General

 D-400-3V is the smallest Dual CO_2 sensor module in the world.
Its Persistent Stability and Temperature Effect Resistance are much favored in warehouse, greenhouse, hospitals etc. besides the small size and consistent accuracy through the life cycle.

Ver 1.0

ELT Sensor
Data Sheet for D-400-3V

Features

• Non-Dispersive Infrared (NDIR) Dual Channel Technology to measure CO_2 levels.

•Excellent compensation of Temperature Effect on CO2 concentration.

• Output mode : TTL-UART,
        (Option : I2C, AVO, PWM).

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

• Two kinds of Manual Calibration are executable.
(Calibration with 0ppm or 400ppm CO2 gas)

• Size : 50mmx69mmx26mm

• Weight : 30 grams

D-400-3V Specifications

General Performance

Operating Temperature : -20 ~ 50℃

Operating Humidity : 0 ~ 95% RH (Non-condensing) ('G' option : 0 ~ 99% RH (Non-condensing) [1])

Operating Environment : HVAC in Hospital, Warehouse, Greenhouse etc.

Storage Temperature : -30℃ ~70℃

CO₂ Measurement

Sensing Method : NDIR (Non-dispersive Infrared)

Measurement Range : 0 to 2,000 (3,000/5,000/10,000ppm, 2%/3%/5% models are available)

Accuracy : ±30ppm ±3% of Reading [2][3][4]

±300ppm ±3% of Reading for 2%,3%,5% high concentration models

Step Response Time (90%, 1/e) : 150 seconds / 90 seconds

Sampling Interval: 3 seconds

Warming-up Time : < 30 seconds (for Operation), 5 minutes (for Accuracy)

Electrical Data

Power Input : 3.3V(3.2V~3.5V) [5]

Current Consumption : Normal mode : 20mA, Peak : 262mA

Product Derivatives and Relative Functions

Products	Feature
D-400-3V	VDD: 3.2V~3.6, UART,(I2C, AVO,PWM-option), '0/400'ppm MCDL
D-400**G**-3V	Resistant up to 99% Humidity for Application of Agricultural Green House, Stock Raising,etc

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(1) D-400**G**-3V: 0 ~ 99% RH (Non-condensing) for Application of Green House

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

(3)10 minutes MCDL with Standard CO2 gas can be used as option.

(4) Air pressure is assumed as 101.3 kPa

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

Pin Map with J1 (3pin) &J2(7pin) Connectors – 2mm pitch

J1	Description
1	Reserved
2	Analog Voltage Output AOUT (0.5~3V) / PWM (option) – *(Select with S1 & S2) / SCL (option)
3	GND

*J2	D-400 (I2C Option) (SW1 : High position)	D-400 (PWM Option) (SW1 : Middle position)	D-400 (UART Option) (**SW1 : Low position)
1	Reserved		
2	TTL **TXD** (3.3V RS232 Sensor Transmit)		
3	TTL **RXD** (3.3V RS232 Sensor Receive)		
4	I2C **SDA** (option)	Reserved	
5	Reserved		
6	#RESET (Low Active)		
7	I2C **SCL** (option)	**PWM** (option)	Analog Voltage Output AOUT (0.5~3V)

* J2 – (for Factory production) , **SW1 : refer to <Fig.1>

Pin Map with J4 (7pin) Connectors – 2mm pitch

J3,J4	D-400 (I2C Option) (SW1 : High position)	D-400 (PWM Option) (SW1 : Middle position)	D-400 (UART Option) (**SW1 : Low position)
1	I2C **SDA**		
2	I2C **SCL** (option)	**PWM** Output (TTL)	**AOUT**(0.5~3V)
***3	**J4** : **VIN3** (3.3V)		
4	GND		
5	TTL **TXD** (3.3V RS232 Sensor Transmit)		
6	TTL **RXD** (3.3V RS232 Sensor Receive)		
7	Analog Voltage Output **AOUT** (0.5~3V)		

*** J4 option : **B-to-B con. : 2.0mm pitch B7B-PH-K-S (JST)**

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

I2C(option) **:** Slave mode only, Internal pull up resister 10kΩ

TTL Level Voltage : $0 \le V_{IL} \le 0.8$, $2 \le V_{IH} \le VDD$, $0 \le V_{OL} \le 0.4$, $2.4 \le V_{OH} \le VDD$ (Volt)

ALARM : Open Collector type

1,000 ppm ≤ Alarm ON, 800 ppm ≥ Alarm OFF
Alarming range can be change by EK-100SL with connected to PC.
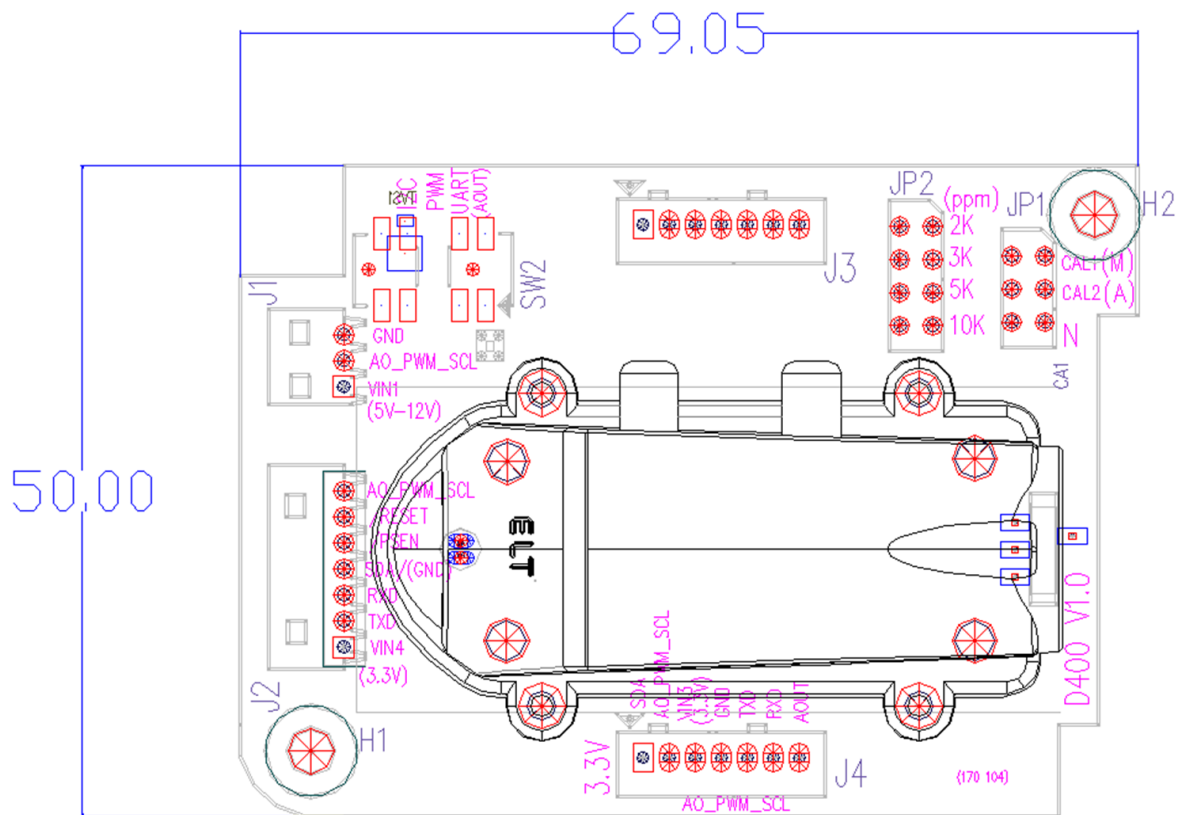
Analog Voltage(option) **:** 0.5~4.5V

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

Jumper Pin Map

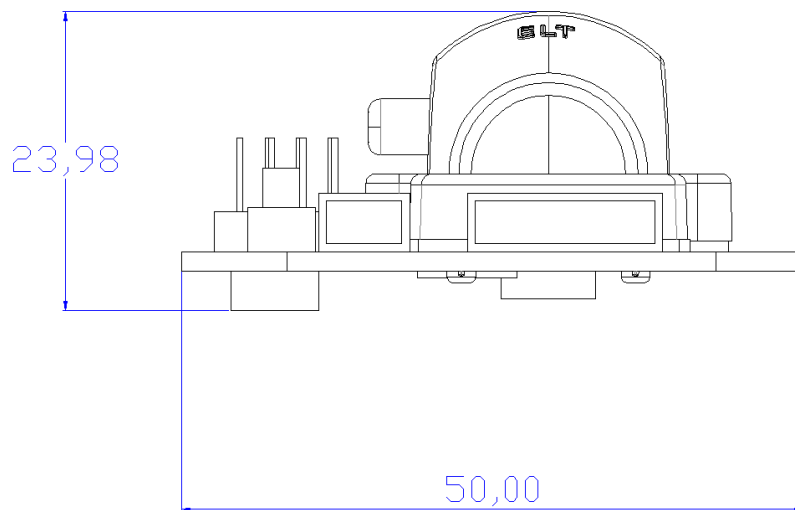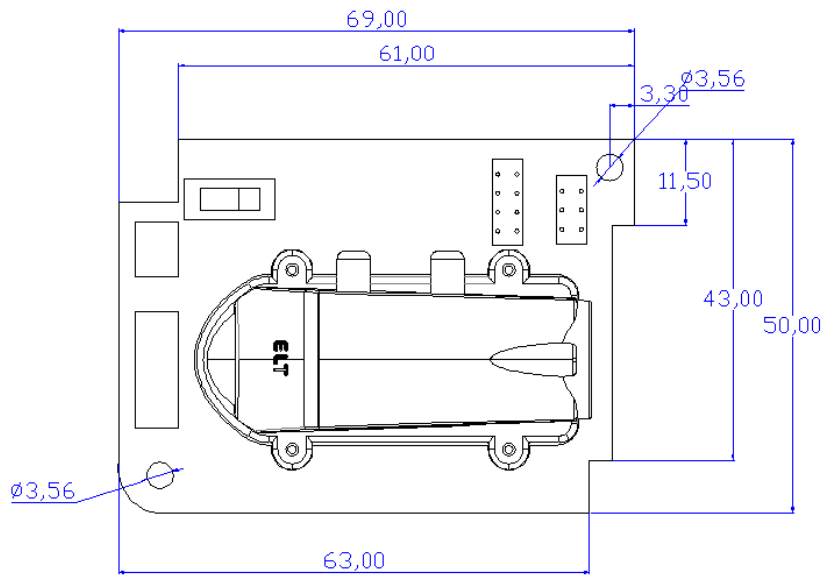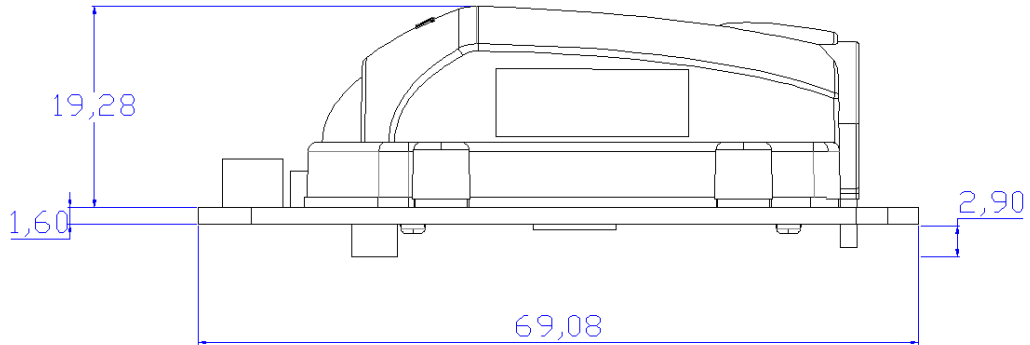| JP1	Description
M (1-2)	CAL1-pin (for 10 minutes MCDL with CO2-'400'ppm-N2-based-gas or Fresh Air)
A (3-4)	CAL2-pin (for 10 minutes MCDL with CO2-'0'ppm-N2-based-gas)
N (5-6)	N

JP2	Description
2K (1-2)	2000 ppm
3K (3-4)	3000 ppm
5K (5-6)	5000 ppm
10K (7-8)	10K ppm

< Fig.1 >

Cavity Dimensions (unit : mm)

50(W) X 69(H) X 23.98(D)

19,28

1,60

2,90

69,08

69,00

61,00

3,30   Ø3,56

11,50

43,00

50,00

Ø3,56

63,00

23,98

50,00

MCDL with CAL1 /CAL2

CAL1 with CO2-'400'ppm-N2-based-gas or CAL2 with CO2-'0'ppm-N2-based-gas is to restore the specification accuracy. Fresh air calibration is also available although the accuracy decreases with the distance from 400ppm.
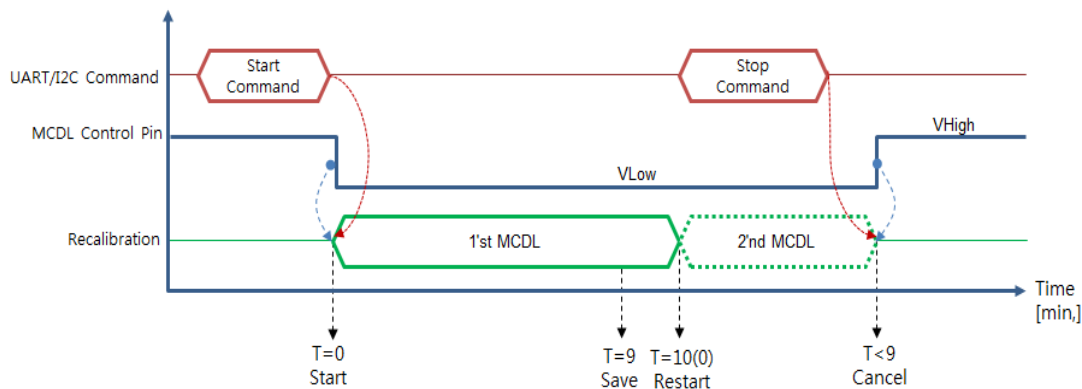
Time Diagram of MCDL

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 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 'ELTWSD') is available

Method 5. Execute Hardware based Manual Calibration (MCDL).

MCDL-pin	CAL-1pin (J12:pin-7 or J13:pin-11)	CAL-2pin (J12:pin-9 or J13:pin-13)	Reference Gas	Calibration time
CAL-1	High	Low	CO2-'400'ppm-N2-based-gas / Fresh Air	Calibration should be finished in between 10 and 18minutes
CAL-2.	Low	High	CO2-'0'ppm-N2-based-gas	

※   1. CAL-1pin and CAL-2pin shouldn't have 'Low' at the same time.
   2. Be sure to escape MCDL fetch loop between 10 minutes and 18minutes to avoid inappropriate calibration.

Output Descriptions

UART Descriptions

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.

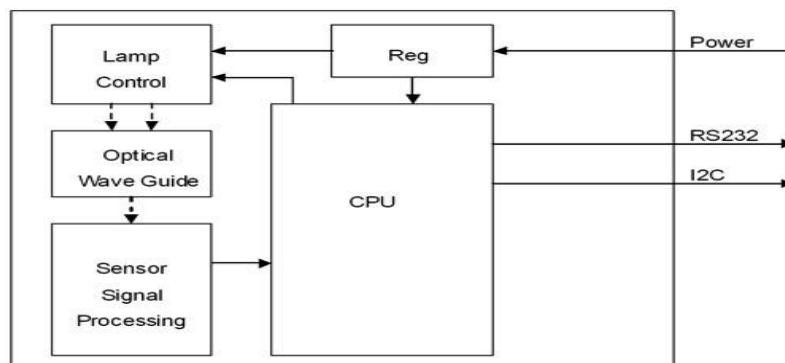## I2C Communication (Only Slave Mode Operation)

Internal pull up resister 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)

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'** could be provided by contacting Sales Rep.

Alarm Descriptions

Alarm signal operates as Open Collector type and send TTL on signal since CO_2 measured value beyond 1,000 ppm until it go down to 800 ppm. It is designed to be activated when CO_2 measured value surpass 1,000 ppm and deactivated down to 800 ppm to avoid unwanted rapid switching by hysteresis effect.

1,000 ppm ≤ Alarm ON, 800 ppm ≥ Alarm OFF
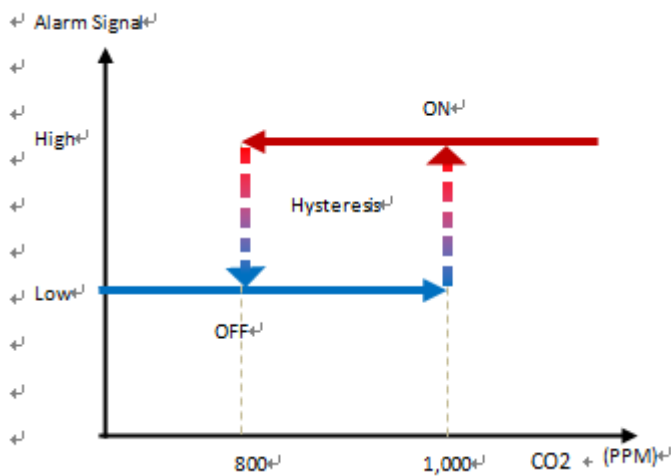
EK-100SL series is available for customer to enable to change alarm activation & deactivation point.

Analog Voltage Output Descriptions : Option

Measured Voltage 0.5V~4.5V match proportionally to 0~ 2,000 each for 2,000 ppm scale sensor and any of 0~3,000 or 5,000 or 10,000 ppm scale sensor could be set by designating on sale. Therefore 4.5V will match 2,000 or 3,000 or 4,000 or 10,000 ppm or 2% or 3% or 5% or 10% each.

* CO_2 Measurement$_{(ppm)}$ = $((\text{Output}_{Voltage} - 0.5)/(4.5 - 0.5)_{Voltage}) \times$ 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)

CO_2 Measurement $_{ppm}$ = (2.5 − 0.5) V ÷ (4.5 − 0.5) V x 2,000. $_{ppm}$

= 2 ÷ 4 x 2,000 $_{ppm}$ = 1,000 $_{ppm}$

PWM Descriptions : Option

* Measurement$_{(ppm)}$ = $(t_H - 2msec)/1000msec \times$ 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.)
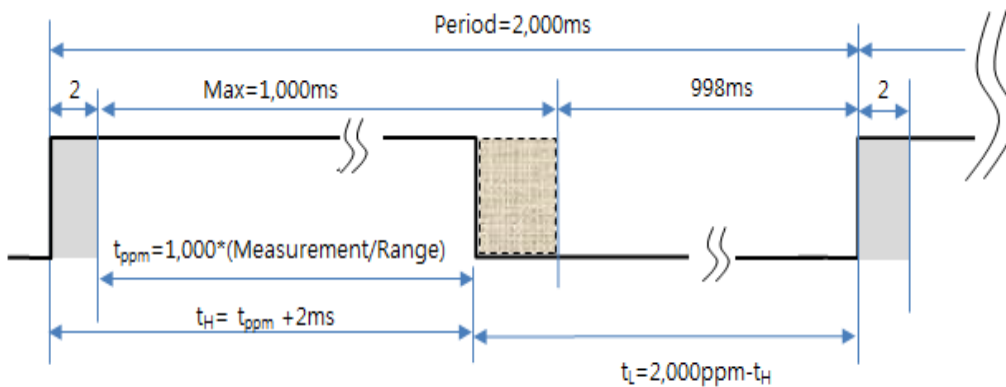
EX) t_H (High Pulse Width) calculation for 400 ppm in 2,000 ppm Range.

*Measurement$_{(ppm)}$ = 400 ppm = $(t_H - 2ms)/2,000msec \times$ 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.)

※Caution

1. Please use only 'PCB' of sensor to avoid the physical shock on sensor without holding Cavity directly. Rough handling or Transportation could result in inaccurate reading..
  But, MCDL with CAL1/CAL2 are available to correct the sensor to normal status.

2. Proper ESD protection during handling is important to avoid electrostatic defect occurrence. The storage of sensor should be insulated as well