## General

S-300 is one of smallest CO2 sensor modules in the world. Its Persistent Stability and Temperature Effect Resistance besides easy management are much favored by customers in stocks raising, greenhouse, scientific projects, etc. S-300-3V is much favored by customers whose application needs 3.3Voltage input and sleep mode support so on.

Data Sheet for S-300-3V
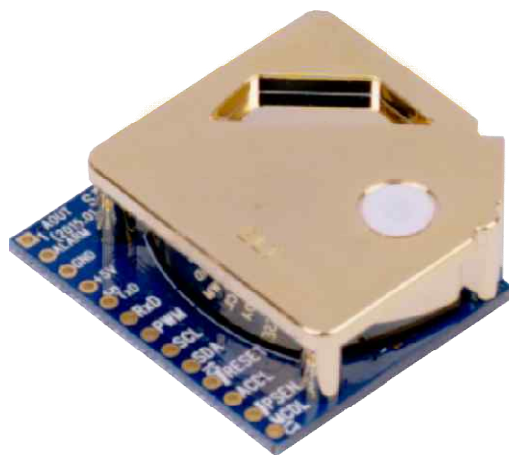
Features

• Non-Dispersive Infrared (NDIR) technology used to measure CO_2 levels.

• Pre-calibrated

• Available outputs : TTL-UART, I2C, ALARM, PWM/Analog Voltage.

• Gold-plated sensor provides long-term calibration stability.

• Installed re-calibration function

• Periodic Automatic Calibration (ACDL) and . Non-Periodic Manual Re-Calibration (MCDL) are available.
.
• ROHS Directive- 2011/65/EU, [EN50581 : 2012,IEC 62321-3-1 : 2013].

• Size : 33mmx33mmx13.1mm

• Weight : 10 grams

S-300-3V Specifications

General Performance

Operating Temperature : -10 ~ 60℃

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

Operating Environment : Residential, Commercial spaces

Storage Temperature : -30℃ ~70℃

CO₂ Measurement

Sensing Method : NDIR (Non-dispersive Infrared)

Measurement Range : 0 ~ 2,000 ppm (0 ~ 3,000/5,000/10,000ppm extended model is available)

Accuracy : ±20ppm ±3% of reading [1][2]

Step Response Time (1/e) : 60 seconds

Sampling Interval: 3 seconds

Warming-up Time : 60 seconds

Electrical Data

Power Input : 3.1V ~ 3.6V[3][4]

Current Consumption : Normal mode : 12mA, Peak < 180mA , Sleep < 0.3mA

Note 1) IAQ application, accuracy is defined after minimum 3 times calibration for 3 weeks.

   2) +/- 2% is added for absolute measurements for uncertainty of calibration gas mixture
      unless the measurement is done with certified calibration mixtures.

   3) DC Supply should be regulated , low noise power source for best accuracy.,

   4) < 0.2mA of Low Power Consumption model

Product Derivatives and Relative Functions

Products	Option List
S-300-3V	UART,I2C, 1st +2nd ALARM, AVO(PWM option), 10' MCDL, ACDL, 13+14 Connector
S-300**L**-3V (Low Power)	Sleep mode is added on S-300, which consume < 0.19mA
S-300**G**-3V (99% Humidity)	Resistance up to 99% Humidity is added on S-300, for Application of Green House
S-300**A**-3V (ACDL S/W)	ACDL Software is added on S-300, which Calibrate Sensor every week

 S-300-3V has various output TTL-UART, I2C, ALARM, AVO (or PWM is selectable as option) and 2.54pitch 13pin side hole connector besides 2mm pitch 10 and 4pin 2 row header connectors. and Periodic Automatic Calibration (ACDL) and Non-Periodic Manual Calibration (10' MCDL) are executable by sending 'Low Signal' to pin-11 and pin-13.

There are 3 derivatives which has additional function on S-300-3V, S-300L-3V is Low Power model, consumes less than 0.2 mA in Sleep mode while as S-300G-3V is hardware-enforced one to be resistant to endure up to 99% humidity for customers whose application is Greenhouse and Stock Raising.

S-300A-3V has ACDL software and calibrate weekly after once in 2day from power-on, without 'Low signal' to J12-7 and J13-13 during operation, appropriate for Indoor Air-Quality Monitoring.

Pin Map with J11&J12 Connectors

UART (J-12:P1&P2) : 38,400BPS, 8bit, No parity, 1 stop bit

I2C (J-12:P3&P4) : Slave mode only, Internal pull up resister
TTL Level Voltage : : $0 \leq V_{IL} \leq 0.4$, $2 \leq V_{IH} \leq VDD$, $0 \leq V_{OL} \leq 0.4$, $2.4 \leq V_{OH} \leq VDD$ (Volt)

J-11	Description
1/3	V_{DD} (+3.3V VCC)
2/4	GND

J-12	S-300-3V	S-300-3V (PWM Option)
1	TTL RXD (← CPU of Master Board)	
2	TTL TXD (→ CPU of Master Board)	
3	I2C SCL	
4	I2C SDA	
5	GND	
6	Analog Voltage Output (0.5~3V)	2ND Alarm ($V_{0.5V}$/V_{3V} TTL Signal Switching)
7	Automatic Calibration (ACDL)	
8	Reserved	
9	10 min. Manual Calibration(MCDL)	
10	Reset (Low Active)	

Analog Voltage(J-12:pin-6, J-13:pin-1) **:** 0.5~3.0 V
In case the PWM option is chosen, Alarm signal comes out instead Analog Voltage.

PWM (J-13:pin-7 is available) :

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

ALARM (1st Alarm **:** Open Collector type, 2nd Alarm : V_{5V}/V_{0V} TTL Signal Switching)
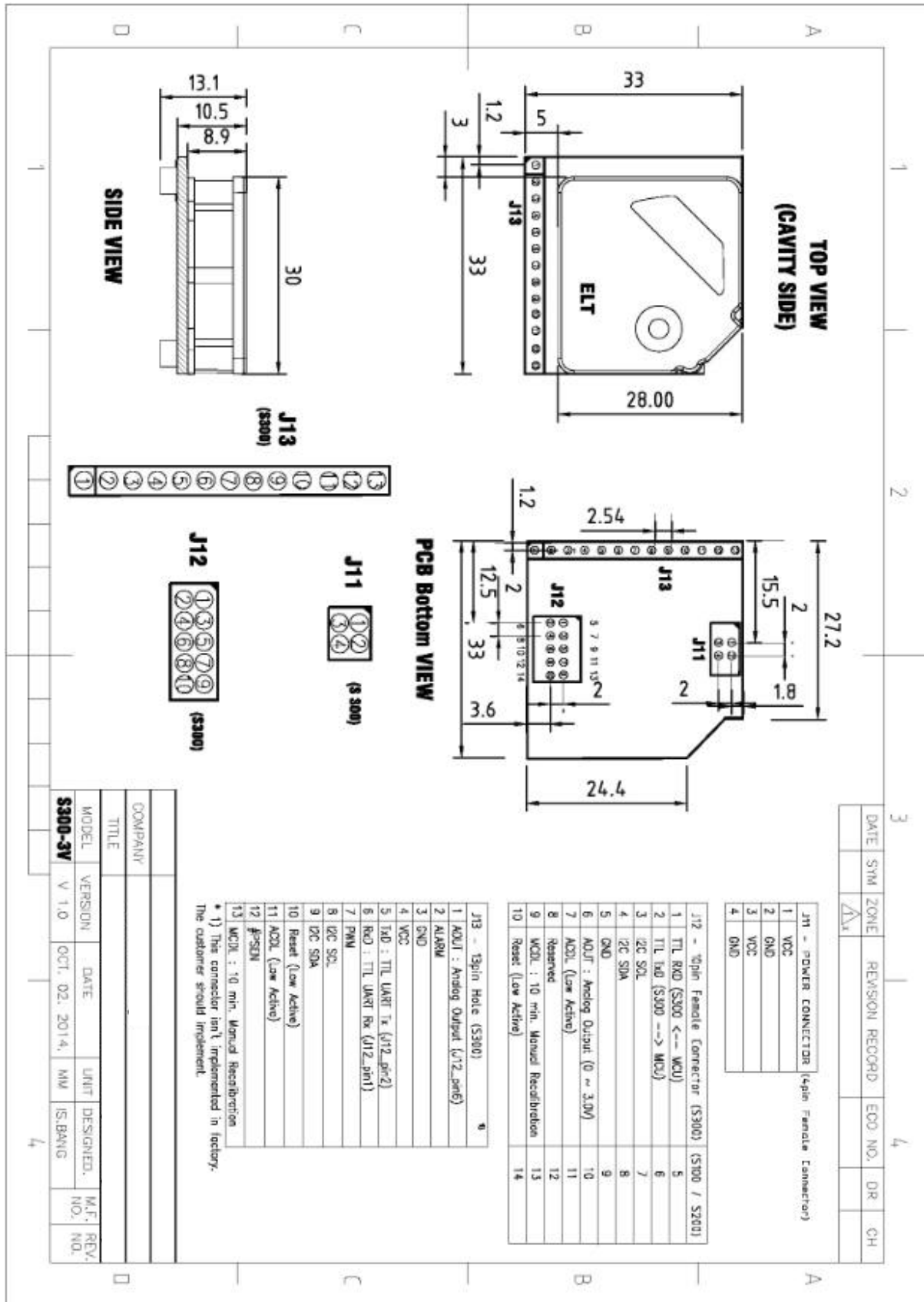
1,000 ppm ≤ Alarm ON, 800 ppm ≥ Alarm OFF
EK-100 is available for customer who is willing to use alarm function with different range.

Pin Map with J13 Connectors

J-13	S-300-3V	S-300-3V (PWM Option)
1	Analog Voltage Output (0.5~3V)	2ND Alarm (TTL Signal $V_{0.5V}$/V_{0V} Switching)
2	1st Alarm (Open Collector)	
3	GND	
4	V_{DD} (+3.3V VCC)	
5	TTL TXD ($\rightarrow$ CPU of Master Board)	
6	TTL RXD ($\leftarrow$ CPU of Master Board)	
7	2nd Alarm ($V_{0.5V}$/V_{3V} TTL Signal Switching)	PWM Output as O.C Default,
8	I2C SCL	
9	I2C SDA	
10	Reset (Low Active)	
11	Automatic Calibration (ACDL)	
12	#PSEN	
13	10 min. Manual Calibration(MCDL)	

TOP VIEW (CAVITY SIDE)

33
1.2
3
5
ELT
28.00

SIDE VIEW

13.1
10.5
8.9
30

J13 (S300)

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬

J12 (S300)

① ③ ⑤ ⑦ ⑨
② ④ ⑥ ⑧ ⑩

J11 (S300)

① ②
③ ④

PCB Bottom VIEW

1.2
2.54
12.5
2
33
3.6
J12
J13
J11
15.5
2
27.2
2
1.8
2
24.4

J11 - POWER CONNECTOR (4pin Female Connector)

1	VCC
2	GND
3	VCC
4	GND

J12 - 10pin Female Connector (S300) (S100 / S200)

1	ADJU : Analog Output (J12 pin6)	6
2	TTL RXD (S300 <-- MCU)	5
3	TTL TxD (S300 --> MCU)	6
4	VCC	7
5	GND	8
6	ADJU : Analog Output (0 ~ 3.0V)	9
7	ADDL (Low Active)	10
8	Reserved	11
9	WCDL : 10 min. Manual Recalibration	12
10	Reset (Low Active)	14

J13 - 13pin Hole (S300)

1	ADJU : Analog Output (J12 pin6)
2	ALARM
3	GND
4	VCC
5	TxD : TTL UART Tx (J12 pin2)
6	RxD : TTL UART Rx (J12 pin1)
7	PWN
8	I2C SCL
9	I2C SDA
10	Reset (Low Active)
11	ADDL (Low Active)
12	#PSEN
13	WCDL : 10 min. Manual Recalibration

* 1) This connector isn't implemented in factory.
The customer should implement.

COMPANY		
TITLE		
MODEL	VERSION	DATE	UNIT	DESIGNED.	M.F. NO.	REV. NO.
S300-3V	V 1.0	OCT. 02. 2014.	MM	IS.BANG		

ACDL function (Automatic Calibration Function in Dimming light with period)

ACDL could be activated as by setting below.
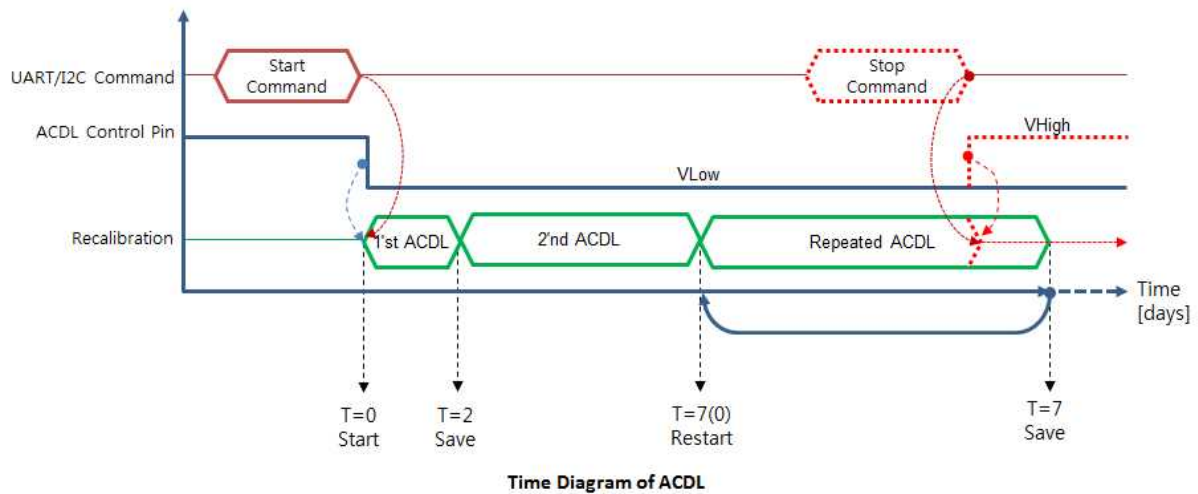
Time Diagram of ACDL

Method 1. UART Command Set; J12: pin-1 (UART-RX) and pin-2 (UART-TX) to Main-Board.
   (J13: pin-6 and pin-5 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. Execute Hardware based ACDL.

J12:pin-7 or J13:pin-11	J12:pin-9 or J13:pin-13	Status	Notes
Low	**High**	**H/W ACDL**	**Calibrate weekly after 2 days since power-on**
High	High	Normal	Operate with Pre-calibrated value in Factory or previous state.

   ※   1. (J12:pin-7 or J13:pin-11) and (J12:pin-9 or J13:pin-13) shouldn't have 'Low' at any time.

   Cf.) Unlike other S-300-3V series, S-300A-3V operate with software based ACDL setting,

      which make sensor always operate with ACDL as default unless MCDL is activated.

Method 4. Let Sensor install on Jig Board, **TRB-100ST (Test and Recalibration Board)** with ambient
   air-flow condition and execute by moving jumper following Manual on the website.

Method 5. **EK-100SL (Evaluation kit, with Emulation program 'ELTWSD')** is available, which
   display and save data on PC through USB connection.

10' MCDL function (10 minute Manual Calibration Function in Dimming light).

 MCDL enable customer to calibrate as needed, MCDL keep at least 10 minute once it start and should be stopped before 18minute to avoid MCDL fetch repetition.
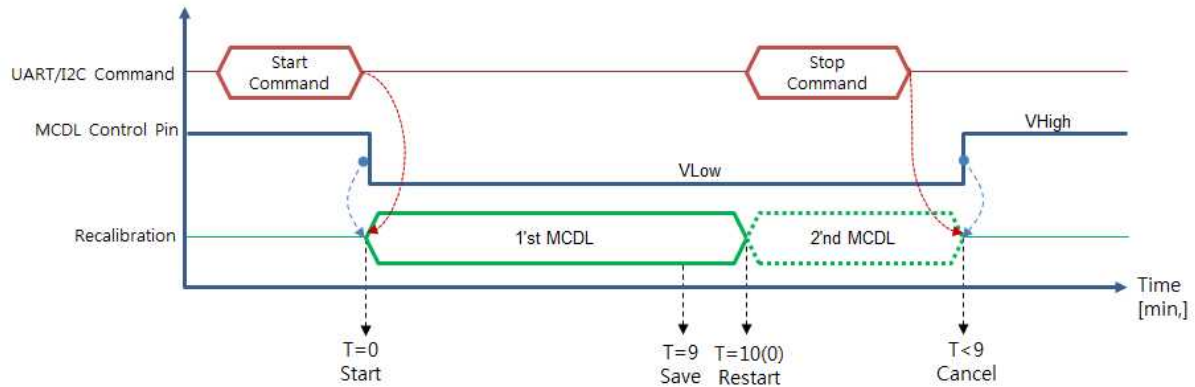
Time Diagram of MCDL

Method 1. UART Command Set;   J12: pin-1 (UART-RX) and pin-2 (UART-TX) to Main-Board   (J13: pin-6 and pin-5 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. Execute Hardware based MCDL.

J12:pin-7 or J13:pin-11	J12:pin-9 or J13:pin-13	Status	Notes
High	**Low**	**H/W MCDL**	**sensor should be located in 400ppm environment (outside) for 10 minutes**
High	High	Normal	Operate with Pre-calibrated value in Factory or previous state.

※   1. (J12:pin-7 or J13:pin-11) and (J12:pin-9 or J13:pin-13) shouldn't have 'Low' at any time.
    2. Be sure to quit MCDL fetch loop before 18minute.
 cf.) Unlike other S-300-3V series, S-300A-3V has nothing to do with (J12:pin-7 or J13:pin-11). It is designed to execute MCDL during pin-13 get Low Active Signal. it return to ACDL as the signal to pin-13 is changed to High De-Active Signal.

Method 4. Let Sensor install on Jig Board, **TRB-100ST (Test and Recalibration Board)** with ambient air-flow condition and execute by moving jumper following Manual on the website.

Method 5. **EK-100SL (Evaluation kit, with Emulation program 'ELTWSD')** is available, which display and save data on PC through USB connection.

Output Descriptions

AVO Description

* Measurement$_{(ppm)}$: 0.5~3.0V

Measured Voltage 0.5V~3.0V matches proportionally to 0 ~ 2,000/3,000/5,000/10,000 ppm or 2%/3%/5%. ppm

* CO_2 Measurement$_{(ppm)}$ = Output $_{Voltage}$– 0.5$_/$ (3.0 – 0.5) $_{Voltage}$ x F.S. $_{ppm}$,
    cf. F.S. $_{(ppm)}$: 2,000/3,000/5,000/10,000 ppm (20,000/30,000/50,000/100,000 is optional.)

    EX) if the Output $_{Voltage}$ is 2.5V in 2,000 ppm (F.S. of Reading range)
    CO2 Measurement $_{ppm}$ = (2.5 – 0.5) V ÷ (3.0 – 0.5) V x 2,000. $_{ppm}$
    = 5 ÷ 4 x 2,000 $_{ppm}$ = 1,600 $_{ppm}$

UART Descriptions

Data Transmit

Interval : 3 seconds

Handshake protocol : None (Data is transmitted to outer device periodically)

Data Format

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

D6 ~ D1	6 byte CO2 density string
SP	Space: 0x20
'ppm'	'ppm' string
CR	Carriage return : 0x0D
LF	Line feed : 0x0A

Above 12byte consist by 6 byte hexadecimal digits,<SP>,0x70 0x70 0x6D, <CR><LF> , where decimal '0' (corresponds to hexadecimal digit '0x30') is replaced by space (corresponds to hexadecimal digit '0x20'),

EX) 1,255 ppm, results '0x20 0x20 0x31 0x32 0x35 0x35 0x20 0x70 0x70 0x6D 0x0D 0x0A', which displays '__1255_ppm<CR><LF>'on screen.

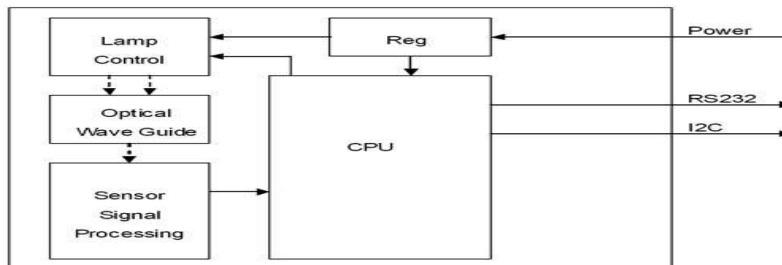## I2C Communication (Only Slave Mode Operation)

Internal pull up resister

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)

Configuration	CO_2	reserved	reserved	reserved	reserved
1 Byte	2 Byte	0x00	0x00	0x00	0x00
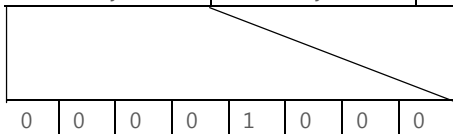
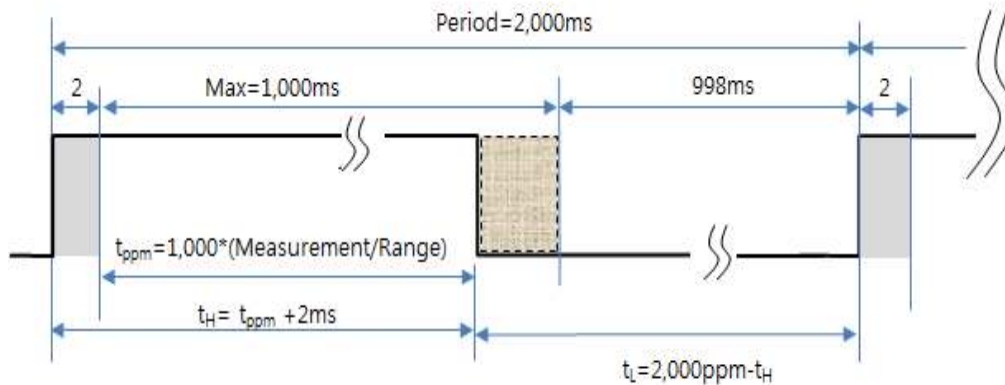| 0	0	0	0	1	0	0	0

   In need of detail protocol specification and time sequence, I2C programming guide is providable by contacting Sales Rep.

PWM Descriptions

* Measurement$_{(ppm)}$ = $(t_H$-2msec$)$/1000msec x Range$_{(ppm)}$ (t_H : High Pulse Width)

* Range$_{(ppm)}$: 2,000/3,000/5,000/10,000 ppm (20,000/30,000/50,000/100,000 is optional.)

EX) t_H (High Pulse Width) calculation for 400 ppm in 2,000 ppm Range.

*Measurement$_{(ppm)}$ = 400 ppm = $(t_H$-2ms$)$/2,000msec x Range$_{(ppm)}$,

*t_H= 1,000 msec * (400 ppm / 2,000 ppm) + 2msec = 202msec

(cf: T_L= Period - t_{H} = 2,000 ppm – 202 msec = 1,798 msec.)

Alarm Descriptions

1st Alarm is Open Collector type which work SPST (Single Pole Single Throw) 1st Alarm is 'OFF ' status at first and turn to 'ON' status since CO2 value go beyond 1,000 ppm until it go down to 800 ppm to avoid unwanted rapid switching by hysteresis effect.

<center>1,000 ppm ≤ Alarm ON, 800 ppm ≥ Alarm OFF</center>
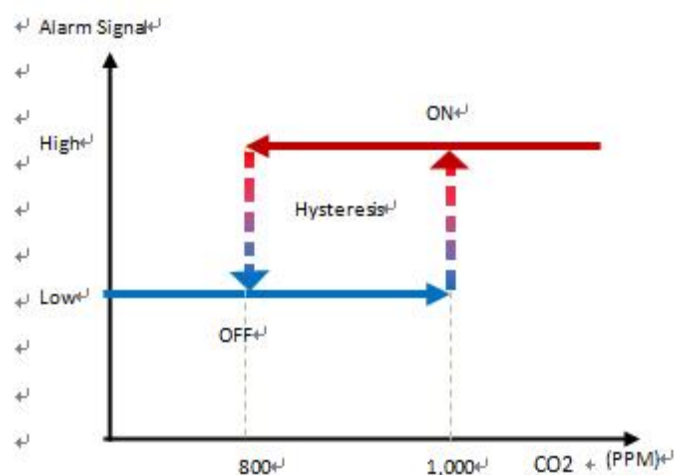
2nd Alarm use 0.5V/3V TTL signal Switching instead of SPST (Single Pole Single Throw) method.

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

Transfer Multisort Elektronik Sp. z o.o.

ul. Ustronna 41

93-350 Łódź, POLSKA