PAN3507DL-TXWA USB OPTICAL MOUSE SINGLE CHIP

General Description

The PAN3507DL-TXWA is a CMOS process optical mouse sensor single chip with USB interface that serves as a non-mechanical motion estimation engine for implementing a computer mouse.

Features

- USB interface
- Single power supply
- Optical motion estimation technology
- Complete 2-D motion sensor
- Accurate motion estimation over a wide range of surfaces
- High speed motion detection up to 37 inches/sec
- High resolution up to 2000 CPI
- Power saving mode during times of no movement
- Supports three buttons (L, M, R) and three axes (X, Y, Z) output
- Z-axis support Mechanical input (Z/2)
- USB spec.
  - Complete Universal Serial Bus specificationV1.1 compatibility
  - Complete USB HID specs V1.11 compatibility
  - Compliant to the USB specification version 2.00
  - Integrated USB transceiver and 1.5Mbps USB serial interface engine
  - 16-bit XY report format
- One dedicated pin for CPI switch and indication
- Flexibility for device type configuration.
  - Interface: USB / PS2
  - CPI resolution: 400 ~ 2000
  - CPI switch type: 4 types available
  - Sensor rotation: 0, +90, -90, 180

Key Specification

Power Supply	Wide operating supply range 4.25V ~ 5.5V
Interface	USB
Optical Lens	1:1
System Clock	24.000 MHz
Speed	37 inches/sec
Acceleration	15g
Resolution	1000(Default)/1600/600 CPI
CPI Switch	1000 -> 1600 -> 600 -> 1000 … (Default)
Frame Rate	4000 frames/sec
Operating Current	10mA @Mouse moving (Normal) 5mA @Mouse not moving (Sleep) 480uA @USB suspend (Suspend)
Package	Shrunk DIP14

Ordering Information

Part Number	Device Type	Interface	Roller
PAN3507DL-TXWA	3D3B	USB (LS,16-bitXY)	Mechanical

PixArt Imaging Inc.
E-mail: fae_service@pixart.com.tw

V0.3 Nov. 2009

1. Pin Configuration

1.1 Pin Description

| Pin #	Name	Type	Definition
1	CPI	I/O	CPI switch input and indication (PWM) output.
2	BL	I	Button left key input.
3	RSV	I	Reserved. Short to ground is necessary.
4	VDD5V	PWR	Chip power VDD 5.0V.
5	VSS	GND	Chip ground.
6	VDDQ	PWR	I/O voltage reference output.
7	VDDA	PWR	Analog voltage reference output.
8	D+	I/O	USB D+.
9	D-	I/O	USB D-.
10	BR	I	Button right key input.
11	BM	I	Button middle key input.
12	LED	O	LED control.
13	Z2	I	Z-axis mechanical scroller input.
14	Z1	I	Z-axis mechanical scroller input.

1.2 Pin Assignment for Sensor Rotate 0˙
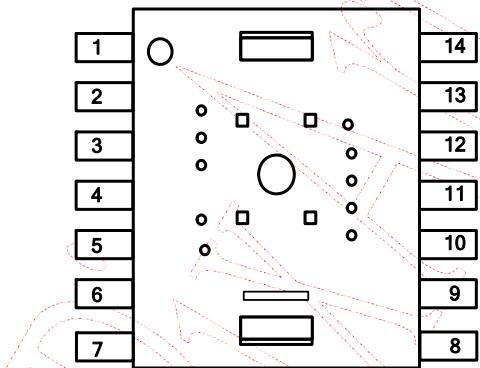

Figure 1. Top View Pinout
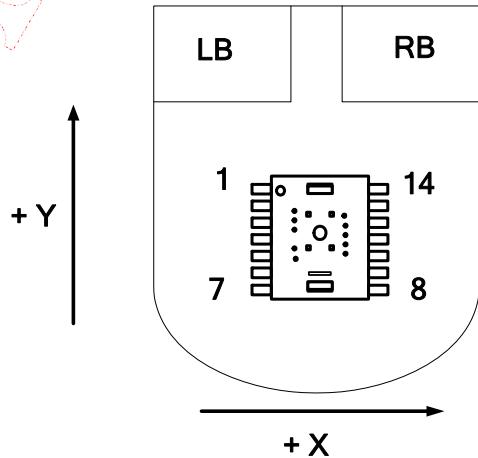
Figure 2. Top View of Mouse

2. Block Diagram and Operation
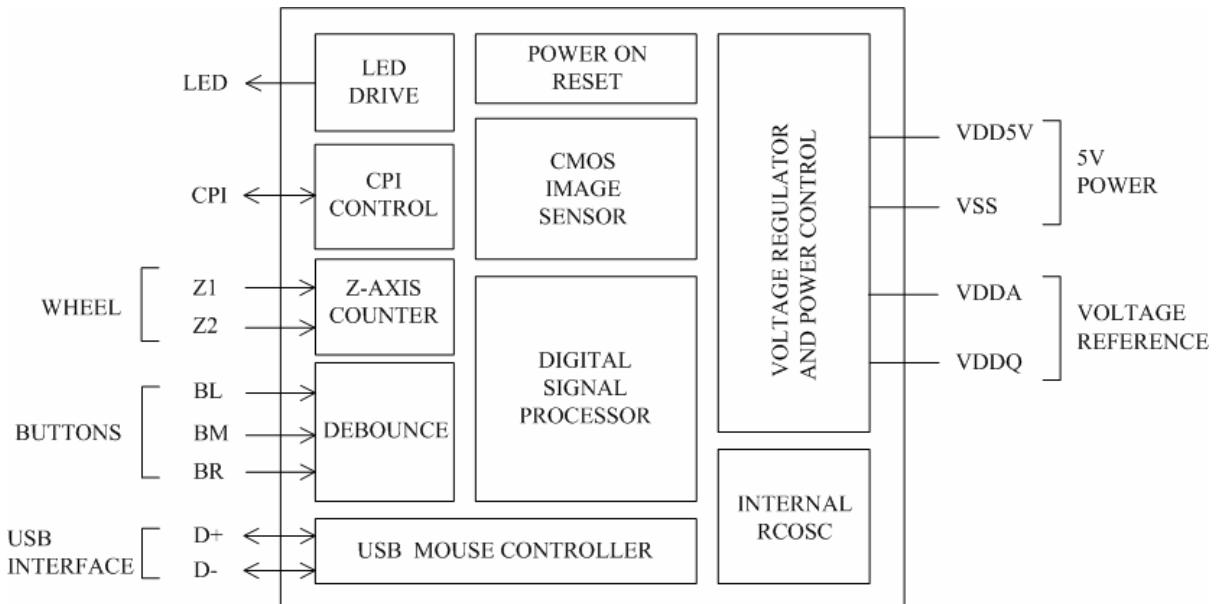
Figure 3. Block Diagram

The PAN3507DL-TXWA supports X, Y, Z three axes, and L, R, M three buttons under USB mode. It is a CMOS process optical mouse sensor single chip with USB interface that serves as a non-mechanical motion estimation engine for implementing a computer mouse.

The PAN3507DL-TXWA is in a 14-pin optical package and comes with the resolution of 1000/1600/600 counts per inch (CPI) and the rate of motion up to 37 inches per second. It includes USB interface so that no mouse controller is needed to interface through USB. The PAN3507DL-TXWA can receive command and echo status or data format, both complete Universal Serial Bus® spec V1.1 and USB HID spec V1.11 compatibility. It is also a cost effective solution to support USB Mouse.

3. Specifications

3.1 Absolute Maximum Ratings

Exposure to absolute maximum rating 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, 1.6 mm below seating plane.
ESD			2	kV	All pins, human body model MIL 883 Method 3015
V_{DC}	DC Supply Voltage	-0.5	V_{DD}+0.5	V	
V_{IN}	DC Input Voltage	-0.5	V_{DDQ}+0.5	V	All I/O pins

3.2 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	
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 7.
R	Resolution		1000		CPI	
A	Acceleration			15	g	
F_{CLK}	Clock Frequency		24		MHz	
FR	Frame Rate		4000		frames/sec	
S	Speed			37	inches/sec	37 inches/sec @1000CPI, A4 paper surface. 20 inches/sec @1000CPI, Black surface.

3.3 AC Electrical Characteristics

Electrical characteristics under recommended operating conditions. Typical values at 25 °C, V_{DD} = 5.0 V, F_{CLK} = 24 MHz.

Symbol	Parameters	Min.	Typ.	Max.	Unit	Notes
T_{pwm}	CPI PWM Period	-	1	-	ms	Refer to Figure 4.
T_d	CPI PWM Low Duty Cycle Time	-	0	-	ms	@0% Low duty
		-	0.2	-	ms	@20% Low duty
		-	0.9	-	ms	@90% Low duty
T_{bd}	Mouse Button Debounce Time	-	10.24	-	ms	Refer to Figure 5.
T_{wd}	Mouse Z Wheel Debounce Time	-	1.024	-	ms	Refer to Figure 5.
T_w	Mouse Z Wheel Time	1143	-	-	us	Refer to Figure 6.

3.4 DC Electrical Characteristics

Electrical characteristics under recommended operating conditions. Typical values at 25 °C, V_{DD} =5.0 V, F_{CLK}=24 MHz.

Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
Type: USB Mouse PWR						
I_{DD}	Supply Current Mouse moving (Normal)	-	10	-	mA	
I_{DD}	Supply Current Mouse not moving (Sleep)	-	5	-	mA	
I_{DD}	Supply Current USB suspend current	-	-	480	uA	
Type: BM, BR, BL, Z2, Z1						
R_{PH1}	Internal Pull Up Resistance	-	30	-	Kohm	BM,BR,BL
R_{PH2}	Internal Pull Up Resistance	-	40	-	Kohm	Z2,Z1
V_{IH}	Input High Voltage	VDDQ*0.7	-	-	V	
V_{IL}	Input Low Voltage	-	-	VDDQ*0.3	V	
Type: USB D-						
R_{PH}	Internal Pull Up Resistance	-	1.5	-	Kohm	
Type: LED						
V_{OL}	Output Low Voltage	-	-	0.5	V	@ I_{OL}=30mA
Type: CPI						
V_{IH}	Input High Voltage	VDDQ*0.7	-	-	V	
V_{IL}	Input Low Voltage	-	-	VDDQ*0.3	V	
V_{OL}	Output Low Voltage	-	-	0.5	V	@ I_{OL}=30mA
Type: VDDQ						
VDDQ	I/O Voltage Reference	-	3.3	-	V	

All rights strictly reserved any portion in this paper shall not be reproduced, copied or transformed to any other forms without permission.   5
PixArt Imaging Inc.
E-mail: fae_service@pixart.com.tw   V0.3 Nov. 2009

3.5 CPI Switch and Indication

The PAN3507DL-TXWA supports CPI switch function that allows user change resolution between 1000/1600/600 through pressing the CPI button. And the corresponding indications will be shown by using PWM output on the same pin, i.e. outputting different duty cycles for different resolution at fixed 1 KHz frequency. It will cause the different brightness on LED. The CPI indication (PWM) output timing and relationship between resolution and duty cycle are as follows,
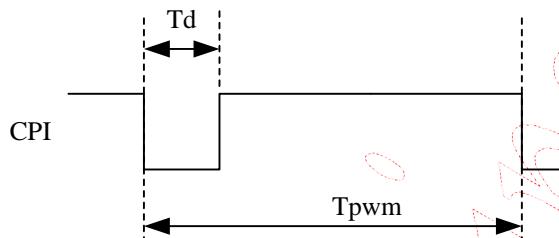

Figure 4. CPI Indication Timing

Resolution	PWM Low Duty	LED Status
1000 cpi	20%	Less brightness
1600 cpi	90%	Much brightness
600 cpi	0%	Dark

3.6 Button and Z-Wheel Debounce Timing

Buttons and Z wheel of PAN3507DL-TXWA include detect and debounce function which are hardware implemented. When press button input signals need keeping low level up to 9.216ms. Button function just can catch data otherwise debounce function will judge it is bounce issue. When scroll Z wheel input signals need keeping turning level up to 0.896ms. Z wheel function just can catch data otherwise debounce function will judge it is bounce issue. And the hardware sample rate is 2us so if bounce time is less than 2us the debounce function will ignore it. Following the below specifications Buttons and Z wheel will work normally.
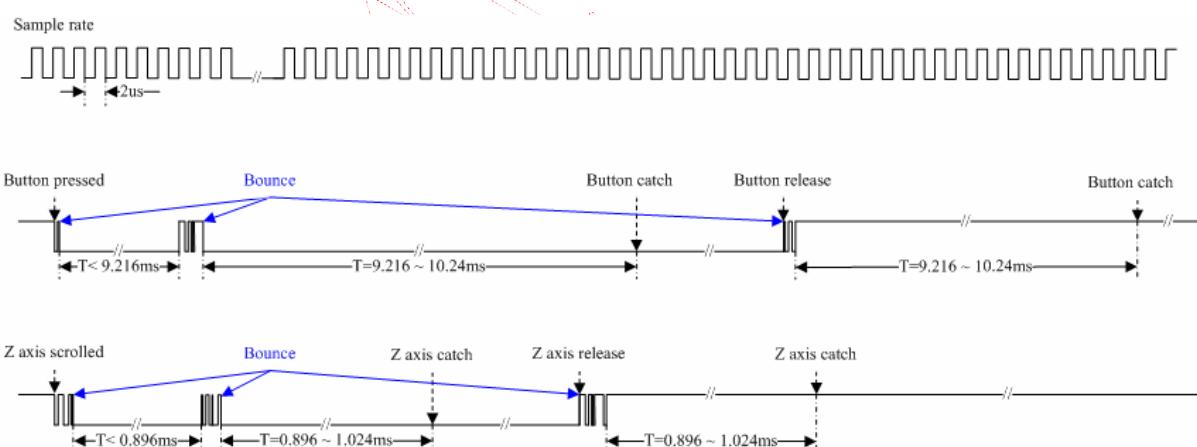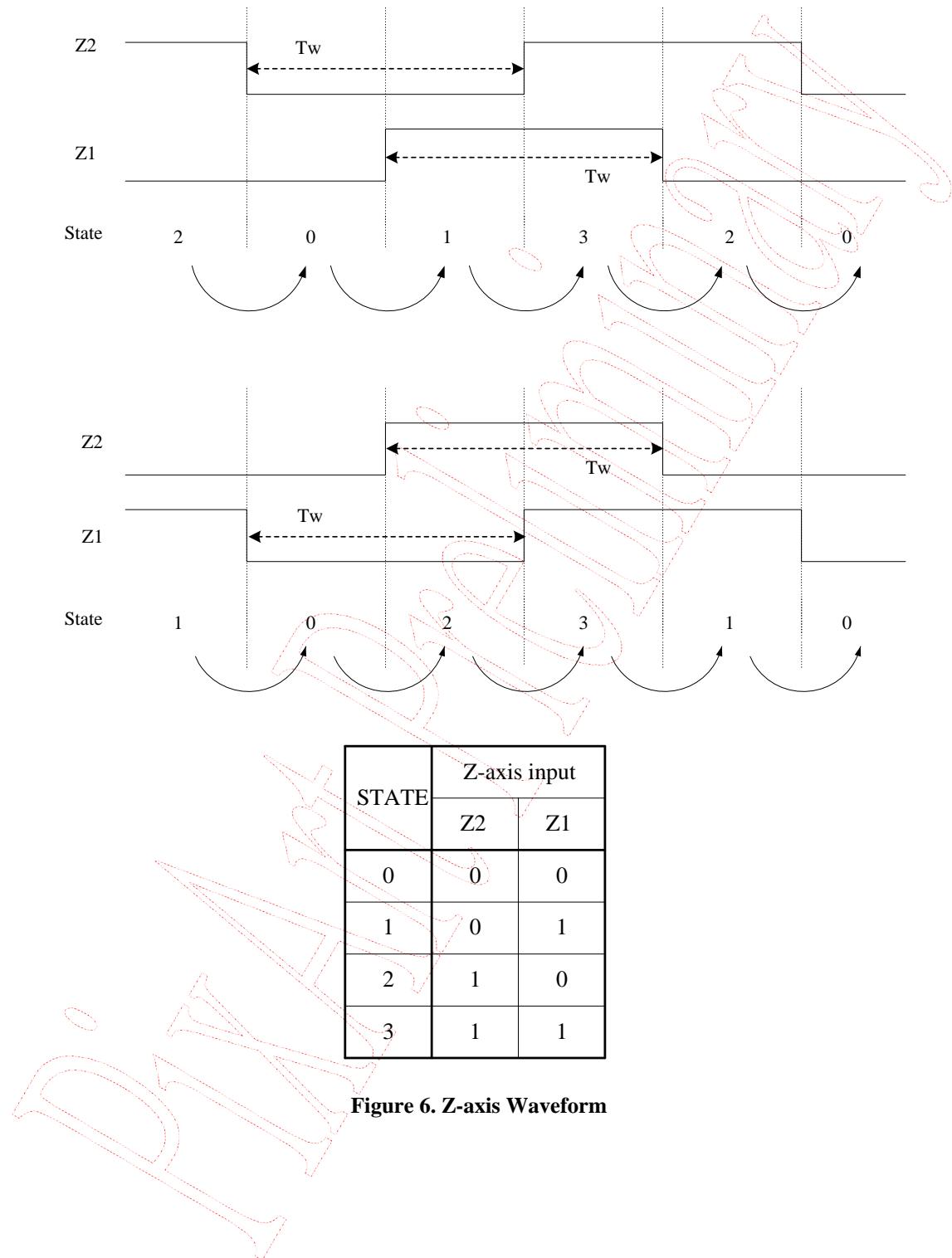

Figure 5. Debounce Timing

3.7 Z-axis Waveform

STATE	Z-axis input	
	Z2	Z1
0	0	0
1	0	1
2	1	0
3	1	1

Figure 6. Z-axis Waveform

V0.3 Nov. 2009

4. Z and 2D/3D Assembly

Package Lid

Lens

Z
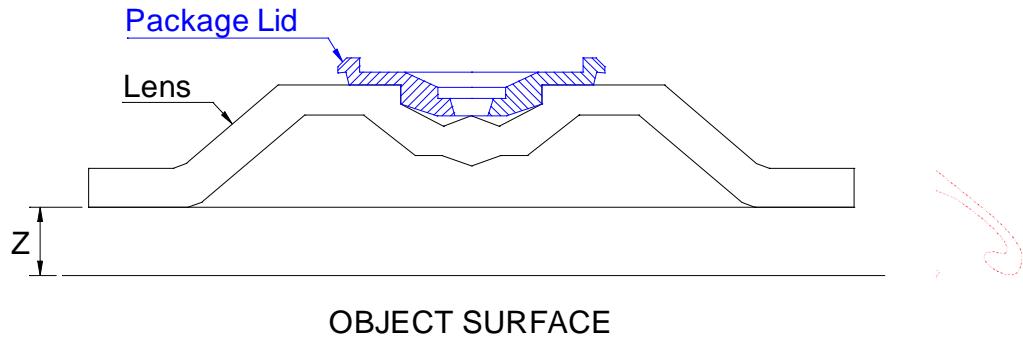
OBJECT SURFACE

Figure 7. Distance from Lens Reference Plane to Surface

BASE PLATE

27.16
26.01
0.59
CLIP
3.00
PLASTIC SPRING
LED

SURFACE IS 0 REF.

13.88±0.2
10.65±0.17
7.45±0.14

PCB
SENSOR
3.45
BASE PLATE ALIGNMENT POST

Unit: mm
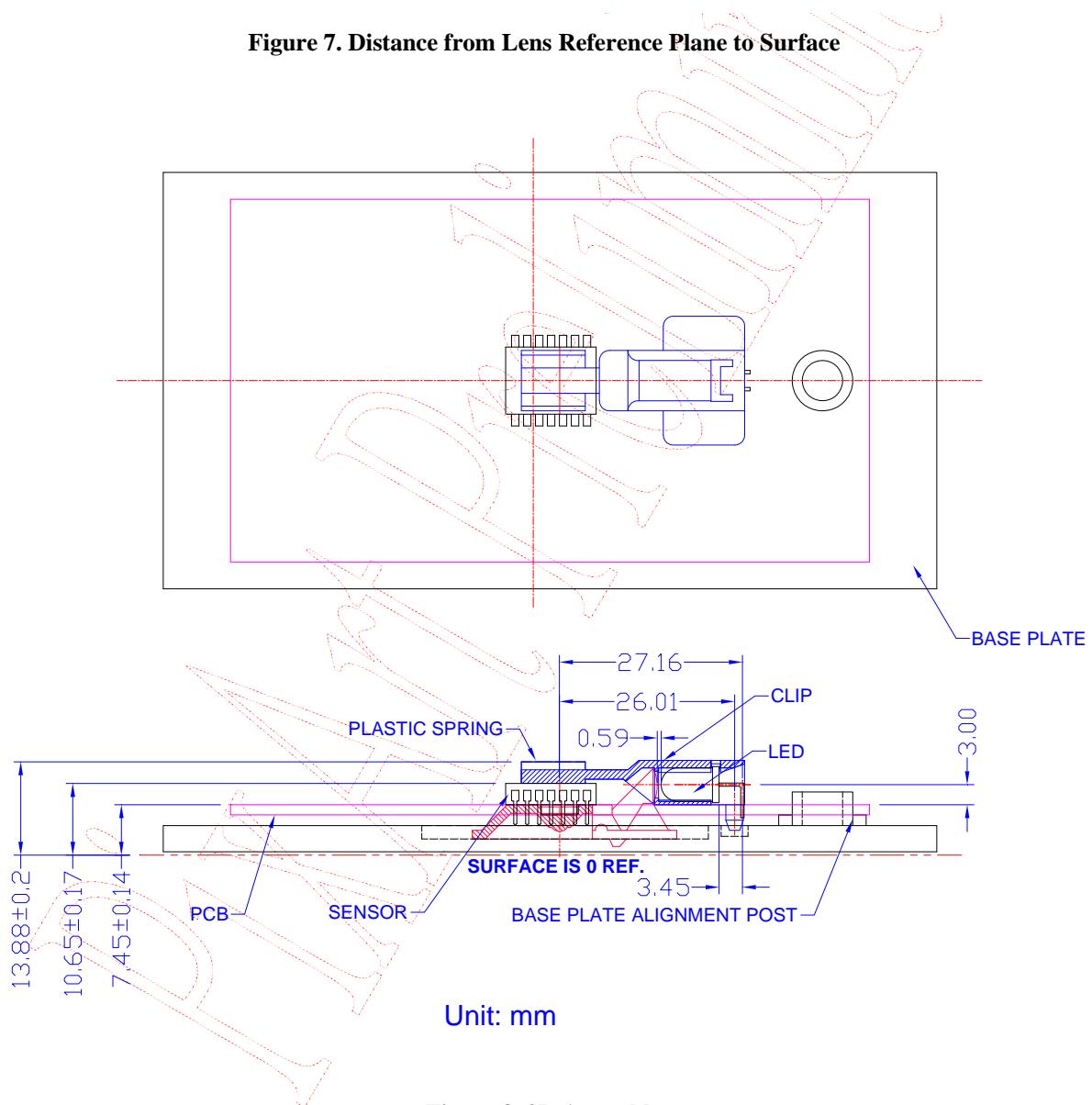
Figure 8. 2D Assembly
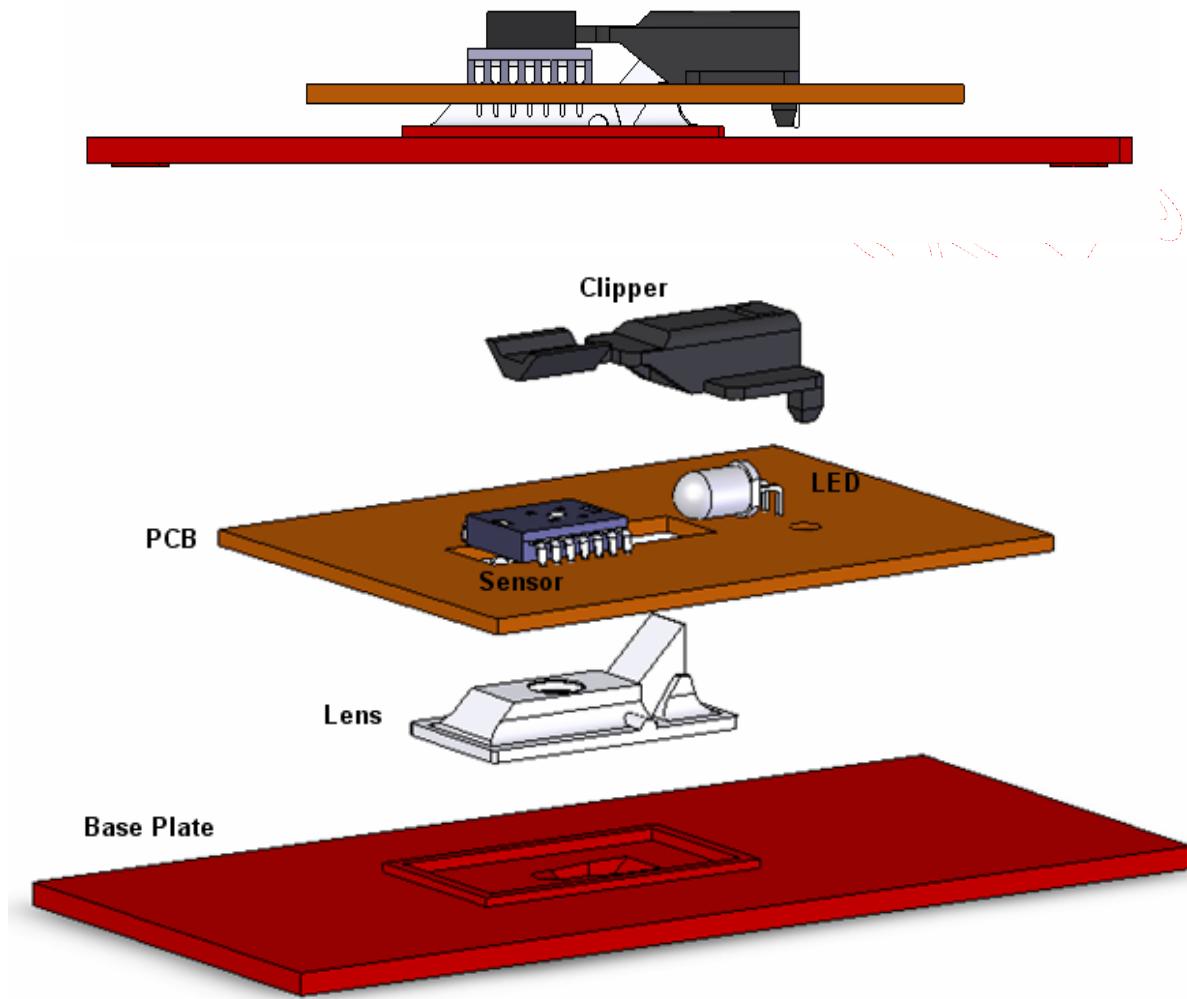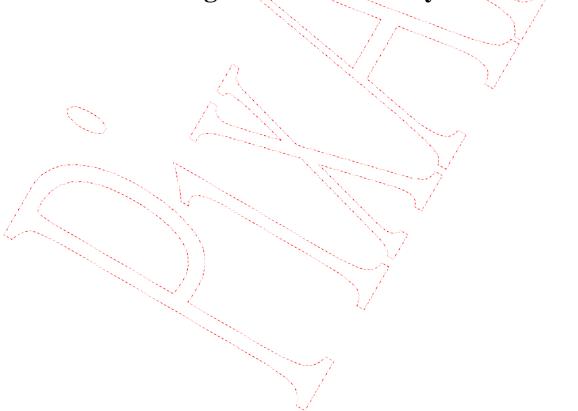
Figure 9. 3D Assembly for Mounting Instructions with Trim Lens

PixArt Imaging Inc.
E-mail: fae_service@pixart.com.tw   V0.3 Nov. 2009

5. USB Interface (3D3B,16-Bit XY)

5.1 USB Command Set Description (USB Descriptor)

The USB HOST detects USB mouse device plug-in and assigns a new unique address to the USB mouse device, then asking USB mouse device for information about the device description, configuration description, and assigning a configuration value for USB mouse device during enumeration period. After enumeration, the USB mouse device is able to transfer motion and button value to the USB host.

Descriptor Type	Byte	Byte	Byte	Byte	Byte	Byte	Byte	Byte
Device Descriptor (18 bytes)	12	01	10	01	00	00	00	08
	3A	09	16	25	00	01	00	02
	00	01						
Configuration Descriptor (9 bytes)	09	02	22	00	01	01	04	A0
	32							
Interface Descriptor (9 bytes)	09	04	00	00	01	03	01	02
	00							
Human Interface Device Descriptor (9 bytes)	09	21	11	01	00	01	22	4F
	00							
Endpoint Descriptor (7 bytes)	07	05	81	03	08	00	0A	
Human Interface Device Report Descriptor (79 bytes, 3D3B, 16-bit XY)	05	01	09	02	A1	01	09	01
	A1	00	05	09	19	01	29	03
	15	00	25	01	95	03	75	01
	81	02	95	01	75	05	81	03
	06	00	FF	09	40	95	02	75
	08	15	81	25	7F	81	02	05
	01	09	38	15	81	25	7F	75
	08	95	01	81	06	09	30	09
	31	16	01	80	26	FF	7F	75
	10	95	02	81	06	C0	C0	
Language String Descriptor (4 bytes)	04	03	09	04				
Manufacture String Descriptor	PIXART							
Product String Descriptor	USB OPTICAL MOUSE							
Configuration String Descriptor	HID-compliant MOUSE							

5.2 USB Data Report Format

The USB report has two data formats, depending on boot or report protocol is selected. One kind of data format is the boot protocol used in legacy environment as 5.2.1. The other kind of data format is USB report protocol format which includes Z-wheel movement data as 5.2.2. If the Z-wheel is scrolled upward the corresponding report data will be 01H. If the Z-wheel is scrolled downward the corresponding report data will be FFH. And the report data will be 00H if Z-wheel is idle.

5.2.1 USB Boot Protocol for Legacy Operation

Byte	Bit	Symbol	Description
1	7 - 3	NC	Reserved
	2	BM	1 = Middle button pressed
	1	BR	1 = Right button pressed
	0	BL	1 = Left button pressed
2	7 - 0	X7 - X0	X data (D7 - D0). A positive value indicates motion to the right; a negative value indicates motion to the left. Bit 0 = LSB.
3	7 - 0	Y7 - Y0	Y data (D7 - D0). A positive value indicates device motion upward; a negative value indicates motion downward. Bit 0 = LSB.

5.2.2 USB Report Protocol

| Byte	Bit	Symbol	Description
1	7 - 5	NC	Reserved
	4	B5	Reserved
	3	B4	Reserved
	2	BM	1 = Middle button pressed
	1	BR	1 = Right button pressed
	0	BL	1 = Left button pressed
2	7 - 0	X7 - X0	X data (D7 - D0). A positive value indicates motion to the right; a negative value indicates motion to the left. Bit 0 = LSB.
3	7 - 0	Y7 - Y0	Y data (D7 - D0). A positive value indicates device motion upward; a negative value indicates motion downward. Bit 0 = LSB.
4	7 - 0	Z7 - Z0	Z-wheel motion data (D7 - D0). A positive value indicates device motion downward; a negative value indicates motion upward. The Z7 - Z0 limit value is ±7. Bit 0 = LSB.
5	7 - 0	X7 - X0	X data (D7 - D0). A positive value indicates motion to the right; a negative value indicates motion to the left. Bit 0 = LSB.
6	7 - 0	X15 - X8	X data (D15 - D8). A positive value indicates motion to the right; a negative value indicates motion to the left. Bit 0 = LSB.
7	7 - 0	Y7 - Y0	Y data (D7 - D0). A positive value indicates device motion upward; a negative value indicates motion downward. Bit 0 = LSB.
8	7 - 0	Y15 - Y8	Y data (D15 - D8). A positive value indicates device motion upward; a negative value indicates motion downward. Bit 0 = LSB.

All rights strictly reserved any portion in this paper shall not be reproduced, copied or transformed to any other forms without permission.   11
PixArt Imaging Inc.
E-mail: fae_service@pixart.com.tw   V0.3 Nov. 2009

6. Referencing Application Circuit

6.1 3D3B Application Circuit
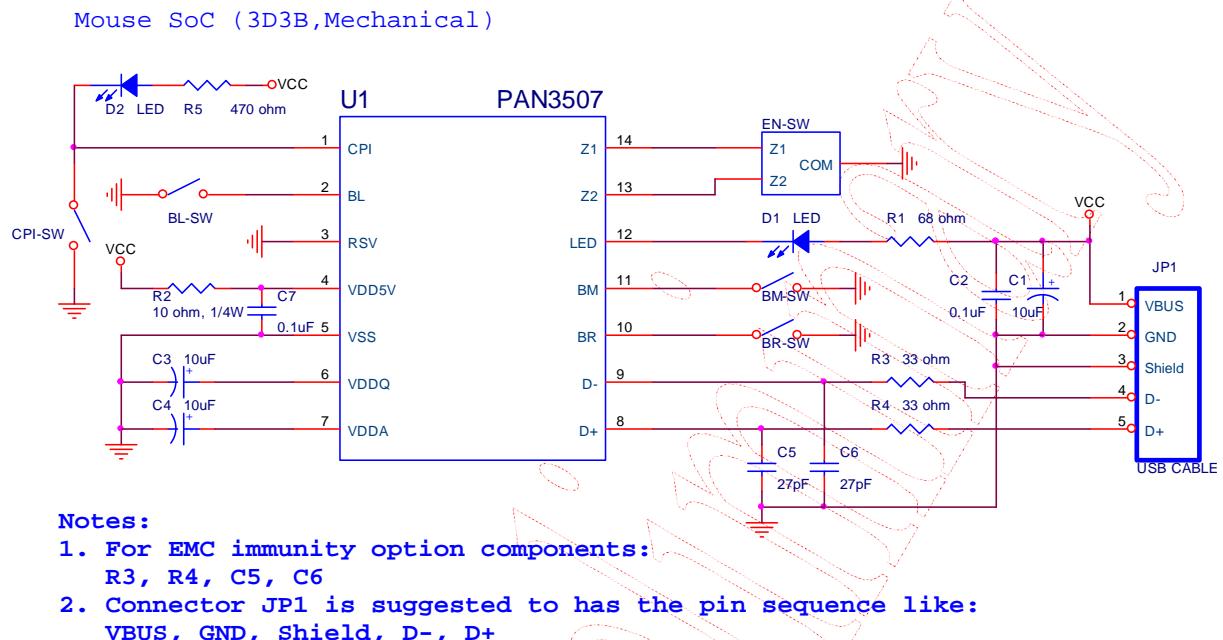
Figure 10. 3D3B Application Circuit

6.2 PCB Layout Guideline

The following guidelines apply to component placement and routing on the PCB. That will get an optimum EMC solution and tracking performance.

6.2.1 Key Components Placement Rules

1. Place bulk capacitor C1 and bypass C2 near the USB CABLE.

2. Place C3 and C4 near SENSOR's pin6 and pin7.

3. The C5/C6 and R3/R4 should be placed as close to the USB CABLE.

6.2.2 Routing Rules

1. Caps for pins VDD5V, VDDQ, VDDA trace length must be less than 5 mm.

6.3 Recommended Value for R1

Radiometric intensity of LED
Bin limits (mW/Sr at 20mA)

LED Bin Grade	Min	Typ	Max	Unit
Q	21.2	-	25.4	mW/Sr

Note: Tolerance for each bin will be ± 15%

R1 value (ohm), V_{DD} =5.0V

LED Bin Grade	Min	Typ	Max	Unit
Q	-	68	-	ohm

7. Package Information

7.1 Package Outline Drawing
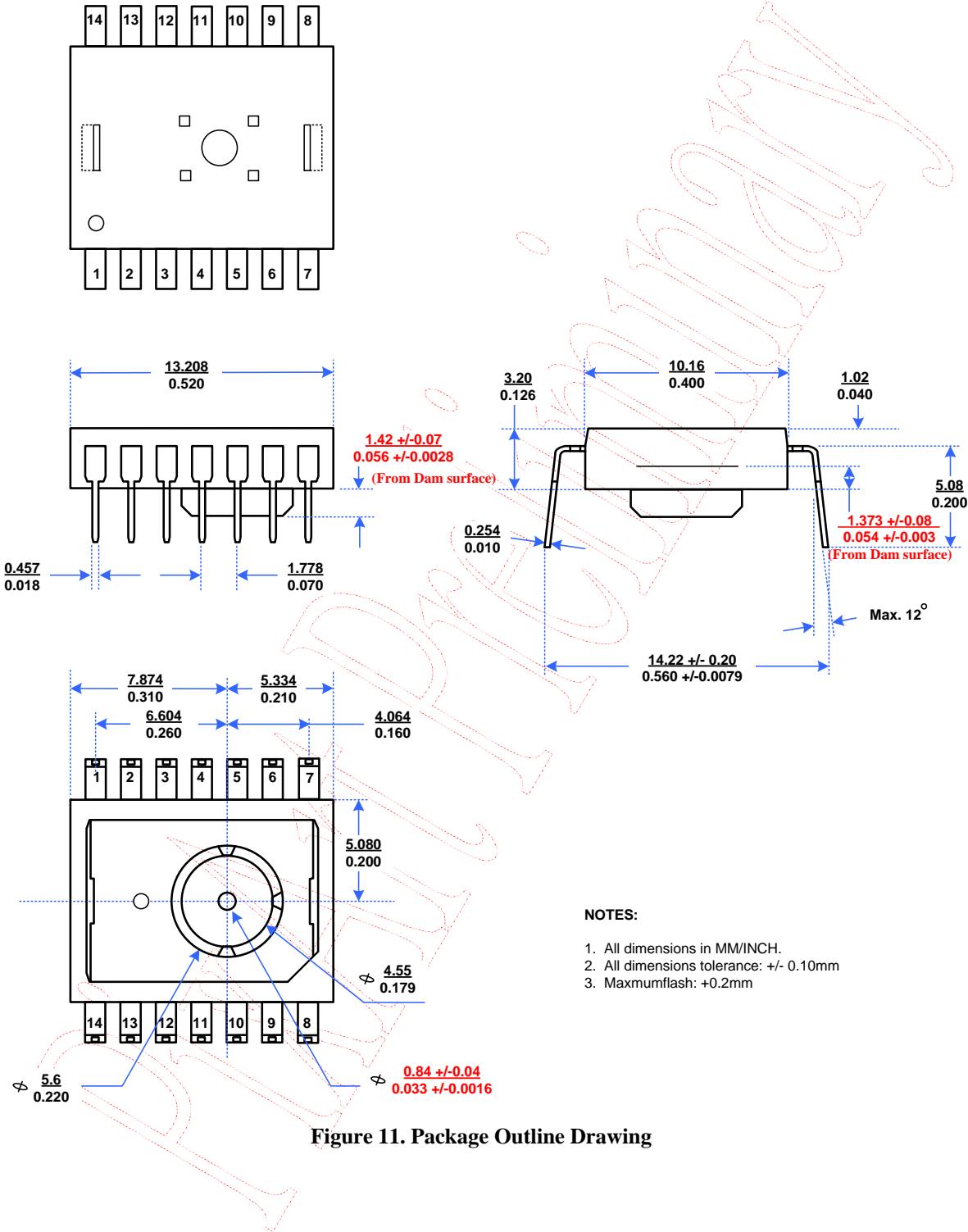
Figure 11. Package Outline Drawing

NOTES:

1. All dimensions in MM/INCH.
2. All dimensions tolerance: +/- 0.10mm
3. Maxmumflash: +0.2mm

7.2 Recommended PCB Mechanical Cutouts and Spacing

All Dimension : mm/inch

Back Side
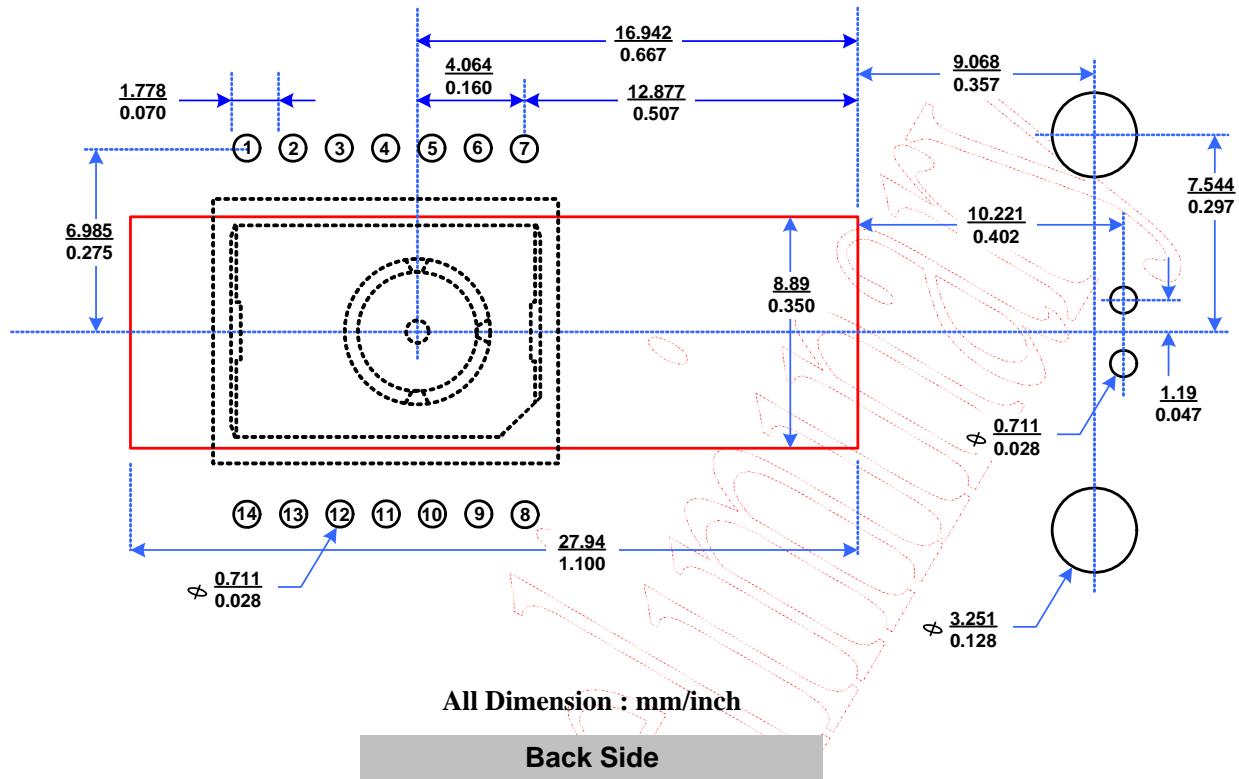
Figure 12. Recommended PCB Mechanical Cutouts and Spacing

14
PixArt Imaging Inc.
E-mail: fae_service@pixart.com.tw   V0.3 Nov. 2009

8. Update History

Version	Update	Date
V0.1	Creation, Preliminary 1st version	05/05/2009
V0.2	1. Modified pin descriptions in section 1.1. 2. Modified application circuits and move it to section 6.1. 3. Contents appended: section 2~7.	07/27/2009
V0.3	1. Modified feature list in page 1. 2. Rearrange DC Electrical Characteristics table. 3. Modified 2D and 3D assembly figure in Section 4.	11/04/2009

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.

All rights strictly reserved any portion in this paper shall not be reproduced, copied or transformed to any other forms without permission.   15
PixArt Imaging Inc.
E-mail: fae_service@pixart.com.tw   V0.3 Nov. 2009