

General

Version 1.2

CH4-S3 is a popular small size and cost-effective methane sensor module with excellent performance. Rapid detection of methane gas leaks is possible while maintaining high accuracy over a wide temperature range. In addition, NDIR can be used for more than 10 years in a stable state for a long time.

ELT Sensor Data Sheet for CH4-S3

Features

- Non-Dispersive Infrared (NDIR) Single Channel Technology to measure CH4 levels.
- Excellent compensation of Temperature Effect on CH4 concentration.
- Output : TTL-UART, I2C, ALARM,
Analog Voltage or PWM is optional.
- Simple Calibration with Non-Periodic Manual Calibration (0_MCDL : CAL1) and Periodic Automatic Calibration (0_ACDL : CAL2).

- Size : 33mmx33mmx13.1mm
- Weight : 10 grams

Specifications

Applications

Gas leakage alarming detector or equipment of CH₄, LNG or combustible gases in Mine, metallurgy, liquefied gas station, petroleum, fuel gas ,etc.

General Performance

Operating Temperature : -20 ~ 50°C

Operating Humidity : 0 ~ 95% RH (Non-condensing), 0 ~ 99% RH (Non-condensing) ⁽¹⁾

Storage Temperature : -30°C ~70°C

Measurement

Sensing Method : NDIR (Non-dispersive Infrared)

Measurement Range : 0 ~ 100% LEL (=0~50,000ppm vol. is optional) ⁽²⁾

Output Default : % LEL, Optional : ppm

Accuracy : ±3% of F.S. ^{(3),(4),(5)}

Detection Limit: 2% LEL (=1,000ppm vol.), **Resolution**: 1% LEL (=500ppm vol.)

Step Response Time (90%, 1/e) : 90 seconds / 45 seconds (Diffusion)

Sampling Interval: 3 seconds

Warming-up Time : < 6 seconds (for Detection), 3 minutes (for Accuracy)

Electrical Data

Power Input : 5V ± 5%⁽⁶⁾

Current Consumption : Normal mode : 12mA, Peak : 240mA, Sleep < 0.5mA

Product Derivatives and Relative Functions

| Products | Feature | Option |
|----------|---|-------------|
| CH4-S3 | UART,I2C, ALARM, PWM, 0_MCDL(CAL1)/0_ACDL(CAL2) | CH4-S3-3V |
| CH4-S3L | Sleep mode is added on CH4-S3 for Low Power, which consume < 9mA | CH4-S3L-3V |
| CH4-S3G | Resistant up to 99% Humidity for Application of Agricultural Green House | CH4-S3G-3V |
| CH4-S3LG | Sleep mode + 99% Humidity | CH4-S3LG-3V |

(1) CH4-S3G : 0 ~ 99% RH (Non-condensing) for Industrial Application of Methane gas.

(2) PPM unit output is selectable as option when you designate on issuing order. (500ppm unit)

(3) 2% should be added for absolute measurements for uncertainty of calibration gas mixture unless '0' ppm or '0'ppm standard gas calibration is done.

(4) Air pressure is assumed as 101.3 kPa.

(5) If sensor is affected by the shock, may need field calibration before installation.

(6) DC Supply should be regulated without ripple < 100mV, low noise power source is needed for best accuracy.

CH4-S3 has various output TTL-UART, I2C, ALARM while as PWM or Analog voltage is selectable as option. 2.54pitch 13pin side hole connector besides 2mm pitch 10 and 4pin 2 row header connectors.

Pin Map with J11&J12 Connectors

| J-11 | Description | |
|------|-------------|--|
| 1/3 | VDD (+5VDC) | |
| 2/4 | GND | |

| J-12 | CH4-S3 | CH4-S3 (Analog Voltage Option) |
|------|--|----------------------------------|
| 1 | TTL RXD (← CPU of Master Board) | |
| 2 | TTL TXD (→ CPU of Master Board) | |
| 3 | I2C SCL | |
| 4 | I2C SDA | |
| 5 | GND | |
| 6 | Reserved | Analog Voltage Output (0.5~4.5V) |
| 7 | CAL2-pin : 0_ACDL (for every 7 days ACDL with periodic CH4-'0'ppm circumstance) | |
| 8 | Reserved | |
| 9 | CAL1-pin : 0_MCDL (for 10 minutes MCDL with CH4-'0'ppm- N2-based-gas or Fresh Air) | |
| 10 | Reset (Low Active) | |

UART 38,400BPS, 8bit, No parity, 1 stop bit
9,600 or 19,200 BPS can selectable through command sets or EK-100SL.

I2C Slave mode only, Internal pull up resister 10kΩ
TTL Level Voltage : $0 \leq V_{IL} \leq 0.8$, $2 \leq V_{IH} \leq V_{DD}$, $0 \leq V_{OL} \leq 0.4$, $2.4 \leq V_{OH} \leq V_{DD}$ (Volt)

ALARM : Open Collector type.
ex) Alarm_On : 25% LEL, Alarm-Off : 20% LEL

Analog Voltage: 0.5~4.5V (option)

PWM (option)

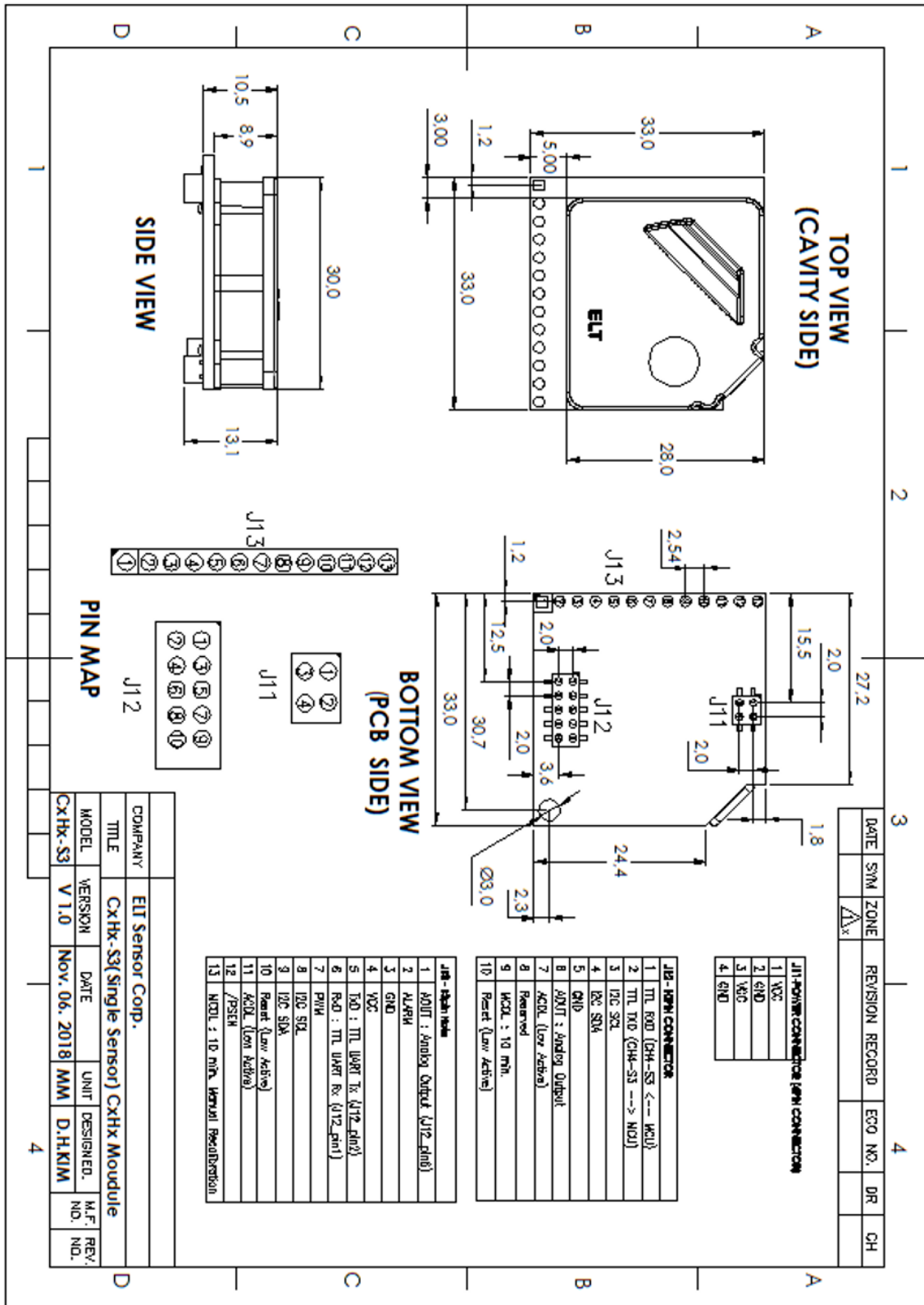
$$t_H = 2 \text{ msec(Start)} + 1,000 \text{ msec} \times (\text{Measurement}_{(\text{ppm})} / \text{Range}_{(\text{ppm})}), T_L = 2,000 \text{ ms} - t_H,$$

Pin Map with J13 Connectors

| J-13 | CH4-S3 | CH4-S3 (PWM/Analog Voltage Option) |
|-------------|--|---|
| 1 | Reserved | Analog Voltage Output (0.5~4.5V) |
| 2 | Alarm (Open Collector) | |
| 3 | GND | |
| 4 | VDD (+5VDC) | |
| 5 | TTL TXD (→ CPU of Master Board) | |
| 6 | TTL RXD (← CPU of Master Board) | |
| 7 | Reserved | PWM Output (TTL) |
| 8 | I2C SCL | |
| 9 | I2C SDA | |
| 10 | Reset (Low Active) | |
| 11 | CAL2-pin (for every 7 days ACDL with periodic CH4-'0'ppm circumstance) | |
| 12 | Reserved | |
| 13 | CAL1-pin (for 10 minutes MCDL with CH4-'0'ppm-N2-based-gas or Fresh Air) | |

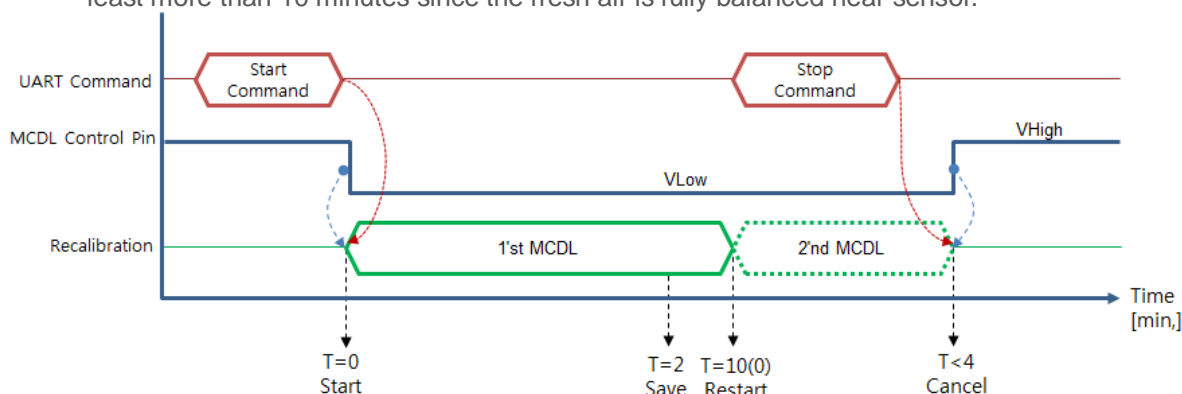
Dimensions (unit : mm)

Dimensions unit : mm



0_MCDL (2 minutes Manual Calibration)

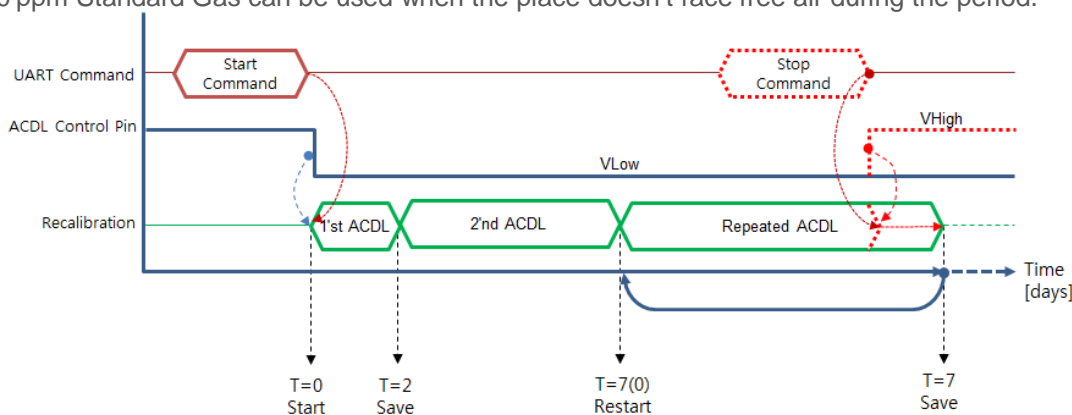
'0' ppm Manual Calibration can be done by giving start command or low signal to CAL1-pin at least more than 10 minutes since the fresh air is fully balanced near sensor.



0_ACDL (Periodic Automatic Calibration)

'0' ppm Periodic Automatic Calibration can be used by giving start command or low signal to CAL2-pin. The sensor calibrate automatically first in 2 days, seconds 5 days and every week.

'0'ppm Standard Gas can be used when the place doesn't face free air during the period.



Method 1. UART Command Set; J12: pin-1 (UART-RX) and pin-2 (UART-TX) to Main-Board (J13: pin-5 and pin-6 are available as well.).

Method 2. I2C Command Set; J12: pin-3 (SCL) and pin-4 (SDA) to Main-Board. (J13: pin-8 and pin-9 are available as well.)

Method 3. Let Sensor install on Jig Board, **TRB-100ST (Test and Recalibration Board)** with ambient air-flow condition or with 0'ppm Standard Gas and execute by moving jumper following Manual on the website.

Method 4. Send string command set below to RXD-pin of Sensor on Emulation program.

EK-100SL (Evaluation kit, with Emulation program 'ELTWSO') is available

Method 5. CAL1 / CAL2-pin settings for 0_MCDL / 0_ACDL

| CAL1 0_MCDL | CAL 2 0_ACDL | Function | Process |
|----------------|-----------------|---------------------|--|
| Low | High | H/W '0'ppm MCDL | Let CH4-S3 sensor be located at ambient place where no methane gas exist and wait 2 minute. '0'ppm Standard gas can be used when '0'ppm is not guaranteed. |
| High | Low | H/W '0' ppm ACDL | Automatic Calibration can be used where CH4 meet the clear air more than 3 minutes per week. |
| High | High | Normal | Operate with Factory Calibrated or previously set status |

- ※ 1. CAL-1pin and CAL-2pin shouldn't have 'Low' at the same time.
- 2. Be sure to escape MCDL fetch loop between 2 minutes and 4minutes to avoid inappropriate calibration.

Output Descriptions

UART Descriptions

Data Format

| SP | SP | SP | D2 | D1 | '% | SP | 'L' | 'E' | 'L' | CR | LF |
|---------|----|----|---------------------------|----|----|----|-----|-----|-----|----|----|
| SP x 3 | | | Space: 0x20 | | | | | | | | |
| D2 ~ D1 | | | 2 byte CH4 density string | | | | | | | | |
| % | | | % : 0x25 | | | | | | | | |
| SP | | | Space: 0x20 | | | | | | | | |
| 'LEL' | | | 'LEL' string | | | | | | | | |
| CR | | | Carriage return : 0x0D | | | | | | | | |
| LF | | | Line feed : 0x0A | | | | | | | | |

Above 12byte consist by 2 byte hexadecimal digits, <SP>,<SP>,<SP>, D2, D1, 0x25, <SP>, 'L', 'E', 'L', <CR><LF> , where decimal '0' (corresponds to hexadecimal digit '0x30') is replaced by space (corresponds to hexadecimal digit '0x20'),

EX) 7% LEL (= 3,500 ppm) string is '0x20 0x20 0x20 0x20 0x37 0x25 0x20 0x4C 0x45 0x4C, 0x0D 0x0A',, of which display on the screen is ' ____7%_LEL<CR><LF>'.

'ppm' display is Option on sale, which D6~D1 string display the CH4 concentration of

| | | | | | | | | | | | |
|----|----|----|----|----|----|----|-----|-----|-----|----|----|
| D6 | D5 | D4 | D3 | D2 | D1 | SP | 'p' | 'p' | 'm' | CR | LF |
|----|----|----|----|----|----|----|-----|-----|-----|----|----|

EX) 3,500 ppm string is '0x20 0x20 0x33 0x35 0x30 0x30 0x20 0x70 0x70 0x6D 0x0D 0x0A', of which display on the screen is ' __3500_ppm<CR><LF>'.

I2C Communication (Only Slave Mode Operation)

Internal pull up resistor 10kΩ

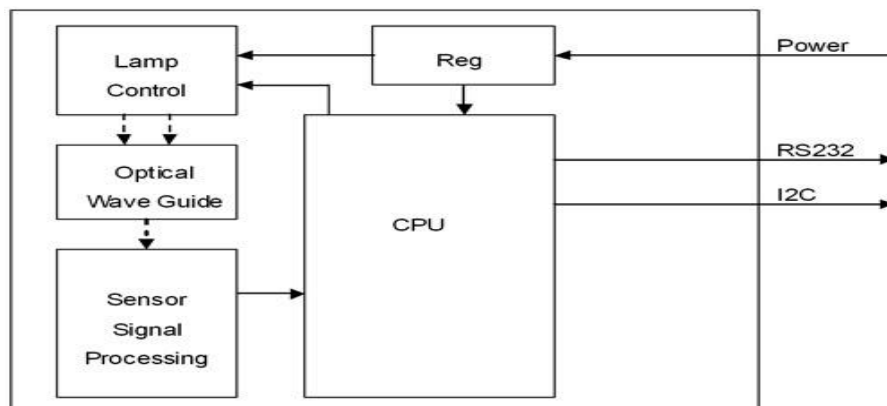
Slave Address: 0x31, Slave Address Byte: Slave Address(0x31) 7 Bit + R/W 1 Bit

| | | | | | | | |
|------|------|------|------|------|------|------|---------|
| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | R/W Bit |

R/W Bit : Read = 1/Write = 0

When reading the data, Slave Address Byte is 0x63, When writing the data, Slave Address Byte is 0x62.

Block Diagram



Transmission Sequence in Master

- 1) I2C Start Condition
- 2) Write Command(Slave Address + R/W Bit(0) = 0x62) Transmission and Check Acknowledge
- 3) Write Command(ASCII 'R' : 0x52) Transmission and Check Acknowledge
- 4) I2C Stop Command
- 5) I2C Start Command
- 6) Read Command(Slave Address + R/W Bit(1) = 0x63) Transmission and Check Acknowledge
- 7) Read 7 Byte Receiving Data from Module and Send Acknowledge
(Delay at least 1ms for reading each byte)

| | | | | | |
|--------|--------|----------|----------|----------|----------|
| Header | CH4 | reserved | reserved | Reserved | reserved |
| 1 Byte | 2 Byte | 0x00 | 0x00 | 0x00 | 0x00 |

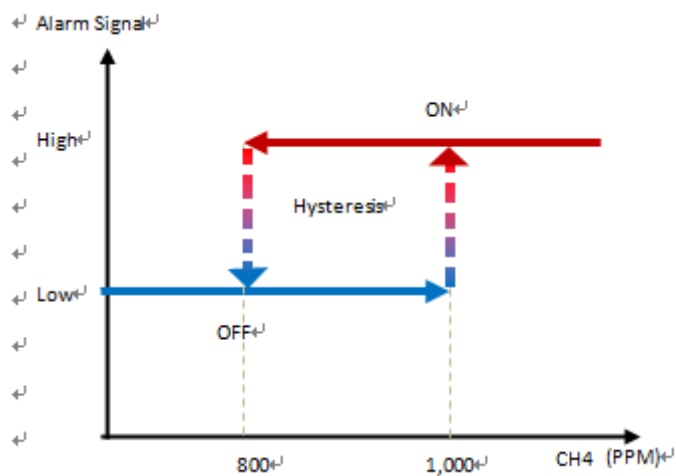
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|

In need of detail protocol specification and time sequence, 'I2C programming guide' could be provided by contacting Sales Rep.

Alarm Descriptions

Alarm signal operates as Open Collector type and send TTL on signal since CH4 measured value beyond 25% LEL until it go down to 20% LEL. It is designed to be activated when CH4 measured value surpass 25% LEL and deactivated down to 20%LEL to avoid unwanted rapid switching by hysteresis effect.

Alarm_On : 25% LEL, Alarm-Off : 20% LEL

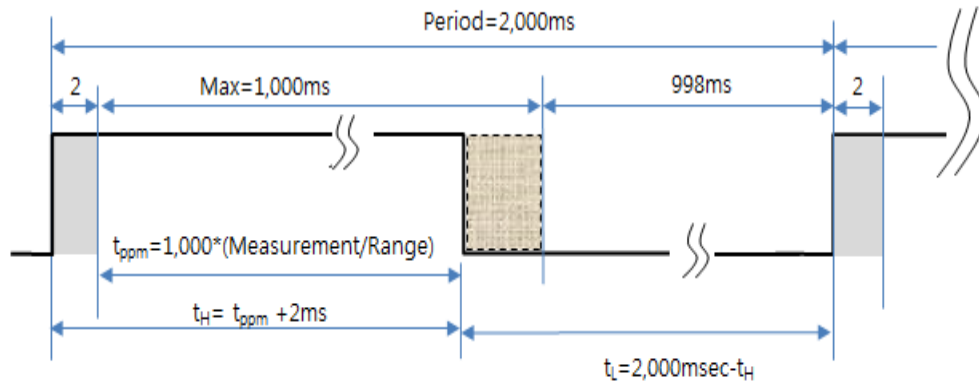


EK-100SL series is available for customer to enable to change alarm activation & deactivation point.

PWM Descriptions : Option

* $Measurement_{(ppm)} = (t_H - 2msec) / 1000msec \times Range_{(ppm)}$ (t_H : High Pulse Width)

* $Range_{(ppm)}$: 0~100% LEL (0~50,000 ppm)



EX) t_H (High Pulse Width) calculation for 50% LEL in 100% LEL Range.

* $Measurement_{(%LEL)} = 50\% LEL = (t_H - 2msec) / 2,000msec \times Range_{(%LEL)}$,

* $t_H = 1,000 msec * (50\% LEL / 100\% LEL) + 2msec = 502msec$

(cf: $T_L = Period - t_H = 2,000 msec - 502 msec = 1,498 msec.$)

Analog Voltage Output Descriptions : Option

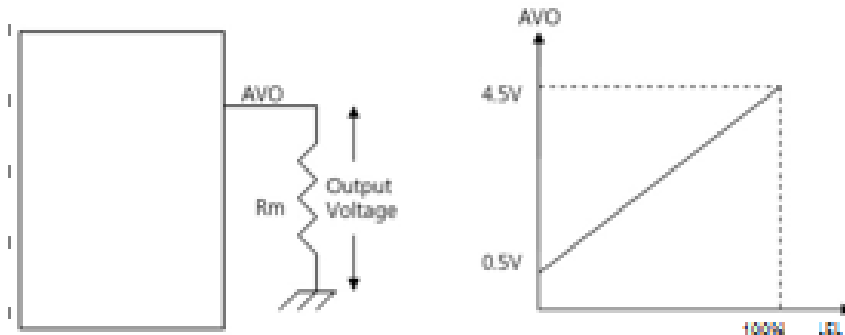
Measured Voltage 0.5V~4.5V match proportionally to 0 ~ 100% LEL.

* $CH_4 Measurement_{(ppm)} = ((Output\ Voltage - 0.5) / (4.5 - 0.5) Voltage) \times 100\% LEL.$

EX) if the Output Voltage is 2.5V in 0~100% LEL range,

$CH_4 (\% LEL) = (2.5 - 0.5) V \div (4.5 - 0.5)V \times 100\% LEL$

$= 0.5 \times 100\% LEL = 50\% LEL$



※ **Caution**

1. The gold cavity part of the sensor module or the PCB outer part should not touch by the customer's case housing. It causes long-term value fluctuation. Be at least 3 mm apart from the housing.
2. When removing and inserting the sensor module, do not hold the gold cavity but hold the PCB on both sides. Put on the electret gloves to prevent the static electricity.
(Excessive force on the gold cavity can affect the initial performance and accuracy of the sensor.)
→ If the measured value is wrong, you can calibrate zero point for more than 10 minutes at CAL1 (MCDL) position and use it with high accuracy.
3. Do not let water get on, drop, or shock the sensor.
4. Do not store the sensors in high temperature and high humidity for long time without applying power. The initial measurement accuracy of the sensor may be affected.
5. Be careful not to be affected by static electricity and induction electromagnetic field around sensor. To prevent static electricity from being generated during assembly, wear electrostatic gloves and work on a static-free workbench. (Keep the sensor in the place where the electricity is removed.)
6. Install the sensor at a position as far away as possible from the motor or vibration. Vibration or noise may be accuracy affected during sensor operation.
7. When using the sensor for the first time or after long term storage, you can use CAL1 MCDL zero point calibration and use it with high accuracy.

※ Specification of C-H Series could be changed without notice.

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