

PMT9101DM-T2QU: Optical Track Sensor

General Description

The PMT9101DM-T2QU is PixArt Imaging's high performance Optical Track Sensor (OTS) using optical navigation technology that enables high accuracy digital surface tracking. The OTS integrates optical sensor and LED source in a single package, with built-in image recognition engine, which does not require code wheel, code strip or any special marking on tracking surface. The OTS sensor offers a direct SPI output, together with motion interrupt signal, the OTS sensor provides easy integration with the host system.

Key Features

- Integrated 16 pin molded lead-frame DIP package
- Four wire serial port interface (SPI)
- Repeated Error of 1% (typical)
- High speed motion detection 150 ips (typical) and acceleration 30 g (max)
- High resolutions up to 8200 cpi with 100 cpi step size
- External interrupt output for motion detection
- Internal Oscillator – no clock input needed

Applications

- Printers / Handheld Printers
- Scanners / Handheld Scanners
- Media / Multi-Function Printers
- Consumer Product Applications
- Devices that require high accuracy to detect tracking or the presence of surfaces

Key Parameters

| Parameter | Value |
|----------------------------|--------------------------------------|
| Interface | 4-Wire SPI |
| Supply Voltage (V) | V _{DD} : 1.8 – 2.1 |
| Resolution (cpi) | 8200 |
| Speed (ips) | 150 (typical) |
| Max Frame Rate (fps) | Up to 7500 |
| Package Type | 16 pin molded lead-frame DIP package |
| Optical Lens Magnification | 1:1 |

Ordering Information

| Part Number | Package Type |
|----------------|--------------------|
| PMT9101DM-T2QU | 16-pin DIP Package |
| LM19-LSI | Lens |



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

1.3 Signal Description

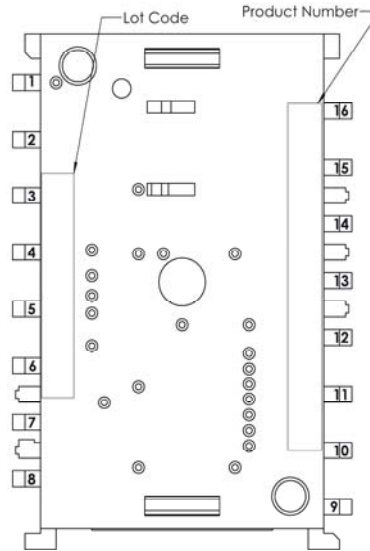


Figure 2. Pin Configuration

Table 1. PMT9101 Signal Pins Description

| Pin No. | Signal Name | Type | Description |
|--------------------------|-------------|--------------------------|---|
| Functional Group: | | Power Supplies | |
| 3 | VDDPIX | Output | LDO output for selective analog circuit |
| 4 | VDD | Power | Input power supply |
| 5 | VDDIO | Power | I/O reference voltage |
| 8 | GND | Ground | Ground |
| Functional Group: | | Control Interface | |
| 10 | SCLK | Input | Serial data clock |
| 11 | MOSI | Input | Serial data input |
| 12 | MISO | Output | Serial data output |
| 13 | NCS | Input | Chip select (active low) |
| Functional Group: | | Functional I/O | |
| 7 | NRESET | Input | Chip reset (active low) |
| 9 | MOTION | Output | Motion detect |
| 15 | LED_P | Output | LED Anode |
| Functional Group: | | Data Interface | |
| 1 | NC | NC | No connection (float) |
| 2 | NC | NC | No connection (float) |
| 6 | NC | NC | No connection (float) |

| Pin No. | Signal Name | Type | Description |
|---------|-------------|------|-----------------------|
| 14 | NC | NC | No connection (float) |
| 16 | NC | NC | No connection (float) |

2.0 Operating Specifications

2.1 Regulatory Requirements

- Passes FCC “Part15, Subpart B, Class B”, “CISPR 22 1997 ClassB” and worldwide analogous emission limits when assembled into a product with shielded cable and following PixArt Imaging’s recommendations.
- Passes IEC 62471: 2006 Photo biological safety of lamps and lamp systems.

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 7 seconds, 1.6mm below seating plane |
| Supply Voltage | V_{DD} | -0.5 | 2.1 | V | |
| | V_{DDIO} | -0.5 | 3.6 | V | |
| Input Voltage | V_{IN} | -0.5 | 3.6 | V | All I/O pins |
| ESD | ESD_{HBM} | | 2 | kV | All pins (Human Body Model) |

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 | | 40 | °C | |
| Power Supply Voltage | V_{DD} | 1.8 | 1.9 | 2.1 | V | Excluding supply noise |
| | V_{DDIO} | 1.8 | 1.9 | 3.6 | V | Excluding supply noise ($V_{DDIO} \geq V_{DD}$) |
| Power Supply Rise Time | t_{RT} | 0.15 | | 20.00 | ms | 0 to VDD min |
| Supply Noise (Sinusoidal) | V_{NA} | | | 100 | mV _{p-p} | 10 kHz – 75 MHz |
| Serial Port Clock Frequency | f_{SCLK} | | | 2 | MHz | 50% duty cycle |
| Distance from Lens Reference Plane to Tracking Surface | Z | 2.2 | 2.4 | 2.6 | mm | |
| Speed | S | | | 150 | ips | |
| Repeated Error | R | | 1 | | % | On white paper & photo paper at nominal height of 2.4mm @ 1 ips velocity over 1 inch travel distance @ 10 ips velocity over 6 inch travel distance |
| Acceleration | A | | | 30 | g | In run mode |

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} | | 27.3 | | mA | Average current consumption, including LED current with 1ms polling. |
| Power Down Current | I_{PD} | | 10 | | uA | |
| Input Low Voltage | V_{IL} | | | $0.3 * V_{DDIO}$ | V | SCLK, MOSI, NCS |
| Input High Voltage | V_{IH} | $0.7 * V_{DDIO}$ | | | V | SCLK, MOSI, NCS |
| Input Hysteresis | V_{I_HYS} | | 100 | | mV | SCLK, MOSI, NCS |
| Input Leakage Current | I_{LEAK} | | ± 1 | ± 10 | uA | $V_{in} = V_{DDIO}$ or 0V, SCLK, MOSI, NCS |
| Output Low Voltage | V_{OL} | | | 0.45 | V | $I_{OUT} = 1mA$, MISO, MOTION |
| Output High Voltage | V_{OH} | $V_{DDIO} - 0.45$ | | | V | $I_{OUT} = -1mA$, MISO, MOTION |

Note: All the parameters are tested under operating conditions: $V_{DD} = 1.9V$, $V_{DDIO} = 1.9V$, LED current = 12 mA, Internal Clock = 70 MHz, Internal Slow Clock = 1.1 kHz, $T_A = 25^\circ C$.

2.5 AC Characteristics

Table 5. AC Electrical Specifications

| Parameters | Symbol | Min. | Typ. | Max. | Unit | Conditions |
|---|------------------------|------|------|------|---------|--|
| Motion Delay After Reset | $t_{MOT-RST}$ | 50 | | | ms | From reset to valid motion, assuming motion is present |
| Shutdown | t_{STDWN} | | | 500 | us | From Shutdown mode active to low current |
| Wake from Shutdown | t_{WAKEUP} | 50 | | | ms | From Shutdown mode inactive to valid motion. Notes: A RESET must be asserted after a shutdown. Refer to section "Notes on Shutdown", also note $t_{MOT-RST}$. |
| MISO Rise Time | t_{r-MISO} | | 50 | | ns | $C_L = 100pF$ |
| MISO Fall Time | t_{f-MISO} | | 50 | | ns | $C_L = 100pF$ |
| MISO Delay After SCLK | $t_{DLY-MISO}$ | | | 90 | ns | From SCLK falling edge to MISO data valid, no load conditions |
| MISO Hold Time | $t_{hold-MISO}$ | 200 | | | ns | Data held until next falling SCLK edge |
| MOSI Hold Time | $t_{hold-MOSI}$ | 200 | | | ns | Amount of time data is valid after SCLK rising edge |
| MOSI Setup Time | $t_{setup-MOSI}$ | 120 | | | ns | From data valid to SCLK rising edge |
| SPI Time Between Write Commands | t_{SWW} | 180 | | | μs | From rising SCLK for last bit of the first data byte, to rising SCLK for last bit of the second data byte. |
| SPI Time Between Write And Read Commands | t_{SWR} | 180 | | | μs | From rising SCLK for last bit of the first data byte, to rising SCLK for last bit of the second address byte. |
| SPI Time Between Read And Subsequent Commands | t_{SRW} t_{SRR} | 20 | | | μs | From rising SCLK for last bit of the first data byte, to falling SCLK for the first bit of the address byte of the next command. |
| SPI Read Address-Data Delay | t_{SRAD} | 160 | | | μs | From rising SCLK for last bit of the address byte, to falling SCLK for first bit of data being read. |

| | | | | | | |
|--|-------------------|-----|----|-----|---------|---|
| SPI Read Address-Data Delay for Burst Mode Motion Read | t_{SRAD_MOTBR} | 35 | | | μs | From rising SCLK for last bit of the address byte, to falling SCLK for first bit of data being read. Applicable for Burst Mode Motion Read only. |
| NCS Inactive After Motion Burst | t_{BEXIT} | 500 | | | ns | Minimum NCS inactive time after motion burst before next SPI usage |
| NCS To SCLK Active | $t_{NCS-SCLK}$ | 120 | | | ns | From last NCS falling edge to first SCLK rising edge |
| SCLK To NCS Inactive (For Read Operation) | $t_{SCLK-NCS}$ | 120 | | | ns | From last SCLK rising edge to NCS rising edge, for valid MISO data transfer |
| SCLK To NCS Inactive (For Write Operation) | $t_{SCLK-NCS}$ | 35 | | | μs | From last SCLK rising edge to NCS rising edge, for valid MOSI data transfer |
| NCS To MISO High-Z | $t_{NCS-MISO}$ | | | 500 | ns | From NCS rising edge to MISO high-Z state |
| MOTION Rise Time | $t_{r-MOTION}$ | | 50 | | ns | $C_L = 100pF$ |
| MOTION Fall Time | $t_{f-MOTION}$ | | 50 | | ns | $C_L = 100pF$ |
| Input Capacitance | C_{in} | | 50 | | pF | SCLK, MOSI, NCS |
| Load Capacitance | C_L | | | 100 | pF | MISO, MOTION |
| Transient Supply Current | I_{DDT} | | | 70 | mA | Max supply current during the supply ramp from 0V to VDD with min 150 us and max 20ms rise time. (Does not include charging currents for bypass capacitors) |
| | I_{DDTIO} | | | 60 | mA | Max supply current during the supply ramp from 0V to VDDIO with min 150 us and max 20ms rise time. (Does not include charging currents for bypass capacitors) |

Notes:

1. All the parameters are tested under operating conditions: $V_{DD} = 1.9V$, $V_{DDIO} = 1.9V$, $T_A = 25^\circ C$.
2. Refer Figure 10. Write Operation, Figure 11. MOSI Set-up and Hold Time, Figure 12. Read Operation, Figure 13. MISO Delay and Hold Time, Figure 14. Timing between two Write commands, Figure 15. Timing between Write and either Write or subsequent Read commands, and Figure 16. Timing between Read and either Write or subsequent Read commands.

3.0 Mechanical Specifications

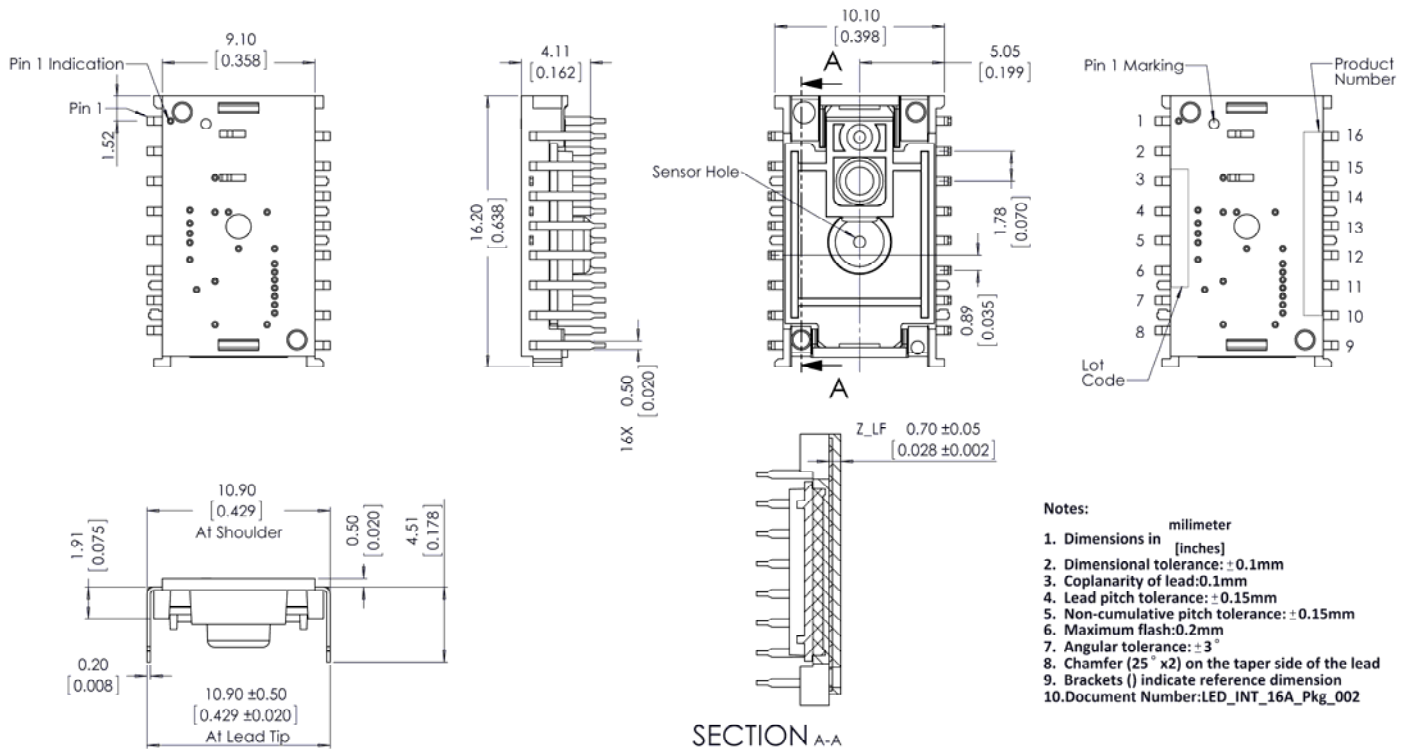
3.1 Package Marking

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

Table 6. Code Identification

| Code | Marking | Description |
|----------------|----------------|---|
| Product Number | PMT9101DM-T2QU | Part number label |
| Lot Code | AYWWXXXXX | A: Assembly House Y: Year WW: Week XXXXX: Reserved as PixArt reference |

3.2 Package Outline Drawing



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

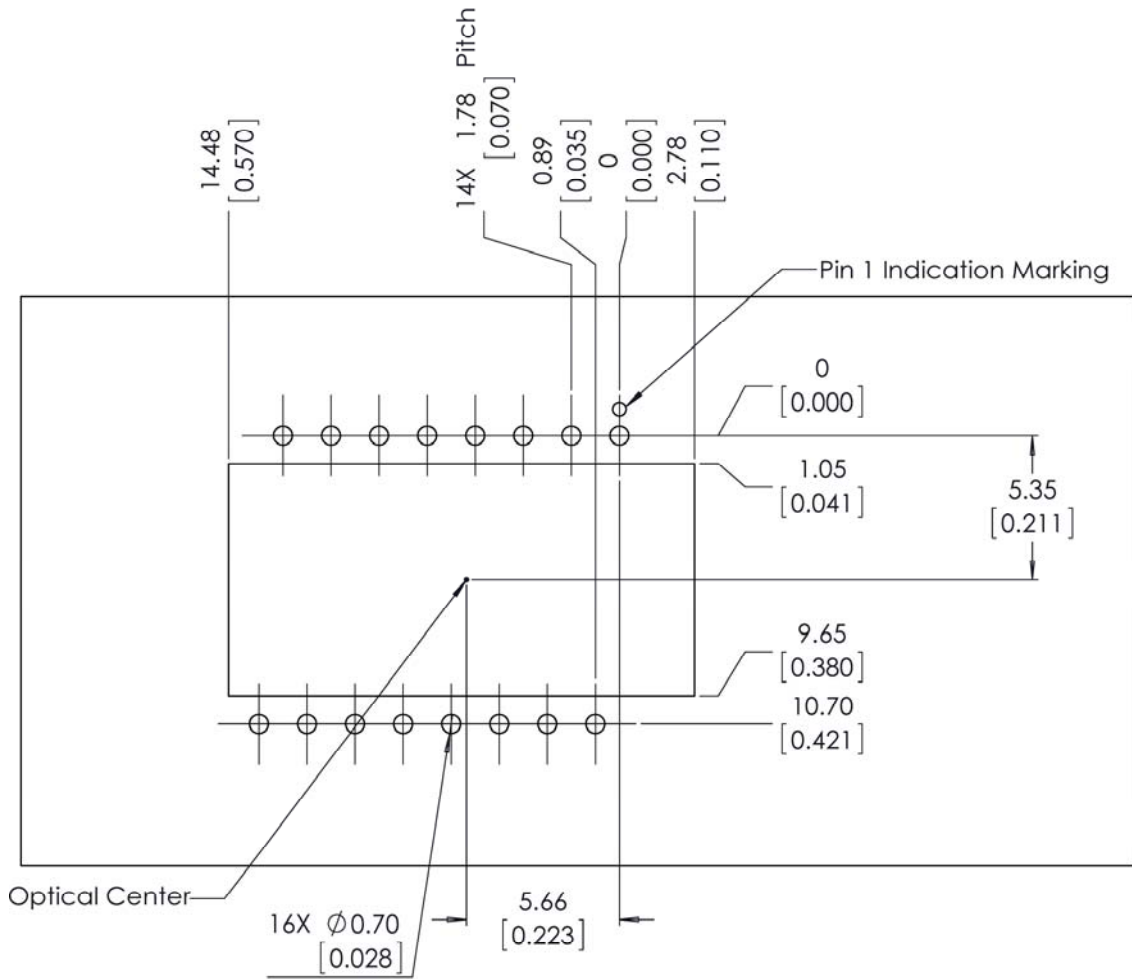


Figure 4. Recommended sensor orientation, mechanical cutouts and spacing (Top View)

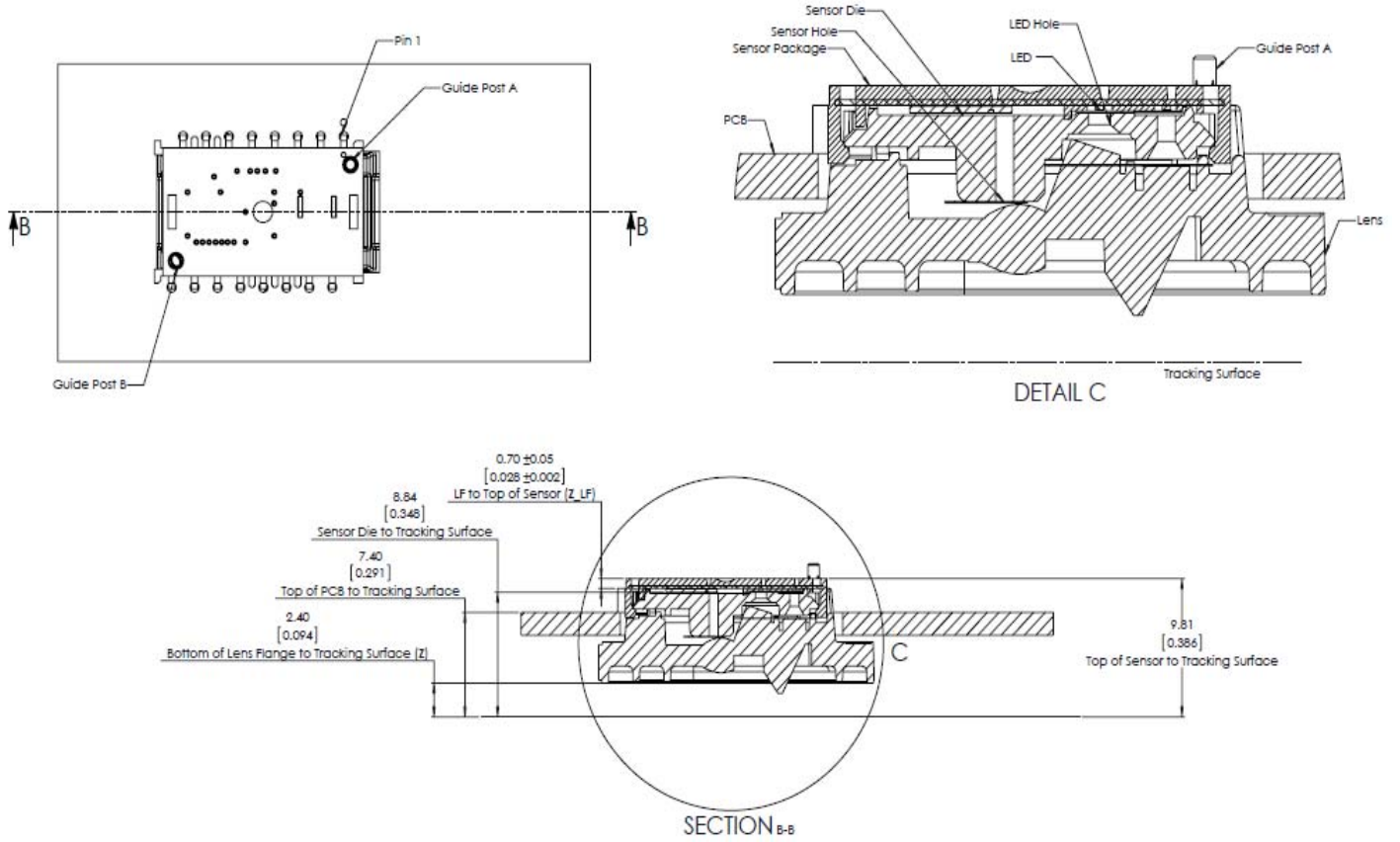


Figure 5. Assembly drawing of PMT9101 and distance from Lens reference plane to Tracking surface (Z)

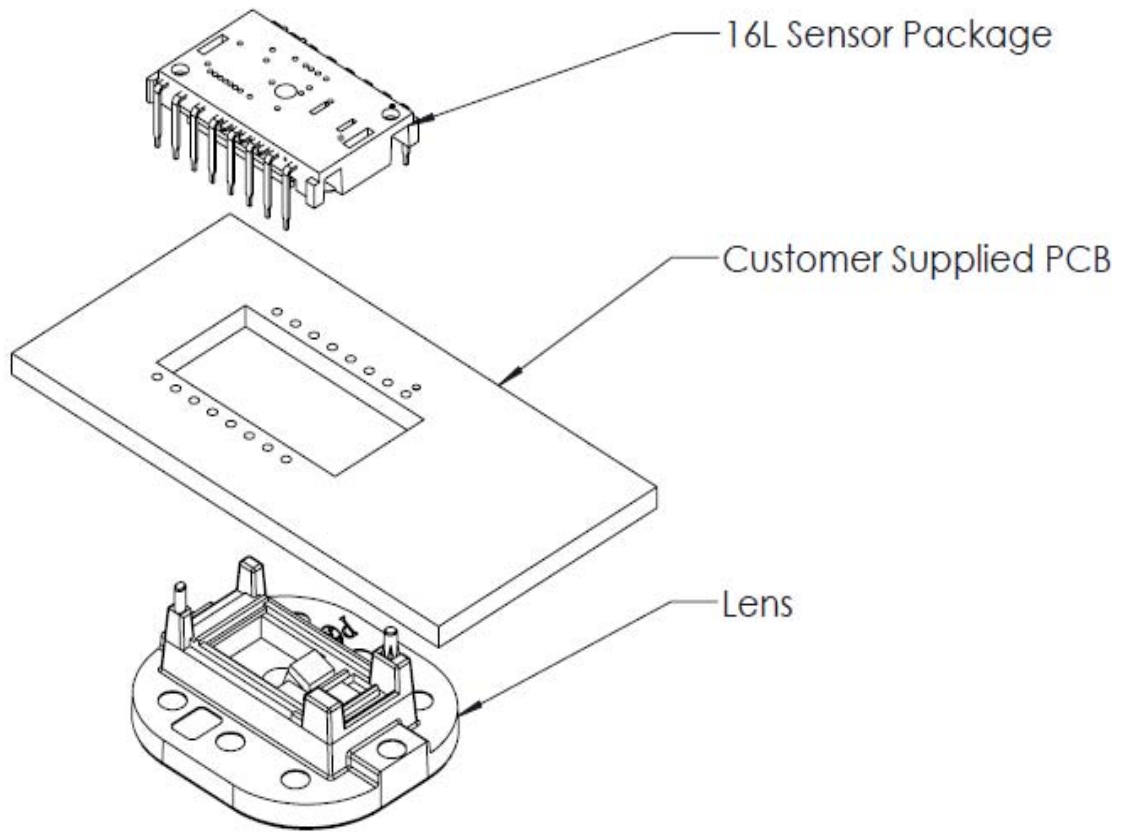


Figure 6. Exploded View of Assembly

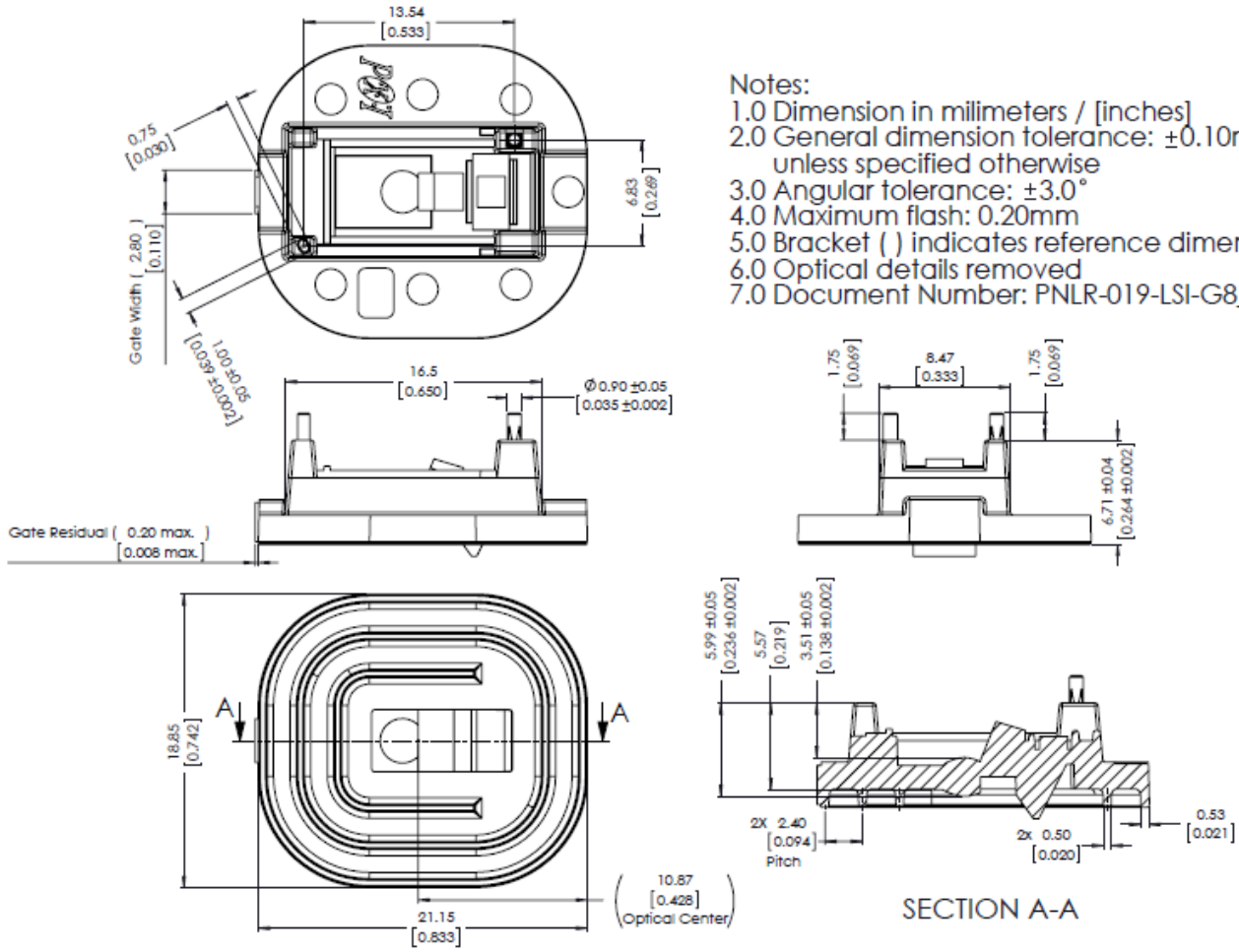


Figure 7. Lens Outline Drawing

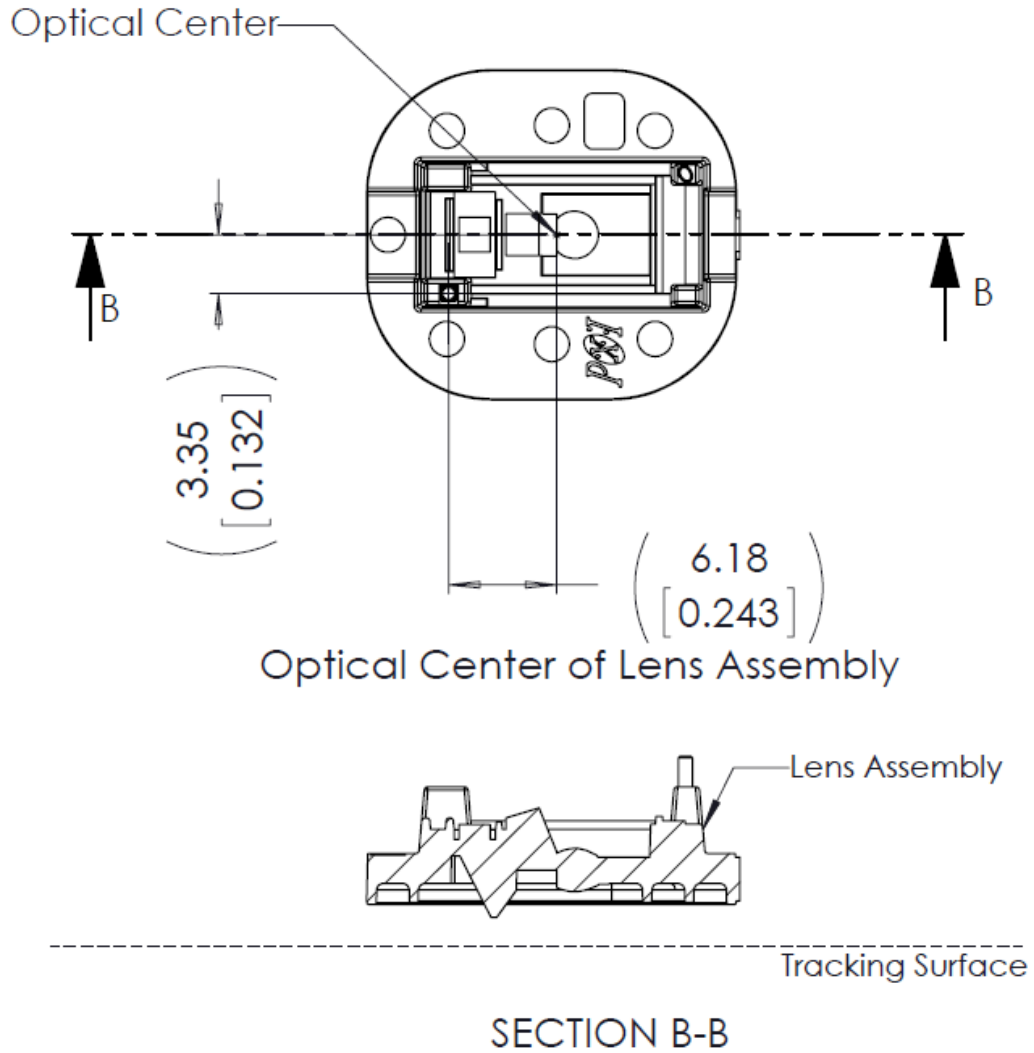
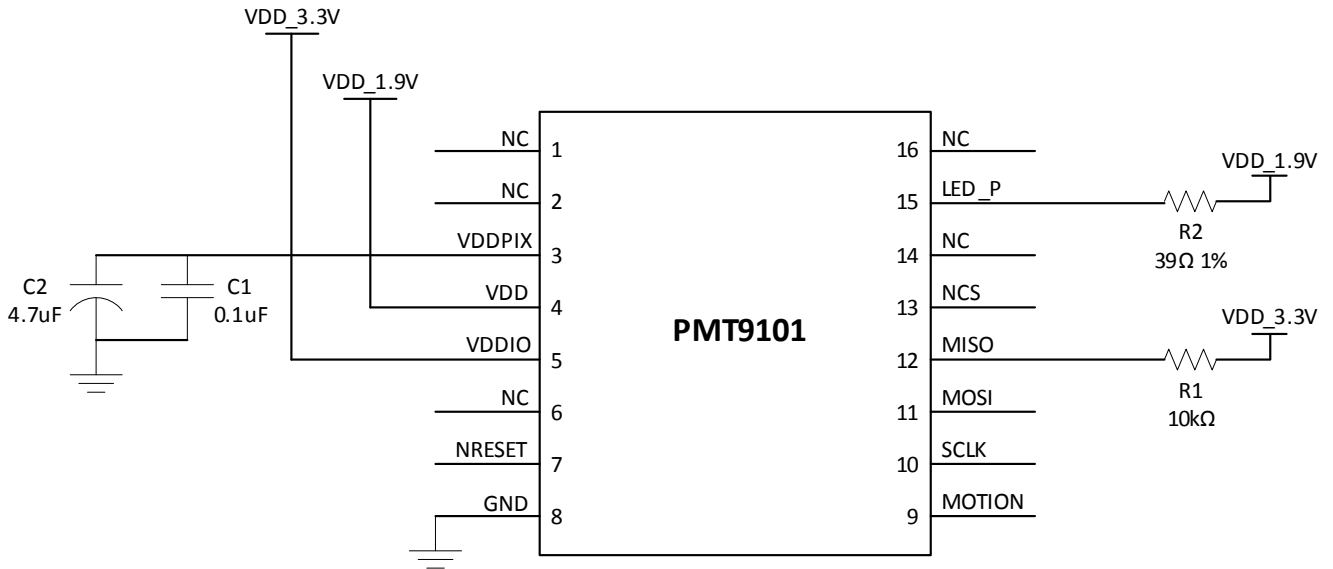


Figure 8. Cross section view of lens assembly

4.0 System Level Description

4.1 Reference Schematic



Note:

1. Capacitors must be placed near sensor.
2. Thicker trace path from VDD_1.9V to LED_P pin.
3. LED's orientation is placed towards the palm of a hand.

| External Component Type | Value | Quantity |
|-------------------------|--------------|----------|
| Capacitor | 0.1uF, 4.7uF | 2 |
| Resistor | 39Ω, 10kΩ | 2 |

Figure 9. PMT9101 Reference Schematics

9.0 Registers

9.1 Registers List

PMT9101 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

| Address | Register Name | Access | Reset | Address | Register Name | Access | Reset |
|---------|---------------|--------|-------|---------|--------------------|--------|-------|
| 0x01 | Product_ID | RO | 0x01 | 0x13 | SROM_Enable | WO | N/A |
| 0x02 | Motion | R/W | 0x20 | 0x24 | Observation | R/W | 0x00 |
| 0x03 | Delta_X_L | RO | 0x00 | 0x25 | Data_Out_Lower | RO | 0x00 |
| 0x04 | Delta_X_H | RO | 0x00 | 0x26 | Data_Out_Upper | RO | 0x00 |
| 0x05 | Delta_Y_L | RO | 0x00 | 0x2A | SROM_ID | RO | 0x00 |
| 0x06 | Delta_Y_H | RO | 0x00 | 0x2B | Min_SQ_Run | R/W | 0x10 |
| 0x07 | SQUAL | RO | 0x00 | 0x2C | Pixel_Threshold | R/W | 0x0A |
| 0x08 | Pixel_Sum | RO | 0x00 | 0x2F | Config5 | R/W | 0x31 |
| 0x09 | Maximum_Pixel | RO | 0x00 | 0x3A | Power_Up_Reset | WO | N/A |
| 0x0A | Minimum_Pixel | RO | 0x00 | 0x3B | Shutdown | WO | N/A |
| 0x0B | Shutter_Lower | RO | 0x12 | 0x3E | Inverse_Product_ID | RO | 0xFE |
| 0x0C | Shutter_Upper | RO | 0x00 | 0x42 | Angle_Snap | R/W | 0x00 |
| 0x0D | Control | R/W | 0x02 | 0x50 | Motion_Burst | R/W | 0x00 |
| 0x0F | Config1 | R/W | 0x31 | 0x62 | SROM_Load_Burst | WO | N/A |
| 0x10 | Config2 | R/W | 0x00 | 0x64 | Pixel_Burst | RO | 0x00 |
| 0x12 | Frame_Capture | R/W | 0x00 | | | | |