MH-Z16
Intelligent Infrared Gas Module

User’s Manual
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 Zhengzhou Winsen Electronics Technology CO., LTD
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Zhengzhou Winsen Electronics Technology CO., LTD.
MH-Z16 Intelligent Infrared Gas Module

1. Profile:
MH-Z16 NDIR Infrared gas module is a common type, small size sensor, using non-dispersive infrared (NDIR) principle to detect the existence of CO₂ in the air, with good selectivity, non-oxygen dependent and long life. Built-in temperature compensation; and it has digital output and PWM wave output. This common type infrared gas sensor is developed by the tight integration of mature infrared absorbing gas detection technology, precision optical circuit design and superior circuit design.

2. Main features:
- High sensitivity, High resolution, Low power consumption
- Output method: UART, PWM wave and analog (DAC)
- Quick response, Good stability
- Temperature compensation,
- Excellent linear output
- Long lifespan
- Anti-water vapor interference
- No poisoning

3. Application:
- HVAC equipment
- Air quality monitoring equipment
- Fresh air system
- Air purification equipment
- Intelligent home
- Education system
- Animal husbandry production
- Safety protection monitoring

4. Main technical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working voltage</td>
<td>4.5 V ~ 5.5V DC</td>
</tr>
<tr>
<td>Average current</td>
<td>&lt; 60mA (5VDC)</td>
</tr>
<tr>
<td>Peak current</td>
<td>150mA (5VDC)</td>
</tr>
<tr>
<td>Interface level</td>
<td>3.3 V (Compatible with 5V)</td>
</tr>
<tr>
<td>Measuring range</td>
<td>0~50000ppm (refer to below table)</td>
</tr>
<tr>
<td>Output signal</td>
<td>PWM</td>
</tr>
<tr>
<td></td>
<td>UART (TTL level)</td>
</tr>
<tr>
<td>Resolution</td>
<td>1 ppm</td>
</tr>
<tr>
<td>Preheat time</td>
<td>3 mins</td>
</tr>
<tr>
<td>Response Time</td>
<td>T₉₀ &lt; 60s</td>
</tr>
<tr>
<td>Working temperature</td>
<td>-20°C ~ 60°C</td>
</tr>
<tr>
<td>Working humidity</td>
<td>0~95%RH (no condensation)</td>
</tr>
<tr>
<td>Size</td>
<td>97<em>20</em>17mm (L<em>W</em>H)</td>
</tr>
<tr>
<td>Weight</td>
<td>21 g</td>
</tr>
<tr>
<td>Lifespan</td>
<td>&gt;5 years</td>
</tr>
</tbody>
</table>
5. Structure

6. Pin Definition

7. Output methods:

<table>
<thead>
<tr>
<th>PIN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN 4</td>
<td>Vin (Voltage Input)</td>
</tr>
<tr>
<td>PIN 3</td>
<td>GND</td>
</tr>
<tr>
<td>PIN 2</td>
<td>Vout (0.4-2V) need to be customized</td>
</tr>
<tr>
<td>PIN 7</td>
<td>PWM</td>
</tr>
<tr>
<td>PIN 1</td>
<td>HD (Zero calibration, low level for more than 7 seconds)</td>
</tr>
<tr>
<td>PIN 5</td>
<td>UART (RXD) 0~3.3V digital input</td>
</tr>
<tr>
<td>PIN 6</td>
<td>UART (TXD) 0~3.3V digital output</td>
</tr>
</tbody>
</table>

**PWM output**

Take 0~2000ppm for example

CO₂ output range: 0~2000ppm

Cycle: 1004ms±5%

Cycle start high level output: 2ms (theoretical value)

The middle cycle: 1000ms±5%

Cycle end low level output: 2ms (theoretical value)

CO₂ concentration: \( C_{\text{ppm}} = \frac{2000 \times (T_H - 2\text{ms})}{(T_H + 4\text{ms})} \)

\( C_{\text{ppm}} \): CO₂ concentration could be calculated by PWM output

\( T_H \): high level output time during cycle
Serial port output (UART)

Hardware connection
Connect module’s Vin-GND-RXD-TXD to users’ 5V-GND-TXD-RXD.
(Users must use TTL level. If RS232 level, it must be converted.)

Software setting
Set serial port baud rate be 9600, data bit 8 bytes, stop bit 1byte, parity bit null.

<table>
<thead>
<tr>
<th>Commands</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x86</td>
<td>Read CO2 concentration</td>
</tr>
<tr>
<td>0x87</td>
<td>Calibrate Zero Point (ZERO)</td>
</tr>
<tr>
<td>0x88</td>
<td>Calibrate Span Point (SPAN)</td>
</tr>
<tr>
<td>0x79</td>
<td>ON/OFF Self-calibration function</td>
</tr>
<tr>
<td>0x99</td>
<td>Detection range setting</td>
</tr>
</tbody>
</table>

**0x86 - Read CO2 concentration**

**Sending command**

<table>
<thead>
<tr>
<th>Byte0</th>
<th>Byte1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Byte</td>
<td>Reserved</td>
<td>Command</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Checksum</td>
</tr>
<tr>
<td>0xFF</td>
<td>0x01</td>
<td>0x86</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x79</td>
</tr>
</tbody>
</table>

**Received command**

<table>
<thead>
<tr>
<th>Byte0</th>
<th>Byte1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Byte</td>
<td>Command</td>
<td>Concentration</td>
<td>Concentration</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Checksum</td>
</tr>
</tbody>
</table>
### CO2 concentration calculation

\[
\text{CO2 concentration} = \text{HIGH} \times 256 + \text{LOW}
\]

For example:

1. Please connect the hardware correctly.
2. Send command FF 01 86 00 00 00 00 00 00 79, Return value FF 86 02 20 00 00 00 00 58

How to calculate concentration: convert hexadecimal 02 into decimal 2, hexadecimal 20 into decimal 32, then 
\[2 \times 256 + 32 = 544 \text{ppm}\]

Caution: Checkvalue please refer to Checksum method.

---

### 0x87-ZERO POINT CALIBRATION

**Send command**

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Byte1</th>
<th>Command</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
<th>Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xFF</td>
<td>0x01</td>
<td>0x87</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No received command

For example:

1. Put the module in 400 ppm standard CO2 gas or clean outdoor environment for at least 20 min;
2. Send command FF 01 87 00 00 00 00 00 78 for zero point calibration.

Caution: *Forbid sending this command in environment except 1.

*This calibration command is required when there is a large deviation in the sensor zero point.

---

### 0x88-SPAN POINT CALIBRATION

**Send command**

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Byte1</th>
<th>Command</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
<th>Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xFF</td>
<td>0x01</td>
<td>0x88</td>
<td>HIGH</td>
<td>LOW</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No received command. If SPAN value is 2000ppm, HIGH=2000\(\times\)256; LOW=2000\%256

Take 2000ppm as SPAN calibration point for example:

Put the module in 2000ppm CO2 gas, stability for at least 20 min.

Send command FF 01 88 07 D0 00 00 00 A0 for span calibration

Caution:

* Please do Zero calibration before SPAN calibration.

* Before sending the SPAN calibration command, please ensure that the sensor is stable for more than 20 minutes at the corresponding concentration.

*It is recommended to use 2000 ppm as the SPAN value for calibration. If you want to use a lower value as the span value, select a value above 1000 ppm.

* If you can not establish the corresponding concentration of the environment, please stop SPAN calibration, otherwise it will lead to sensor failure. It is forbidden to send this command without putting the sensor under standard gas.
### 0x79- ON/OFF Self-calibration for zero point

**Send command**

<table>
<thead>
<tr>
<th>Byte0</th>
<th>Byte1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Byte</td>
<td>Reserved</td>
<td>Command</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Checksum</td>
</tr>
<tr>
<td>0xFF</td>
<td>0x01</td>
<td>0x79</td>
<td>0xA0/0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>Checksum</td>
</tr>
</tbody>
</table>

**For example:**

ON this function, send command: FF 01 79 A0 00 00 00 00 E6

OFF this function, send command: FF 01 79 00 00 00 00 00 86

NOTE: This function is on when Byte3 is 0xA0 while this function is off when Byte3 is 0x00.

Default status is this function on.

### 0x99- Detection range resetting

**Send command**

<table>
<thead>
<tr>
<th>Byte0</th>
<th>Byte1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Byte</td>
<td>Reserved</td>
<td>Command</td>
<td>Reserved</td>
<td>Detection range</td>
<td>Detection range</td>
<td>Detection range</td>
<td>Detection range</td>
<td>Checksum</td>
</tr>
<tr>
<td>0xFF</td>
<td>0x01</td>
<td>0x99</td>
<td>HIGH</td>
<td>Data 1</td>
<td>Data 2</td>
<td>Data 3</td>
<td>Data 4</td>
<td>Checksum</td>
</tr>
</tbody>
</table>

**No Received command**

**For example:**

*Set 2000ppm detection range, send command: FF 01 99 00 00 00 07 D0 8F

*Set 10000ppm detection range, send command: FF 01 99 00 00 00 27 10 2F

**Note:**

*Range Bit 24-31=Range>>24(low 8 bit); Range bit 16-23=Range>>16(low 8 bit); Range bit 8-15=Range>>8(low 8 bit); Range bit 0-7 low 8 bit

*Send command is Hexadecimal data

### Checksum calculation method

Checksum = \{(Negative\{(Byte1+Byte2+Byte3+Byte4+Byte5+Byte6+Byte7)\}) +1 \}

**For example:**

<table>
<thead>
<tr>
<th>Byte0</th>
<th>Byte1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Byte</td>
<td>Reserved</td>
<td>Command</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Checksum</td>
</tr>
<tr>
<td>0xFF</td>
<td>0x01</td>
<td>0x86</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>0x00</td>
<td>Checksum</td>
</tr>
</tbody>
</table>

Calculating Checksum:

1. From Byte 1 to Byte 7: 0x01 + 0x86 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 = 0x87
2. Negative: 0xFF - 0x87 = 0x78
3. Then+1: 0x78 + 0x01 = 0x79

C language
char getCheckSum(char *packet)
{
    char i, checksum;
    for( i = 1; i < 8; i++)
    {
        checksum += packet[i];
    }
    checksum = 0xff – checksum;
    checksum += 1;
    return checksum;
}

8. Zero Point Calibration

About zero-point calibration:
This module has three methods for zero-point calibration: hand-operated method, sending command method and self-calibration. All the zero point is at 400ppm CO2.

Hand-operated method: Connect module’s HD pin to low level(0V), lasting for at least 7 seconds. Please ensure that the sensor is stable for at least 20 minutes under 400ppm standard gas before calibrating the products.

Sending command method: See the command above.

Auto-calibration method:
Auto-calibration function means, after the sensor running in the working place for period, it can judge the zero point intelligently and do the zero calibration automatically. After power on the sensors for at least 24 hours, the self-calibration function will operate automatically in every 24 hours and the calibration point is 400ppm. This method is suitable for office and home environment, not suitable for agriculture greenhouse, farm, refrigerator. If the module is used in latter environment, please turn off this function. If close this function, please do zero-point calibration terminally, if necessary, please do it by hands or by command.

9. Cautions:
9.1 Please avoid the pressure of its gilded plastic chamber from any direction, during welding, installation, and use.
9.2 When placed in small space, the space should be well ventilated, especially for diffusion window.
9.3 The module should be away from heat, and avoid direct sunlight or other heat radiation.
9.4 The sensor should be calibrated regularly and the calibration cycle is recommended for no more than 6 months.
9.5 Do not use the sensor in the high dusty environment for long time.
9.6 To ensure the normal work, the power supply must be among 4.5V~5.5V DC rang, the power current must be not less than 150mA. Out of this range, it will result in the failure of the sensor. (The concentration output is low, or the sensor cannot operate properly)
9.7 During manual zero calibration, the sensor must work in stable gas environment (400ppm) for over 20 minutes. Connect the HD pin to low level (0V) for over 7 seconds.