



IPS Series Sensor

3100 / 5100 / 7100

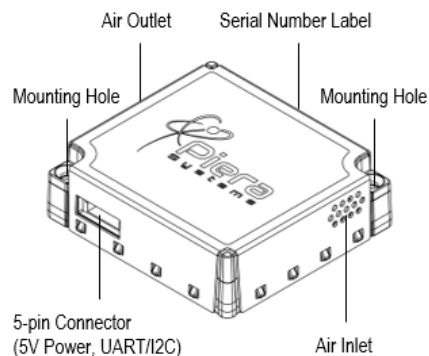
Photon Counting Intelligent Particle Sensor for Accurate Air Quality Monitoring Product Specification

Product Summary

The Piera IPS is a photon counting readout-based highly sensitive optoelectronic particulate sensor. Utilizing Piera's PCIC as a core processor, the IPS is compact and consumes low power while capable of fast data acquisition and readout, as well as categorizing particulates based on the size. The IPS features an adjustable sensitivity control for various applications. Using the state-of-the-art unique sizing and count algorithm to identify different particulates, the IPS is suitable for true real-time precise airborne particulate matter monitoring and particle size distribution analysis. Each Piera IPS is calibrated to a reference instrument via Piera Automated Calibration (PASCAL) System.

Features

- Ultra-high sensitivity for detecting airborne particulates (PM0.1 – PM10*)
- Fast data acquisition and sampling
- Supports UART and I²C
- IoT/Network support*
- Plug-and-play
- Adjustable sampling/data acquisition timing
- Sensitivity control*
- Power saving mode
- Fan control and cleaning mode
- Built-in output data unit conversion options
- Firmware update capability*
- High accuracy and reliability
- Small, robust and long-term stability
- Mounting screw holes



Applications

- Indoor air quality monitoring & management systems
- Ventilation systems
- Real-time particle distribution analysis
- Wide-range particle detection

- ⚠ Do not obstruct the air inlet and outlet during operation.
- ⚠ Do not operate in a heavily contaminated environment.
- ⚠ Intended for indoor use. Outdoor conditions may affect the sensor performance.

* Contact Piera Systems for more details.

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1. Sensor Specifications

	Conditions	Value	Units
Particle Count (PC) Resolution	-	1	#/L
Mass Concentration (PM) Resolution	-	0.1	ug/m ³
Effective Particle Count Concentration (PC) Range ¹	-	0 – 100,000,000	#/L
Particle Count (PC) Precision ² (≤PC2.5)	0 – 200,000 #/L	±20,000	#/L Ave.
	> 200,000 #/L	±10	% Ave.
Particle Count (PC) Precision ² (>PC2.5)	0 – 1,000,000 #/L	±100,000	#/L Ave.
	> 1,000,000 #/L	±10	% Ave.
Effective Mass Concentration (PM) Range ¹	-	0 – 6,000	ug/m ³
Mass Concentration (PM) Precision ² (≤PM2.5)	0 – 50 ug/m ³	±5	ug/m ³ Ave.
	>50 ug/m ³	±10	% Ave.
Mass Concentration (PM) Precision ² (>PM2.5)	0 – 50 ug/m ³	±10	ug/m ³ Ave.
	>50 ug/m ³	±20	% Ave.
Particle Size Bin Allocation (PC: differential, PM cumulative)	PC0.1 ³	0.05 to < 0.1	um
	PC0.3	0.1 to < 0.3	um
	PC0.5	0.3 to < 0.5	um
	PC1.0	0.5 to < 1.0	um
	PC2.5	1.0 to < 2.5	um
	PC5.0	2.5 to < 5.0	um
	PC10	5.0 to < 10	um
Start-up Time ⁴	Default: 5 (until stable output)	>2.5	s
Count Sampling Time	Default: 0.2	≥0.1	s
Data Output Interval	Default: 1 (0.2 in debug mode)	≥0.1	s
Lifetime ⁵	-	>8	Years
Air flow rate	Standard atmosphere	0.13	LPM
Laser Wavelength	Typical	658	nm
Laser Diode Power Consumption ⁶	Typical	3.5	mW
Dimensions	4.6 x 4.15 x 1.24		cm
Weight	26		g

Table 1. Piera IPS specifications

1. Device will report data with accuracy specified on this datasheet within the respective ranges. The precision is not guaranteed beyond the ranges.
2. Device-to-device variation based on average readings over multiple sampling concentration levels using 1.5% potassium chloride solution at 25 °C and 50%RH. Piera uses GRIMM 11D for individual device calibration. Different reference instruments may yield different data under various conditions.
3. Extrapolated data. Contact Piera Systems for further details.
4. Start-up time is 5 second by default. Any data output during this period should be discarded. Subject to change depending on the user settings for the count sampling time. The start-up time may be longer depending on the environment where device is being used in.
5. Lifetime may vary depending on different operating conditions.
6. Complies with the IEC60825-12 specification.

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2. Electrical Specifications

2.1. Electrical Characteristics

Parameter	Conditions	Value	Units
Supply voltage	-	4.5 – 5.5	V
Average supply current	Measurement mode	65	mA
	Sleep mode (UART)	67	uA
	Sleep mode (I ² C)	273	uA
Input high level voltage (V _{IH})	-	>2.31	V
Input low level voltage (V _{IL})	-	<0.99	V
Output high level voltage (V _{OH})	-	>2.9	V
Output low level voltage (V _{OL})	-	<0.4	V

Table 2. Electrical specifications

2.2. Absolute Minimum and Maximum Ratings

Parameter	Rating
Supply voltage VDD	-0.3 to 5.5 V
Interface Select SEL	-0.3 to 4.0 V
Rx, Tx I/Os	-0.3 to 4.0V
Operating temperature range	-10 to +60
Storage temperature range	-40 to +80
Operating humidity range	0 to 95% RH (non-condensing)
ESD CDM (Charge Device Model)	±4 kV contact, ±8 kV open air

Table 3. Absolute minimum and maximum ratings

2.3. Recommended Operation Conditions

The sensor best performs when operated within 10 – 40°C and 20 – 80% RH, should be placed in stable temperature and relative humidity locations.

Avoid operating in a heavily contaminated environment; under excessive ambient light, and/or wind.

3. Hardware and Settings

3.1. Hardware Interface

The interface connector and the description of the pin layout is shown in Fig. 1. The mating female connector should be 5-pin with 1.5mm-pitch. A sample connector info can be found [here](#).



Fig. 1. Interface connector I/O pins



Pin	Name	Description	Comments
1	VDD	Supply voltage	5V ± 10%
2	Rx	UART: Receiving pin for communication	LVTTTL 3.3V
	SDA	I ² C: Serial data input/output	
3	Tx	UART: Transmitting pin for communication	LVTTTL 3.3V
	SCL	I ² C: Serial clock input	
4	SEL	Interface select	Floating: UART
			GND: I ² C
5	GND	Ground	-

Table 4. Interface connector I/O pin description

3.2. Default Settings

Features	Default Settings	Description
Auto Mode	On	IPS starts to readout data once power is on – Plug-and play.
Data Output Interval	1 second	IPS reads out all available bin data every 1 second interval.
PM Data Output	On	IPS reads out mass concentration (PM) data as well as particle counts (PC) data.
Serial Number Output	On	Device serial number is displayed at the end of each data string.
Network Serial Key Output*	On	Device network serial key is displayed at the end of each data string for IoT applications.
Auto Cleaning Mode	On, 1/week	IPS will initiate auto cleaning cycle every week for 10 seconds.
PC Data Output Unit	#/L	Displayed PC data is in number of particles per liter.
PM Data Output Unit	ug/m ³	Displayed PM data is in micrograms per cubic meter.
VSD Mode*	On	Vape/Smoke Detection feature is standard on IPS-7100 models, and the feature is enabled.
CRC	Off	CRC16 mode disabled.

Table 5. Default settings for UART

*For equipped models only. Please refer to the Product Lineup section.

4. Communication Protocols

4.1. Physical Layer

The IPS has Rx and Tx lines with unipolar logic levels. A transmitted byte over UART is shown in Fig. 2. The data speed is 115,200 baud, 1 stop bit with no parity. The IPS offers both a UART and I²C interface.

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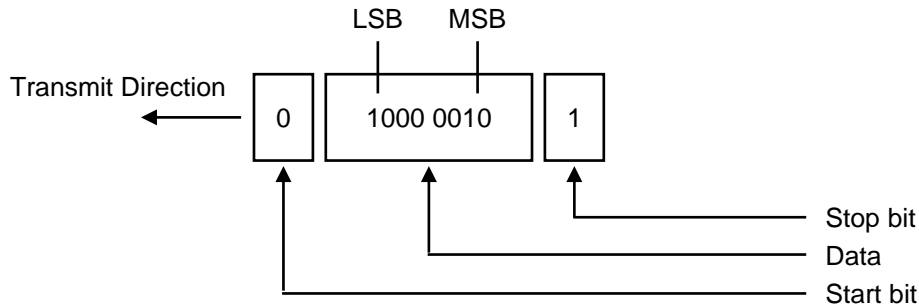


Fig. 2. UART (Universal Asynchronous Receiver Transmitter) data transfer

4.2. UART Interface

Fig. 3 shows the typical UART application circuit, which has 5 I/O pins; VDD, Rx, Tx, SEL, and GND. All commands for IPS (slave) are in printable ASCII strings for convenience. The IPS also replies in printable ASCII string format. Therefore, any serial communication program available on PC and application systems (master devices) can be used to download commands and see the results. An UART cable length should be less than 5m, or 16.5ft.

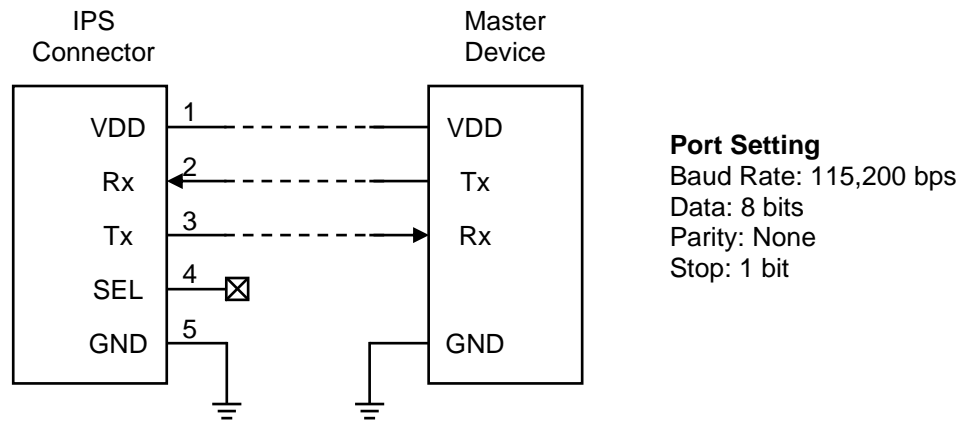


Fig. 3. Typical UART interfacing

4.2.1. Default Sensor Settings

By default, the IPS starts to send data automatically via UART every 1 second as the device is powered up: a series of ASCII characters containing particle counts (PC) and mass concentration (PM) data followed by both device serial number and its network serial key. The PC data is in #/L, and the PM is in ug/m³. Allow at least 5 seconds to obtain stable data. Sensor may send Zero data before this initialization period. The IPS will run self-cleaning cycle for 10 seconds once a week by default.



If your device is equipped with the Vape/Smoke Detection (VSD) algorithm, the VSD mode is on by default. It is standard on IPS-7100 models.

Factory settings:

- | | |
|---|----------------|
| 1. Auto Mode | \$Wmodesel=0 |
| 2. 1 second Data Output Interval Time | \$Winterval=1 |
| 3. PM Data Output | \$Wpmd=1 |
| 4. Output Serial Number and Key Code | \$Wazure=1 |
| 5. Weekly Auto Cleaning | \$Wclnp=604800 |
| 6. Output Unit in #/L and ug/m ³ | \$Wunit=0 |
| 7. Vape-Smoke Detection Mode | \$Wvsd=1 |

To reset the sensor to default factory settings, use the following command.

```
$Wfactory=[CR][LF]
```

Note that ENTER key ([CR][LF]) must follow every command.

4.2.2. Operating Mode Setting – Manual or Automatic Mode

The IPS uses simple ASCII strings to communicate between the slave (IPS sensor) and the master device (application system). The internal blow fan is on as power is supplied.

Automatic Mode: Sensor starts operation and outputs data when the sensor is connected to power through USB connector. On this mode, the sensor outputs data automatically without the “Set Interval Time” command when plugged in a master system (like PC). The sensor outputs data according to the set Interval Time.

a. Set Auto Mode

```
$Wmodesel=0[CR][LF]
```

```
$Wreset=[CR][LF]
```

b. Change the Interval Time on Automatic Mode

\$Winterval=<n>[CR][LF], where n is interval in second, ranging from 1 to 65,535s.

Manual Mode:

a. Set Interval Time

\$Winterval=<n>[CR][LF], where n is interval in second ranging of 0 – 65,535s. Note that “0” doesn’t output any data automatically, it must be polled using \$Rget=.



4.2.3. Real-time Data Retrieving

The IPS offers a special mode for getting data (PCx and PMx) immediately at any time. This can be used to poll data when Winterval=0 is set.

\$Rget=[CR][LF] to retrieve a dataset for all PC and PM.

4.2.4. IoT Communication Mode

For models that are equipped with this feature, the IPS sends out its unique network serial key for IoT communication. When the IoT communication mode is enabled, device serial number and network key will be displayed at the end of each data string. The sensor memorizes the previous settings once the mode is set.

\$Wazure=1[CR][LF] to enable IoT Communication Mode

\$Wazure=0[CR][LF] to disable IoT Communication Mode

4.2.5. Fan Control and Cleaning Mode

The fan is automatically on when the power is supplied to the module. To turn on or off the fan manually, use the following commands as below:

\$Wfan=1[CR][LF] to turn on the fan

\$Wfan=0[CR][LF] to turn off the fan

\$Wcln=1[CR][LF] to initiate the cleaning cycle manually

\$Wcln=0[CR][LF] to stop the cleaning cycle manually

\$Wclnp=<n>[CR][LF] to set the auto self-cleaning interval where n is interval in second (604,800 by default)

\$Wclnp=0[CR][LF] to stop the auto self-cleaning mode

4.2.6. PC and PM Unit Change

To change measured data unit, use the following command:

\$Wunit=<n>[CR][LF] where n==0, 1, 2, or 3

1 for PC, PM values per ft^3 , 2 for PC, PM value per m^3 , 3 for PC, PM value per *liter*.

The default factory setting is n==0 for count number per *liter* and mass number per m^3 .

4.2.7. Power Saving Mode (PSM)

The IPS can hibernate to save energy depending on applications. The IPS will enter hibernation, disabling power to the sensor. The fan, laser diode will all be turned off, and the CPU also goes into deep-sleep mode (<67uA, <273uA for I²C). Any trigger pulse (1ms with 50%duty) will wake up the sensor. It will start gathering data normally after a brief warmup period.

\$Wpsm=1[CR][LF] to initiate PSM



4.2.8. Vape/Smoke Detection (VSD) Mode

If equipped, the IPS can function as a vape/smoke sensor. The device will detect any event of vaping or smoking, and it will send out alerts (print strings "Smoke Detected" or "Vape Detected") when the VSD is enabled. The device will continue to readout data normally even when the VSD Mode is on.

This feature is standard on every IPS-7100 models. Other models may be upgraded to access this feature on demand.

\$Wvsd=1 [CR][LF] to enable VSD Mode

\$Wvsd=0 [CR][LF] to disable VSD Mode

Warning: IPS is not meant for replacing standard indoor smoke/fire alarms!

4.2.9. Cyclic Redundancy Check (CRC)

Supports CRC16 code. Please refer to the CRC16 code functions.

\$Wcrc=1 [CR][LF] to enable data transfer with CRC code.

\$Wcrc=0 [CR][LF] to disable CRC code.

Adds CRC16 to the end of data output. Each output line will now include two extra bytes just before [CR][LF].

4.2.10. Low Data Mode (LDM)

LDM can be enabled to reduce the amount of data sent from IPS sensor.

\$Wldm=1 [CR][LF] to enable low data mode.

\$Wldm=0 [CR][LF] to set standard data transfer mode.

A data string example for PC0.1, PC0.3, PC0.5, PC1.0, PC2.5, PC5.0, PC10, PM0.1, PM0.3, PM0.5, PM1.0, PM2.5, PM5.0, PM10 is as follows.

32750000,8492000,4520500,428500,11500,780,268,0.2736459,0.21894411,0.69106513,0.90588760,
0.95394840,0.98977848,1.8606841

Azure Key will not be sent, supports CRC16 code.

If \$Wpmd=0 [CR][LF] is not used, any PM data will be removed, only sending PC data as an example below.

32750000,8492000,4520500,428500,11500,780,268

4.2.11. Baud rate

This is to change the data transfer rate.

\$Wuart=1 [CR][LF] for 9600 bps



`$Wuart=0 [CR][LF]` for 115200 bps

The device resets itself if baud rate is changed via this command, stays the same until any further changes are made. It is recommended to use 9600 bps for LDM mode.

Note: Terminal connection parameters need to be modified if baud rate change is made, and the device requires reconnect at the new baud rate set.

4.2.12. Sensitivity and Detection Range Control

The IPS has two outstanding features for detecting various sized particulate matters. The user may customize the IPS depending on applications by adjusting sensitivity control voltage and/or detection range control voltage of the sensor. This feature is available for IPS-5100, IPS-5500, and IPS-7100.

Note: The user is required to calibrate for any particle size range that is not offered by standard IPS sensor output bins. Piera Systems does not guarantee the accuracy of the data obtained in this mode.

Contact Piera Systems for more details.

Sensitivity Control

The sensitivity control voltage of IPS is initially set to 1,800mV for general purpose operations. User can adjust the sensitivity of IPS when operating in special environments.

`$WVref=1800[CR][LF]` where 1700 means Vref is set to 1,800mV

Detection Range Control

The IPS has 5 different equally spaced electrical bins to categorize the particulate matters by their sizes. The detection range control voltage of IPS is by default set to 2,500mV for typical measurement environment, which sets 5 internal threshold voltages (Vth1, Vth2, Vth3, Vth4, and Vth5). The parameter should be in between 1500 and 3000.

`$WVth=2500[CR][LF]` where 2500 sets the threshold voltages as follows:

Vth1=0.5V, Vth2=1.0V, Vth3=1.5V, Vth4=2.0V, and Vth5=2.5V.

4.2.13. Debugging Mode

The IPS offers a debugging mode for the advanced users who want to develop/modify the algorithm by getting the raw data from the sensor. The user can access to raw ASIC data by enabling debugging mode.

`$Wdebug=1[CR][LF]`, where x==1 for enabling the debugging mode, x==0 for disabling the debugging mode, which is the default.

When the command is sent to the module, raw data will be displayed as the following example:

```

$Won=1
Won=1
Turn on sensing for 200 [ms]
Init ...
N0[x],1,1,0,0,1,P[x],4,1,0,0,176,PC0.1, 32750000,PC0.3, 8492000,PC0.5,
4520500,PC1.0, 428500,PC2.5, 11500,PC5.0, 780,PC10, 268,PM0.1, 0.2736459,PM0.3,
0.21894411,PM0.5, 0.69106513,PM1.0, 0.90588760,PM2.5, 0.95394840,PM5.0,
0.98977848,PM10, 1.8606841
N0[x],1,2,0,0,2,P[x],5,6,0,0,22,
N0[x],0,0,0,0,0,P[x],0,0,0,0,0,
N0[x],1,0,0,0,2,P[x],5,0,0,0,47,
N0[x],1,1,0,0,2,P[x],1,7,0,0,40
N0[x],0,0,0,0,0,P[x],0,0,0,0,0,PC0.1, 41003000,PC0.3, 10631984,PC0.5, 5768158,PC1.0,
569905,PC2.5, 15295,PC5.0, 1037,PC10, 89,PM0.1, 0.3426046,PM0.3,
0.27411801,PM0.5, 0.87654443,PM1.0, 1.16225832,PM2.5, 1.22617918,PM5.0,
1.27381481,PM10, 1.30579169
N0[x],0,0,0,0,2,P[x],0,0,0,0,44,

```

Where, N0[x] means 5 bin counting numbers on Vth1, Vth2, Vth3, Vth4, and Vth5 respectively, and P[x] is pulse widths of corresponding bin on every 200ms @\$Won=1.

The sampling interval can be changed by: \$Won=2 for 500ms, \$Won=3 for 1,000ms, and etc.

Note: The user is required to calibrate the IPS independently. Contact Piera Systems for more details.

4.3. I²C Interface

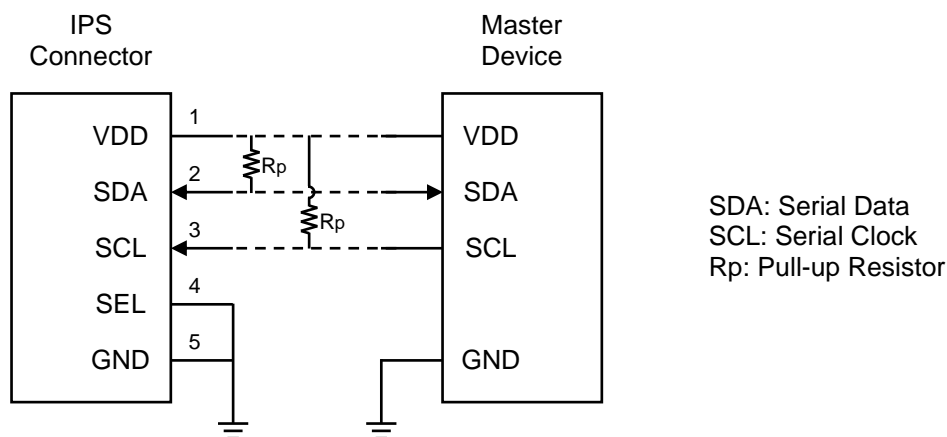


Fig. 4. Typical I²C interfacing



SDA is the serial data input/output pin and SCL is the serial clock pin between IPS and a master device. The Rp is pull-up resistor as the SDA and SCL are open drains, and IPS has internal 4.7kΩ resistors built-in. Because the I²C interfacing is generally used for communication between short distance devices less than 10cm, a particular attention must be paid to electromagnetic interference and crosstalk with well shielded connection cables/PCB patterns. I²C device ID is 0x4b.

Note: IPS's I²C is configured with polling method.

4.3.1. Header Byte

Write Command: 0x96, Read Command: 0x97

Header: 0x96						
S	'1001 011'	W	A	Command	A	●●● Header byte = I2C address (0x4b) <<1+W(0)

Header: 0x97					
S	'1001 011'	R	A	●●● Header byte = I2C address (0x4b) <<1+R(1)	

4.3.2. Write Format

You must wait at least 1 second after sending a write command before sending another write command.

Command without Data

S	I ² C address (7)	W	A	Command (8)	A	P	I ² C address (7) = 0x4b
---	------------------------------	---	---	-------------	---	---	-------------------------------------

Ex: 0x2d, 0x2e Commands

Command with 1 parameter (1byte)

S	I ² C address (7)	W	A	Command (8)	A	Parameter (8)	A	P
---	------------------------------	---	---	-------------	---	---------------	---	---

Ex: 0x10, 0x22, 0x23, 0x24, 0x2b, 0x2c Commands

Command with 2 parameters (2byte)

S	I ² C address (7)	W	A	Command (8)	A	Parameter (8)	A	Parameter (8)	A	P
---	------------------------------	---	---	-------------	---	---------------	---	---------------	---	---

Ex: 0x26, 0x27, 0x28, 0x29 Commands

Command with 4 parameters (4byte)

S	I ² C address (7)	W	A	Command (8)	A	Parameter (8)	A	Parameter (8)	A
---	------------------------------	---	---	-------------	---	---------------	---	---------------	---

Ex: 0x21 Commands

Parameter (8)	A	Parameter (8)	A	P
---------------	---	---------------	---	---

Write commands are defined on the following table:

CMD	Function	Parameters	Description
0x10	Start/Stop	3,2,1 or 0	Stop measurement (n=0) or start measurement with timer=n, n=1 for 200ms, 2 for 500ms and 3 for 1,000ms
0x21	Set Cleaning Interval	[n1],..., [n4]	[n1]<<24+[n2] <<16+[n3] <<8+[n4]&0xff



0x23	Power Saving Mode	1 or 0	0x01: Enter Power Saving Mode (<273uA), 0x0: Wake up pulse
0x24	Set Data Unit	[n=0,1,2,3]	For PC: 0 for #/L, 1 for #/ft ³ , 2 for #/m ³ and 3 for #/L For PM: 0 for ug/m ³ , 1 for ug/ft ³ , 2 for ug/m ³ and 3 for ug/L
0x26	Set Vth	[n1], [n2]	Set detection range control voltage [n1] – MSB [n2] – LSB
0x29	Set Vref	[n1], [n2]	Set sensitivity control voltage [n1] – MSB [n2] – LSB
0x2b	Fan Operation	1 or 0	0x01: Start fan, 0x0: Stop fan
0x2c	Start Cleaning	1 or 0	0x01: Start cleaning, 0x0: Stop cleaning
0x2d	Reset	None	Resets the sensor module Allow approx. 5 seconds for normal communication
0x2e	Factory Reset	None	Restore all factory default settings

Table 6. I2C write commands

When using 0x10 or 0x23 commands, sampling is reset. Please allow approximately 5 seconds for warmup.

4.3.3. Read Format

Command expecting data from the host

S	I ² C address (7)	W	A	Command (8)	A	Sr	I ² C address (7)	R	A
---	------------------------------	---	---	-------------	---	----	------------------------------	---	---

Data1 (8)	A	...	DataN (8)	N	P
-----------	---	-----	-----------	---	---

Ex: 0x11, 0x12, 0x61, 0x62, 0x64, 0x65, 0x66, 0x6a, 0x77, 0x78, 0x79 Commands

S: Start; Sr: Repeat Start; A: Ack; N: Nack; P: Stop

Read commands are defined on the following table:

CMD	Function	Parameters	Description
0x11	Read PC data (3 Series)	[n1],..., [n12] [n13][n14]	Read measured PC data for all 3 bins Each data has 4 unsigned bytes Number of data: [n1~n28] = 4byte x 3 CRC16: [n13]x256+[n14]
	Read PC data (5 Series)	[n1],..., [n20] [n21][n22]	Read measured PC data for all 5 bins Each data has 4 unsigned bytes Number of data: [n1~n28] = 4byte x 5 CRC16: [n21]x256+[n22]
	Read PC data (7 Series)	[n1],..., [n28] [n29][n30]	Read measured PC data for all 7 bins Each data has 4 unsigned bytes Number of data: [n1~n28] = 4byte x 7 CRC16: [n29]x256+[n30]
0x12	Read PM data (3 Series)	[n1],..., [n12] [n13][n14] [n15][n16]	Read measured PM data for all 3 bins Each data has 4 bytes Float (IEEE-754) format The ordering method of the data conversion is Little Endian, i.e, if 4 byte data of ABCD is input, then DCBA is output with real number (floating point number).

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			<p>Number of data: [n1 – n28] = 4byte x 3 EVENT INFO: [n13]x256+[n14] (0: Nothing 1: event 2: smoke 3: vape ... reserved) CRC16: [n15]x256+[n16]</p>
	Read PM data (5 Series)	[n1],..., [n20] [n21][n22] [n23][n24]	<p>Read measured PM data for all 5 bins Each data has 4 bytes Float (IEEE-754) format The ordering method of the data conversion is Little Endian, i.e, if 4 byte data of ABCD is input, then DCBA is output with real number (floating point number). Number of data: [n1 – n28] = 4byte x 5 EVENT INFO: [n21]x256+[n22] (0: Nothing 1: event 2: smoke 3: vape ... reserved) CRC16: [n23]x256+[n24]</p>
	Read PM data (7 Series)	[n1],..., [n28] [n29][n30] [n31][n32]	<p>Read measured PM data for all 7 bins Each data has 4 bytes Float (IEEE-754) format The ordering method of the data conversion is Little Endian, i.e, if 4 byte data of ABCD is input, then DCBA is output with real number (floating point number). Number of data: [n1 – n28] = 4byte x 7 EVENT INFO: [n29]x256+[n30] (0: Nothing 1: event 2: smoke 3: vape ... reserved) CRC16: [n31]x256+[n32]</p>
0x61	Read Cleaning Interval	[n1],..., [n4] [n5][n6]	<p>4 bytes are unsigned integer in second Default value = 604,800 [s] or 1 week CRC16: [n5]x256+[n6]</p>
0x64	Read Data Unit	[n1=0, 1, 2, 3] [n2][n3]	<p>For PC: 0 for #/L, 1 for #/ft³, 2 for #/m³ and 3 for #/L For PM: 0 for ug/m³, 1 for ug/ft³, 2 for ug/m³ and 3 for ug/L CRC16: [n2]x256+[n3]</p>
0x65	Read Start/Stop	[n1],..., [n4]	<p>Measurement period reading, [n1]x256+[n2] in ms CRC16: [n3]x256+[n4]</p>
0x66	Read Vth	[n1],..., [n4]	<p>Detection range control voltage reading, [n1]x256+[n2] CRC16: [n3]x256+[n4]</p>
0x69	Read Vref	[n1],..., [n4]	<p>Sensitivity control voltage reading, [n1]x256+[n2] CRC16: [n3]x256+[n4]</p>
0x6a	Read Status	[n1],..., [n3]	<p>Read status byte (b0: fan on/off, b1: cleaning on/off, b2: PSM on/off) Each bit is 0 for off and 1 for "On" b3=1 is for UART and 0 is for I²C. CRC16: [n2]x256+[n3]</p>
0x77	Read Serial Number	[n1],..., [n19]	<p>[n1] – [n17] : Serial Number CRC16: [n18]x256+[n19]</p>
0x78	Read version number	[n1],..., [n9]	<p>[n1] – [n7] : Version number CRC16: [n8]x256+[n9]</p>
0x79	Read Network Serial key	[n1],..., [n26]	<p>[n1] – [n24] : Serial key CRC16: [n25]x256+[n26]</p>

Table 7. I2C read commands

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CRC16 code for reference:

```
#define POLY 0x8408

uint16_t CRC16(uint8_t *byte, int len)
{
    int i, j;
    u16 data=0;
    u16 crc=0xffff;

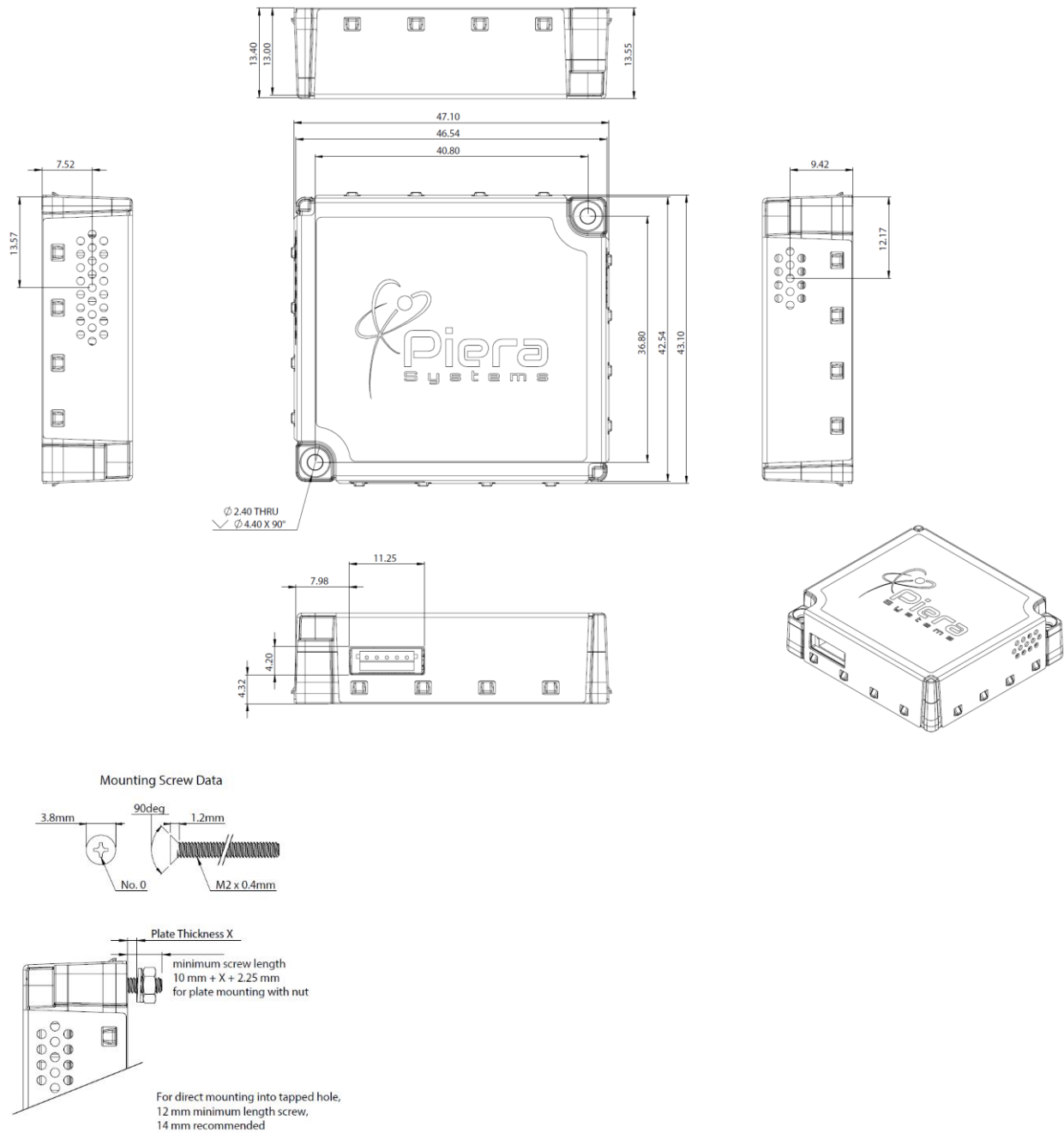
    for(j=0;j<len;j++)
    {
        data = (u16)0xff & byte[j];
        for(i=0;i<8;i++, data >>= 1)
        {
            if((crc & 0x0001) ^ (data & 0x0001))
                crc = (crc >> 1) ^ POLY;
            else
                crc >>= 1;
        }
    }

    crc = ~crc;
    data = crc;
    crc = (crc << 8)|(data>>8 &0xff);

    return crc;
}
```



5. Technical Drawings



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6. Product Lineup

Models		IPS-3100	IPS-5100	IPS-7100	IPS-7100C*
# of Bins		3	5	7	7
Binning Output	0.1			o	o
	0.3			o	o
	0.5		o	o	o
	1.0	o	o	o	o
	2.5	o	o	o	o
	5.0		o	o	o
	10	o	o	o	o
Key Features	Output in particle counts	o	o	o	o
	Output data unit conversion	o	o	o	o
	IoT network support		o	o	o
	USB firmware update		o	o	o
	Customizable sensitivity			o	o
	Customizable binning			o	o
	Calibration certificate				o
Remarks		Mass quantity order only		-	-

Table 6. IPS series product lineup and features

*Contact Piera systems for details.

7. Ordering Information

Please visit www.pierasystems.com or email to info@pierasystems.com.

8. Important Notices

8.1. Warning, Personal Injury

Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. Do not use this product for applications other than its intended and authorized use. Before installing, handling, using or servicing this product, please consult the data sheet and application notes. Failure to comply with these instructions could result in death or serious injury.

If the Buyer shall purchase or use IPS for any unintended or unauthorized application, Buyer shall defend, indemnify and hold harmless Piera and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use,

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even if Piera shall be allegedly negligent with respect to the design or the manufacture of the product.

8.2. ESD Precautions

The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take customary and statutory ESD precautions when handling this product.

8.3. Warranty

Piera warrants solely to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product shall be of the quality, material and workmanship defined in Piera's published specifications of the product. Within such period, if proven to be defective, Piera shall repair and/or replace the product, in Piera's discretion, free of charge to the Buyer, provided that:

- notice in writing describing the defects shall be given to Piera within 14 (fourteen) days after their appearance;
- such defects shall be found, to Piera's reasonable satisfaction, to have arisen from Piera's faulty design, material, or workmanship;
- the defective product shall be returned to Piera at the Buyer's expense; and
- the warranty period for any repaired or replaced product shall be limited to the unexpired portion of the original period.

This warranty does not apply to any equipment which has not been installed and used within the specifications recommended by Piera for the intended and proper use of the equipment.

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