

## PMW3360DM-T2QU: Optical Gaming Navigation Sensor

### General Description

PMW3360DM-T2QU is PixArt Imaging's high end gaming sensor which comprises of navigation sensor and IR LED integrated in a 16pin molded lead-frame DIP package. It provides best in class gaming experience with the enhanced features of high speed, high resolution, high accuracy and selectable lift detection height to fulfill professional gamers' need. The sensor comes with self-adjusting variable frame rate algorithm to enable wireless gaming application. It is designed to be used with LM19-LSI lens to achieve optimum performance.

### Key Features

- Integrated 16 pin molded lead-frame DIP package with IR LED
- Operating Voltage: 1.8V - 2.1V
- Lift detection options
  - Manual lift cut off calibration
  - 2mm
  - 3mm
- High speed motion detection 250ips (typical) and acceleration 50g (max).
- Selectable resolutions up to 12000cpi with 100cpi step size
- Resolution error of 1% (typical)
- Four wire serial port interface (SPI)
- External interrupt output for motion detection
- Internal oscillator — no clock input needed
- Self-adjusting variable frame rate for optimum power performance in wireless application
- Customizable response time and downshift time for rest modes
- Enhanced programmability
  - Angle snapping
  - Angle tunability

### Applications

- Wired and Wireless Optical gaming mice
- Integrated input devices
- Battery-powered input devices

### Key Sensor Parameters

| Parameter          | Value                                                       |
|--------------------|-------------------------------------------------------------|
| Power supply Range | 1.8V - 2.1V                                                 |
| Optical Lens       | 1:1                                                         |
| Interface          | 4 wire Serial Port Interface (SPI)                          |
| System Clock       | 70MHz                                                       |
| Frame Rate         | Up to 12000 fps                                             |
| Speed              | 250ips (typical)                                            |
| Resolution         | 12000 cpi                                                   |
| Package Type       | 16 pin molded lead-frame DIP package with integrated IR LED |

### Ordering Information

| Part Number    | Package Type |
|----------------|--------------|
| PMW3360DM-T2QU | 16pin-DIP    |
| LM19-LSI       | Lens         |



Lead (Pb) Free  
RoHS 6 fully  
compliant



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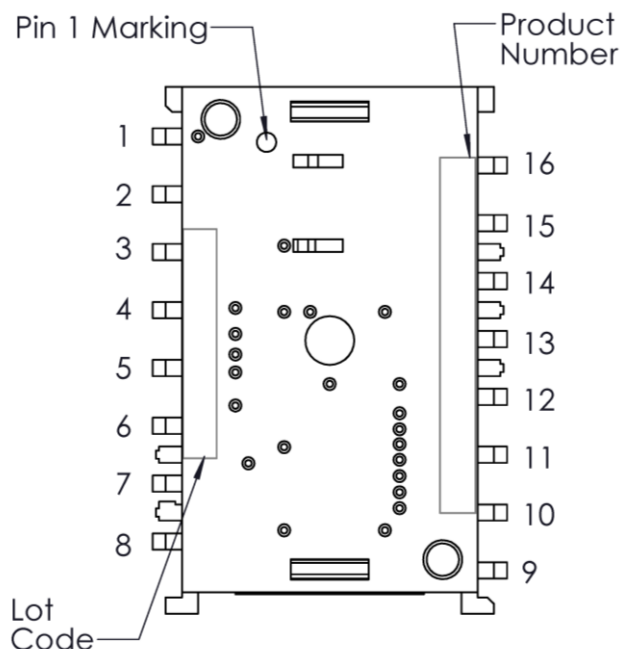
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## 1.0 System Level Description

This section covers PMW3360's guidelines and recommendations in term of sensor, lens & PCB assemblies.

### 1.1 Pin Configuration



| Pin No. | Function                       | Symbol | Type   | Description                             |
|---------|--------------------------------|--------|--------|-----------------------------------------|
| 1       | NA                             | NC     | NC     | (Float)                                 |
| 2       | NA                             | NC     | NC     | (Float)                                 |
| 3       | Supply Voltage and I/O Voltage | VDDPIX | Power  | LDO output for selective analog circuit |
| 4       |                                | VDD    | Power  | Input power supply                      |
| 5       |                                | VDDIO  | Power  | I/O reference voltage                   |
| 6       | NA                             | NC     | NC     | (Float)                                 |
| 7       | Reset control                  | NRESET | Input  | Chip reset(active low)                  |
| 8       | Ground                         | GND    | GND    | Ground                                  |
| 9       | Motion Output                  | MOTION | Output | Motion detect                           |
| 10      | 4-wire spi communication       | SCLK   | Input  | Serial data clock                       |
| 11      |                                | MOSI   | Input  | Serial data input                       |
| 12      |                                | MISO   | Output | Serial data output                      |
| 13      |                                | NCS    | Input  | Chip select(active low)                 |
| 14      | NA                             | NC     | NC     | (Float)                                 |
| 15      | LED                            | LED_P  | Input  | LED Anode                               |
| 16      | NA                             | NC     | NC     | (Float)                                 |

Figure 1. Device output pins

Table 1. PMW3360DM-T2QU Pin Description

| Items          | Marking        | Remark                                                               |
|----------------|----------------|----------------------------------------------------------------------|
| Product Number | PMW3360DM-T2QU |                                                                      |
| Lot Code       | AYWWXXXXX      | A : Assembly house<br>Y: Year<br>WW: Week<br>XXXXX: PixArt reference |

## 1.2 Package Outline Drawing

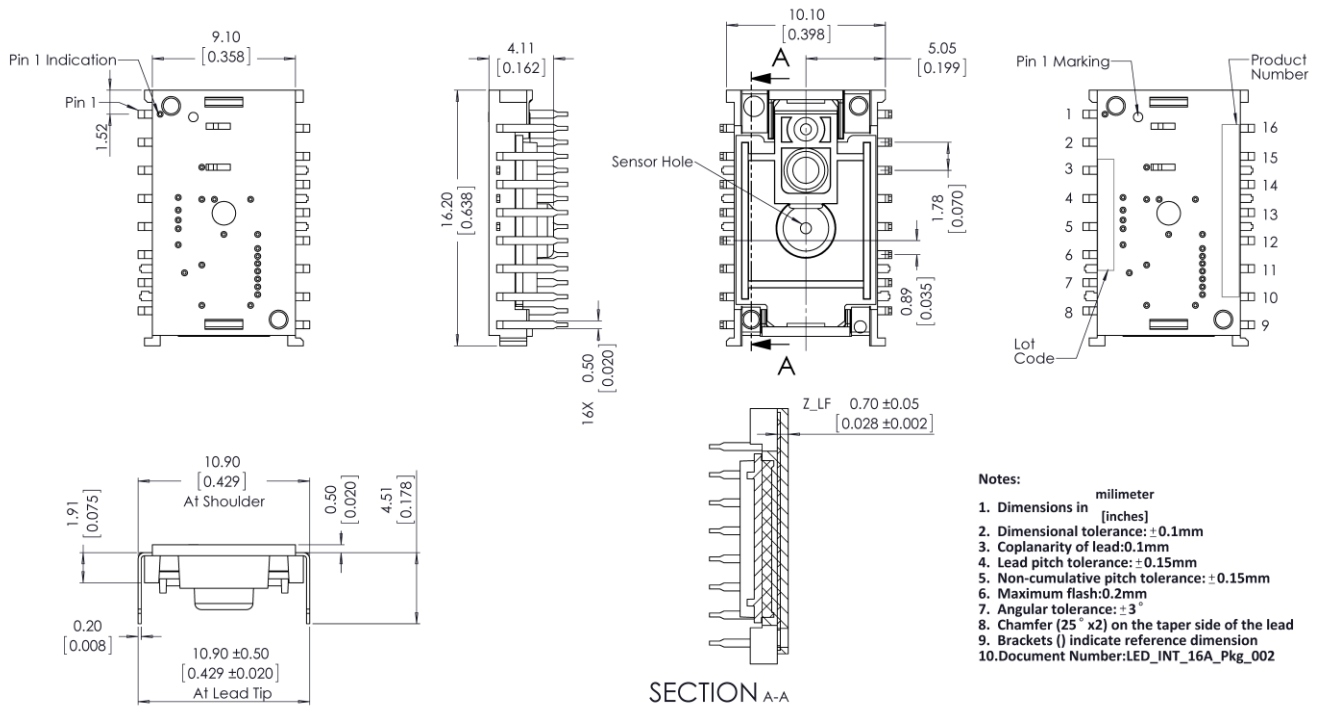


Figure 2. Packages Outline Drawing

**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.

1.3 Assembly Drawings

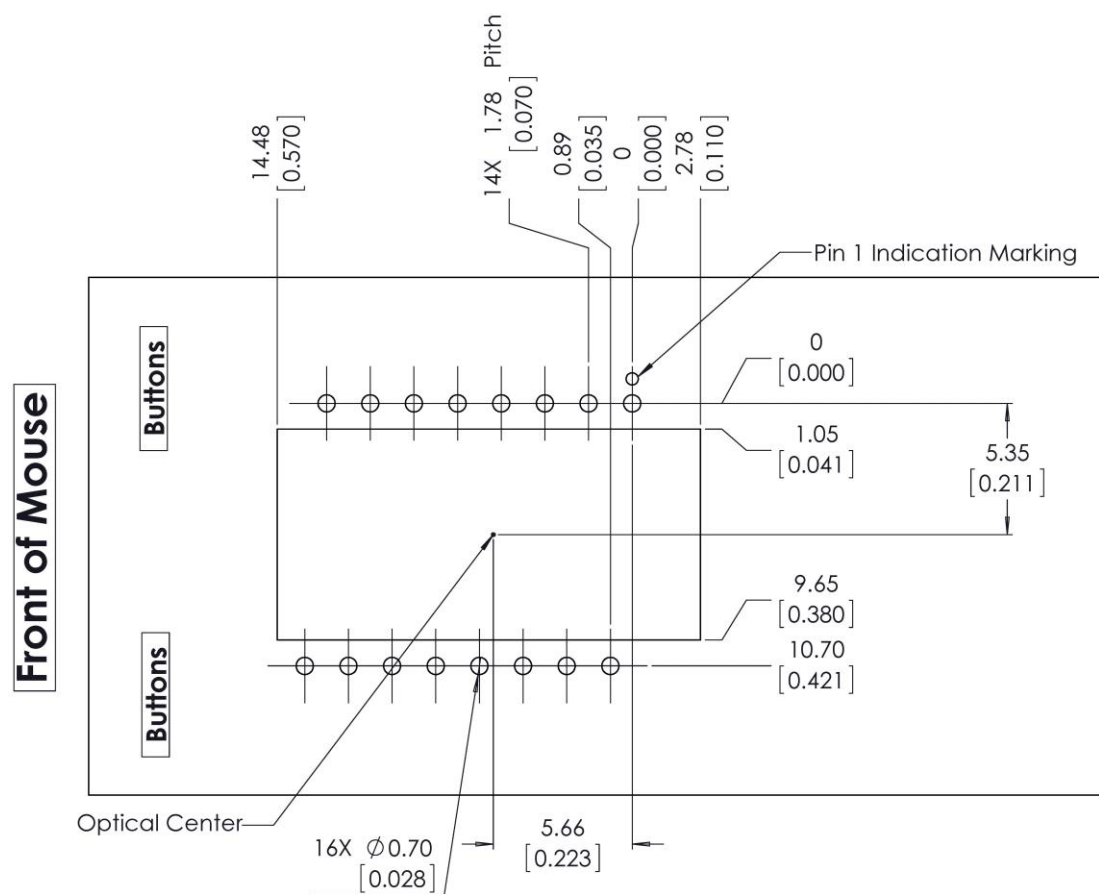


Figure 3. Recommended sensor orientation, mechanical cutouts and spacing (Top View)

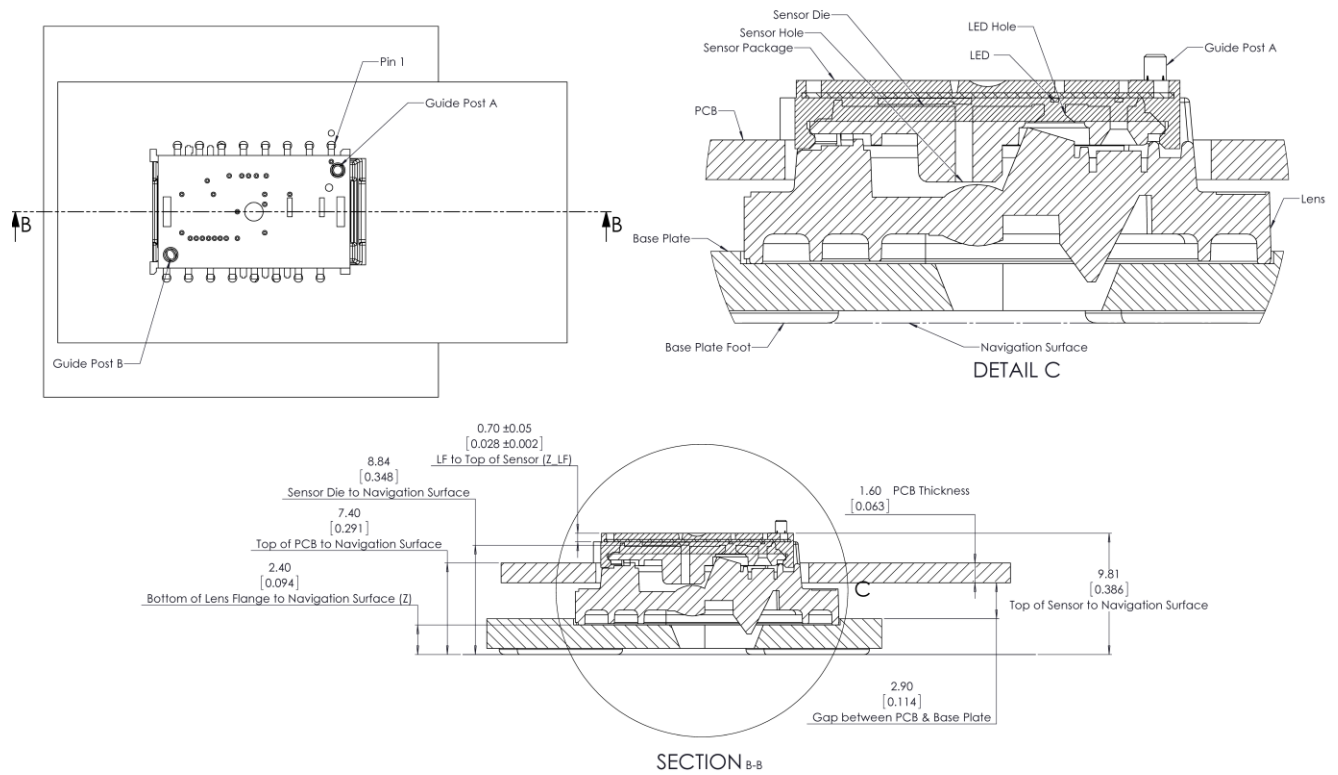


Figure 4. Assembly drawing of PMW3360DM-T2QU and distance from lens reference plane to tracking surface (Z)

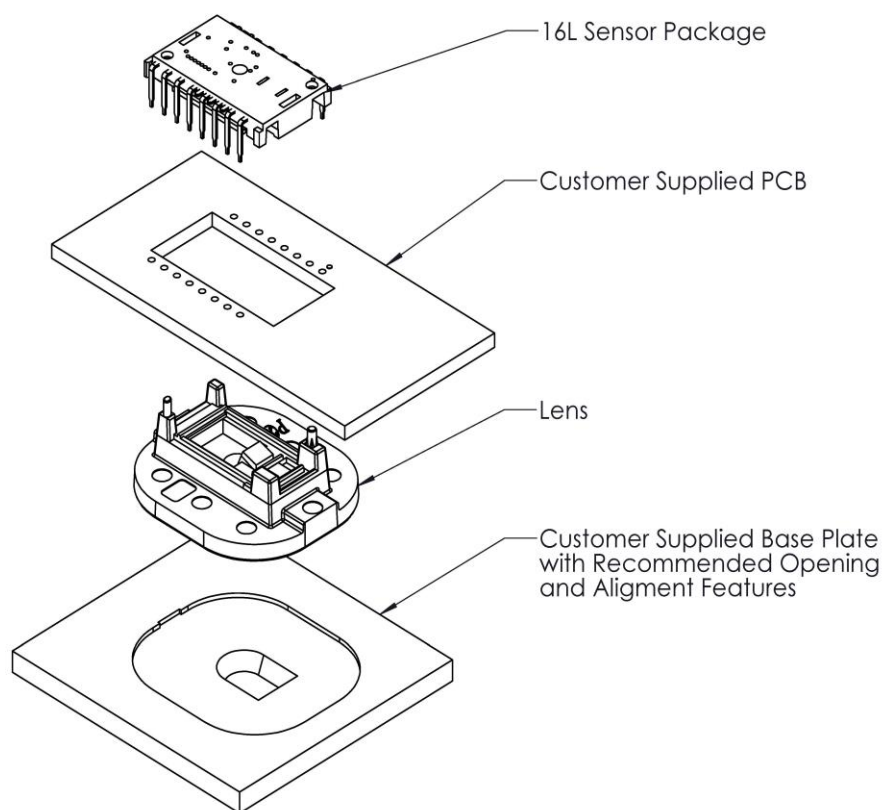
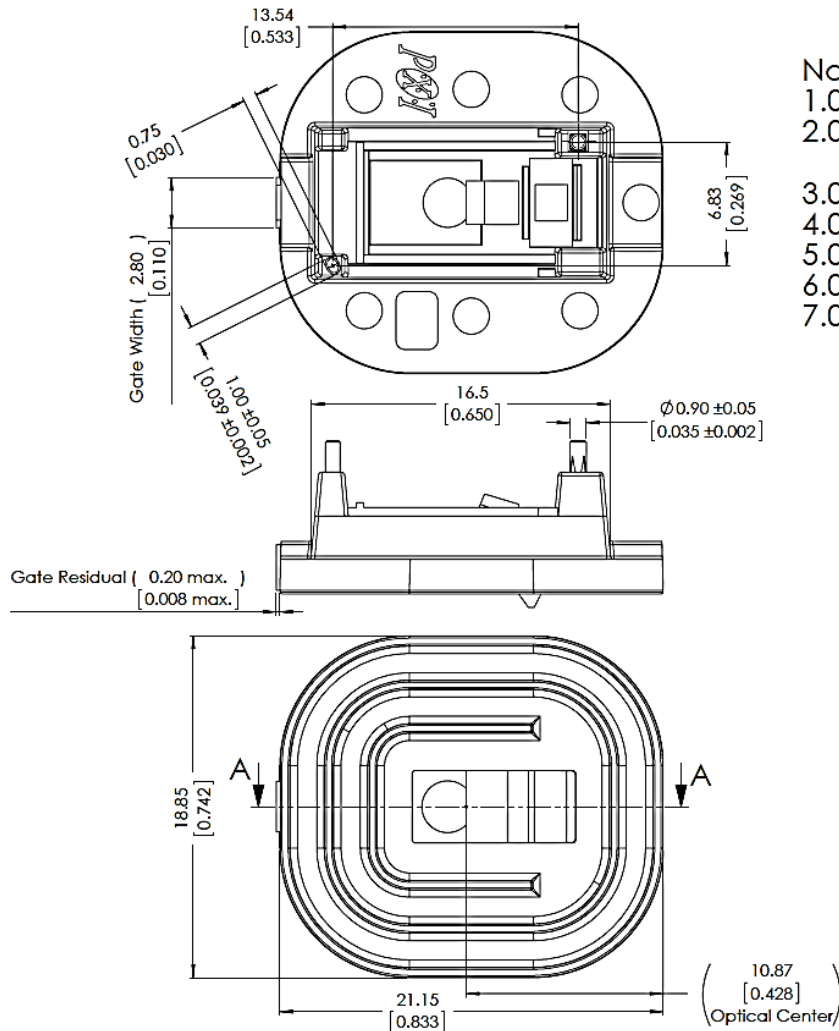


Figure 5. Exploded View of Assembly



Notes:

- 1.0 Dimension in millimeters / [inches]
- 2.0 General dimension tolerance:  $\pm 0.10\text{mm}$  unless specified otherwise
- 3.0 Angular tolerance:  $\pm 3.0^\circ$
- 4.0 Maximum flash: 0.20mm
- 5.0 Bracket ( ) indicates reference dimension
- 6.0 Optical details removed
- 7.0 Document Number: PNLR-019-LSI-G8\_010

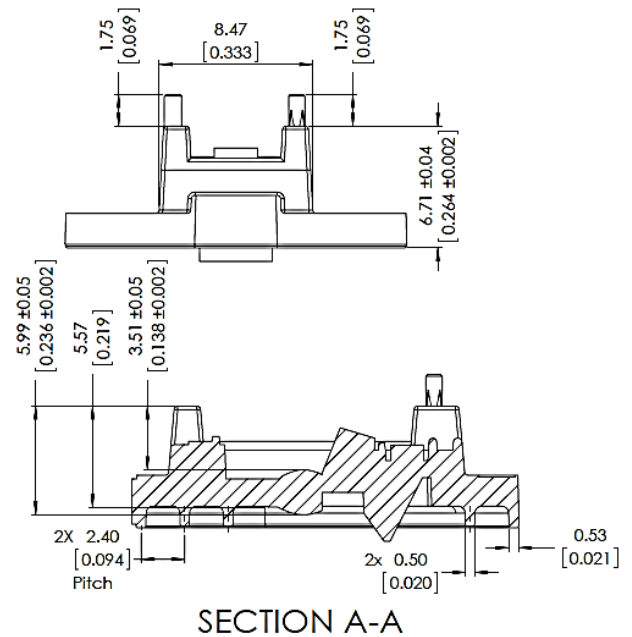


Figure 6. Lens Outline Drawing



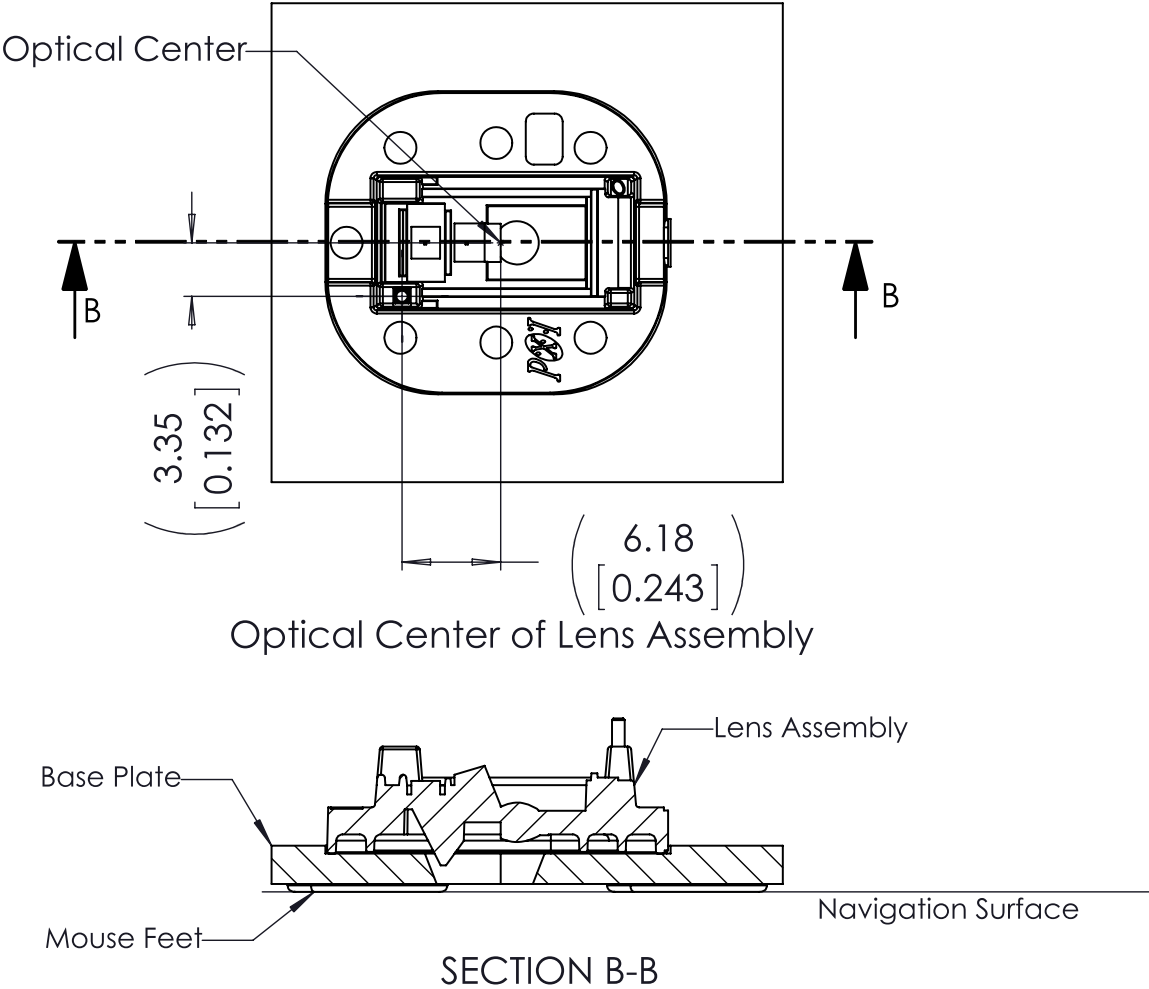
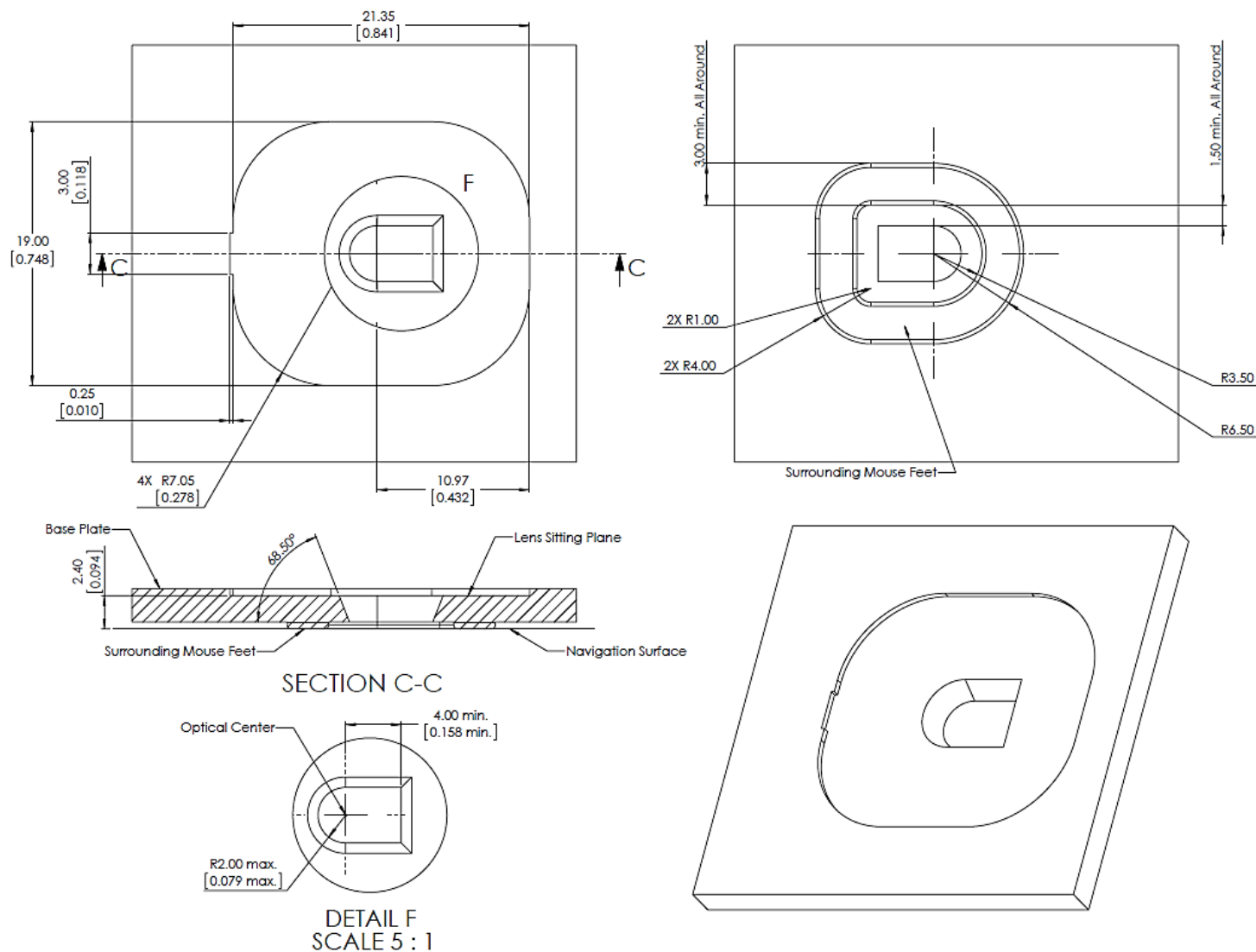


Figure 7. Cross section view of lens assembly



**Note:** Mouse feet should be placed close to the opening to stabilize the surface within the FOV of the sensor.

## 1.4 PCB Assembly Recommendation

- 1) Insert the integrated sensor and all other electrical components into PCB.
- 2) Wave-solder the entire assembly in a no-wash solder process utilizing solder-fixturing. A solder-fixturing is required to protect the sensor from flux spray and wave solder.
- 3) Avoid getting any solder flux onto the sensor body as there is potential for flux to seep into the sensor package, the solder fixturing should be designed to expose only the sensor leads to flux spray & molten solder while shielding the sensor body and optical apertures. The fixturing should also set the sensor at the correct position and height on the PCB.
- 4) Place the lens onto the base plate. Care must be taken to avoid contamination on the optical surfaces.
- 5) Remove the protective kapton tapes from optical apertures of the sensor. Care must be taken to prevent Contaminants from entering the apertures. Do not place the PCB with the sensor facing up during the entire mouse assembly process. Hold the PCB vertically when removing kapton tape.
- 6) Insert PCB assembly over the lens onto the base plate aligning post to retain PCB assembly. The sensor package will self-align to the lens via the guide posts. The optical position reference for the PCB is set by the base plate and lens. Note that the PCB motion due to button presses must be minimized to maintain optical alignment.
- 7) **Recommendation:** The lens can be permanently secured to the sensor package by melting the lens' guide posts over the sensor with heat staking process. Please refer to the application note PMS0122-LM19-LSI-AN for more details.
- 8) Install mouse top case. There must be a feature in the top case to press down onto the PCB assembly to ensure all components are stacked or interlocked to the correct vertical height.

Sensor Block Diagram

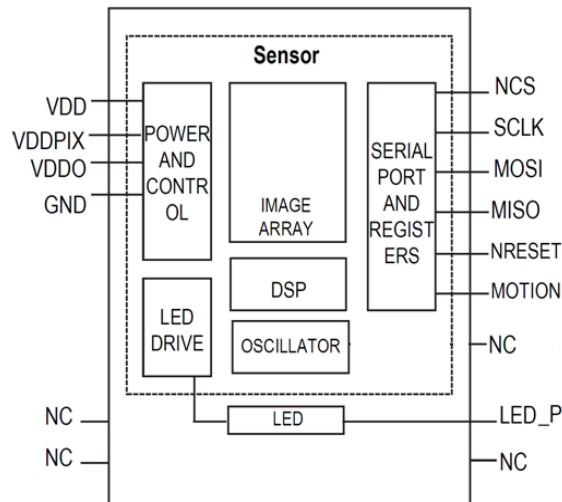


Figure 9. Block diagram of PMW3360DM-T2QU

## 1.5 Reference Schematics

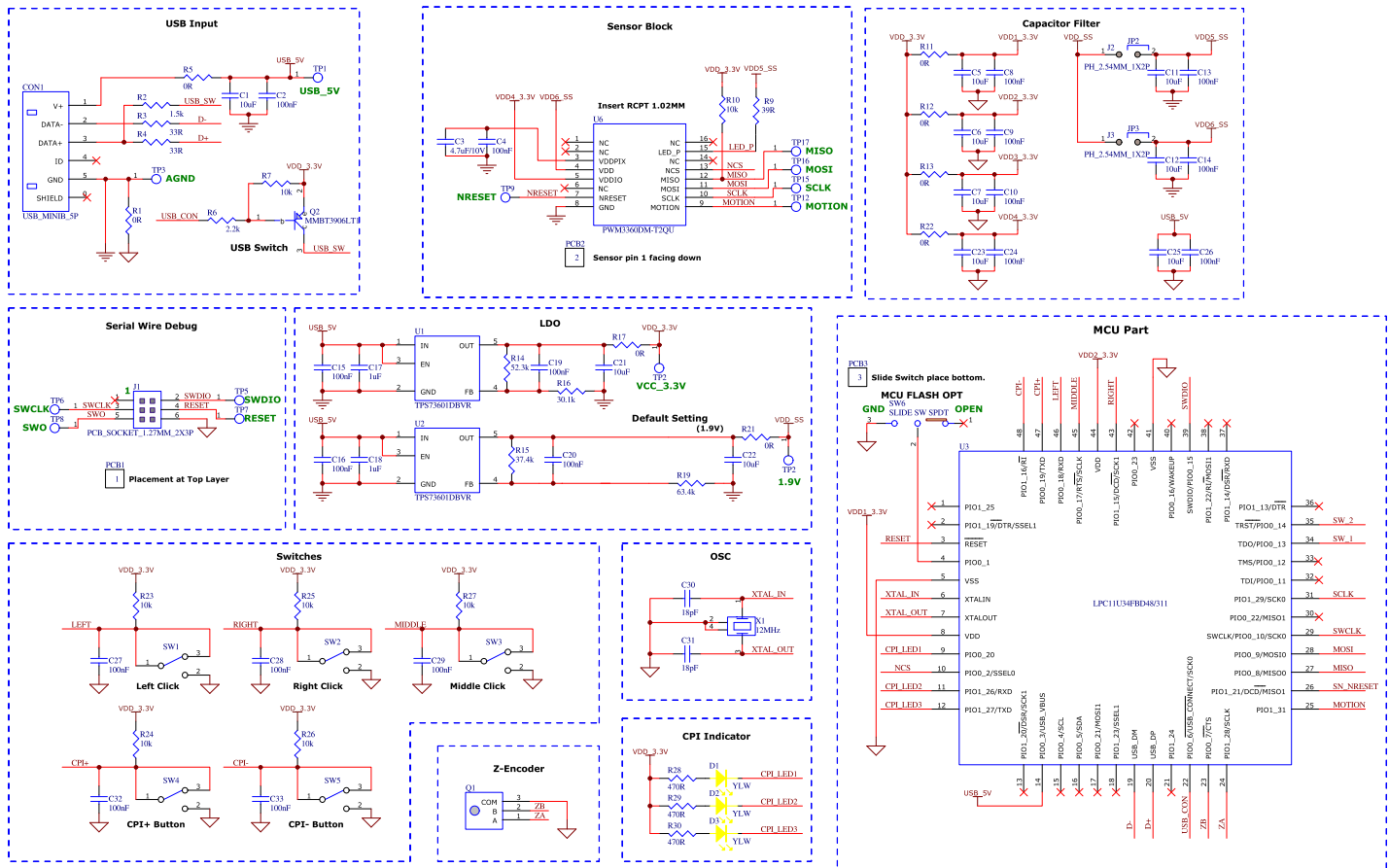


Figure 10. Schematic diagram for interface between PMW3360DM-T2QU and microcontroller on a wired solution

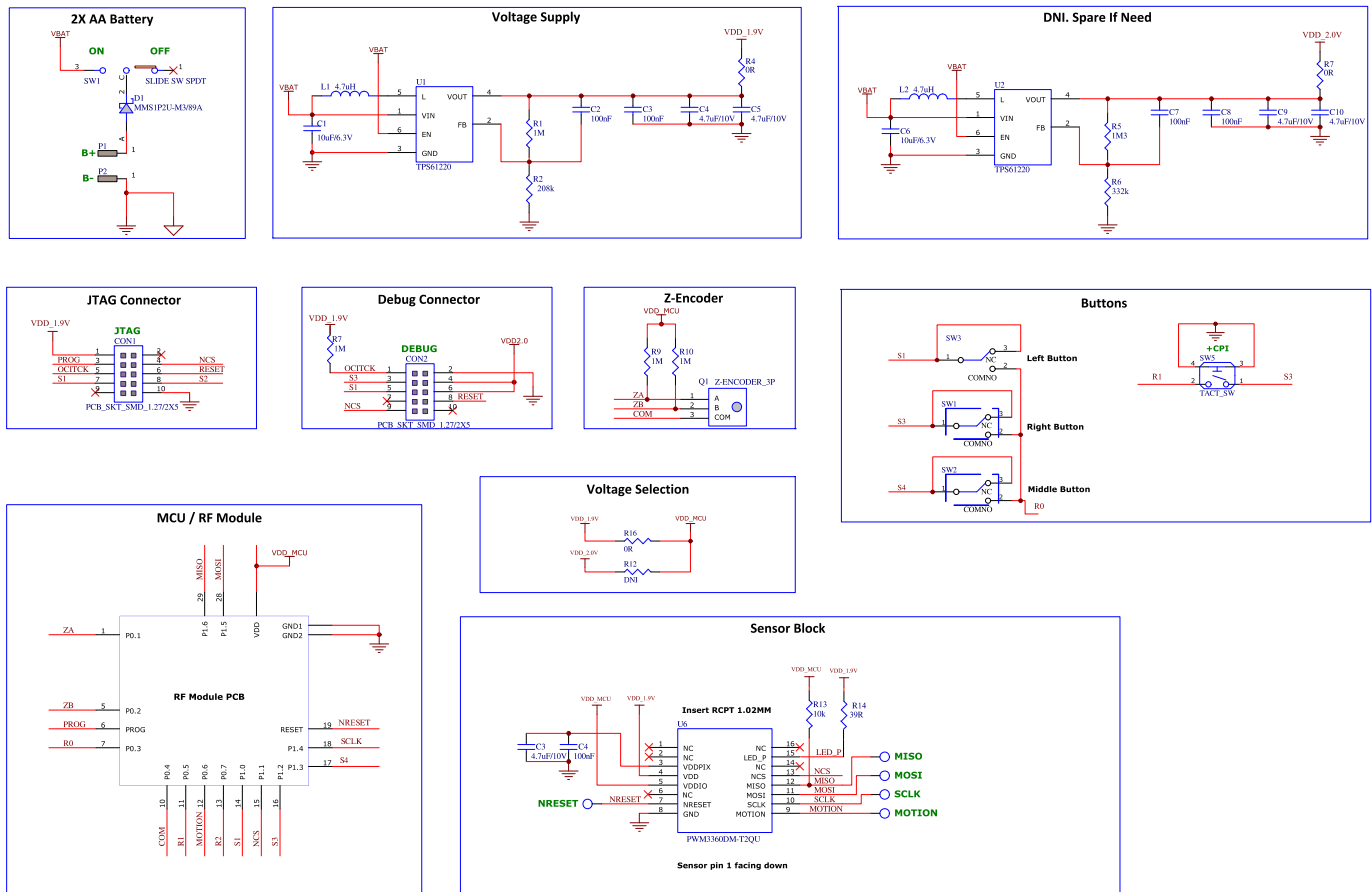


Figure 11. Schematic diagram for interface between PMW3360DM-T2QU and microcontroller on a wireless solution

## 2.0 Electrical Specifications

### Regulatory Requirements

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

### 2.1 Absolute Maximum Ratings

Table 2: Absolute Maximum Ratings

| Parameter               | Symbol              | Minimum | Maximum | Units | Notes                                     |
|-------------------------|---------------------|---------|---------|-------|-------------------------------------------|
| Storage Temperature     | T <sub>S</sub>      | -40     | 85      | °C    |                                           |
| Lead Solder Temperature | T <sub>SOLDER</sub> |         | 260     | °C    | For 7 seconds, 1.6mm below seating plane. |
| Supply Voltage          | V <sub>DD</sub>     | -0.5    | 2.10    | V     |                                           |
|                         | V <sub>DDIO</sub>   | -0.5    | 3.60    | V     |                                           |
| ESD (Human Body Model)  |                     |         | 2       | kV    | All pins                                  |
| Input Voltage           | V <sub>IN</sub>     | -0.5    | 3.6     | V     | All I/O pins.                             |

### 2.2 Recommended Operating Conditions

Table 3: Recommended Operating Condition

| Parameter                                              | Symbol            | Min  | Typ. | Max  | Units | Notes                                                                |
|--------------------------------------------------------|-------------------|------|------|------|-------|----------------------------------------------------------------------|
| Operating Temperature                                  | T <sub>A</sub>    | 0    |      | 40   | °C    |                                                                      |
| Power Supply Voltage                                   | V <sub>DD</sub>   | 1.80 | 1.90 | 2.10 | V     | excluding supply noise                                               |
|                                                        | V <sub>DDIO</sub> | 1.80 | 1.90 | 3.60 | V     | excluding supply noise. (VDDIO must be same or greater than VDD)     |
| Power Supply Rise Time                                 | t <sub>RT</sub>   | 0.15 |      | 20   | ms    | 0 to VDD min                                                         |
| Supply Noise (Sinusoidal)                              | V <sub>NA</sub>   |      |      | 100  | mVp-p | 10 kHz — 75 MHz                                                      |
| Serial Port Clock Frequency                            | f <sub>SCLK</sub> |      |      | 2.0  | MHz   | 50% duty cycle                                                       |
| Distance from Lens Reference Plane to Tracking Surface | Z                 | 2.2  | 2.4  | 2.6  | mm    |                                                                      |
| Speed                                                  | S                 |      | 250  |      | ips   | 300ips on QCK, Vespula Speed, Vespula Control and FUNC 1030 surfaces |
| Resolution error                                       | ResErr            |      | 1    |      | %     | Up to 200ips on QCK with 5000 cpi                                    |
| Acceleration                                           | A                 |      |      | 50   | g     | In run mode                                                          |

## 2.3 AC Electrical Specifications

**Table 4. AC Electrical Specifications**

Electrical characteristics over recommended operating conditions. Typical values at 25 °C,  $V_{DD} = 1.9\text{ V}$ ,  $V_{DDIO} = 1.9\text{ V}$ .

| Parameter                                              | Symbol                 | Minimum | Typical | Maximum | Units         | Notes                                                                                                                                                        |
|--------------------------------------------------------|------------------------|---------|---------|---------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Motion Delay After Reset                               | $t_{MOT-RST}$          | 50      |         |         | ms            | From reset to valid motion, assuming motion is present                                                                                                       |
| Shutdown                                               | $t_{STDWN}$            |         |         | 500     | $\mu\text{s}$ | 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            | $C_L = 100\text{pF}$                                                                                                                                         |
| MISO Fall Time                                         | $t_{f-MISO}$           |         | 50      |         | ns            | $C_L = 100\text{pF}$                                                                                                                                         |
| 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     |         |         | $\mu\text{s}$ | 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     |         |         | $\mu\text{s}$ | 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          | $t_{SRW}$<br>$t_{SRR}$ | 20      |         |         | $\mu\text{s}$ | 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     |         |         | $\mu\text{s}$ | 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      |         |         | $\mu\text{s}$ | 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                                                                                                         |

| Parameter                                     | Symbol                | Minimum | Typical | Maximum | Units         | Notes                                                                                                                                                                                |
|-----------------------------------------------|-----------------------|---------|---------|---------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SCLK To NCS Inactive<br>(For Read Operation)  | $t_{\text{SCLK-NCS}}$ | 120     |         |         | ns            | From last SCLK rising edge to NCS rising edge, for valid MISO data transfer                                                                                                          |
| SCLK To NCS Inactive<br>(For Write Operation) | $t_{\text{SCLK-NCS}}$ | 35      |         |         | $\mu\text{s}$ | From last SCLK rising edge to NCS rising edge, for valid MOSI data transfer                                                                                                          |
| NCS To MISO High-Z                            | $t_{\text{NCS-MISO}}$ |         |         | 500     | ns            | From NCS rising edge to MISO high-Z state                                                                                                                                            |
| MOTION Rise Time                              | $t_{\text{r-MOTION}}$ |         | 50      |         | ns            | $C_L = 100\text{pF}$                                                                                                                                                                 |
| MOTION Fall Time                              | $t_{\text{f-MOTION}}$ |         | 50      |         | ns            | $C_L = 100\text{pF}$                                                                                                                                                                 |
| Input Capacitance                             | $C_{\text{in}}$       |         | 50      |         | pF            | SCLK, MOSI, NCS                                                                                                                                                                      |
| Load Capacitance                              | $C_L$                 |         |         | 100     | pF            | MISO, MOTION                                                                                                                                                                         |
| Transient Supply Current                      | $I_{\text{DDT}}$      |         |         | 70      | mA            | Max supply current during the supply ramp from 0V to $V_{\text{DD}}$ with min 150 $\mu\text{s}$ and max 20ms rise time. (Does not include charging currents for bypass capacitors)   |
|                                               | $I_{\text{DDTIO}}$    |         |         | 60      | mA            | Max supply current during the supply ramp from 0V to $V_{\text{DDIO}}$ with min 150 $\mu\text{s}$ and max 20ms rise time. (Does not include charging currents for bypass capacitors) |

## 2.4 DC Electrical Specifications

Table 5. DC Electrical Specifications

Electrical characteristics, over recommended operating conditions. Typical values at 25 °C,  $V_{\text{DD}} = 1.9\text{V}$ ,  $V_{\text{DDIO}} = 1.9\text{V}$ , LED current at 12mA, 70MHz (internal), and 1.1kHz (slow clock).

| Parameter             | Symbol                 | Min                          | Typ.    | Max                          | Units         | Notes                                                                |
|-----------------------|------------------------|------------------------------|---------|------------------------------|---------------|----------------------------------------------------------------------|
| DC Supply Current     | $I_{\text{DD\_RUN1}}$  |                              | 16.3    |                              | mA            | Average current consumption, including LED current with 1ms polling. |
|                       | $I_{\text{DD\_RUN2}}$  |                              | 18.6    |                              | mA            |                                                                      |
|                       | $I_{\text{DD\_RUN3}}$  |                              | 21.6    |                              | mA            |                                                                      |
|                       | $I_{\text{DD\_RUN4}}$  |                              | 37.0    |                              | mA            |                                                                      |
|                       | $I_{\text{DD\_REST1}}$ |                              | 2.8     |                              | mA            |                                                                      |
|                       | $I_{\text{DD\_REST2}}$ |                              | 61.0    |                              | $\mu\text{A}$ |                                                                      |
|                       | $I_{\text{DD\_REST3}}$ |                              | 32.0    |                              | $\mu\text{A}$ |                                                                      |
| Power Down Current    | $I_{\text{PD}}$        |                              | 10      |                              | $\mu\text{A}$ |                                                                      |
| Input Low Voltage     | $V_{\text{IL}}$        |                              |         | $0.3 \times V_{\text{DDIO}}$ | V             | SCLK, MOSI, NCS                                                      |
| Input High Voltage    | $V_{\text{IH}}$        | $0.7 \times V_{\text{DDIO}}$ |         |                              | V             | SCLK, MOSI, NCS                                                      |
| Input Hysteresis      | $V_{\text{I\_HYS}}$    |                              | 100     |                              | mV            | SCLK, MOSI, NCS                                                      |
| Input Leakage Current | $I_{\text{leak}}$      |                              | $\pm 1$ | $\pm 10$                     | $\mu\text{A}$ | $V_{\text{in}} = V_{\text{DDIO}}$ or 0V, SCLK, MOSI, NCS             |
| Output Low Voltage    | $V_{\text{OL}}$        |                              |         | 0.45                         | V             | $I_{\text{out}} = 1\text{mA}$ , MISO, MOTION                         |
| Output High Voltage   | $V_{\text{OH}}$        | $V_{\text{DDIO}} - 0.45$     |         |                              | V             | $I_{\text{out}} = -1\text{mA}$ , MISO, MOTION                        |



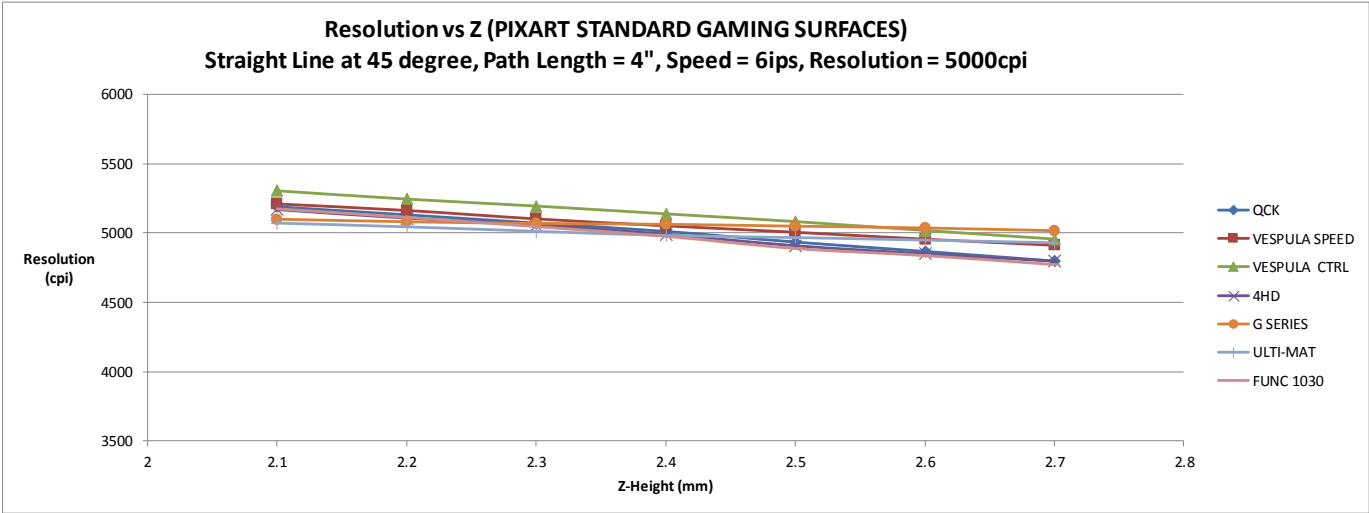


Figure 12 Mean Resolution vs. Z at default resolution at 5000cpi

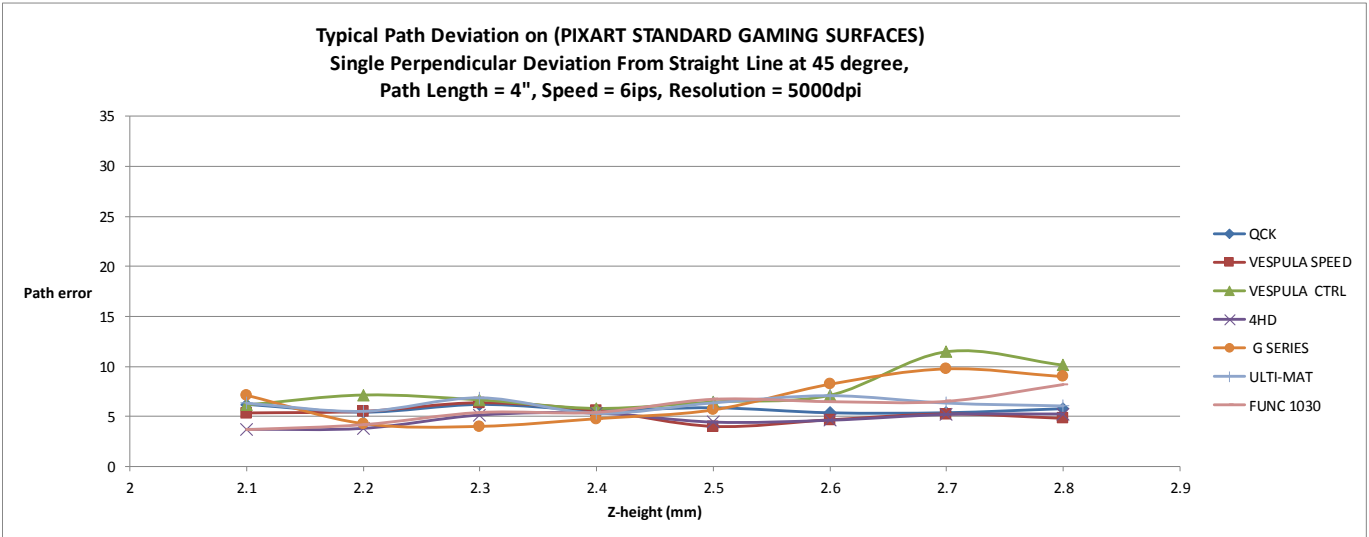


Figure 13 Path error vs. Z-height at default resolution at 5000cpi (mm)

### 3.0 Registers Table

PMW3360DM-T2QU 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. **Note: (R = Read / W = Write or Read/Write= RW)**

| Address | Register                   | Access | Default Value |
|---------|----------------------------|--------|---------------|
| 0x00    | Product_ID                 | R      | 0x42          |
| 0x01    | Revision_ID                | R      | 0x01          |
| 0x02    | Motion                     | RW     | 0x20          |
| 0x03    | Delta_X_L                  | R      | 0x00          |
| 0x04    | Delta_X_H                  | R      | 0x00          |
| 0x05    | Delta_Y_L                  | R      | 0x00          |
| 0x06    | Delta_Y_H                  | R      | 0x00          |
| 0x07    | SQUAL                      | R      | 0x00          |
| 0x08    | Pixel_Sum                  | R      | 0x00          |
| 0x09    | Maximum_Pixel              | R      | 0x00          |
| 0x0A    | Minimum_Pixel              | R      | 0x00          |
| 0x0B    | Shutter_Lower              | R      | 0x12          |
| 0x0C    | Shutter_Upper              | R      | 0x00          |
| 0x0D    | Control                    | RW     | 0x02          |
| 0x0F    | Config1                    | RW     | 0x31          |
| 0x10    | Config2                    | RW     | 0x20          |
| 0x11    | Angle_Tune                 | RW     | 0x00          |
| 0x12    | Frame_Capture              | RW     | 0x00          |
| 0x13    | SROM_Enable                | W      | N/A           |
| 0x14    | Run_Downshift              | RW     | 0x32          |
| 0x15    | Rest1_Rate_Lower           | RW     | 0x00          |
| 0x16    | Rest1_Rate_Upper           | RW     | 0x00          |
| 0x17    | Rest1_Downshift            | RW     | 0x1F          |
| 0x18    | Rest2_Rate_Lower           | RW     | 0x63          |
| 0x19    | Rest2_Rate_Upper           | RW     | 0x00          |
| 0x1A    | Rest2_Downshift            | RW     | 0xBC          |
| 0x1B    | Rest3_Rate_Lower           | RW     | 0xF3          |
| 0x1C    | Rest3_Rate_Upper           | RW     | 0x01          |
| 0x24    | Observation                | RW     | 0x00          |
| 0x25    | Data_Out_Lower             | R      | 0x00          |
| 0x26    | Data_Out_Upper             | R      | 0x00          |
| 0x29    | Pixel_Dump                 | RW     | 0x00          |
| 0x2A    | SROM_ID                    | R      | 0x00          |
| 0x2B    | Min_SQ_Run                 | RW     | 0x10          |
| 0x2C    | Pixel_Threshold            | RW     | 0x0A          |
| 0x2F    | Config5                    | RW     | 0x31          |
| 0x3A    | Power_Up_Reset             | W      | N/A           |
| 0x3B    | Shutdown                   | W      | N/A           |
| 0x3F    | Inverse_Product_ID         | R      | 0xBD          |
| 0x41    | LiftCutoff_Tune3           | RW     | 0x00          |
| 0x42    | Angle_Snap                 | RW     | 0x00          |
| 0x4A    | LiftCutoff_Tune1           | RW     | 0x00          |
| 0x50    | Motion_Burst               | RW     | 0x00          |
| 0x58    | LiftCutoff_Tune_Timeout    | RW     | 0x27          |
| 0x5A    | LiftCutoff_Tune_Min_Length | RW     | 0x09          |
| 0x62    | SROM_Load_Burst            | W      | N/A           |
| 0x63    | Lift_Config                | RW     | 0x02          |
| 0x64    | Pixel_Burst                | R      | 0x00          |
| 0x65    | LiftCutoff_Tune2           | R      | 0x00          |