12 VDC AC/DC adaptor
- Enclosure mounting brackets
- User guide (<https://www.aeroqual.com/wp-content/uploads/SM70-User-Guide.pdf>)

Please check that all these components have been supplied and contact your dealer or Aeroqual via email at: technical@aeroqual.com if any of the components are missing.

3. About Your Monitor / Controller

The Aeroqual SM70 Monitor is designed for monitoring of ozone gases in an indoor environment. It can be supplied with three different firmware versions which control the internal relay in different ways depending on the application (see table below). The version installed is indicated on an internal label under the lid. Please ensure you have the version you require.

Table 1: SM70 firmware versions and description

Firmware	Description
AA	Alarm Above: the relay is energised when the reading is above the setpoint
AB	Alarm Below: the relay is energised when the reading is below the setpoint.
C10	Control 10%: the relay is energised to control the gas concentration to a band within +/-10% of the setpoint.

The SM70 enclosure is supplied pre-drilled with a cable gland to facilitate connection to the relay and communication terminations analogue output.

▲ IMPORTANT

- The SM70 is a sensitive instrument and should not be exposed to steam, water/chemical spray or high levels of dust. Doing so may significantly shorten the life of the sensor and impair accuracy.

4. Getting Started

4.1. *Installation*

Wall mounting brackets are provided and fit into the holes at each corner of the enclosure. Concealed, tamperproof screw fixing through the corner posts of the enclosure is also possible without using the fixing brackets. The SM70 should be installed at a location that is free from contaminants that might affect the performance of the sensor module.



4.2. *Turning the monitor on and off*

The SM70 is designed to run constantly. To turn the monitor on simply plug in the 12 VDC cable from the AC adaptor and turn on at the mains switch. To turn the SM70 off, switch it off at the mains switch.

4.3. *Warming up*

The SM70 sensor sometimes requires warming up to achieve a stable baseline. It has an inbuilt warming cycle of about 3 minutes. Under certain conditions, warm-up time may be longer. If it is the first time the monitor has been powered on it is recommended to run it for 24 hours for stable readings.

4.4. *External Wiring through the Cable Gland*

The SM70 enclosure is pre-drilled and fitted with a cable gland to facilitate a cable connection to the SM70 relay, data output connectors and analogue output.



Cable gland for RS232
or RS485 connection

5. Input and Output Signals

The SM70 sensor board contains LEDs and a dipswitch which are accessible once the sensor board is detached from the lid. See section 6.0

5.1. **RELAY Dipswitch**

The Relay dipswitch changes the set point for activation of the on-board relay. See section 4.3 for a description of the concentration set points.

5.2. **LEDs**

5.2.1. **Status LED**

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 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.

5.2.2. **Relay LED**

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

5.3. **Relay**

The SM70 sensor module can be used as a simple gas sensitive relay switch to control devices or activate alarms using the on-board relay. The relay has COM (common), NO (normally open), NC (normally closed) contacts. Three SM70 relay control firmware programs are available:

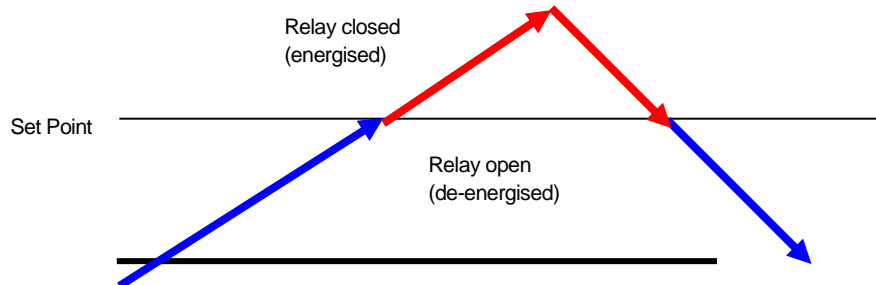
- Alarm Above (AA) – **This is the default software**
- Alarm Below (AB)
- Control 10% (C10)

The user should have specified the program installed prior to delivery. The relay logic of the three firmware versions is described below. External equipment connected to the on-board relay should be wired appropriately to the normally open or normally closed contacts.

6. Firmware

6.1. Alarm Above (AA) Firmware

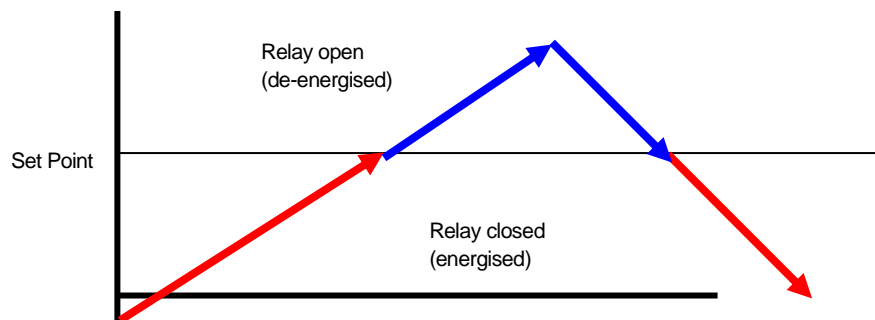
The relay is programmed to energise above the selected set point. Typical applications are health and safety alarm/warning systems or switching external equipment on and off.



- 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)

6.2. Alarm Below (AB) Firmware

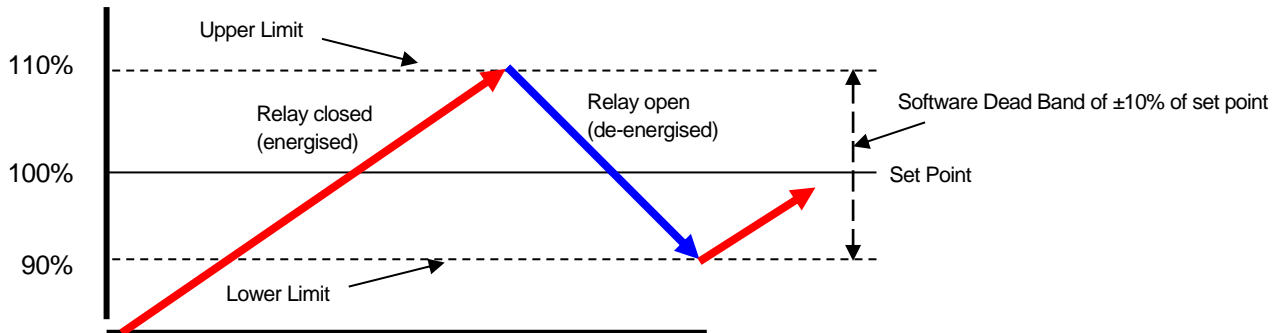
The relay is programmed to energise below the selected set point. Typical applications are fail safe warning systems or controlling a gas generator.



- 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)

6.3. Control 10% (C10) Firmware

The relay is programmed to open and close around the selected control set point $\pm 10\%$ 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)

7. 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 setpoint levels for different dipswitch settings are provided below for some sensors. Contact Aeroqual if your sensor is not listed.

Relay dipswitch (1 2 3 4)	O3 (0-0.150ppm) (UZ)	O3 (0-0.5ppm) (LZ)	O3 (0-10ppm) (GZ)
on on on on	0.000	0.000	0
off on on on	0.010	0.025	0.5
on off on on	0.020	0.050	1
off off on on	0.030	0.075	1.5
on on off on	0.040	0.100	2
off on off on *	0.050	0.125	2.5
on off off on	0.060	0.150	3
off off off on	0.070	0.175	3.5
on on on off	0.080	0.200	4
off on on off	0.090	0.225	4.5
on off on off	0.100	0.250	5
off off on off	0.110	0.300	6
on on off off	0.120	0.350	7
off on off off	0.130	0.400	8
on off off off	0.140	0.450	9
off off off off	0.150	0.500	10

* Factory default setting

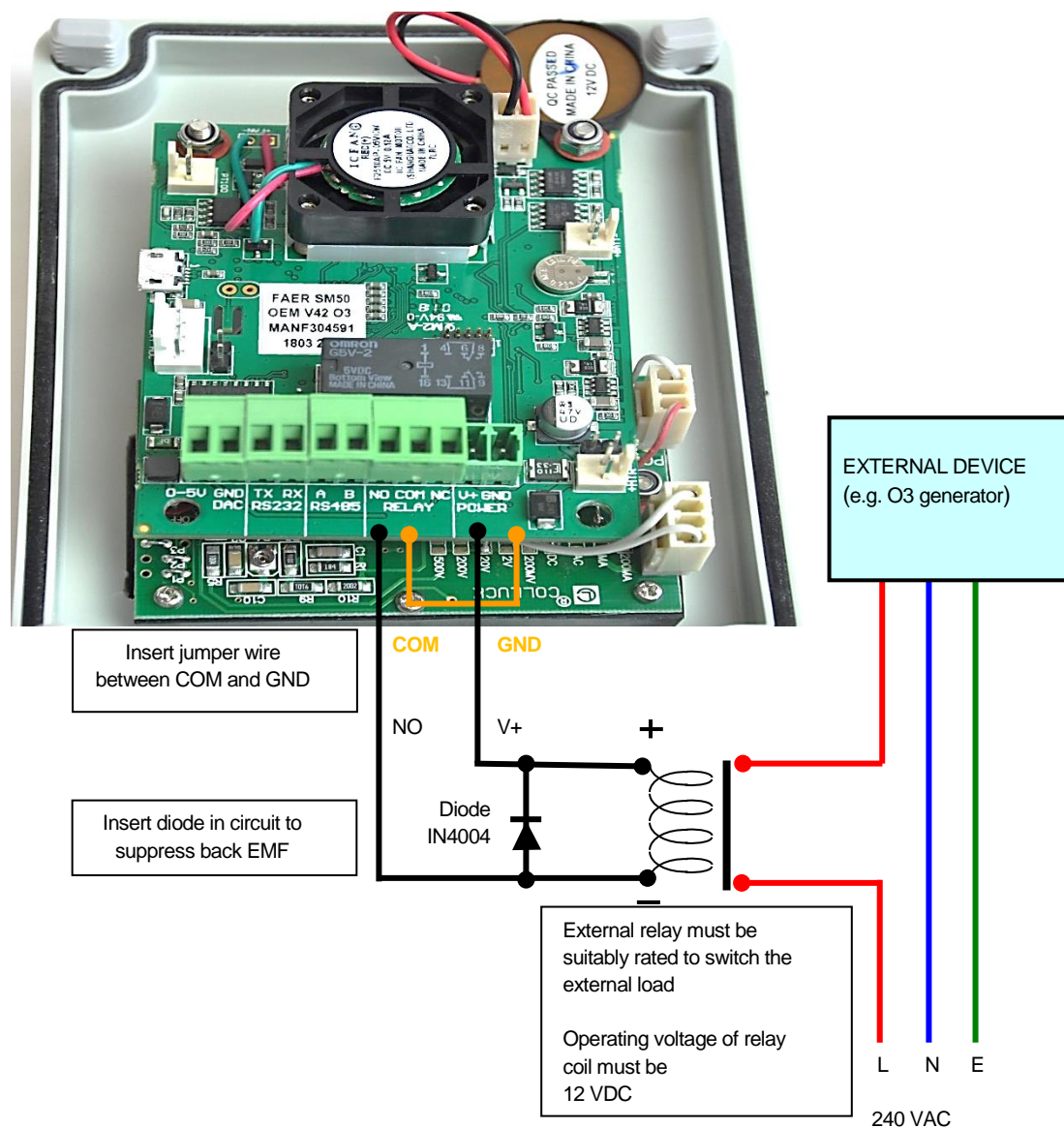
8. Wiring to the Relay

▲ IMPORTANT

- If you require the SM70 be used to control a mains powered device you will need to include a separate mains rated relay. Mains equipment should only be wired by a certified electrician.

- Open up the SM70 enclosure.
- Turn over the PCB board so that the underside is visible as shown below.
- Using the screw connector on the PC board, wire the desired external device to either the normally open or normally closed contacts as required for your application and firmware version.
- Feed the cable through the supplied 12mm cable gland to your external devices.

Diagram showing a method of connecting a SM70 to a mains powered device.



8.1. 0-5VDC Analog 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, the 0-0.5 ppm (SM70 LZ) O₃ SM70 module would output 5V at 0.500 ppm ozone). The resolution of the analogue signal is 8 bit. NOTE: The 0-0.150ppm (SM70 UZ) O₃ sensor analogue output is 1.5V (full scale). The 0-10ppm (OZG) O₃ sensor analogue output in 5v is 10ppm.

8.2. Serial 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 TX, RX and DNG 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 SM70.

9. Calibration

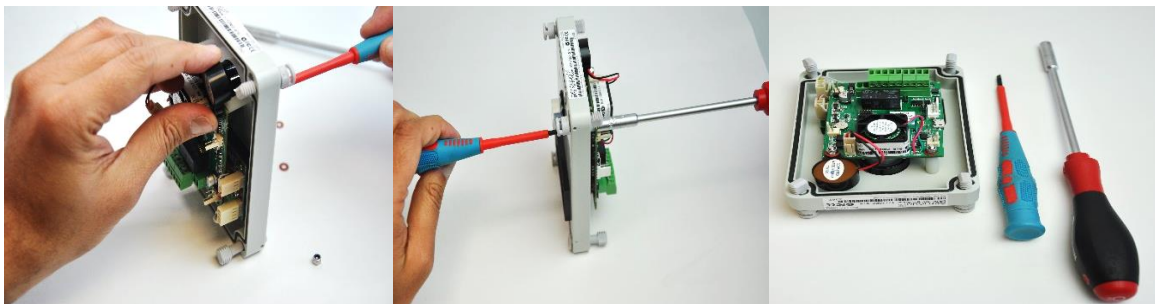
The sensor in the SM70 cannot be calibrated. The entire sensor board is replaced when required. A bump test may be used to test the operation of the sensor. A bump test typically involves brief exposure of the sensor to a known quantity of gas and making sure the monitor reading corresponds with that concentration. Unlike calibration there is no adjustment of the monitor in response to the level of gas detected.

10. Maintenance

The SM70 is designed to be a low maintenance instrument with no user serviceable components. The sensor board needs to be replaced with a calibrated board annually.

10.1. Replacing the Sensor Board

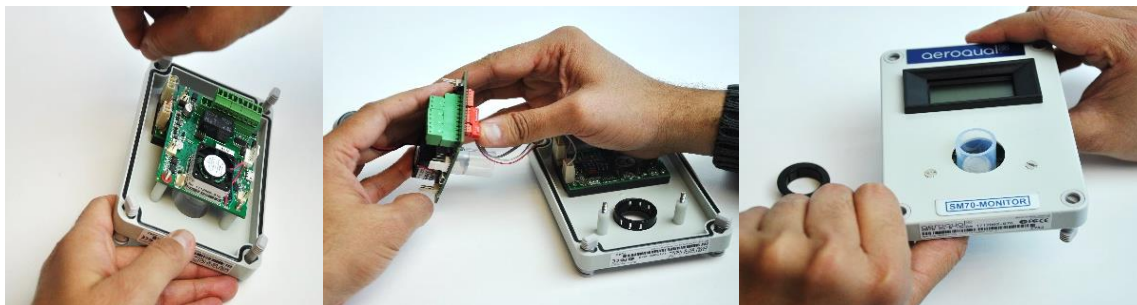
- Unscrew the four lid screws and remove lid.
- Un-screw sensor board using a 5.5mm hexa-socket screwdriver and remove cabling.



- Keep the screws, nuts, washers and standoffs for re-use.
- Connect cabling to new sensor board and re-attach to enclosure lid. Use flat screwdriver to hold screw in place during tightening
- Make sure the board does not rest on connectors.



- Place board in enclosure ensuring screws slide through both holes so board is resting on the plastic standoffs underneath



Note: Remember to replace the brown washers

11. Troubleshooting

A fault diagnosis table is given below. Please consult this in the first instance to help diagnose a suspected fault. If you are unable to find the fault in the table or the suggested remedy does not work, please contact Aeroqual's Technical Support by sending an email to technical@aeroqual.com.

Fault	Possible causes	Remedy
No Power	<ul style="list-style-type: none"> Power supply failure SM70 damaged 	<ul style="list-style-type: none"> Replace 12 VDC plug pack Replace sensor board
Sensor failure (Status LED flashes quickly)	<ul style="list-style-type: none"> Sensor needs warming up Air contaminated SM70 sensor damaged 	<ul style="list-style-type: none"> Run the SM70 for 24 hours in clean air Move SM70 to a clean environment Replace sensor board
Reading high in clean air	<ul style="list-style-type: none"> Insufficient warm up Air contaminated Sensor damaged 	<ul style="list-style-type: none"> Run the SM70 for 24 hours in clean air Move the sensor to clean air environment Replace sensor board
Reading lower than expected	<ul style="list-style-type: none"> Gas concentration is lower than expected Interfering gas present Sensor calibration incorrect 	<ul style="list-style-type: none"> Sensor is working properly Interfering gas needs to be compensated/ removed Replace sensor board
Reading higher than expected	<ul style="list-style-type: none"> Gas concentration is higher than expected Interfering gas present Sensor calibration incorrect 	<ul style="list-style-type: none"> Sensor is working properly Interfering gas needs to be compensated/ removed Replace sensor board
Reading unstable	<ul style="list-style-type: none"> Power supply unstable Local airflow is unstable EMF interference is high 	<ul style="list-style-type: none"> Replace power supply Shield unit from airflow Shield unit from interference.

12. Specifications

Sensor type	Analytic GSS Technology® Gas Sensitive Semiconductor
Sensor specifications	<ul style="list-style-type: none"> • 0 – 0.15 ppm (Ultra low range) • 0 – 0.5 ppm (Low range) • 0 – 10 ppm (High range)
Sampling method	Active sampling
Operational mode	Continuous Control or Alarm
Operating temperature	0°C to 40°C
Operating relative humidity	10% to 90% non-condensing
Warm up time	3 minutes
Display	3.5 digit LCD
Relay set point	User defined
Digital output	RS232 and RS485
Analog output	0 - 5 VDC (8 bit)/ 0-1.5V (UZ sensor board)
Relay output	24 V; 5A (max.)
Buzzer alarm (optional)	Internal piezo 85 db @ 30 cm
Power supply	12 VDC; 800 mA; Plug-in AC power adaptor supplied
Enclosure rating	IP20 & NEMA 1 equivalent
Enclosure dimensions	130 W x 94 H x 57 D (mm); 5 1/8 W x 3 3/4 H x 2 1/4 D (in)
Enclosure casing	Flame resistant thermoplastic PS
Enclosure mounting	Screw fix
Weight	< 270 g; 9.5 oz (excludes AC power adaptor)
Approvals	Part 15 of FCC Rules EN 61000-6-3: 2001 EN 61000-6-1: 2001



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15. Statements of Compliance

The Aeroqual SM70 complies with EN 50082-1:1997

The Aeroqual SM70 complies with EN 50081-1:1992

The Aeroqual SM70 complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) these devices may not cause harmful interference, and (2) these devices must accept any interference received, including interference that may cause undesired operation.

16. Serial Communication Protocols

16.1. RS232 Protocol

The Aeroqual SM70 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. SM70 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. SM70 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.
- * CHECKSUM - 1 byte the data stream's check sum - that makes the command stream total sum is zero.

3. SM70 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. SM70 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 SM70 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
Reserved5	* b6 Reserved not been used
Reserved6	* b7 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 SM70 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

16.2. RS485 Protocol

The Aeroqual SM70 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 SM70 sensor module RS485 protocol is a slave mode. Master receivers need send request command to get response.

1. SM70 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. SM70 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