PAW3601DH-NF Bundles Datasheet introduction

- **The PAW3601DH-NF sensor along with the PNLR-00038 lens and PNDR-00004 laser diode form a complete and compact laser mouse tracking system.**
- **High speed motion detection up to 28 inches/sec and acceleration can be up to 20g.**
- **This document will begin with some general information and usage guidelines on the bundle set.**

Part Number	Part Number Description
PAW3601DH-NF	CMOS Laser Mouse Sensor
PNDR-00004	Multi-Mode Vertical-Cavity Surface Emitting Laser (VCSEL)
PNLR-00038	Laser Mouse Rectangular Lens

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PAW3601DH-NF CMOS LASER MOUSE SENSOR

General Description

PAW3601DH-NF is a CMOS laser mouse sensor with DSP integration chip that serves as a non-mechanical motion estimation engine for implementing a computer mouse.

Features

- Single power supply
- Precise laser motion estimation technology
- Complete 2-D motion sensor
- No mechanical parts
- Accurate motion estimation over most of surfaces
- High speed motion detection up to 28 inches/sec and acceleration can be up to 20g
- High resolution up to 1600 cpi
- Power down pin and register setting for low power dissipation
- Power saving mode during times of no movement
- Serial Interface for programming and data transfer
- Low power for wireless application
- No fly on the air

Key Specification

Power Supply	4.25V ~ 5.5V (VDD) 3.0V ~ 3.6V (VDDD, VDDA)
System Clock	27 MHz
Speed	28+ inches/sec
Acceleration	20g
Resolution	800/1600 cpi
Frame Rate	6600 frames/sec
Operating Current	< 18 mA @Mouse moving (Normal) < 8 mA @Mouse not moving (Sleep) < 200 uA @Shutdown mode
Package	Shrunk DIP20

Ordering Information

Order number	I/O	Resolution
PAW3601DH-NF	CMOS output	800/1600 cpi

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1. Pin Configuration

1.1 Pin Description

Pin No.	Name	Type	Definition
1	VSS_LD	GND	LD ground
2	LD	OUT	LD control
3	OSCOUT	OUT	Resonator output
4	OSCIN	IN	Resonator input
5	VDDD	PWR	Chip digital power, 3.3V
6	VSSD	GND	Chip digital ground
7	VSSA	GND	Chip analog ground
8	VDD	PWR	Chip power, 5V power supply
9	VDDA	PWR	Chip analog power, 3.3V
10	NC	-	No connection
11	YA	OUT	YA quadrature output
12	YB	OUT	YB quadrature output
13	XA	OUT	XA quadrature output
14	XB	OUT	XB quadrature output
15	NC	-	No connection
16	NC	-	No connection
17	CPI	IN	CPI IO trap select pin Pull-high to VCC (3.3V or 5.0V): 800 cpi Pull-low to GND: 1600 cpi
18	SCLK	IN	Serial interface clock
19	SDIO	I/O	Serial interface bi-direction data
20	PD	IN	Power down pin, active high

1.2 Pin Assignment

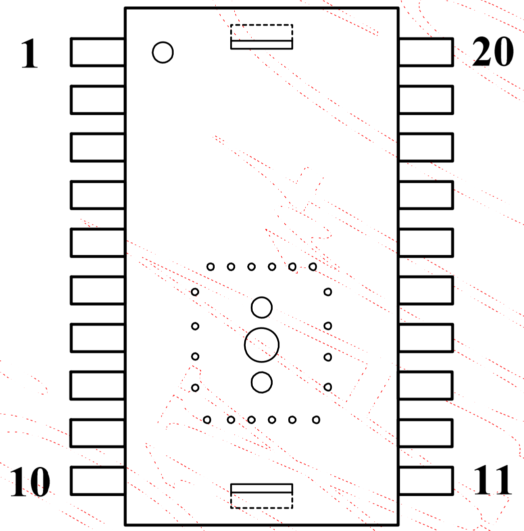

Figure 1. Top View Pinout

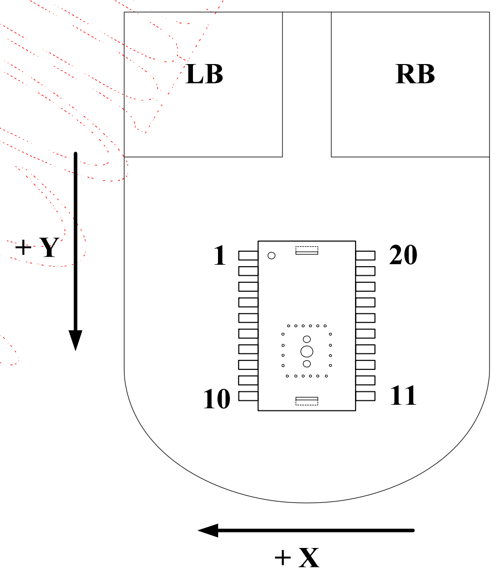

Figure 2. Top View of Mouse

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2. Block Diagram and Operation

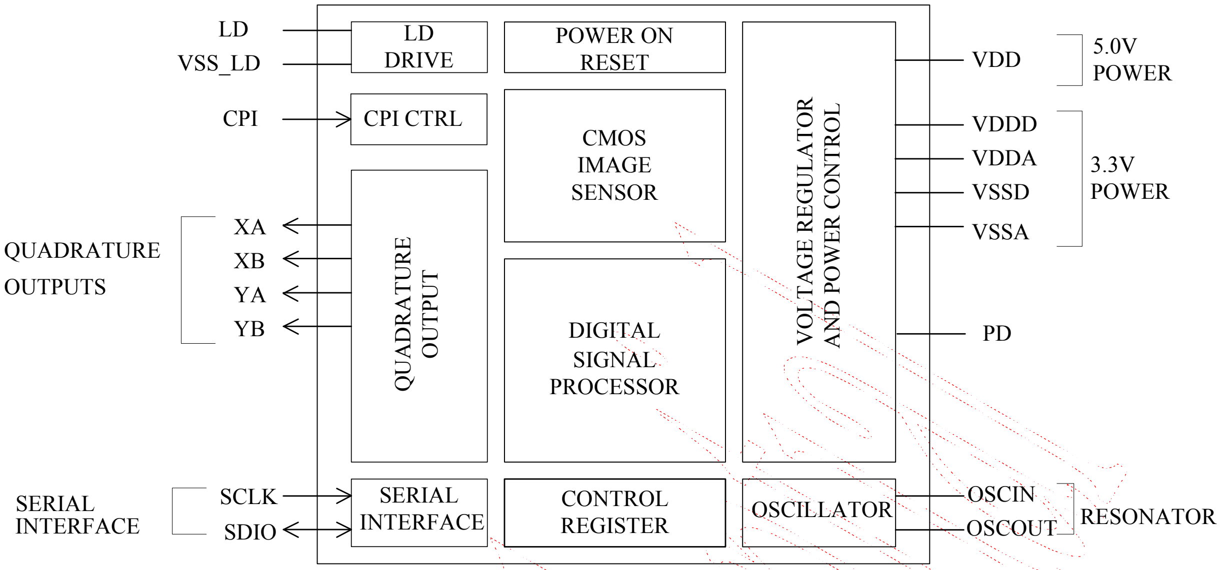

Figure 3. Block Diagram

In the traditional optical mouse, it uses LED as a light source. The light illuminates on the working surface and generates the bright and dark shadow that shows the micro-texture of the surface. The imaging sensor in the optical mouse chip captures sequential this micro-texture images of the working surface. Based on the captured images, the optical chip can determine the speed and direction when the optical mouse is moving. Thus, for the more rough surface, the more obvious shadow image will be generated and much easier to determine the movement and direction.

The PAW3601DH-NF is a CMOS laser mouse sensor with DSP integration chip that serves as a non-mechanical motion estimation engine for implementing a computer mouse. It is based on new laser speckle navigation technology. In the laser mouse, it uses laser diode (LD), specially uses VCSEL (Vertical Cavity Surface Emitting Laser) as light source, where laser is one kind of coherent light. When this light illuminates on the working surface, the surface will reflect and diffuse the incident light and generates speckle pattern. The imaging sensor in the laser mouse chip detects the speckle pattern that generated from the working surface and determines the movement and direction. Since the speckle pattern can be generated on the most of the surface if this surface is not perfect smooth or transparent, the laser mouse can adapt on more surfaces as compared with traditional LED-based optical mouse. The mouse sensor is in a 20-pin optical package. The output format is two-channel quadrature (X and Y direction), which emulates encoder phototransistors. The current X and Y information are also available in registers accessed via a serial port. The word "mouse sensor," instead of PAW3601DH-NF, is used in the document.

3. Registers and Operation

The PAW3601DH-NF can be programmed through registers, via the serial port, and 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	0x0N	Four bits [3:0] number with the product identifier Reserved[3:0] number is reserved for further
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	-	Bit field
0x06	Configuration	R/W	-	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 change. It can be used to verify that the serial communications link is OK.							

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

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0x02	Motion_Status							
Bit	7	6	5	4	3	2	1	0
Field	Motion	Reserved[3:2]		DYOVF	DXOVF	Reserved[1:0]		RES
Usage	Register 0x02 allows the user to determine if motion has occurred since the last time it was read. If so, then the user should read registers 0x03 and 0x04 to get the accumulated motion. It also tells 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
	Field Name	**Description**
	Motion	Motion since last report or PD **0 = No motion (Default)** 1 = Motion occurred, data ready for reading in ***Delta_X*** and ***Delta_Y*** registers
	Reserved[3:2]	Reserved for future use
	DYOVF	Motion Delta Y overflow, ΔY buffer has overflowed since last report **0 = No overflow (Default)** 1 = Overflow has occurred
	DXOVF	Motion Delta X overflow, ΔX buffer has overflowed since last report **0 = No overflow (Default)** 1 = Overflow has occurred
	Reserved[1:0]	Reserved for future use
	RES	Resolution in counts per inch 0 = 1600 1 = 800

0x03	Delta_X							
Bit	7	6	5	4	3	2	1	0
Field	X7	X6	X5	X4	X3	X2	X1	X0
Usage	X movement is counts since last report. Absolute value is determined by resolution. Reading clears the register. Report range –128 ~ +127.							

0x04	Delta_Y							
Bit	7	6	5	4	3	2	1	0
Field	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0
Usage	Y movement is counts since last report. Absolute value is determined by resolution. Reading clears the register. Report range –128 ~ +127.							

0x05	**Operation_Mode**							
Bit	7	6	5	4	3	2	1	0
Field	LDsht_enh	XY_enh	Reserved	Slp_enh	Slp2au	Slp2mu	Slp1mu	Wakeup

Usage

Register 0x05 allows the user to change the operation of the mouse sensor. Shown below are the bits, their default values, and optional values.

Operation_Mode[4:0]
"0xxxx" = Disable sleep mode
"10xxx" = Enable sleep mode[1]
"11xxx" = Enable sleep mode[2]
"1x100" = Force enter sleep2[3]
"1x010" = Force enter sleep1[3]
"1x001" = Force wakeup from sleep mode[3]

Notes:

1. Enable sleep mode, but disable automatic entering sleep2 mode, that is, only 2 modes will be used, normal mode and sleep1 mode. After 0.45 sec not moving during normal mode, the mouse sensor will enter sleep1 mode, and keep on sleep1 mode until moving is detected or wakeup is asserted.
2. Enable sleep mode full function, that is 3 modes will be used, normal mode, sleep1 mode and sleep2 mode. After 0.45 sec not moving during normal mode, the mouse sensor will enter sleep1 mode, and keep on sleep1 mode until moving is detected or wakeup is asserted.

   And after 27.3 sec not moving during sleep1 mode, the chip will enter sleep2 mode, and keep on sleep2 mode until detect moving or force wakeup to normal mode.

Mode	Sampling rate @6600 frame/sec	Active duty cycle @6600 frame/sec
Sleep1	206/sec	22%
Sleep2	6.43/sec	2.25%

3. Only one of these three bits slp2mu_enh, slp1mu_enh, and wakeup can be set to 1 at the same time, others have to be set to 0. After a period of time, the bit, which was set to 1, will be reset to 0 by internal signal.

Notes

Field Name	**Description**
LDsht_enh	LD shutter enable/disable 0 = Disable **1 = Enable (Default)**
XY_enh	XY quadrature output enable/disable 0 = Disable **1 = Enable (Default)**
Reserved	Reserved for future use
Slp_enh	Sleep mode enable/disable 0 = Disable **1 = Enable (Default)**
Slp2au	Automatic enter sleep2 mode enable/disable **0 = Disable (Default)** 1 = Enable
Slp2mu	Manual enter sleep2 mode, set "1" will enter sleep2 and this bit will be reset to "0"
Slp1mu	Manual enter sleep1 mode, set "1" will enter sleep1 and this bit will be reset to "0"
Wakeup	Manual wake up from sleep mode, set "1" will enter wakeup and this bit will be reset to "0"

<table>
<tr><th>0x06</th><th colspan="8">Configuration</th></tr>
<tr><td>Bit</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Field</td><td colspan="4">Reserved[5:2]</td><td>PD_enh</td><td colspan="2">Reserved[1:0]</td><td>RES</td></tr>
<tr><td>Usage</td><td colspan="8">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.</td></tr>
<tr><td rowspan="5">Notes</td><td colspan="2">Field Name</td><td colspan="6">Description</td></tr>
<tr><td colspan="2">Reserved[5:2]</td><td colspan="6">Reserved for future use</td></tr>
<tr><td colspan="2">PD_enh</td><td colspan="6">Power down mode
0 = Normal operation (Default)
1 = Power down mode</td></tr>
<tr><td colspan="2">Reserved[1:0]</td><td colspan="6">Reserved for future use. Must be written to “00”</td></tr>
<tr><td colspan="2">RES</td><td colspan="6">Output resolution setting. In the power-on initial state, the resolution is depend on the CPI IO trap select pin. If the mouse controller writes the register, it is depend on the register value.
0 = 1600
1 = 800</td></tr>
</table>

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	
	Lead Solder Temp		260	°C	For 10 seconds, 1.6mm below seating plane.
V_{DC}	DC Supply Voltage	-0.5	V_{DD} + 0.5 (V_{DDA}, V_{DDD}) + 0.3	V	
V_{IN}	DC Input Voltage	-0.5	V_{DD} + 0.5 (V_{DDA}, V_{DDD}) + 0.3	V	PD, SDIO, SCLK, XA, XB, YA, YB,VDD
ESD			2	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_{DD}	Power Supply Voltage	4.25	5.0	5.5	V	
VDDD,VDDA	Power Supply Voltage	3.0	3.3	3.6	V	
V_N	Supply Noise			100	mV	Peak to peak within 0 - 100 MHz
SCLK	Serial Port Clock Frequency			10	MHz	
Z	Distance from Lens Reference Plane to Surface	2.3	2.4	2.5	mm	
R	Resolution		800	1600	cpi	
A	Acceleration			20	g	
F_{CLK}	Clock Frequency	18.000	27.000	27.245	MHz	Set by ceramic resonator
FR	Frame Rate	4400	6600	6650	frames/sec	4400 frames/sec @ F_{CLK} = 18.000 MHz 6600 frames/sec @ F_{CLK} = 27.000 MHz 6650 frames/sec @ F_{CLK} = 27.245 MHz
S	Speed			18.7 28.0 28.2	inches/sec	18.7 inches/sec@ F_{CLK} = 18.000 MHz 28.0 inches/sec@ F_{CLK} = 27.000 MHz 28.2 inches/sec@ F_{CLK} = 27.245 MHz

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4.3 AC Operating Condition

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, V_{DD} = 5.0 V, F_{CLK} = 27.000 MHz

Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
t_{PD}	Power Down		500		us	From PD↑ (refer to Figure 15)
t_{PDW}	PD Pulse Width	700			us	Pulse width to reset the serial interface (refer to Figure 15).
t_{PDR}	PD Pulse Register			152	us	One frame time maximum after setting bit 3 in the Configuration register (refer to Figure 17).
t_{PUPD}	Power Up from PD↓	8		14.15	ms	From PD↓ to valid quad signals. After t_{PUPD}, all registers contain valid data from first image after PD↓. Note that an additional 90 frames for Auto-Exposure (AE) stabilization may be required if mouse movement occurred while PD was high. (refer to Figure 15)
t_{PU}	Power Up from V_{DD}↑	8		14.15	ms	From V_{DD}↑ to valid quad signals.
t_{HOLD}	SDIO Read Hold Time		3		us	Minimum hold time for valid data (refer to Figure 11).
t_{RESYNC}	Serial Interface RESYNC.	1			us	Refer to Figure 13.
t_{SIWTT}	Serial Interface Watchdog Timer Timeout	1.7			ms	Refer to Figure 13.
t_r , t_f	Rise and Fall Times: SDIO		25, 20		ns	C_L = 30 pf
t_r , t_f	Rise and Fall Times: XA, XB, YA, YB		25, 20		ns	C_L = 30 pf
t_r , t_f	Rise and Fall Times: ILD		60, 10		ns	

4.4 DC Electrical Characteristics

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, V_{DD} = 5.0 V, F_{CLK} = 27.000 MHz

Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
Type: PWR						
I_{DD}	Supply Current Mouse Moving (Normal)		18		mA	XA, XB, YA, YB, SCLK, SDIO = no load
I_{DD}	Supply Current Mouse Not Moving (Sleep1)		8		mA	
I_{DDPD}	Supply Current (Power Down)		200		uA	PD, SCLK, SDIO = high
Type: SCLK, SDIO, PD						
V_{IH}	Input Voltage HIGH	2.0				
V_{IL}	Input Voltage LOW			0.7	V	
V_{OH}	Output Voltage HIGH	2.4			V	@I_{OH} = 2 mA (SDIO only)
V_{OL}	Output Voltage LOW			0.6	V	@I_{OL} = 2 mA (SDIO only)
Type: OSCIN						
V_{IH}	Input Voltage HIGH	2.0			V	When driving from an external source
V_{IL}	Input Voltage LOW			0.7	V	When driving from an external source
Type: LD						
V_{OL}	Output Voltage LOW			250	mV	@I_{OL} = 20 mA
Type: XA, XB, YA, YB						
V_{OH}	Output Voltage HIGH	2.4			V	@I_{OH} = 2 mA
V_{OL}	Output Voltage LOW			0.6	V	@I_{OL} = 2 mA

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5. 2D/3D Assembly

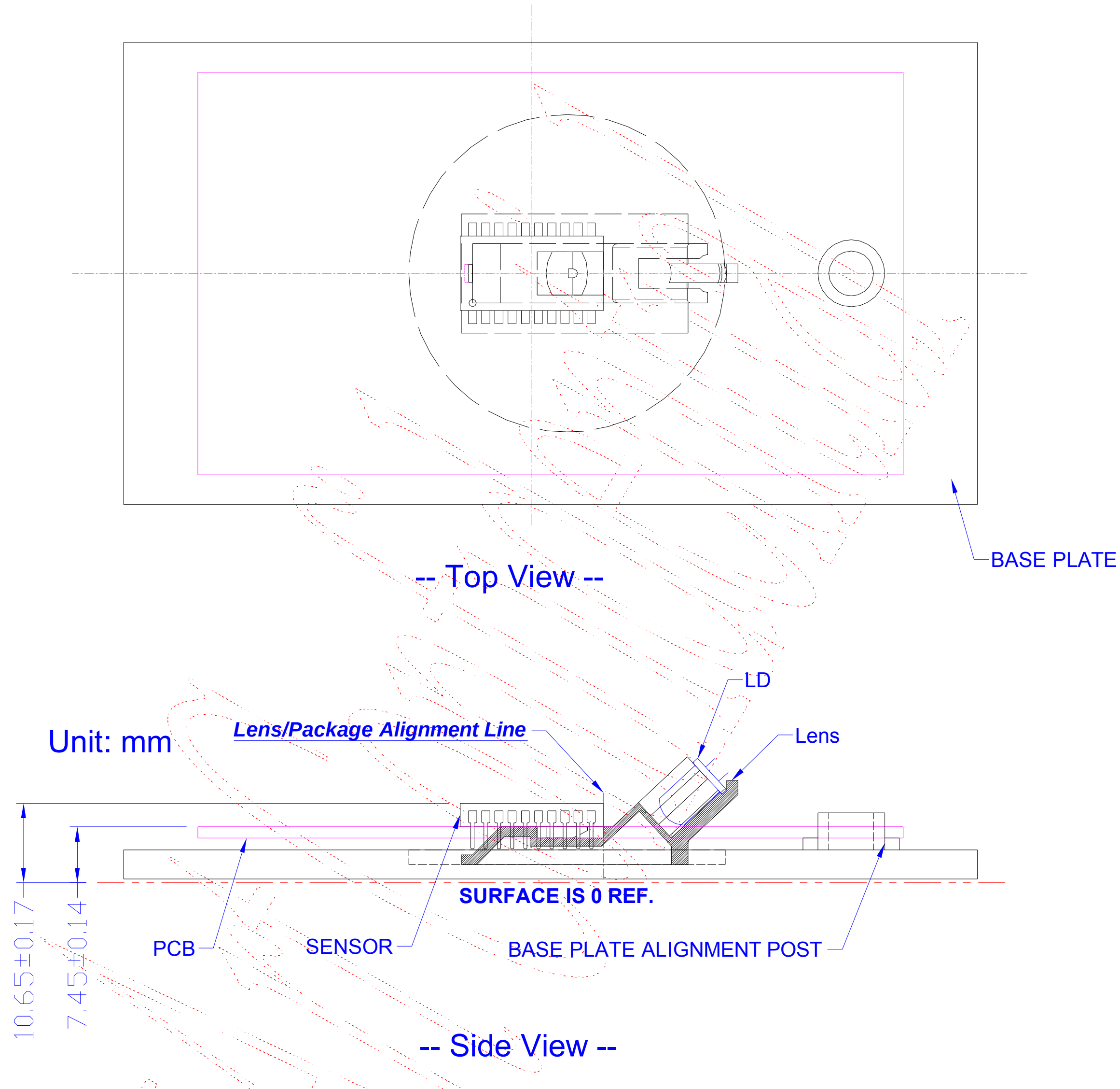
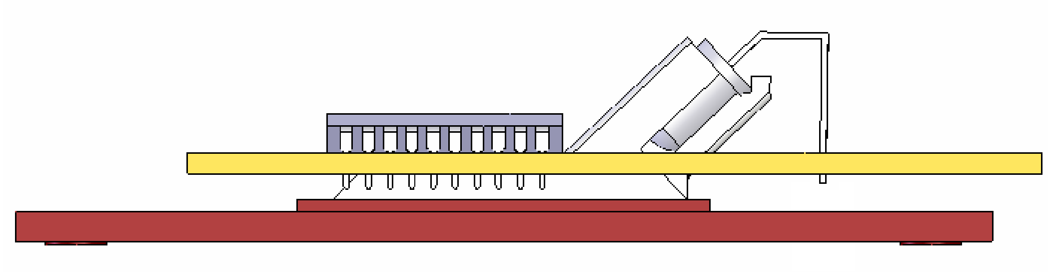


Figure 4. 2D Assembly



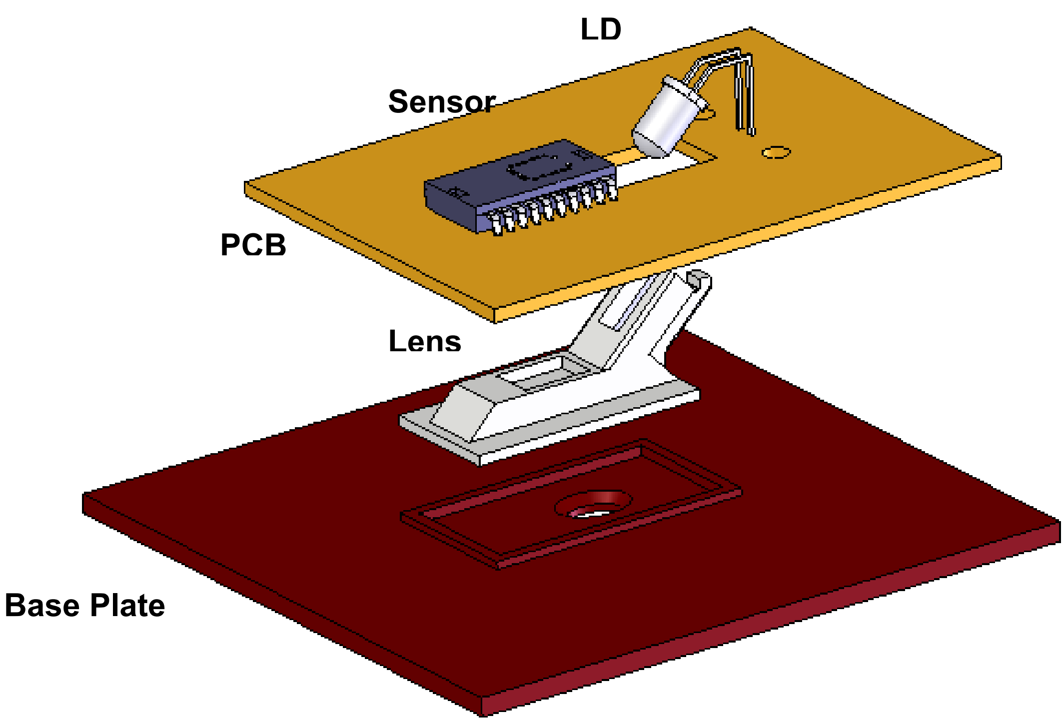


Figure 5. 3D Assembly for Mounting Instructions

6. Quadrature Mode

The quadrature state of the mouse sensor tells the mouse controller which direction the mouse is moving in. The output format is two channels quadrature (X and Y direction), which emulates encoder phototransistors. The DSP generates the Δx and Δy relative displacement values that are converted into two channel quadrature signals. The following diagrams show the timing for positive X motion, to the left or positive Y motion, down.

6.1 Quadrature Output Timing

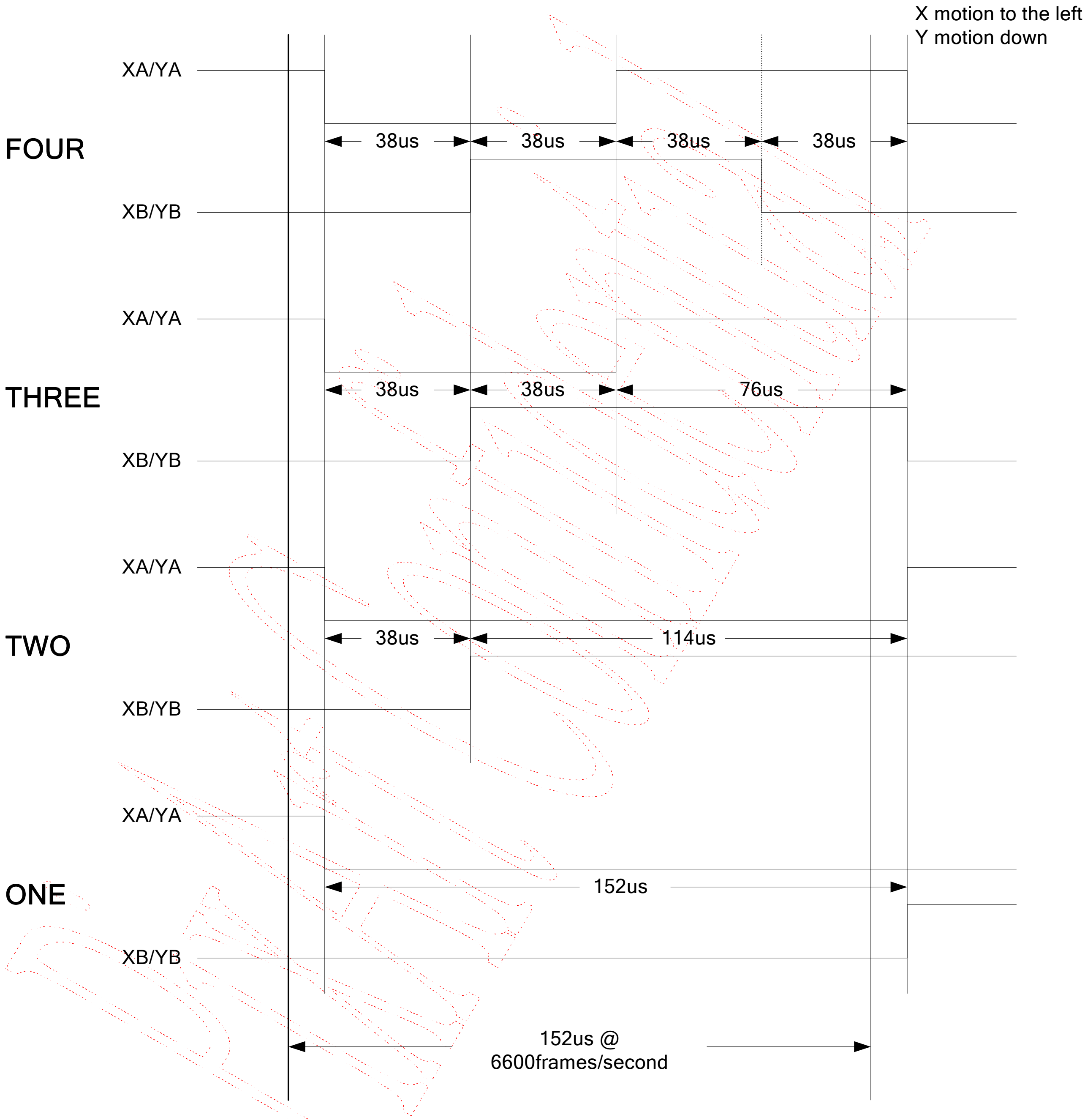
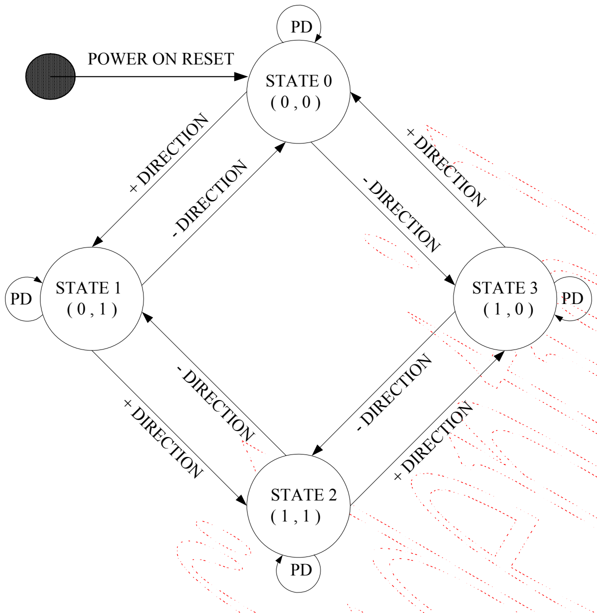


Figure 6. Quadrature Output Timing

6.2 Quadrature Output State Machine

The following state machine shows the states of the quadrature output pins. The three things to note are that state 0 is entered after a power on reset. While the PD pin is asserted, the state machine is halted. Once PD is de-asserted, the state machine picks up from where it left off. During times of mouse no movement will entry power saving mode, until mouse was moved.



STATE	X/Y output	
	XA/YA	XB/YB
0	0	0
1	0	1
2	1	1
3	1	0

Figure 7. State Machine

6.3 Quadrature Output Waveform

The following diagrams show the waveform of the two channel quadrature outputs. If the X, Y is motionless, the (XA, XB), (YA, YB) will keep in final state. Each state change (ex. STATE2 → STATE3) is one count.

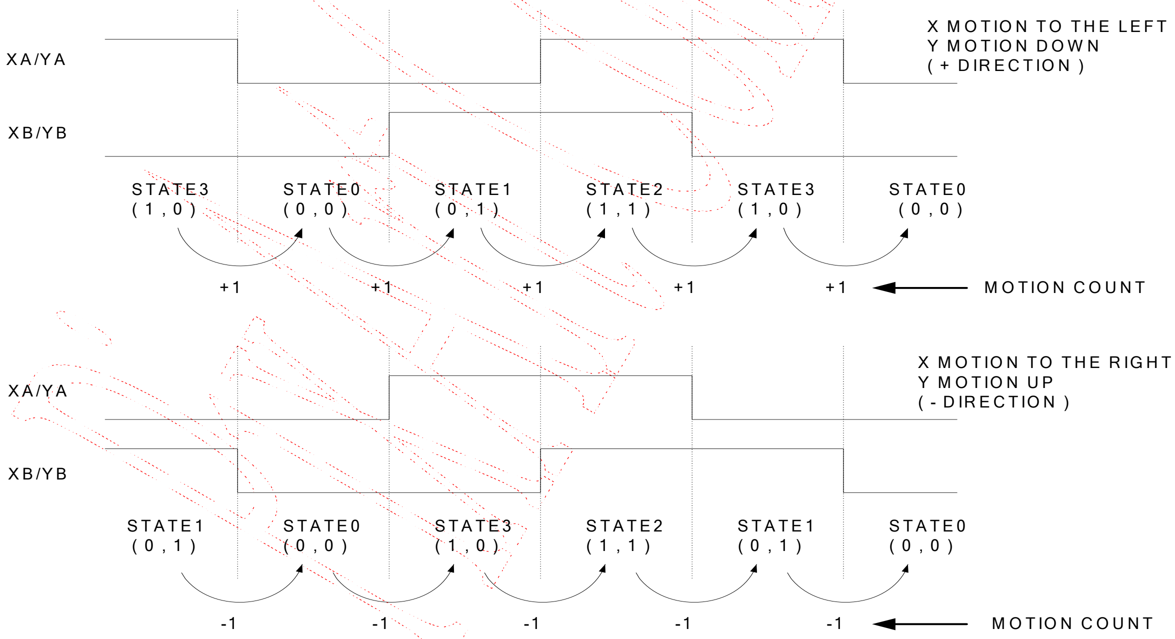


Figure 8. Quadrature Output Waveform

7. Serial Interface

The synchronous serial port is used to set and read parameters in the mouse sensor, and can be used to read out the motion information instead of the quadrature data pins.

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.

PD: A third line is sometimes involved. PD (Power Down pin) is usually used to place the mouse sensor in a low power mode to meet USB suspend specification. PD can also be used to force re-synchronization between the mouse controller and the mouse sensor in case of an error.

7.1 Transmission Protocol

The transmission protocol is a two-wire link, half duplex protocol between the mouse 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 bit7 as its MSB to indicate data direction. The second byte contains the data.

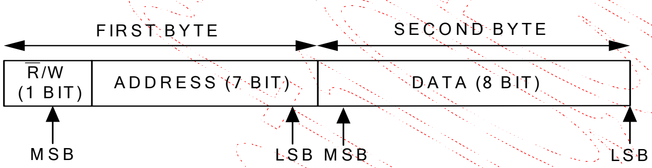


Figure 9. Transmission Protocol

7.1.1 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 micro controller changes SDIO on falling edges of SCLK. The mouse sensor reads SDIO on rising edges of SCLK.

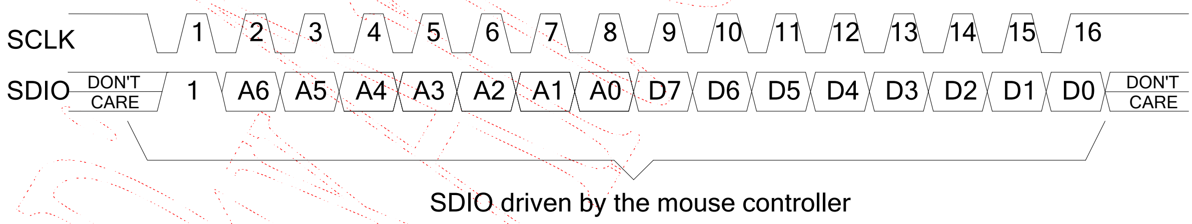


Figure10. Write Operation

7.1.2 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 micro 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.

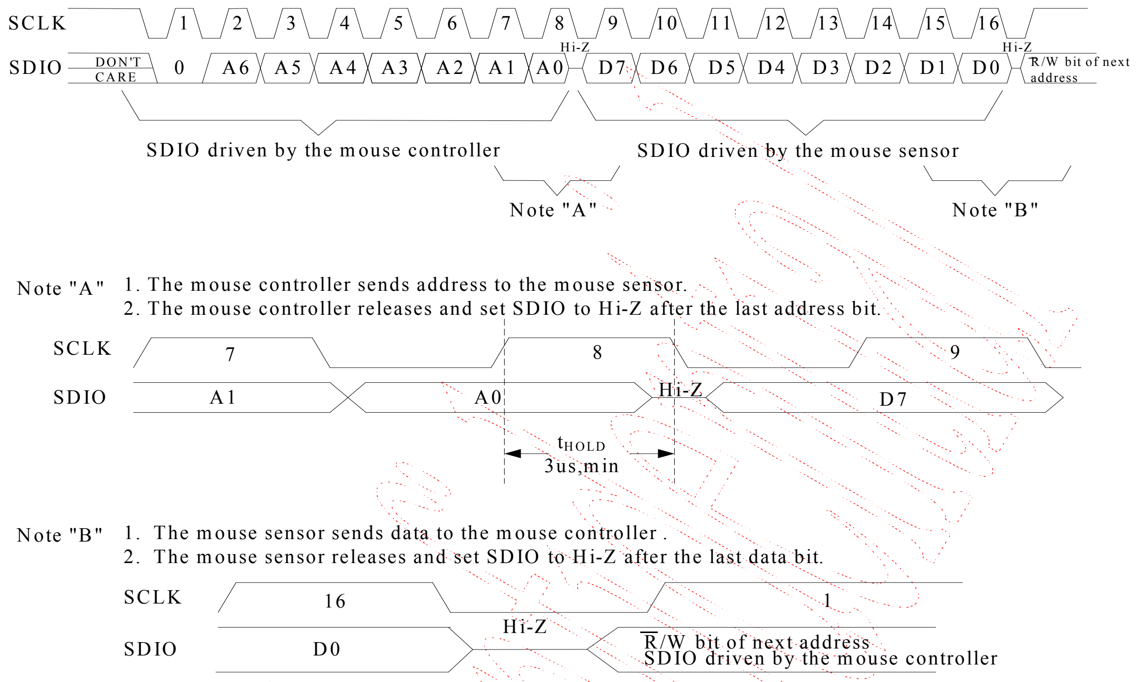


Figure 11. Read Operation

7.2 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. There are two different ways for re-synchronous serial interface.

- Re-synchronous serial interface using PD pin (see Section 7.2.1)
- Re-synchronous serial interface using watchdog timer timeout (see Section 7.2.2)

Note that "watchdog timer timeout" (see Section 7.2.2) 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.

- 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 raise PD pin (see Section 7.2.1) or use watchdog timer timeout (see Section 7.2.2) for re-synchronous serial interface.
- 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 raise PD pin (see Section 7.2.1) or use watchdog timer timeout (see Section 7.2.2) for re-synchronous serial interface.
- USB suspend - Termination of a transmission by the mouse controller may be required sometimes (for example, due to a USB suspend interrupt during a read operation). An easy way to solve this is to raise PD pin (see Section 7.2.1) or use watchdog timer timeout (see Section 7.2.2) for re-synchronous serial interface.

7.2.1 Re-Synchronous Serial Interface Using PD Pin

The mouse controller raises PD line to reach re-synchronous serial interface after an incorrect read. The mouse sensor will reset the serial port but will not reset the registers and be prepared for the beginning of a new transmission. Note that using "PD pin" to reach re-synchronous is quicker than using "watchdog timer timeout".

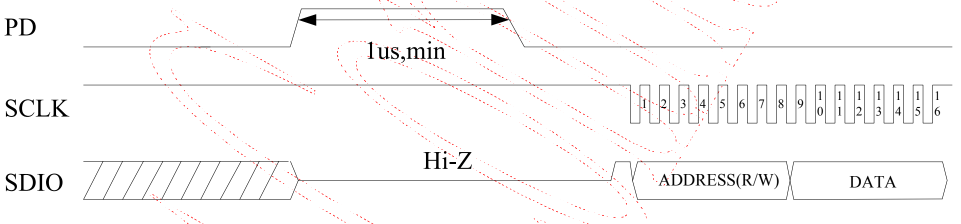


Figure 12. Re-synchronous Serial Interface Using PD Pin

7.2.2 Re-Synchronous Serial Interface Using Watchdog Timer Timeout

The mouse controller can toggle the SCLK line from high to low to high and wait at least t_{SIWTT} to reach re-synchronous serial interface after an incorrect read. The mouse sensor will reset the serial port but will not reset the registers and be prepared for the beginning of a new transmission.

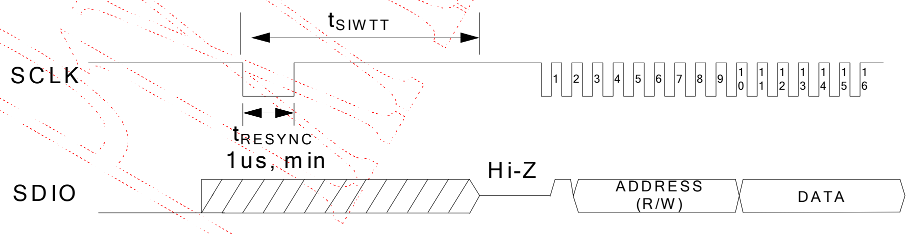


Figure 13. Re-synchronous Serial Interface Using Watchdog Timer Timeout

7.3 Full Chip Reset

To place the SDIO pin into the Hi-Z state, first raise the PD line, toggle the SCLK line from high to low to high and then fall the PD line. The mouse sensor will reset the serial port, the registers, and then be prepared for the beginning of a new transmission.

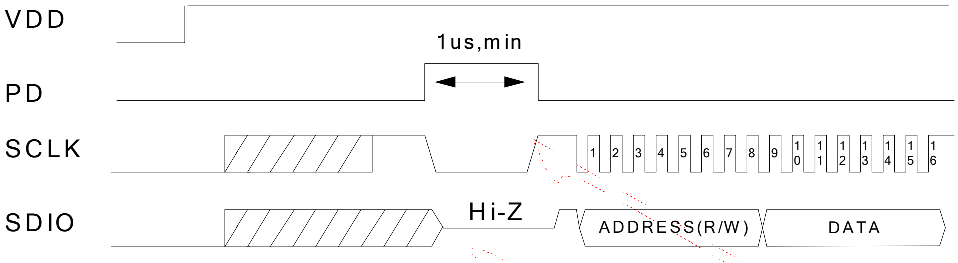


Figure 14. Soft Reset the Mouse Sensor (Reset Full Chip and SDIO Line Set to Hi-Z State)

7.4 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 release 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).

7.5 Power Down Mode

There are two different ways to entry power down mode, using the PD line (see Section 7.5.1) or register setting (see Section 7.5.2).

7.5.1 PD Line Power Down Mode

To place the mouse sensor in a low power mode to meet USB suspend specification, raises the PD line at least 700us. Then PD line can stay high, with the mouse sensor in the shutdown state, or the PD pin can be lowered, returning the mouse sensor to normal operation.

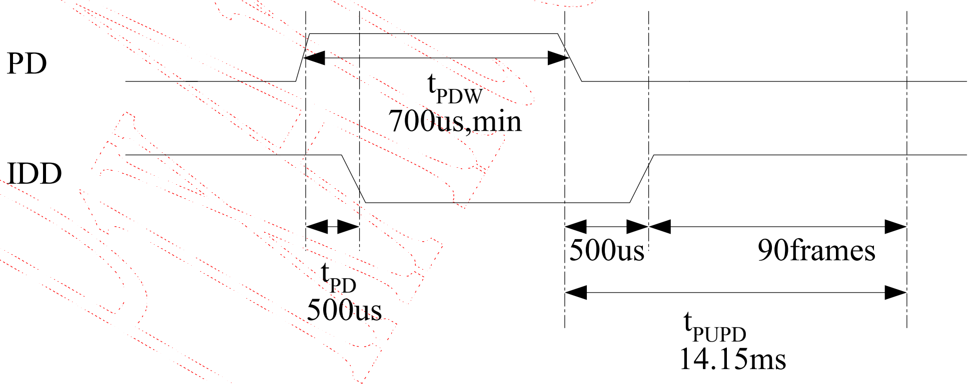


Figure 15. Power Down Minimum Pulse Width

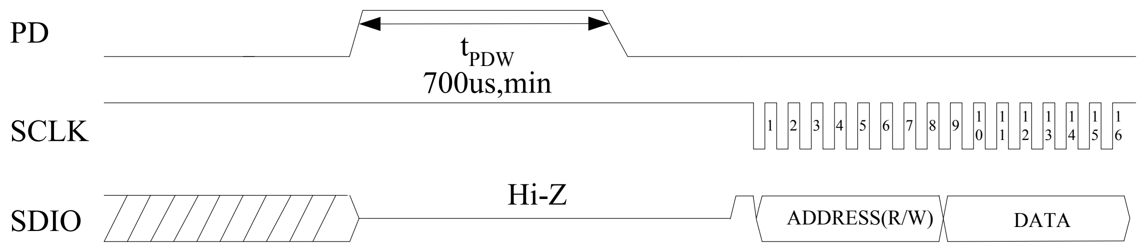


Figure 16. PD Line Power Down Mode

7.5.2 Register Power Down Mode

The mouse sensor can be placed in a power down mode by setting ***PD_enh*** bit (bit 3) in the ***configuration*** register via a serial port write operation. After setting the configuration register, wait at least 1frame times. To get the chip out of the power down mode, clear ***PD_enh*** bit (bit 3) in the ***configuration*** register via a serial port write operation. In the power down mode, the serial interface watchdog timer is not available (see Section 7.2.2). 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.

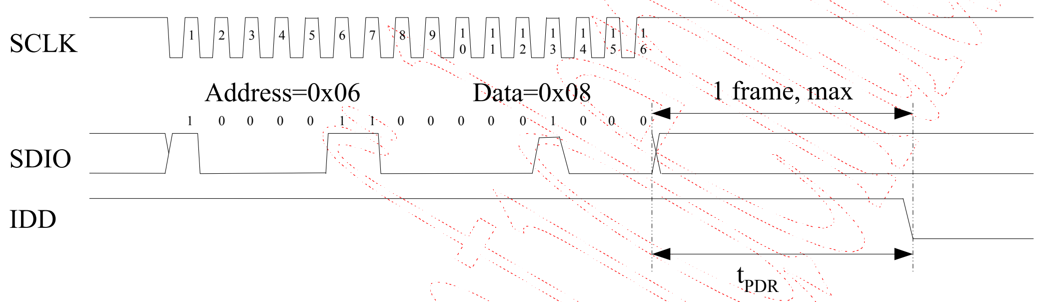


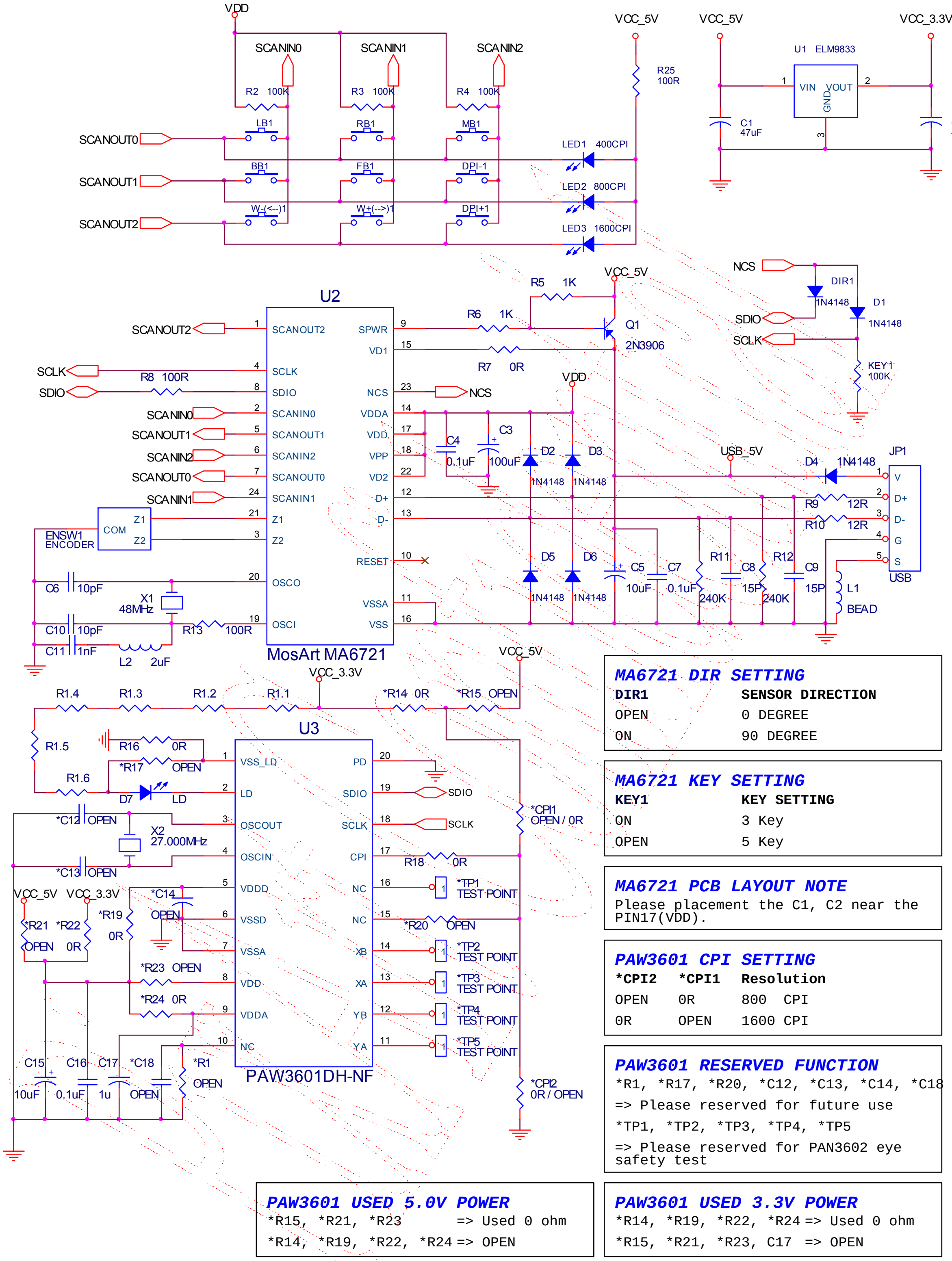
Figure 17. Power-down Configuration Register Writing Operation

7.6 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 micro controller can verify the synchronization of the serial port by periodically reading the ***Produc_ID*** register.

8. Referencing Application Circuit

8.1 Recommended Typical Application Using Serial Interface



MA6721 DIR SETTING

DIR1	SENSOR DIRECTION
OPEN	0 DEGREE
ON	90 DEGREE

MA6721 KEY SETTING

KEY1	KEY SETTING
ON	3 Key
OPEN	5 Key

MA6721 PCB LAYOUT NOTE

Please placement the C1, C2 near the PIN17(VDD).

PAW3601 CPI SETTING

*CPI2	*CPI1	Resolution
OPEN	0R	800 CPI
0R	OPEN	1600 CPI

PAW3601 RESERVED FUNCTION

*R1, *R17, *R20, *C12, *C13, *C14, *C18
=> Please reserved for future use
*TP1, *TP2, *TP3, *TP4, *TP5
=> Please reserved for PAN3602 eye safety test

PAW3601 USED 5.0V POWER

*R15, *R21, *R23 => Used 0 ohm
*R14, *R19, *R22, *R24 => OPEN

PAW3601 USED 3.3V POWER

*R14, *R19, *R22, *R24 => Used 0 ohm
*R15, *R21, *R23, C17 => OPEN

Figure 18. Application Circuit Using Serial Interface with MosArt MA6721 (Full Speed USB)

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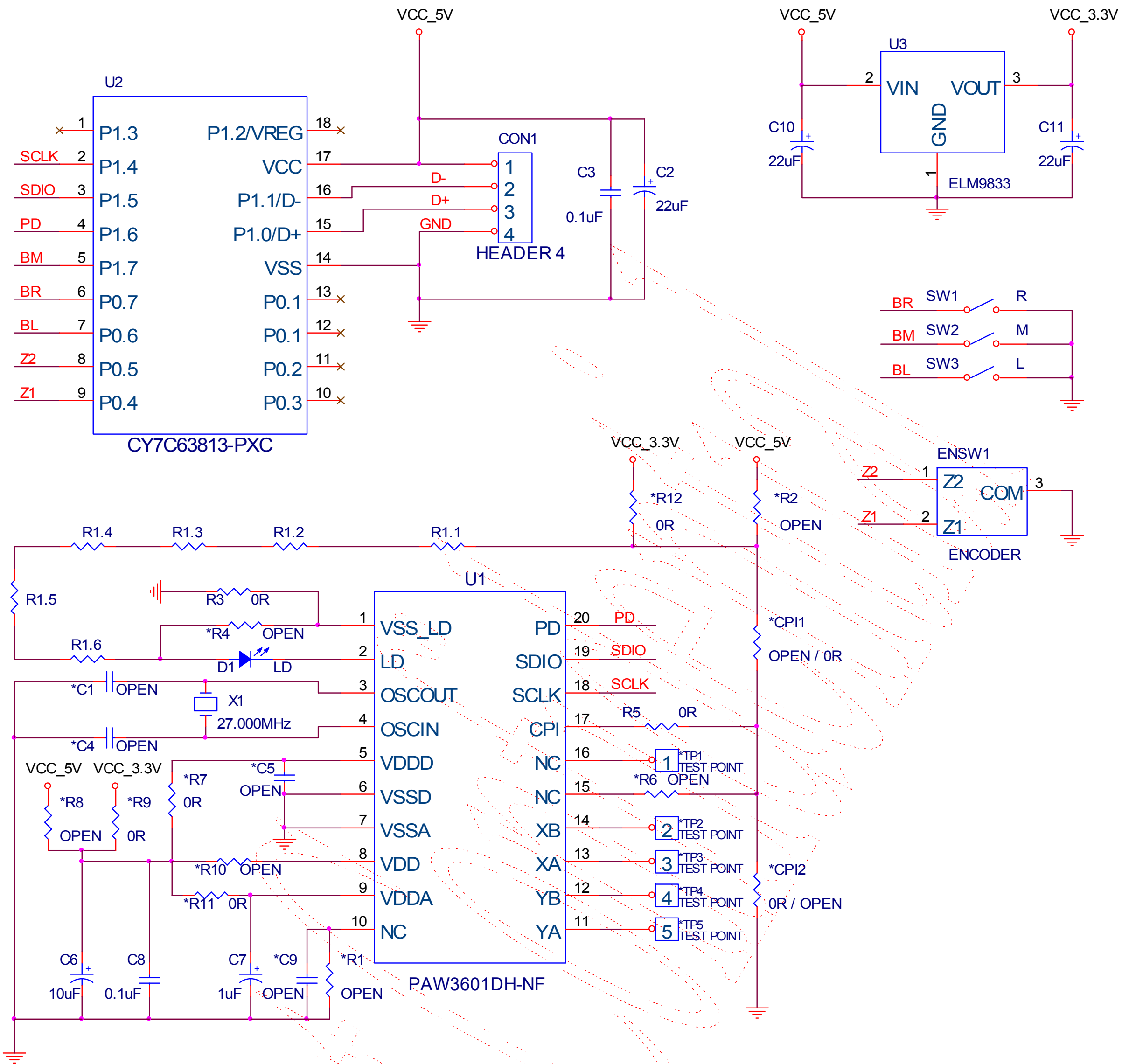
8.2 Recommended Typical Application Using Serial Interface



PAW3601 CPI SETTING

*CPI2	*CPI1	Resolution
OPEN	0R	800 CPI
0R	OPEN	1600 CPI

PAW3601 RESERVED FUNCTION

*R1, *R4, *R6, *C1, *C4, *C5, *C9
=> Please reserved for future use
*TP1, *TP2, *TP3, *TP4, *TP5,
=> Please reserved for PAN3602 eye safety test

PAW3601 USED 3.3V POWER

*R1, *R9, *R7, *R11 => Used 0 ohm
*R2, *R8, *R10, C7 => OPEN

PAW3601 USED 5.0V POWER

*R2, *R8, *R10 => Used 0 ohm
*R9, *R7, *R11, *R12 => OPEN

Figure 19. Application Circuit Using Serial Interface with CYPRESS CY7C63813 (Low Speed USB)

8.3 Typical Application for Wireless Laser Mouse, Power Source from Pin-5, 9

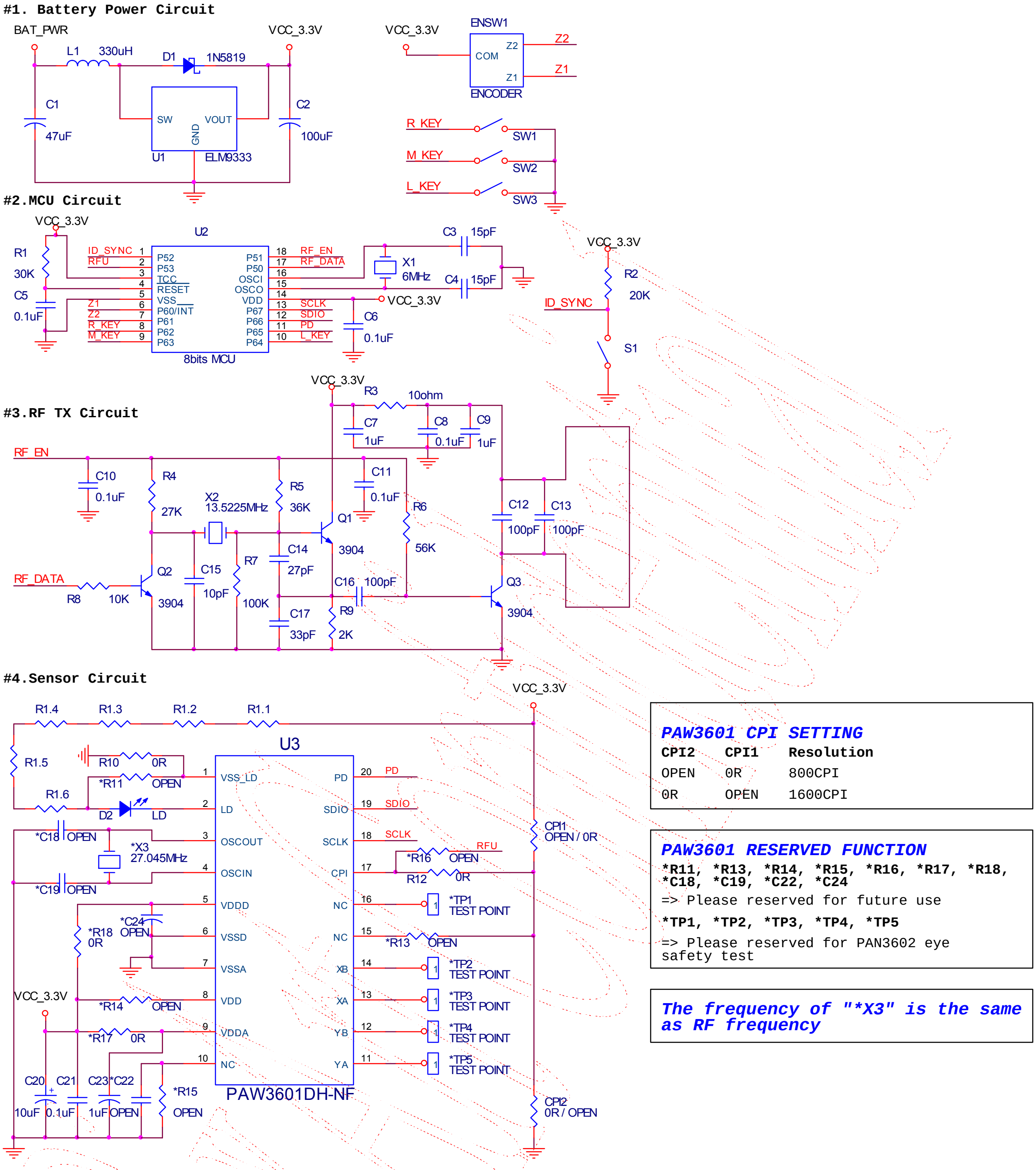


Figure 20. RF Application Circuit Using Pin-5, 9 for Power Supply Source

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8.3 Typical Application for RF Receiver

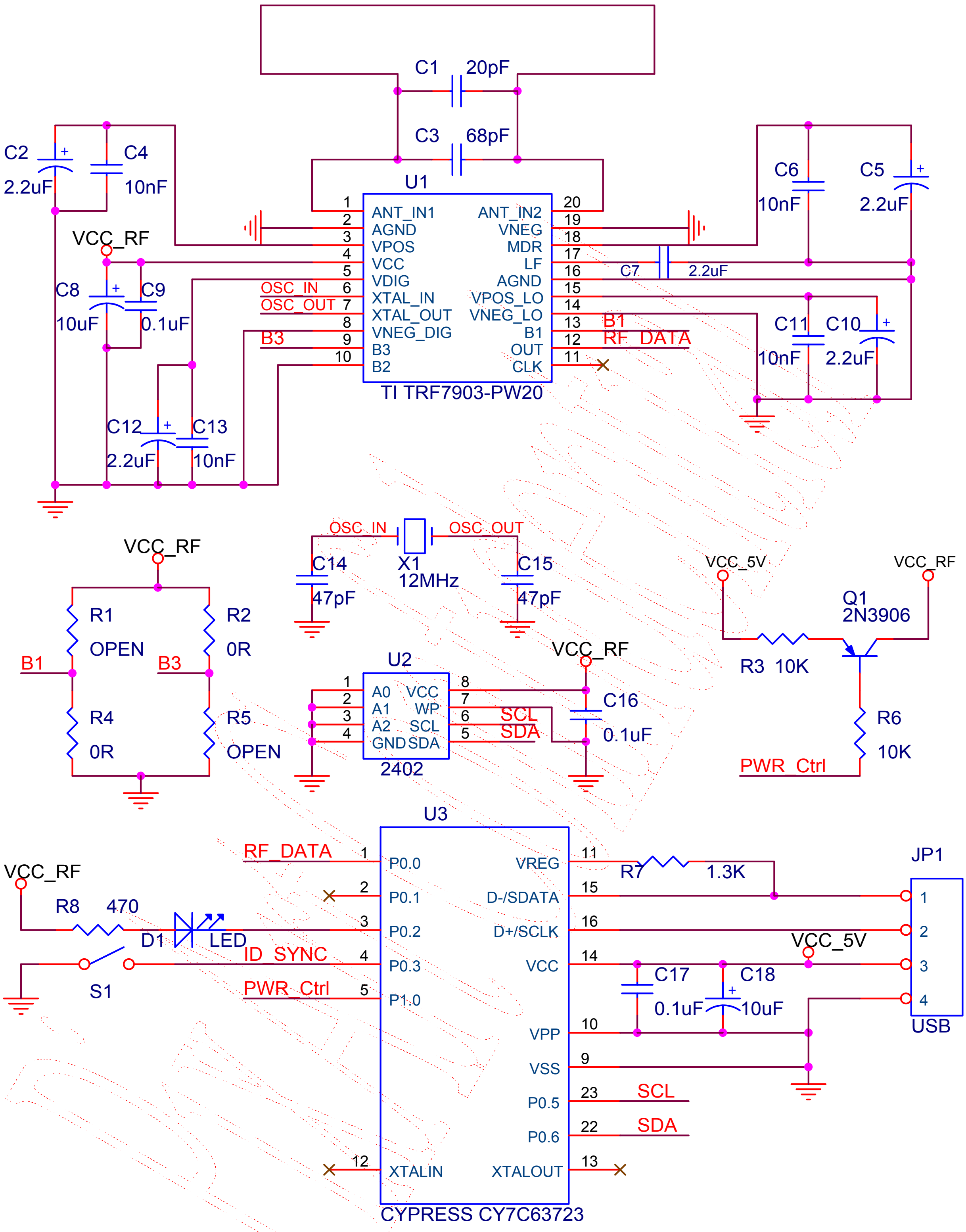

Figure 21. RF Receiver Application Circuit

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8.4 PCB Layout Consideration

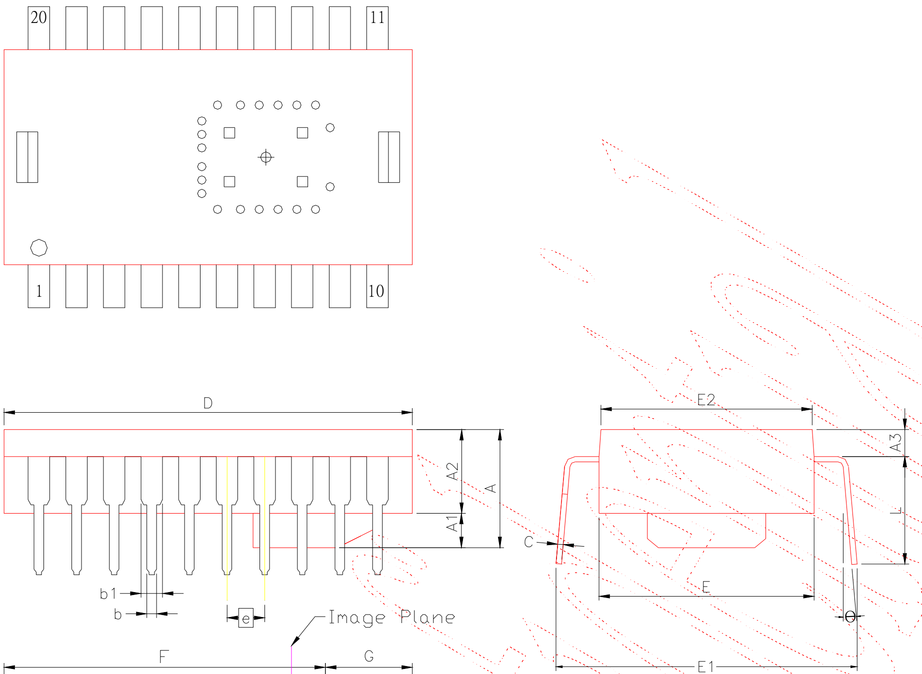
1. Caps for pins 5, 8, 9, 10 **MUST** have trace lengths **LESS** than **5mm**.
2. The trace lengths of OSCOUT, OSCIN must less than **6mm**.
3. Avoid the eye safety issue, please placement the R1.1 ~ R1.6 in a straight line and avoid any resistor to short each other or short to VCC.
4. Avoid the eye safety issue, please guard the trace from LD's cathode to mouse sensor's PIN2 (LD) and avoid short to ground.

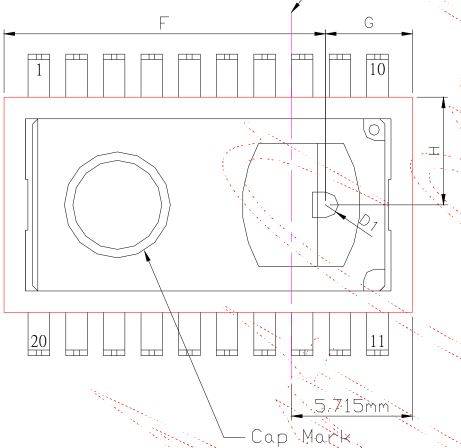
8.5 Recommended Value for R1

Please refer to LD (VCSEL) data sheet.

9. Package Information

9.1 Package Outline Drawing





SYMBOL	DIMENSION (MM)			DIMENSION (MIL)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	4.430	4.630	4.830	174	182	190
A1	1.350	1.450	1.550	53	57	61
A2	3.080	3.180	3.280	121	125	129
A3	0.920	1.020	1.120	36	41	44
b	0.357	0.457	0.508	14	18	20
b1	0.889	1.016	1.143	35	40	45
c	0.203	0.254	0.279	8	10	11
D	19.20	19.30	19.40	756	760	764
D1	0.500	0.600	0.700	20	24	28
E	10.060	10.160	10.260	396	400	404
E1	14.020	14.220	14.420	552	560	568
E2	9.880	9.980	10.080	389	393	397
F	15.090	15.190	15.290	594	598	602
G	4.000	4.100	4.200	157	161	165
H	4.980	5.080	5.180	196	200	204
e	1.778 BASIC			70 BASIC		
L	4.980	5.080	5.180	196	200	204
θ	—	—	12°	—	—	12°

Figure 22. Package Outline Drawing

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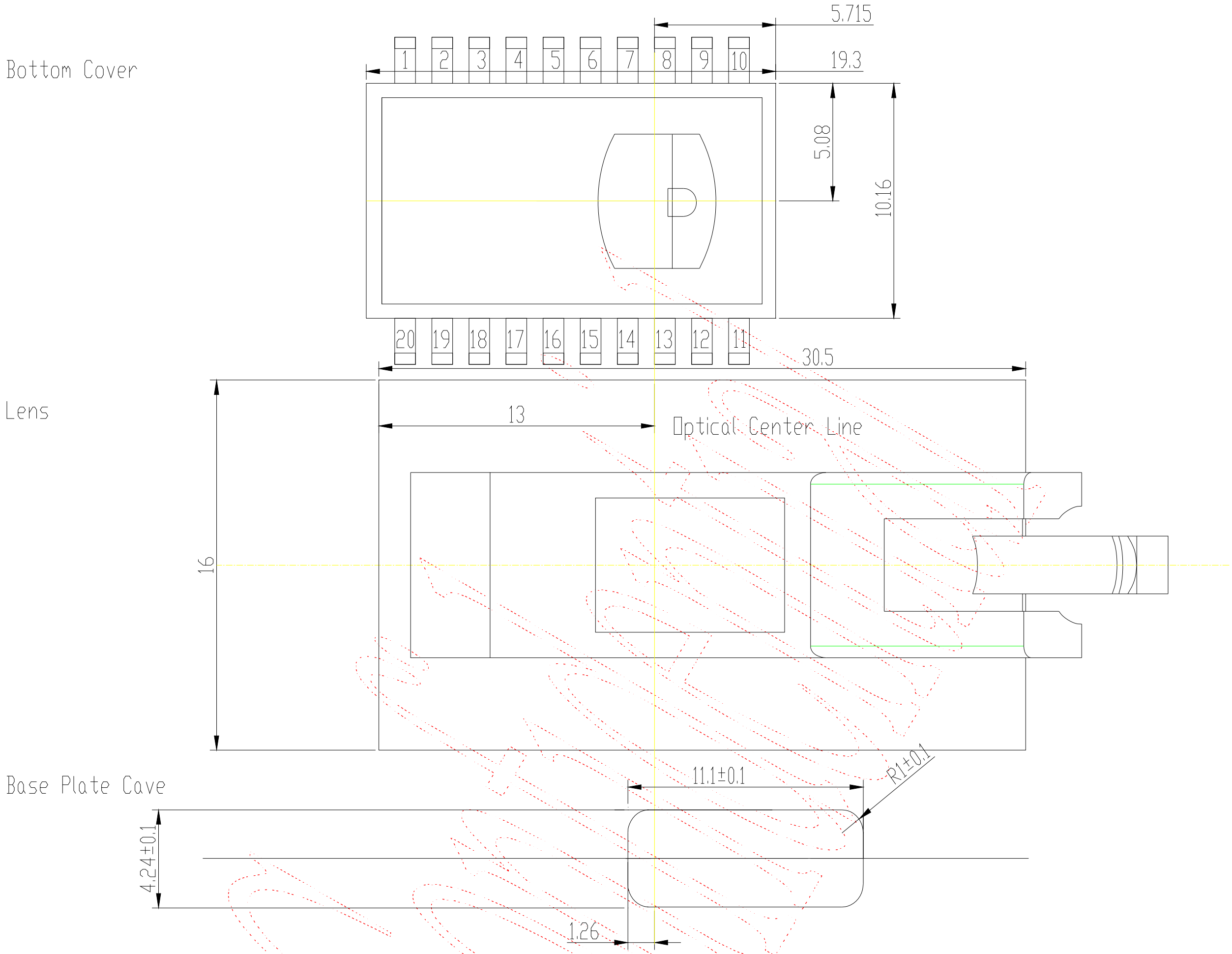
9.2 Base Plate Molding Dimension



All Dimensions : mm

Figure 23. Base Plate Molding Dimension

9.3 Recommended PCB Mechanical Cutouts and Spacing

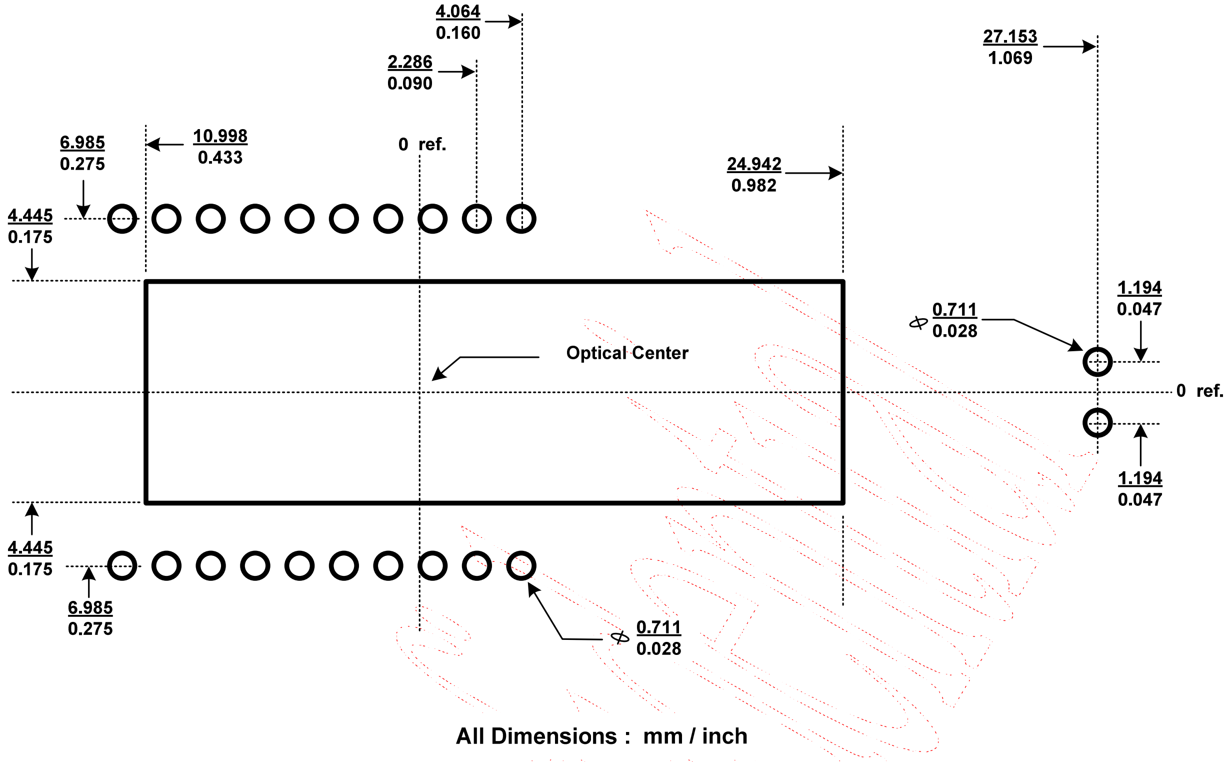


Figure 24. Recommended PCB Mechanical Cutouts and Spacing

Vertical Cavity Surface Emitting Laser

(VCSEL)

Components Specification

Distribution

Internal Only □

External All □

External Restricted □ **If restricted, specify restricted to whom:**

____

Document No.: PNDR-00004

Revision: Rev 2.50

Date: 2007/08/20

Revision History

Revision	Author	Date	Description
1.0	M.H.Chien	2006/06/14	Initial version
1.5	Chadwick	2007/01/18	Add VDD=2.7V and delete VDD=5.0V constraint resistor table
2.0	Chadwick	2007/05/04	Revise resistor table for higher CW radiant power 300uW ~550uW on Mouse operation ; Delete P32/P64/P68/P72/P76/P80 six Grades
2.5	Chadwick	2007/08/20	Note constraint resistor table for PAN/PAW 3601DH-NF and add new constraint resistor table for PAN/PAW 3602DH-NF

PNDR-00004

850nm Epoxy molded VCSEL for Laser Mouse

FEATURES

- Epoxy Molded with round emission surface.
- Small divergence angle.

ELECTRO-OPTICAL CHARACTERISTICS:

PARAMETERS	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITIONS
Output Power	P_o		0.475	0.7	mW	$I=I_F$ (1)
Wavelength	λ_P	830	850	860	nm	I_F = 6 mA
Forward Voltage	V_F	1.6	1.75	1.9	V	I_F = 6 mA
Series Resistance	R_S		40	60	Ω	I_F = 6 mA
Breakdown voltage	V_{BD}	7	14		V	Ir = 10uA
Beam Divergence($1/e^2$)	θ		8		degree	I_F = 6 mA

Notes :(1) Binning

APPLY TO PAN/PAW 3601 DH-NF

Optical power at each of following nominal bin operating current and constrained resistor at **VDD=2.7V**

Bin grade	LD current (mA)	Single Constrain resistor :R(Ω)	6 Series Constrain resistor: r_n (Ω)	Bin grade	LD current (mA)	Single Constrain resistor :R(Ω)	6 Series Constrain resistor: r_n (Ω)
P36	3.6	282	47	P50	5.0	180	30
P40	4.0	234	39	P52	5.2	162	27
P42	4.2	234	39	P54	5.4	162	27
P44	4.4	216	36	P56	5.6	132	22
P46	4.6	198	33	P58	5.8	132	22
P48	4.8	180	30	P60	6.0	132	22

Single constrain resistor R value = 6 series connection resistor for eye safety protection

$R = r_1+r_2+r_3+r_4+r_5+r_6$

Ex. P48:180Ω = 30Ω+ 30Ω+30Ω+30Ω+30Ω+30Ω

Optical power at each of following nominal bin operating current and constrained resistor at **VDD= 3.3V**

Bin grade	LD current (mA)	Single Constrain resistor :R(Ω)	6 Series Constrain resistor: r_n (Ω)	Bin grade	LD current (mA)	Single Constrain resistor :R(Ω)	6 Series Constrain resistor: r_n (Ω)
P36	3.6	450	75	P50	5.0	306	51
P40	4.0	408	68	P52	5.2	282	47
P42	4.2	372	62	P54	5.4	282	47
P44	4.4	372	62	P56	5.6	258	43
P46	4.6	336	56	P58	5.8	234	39
P48	4.8	306	51	P60	6.0	216	36

Single constrain resistor R value = 6 series connection resistor for eye safety protection

$R = r_1+r_2+r_3+r_4+r_5+r_6$

Ex. P48: 306Ω = 51Ω+ 51Ω+51Ω+51Ω+51Ω+51Ω

Warning! For Single constrain resistor(R) and 6 series constrain resistor(r_n), please using the recommend value, if resistor value is less than recommend value, there will be eye safety issue.

APPLY TO PAN/PAW 3602 DH-NF

Optical power at each of following nominal bin operating current and constrained resistor

Bin grade	LD current (mA)	Single Constrain resistor :R(Ω)	Bin grade	LD current (mA)	Single Constrain resistor :R(Ω)
P36	3.6	19K	P50	5.0	15K
P40	4.0	18K	P52	5.2	14K
P42	4.2	17.5K	P54	5.4	13K
P44	4.4	17K	P56	5.6	12.5K
P46	4.6	16.5K	P58	5.8	12K
P48	4.8	16K	P60	6.0	11.5K

Warning! For Single constrain resistor(R) , please using the recommend value, if resistor value is less than recommend value, there will be eye safety issue.

ABSOLUTE MAXIMUM RATINGS:

PARAMETERS	MIN	MAX	UNIT	Condition
Storage Temperature	-30	85	°C	
Operating Temperature	-10	60	°C	
Continuous Forward Current		12	mA	
Continuous Reverse Voltage		7	V	
Lead Solder Temperature		260	°C	10 seconds

Fig. 1 Typical Optical Characteristics

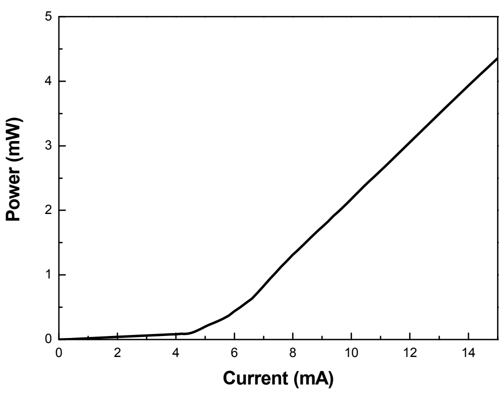
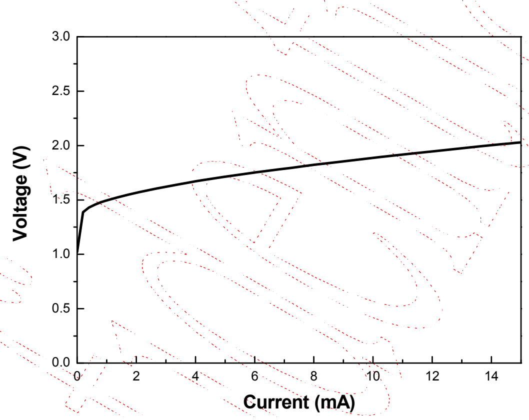
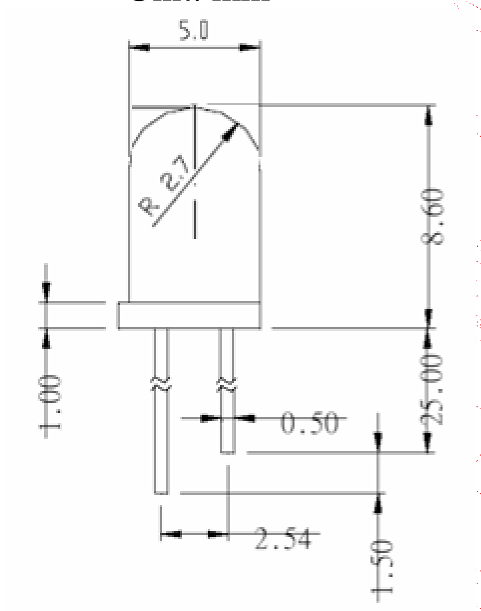


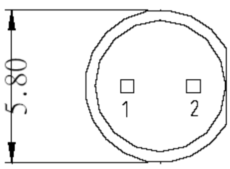
Fig. 2 Typical Electrical Characteristics



OUTLINE DIMENSIONS:

- Unit: mm



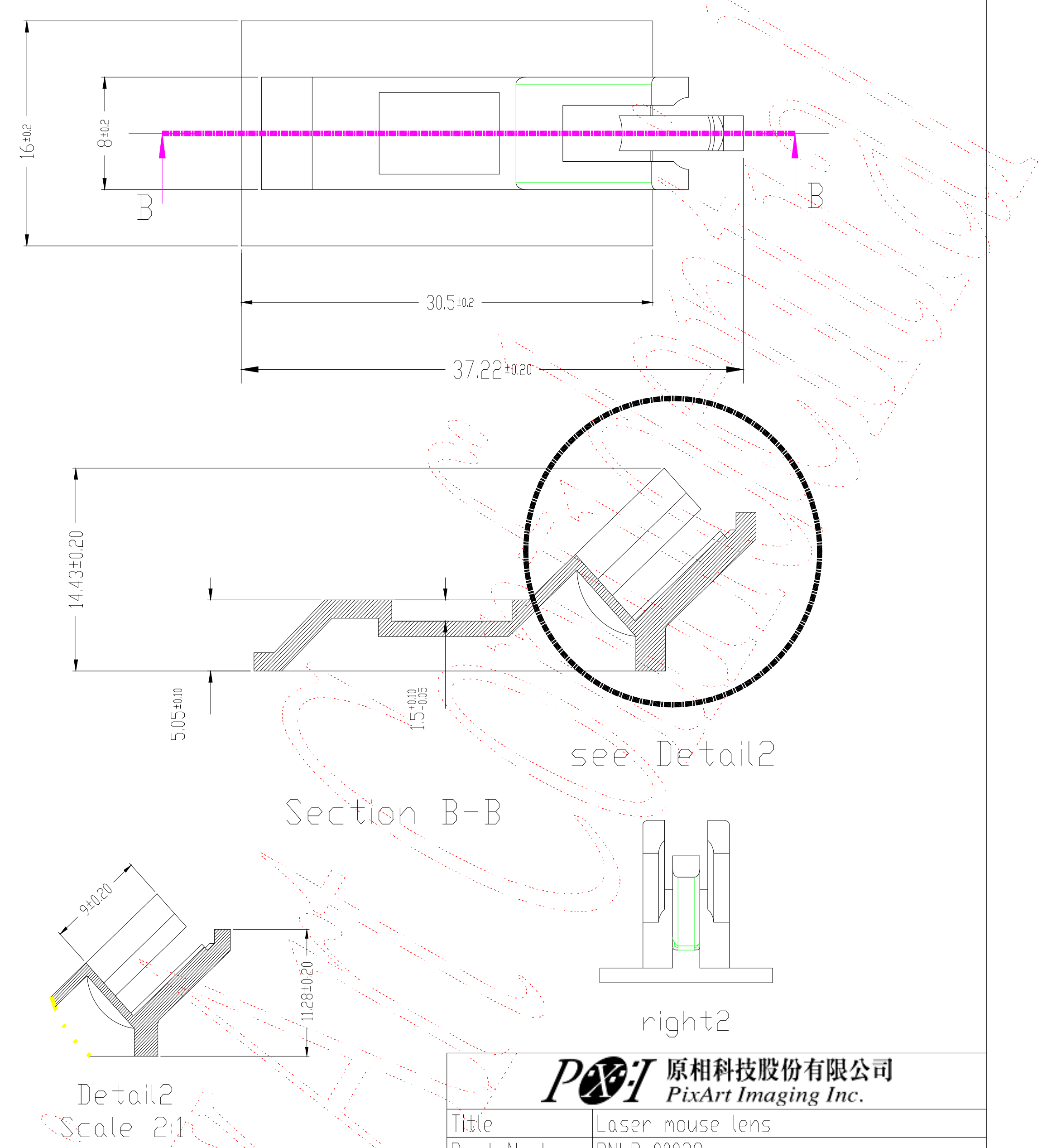


Pinout
1. Anode
2. Cathode

WARNING:

The VCSEL is a class IIIa laser in the safety standard ANSI Z136.1 and should be treated as a potential eye hazard.

PNLR-00038 Lens Dimensions



原相科技股份有限公司
PixArt Imaging Inc.

Rev.	Description	Date	Material	PMMA		
			Title	Laser mouse lens		
			Part Number	PNLR-00038		
V 1.0	New Issue	04/10/06				
			Drawn	M.H.Chien 04/10/06	Scale	2 : 1
			Check			
			Approve		Rev.	V 1.0

10. Update History

Version	Update	Date
V1.0	Creation, Preliminary 1st version	04/01/2005
V1.1	Features Key Specification 1. Pin Description 2. Block Diagram and Operation 3.2 Register Descriptions 4. Specifications 7. Referencing Application Circuit 7.1 Recommended Typical Application using Serial Interface, Power Source by Pin-8 7.2 Typical Application for Wireless Laser Mouse, Power Source by Pin-5, 9 7.3 Typical Application for RF Receiver 7.4 PCB Layout Consideration 7.5 Recommended Value for R1 8.1 Package Outline Drawing	12/22/2005
V1.2	Add schematic PAW3601DH-NF with MosArt MA6721 solution	12/29/2005
V1.3	1. Add schematic PAW3601DH-NF with CYPRESS CY7C63813 solution 2. Update the schematic of Figure 16, 17, 18(Add VCC 3V solution, LD have to used fixed 3V from regulator) 3. Add Base plate molding dimension	03/31/2006
V2.0	1. Add specification of LD. 2. Add Lens Dimensions. 3. Add 2D Assembly.	08/28/2006
V2.1	Modify describe of R1 resister	09/07/2006
V2.2	1. Modify describe of LD resister 2. Add 3D Assembly 3. Modify Base plate molding dimension	08/21/2007

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.