PAW3204DB-TJDM
LITTLE LOW POWER WIRELESS MOUSE SENSOR

General Description

The PAW3204DB-TJDM, AKA PAW3204LL, is a high performance and little low power CMOS process optical mouse sensor with DSP integration chip that serves as a non-mechanical motion estimation engine for implementing a computer wireless mouse. With adaptive frame rate control, known as AFC, this optical mouse sensor gains extra power saving during mouse moving.

Features

- **Single power supply**
- **Precise optical motion estimation technology**
- **Complete 2-D motion sensor**
- **Accurate motion estimation over a wide range of surfaces**
- **High speed motion detection up to 30 inches/sec**
- **High resolution up to 1600 CPI**
- **Power saving mode during times of no movement**
- **Serial interface for programming and data transfer**
- **Built-in low power Timer (LPT) for sleep1/sleep2 mode**
- **MOTSWK pin to wake up mouse controller when sensor wakes up from sleep mode**
- **Wide operation range from 2.1V to 3.6V**
- **Low power operation under 1.98V**
- **Adaptive frame rate control for extra power saving during moving**

Key Specification

Power Supply	**Operating voltage** **1.73V ~ 1.98V (VDD and VDDA short)** **2.1V ~ 3.6V (VDD)**
Optical Lens	**1:1**
Speed	**Up to 30 inches/sec**
Acceleration	**TBD**
Resolution	**800/ 1000(Default)/ 1200/ 1600 CPI**
Frame Rate	**Up to 3200 frames/sec**
Typical Operating Current	**TBD @ Mouse moving (Normal)** **TBD @ Mouse not moving (Sleep1)** **TBD @ Mouse not moving (Sleep2)** **TBD @ Power down mode** ***including LED, typical value**
Package	**Staggered DIP8**

Ordering Information

Order Number	Resolution
PAW3204DB-TJDM	1000 CPI

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1. Pin Configuration

1.1 Pin Description

Pin	Name	Type	Definition
1	PD	IN	Hardware control to enter power down mode. Build-in 1M ohm pull-down resistor. Level High: enter power down mode Level Low: leave power down mode
2	MOTSWK	OUT	Motion detect (active low output, see Section7)
3	SDIO	I/O	Serial interface bi-direction data
4	SCLK	IN	Serial interface clock
5	LED	OUT	LED control
6	VSS	GND	Chip ground
7	VDD	PWR	Power supply (2.1V~3.6V) for internal power regulator, VDDA (1.9V) is the power regulator output. Power supply (1.73V~1.98V) for low power operation voltage
8	VDDA	PWR	Analog/Digital supply voltage (1.9V) Power supply (1.73V~1.98V) for low power operation voltage

1.2 Pin Assignment

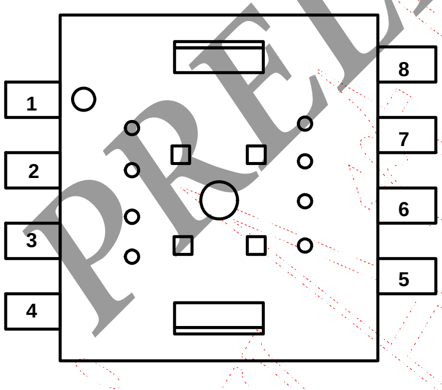

Figure 1. Top View Pinout

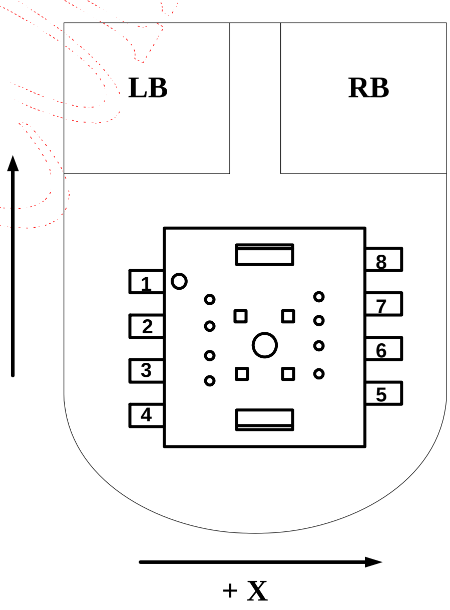

Figure 2. Top View of Mouse

2. Block Diagram and Operation

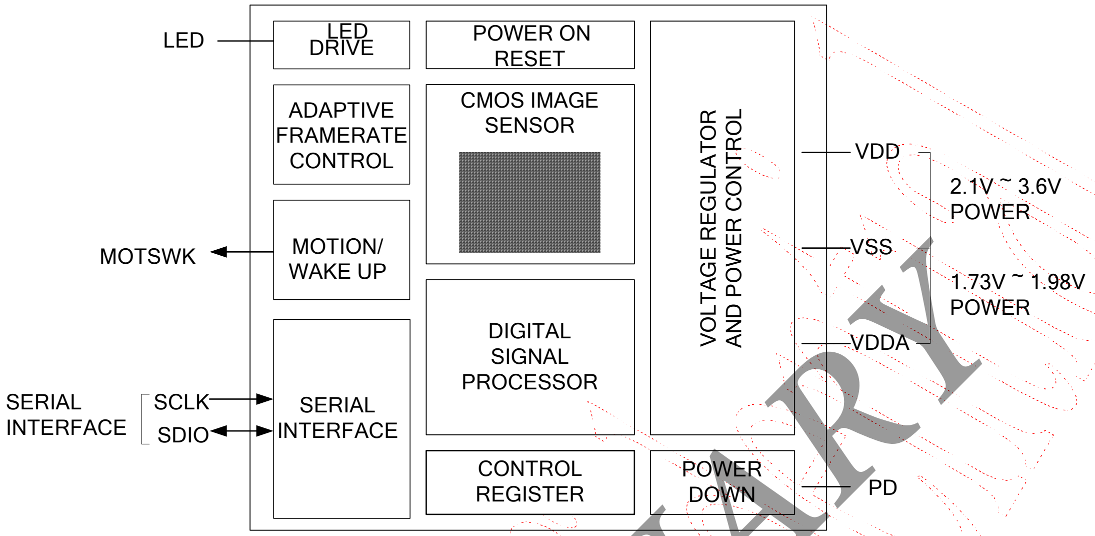

Figure 3. Block Diagram

The PAW3204DB-TJDM, AKA PAW3204LL, is a high performance and little low power CMOS-process optical mouse sensor with DSP integration chip that serves as a non-mechanical motion estimation engine for implementing a wireless computer mouse. It is based on new optical navigation technology, which measures changes in position by optically acquiring sequential surface images (frames) and mathematically determining the direction and magnitude of movement. The mouse sensor is in an 8-pin optical package. The current X and Y information are available in registers accessed via a serial port. The word "mouse sensor", instead of PAW3204DB-TJDM, is used in the document.

With brand-new technology, adaptive frame rate control (also known as AFC), the mouse sensor gain extra power saving during mouse moving. The AFC servers position/speed detection and then mapping to different frame rate. With lower frame rate, it leads to lower power consumption of the mouse sensor and LED. The mouse sensor is featured with THREE-level AFC which is 3200/1600/1060 frame per second.

3. Registers and Operation

The mouse sensor can be programmed through registers via the serial port. Also, the DSP configuration and motion data can be read from these registers. All registers not listed are reserved, and should never be written by firmware.

3.1 Registers

Address	Name	R/W	Default	Data Type
0x00	Product_ID1	R	0x30	Eight bits[11:4] number with the product identifier
0x01	Product_ID2	R	0xCX	Upper Four bits[3:0] number with the product identifier Lower Four bits[3:0] number with the product version
0x02	Motion_Status	R	-	Bit field
0x03	Delta_X	R	-	Eight bits 2's complement number
0x04	Delta_Y	R	-	Eight bits 2's complement number
0x05	Operation_Mode	R/W	0xB8	Bit field
0x06	Configuration	R/W	0x01	Bit field
0x07	Image_Quality	R	-	Eight bits unsigned integer
0x08	Operation_State	R	-	Bit field
0x09	Write_Protect	R/W	0x00	Bit field
0x0A	Sleep1_Setting	R/W	0x72	Bit field
0x0B	Enter_Time	R/W	0x12	Bit field
0x0C	Sleep2_Setting	R/W	0x92	Bit field
0x0D	Image_ Threshold	R/W	0x1E	Eight bits unsigned integer
0x0E	Image_ Recognition	R/W	0xE5	Bit field

3.2 Register Descriptions

0x00	Product_ID1							
Bit	7	6	5	4	3	2	1	0
Field	PID[11:4]							
Usage	The value in this register can't be changed. It can be used to verify the serial communications link is OK.							

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0x01	**Product_ID2**							
Bit	7	6	5	4	3	2	1	0
Field	PID[3:0]				VID[3:0]			
Usage	The value in this register can't be changed. PID[3:0] can be used to verify that the serial communications link is OK. VID[3:0] is a value between 0x0 and 0xF, it represents the chip version.							

0x02	**Motion_Status**							
Bit	7	6	5	4	3	2	1	0
Field	Motion	Reserved[1:0]		DYOVF	DXOVF	RES[2:0]		
Usage	***Motion_Status*** register allows the user to determine if motion has occurred since the last time it was read. If so, then the user should read ***Delta_X*** and ***Delta_Y*** registers to get the accumulated motion. It also reveals if the motion buffers have overflowed since the last reading. The current resolution is also shown. Reading this register freezes the ***Delta_X*** and ***Delta_Y*** register values. Read this register before reading the ***Delta_X*** and ***Delta_Y*** registers. If ***Delta_X*** and ***Delta_Y*** are not read before the motion register is read a second time, the data in ***Delta_X*** and ***Delta_Y*** will be lost.							

Notes:

Field Name	**Description**
Motion	Motion since last report **0 = No motion (Default)** 1 = Motion occurred, freeze motion data in ***Delta_X*** and ***Delta_Y*** registers
Reserved[1:0]	Reserved for future use
DYOVF	Motion Delta Y overflow, ΔY buffer overflowed since last report **0 = No overflow (Default)** 1 = Overflow has occurred
DXOVF	Motion Delta X overflow, ΔX buffer overflowed since last report **0 = No overflow (Default)** 1 = Overflow has occurred
RES[2:0]	Resolution in counts per inch 000 = 800 001 = 1000 **(Default)** 010 = 1200 011 = 1600 100 – 111: reserved

0x03	**Delta_X**							
Bit	7	6	5	4	3	2	1	0
Field	X7	X6	X5	X4	X3	X2	X1	X0
Usage	X movement since last data frozen by reading ***Motion_Status*** register. Absolute value is determined by resolution. A reading clears the register. Report range –128 ~ +127. The MSB bit represents as sign bit.							

0x04	**Delta_Y**							
Bit	7	6	5	4	3	2	1	0
Field	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0
Usage	Y movement since last data frozen by reading ***Motion_Status*** register. Absolute value is determined by resolution. A reading clears the register. Report range –128 ~ +127. The MSB bit represents as sign bit.							

0x05	Operation_Mode							
Bit	7	6	5	4	3	2	1	0
Field	LEDsht_enh	**0**	**1**	Slp_enh	Slp2_enh	Slp2For	Slp1For	Wakeup

Usage

Operation_Mode register allows the user to change the mouse sensor operation modes. Shown below are the bits, their default values, and optional values.

Operation_Mode[4:0]

"0xxxx" = Disable sleep mode

"10xxx" = Enable sleep1 mode[1]

"11xxx" = Enable sleep2 mode[2]

"11100" = Force entering sleep2[3]

"1x010" = Force entering sleep1[3]

"1x001" = Force wakeup from sleep mode[3]

Notes:

1. Enable sleep mode, but disable automatic entering sleep2 mode. In this case, only **2** modes are available, normal mode and sleep1 mode. After 256 ms (typical) not moving during normal mode, the mouse sensor will enter sleep1 mode, and keep on sleep1 mode until motion detected or wakeup bit asserted. Note that the entering time depends on the setting of ***Enter_Time*** register.
2. Enable sleep mode full function. In this case, **3** modes are available, normal mode, sleep1 mode and sleep2 mode. After 256 ms (typical) not moving during normal mode, the mouse sensor will enter sleep1 mode, and keep on sleep1 mode until motion detected or wakeup bit asserted.

   After 61 sec (typical) not moving during sleep1 mode, the mouse sensor will enter sleep2 mode, and keep on sleep2 mode until motion detected or force wakeup to normal mode. Note that the entering time depends on the setting of ***Enter_Time*** register.
3. Only ONE of these three bits, slp2mu_enh/slp1mu_enh/wakeup, can be set to 1 at a single register write, others MUST be 0. After function works, the asserted bit will be reset to 0 by internal signal.
4. To force entering normal mode, clear ***Slp_enh/Slp2_enh*** bit when the mouse sensor is in normal mode; otherwise, in sleep mode, clear ***Slp_enh/Slp2_enh*** bit, and then assert ***Wakeup*** bit.

Notes

Field Name	**Description**
LEDsht_enh	LED shutter enable/disable 0 = Disable **1 = Enable (Default)**
Bit [6:5]	MUST always be **01**
Slp_enh	Sleep mode enable/disable 0 = Disable **1 = Enable (Default)** *Note that disable sleep mode will also disable AFC function
Slp2_enh	Automatic enter sleep2 mode enable/disable 0 = Disable **1 = Enable (Default)**

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	Slp2For	Force entering sleep2 mode. Set "1" to enter sleep2, and then it will be reset to "0"
	Slp1For	Force entering sleep1 mode. Set "1" to enter sleep1, and then it will be reset to "0"
	Wakeup	Manual wake up from sleep mode, set "1" to wakeup and then it will be reset to "0"

0x06	**Configuration**							
Bit	7	6	5	4	3	2	1	0
Field	Reset	Mot0Swk1	**0**	**0**	PD_enh	CPI [2:0]		

Usage

The ***Configuration*** register allows the user to change the configuration of the mouse sensor. Shown below are the bits, their default values, and optional values.

With ***Mot0Swk1*** bit is clear, the MOTSWK pin is "level-sensitive". The pin level remains low when motion has occurred; The mouse controller can read ***Motion_Status*** register, ***Delta_X*** register, then ***Delta_Y*** register sequentially to acquire motion data. After the mouse controller reads all data, ***Delta_X*** and ***Delta_Y*** are both zero, the pin level will be high (see Section7).

With ***Mot0Swk1*** bit is set, the MOTSWK pin is "edge-sensitive". The pin will send a low pulse to trigger the mouse controller when the mouse sensor entering normal mode from sleep mode. The mouse controller can read ***Motion_Status*** register, ***Delta_X*** register, then ***Delta_Y*** register sequentially to acquire motion data (see Section7).

Notes

Field Name	**Description**
Reset	Full chip reset **0 = Normal operation mode (Default)** 1 = Full chip reset
Mot0Swk1	MOTSWK pin output selection (see Section 7) **0 = Motion function output (Default)** 1 = SWKINT function output
Bit [5:4]	MUST always be **00**
PD_enh	Power down mode **0 = Normal operation (Default)** 1 = Power down mode
CPI[2:0]	Output resolution setting, setting with CPI mode select bit 000 = 800 001 = 1000 **(Default)** 010 = 1200 011 = 1600 100 – 111: reserved

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0x07	**Image_Quality**							
Bit	7	6	5	4	3	2	1	0
Field	Imgqa[7:0]							
Usage	Image Quality is a quality level of the mouse sensor in the current frame. Report range 0 ~ 255. The minimum required level is to be larger than the value of ***Image_ Threshold*** register. otherwise, the DSP would not process the motion data.							
Notes	**Field Name**	**Description**						
	Imgqa[7:0]	Image quality report range: 0(worst) ~ 255(best).						

0x08	**Operation_State**							
Bit	7	6	5	4	3	2	1	0
Field	Reserved[3:0]				Slp_state	Op_state[2:0]		
Usage	***Operation_State*** register allows the user to read the operation state of the sensor.							
Notes	**Field Name**	**Description**						
	Reserved[3:0]	Reserved for future use						
	Slp_state	Sleep state (If Op_state[2:0] is 110, the Slp_state bit is effective.) 0 = LPT sleep1 1 = LPT sleep2						
	Op_state[2:0]	000 = Normal state, 3200 FPS (with sleep function disable) 001 = Normal state, 3200 FPS (with sleep function enable) 011 = Normal state, 1600 FPS (with sleep function enable) 101 = Normal state, 1060 FPS (with sleep function enable) 110 = Sleep mode (see Slp_state bit to get sleep state.) Other values as transition state.						

0x09	**Write_Protect**							
Bit	7	6	5	4	3	2	1	0
Field	WP[7:0]							
Usage	Write protect for the register 0x0A ~ 0x7F.							
Notes	**Field Name**	**Description**						
	WP[7:0]	Write protect enable/disable for the address after 0x09 **0x00 = Enable (Default)**, register 0x0A ~ 0x7F are read only 0x5A = Disable, register 0x0A ~ 0x7F can be read/written						

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0x0A	**Sleep1_Setting**							
Bit	7	6	5	4	3	2	1	0
Field	Slp1_freq[3:0]				**0**	**0**	**1**	**0**
Usage	***Sleep1_Setting*** register allows the user to set frequency time for the sleep1 mode.							
Notes	**Field Name**	**Description**						
	Slp1_freq[3:0]	Setting frequency time for the sleep1 mode. A scale is 4ms. Relative to its value 0 ~ 15, the frequency time is 4ms ~ 64ms. Default is 32ms. (slp1_freq[3:0] = 0111)						
	Bit [3:0]	MUST always be **0010**						

0x0B	**Enter_Time**							
Bit	7	6	5	4	3	2	1	0
Field	Slp1_etm[3:0]				Slp2_etm[3:0]			
Usage	***Enter_Time*** register allows the user to set enter time for the sleep1 and sleep2 mode.							
Notes	**Field Name**	**Description**						
	Slp1_etm[3:0]	Setting sleep1 enter time. A scale is 128ms. Relative to its value 0 ~ 15, the frequency time is 128ms ~ 2048ms. Default is 256ms. (slp1_etm[3:0] = 0001)						
	Slp2_etm[3:0]	Setting sleep2 enter time. A scale is 20480ms. Relative to its value 0 ~ 15, the frequency time is 20480ms ~ 327680ms. Default is 61440ms (about 61 sec). (slp2_etm[3:0] = 0010)						

0x0C	**Sleep2_Setting**							
Bit	7	6	5	4	3	2	1	0
Field	Slp2_freq[3:0]				**0**	**0**	**1**	**0**
Usage	***Sleep2_Setting*** register allows the user to set frequency time for the sleep2 mode.							
Notes	**Field Name**	**Description**						
	Slp2_freq[3:0]	Setting frequency time for the sleep2 mode. A scale is 32ms. Relative to its value 0 ~ 15, the frequency time is 32ms ~ 512ms. Default is 320ms. (slp2_freq[3:0] = 1001)						
	Bit [3:0]	MUST always be **0010**						

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0x0D	**Image_ Threshold**							
Bit	7	6	5	4	3	2	1	0
Field	Imgqa_th[7:0]							
Usage	***Image_ Threshold*** register allows the user to set image threshold. The mouse sensor calculates data to ***Delta_X*** and ***Delta_Y*** registers when image quality (please see ***Image_Quality*** register) is larger than image threshold.							
Notes	**Field Name**	**Description**						
	Imgqa_th[7:0]	Image threshold: 0 (High recognition rate) ~ 255 (Low recognition rate). The minimum level for normally working is 30. Default is 00011110.						

0x0E	**Image_Recognition**							
Bit	7	6	5	4	3	2	1	0
Field	pk_wt[2:0]			**0**	Imgqa_df[3:0]			
Usage	***Image_Recognition*** register allows the user to set recognition rate.							
Notes	**Field Name**	**Description**						
	pk_wt[2:0]	Peak threshold weighting: 0 (Low recognition rate) ~ 7 (High recognition rate). Default is 111.						
	Bit 4	MUST always be **0**						
	Imgqa_df[3:0]	Image qualification threshold difference: 0 (High recognition rate) ~ 15 (Low recognition rate). Default is 0101.						

4. Specifications

4.1 Absolute Maximum Ratings

Stresses above those listed under "Absolute Maximum Rating" may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter	Min	Max	Unit	Notes
T_{STG}	Storage Temperature	-40	85	°C	
TA	Operating Temperature	-15	55	°C	
V_{DC}	DC Supply Voltage	-0.2	V_{dd1} + 0.2	V	
		-0.3	V_{dd2} + 0.3	V	
V_{IN}	DC Input Voltage	-0.3	V_{DC}	V	All I/O pin
	Lead Solder Temp	-	260	°C	For 10 seconds, 1.6mm below seating plane.
ESD		-	TBD	kV	All pins, human body model MIL 883 Method 3015

4.2 Recommend Operating Condition

Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
T_A	Operating Temperature	0	-	40	°C	
V_{dd1}	Power Supply Voltage	1.73	1.8	1.98	V	VDDA, VDD short
V_{dd2}		2.1	2.7	3.6		VDD
V_{Npp}	Supply Noise	-	-	100	mV	Peak to peak within 10K - 80 MHz
Z	Distance From lens Reference Plane to Surface	2.3	2.4	2.5	mm	Refer to Figure 4.
R	Resolution	800	1000	1600	CPI	
SCLK	Serial Port Clock Frequency	-	-	TBD	MHz	
FR	Frame Rate	-	1600	3200	frames/s	
S	Speed	0	-	30	inches/s	
A	Acceleration	0	-	TBD	g	

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4.3 AC Operating Condition (1.8V / 2.7V)

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, V_{DD} = 2.7 V for 2.7V application and V_{DD} = V_{DDA} = 1.8 V for 1.8V application.

Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
t_{PDR}	PD Pulse Register	-	-	625	us	Two frames time maximum after setting ***PD_enh*** bit in the ***Configuration*** register @3200frame/sec (refer to Figure 11).
t_{PU}	Power Up from V_{DD}↑	10	-	29	ms	From V_{DD}↑ to valid motion signals. 500usec + 90 frames.
t_{HOLD}	SDIO Read Hold Time	-	3	-	us	Minimum hold time for valid data (refer to Figure 9).
t_{RESYNC}	Serial Interface RESYNC.	1	-	-	us	@3200 frame/sec (refer to Figure 10)
t_{SIWTT}	Serial Interface Watchdog Timer Timeout	1.7 32 320	-	-	ms	@3200 frame/sec (refer to Figure 10) 1.7ms for normal mode, 32ms (typical) for sleep1 mode, 320ms (typical) for sleep2 mode. Note that the value depends on the setting of ***Sleep1_Setting*** register and ***Sleep2_Setting*** register.
t_{SWKINT}	Sensor Wakeup Interrupt Time	-	157	-	us	
t_r , t_f	Rise and Fall Times: SDIO	-	30, 30	-	ns	C_L = 30 pF
t_r , t_f	Rise and Fall Times: ILED	-	30, 30	-	ns	

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4.4 DC Electrical Characteristics (1.8V)

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, $V_{DD} = V_{DDA} = 1.8$ V

Symbol	Parameter	Min.	Typ.	Max.	Unit	
Type: Power						
I_{DDN}	Supply Current Mouse Moving (Normal)	-	TBD	-	mA	
I_{DDS1}	Supply Current Mouse Not Moving (Sleep1)	-	TBD	-	uA	
I_{DDS2}	Supply Current Mouse Not Moving (Sleep2)	-	TBD	-	uA	
I_{DDPD}	Supply Current (Power Down)	-	TBD	-	uA	
Type: SCLK, SDIO						
V_{IH}	Input Voltage HIGH	VDD*0.7	-	-	V	
V_{IL}	Input Voltage LOW	-	-	VDD*0.3	V	
V_{OH}	Output Voltage HIGH	VDD-0.4	-	-	V	@I_{OH} = 2mA
V_{OL}	Output Voltage LOW	-	-	0.4	V	@I_{OL} = 2mA
Type: LED						
V_{OL}	Output Voltage LOW	-	-	380	mV	@I_{OL} = 25mA

4.5 DC Electrical Characteristics (2.7V)

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, $V_{DD} = 2.7$ V

Symbol	Parameter	Min.	Typ.	Max.	Unit	
Type: Power						
I_{DDN}	Supply Current Mouse Moving (Normal)	-	TBD	-	mA	
I_{DDS1}	Supply Current Mouse Not Moving (Sleep1)	-	TBD	-	uA	
I_{DDS2}	Supply Current Mouse Not Moving (Sleep2)	-	TBD	-	uA	
I_{DDPD}	Supply Current (Power Down)	-	TBD	-	uA	
Type: SCLK, SDIO						
V_{IH}	Input Voltage HIGH	VDD*0.7	-	-	V	
V_{IL}	Input Voltage LOW	-	-	VDD*0.3	V	
V_{OH}	Output Voltage HIGH	VDD-0.4	-	-	V	@I_{OH} = 2mA
V_{OL}	Output Voltage LOW	-	-	0.4	V	@I_{OL} = 2mA
Type: LED						
V_{OL}	Output Voltage LOW	-	-	380	mV	@I_{OL} = 25mA

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5. Z and 2D/3D Assembly

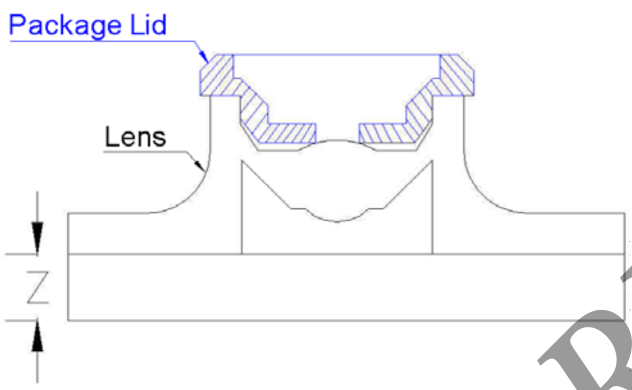

Figure 4. Distance from Lens Reference Plane to Surface

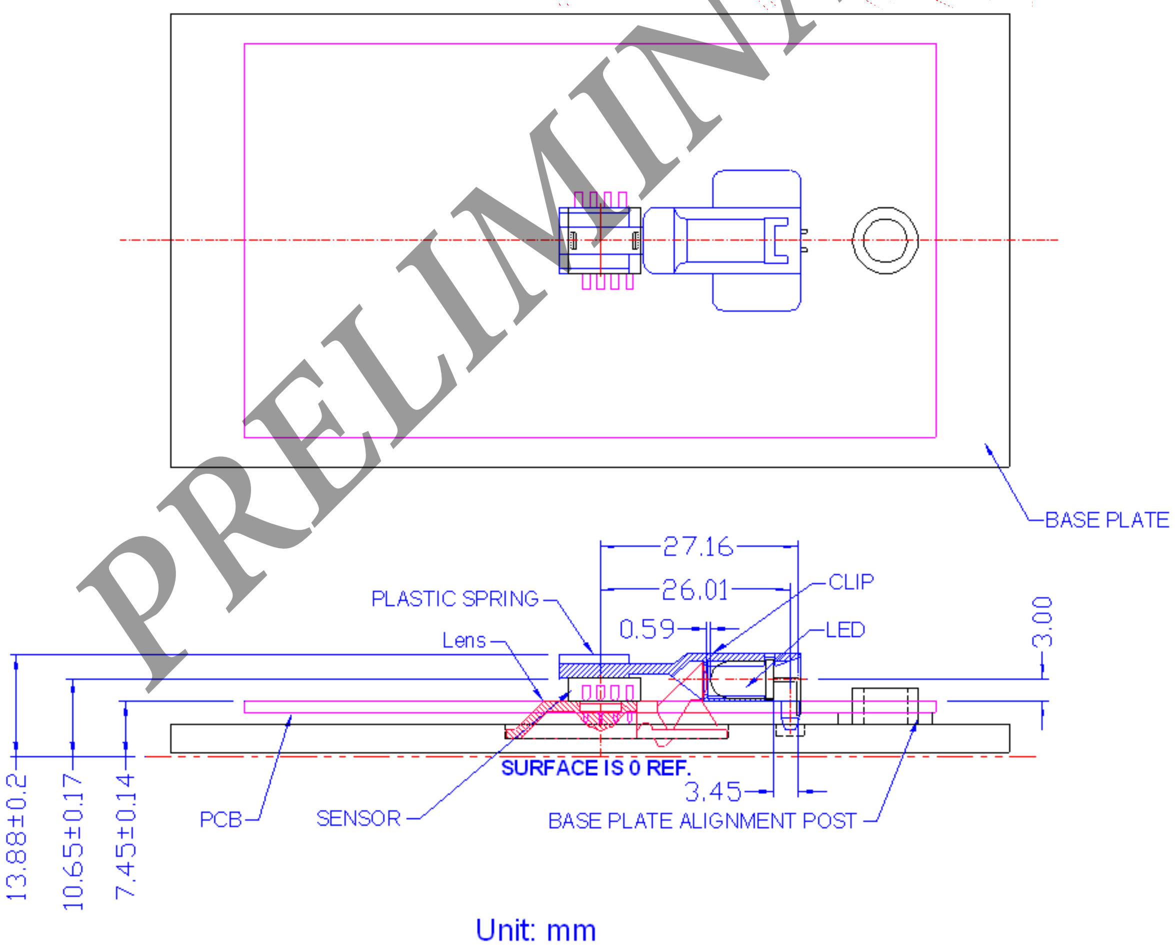

Figure 5. 2D Assembly

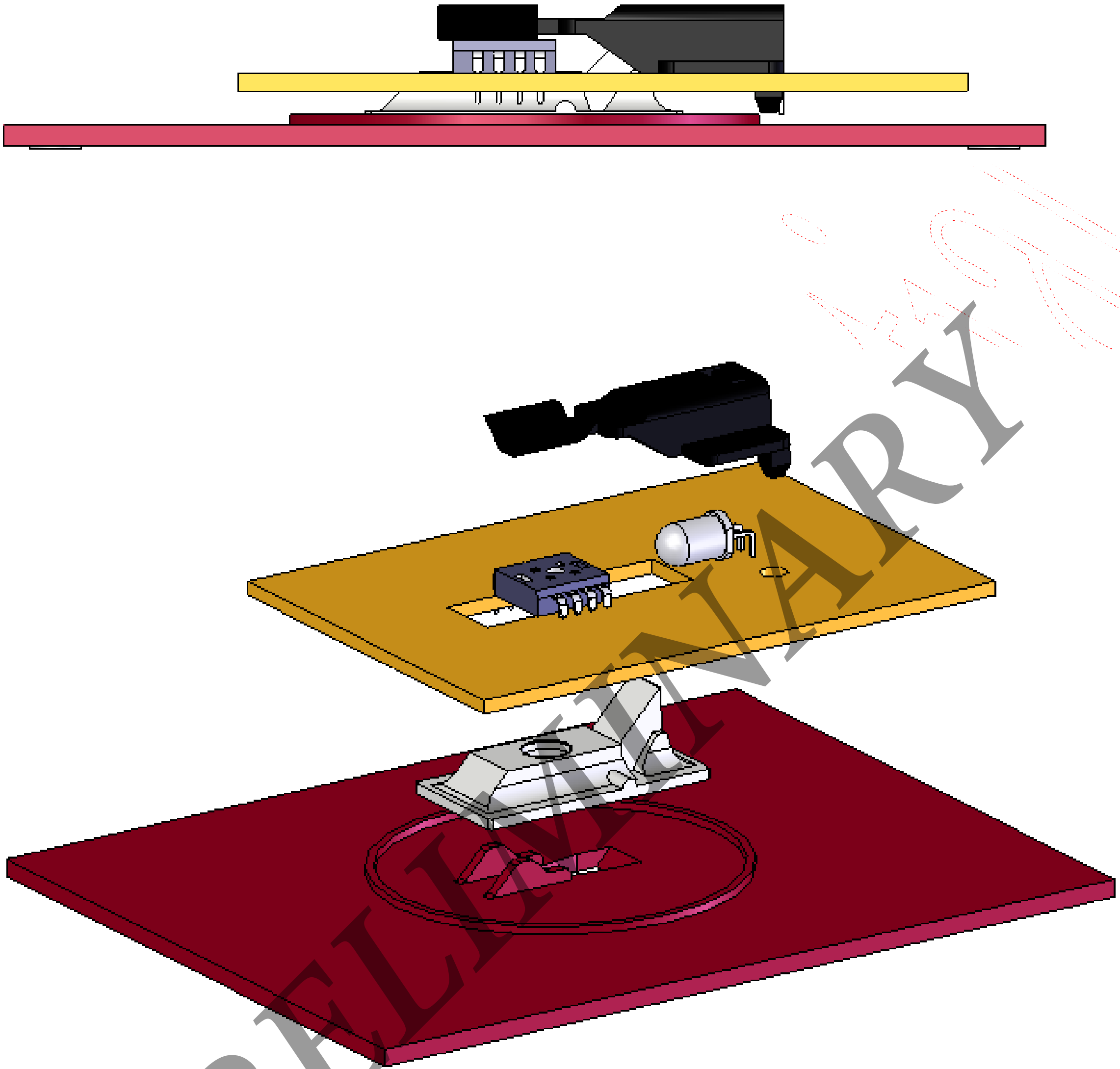

Figure 6. 3D Assembly for Mounting Instructions

6. Serial Interface

The synchronous serial port is used to set and read parameters in the mouse sensor.

SCLK: The serial clock line. It is always generated by the mouse controller.

SDIO: The serial data line is used to write and read data.

6.1 Transmission Protocol

The transmission protocol is a two-wire link, half duplex protocol between the micro-controller and the mouse sensor. All data changes on SDIO are initiated by the falling edge on SCLK. The mouse controller always initiates communication; the mouse sensor never initiates data transfers.

The transmission protocol consists of the two operation modes:

- Write Operation.
- Read Operation.

Both of the two operation modes consist of two bytes. The first byte contains the address (seven bits) and has a bit 7 as its MSB to indicate data direction. The second byte contains the data.

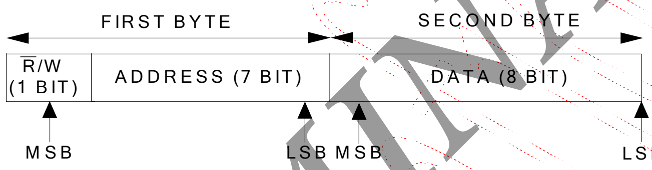

Figure 7. Transmission Protocol

6.1.1 Write Operation

A write operation, which means that data is going from the mouse controller to the mouse sensor, is always initiated by the mouse controller and consists of two bytes. The first byte contains the address (seven bits) and has a "1" as its MSB to indicate data direction. The second byte contains the data. The transfer is synchronized by SCLK. The mouse controller changes SDIO on falling edges of SCLK. The mouse sensor reads SDIO on rising edges of SCLK.

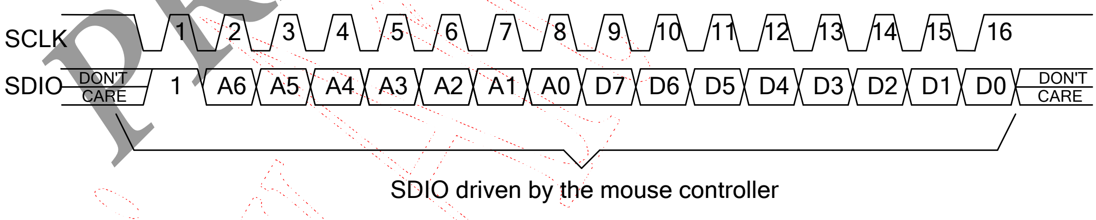

Figure 8. Write Operation

6.1.2 Read Operation

A read operation, which means that data is going from the mouse sensor to the mouse controller, is always initiated by the mouse controller and consists of two bytes. The first byte contains the address, is written by the mouse controller, and has a "0" as its MSB to indicate data direction. The second byte contains the data and is driven by the mouse sensor. The transfer is synchronized by SCLK. SDIO is changed on falling edges of SCLK and read on every rising edge of SCLK. The mouse controller must go to a high Z state after the last address data bit. The mouse sensor will go to the high Z state after the last data bit.

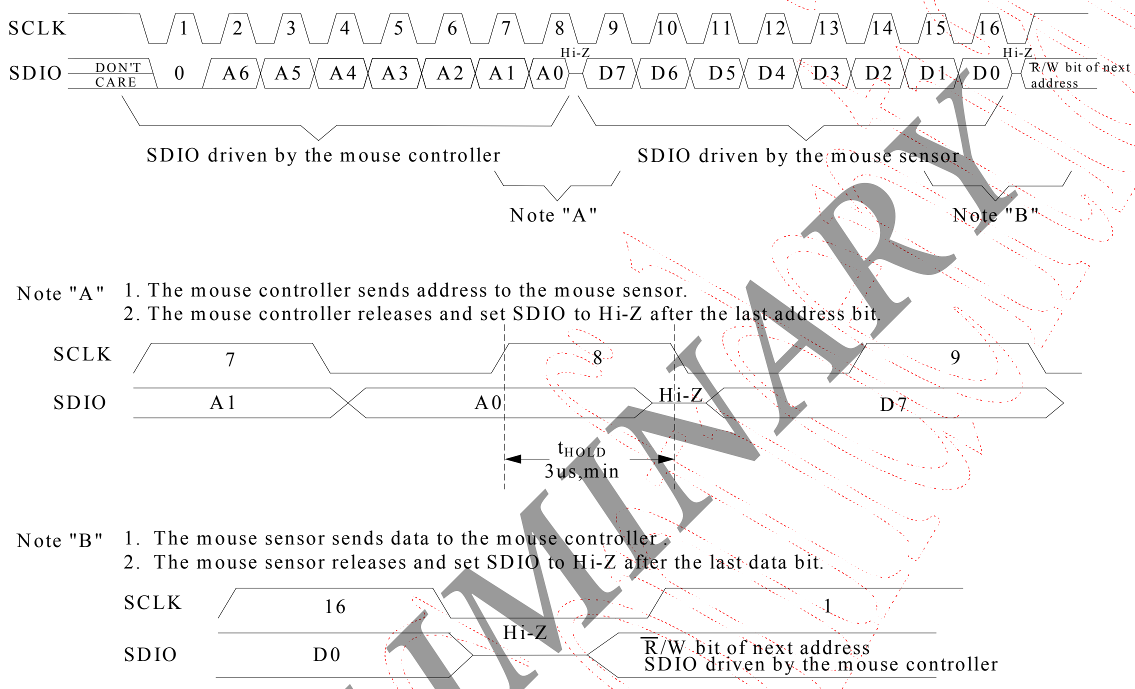

Figure 9. Read Operation

6.2 Re-Synchronous Serial Interface

If the mouse controller and the mouse sensor get out of synchronization, then the data either written or read from the registers will be incorrect. In such a case, an easy way to solve this condition is to toggle the SCLK line from high to low for least t_{RESYNC}, and then MUST toggle it from low to high to wait at least t_{SIWTT} to reach re-synchronous the serial port. This method is called by "watchdog timer timeout". The mouse sensor will reset the serial port without resetting the registers and be prepared for the beginning of a new transmission.

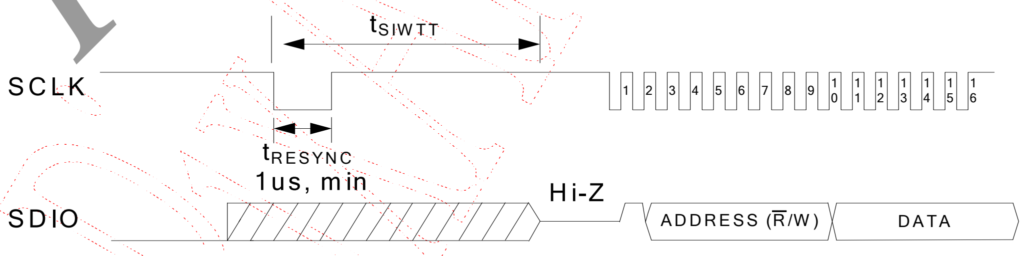

Figure 10. Re-synchronous Serial Interface Using Watchdog Timer Timeout

Note that this function is disabled when the mouse sensor is in the power down mode. If the user uses this function during the power down mode, it will get out of synchronization. The mouse sensor and the mouse controller also might get out of synchronization due to following conditions.

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- Power On Problem - The problem occurs if the mouse sensor powers up before the mouse controller sets the SCLK and SDIO lines to be output. The mouse sensor and the mouse controller might get out of synchronization due to power on problem. An easy way to solve this is to use "watchdog timer timeout".
- ESD Events - The mouse sensor and the mouse controller might get out of synchronization due to ESD events. An easy way to solve this is to use "watchdog timer timeout".

6.3 Collision Detection on SDIO

The only time that the mouse sensor drives the SDIO line is during a READ operation. To avoid data collisions, the mouse controller should release SDIO before the falling edge of SCLK after the last address bit. The mouse sensor begins to drive SDIO after the next falling edge of SCLK. The mouse sensor releases SDIO of the rising SCLK edge after the last data bit. The mouse controller can begin driving SDIO any time after that. In order to maintain low power consumption in normal operation or when the PD pin is pulled high, the mouse controller should not leave SDIO floating until the next transmission (although that will not cause any communication difficulties).

6.4 Power Down Mode

The mouse sensor can be placed in a power-down mode by setting ***PD_enh*** bit in the ***Configuration*** register via a serial port write operation. After setting the ***Configuration*** register, wait at most 2 frames times. To get the chip out of the power down mode, clear ***PD_enh*** bit in the ***Configuration*** register via a serial port write operation. In the power down mode, the serial interface watchdog timer (see Section 6.2) is not available. But, the serial interface still can read/write normally. For an accurate report after leave the power down mode, wait about 3ms before the mouse controller is able to issue any write/read operation to the mouse sensor.

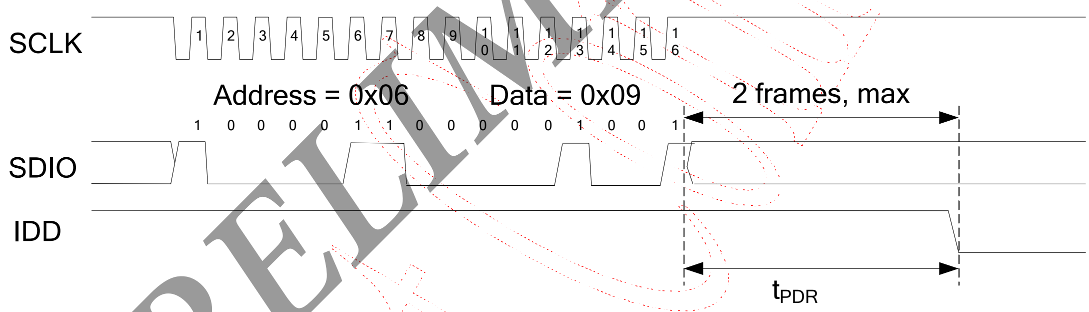

Figure 11. Power-down Configuration Register Writing Operation

6.5 Error Detection

1. The mouse controller can verify success of write operations by issuing a read command to the same address and comparing written data to read data.
2. The mouse controller can verify the synchronization of the serial port by periodically reading the product ID register

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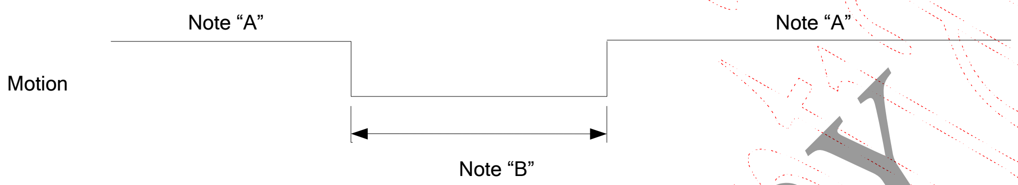
7. MOTSWK function

7.1 Motion function

To use Motion function, the ***Mot0Swk1*** bit in the ***Configuration*** register must be set to zero. Motion is used to monitor if the mouse sensor data is clear. If motion data are not clear, MOTSWK pin level will remain low. After the mouse controller reads all motion data from the mouse sensor, the mouse sensor will set MOTSWK pin level to high.



Note "A": Motion data is clear.
Note "B": Motion data is not clear. Register 3, 4 may be queued non-zero data

Figure 12. Motion function

7.2 SWKINT function

To use SWKINT function, the ***Mot0Swk1*** bit in the ***Configuration*** register must be set to one. SWKINT works when the mouse sensor is in the sleep mode and the mouse controller is also in the sleep mode. If the mouse sensor detects any motion occurrence at this moment, the mouse sensor will wake the mouse controller up promptly via MOTSWK pin. The mouse sensor will trigger the mouse controller at the rising/falling edge of MOTSWK pin.

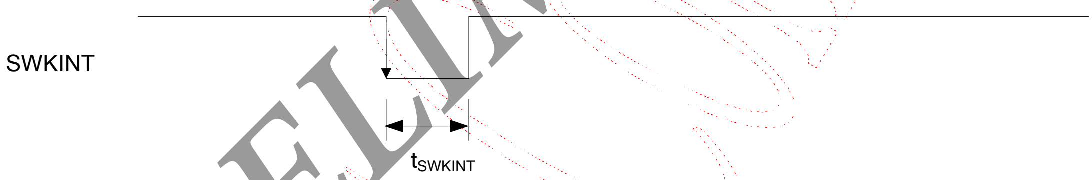


Figure 13. SWKINT function

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8. Referencing Application Circuit

8.1 Power 2.7V Application Circuit (with Red LED, 2.4GHz Transceiver)

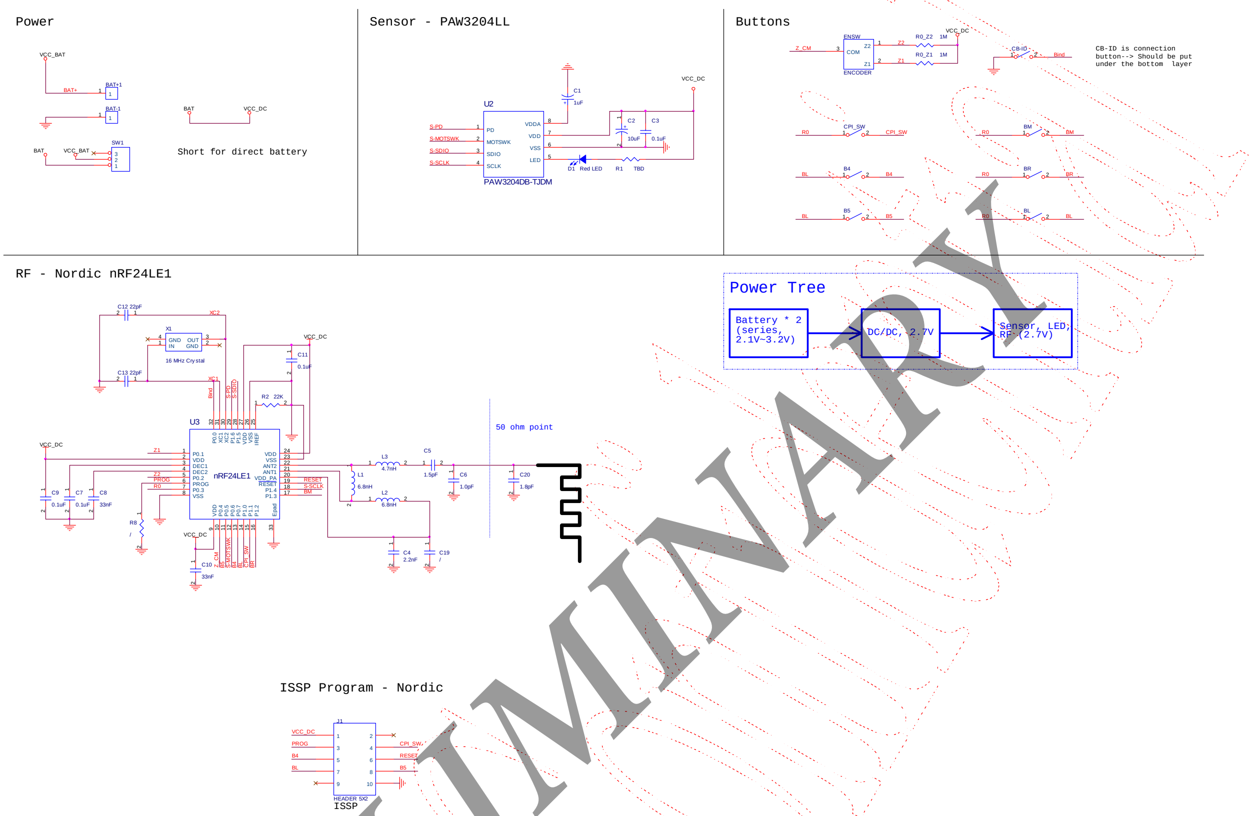

Figure 14. Application Circuit for 2.7V, (with Red LED)

8.2 PCB Layout Consideration

- Caps for pins7, 8 must have trace lengths less than **5mm**.

8.3 Recommended Value for R1

8.3.1 Using Red LED for 2.7V

- Radiometric intensity of LED

  Bin limits (mW/Sr at 20mA). Recommended using Everlight 7343USRC/S1029-1 LED.

LED Bin Grade	Min.	Typ.	Max.
Q	21.2	-	25.4

Note: Tolerance for each bin will be ± 15%

Suggested R1(ohm):

LED Bin Grade	Min.	Typ.	Max.
Q	TBD	TBD	TBD

8.3.2 Summary

Light Source	LED Bin Grade	V_{LED}	R1		
			Min.	Typ.	Max.
Red LED	Q	2.7	TBD	TBD	TBD

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9. Optical Criterion

9.1 Recommended Red LED Angle Criterion

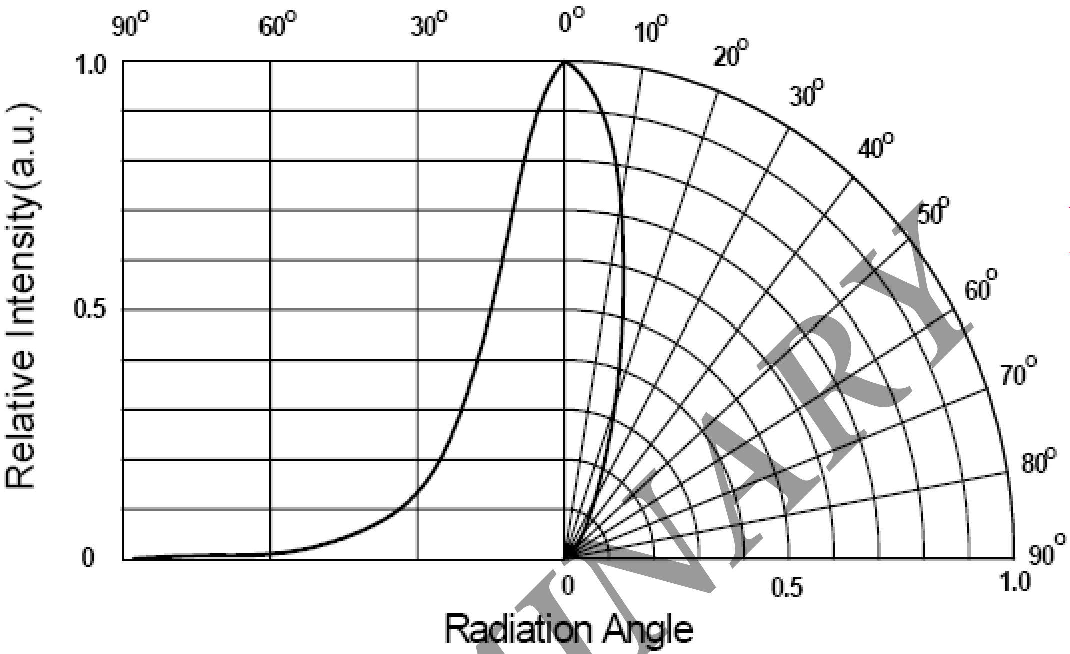

Figure 15. Radiation Characteristics

LED Viewing Angle	Min.	Typ.	Max.
$2\theta_{1/2}$	24	30	36

- Recommended using Chang-Yu LED goniophotometer V110 to measure the LED viewing angle.

9.2 Recommended Value for Optical Power

- In order to balance tracking performance of PAW3204DB-TJDM and lower power consumption of LED, PixArt recommended a value for optical power. The power MUST fit in the following table by adjusting R1 value when LED source is not recommended one. Optical power is measured from base plate rectangle hole with LED in DC mode. (Please see optical power measurement method AP note). Recommended using ADCMT power meter 8230E to measure the optical power.

Parameter	Min.	Typ.	Max.	Unit
Optical Power	TBD	-	TBD	uW

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10. Package Information

10.1 Package Outline Drawing

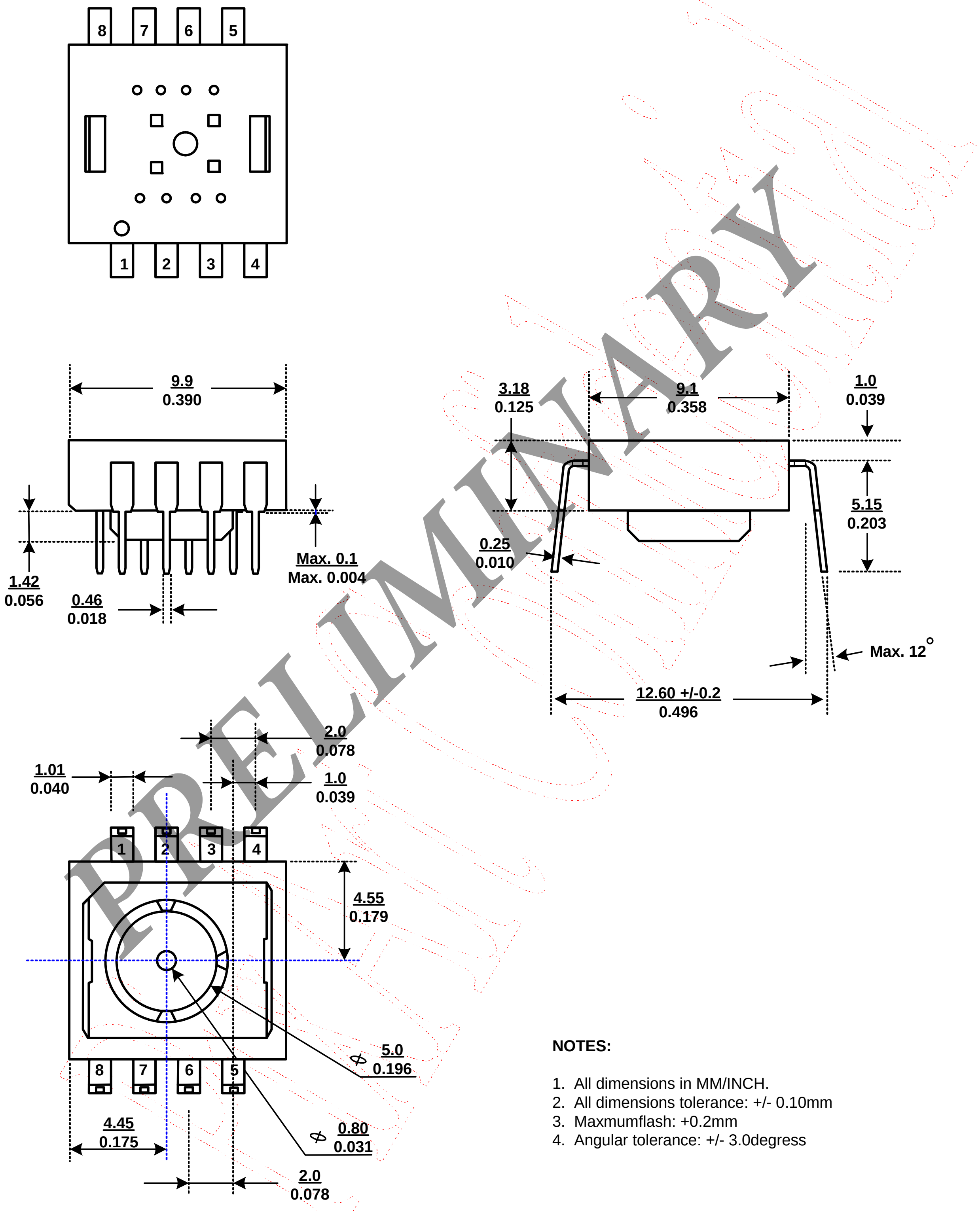

Figure 16. Package Outline Drawing

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10.2 Recommended PCB Mechanical Cutouts and Spacing

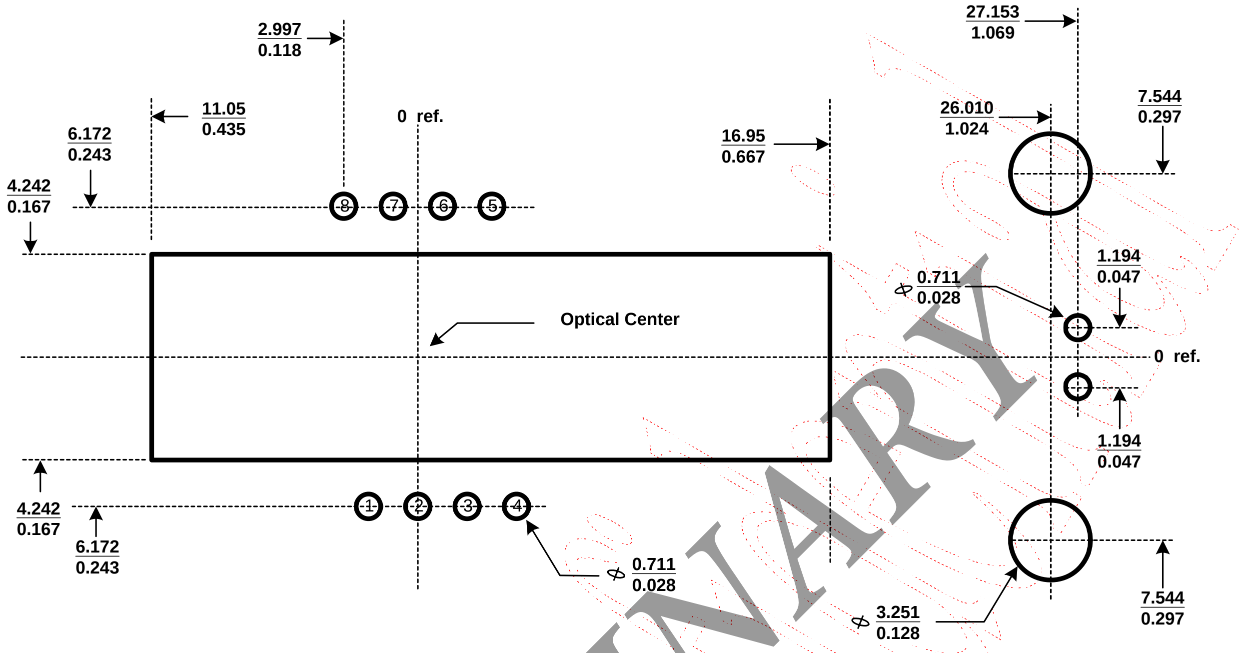

Figure 17. Recommended PCB Mechanical Cutouts and Spacing

11. Update History

Version	Update	Date
V0.1	Creation, Preliminary 1st version	01/20/2011

Note: The Part No. of the Mouse Product with Prefix "PAN" shall NOT be made, sold, offered to sell, imported or used in or into USA, Canada, Japan and EU. For "PAN", PixArt has only gained territory-limited patent license from Avago. Avago reserve right to take legal action against our customers who fails to comply the above term. PLEASE NOTE THAT PixArt will NOT defend, indemnify, or provide any assistance to our customers who fail to comply the term. IF YOU DO NOT AGREE THE TERM, PIXART WILL NOT DELIVER "PAN" PRODUCTS TO YOU.