Datasheet

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TES0909

Dual Channels NDIR CO2 Sensor Module

TES0909- Dual Channels NDIR CO$_2$ Sensor Module

Introduction

TES0909 is an ultra-small dual channels NDIR sensor module with digital interfaces for CO2 concentration measurement.

The dual-channel NDIR CO2 sensor module, TES0909, offers excellent performance that overcomes the drift of a light source and CO$_2$ over time by using Tempus' faster response NDIR sensors with its unique module structure.

TES0909 series are an ideal solution for customers seeking simple integration into user's product. TES0909 is with performance of high accuracy and stability at a reasonable price. It is the individually pre-calibrated module and possible to measure CO$_2$ concentration up to 5,000ppm. (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 RS232
- ABC feature support
- Manual Calibration support (@400ppm, 25℃)

Applications

- HVAC (Heating, Ventilation, Air-conditioning)
- Air conditioner
- Environment management system
- Indoor air quality (IAQ) control
- Automatic air ventilation system
- Smart farm

Pin Description

Pin No.	Pin Name	Description
1	Tx	UART-Tx
2	Rx	UART-Rx
3	+5V	Power supply input (+5V)
4	GND	Power supply input (GND)

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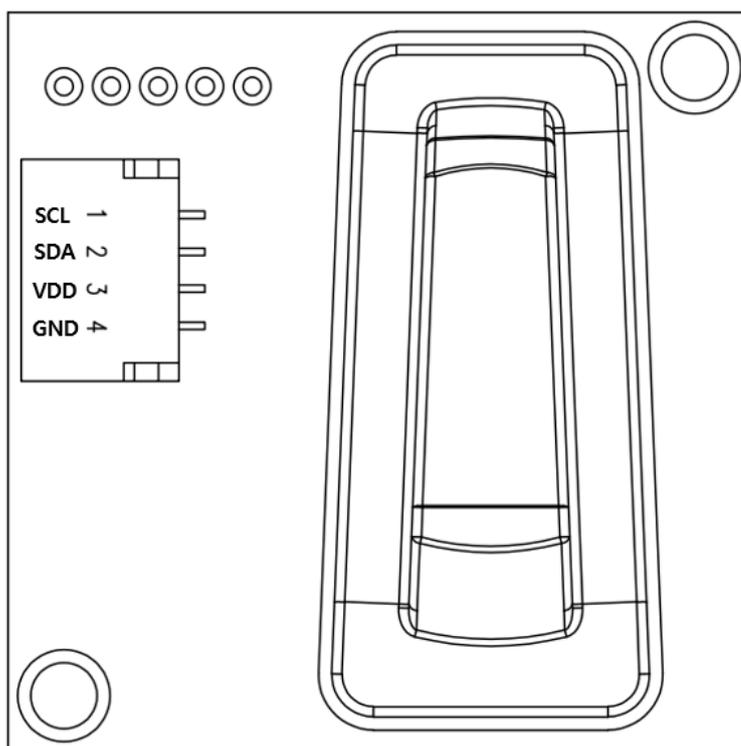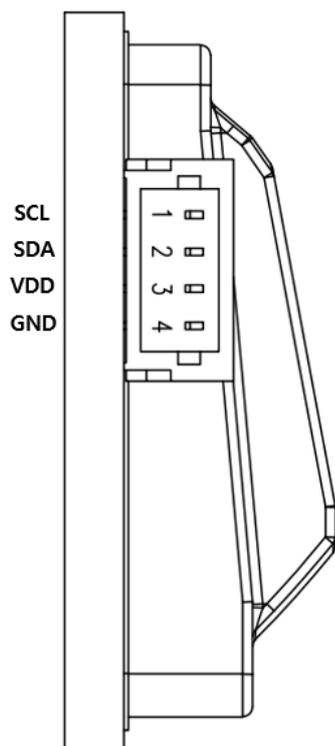
Specifications

Item		Specification
General	Product Name	Dual Channel NDIR CO2 sensor module
	Operation Technology	Non-dispersive Infrared (NDIR)
	Operating Temperature	-40℃ ～ 85℃ (Non-condensing)
	Operating Humidity	0 ~ 95% RH (Non-condensing)
	Operating Environment	Residential, Commercial spaces
	Storage Temperature	-50℃ ～ 95℃(Non-condensing)
CO2 Measurement	Sensing Method	Dual Channel NDIR (Non-dispersive Infrared)
	Measurement Range	400 to 5,000 ppm
	Accuracy	±(50ppm +5% of measured value)
	Warm-up Time	< 2 minutes
	Response Time	< 30 seconds (diffusion)
	Sampling Interval	5 seconds
Electrical data	Supply Voltage	5V (4.75V ~ 5.25V)
	Consumption Current	Average current 21.0 mA@5V Peak current 170 mA@5V Emitter On 120 mA@5V Emitter Off 15 mA@5V
	Output connector	4pins
Output interface	Digital Output	RS232

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Digital Interfaces

The TES0909 has a digital intefaces with RS232.

1. UART Interface

TES0909 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.
Its message format is like as below

1.1   UART Protocol

Format of the Message

UART Request Message Format

2 bytes	1 byte	1 byte	n byte	2 bytes
Sync	Command	Length	Data	Crc16

Type	Size	Description
Sync	2 bytes	Sync Data, 0xAA55
Command	1 byte	Command code. details in Command List
Length	1 byte	Data Size Field
Data	n byte	Data to be transmitted
CRC16	2 bytes	Error check code

UART Response Message Format

2 bytes	1 byte	1 byte	n byte	2 bytes
Sync	Response	Length	Data	Crc16

Type	Size	Description
Sync	2 bytes	Sync Data, 0xBB66
Response	1 byte	Response code.
Length	1 byte	Data Size Field
Data	n byte	Data to be reported
CRC16	2 bytes	Error check code

Host must include the **Cyclical Redundancy Check fields (CRC16)** at the end of the message for error check.

All command/response is hexadecimal.

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1.1.1 Command/Response List

Name	Code	Description
CMD_GET_VER	0x10	Read Firmware Version Information
CMD_GET_SER	0x12	Read Serial Number
CMD_GET_PPM	0x14	Read PPM
CMD_GET_ABC_ON	0x20	Read ABC mode on/off
CMD_SET_ABC_ON	0x22	Write ABC mode on/off
CMD_GET_ABC_DUR	0x24	Read ABC Period
CMD_SET_ABC_DUR	0x26	Write ABC Period
CMD_SET_MANUAL_CAL	0x4C	Calibrate TES0909 to 400ppm
CMD_RESET_PWR	0x1E	Reset power supplied to TES0909

READ PPM (CMD_GET_PPM)

This command will return the measured CO_2 result.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x14	Command
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x15	Response
0x02	Length
DATA[0]	Gas Concentration (LSB)
DATA[1]	Gas Concentration (MSB)
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

To calculate the ppm, do the following.

$$PPM = MSB\ (HEX\ to\ DEC) \times 256 + LSB\ (HEX\ to\ DEC)$$

FIRMWARE VERSION (CMD_GET_VER)

 This command will return the current firmware version number.

Version number is something such as v1.1.2

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x10	Command
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x11	Response
0x03	Length
DATA[0]	Major
DATA[1]	Minor
DATA[2]	Build
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

SERIAL NUMBER (CMD_GET_SER)

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

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x12	Command
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x13	Response
0x08	Length
DATA[0]	S/N Byte 0 (LSB)
…	…
…	…
DATA[7]	S/N Byte 7 (MSB)
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

ABC ON/OFF (CMD_GET_ABC_ON)

This command will report ABC ON state of TES0909. If value is 0, ABC feature will be turned off.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x20	Command
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x21	Response
0x02	Length
0x00	
DATA[0]	ABC ON/OFF
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

ABC ON/OFF (CMD_SET_ABC_ON)

This command will enable/disable ABC feature of TES0909. If value is 0, ABC feature will be turned off.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x22	Command
0x02	Length
0x00	
DATA[0]	ABC ON/OFF
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x23	Response
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

ABC DURATION (CMD_GET_ABC_DUR)

This command will report ABC period of TES0909.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x24	Command
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x25	Response
0x02	Length
DATA[0]	ABC Duration (LSB)
DATA[1]	ABC Duration (MSB)
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

ABC DURATION (CMD_SET_ABC_DUR)

This command will set ABC period of TES0909. By default, its value is "7" which means 7 days. Period starts from "0".

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x26	Command
0x02	Length
DATA[0]	ABC Duration (LSB)
DATA[1]	ABC Duration (MSB)
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x27	Response
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

MANUAL CALIBRATION (CMD_SET_MANUAL_CAL)

This command will calibrate TES0909 to 400ppm. At this moment, the environment temperature should be set to 25℃.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x4C	Command
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x4D	Response
0x00	Length
CRC[0]	CRC (LSB)
CRC[1]	CRC (MSB)

POWER RESET (CMD_RESET_PWR)

This command will reset the power supplied to TES0909. It is not resetting the value of the register, but re-applying power.

Therefore, re-supplying power to the sensor does not change the ABC on/off setting, ABC duration, ABC offset, and the value set by the user is loaded as it was.

For example, if the user sends a command to set the ABC duration to 1 day before re-supplying the power, the ABC duration remains as 1 day even if power is supplied again.

However, the time counter used to check whether the ABC duration has passed is stored in RAM, not flash. So when power is supplied again, the count is lost, and it starts again from 0.

For example, if the ABC duration is 7 days, and the sensor is powered on continuously for 5 days and then powered off, the ABC calibration will not be performed after 2 days after the next power is supplied, but it will be performed after 7days.

Example :

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x1E	Command
0x00	Size
0x38	CRC (LSB)
0x4C	CRC (MSB)

Response (UART)

No response. After sending this command, the power is reset immediately.

1.1.2 CRC API

```c
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. ABC feature

TES0909 supports ABC (Automatic Background Calibration) feature.

TES0909 monitors the trends and min/max value of CO_2 ppm, and counts its timeframe.

Once its time count reaches at "ABC Period", ABC algorithm will apply and count its timeframe from zero again.

Its time counting is working while its power is supplying, so in case of its power is off and on, its time counting starts from zero again and counter will be reset.

So, if user wants to make ABC feature working, need to keep power on without off.

User can enable or disable ABC feature by "0x22" command set with given 1-byte option value.

By default, its ABC feature is "ON".

Please refer to the ABC_ONOFF.

Also, user can change its ABC duration by "0x26" command set with given duration value.

By default, its ABC duration is "7" and its range is "1 ~ 7".

Please refer to the ABC_DURATION.

3. Manual Calibration feature

TES0909 supports Manual Calibration (MC).

Due to shock during the transportation or incorrect installation, TES0909 can drift to unrelated ambient concentrations.

Manual Calibration compensates the drift to 400ppm immediately.

For accuracy compensation, TES0909 should be supplied power at least 3 minutes in a well-ventilated and stable environment prior to calibration. Also, it should be done at room temperature.
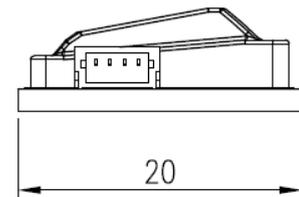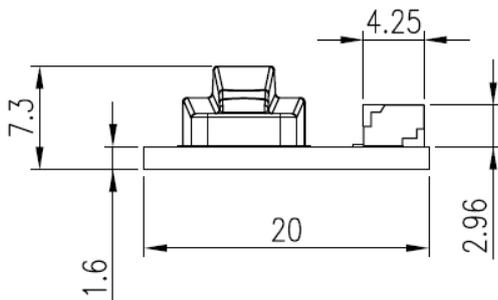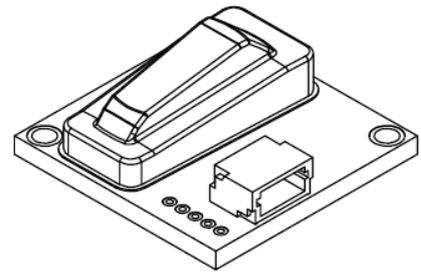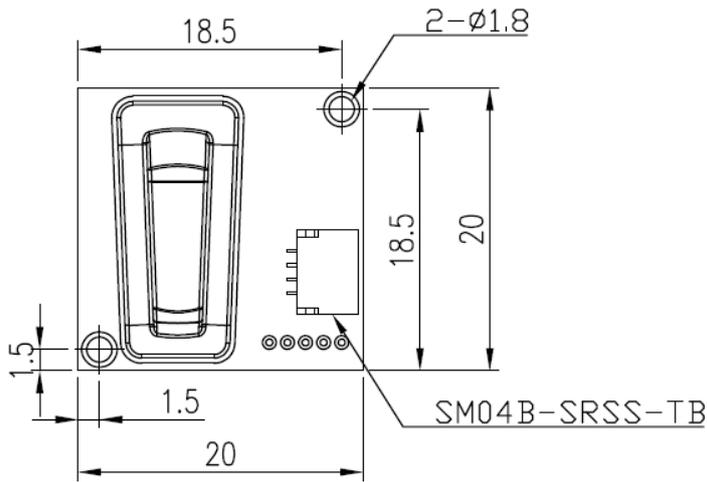
MC updates calibration parameters permanently unlike ABC.

If the user wants to calibrate the sensor without using ABC, MC is the best way.

User can manually calibrate the sensor to 400ppm via the "0x4C" command set.

Please refer to the MANUAL_CAL.

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Dimension Information (mm)

SM04B-SRSS-TB

* Module Dimension : 20.0mm (W) x 20.0mm (L) x 7.3mm (H)