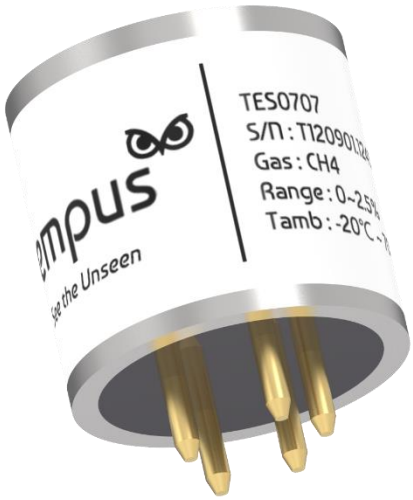
Tempus
Sensor for Lifecare Service

Datasheet (Preliminary)

Rev. 0.03/ Sep. 2024

TES0707

Methane Sensor



TES0707- Dual Channels NDIR CH4 Sensor Module

Introduction

TES0707 is an ultra-small dual channels NDIR sensor module with digital interfaces for CH4 concentration measurement.

The dual-channel NDIR CH4 sensor module, TES0707, offers excellent performance that overcomes the drift of a light source and CH4 over time by using Tempus' faster response NDIR sensors with its unique module structure.

TES0707 is a suitable sensor for gas leak alarming applications, and it is an ideal solution for customers who require low concentration precision.

TES0707 is with performance of high accuracy and stability at a reasonable price. It is the individually pre-calibrated module and possible to measure CH4 concentration up to 2,000ppm. (Other maximum concentration is available upon request).

Features

- Ultra-Small Size
- Low Power
- High Accuracy and Excellent stability
- Absolute measurement with Dual-channel NDIR sensor
- Pre-calibrated and ready-to-use
- Digital interface using RS-232 and PWM
- Digital output for CH4 level warning. (ex: Warning When >1,500ppm)
- ABC feature support
- Manual Calibration support (@0ppm, 25℃)

Applications

- Mining
- Automation & Control
- Indoor Air Quality
- Industrial Health & Safety

Specifications

Power Supply		Minimum	Typical	Maximum
Operating voltage range		4.8 VDC	5 VDC	5.2 VDC
Average Current Consumption		38mA	39mA	40mA
Temperature				
Operating Temperature		-40℃ to 75℃		
Storage Temperature		-20℃ to 55℃		
Humidity				
Operating Humidity		0%	50%	99%
Storage Humidity		0%	50%	90%
Pressure				
Operating Pressure		*80kPa ~ 120kPa*		
Storage Pressure		*80kPa ~ 120kPa*		
Output Signal				
UART	Single Format	8 data bits, 1 stop bit, no parity		
	Baud Rate	9600 bps Only		
Technical specifications				
Body Material		Stainless Steel		
Weight		20 g	23 g	25 g

Typical Performance Characteristics

(All Data are related to a calibrated sensor and conditions: Temperature 20℃, Relative Humidity 20% RH, Pressure 101kPa, 1L/min Gas Flow, unless otherwise stated)

Item	Specification
Gas	Methane
Measurement Range	0 ~ 5%Vol
Accuracy	0~1% : ≤ ±0.06% Vol 1%~2.5% : ≤ ±6% of reading 2.5%~full range : ≤ ±6% of reading
Resolution	1ppm
Warm-up Time	< 50 seconds
Maximum Response Time (T_{90})	< 25 seconds
Zero Repeatability	±0.01% Vol

Digital Interfaces

The TES0707 has several digital intefaces such as RS232, PWM. Users control the register map through digital intefaces by reading and writing register values. This section describes each digital interface and the command/response map will be introduced in the next section.

1. UART Interface

TES0707 support a RS232 Serial interface. Pin Rx is UART Rx (input to sensor) and Pin Tx is UART Tx (output from sensor). In details, UART Conditions are :

- 9600 Baud rates
- No Parity Bit
- 1 Stop bit
- 8 Data bits
- No Flow control

Host can get more inforamtions like PPM, version info, serial number via command/request data.
Its message format is like as below

1.1 UART Protocol

Format of the Message

UART Request Message Format

2 byte		1 byte	1 byte	n byte	2 byte	
SYNC1	SYNC2	CMD	LEN	DATA1...DATAn	CRC1	CRC2

Type	Size	Description
SYNC	2 byte	SYNC Data (0xAA, 0x55)
CMD	1 byte	Data length + 1 (including CMD + DATA)
LEN	1 byte	Data length (Number of valid data (in BYTEs) after LEN, excluding CRC
DATA	n byte	Data to be transmitted
CRC	2 byte	CRC Data

UART Response Message Format

2 byte		1 byte	1 byte	n byte	2 byte	
SYNC1	SYNC2	CMD	LEN	DATA1...DATAn	CRC1	CRC2

Type	Size	Description
SYNC	2 byte	SYNC Data (0xBB, 0x66)
CMD	1 byte	Data length + 1 (including CMD + DATA)
LEN	1 byte	Data length (Number of valid data (in BYTEs) after LEN, excluding CRC
DATA	n byte	Data to be transmitted
CRC	2 byte	CRC Data

1.1.1 Command/Response List

Name	Code	Description
CMD_GET_PPM	0x14	Read PPM
CMD_GET_SERIAL	0x12	Read TES0707 Serial number
CMD_GET_VER	0x10	Read Firmware Version Information

READ PPM (CMD_GET_PPM)

This command will return the measured Methane result.

Request (UART)

0xAA	SYNC1
0x55	SYNC2
0x14	CMD
0x00	Length
0x3E	CRC1
0xEC	CRC2

Response (UART)

0xBB	SYNC1
0x66	SYNC2
0x15	CMD (Response)
0x04	Length
DATA[1]	PPM (LSB)
DATA[2]	PPM
DATA[3]	PPM
DATA[4]	PPM (MSB)
xx	CRC1
xx	CRC2

To calculate the ppm, do the following.

$$\mathbf{PPM} = \mathbf{DATA}[\mathbf{4}] \ll \mathbf{24} \mid \boldsymbol{DATA}[\mathbf{3}] \ll \mathbf{16} \mid \boldsymbol{DATA}[\mathbf{2}] \ll \mathbf{8} \mid \boldsymbol{DATA}[\mathbf{1}]$$

SERIAL NUMBER (CMD_GET_SER)

This command will return serial number of the sensor. Length of serial number is 8 bytes.

Request (UART)

0xAA	SYNC1
0x55	SYNC2
0x12	CMD
0x00	Length
0x3D	CRC1
0x4C	CRC2

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x13	Response
0x08	Size
xx	S/N Byte 0 (LSB)
…	…
…	…
xx	S/N Byte 7 (MSB)
xx	CRC (LSB)
xx	CRC (MSB)

FIRMWARE VERSION (CMD_GET_VER)

This command will return the current firmware version number.
Version number.is something such as v1.1.0

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x10	Command
0x00	Size
0x3C	CRC (LSB)
0x2C	CRC (MSB)

Response (UART)

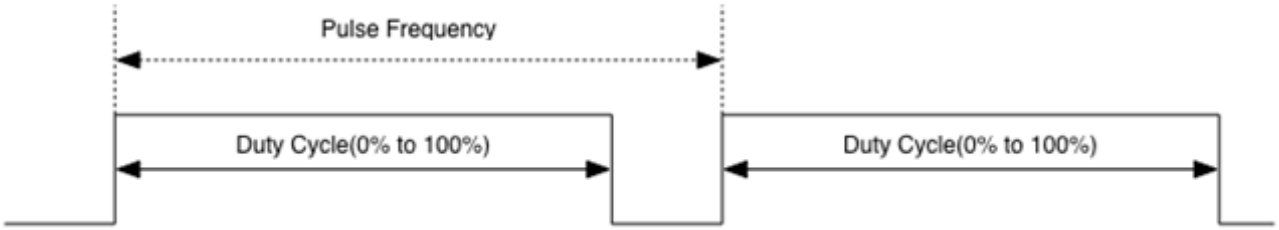
0xBB	Sync (MSB)
0x66	Sync (LSB)
0x11	Response
0x03	Size
xx	Major
xx	Minor
xx	Build
xx	CRC (LSB)
xx	CRC (MSB)

CRC API

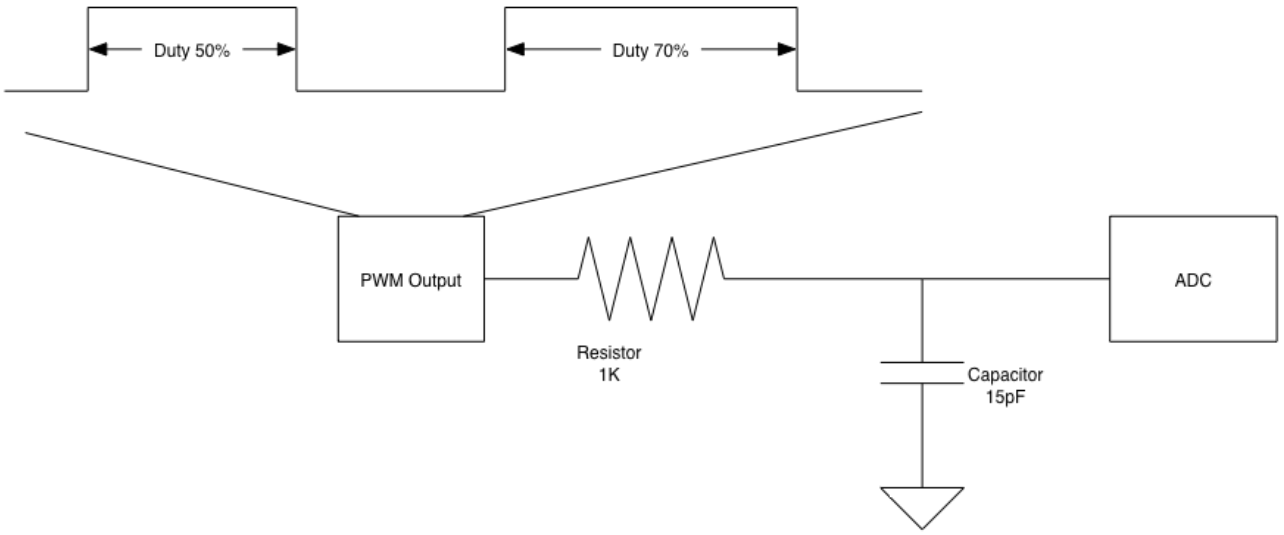
```
uint16_t Calculate_CRC16 ( uint8_t *cmd , int cmd_length )
{
        uint16_t ret = 0xffff , polynomial = 0xa001 ;
        int shift = 0x0;
        for ( int i = cmd_length – 1 ;   i >= 0 ; i-- )   {
              unt16_t code = ( uint16_t )( cmd [ cmd_length -1 - i ]   & 0xff );
              ret = ret ^ code ;
              shift = 0x0;
              while ( shift <= 7 )   {
                    if ( ret & 0x1 ) {
                          ret = ret >> 1;
                          ret = ret ^ polynomial ;
                    } else {
                          ret = ret >> 1;
                    }
                    shift++;
             }
        }
        return ret;
}
```

2. PWM Operation

PWM(Pulse Width Modulation) signal is a digital signal which is equivalent to analog output in power.



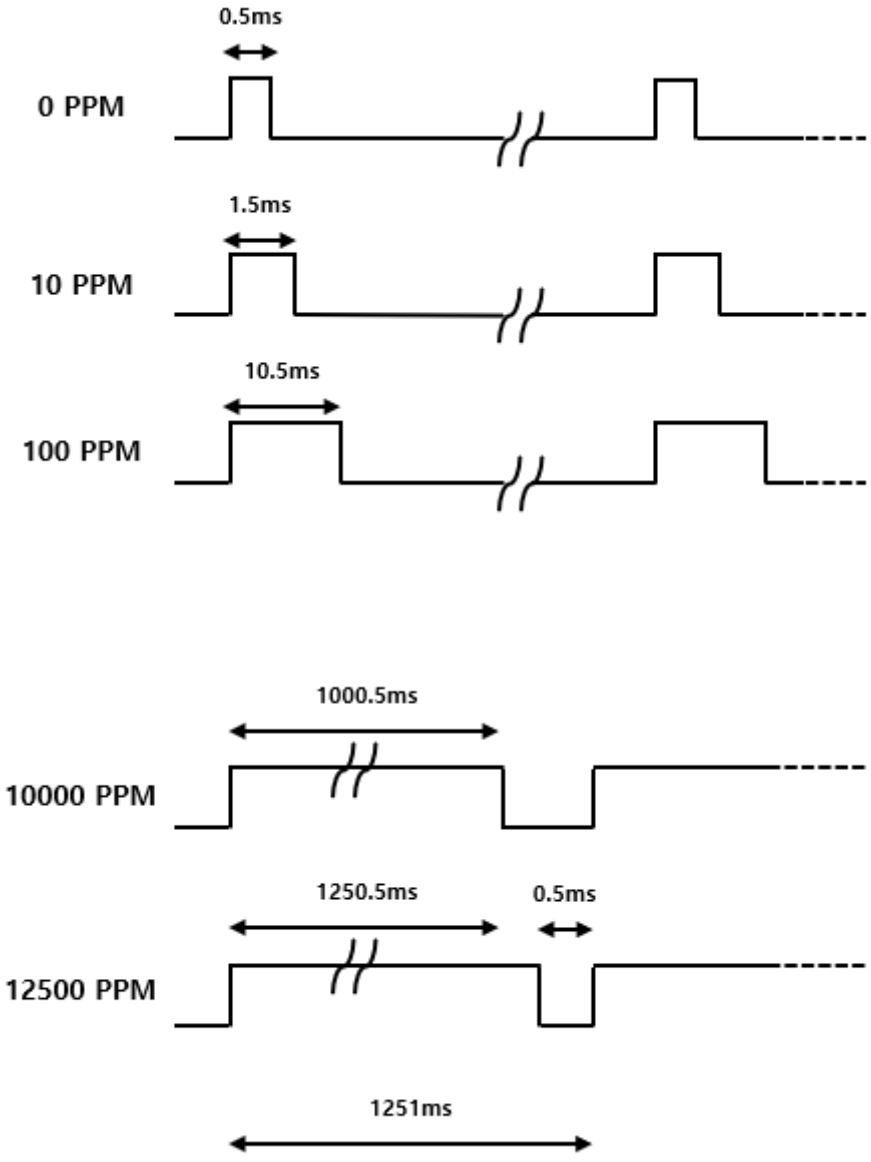
A general ADC is able to read PWM output through LPF. The circuit shows generic first order low pass filter for converting PWM to analog signal to read it through an analog to digital converter.



Simplified Low Pass Filter for PWM signal input to an ADC

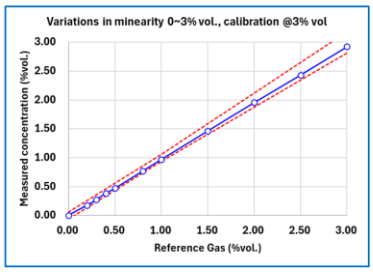
TES0707 PWM output will be proportional to a 0 to 12500(1/4 LEL) ppm and operate at 0.8Hz. The user can measure the duration of PWM pulse.

TOTAL PERIOD	1251.0 ms
OUTPUT range	0 to 12500 ppm*(1)
Methane Level	$\mathrm{Cppm} = (\ \mathrm{PWM\ ON} - 0.5\ )/(\ 1250\ /\ 12500\ )$

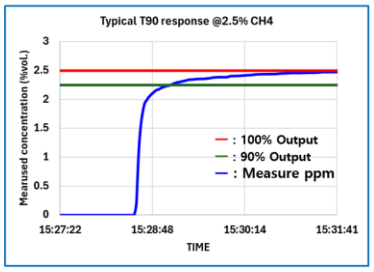


General Performance

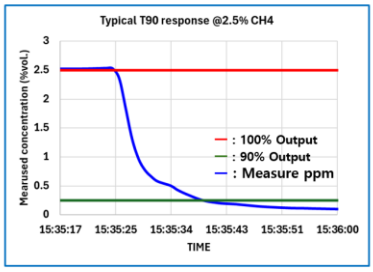
Typical Linearity 0~3% CH4



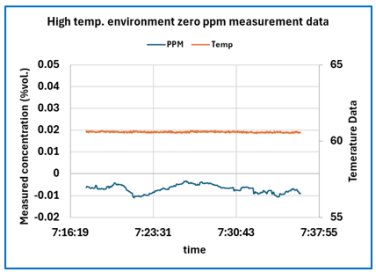
Typical T90 Response Time



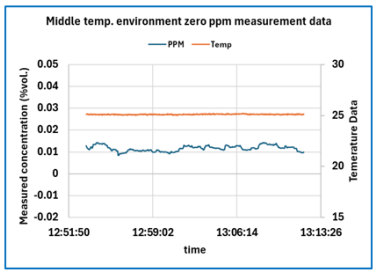
Typical recovery Time (from 2.5% CH4)



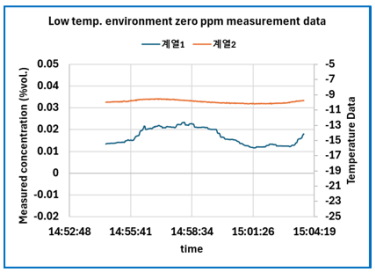
Zero ppm Stability (@60℃)



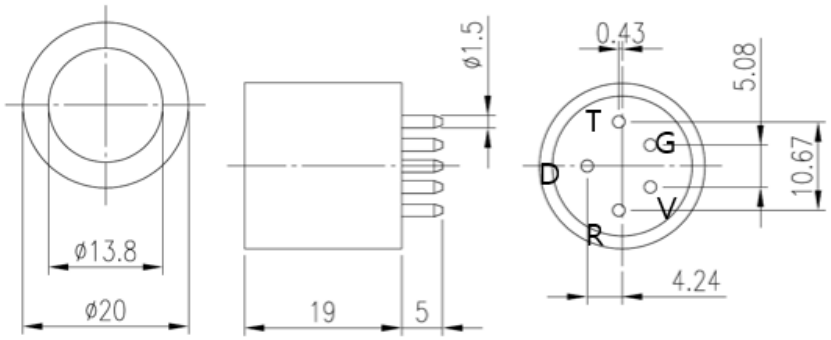
Zero ppm Stability (@25℃)



Zero ppm Stability (@-10℃)



Pin Description



Pin	Name	Description
G	GND	GND Plane, (0 V)
V	VDD	Power Input (4.8 ~ 5.2V)
R	RX	Data received
D	Vout	PWM Output. See Application Note 1 Protocol Section
T	TX	Data Transmitted

Note 1 : Do Not Solder Pins, Use sockets to push-fit the sensor in the instrument. Please refer to our handling precautions on page 4.
Note 2 : Input voltage of 5.0v is Recommended
Note 3 : All Dimensions in mm. All tolerances Linear +- 0.1mm and Angular 0.5˚ unless otherwise stated.
Note 4 : Pins height 5.0mm (+- 0.2mm)

Precautions

Intended use

• This device has been designed to be used as component together with instruments to detect either flammable gas or carbon dioxide of certain concentrations. Please read recommended applications on page 2 for more details.

Handling

• This Sensor is a precision device. Do not drop it or subject it to excessive shock or force. Doing so may damage the Sensor or change its characteristics. Never subject the connector to unnecessary force. Do not use a Sensor that has been dropped.

• Take countermeasures against static electricity before you handle the Sensor.

• Keep the humidity between 0 to 90%.

• Use conductive or cotton type for gloves and finger cots.

• Wear a wrist strap on either the right or left hand.

• Turn OFF the power supply to the system before you install the Sensor. Working with the Sensor while the power supply is turned ON may cause malfunctions.

• Always check operation after you install the Sensor.

• Make sure to wire the polarity of the terminals correctly. Incorrect polarity may damage the Sensor.

• Never attempt to disassemble the Sensor.

• Avoid mechanical force against pins or sockets. Protect from dust and sprayed acidic particles.

• Do not immerse in water or other fluids.

• Do not solder the module directly onto a pcb or to wires. Excessive heat could cause damage.