MIR & MEC OEM

Communication Protocol Manual

Commercial in Confidence

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07/07/2021	02	PJO	2021-0098	Rename to MIR & MEC, move to MIR folder, remove 5S3 references	DG	16/07/2021	-	-	-
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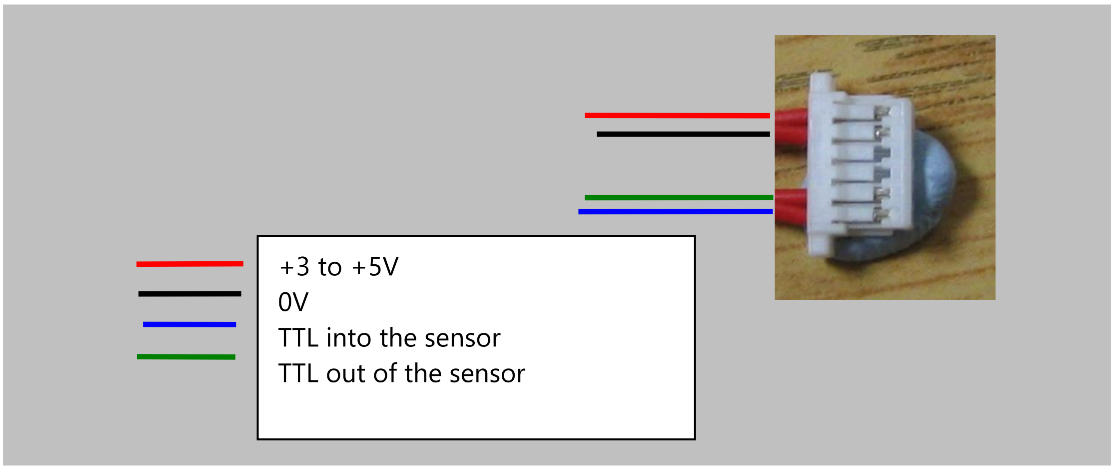
1 Introduction

This document describes the communications protocol to interface with MIR and MEC sensor products.

2 MIR connections

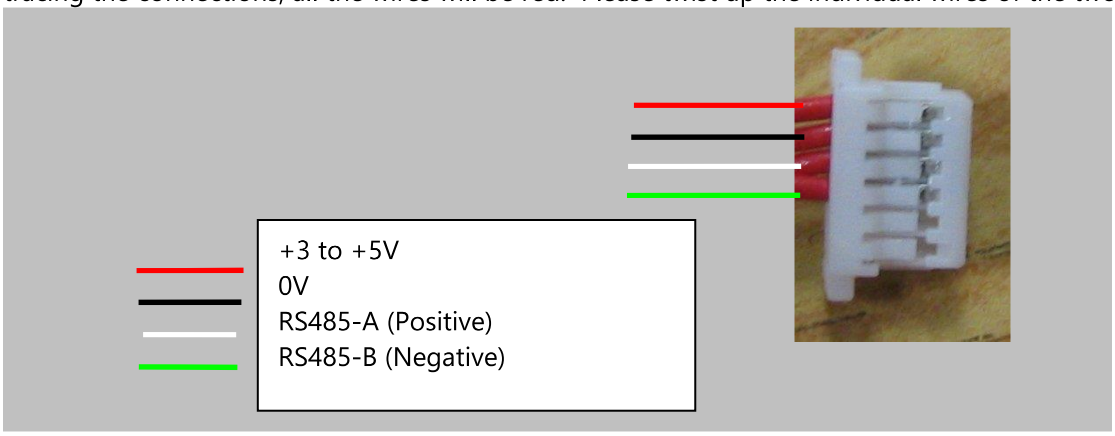
2.1 TTL Comms Cable

The TTL Comms cable should be terminated with a 6 way Harwin/Molex plug and four connecting wires. Connect as shown below. The colours are purely for ease of tracing the connections, all the wires will be either red or black (Depending if Harwin or Molex connectors). Please twist up the individual wires of the two pairs.



2.2 RS485 Comms Cable

The RS485 Comms cable should be terminated with a 6 way Harwin plug (Farnell 872-8895) and four connecting wires (Farnell 872-9204). Connect as shown below. The colours are purely for ease of tracing the connections, all the wires will be red. Please twist up the individual wires of the two pairs.



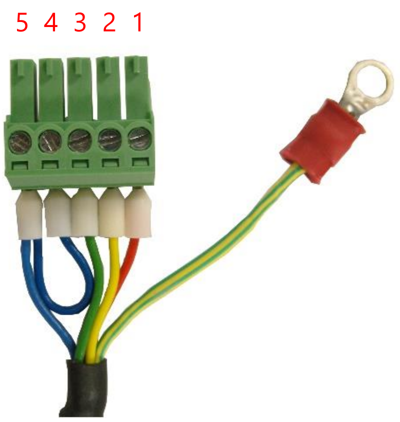
3 MEC connection

3.1 Electrical connections (External)

Electrical connections with the sensor are made via a short screened cable. The cable screen is joined to a green/yellow wire terminated with an M4 ring terminal. This wire is un-terminated inside the MEC enclosure.

Table 1 Electrical Connections (External)

TERMINAL	CORE COLOUR	SIGNAL	DETAILS
1	Red	+SUPPLY	Power Supply 4.5 to 5.5V DC
5	Blue	-SUPPLY	
4	Blue	RS485 reference	Used for 3-wire connection
2	Yellow	RS485A	RS485 communications
3	Green	RS485B	



Use of the screen will depend on the particular installation. It is best connected to a clean Earth to form a shield around the sensor cable. Note that it is not recommended for the screen to be connected to the negative supply line.

3.2 Electrical connections (Internal)

The electrical connections made to the internal electronics are made via clamp terminals. It is important to ensure that each core or the cable is connected to the correct terminal. Shown below are the correct electrical connections for the power/comms and Oxygen cell.

4 Communications settings

To establish communications over the sensor serial bus, the serial connection should be configured as follows:

Table 2 Serial Communications Settings

Parameter	Value
BAUD rate	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

4.1 Sensor node addressing

All sensors are connected to the same RS485 serial bus and so need to be individually addressed when communicating. For this reason, only one sensor can be communicated with at any one time. A node address value is included in each message (see section 5.1) to indicate which sensor is being addressed. Each sensor will receive the message, but only the sensor with the matching node address will reply. When replying, the sensor will reply with its node address in its reply message. For a list of sensor node addresses, see ***Table 3***.

Table 3 Sensor Specific Details

Sensor type	Node address (hexadecimal)	Output units
Carbon dioxide (CO_2)	00h	ppm
Oxygen (O_2)	40h	ppm
Carbon monoxide (CO)	50h	ppm
Volatile organic compounds (VOC)	60h	ppm

If used individually all sensors can be addressed with node address FFH.

5 Communications protocol

This section gives details of the serial messages that can be used to communicate with each sensor.

5.1 Message format

The standard message format for all communications is as follows:

:<NN><M..M><B..B><CCCC><cr>

- All messages start with a colon. Each sensor will look for this character to indicate the start of a message sequence.
- <NN> - This is the node address of the target sensor expressed in hexadecimal format (see number formats below).
- <M..M> - This is the command section of the message defining the action to be undertaken by the sensor (see individual message explanations).
- <B..B> - This is the message body and will vary depending on the message type (see individual message descriptions).
- <CCCC> - This is the checksum value for the message expressed in hexadecimal format (see number formats below).
- <cr> - The carriage return character (0Dh). A carriage return indicates to the receiving device that message transmission is complete.

5.2 Message checksum

The checksum is the modulo 16 sum of all the characters between but excluding the colon and the start of the checksum.

<u>Example</u>

For the message:

:50GV0102<cr>

- The checksum value for the message is the unsigned 16bit value 0102h
- The checksum value is calculated by adding the ASCII characters ‘5’, ‘0’, ‘G’ and ‘V’.

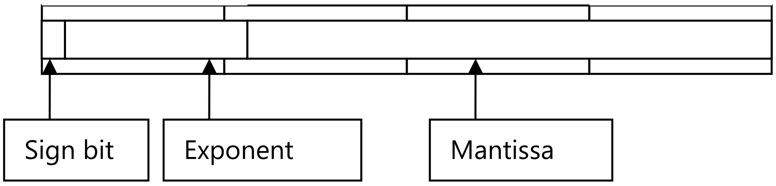
5.3 Number formats

All integer values are represented in hexadecimal format with each hexadecimal digit represented by an ASCII character (capital for all letters). Values are always represented by pairs of characters. All bytes are arranged with most significant byte first.

Table 4 Integer Formatting

Value size	Decimal value	Hexadecimal value	ASCII representation in message
8 bit	90	5Ah	5A
16 bit	2268	8DCh	08DC
32 bit	1978621369	75EF5DB9h	75EF5DB9

The floating point numbers are encoded in 32 bit IEEEE754 format:



The number is given by:

$$-1^{sign} \times 2^{\exp - 127} \times 1.mantissa$$

Note that the sign bit is the most significant bit of the exponent byte, and the exponent is therefore shifted one bit to the right and crosses a byte boundary.

In a communications message they are transmitted as eight hex ASCII characters, most significant first. For example, 1.0f would be transmitted as 3F800000.

5.4 Messages

5.4.1 Poll sensor for gas value

Detail: Used to read the current gas value from the sensor
Send command: :<NN>GV<CCCC><cr> **Reply:** :<NN>gv<VVVVVVVV><FFFFFFFF><CCCC><cr> **Data:** <NN> - (8 bit unsigned integer) The node address of the sensor <VVVVVVVV> - (32 bit floating point) The current gas value <FFFFFFFF> - (32 bit unsigned integer) The sensor status flags (see ***Table 5***) <CCCC> - (16 bit unsigned integer) The message checksum <cr> - The carriage return character **Notes:** The units of the value returned depend on the sensor type (see ***Table 3***) The value will be returned as either mbar partial pressure or ppm. If ppm output, bit 4 of the status flags will be set (see ***Table 5***).

Table 5 Sensor Status Flags

Bit	Mask	Status	Notes	Fault*
31	80000000h	Warm-up	Set at power-up and after each calibration. Clears automatically after a timeout (20-60 sec).	
30	40000000h	Failed	Software has hit a fatal error	
29	20000000h	Fault	Sensor has identified a fault but is still operating	
28	10000000h	Config CRC error	The sensor has detected a corrupt configuration	Y
27	08000000h	Reference range fault of sensor open circuit	Sensor lamp reference is out of range (CO_2 only) or cell component is open circuit.	Y
26	04000000h	Lamp DAC saturated	DAC for lamp drive has saturated (CO_2 only)	Y
25	02000000h	Lamp or PID fault	PID lamp fault	Y
24	01000000h	Power supply fault	Sensor power supply fault	Y
23	00800000h	Temperature fault	Temperature out of range	Y
22	00400000h	Noisy	Sensor power supply has excessive noise	Y
21	00200000h	-	-	
20	00100000h	Initialisation fault	Sensor did not pass all power-up checks	Y
19	00080000h	Local pressure Fault	The local measured pressure value is out of range	Y
18	00040000h	Remote pressure Fault	The remote pressure value provided is out of range	Y
17	00020000h	Program CRC error	The sensor has detected a corruption in program memory	Y
16	00010000h	Table CRC error	The sensor has detected a corruption in its data tables	Y
15	00008000h	-	-	
14	00004000h	-	-	
13	00002000h	-	-	
12	00001000h	-	-	
11	00000800h	User cal points too close	The calibration points are too close together. Cleared by re-calibrating correctly.	Y
10	00000400h	Detector / sensor ADC over-range	The detection ADC is over maximum usable range	Y
9	00000200h	Sensor ADC under-range	The detection ADC is under minimum usable range	Y
8	00000100h	Over range	The reading is above the sensor's calibrated range	Y
7	00000080h	Under range	The reading is below the sensor's calibrated range	Y
6	00000040h	PID power fault	Power failure to PID lamp	Y
5	00000020h	PID oscillator fault	Oscillator fault on PID	Y
4	00000010h	ppm/mbar output	This bit is set if the value returned form the senor is in ppm units. If cleared, the value is returned in mbar partial pressure units.	
3	00000008h	AVdd out of range	AVdd is out of range	Y
2	00000004h	-	-	
1	00000002h	-	-	
0	00000001h	-	-	

*This column denotes that if any of the bits marked 'Y' are set by the sensor, they will be accompanied by a set bit 29 which is the global 'sensor in fault' flag.

5.4.2 Calibrate the sensor

Detail: Used to read the current local pressure value from the sensor

Send command:

:<NN>JG<XX><AAAAAAAA><CCCC><cr>

Reply:

:<NN>jg<XX><FFFF><CCCC><cr>

Data:

<NN> - (8 bit unsigned integer) The node address of the sensor
<XX> - (8 bit unsigned integer) The calibration control byte (see ***Table 6***)
<AAAAAAAA> - (32 bit floating point) The gas value to use for calibration
<FFFF> - (16 bit unsigned integer) The calibration status (see ***Table 7***)
<CCCC> - (16 bit unsigned integer) The message checksum
<cr> - The carriage return character

Notes:

When a calibration message is received, the sensor will determine whether or not a requested calibration adjustment is valid. If the value supplied is determined to be outside of acceptable limits, or would be too large a deviation from the current calibration then the calibration will be rejected and will not be stored in the sensor's memory. The calibration status flags indicate the result of the calibration (see ***Table 7***)

After each successfully received calibration command, the sensor will enter a warm-up state whilst the calibration is processed.

The calibration value must be passed as either mbar partial pressure or ppm, setting or clearing the appropriate flag bit in the calibration controls byte to indicate which units type is being provided.

Each sensor's calibration is defined by two calibration points. To fully calibrate a sensor a high calibration and a low calibration must be performed. The high calibration should generally be performed using a gas concentration towards the high end of the sensor's range, whilst the low calibration should be performed close to the low end of the sensor range. In most cases, this will be zero concentration gas. The high or low calibration is performed by setting or clearing the appropriate bit in the calibration control byte (see ***Table 6***).

For CO_2 sensors, the concentration of the zero gas should always contain 0% CO_2. Any other value passed to the sensor for a low calibration will be rejected.

For the CO sensor to calibrate successfully all calibration gases must contain at least a small concentration of O_2 in order for the chemical reaction to take place within the cell. The balance gas composition should reflect the atmosphere to be monitored (e.g. use cal. gas with air balance when monitoring CO in air).

Table 6 Calibration Control Byte Flags

Bit	Name	Description, meaning when set
7	-	-
6	-	-
5	-	-
4	ppm/mbar	Set if calibration value supplied is in ppm units Clear for calibration value in partial pressure units (mbar)
3	-	-
2	-	-
1	-	-
0	Cal point	Set for high calibration, clear for low calibration

Table 7 Calibration Status Flags

Bit	Name	Description, meaning when set
15	-	-
14	-	-
13	-	-
12	-	-
11	-	-
10	-	-
9	-	-
8	-	-
7	Cal Value High	Cal value too great
6	Cal Value Low	Cal value too small
5	Cal Correction Too Big	Upper limit of cal correction exceeded
4	Cal Correction Too Small	Lower limit of cal correction exceeded
3	-	-
2	-	-
1	-	-
0	-	-

Note: If no bits are set then the calibration adjustment is considered to have been successfully applied.