PAW3204LU-TJDU
SMD-TYPED ULTRA LOW POWER WIRELESS MOUSE SENSOR

General Description

The PAW3204LU-TJDU is a SMD-typed high performance and ultra 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, AKA 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 1500 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**
- **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**
- **LED drive mode configuration**

Key Specification

Power Supply	**Operating voltage** **1.73V ~ 1.98V (VDD and VDDA short)** **2.1V ~ 3.6V (VDD)**
Optical Lens	**1:0.8**
Speed	**Up to 30 inches/sec**
Acceleration	**Up to 10 G**
Resolution	**500/ 650/ 750(Default)/ 1000/ 1300 /1500 CPI**
Frame Rate	**Up to 2400 frames/sec**
Typical Operating Current **(without I/O toggling)**	**1.6 mA @ Mouse moving (Normal1)** **1.2 mA @ Mouse moving (Normal2)** **1.0 mA @ Mouse moving (Normal3)** **70 uA @ Mouse not moving (Sleep1)** **10 uA @ Mouse not moving (Sleep2)** **9 uA @ Power down mode** *including LED, typical value
Package	**SMD, 8 balls**

Ordering Information

Order Number	Bundle Part Number	Part Description
PAW3204LU-TJDU	PAW3204LU-TJDU	SMD CMOS Optical Mouse Sensor
	PNSR-015-RB1	Bundle Lens for Infrared LED

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

1. Pin Configuration

1.1 Pin Description

Pin	Name	Type	Definition
A1	VDDA	PWR	Analog/Digital supply voltage (1.9V) Power supply (1.73V~1.98V) for low power operation voltage
C1	VSS	GND	Chip ground
E1	LED	OUT	LED control
B2	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
D2	SDIO	I/O	Serial interface bi-direction data *Initial with input floating
A3	ATPG_EN	IN	Reserved. Connect to ground
C3	MOTSWK	OUT	Motion detect (active low, see Section7) *Initial with output high
E3	SCLK	IN	Serial interface clock *Initial with input floating

1.2 Pin Assignment

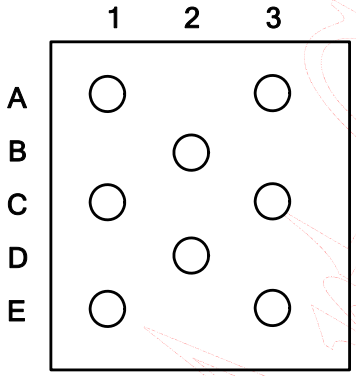

Figure 1. Top View Pinout

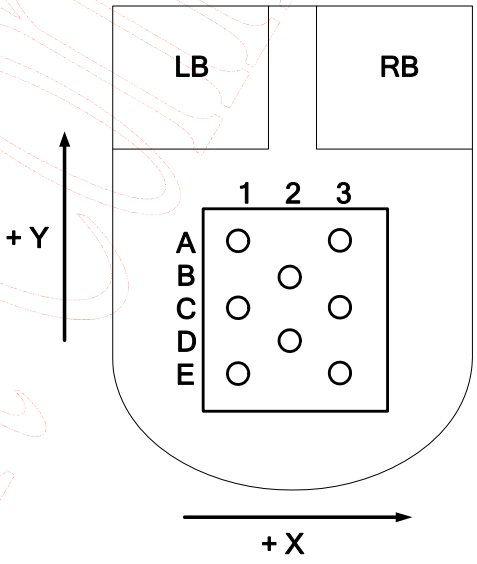

Figure 2. Top View of Mouse

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2. Block Diagram and Operation

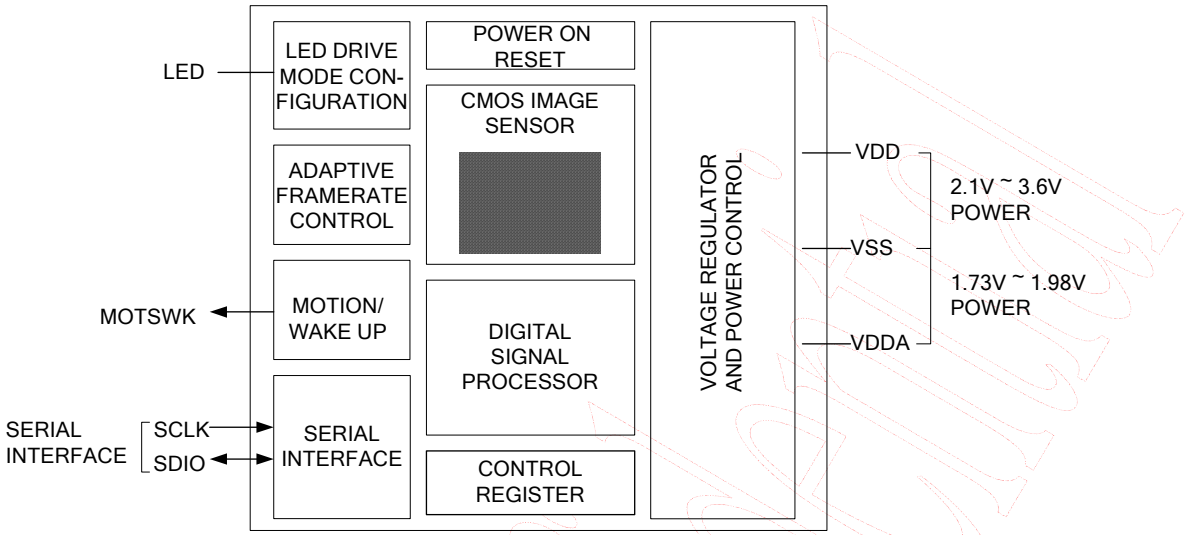

Figure 3. Block Diagram

The PAW3204LU-TJDU is a SMD-typed high performance and ultra 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-ball SMD package. The current X and Y information are available in registers accessed via a serial port. The word "mouse sensor", instead of PAW3204LU-TJDU, is used in the document.

With LED control 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 2400/1200/800 frame per second.

A brand-new configurable LED drive mode switch function provides flexible choice for the user to achieve different LED application. The mouse sensor provides TWO choices with Current DAC mode, and Current Switch modes. **Note that default drive is Current DAC mode**.

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	0xFX	Upper Four bits[3:0] number with the product identifier Lower Four bits[3:0] number with the product version(VID)
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	0x02	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	0x70	Bit field
0x0B	Enter_Time	R/W	0x10	Bit field
0x0C	Sleep2_Setting	R/W	0x70	Bit field
0x0D	Image_ Threshold	R/W	0x14	Eight bits unsigned integer
0x0E	Image_ Recognition	R/W	0xE5	Bit field
0x31	AE_State_Index	R	-	Lower Six bits[5:0] unsigned integer
0x37	Frameavg	R	-	Eight bits unsigned integer
0x41	LED_DriveStrength	R/W	0xE8	LED drive strength selection
0x43	LED_DriveMode	R/W	0xA9	LED drive mode selection

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		-	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_{dd1}	Power Supply Voltage	1.73	1.9	1.98	V	VDDA, VDD short
V_{dd2}		2.1	2.7	3.6		VDD
V_{Npp}	Supply Noise	-	-	150	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.
Y1	Distance from PCB surface to object surface	5.75	5.85	5.95	mm	PCB to Lens housing surface **must be contact**.
Y2	PCB THICKNESS		1.6		mm	1.6mm is the recommended PCB thickness.
R	Resolution	500	750	1500	CPI	
SCLK	Serial Port Clock Frequency	0.08	-	1	MHz	
FR	Frame Rate	800	1200	2400	frames/s	@ Normal mode, +/- 5% tolerance
S	Speed	0	-	30	inches/s	
A	Acceleration	0	-	10	g	

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A	Acceleration	0	-	10	g	

4.3 AC Operating Condition (1.9V / 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} = 1.9 V for 1.9V application.

Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
t_{PDR}	PD Pulse Register	-	-	836	us	Two frames time maximum after setting ***PD_enh*** bit in the ***Configuration*** register @2400frame/sec (refer to Figure 15).
t_{PU}	Power Up from V_{DD}↑	10	-	38	ms	From V_{DD}↑ to valid motion signals. And also for valid register read/write after HW/SW reset. 500usec + 90 frames.
t_{HOLD}	SDIO Read Hold Time	3	3	-	us	Minimum hold time for valid data (refer to Figure 10).
t_{RESYNC}	Serial Interface RESYNC.	1	-	-	us	@2400 frame/sec (refer to Figure 14)
t_{SIWTT}	Serial Interface Watchdog Timer Timeout	1.7 32 512	-	-	ms	@2400 frame/sec (refer to Figure 14) 1.7ms for normal mode, 32ms (typical) for sleep1 mode, 512ms (typical) for sleep2 mode. Note that the value depends on the setting of ***Sleep1_Setting*** register and ***Sleep2_Setting*** register.
$t_{ForSlp-EN}$	Force Entering Sleep Mode	-	-	2	ms	From Normal mode to target Sleep mode by bits setting (refer to Register 0x05)
$t_{ForSlp-DIS}$	Force Waking from Sleep Mode	-	-	38	ms	From Sleep mode to Normal mode by Wakeup bit setting (refer to Register 0x05)
$t_{DLY-SDIO}$	SDIO delay after SCLK	-	-	120	ns	From SCLK falling edge to SDIO data valid, no load conditions
t_{SWW}	SPI Time between two Write Commands	25	-	-	us	From rising SCLK for last bit of the first data byte, Commands to rising SCLK for last bit of the second data byte (refer to Figure 11)
t_{SWR}	SPI Time between Write and Read Commands	15	-	-	us	From rising SCLK f or last bit of the first data byte, to rising SCLK for last bit of the second address byte (refer to Figure 12)
t_{SRW} t_{SRR}	SPI Time between Read and Subsequent Commands	500	-	-	ns	From rising SCLK for last bit of the first data byte, to falling SCLK for the first bit of the next address (refer to Figure 13)
t_{SRAD}	SPI Read Address-Data Delay	3	-	-	us	From rising SCLK for last bit of the address byte, to falling SCLK for first bit of data being read (refer to Figure 13)
t_{SWKINT}	Wakeup Interrupt Time	-	418	-	us	
t_r , t_f	Rise and Fall Times: SDIO	-	30, 30	-	ns	C_L = 30 pF

4.4 DC Electrical Characteristics (1.9V)

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, $V_{DD} = V_{DDA} = 1.9$ V

Symbol	Parameter	Min.	Typ.	Max.	Unit	
Type: Power (Including LED current)						
I_{DDN1}	Supply Current Mouse Moving (Normal1)	-	1.6	-	mA	@ 2400 FPS
I_{DDN2}	Supply Current Mouse Moving (Normal2)	-	1.2	-	mA	@ 1200 FPS
I_{DDN3}	Supply Current Mouse Moving (Normal3)	-	1.0	-	mA	@ 800 FPS
I_{DDS1}	Supply Current Mouse Not Moving (Sleep1)	-	70	-	uA	
I_{DDS2}	Supply Current Mouse Not Moving (Sleep2)	-	10	-	uA	
I_{DDPD}	Supply Current (Power Down)	-	9	-	uA	
Type: SCLK, SDIO, PD, MOTSWK						
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	-	-	100	mV	@I_{OL} = 10mA
I_{LEDS}	LED Sink Current	-	-	50	mA	

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 (Including LED current)						
I_{DDN1}	Supply Current Mouse Moving (Normal1)	-	1.6	-	mA	@ 2400 FPS
I_{DDN2}	Supply Current Mouse Moving (Normal2)	-	1.2	-	mA	@ 1200 FPS
I_{DDN3}	Supply Current Mouse Moving (Normal3)	-	1.0	-	mA	@ 800 FPS
I_{DDS1}	Supply Current Mouse Not Moving (Sleep1)	-	70	-	uA	
I_{DDS2}	Supply Current Mouse Not Moving (Sleep2)	-	10	-	uA	
I_{DDPD}	Supply Current (Power Down)	-	9	-	uA	
Type: SCLK, SDIO, PD, MOTSWK						
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	-	-	100	mV	@I_{OL} = 10mA
I_{LEDS}	LED Sink Current	-	-	50	mA	

5. Z, 2D/3D Assembly, PCB Position

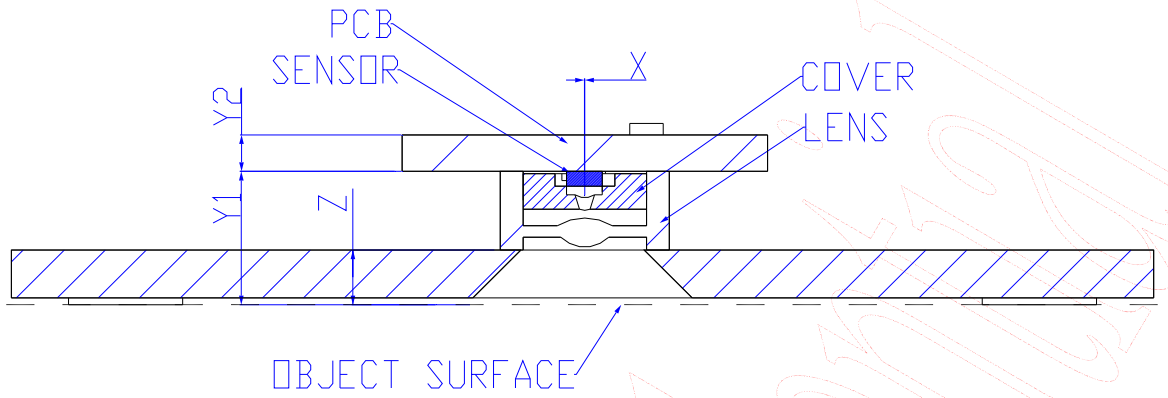

Figure 4. Distance from Lens Reference Plane to Surface

PARAMETERS	SYMBOL	MIN	TYP	MAX	UNIT	CONDITIONS
Distance from center of IC to center of Aperture stop	X			0.076	mm	Center of Aperture stop is close to center of IC by self-align housing.
Distance from PCB surface to object surface	Y1	5.72	5.85	5.98	mm	PCB to Lens housing surface **must be contact**.
PCB THICKNESS	Y2		(1.6)		mm	1.6mm is the recommended PCB thickness.
Distance from object surface to lens reference plane	Z	2.3	2.4	2.5	mm	

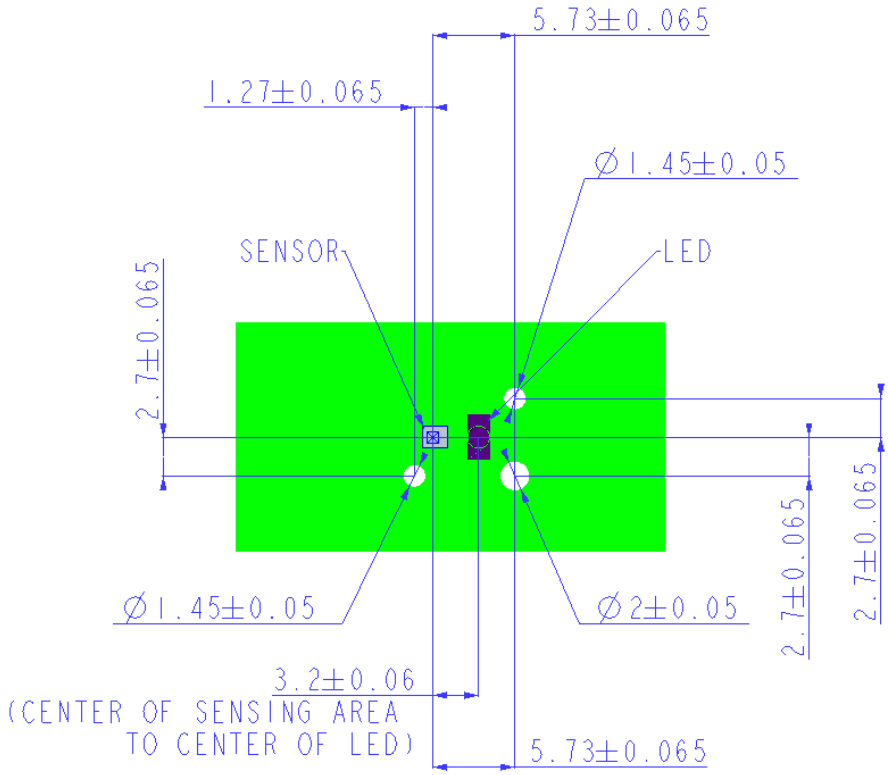

Figure 6. PCB Position for Layout/Mounting Instructions

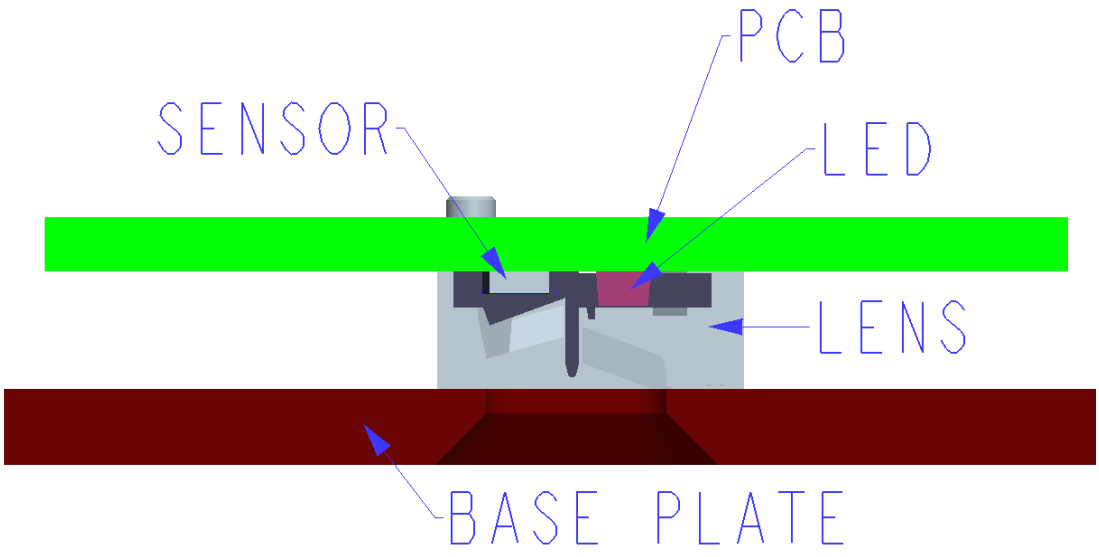

Figure 7. 3D Assembly for Mounting Instructions

9. Referencing Application Circuit

9.1 Power 2.7V Application Circuit, no DC/DC (with Infrared LED, 2.4GHz Transceiver)

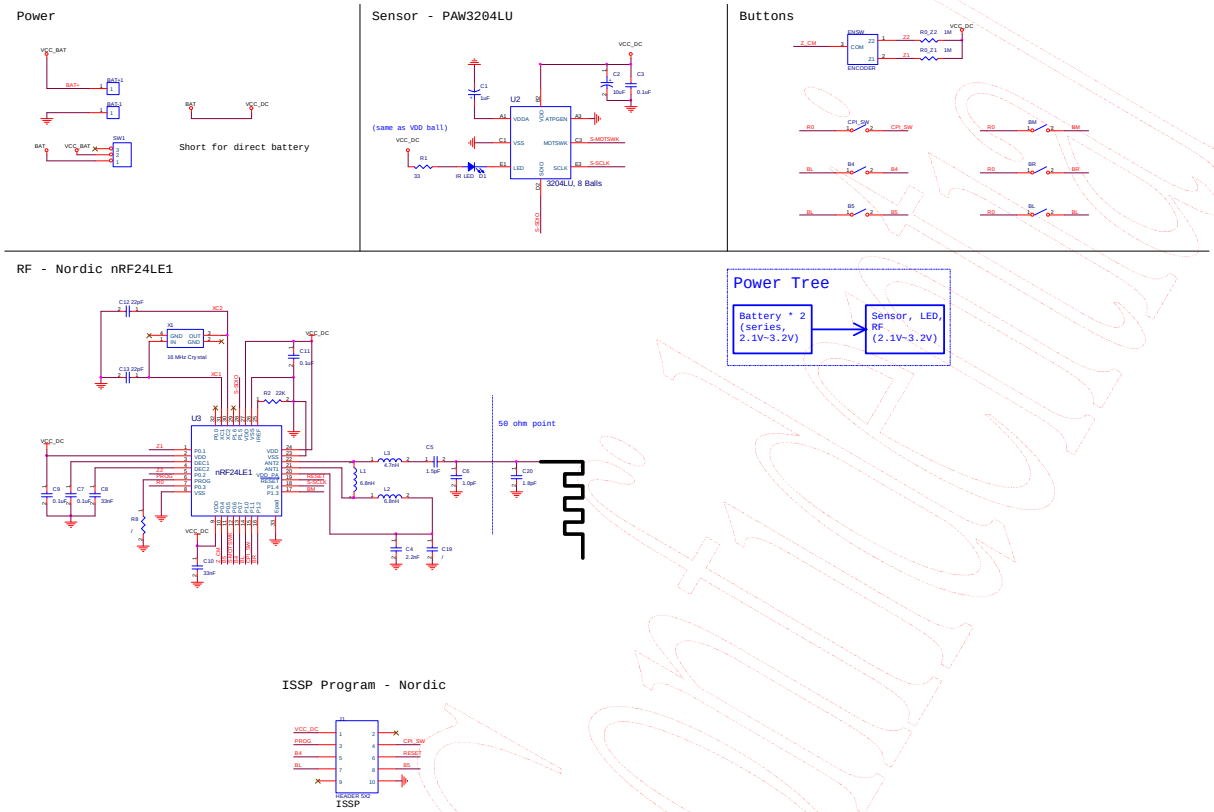

Figure 19. Application Circuit for 2.7V, no DC/DC (with Infrared LED)

9.2 Power 1.9V Application Circuit, one DC/DC (with Infrared LED, 2.4GHz Transceiver)

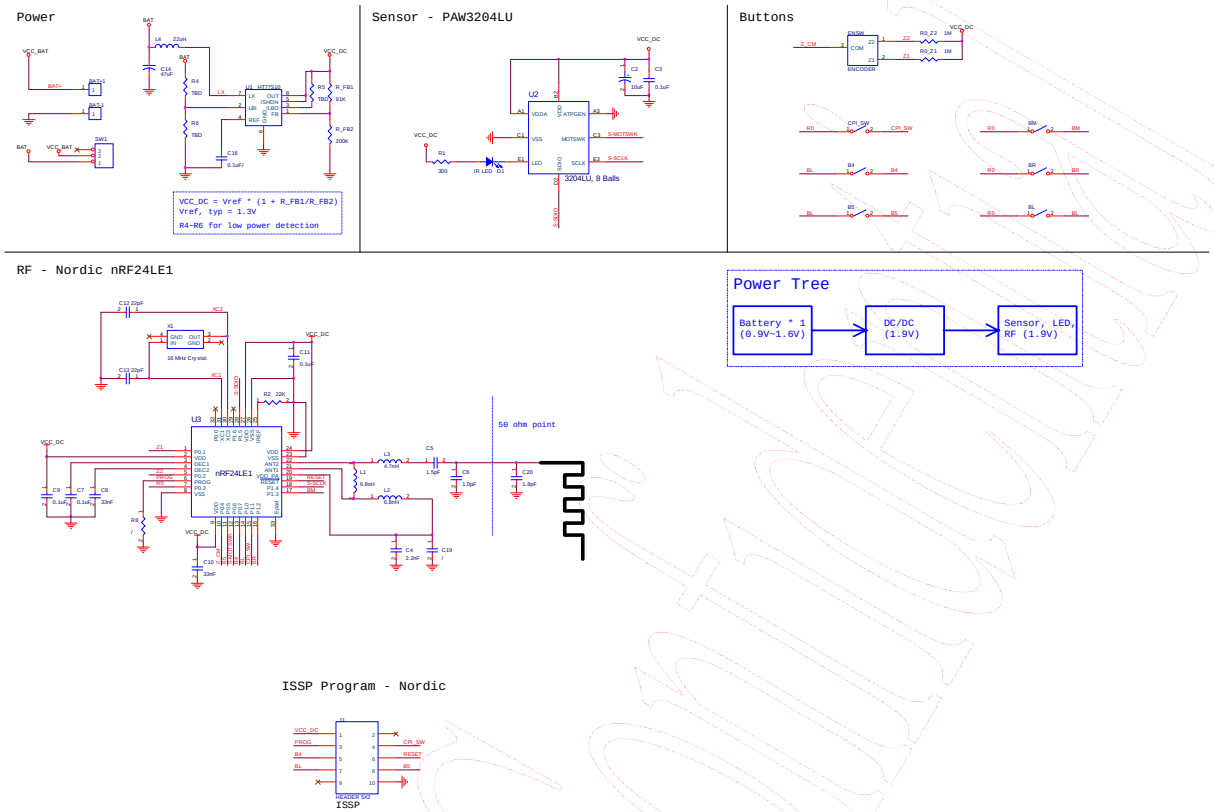

Figure 20. Application Circuit for 1.9V, one DC/DC (with Infrared LED)

9.3 PCB Layout Consideration

- Caps for balls A1, B2 must have trace lengths less than **5mm**.

9.4 Recommended Value for R1

Light Source	V_{LED}	R1		
		Min.	Typ.	Max.
Infrared LED	2.1~3.6	-	33	-
	1.73~1.98	-	300	-

* Recommended using LTE-C216-P-W LED.

** Recommends using internal current DAC for 2.1V~3.6V, and R1 is unnecessary.

10. Optical Criterion

10.1 Recommended Infrared LED Angle Criterion

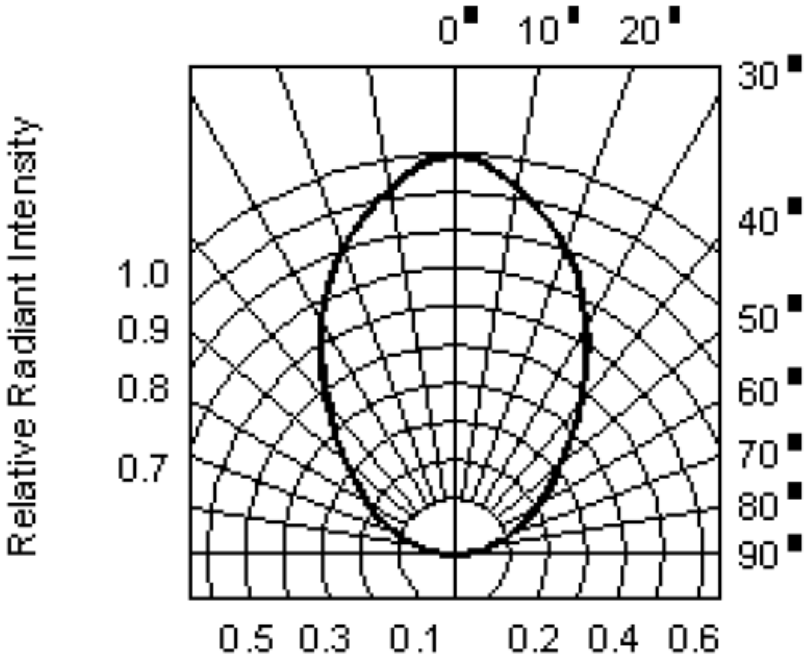

Figure 21. Radiation Characteristics

LED Viewing Angle	Min.	Typ.	Max.
$2\theta_{1/2}$	-	100	-

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

10.2 Recommended Value for Optical Power

- In order to balance tracking performance of PAW3204LU-TJDU 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	200	-	1000	uW

11. Package Information

11.1 Package Outline Drawing

	Symbol	Nominal	Min.	Max.
			µm	
Package Body Dimension X	A	1567	1542	1592
Package Body Dimension Y	B	1751.8	1726.8	1776.8
Package Height	C	665	605	725
Ball Height	C1	130	100	160
Package Body Thickness	C2	535	490	580
Thickness of Glass surface to wafer	C3	405	385	425
Ball Diameter	D	250	220	280
Total Pin Count	N	8		
Pin Count X axis	N1	3		
Pin Count Y axis	N2	5		
Pins Pitch X axis	J1	440		
Pins Pitch Y axis	J2	300		
Edge to Pin Center Distance along X	S1	343.5	313.5	373.5
Edge to Pin Center Distance along Y	S2	275.9	245.9	305.9

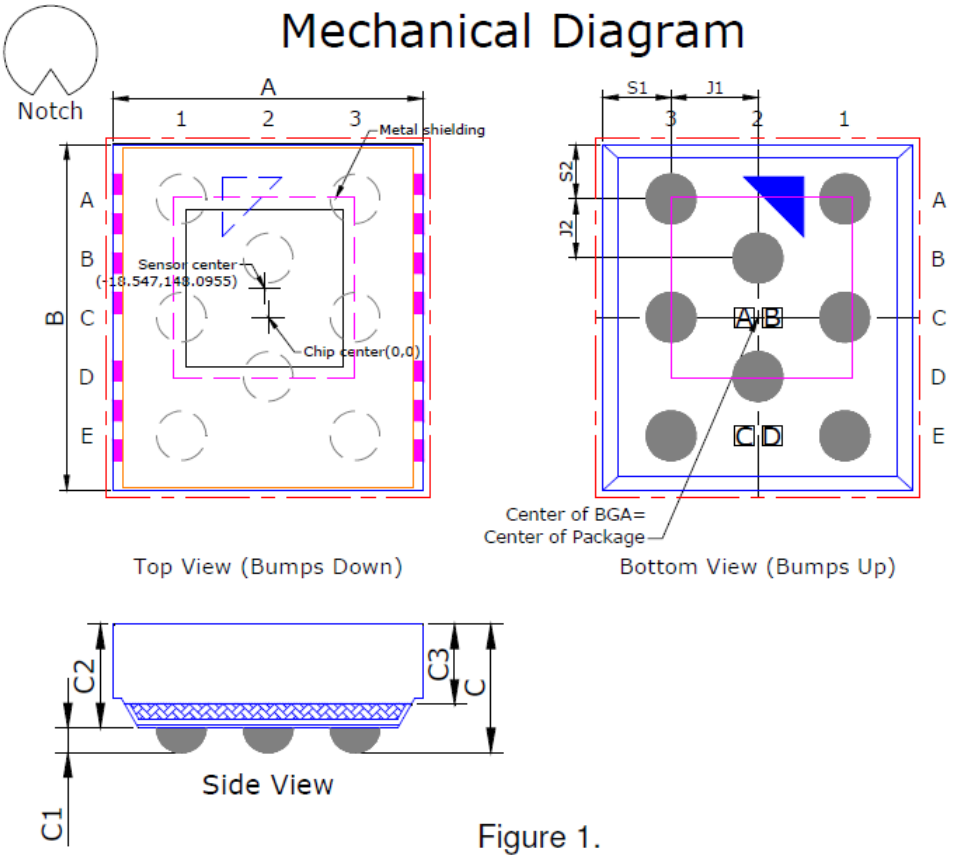

Figure 22. Package Outline Drawing