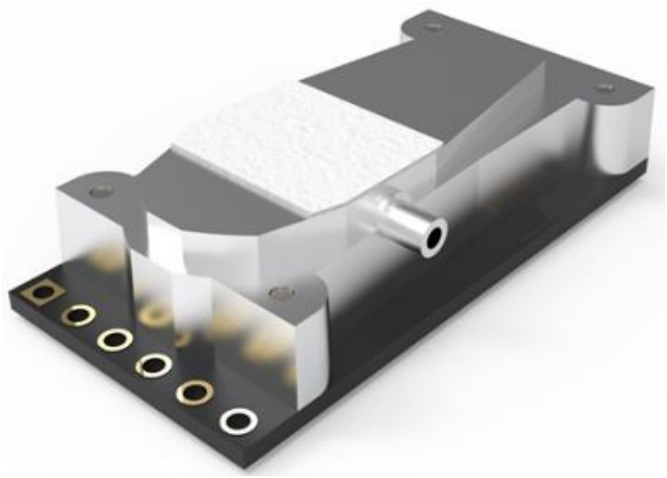


PRELIMINARY DATASHEET

SG112A (1kHz) Gas Sensor Dual Channel NDIR $C0_2$ Sensor Module

UNITRONIC

UNITRONIC GmbH
Hellersbergstraße 10a
41460 Neuss

Telefon 0211 / 95 110
Telefax 0211 / 95 11 111
info@unitronic.de

PART OF
LAGERCRANTZ GROUP

Introduction

SG112A is a compact dual channel non-dispersive infrared (NDIR) sensor module with digital interfaces for measuring CO2 in ambient air.

With an autonomous self-calibration function, the SG112A sensor offers dependable performance by eliminating sensor signal drifts caused by environmental changes and component ageing.

The SG112A has multiple digital interfaces for customer use to seamlessly integrate SG112A with other hardware systems. . The sensor module is individually pre-calibrated, does not require calibrations in the field, and measured CO2 concentrations up to 5,000 ppm (factory set, other maximum concentrations and alarm settings are available upon request).

Features

- Small size
- Low power
- High accuracy and excellent stability
- Absolute measurement with dual-channel self-calibration NDIR technology
- Pre-calibrated and ready-to-use
- Digital interface using RS232 and PWM
- Digital outputs for high level of CO2 warning (Alarm when concentration >2000ppm; other settings available upon request)
- (ABC) feature support

Applications

- Indoor air quality (IAQ) controls
- Automatic air ventilation systems
- Smart farms and agriculture
- HVAC (Heating, Ventilation, Air Conditioning)
- Environment monitoring/management systems

Pin Configuration*

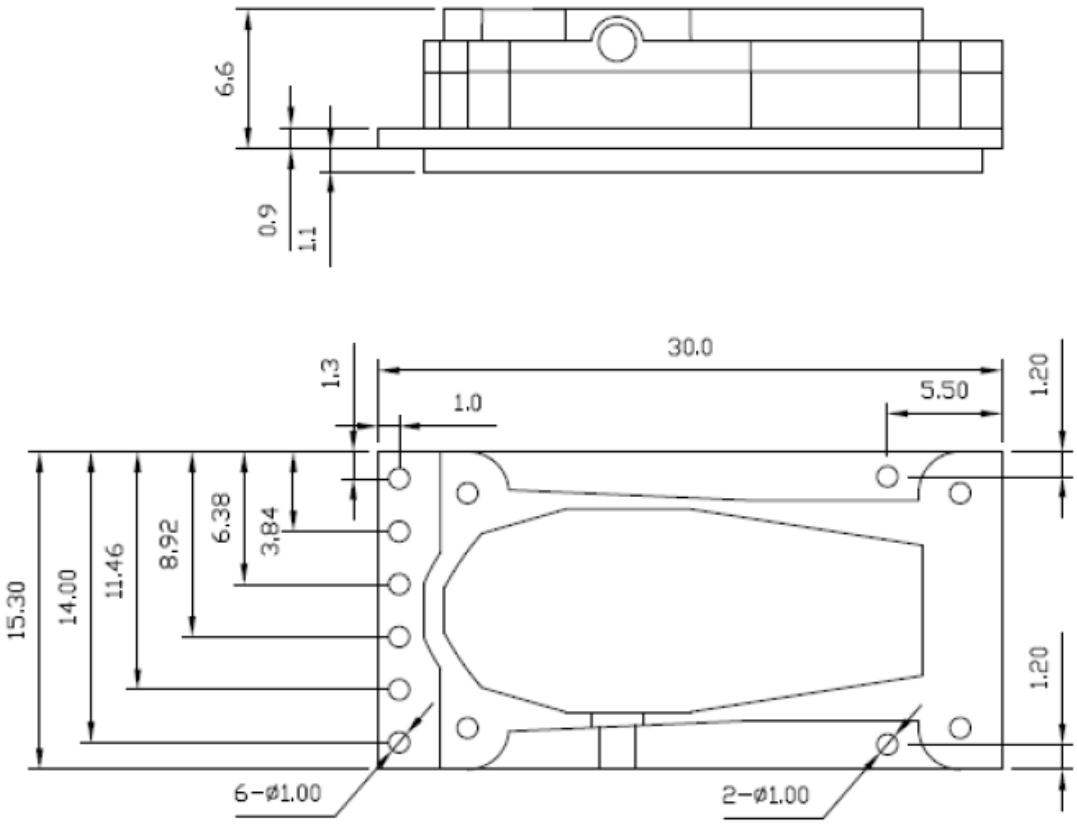
Pin No.	Pin Name	Description
1	TX	TX: 3.3V(Typ) CMOS Level Signal
2	RX	RX: 3.3V(Typ) CMOS Level Signal
3	+5V	+5V Input
4	GND	Ground
5	PWM	PWM Output: 3.3V(Typ) CMOS Level Signal
6	ALARM	ALARM Signal

Specifications

Item		Specification
General	Product Name	Dual Channel NDIR CO2 sensor module
	Operation Technology	Non-dispersive Infrared(NDIR)
	Operating Temperature	-10℃ ~ 50℃ (Non-condensing)
	Operating Humidity	0 ~ 95% RH (Non-condensing)
	Operating Environment	Residential, Commercial spaces
	Storage Temperature	-20℃ ~ 80℃(Non-condensing)
CO2 Measurement	Sensing Method	Dual Channel NDIR (Non-dispersive Infrared)
	Measurement Range	400 to 5,000 ppm
	Accuracy	±(50ppm +3% of measured value)
	Warm-up Time	< 2 minutes
	Response Time	< 30 seconds (diffusion)
	Sampling Interval	2 seconds
Electrical data	Power Input	5 VDC @5% (4.75Vdc ~ 5.25Vdc) Average current 25.0 mA@5V IR Lamp On 120 mA@5V IR Lamp Off 10 mA@5V Peak Current 520mA@5V
	Output connector	6 pins (Terminals not mounted)
Output interface	Digital Input/Output	RS232(UART), PWM, Alarm CMOS level output V_IL max= 0.475*3.3-0.2 = 1.3675V V_IH min= 0.5*3.3+0.2 = 1.85V
Abs. max ratings	UART Max voltage	5.5V
	UART Min voltage	-0.3V
	PWM Max voltage	3.6V
	PWM Min voltage	-0.3V
Weight	Module Weight	2.7g

* Specification is subject to change without notice

Dimensions



* Module Total Dimension: 30.0mm (W) x 15.3mm (L) x 7.7mm (H)
* Specification is subject to change without notice.*
* "2-ø1.00" is for mounting only and not electronically connected.

Digital Interfaces

The SG112A has multiple digital interfaces such as RS232, PWM, and alarm indication. Users control the register map through digital interfaces by reading and writing register values. This section describes each digital interface. The command/response maps are introduced in the following section.

UART Interface

SG112A supports a RS232 Serial interface. Pin Rx is UART Rx (CMOS level input to sensor) and Pin Tx is UART Tx (CMOS level output from sensor). In detail, the UART specifications are:

- 9600 baud rate
- No parity bit
- 1 stop bit
- 8 data bits
- No flow control

The SG112A sends (push) CO_2 information (ppm) to a Host via the UART interface every 2 seconds (other measurement intervals available upon request). A Host can also obtain additional information such as version details, serial number, and alarm setting via command/request data. The device message format is shown below.

UART Command 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

A Host must include the Cyclical Redundancy Check fields (CRC16) at the end of the message to ensure detecting any error.

Command/Response List

Name	Code	R/W	Data Type	Description
CMD_GET_VER	0x10	RO	-	Read Firmware Version Information
CMD_GET_SER	0x12	RO	-	Read Serial Number
CMD_GET_PPM	0x14	RO	-	Read PPM
CMD_GET_ALARM	0x16	RO	-	Read Alarm Level
CMD_SET_ALARM	0x18	WO	uint16_t	Write Alarm Level
CMD_GET_ABC_ON	0x20	RO	-	Read ABC mode on/off
CMD_SET_ABC_ON	0x22	WO	uint16_t	Write ABC mode on/off
CMD_GET_ABC_DUR	0x24	RO	-	Read ABC Period
CMD_SET_ABC_DUR	0x26	WO	uint16_t	Write ABC Period

Examples of Protocol

Read PPM

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x15	Response
0x02	Size
xx	Gas Concentration (LSB)
xx	Gas Concentration (MSB)
xx	CRC (LSB)
xx	CRC (MSB)

PPM information is calculated by using the following equation:
PPM = (MSB × 256) + LSB

FIRMWARE VERSION (CMD_GET_VER)

This command will return the current Firmware Version number, for example v1.1.2

Example 1: request / response command for reading the Firmware Version.

Request (UART)

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

SERIAL NUMBER (CMD_GET_SER)

This command will return the Serial Number of the sensor. The length of the Serial Number is 8 bytes.

Example 2: Request / Response command for reading the Serial Number.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x12	Command
0x00	Size
xx	CRC (LSB)
xx	CRC (MSB)

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)

ALARM READ (CMD_GET_ALARM)

This command reports the Alarm PPM Value in the Register. By default, its value is 2,000.

Example 3: Request / Response command for reading the Alarm Value.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x16	Command
0x00	Size
xx	CRC (LSB)
xx	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x17	Response
0x02	Size
xx	Alarm PPM (LSB)
xx	Alarm PPM (MSB)
xx	CRC (LSB)
xx	CRC (MSB)

ALARM WRITE (CMD_SET_ALARM)

This command writes an Alarm Value in the Alarm register. If the value in Alarm register is 0, the Alarm Function will be turned off.

Example 4: Request / Response command for writing an Alarm Value.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x18	Command
0x02	Size
xx	Alarm PPM (LSB)
xx	Alarm PPM (MSB)
xx	CRC (LSB)
xx	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x19	Response
0x00	Size
xx	CRC (LSB)
xx	CRC (MSB)

ABC Feature

The SG112A has a very unique Automatic Background Calibration (ABC) feature. The device monitors the trends and min/max values of CO2 concentrations, and keeps track of the timeframe.

Once its time counter reaches the “ABC Period”, the ABC algorithm executes automatically, and the timeframe counter starts from zero again.

Time counting only works while power is on. Therefore. when a power-off and -on, the time-frame counter is reset, and the counter starts from zero again. In order to keep the ABC feature working properly, the user therefore needs to make sure that power to the device is not interrupted.

Users can enable or disable the ABC feature by sending the “0x22” command set with a 1-byte option value. By default, the ABC feature is “ON”. Please refer to the ABC_ONOFF section of this datasheet.

Users can also change the ABC duration by sending the “0x26” command with a duration value. By default, the ABC duration is “7” and the range is “1 ~ 7”. Please refer to the ABC DURATION section of this datasheet.

ABC ON/OFF (CMD_SET_ABC_ON)

This command will enable/disable the Automatic Background Calibration (ABC) feature of SG112A. If the value is 0, the ABC feature will be turned off.

Example 5: Request / Response to enable/dis- able the ABC feature.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x20	Command
0x00	Size
Xx	CRC (LSB)
xx	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x21	Response
0x02	Size
0x00	
xx	ABC ON/OFF
xx	CRC (LSB)
xx	CRC (MSB)

ABC ON/OFF (CMD_GET_ABC_ON)

This command will report the ON state of the Automatic Background Calibration (ABC) feature of SG112A. If the value is 0, the ABC feature is turned off.

Example 6: Request response to the ABC feature ON status.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x22	Command
0x02	Size
0x00	
xx	ABC ON/OFF
xx	CRC (LSB)
xx	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x23	Response
0x00	Size
xx	CRC (LSB)
xx	CRC (MSB)

ABC Duration (CMD_GET_ABC_DUR)

This command will set the period of the Automatic Background Calibration (ABC) feature of SG112A. By default, its value is “7”, which sets the period to 7 days. The value starts at “0”.

Example 7: Request response to the ABC feature duration.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x24	Command
0x00	Size
xx	CRC (LSB)
xx	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x25	Response
0x02	Size
xx	ABC Duration (LSB)
xx	ABC Duration (MSB)
xx	CRC (LSB)
xx	CRC (MSB)

ABC Duration (CMD_SET_ABC_DUR)

This command will report the period of the Automatic Background Calibration (ABC) feature of SG112A. If the value is 0, the ABC feature is turned off.

Example 8: Request response to the ABC feature duration.

Request (UART)

0xAA	Sync (MSB)
0x55	Sync (LSB)
0x26	Command
0x02	Size
xx	ABC Duration (LSB)
xx	ABC Duration (MSB)
xx	CRC (LSB)
xx	CRC (MSB)

Response (UART)

0xBB	Sync (MSB)
0x66	Sync (LSB)
0x27	Response
0x00	Size
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;
}
```

Stop Periodic CO2 Concentration Measurement

By default, the SG112A acquires and sends CO2 concentrations in ppm to the host every 2 seconds. The host, therefore, doesn't need to take any action to receive ppm values.
If the host doesn't need the ppm push information periodically, that is, if the host wants to read ppm values only on-demand, this can be done via the command CMD_GET_PPM, 0x14.
While the SG112A is sending ppm data periodically, if the host sends the CMD_GET_ PPM command, periodic CO2 concentration measurement will be deactivated and ppm data will no longer be sent to the host.

Subsequently, the host can only read ppm data on-demand by sending the CMD_GET_ PPM command. If the host wants to enable the periodic ppm measurement feature again, the SG112A module must be reset.

Example:

Request (UART)

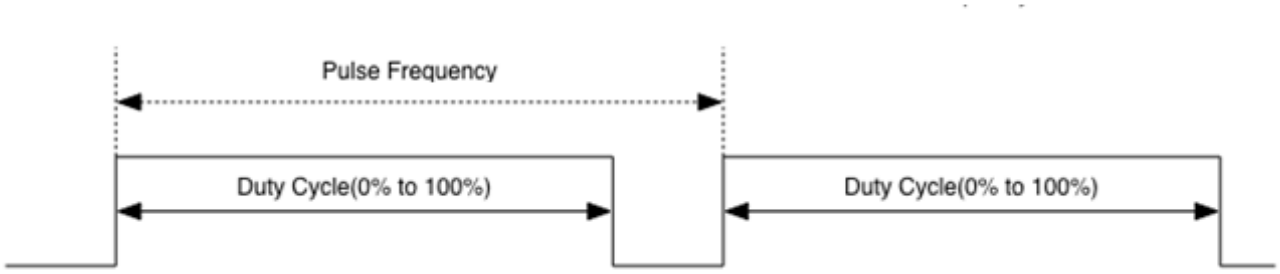
0xAA	Sync (MSB)
0x55	Sync (LSB)
0x14	Command
0x00	Size
xx	CRC (LSB)
xx	CRC (MSB)

Response (UART)

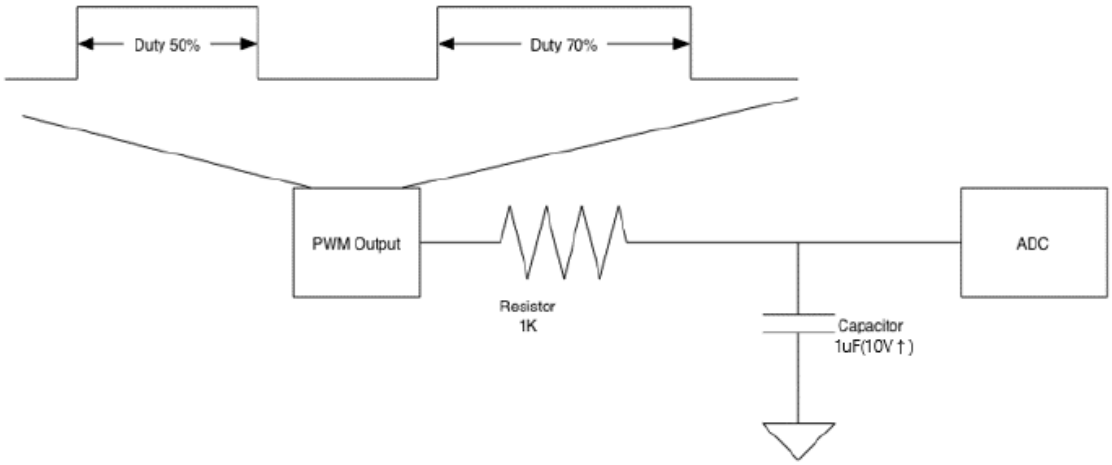
0xBB	Sync (MSB)
0x66	Sync (LSB)
0x15	Response
0x02	Size
xx	Gas Concentration (LSB)
xx	Gas Concentration (MSB)
xx	CRC (LSB)
xx	CRC (MSB)

PWM Operation

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

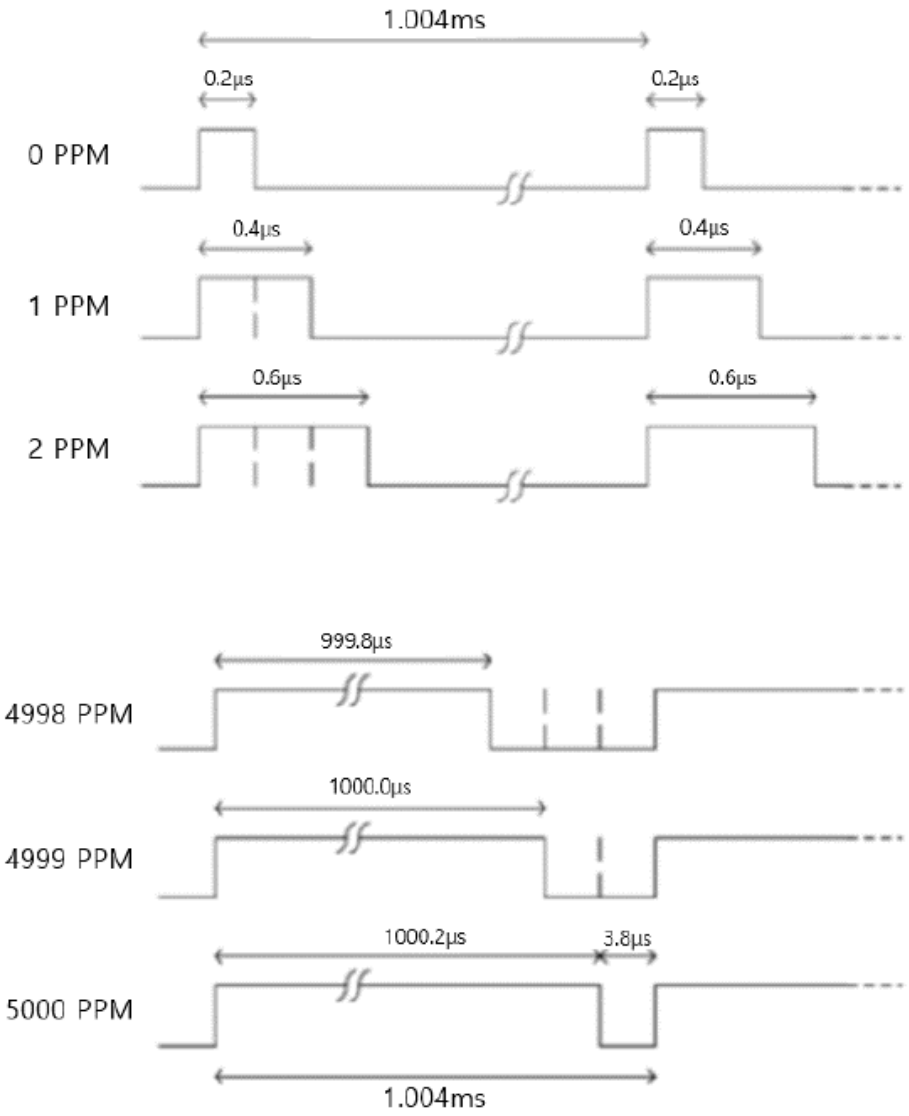


A general analog to digital converter (ADC) is able to read a PWM output through a low- pass filter. The circuit shows a generic first order low pass filter for converting a PWM to an analog signal in order to read it through an ADC.



The SG112A PWM output will be proportional to a 400 to 5000 ppm span and operate at 1kHz. The user can measure the duration of the PWM pulse.

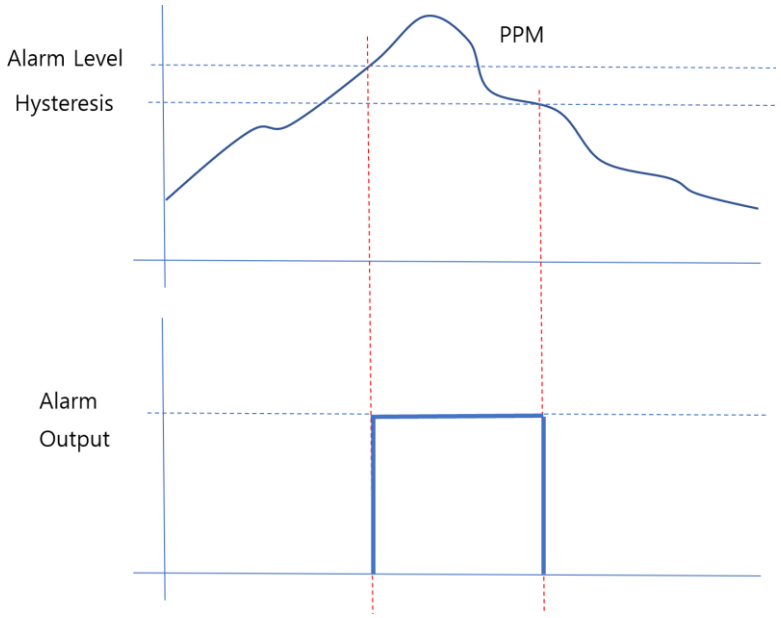
TOTAL PERIOD	1.004 ms
OUTPUT range	400 to 5000 ppm
CO2 Level	$\mathrm{Cppm} = (\,\mathrm{PWM\ ON} - 0.2\mu\,)/(\,0.2\mu\,)$



Alarm Operation

The alarm operation is controlled by setting register addresses. This register stores the CO2 alarm level and its default value is 2,000 ppm CO2.

The host can change the ALARM level via command, as well as enabled/disable function. The alarm level has built-in hysteresis.



Do not touch or remove the particle filter!

About nanotron Technologies GmbH

Nanotron is a leading provider of electronic location awareness solutions. If knowing what, where and when is mission-critical to your business, rely on nanotron with Location Running. Nanotron's solutions deliver precise position data augmented by context information in real-time. Location Running means, reliably offering improved safety and increased productivity, 24 hours a day, 7 days per week: Location-Awareness for the Internet of Things (IoT).

An Inpixon Company

In 2020, nanotron was acquired by Inpixon (Nasdaq: INPX), a leader in Indoor Intelligence. Recognized as an industry leader in the ultra-wideband (UWB) market, nanotron's precision location awareness technology solutions enhance Inpixon's offering and homogenize the positioning of people and assets, both indoors and outdoors. Together, nanotron's solutions and Inpixon's indoor data technology, sensors, video surveillance solutions, and GPS offerings, combine to deliver actionable indoor location data and intelligence.

For more information about Inpixon, visit www.inpixon.com