

# PMT9123QS-TVIT: Low Power Right Angle Optical Track Sensor

## Product Datasheet

### General Description

The PMT9123QS-TVIT is PixArt Imaging's low power, right angle Optical Track Sensor in a small form factor QFN package. It has a new low-power architecture and automatic power management modes, based on optical navigation technology that enables digital surface tracking, ideal for battery-powered wireless input devices. The PMT9123QS-TVIT integrates optical sensor and IR LED light source in a single SMT package, and together with LST0-M30 lens assembly, form a complete and compact tracking system that does not require code wheel, code strip and any special marking on tracking surfaces for motion control or tracking purposes.

### Key Features

- Right Angle Small Form Factor Package with total solution size of 6.0 mm x 6.0 mm x 3.6 mm enabling 90 degree viewing angle to the tracking surface
- Low power consumption of 0.45 mA @ run mode with programmable down shifts and wake up times
- 12-bits motion data registers
- High speed motion detection 25 ips and acceleration 8 g
- Motion detect pin output
- Internal oscillator – no clock input needed
- Resolution up to 2000 cpi

### Applications

- Devices that require motion and tracking capabilities
- Suitable for space-constraint and battery-powered devices
- Consumer Product Applications

### Key Parameters

Parameter	Value
Supply Voltage (V)	V <sub>DD</sub> : 1.7 – 2.0
Resolution (cpi)	2000
Speed (ips)	25
Acceleration (g)	8
Interface	2-Wire Interface (TWI)
Area of Interest (AOI)	3 x 3 mm
Package Type	28-pin QFN Package with Lens Assembly: 6.0 x 6.0 x 3.6 mm
Optical Lens Magnification	1:1

### Ordering Information

Part Number	Package Type
PMT9123QS-TVIT	28-pin QFN Package
LST0-M30	Lens Assembly



For any additional inquiries, please contact us at <http://www.pixart.com/contact.asp>

1.3 Signal Description

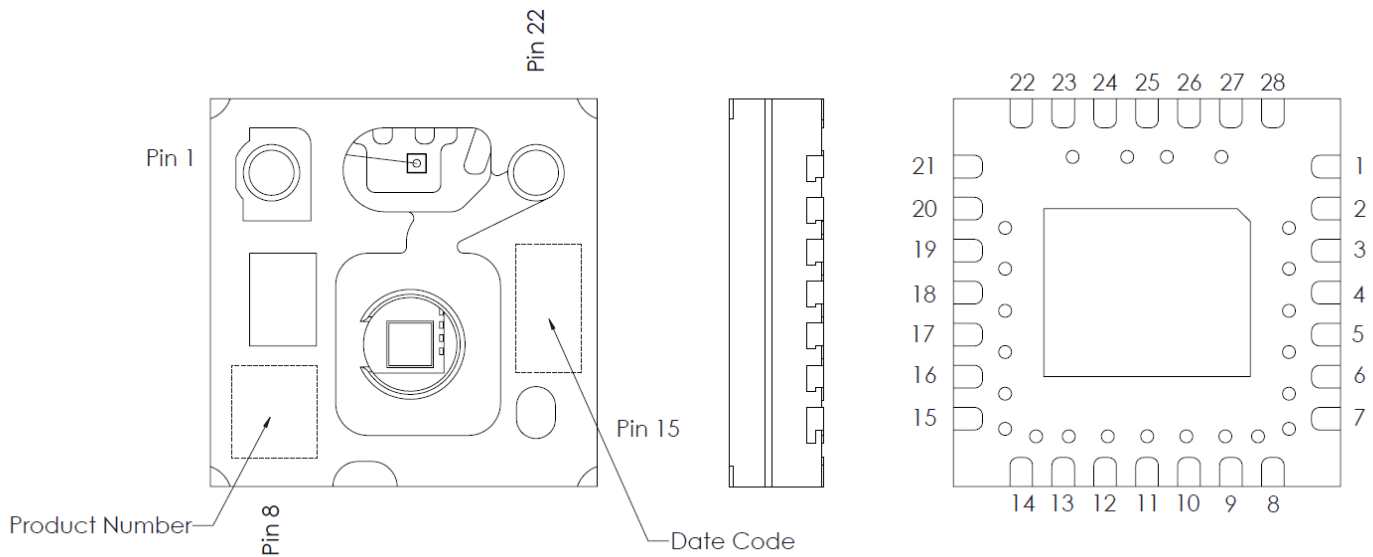


Figure 2. Pin Configuration

Table 1. PMT9123 Signal Pins Description

Pin No.	Signal Name	Type	Description
<b>Functional Group:</b>		<b>Power Supplies</b>	
3	VREG	Power	Internal voltage output
4	VDD	Power	Supply voltage (1.8 V)
27	LED+	Power	Supply to LED anode
1	GND	Ground	Ground
11	GND	Ground	Ground
21	GND	Ground	Ground
22	GND	Ground	Ground
28	GND	Ground	Ground
24	LED-	Ground	LED cathode, must connect to XY_LED
25	LED-	Ground	LED cathode, must connect to XY_LED
26	LED-	Ground	LED cathode, must connect to XY_LED
<b>Functional Group:</b>		<b>Control Interface</b>	
7	SCL	Input	Serial data clock
20	SDA	Input / Output	Serial data

Pin No.	Signal Name	Type	Description
<b>Functional Group:</b>		<b>Functional I/O</b>	
16	MOTION	Output	Motion detect output (Active low)
17	NRESET	Input	Chip reset (Active low)
19	XY_LED	Input	LED control, must connect to LED-
<b>Functional Group:</b>		<b>Special Function Pin</b>	
2	NC	NC	No connection (float)
5	NC	NC	No connection (float)
6	NC	NC	No connection (float)
8	NC	NC	No connection (float)
9	NC	NC	No connection (float)
10	NC	NC	No connection (float)
12	NC	NC	No connection (float)
13	NC	NC	No connection (float)
14	NC	NC	No connection (float)
15	NC	NC	No connection (float)
18	NC	NC	No connection (float)
23	NC	NC	No connection (float)
29*	GND	Ground Paddle	Bottom of QFN package must be connected to circuit ground

## 2.0 Operating Specifications

### 2.1 Regulatory Requirements

- Passes FCC B and worldwide analogous emission limits when assembled into a device with shielded cable and following PixArt's recommendations.
- Passes IEC-1000-4-3 radiated susceptibility level when assembled into a device with shielded cable and following PixArt's recommendations.

### 2.2 Absolute Maximum Ratings

Table 2. Absolute Maximum Ratings

Parameters	Symbol	Min.	Max.	Unit	Notes
Storage Temperature	$T_S$	-40	85	°C	
Lead Solder Temperature	$T_{SOLDER}$		260	°C	For 1.4 seconds
Supply Voltage	$V_{DD}$	-0.5	2.1	V	
LED Supply Voltage	$V_{LED}$	-0.5	2.1	V	
Moisture Sensitivity Level	MSL		1		Referring to JEDEC-J-STD-020
ESD (Sensor only)	$ESD_{HBM}$		2	kV	All pins (Human Body Model, JESD22-A114-E)
Latchup Current	$I_{out}$		200	mA	All pins

**Notes:**

1. Maximum Ratings are those values beyond which damage to the device may occur.
2. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute maximum-rated conditions is not implied.
3. Functional operation should be restricted to the Recommended Operating Conditions.

## 2.3 Recommended Operating Conditions

Table 3. Recommended Operating Conditions

Description	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Temperature	$T_A$	0		55	°C	
Power Supply Voltage	$V_{DD}$	1.7	1.8	2.0	V	Including $V_{NA}$ noise
	$V_{LED}$	1.7	1.8	2.0	V	Including supply noise
Power Supply Rise Time	$t_{RT}$	0.15		20	ms	0 to $V_{DD}$ min
Supply Noise (Sinusoidal)	$V_{NA}$			100	mV <sub>p-p</sub>	10 kHz – 50 MHz
Load Capacitance	$C_{out}$			100	pF	SDA and MOTION
Distance from Package Edge to Tracking Surface	Z	1.3	1.5	1.7	mm	
Area Of Interest	AOI	3 x 3			mm	Refer Section 3.4 Area Of Interest (AOI) for details.
Speed	S		25		ips	
Acceleration	A		8		g	

**Note:** PixArt does not guarantee the performance if the operating temperature is beyond the specified limit.

## 2.4 DC Characteristics

Table 4. DC Electrical Specifications

Parameters	Symbol	Min.	Typ.	Max.	Unit	Conditions
Supply Current	$I_{DD\_RUN}$		0.45		mA	Average current consumption, including LED current. No load on SDA.
	$I_{DD\_REST1}$		50		uA	
	$I_{DD\_REST2}$		20		uA	
	$I_{DD\_REST3}$		7		uA	
Power Down Current	$I_{PD}$		3		uA	
Input Low Voltage	$V_{IL}$			$0.2 * V_{DD}$	V	SCL, SDA
Input High Voltage	$V_{IH}$	$0.8 * V_{DD}$			V	SCL, SDA
Input Hysteresis	$V_{I\_HYS}$		100		mV	SCL, SDA
Input Leakage Current	$I_{LEAK}$		$\pm 1$	$\pm 10$	uA	$V = 0.7 * V_{DD}$ , SCL, SDA
Output Low Voltage	$V_{OL}$			$0.2 * V_{DD}$	V	$I_{OUT} = 1mA$ , SDA, MOTION
Output High Voltage	$V_{OH}$	$0.8 * V_{DD}$			V	$I_{OUT} = -1mA$ , SDA, MOTION

**Note:** All the parameters are tested under operating conditions:  $V_{DD} = 1.8$  V, LED current = 8 mA, Internal Clock = 16 MHz, Internal Slow Clock = 1 kHz,  $T_A = 25$  °C.

## 2.5 AC Characteristics

Table 5. AC Electrical Specifications

Parameters	Symbol	Min.	Typ.	Max.	Unit	Conditions
SCL Clock Frequency	f <sub>scl</sub>			400	kHz	
Hold Time (repeated) START condition	t <sub>HD_STA</sub>	0.6			us	After this period, the 1 <sup>st</sup> clock pulse is generated.
LOW period of the SCL Clock	t <sub>LOW</sub>	1.0			us	
HIGH period of the SCL Clock	t <sub>HIGH</sub>	0.6			us	
Set-up time for a repeated START condition	t <sub>SU_STA</sub>	0.6			us	
Data Hold Time	t <sub>HD_DAT</sub>	0 <sup>3</sup>			us	
Data Set-up Time	t <sub>SU_DAT</sub>	100			ns	
Rise Time of both SDA & SCL signals	t <sub>r</sub>	20+0.1C <sub>b</sub> <sup>4</sup>		300	ns	
Fall Time of both SDA & SCL signals	t <sub>f</sub>	20+0.1C <sub>b</sub> <sup>4</sup>		300	ns	
Set-up time for STOP condition	t <sub>SU_STO</sub>	0.6			us	
Bus free between a STOP & START condition	t <sub>BUF</sub>	1.3			us	
Capacitive Load for each bus line	C <sub>b</sub>			400	pF	
Noise Margin at the LOW level for each connected device	V <sub>NL</sub>	0.1V <sub>DD</sub>			V	Including hysteresis
Noise Margin at the HIGH level for each connected device	V <sub>NH</sub>	0.2V <sub>DD</sub>			V	Including hysteresis

### Notes:

1. All the parameters are tested under operating conditions: V<sub>DD</sub> = 1.8 V, T<sub>A</sub> = 25 °C.
2. All values referred to V<sub>IHmin</sub> and V<sub>ILmax</sub> levels.
3. A device must internally provide a hold time of at least 300 ns for the SDA signal (referred to the V<sub>IHmin</sub> of the SCL signal) to bridge the undefined region of the falling edge of SCL.
4. C<sub>b</sub> = Total capacitance of one bus line in pF.

### 3.0 Mechanical Specifications

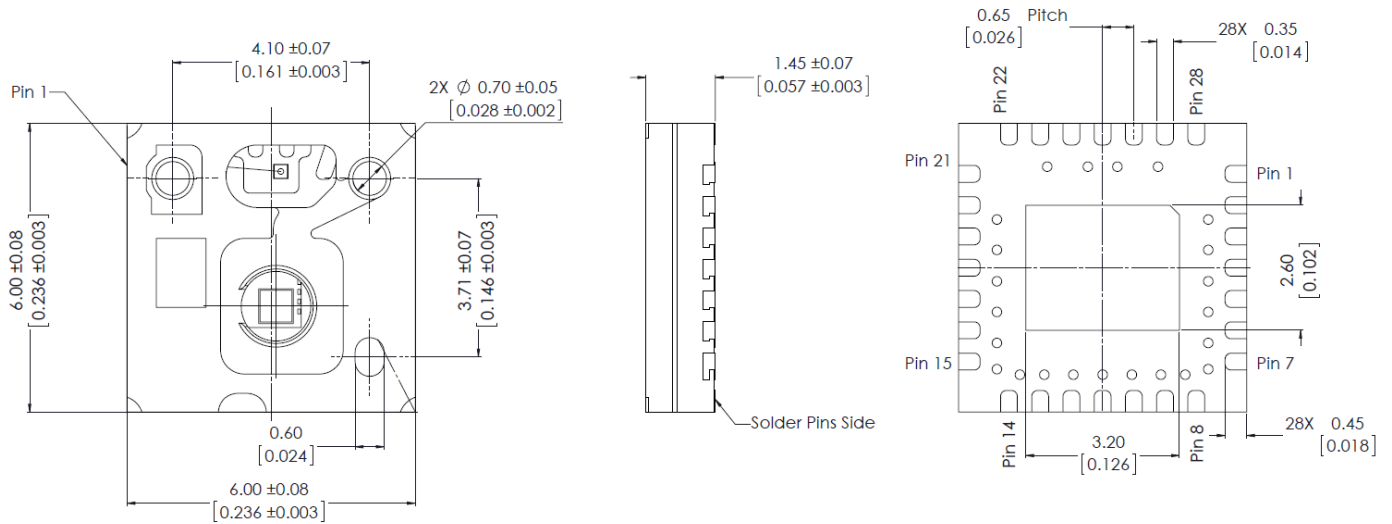
#### 3.1 Package Marking

Refer to Figure 2. Pin Configuration for the code marking location on the device package.

Table 6. Code Identification

Code	Marking	Description
Product Number	PMT9123QS-TVIT	Part number label
Date Code	AYWWXXXXX	A: Assembly House Y: Year WW: Week XXXXX: Reserved as PixArt reference

3.2 Package Outline Drawing



Notes:

1. Dimensions in millimeters  
[inches]
2. Coplanarity of pads: 0.08mm
3. Non-cumulative pad pitch tolerance:  $\pm 0.10$ mm
4. Maximum flash:  $\pm 0.20$ mm
5. Dimensional tolerance:  $\pm 0.10$ mm unless otherwise stated
6. Document number: PMT9123QS-TVIT-G8\_005

CAUTION: It is advised that normal static discharge precautions be taken in handling and assembling of this component to prevent damage and/or degradation which may be induced by ESD.

Figure 3. Package Outline Drawing



3.3 Assembly Drawings

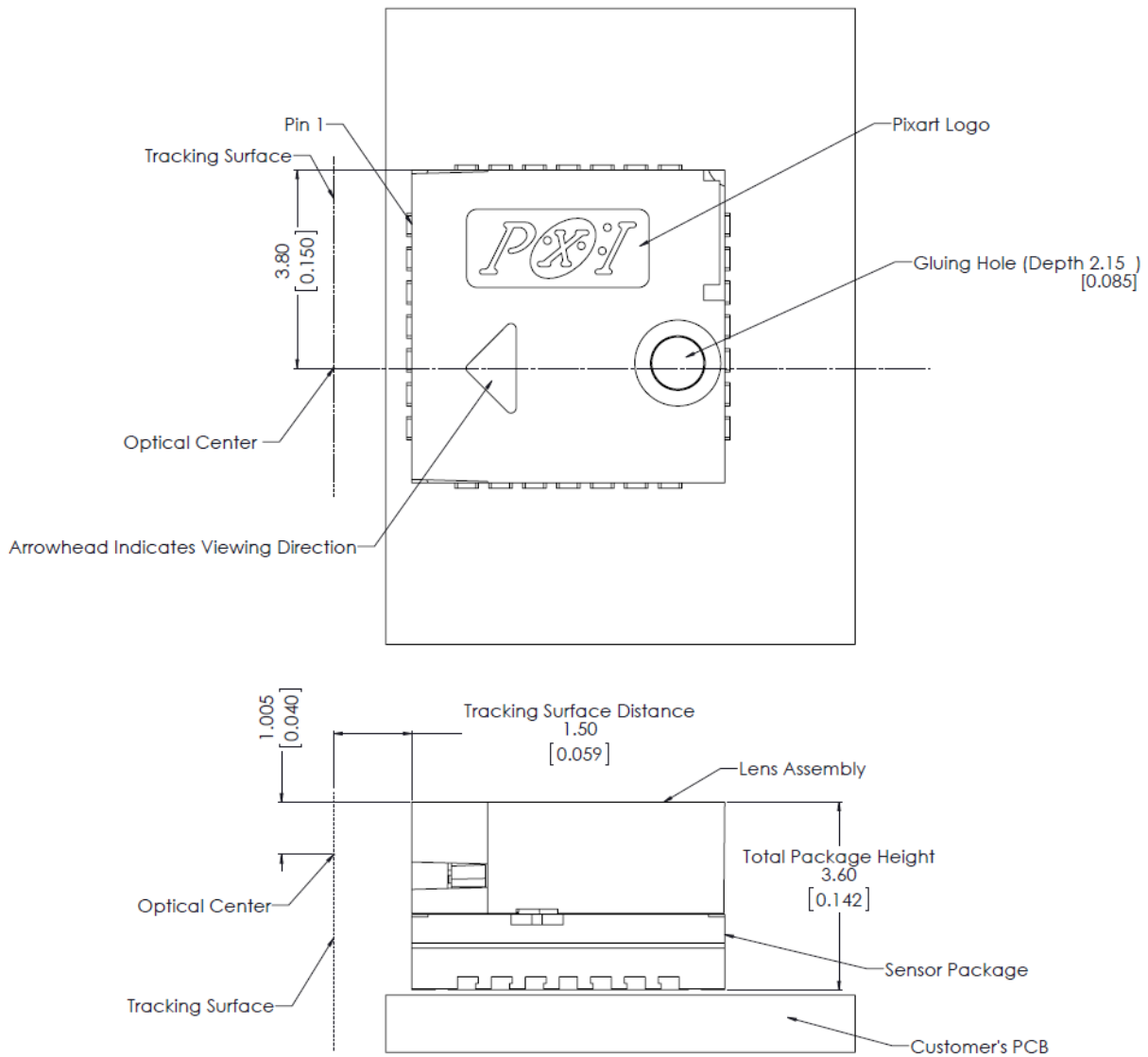


Figure 4. Assembly Drawing

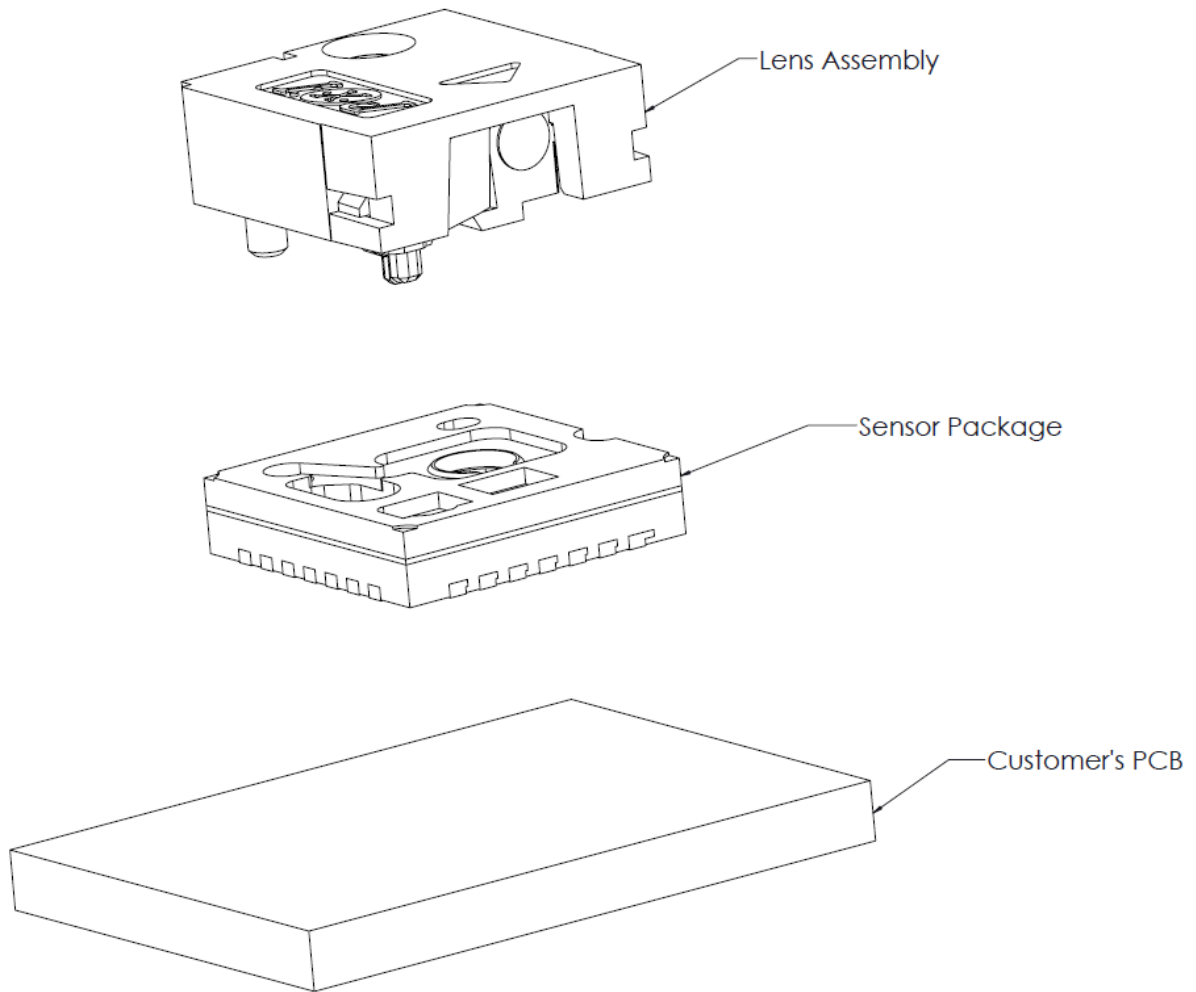
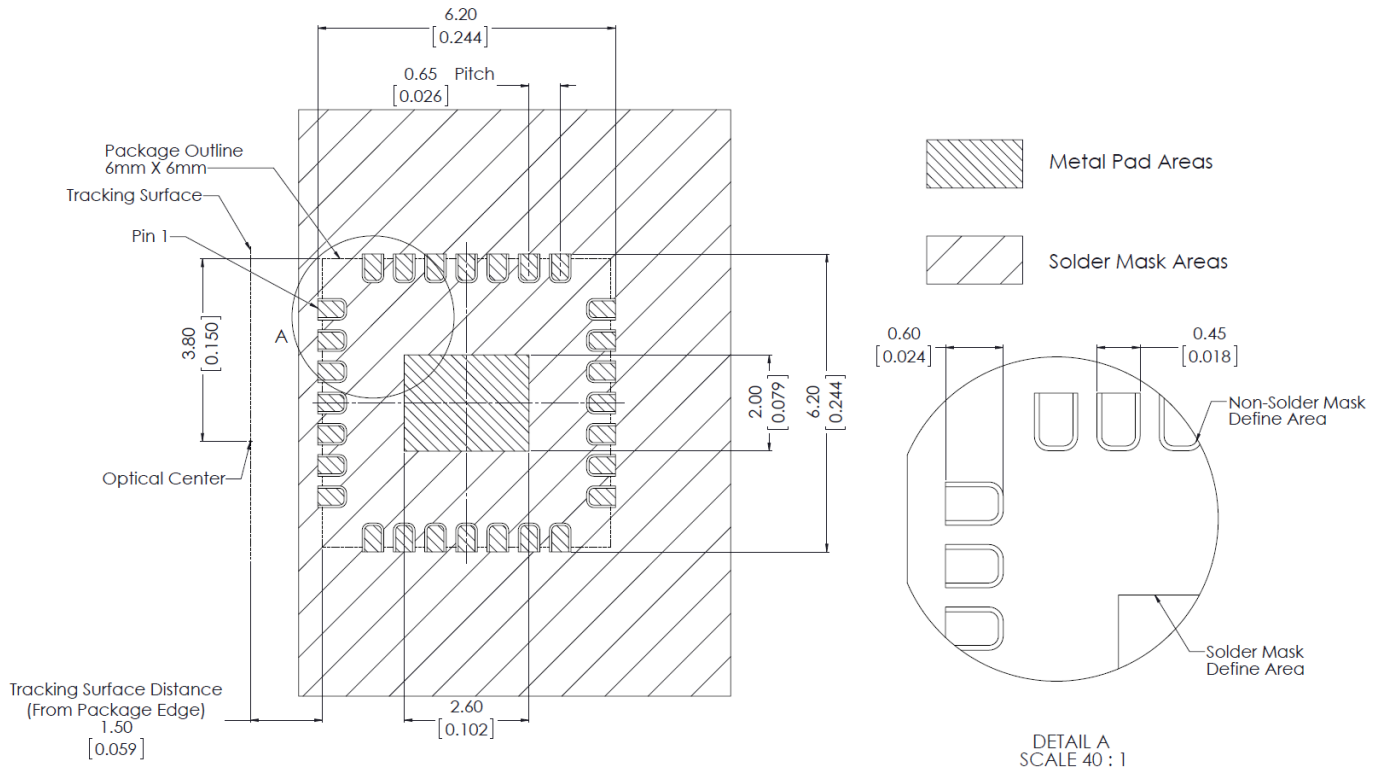


Figure 5. Exploded View of System Assembly



Note: Bottom center pad of QFN package must be connected to circuit ground.

Figure 6. Recommended PCB Layout

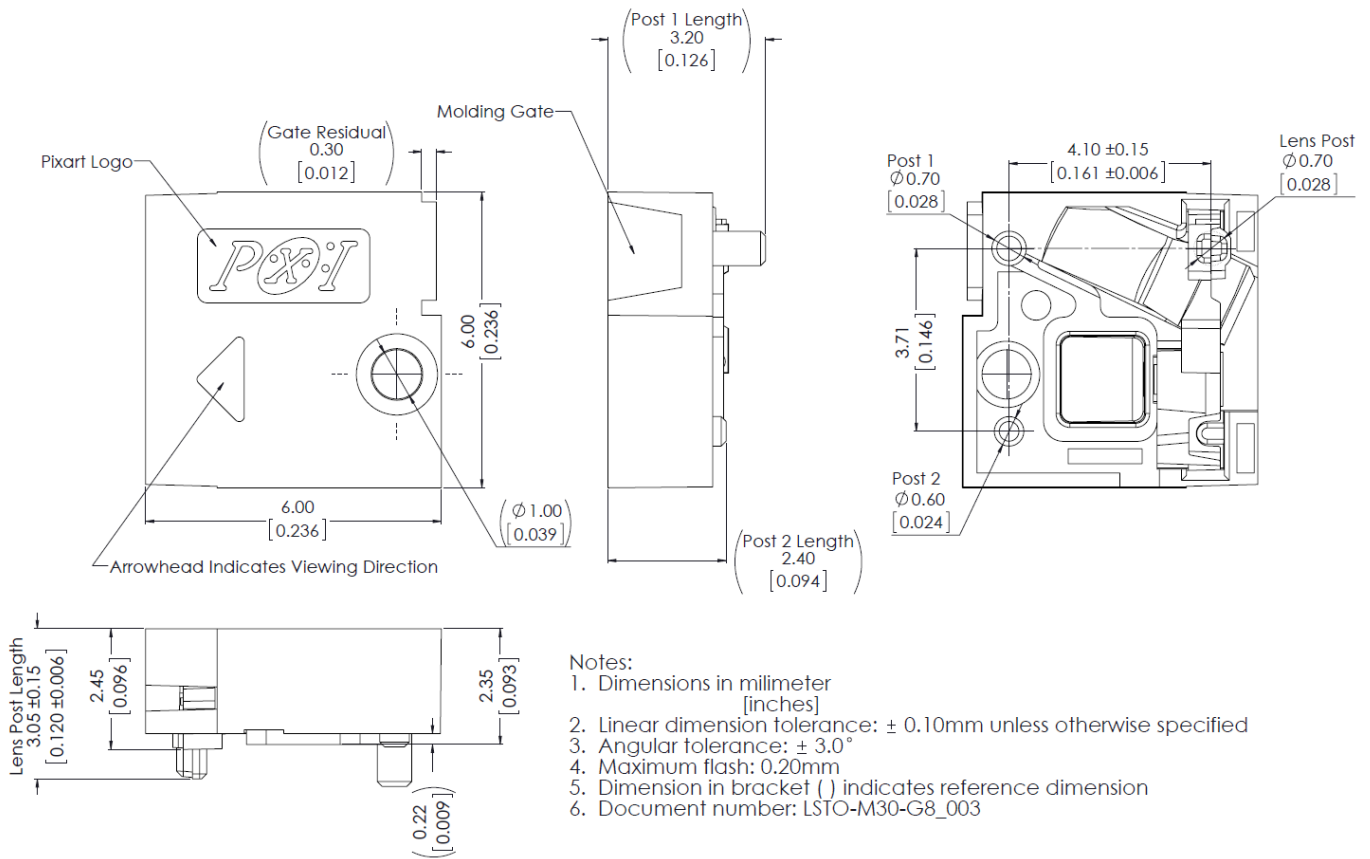


Figure 7. Lens Assembly Outline Drawing

### 3.4 Area Of Interest (AOI)

Area Of Interest (AOI) refers to the minimum surface area for good tracking performance. The minimum AOI is 3 x 3 mm, and should be centered with reference to the optical center. Refer below figure for illustration.

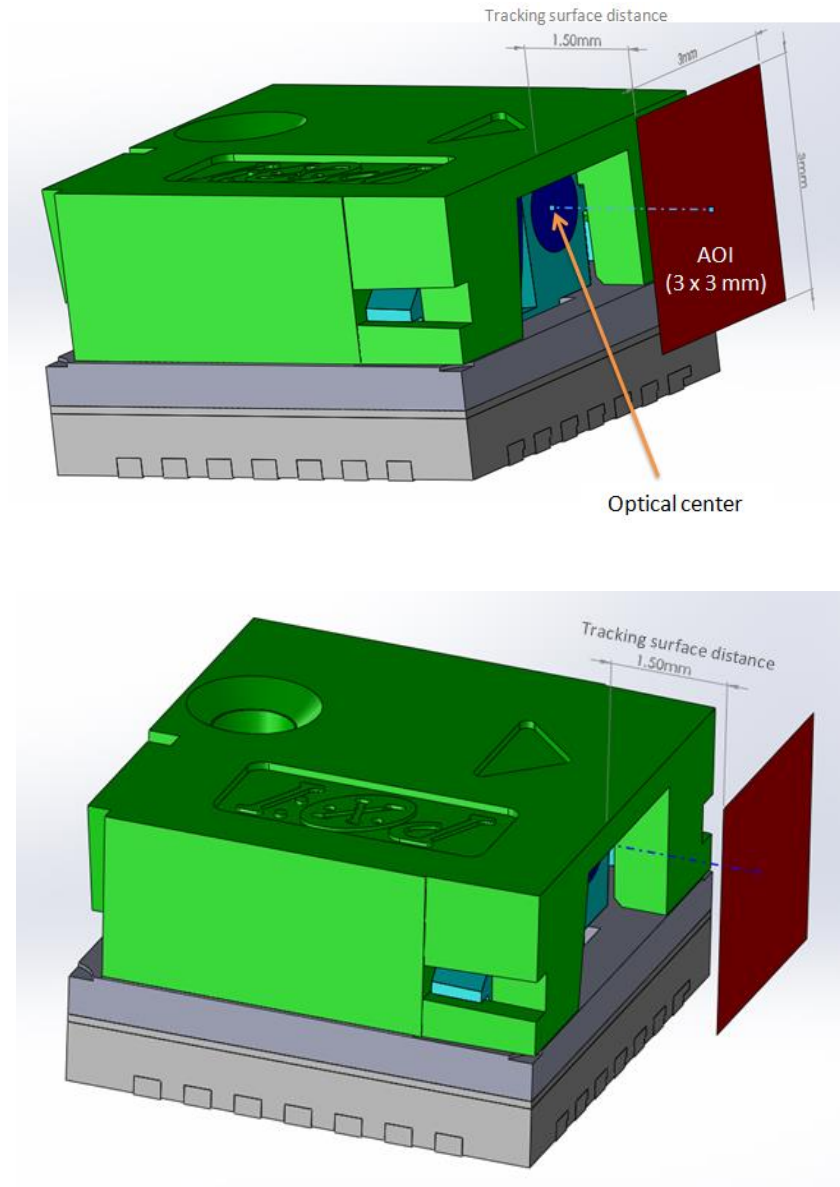
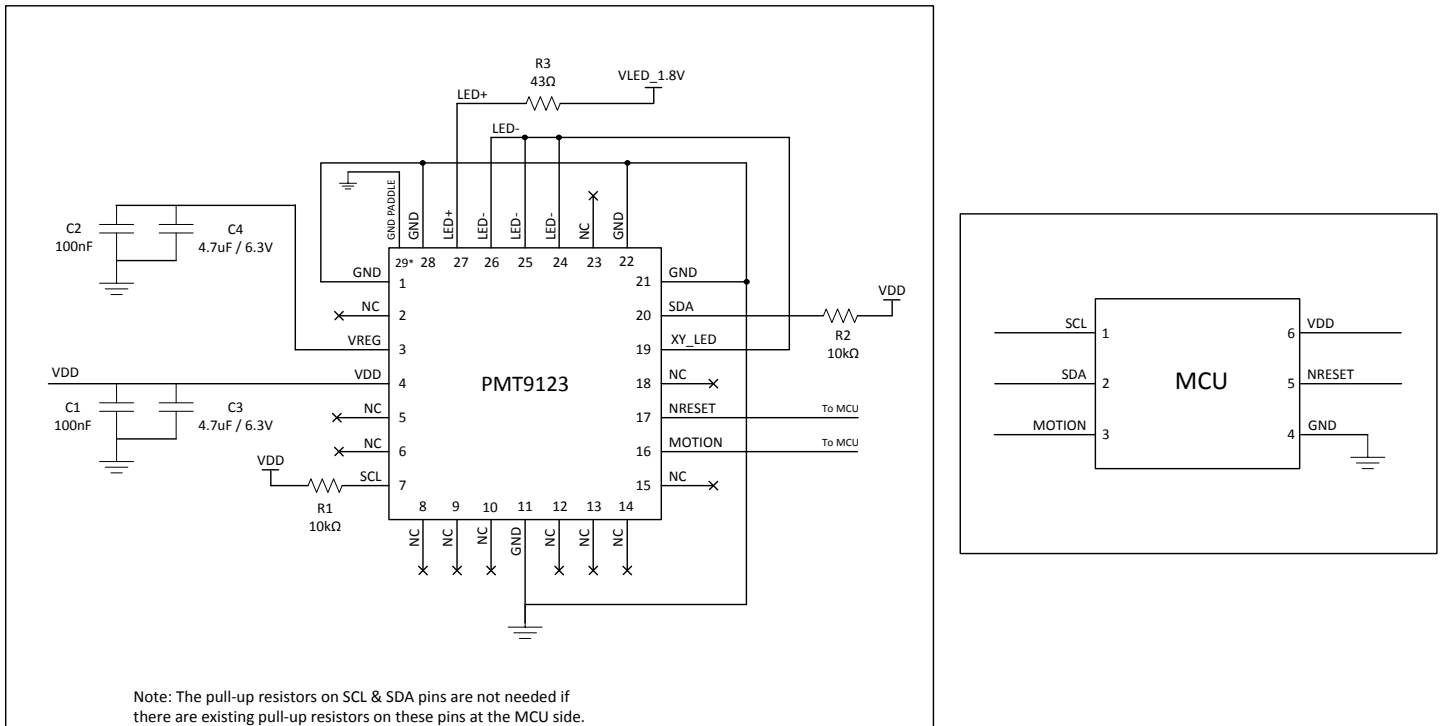


Figure 8. Area Of Interest

## 4.0 System Level Description

### 4.1 Reference Schematic



V <sub>LED</sub> (V)	Corresponding resistor R3 Value (Ω)
1.7	33
1.8	43
1.9	56
2.0	68

Figure 9. PMT9123 Reference Schematics

## 8.0 Registers

### 8.1 Registers List

PMT9123 registers are accessible via the serial port. The registers are used to read motion data and status as well as to set the device configuration.

Table 7. Register List

Page	Address	Register Name	Access	Reset	Page	Address	Register Name	Access	Reset
35	0x00	Product_ID	RO	0x41	39	0x15	Rest1_Rate	R/W	0x04
35	0x01	Revision_ID	RO	0x01	39	0x16	Rest1_Downshift	R/W	0x10
41	0x02	Motion	R/W	0x00	39	0x17	Rest2_Rate	R/W	0x0A
42	0x03	Delta_X_L	RO	N/A	40	0x18	Rest2_Downshift	R/W	0x2F
42	0x04	Delta_Y_L	RO	N/A	40	0x19	Rest3_Rate	R/W	0x05
43	0x05	Delta_XY_H	RO	N/A	46	0x1D	Observation	R/W	0x1F
44	0x06	SQUAL	RO	N/A	46	0x24	Frame_Capture1	R/W	0x00
44	0x07	Shutter_Upper	RO	N/A	47	0x25	Frame_Capture2	R/W	0x4F
44	0x08	Shutter_Lower	RO	N/A	36	0x3A	Power_Up_Reset	WO	N/A
45	0x09	Pix_Max	RO	N/A	36	0x3B	Shutdown	WO	N/A
45	0x0A	Pix_Avg	RO	N/A	37	0x41	Enable_Register_Write	WO	N/A
45	0x0B	Pix_Min	RO	N/A	38	0x48	Resolution_Step	R/W	0x0B
37	0x11	Performance	R/W	0x00	38	0x4D	Orientation	R/W	0x7A
39	0x14	Run_Downshift	R/W	0x02					

### 8.2 Performance Optimization Registers

Upon power-up of PMT9123, there are a few sets of registers to configure in order to achieve optimum performance of the sensor. These registers are PixArt proprietary information, thus no additional information is provided in this datasheet with regards to these register’s descriptions.

Table 8. Performance Optimization Registers

Address	Value
Tracking performance optimization	
0x11	0x0C
0x14	0x04
0x25	0x0F
0x27	0xAA
0x34	0x80
0x35	0x03
0x39	0x89
0x4D	0x79
0x53	0x96
0x58	0x66
0x5D	0x56