

PAW3902JF-TXQT: Optical Motion Tracking Chip

Product Datasheet

General Description

The PAW3902JF-TXQT is PixArt Imaging's latest improved low light performance optical motion tracking chip designed to a wide working range of 80 mm to infinity. Its latest state of the art architecture allows motion tracking under low light condition of down to 30 lux. In addition, a dedicated super low light mode is designed for motion tracking at single digit lux which is suitable for low speed super low light hovering stabilization function. It is housed in a smaller form factor of 14-pin land-grid-array (LGA) package and is most suitable for far field application for motion detection, e.g Drone.

Key Features

- Three Operation Modes to cater different far field application needs and ambient conditions.

Mode	Description	Lux (Typ)
0 @ 126 fps	Bright Mode for general motion tracking	60
1 @ 126 fps (Default)	Low Light Mode for low light motion tracking	30
2 @ 50 fps	Super Low Light Mode for super low light and low speed motion tracking	9

- Wide working range from 80 mm to infinity
- No lens focusing required during lens mounting process
- Power consumption of 6 mA typical @ run mode
- Effective viewing angle of 42 degree
- High speed of max 7.4 rad/s (Mode 0 & 1)
- 16-bits motion data registers
- Motion detect pin output

- Internal oscillator – no clock input needed
- Frame capture via register read is available
- Synchronized Chip Operation

Applications

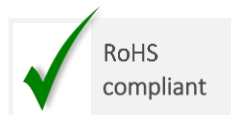
- Devices that require far field motion detection and hovering stability, e.g Drone
- Indoor and outdoor X-Y positioning especially in GPS denied environment

Key Parameters

Parameter	Value
Supply Voltage (V)	V _{DD} : 1.8 – 2.1 V _{DDIO} : 1.8 – 3.6
Working Range (mm)	80 to infinity
Interface	4-Wire SPI @ 2 MHz
Package Type	14-pin LGA Package with L214-ZSZ Lens Assembly: 5 x 5 x 3.08 mm

Ordering Information

Part Number	Package Type
PAW3902JF-TXQT	14-pin LGA Package
L214-ZSZ	Lens Assembly



For any additional inquiries, please contact us at <http://www.pixart.com/contact.asp>

1.0 Signal Description

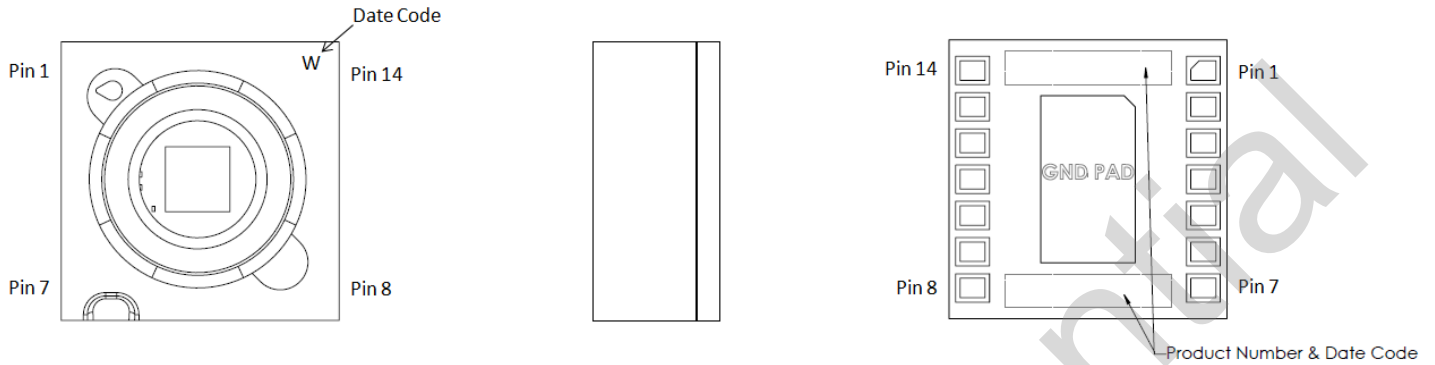


Figure 1. Pin Configuration

Table 1. Signal Pins Description

Pin No.	Signal Name	Type	Description
Functional Group:		Power Supplies	
2	VDD	Power	Input power supply
3	VDDIO	Power	I/O reference voltage
4	VREG	Power	Internal voltage output
1	GND	Ground	Ground
14	GND	Ground	Ground
Functional Group:		Control Interface	
9	MOSI	Input	Serial data input
10	SCLK	Input	Serial data clock
11	MISO	Output	Serial data output
12	NCS	Input	Chip select
Functional Group:		Functional I/O	
7	NRESET	Input	Hardware reset (Active low)
8	MOTION	Output	Motion interrupt (Active low)
13	LED_N	Input	External LED control pin (Active low) (Refer Appendix A for more details)
Functional Group:		Special Function Pin	
5 - 6	NC	NC	No connection (float)
15*	GND PAD	Ground Pad	Bottom of LGA package must be connected to circuit ground

2.0 Operating Specifications

2.1 Absolute Maximum Ratings

Table 2. Absolute Maximum Ratings

Parameters	Symbol	Min.	Max.	Unit	Notes
Storage Temperature	T_S	-40	85	°C	
Lead-Free Solder Temperature	T_{SOLDER}		260	°C	
Supply Voltage	V_{DD}	-0.5	2.1	V	
	V_{DDIO}	-0.5	3.6	V	
Input Voltage	V_{IN}	-0.5	3.6	V	All I/O pins
ESD	ESD_{HBM}		2	kV	All pins (Human Body Model)

Notes:

1. Maximum Ratings are those values beyond which damage to the device may occur.
2. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute maximum-rated conditions is not implied.
3. Functional operation should be restricted to the Recommended Operating Conditions.

2.2 Recommended Operating Conditions

Table 3. Recommended Operating Conditions

Description	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Temperature	T_A	0		60	°C	
Power Supply Voltage	V_{DD}	1.8	2.0	2.1	V	Including supply noise
	V_{DDIO}	1.8	2.0	3.6	V	$V_{DDIO} \geq V_{DD}$
Power Supply Rise Time	t_{RT}	0.15		20	ms	0 to V_{DD} min
Supply Noise (Sinusoidal)	V_{NA}			100	mV _{p-p}	10 kHz – 75 MHz
Serial Port Clock Frequency	f_{SCLK}			2	MHz	50% duty cycle
Working Range	Z	80			mm	
Effective Viewing Angle	V_A		42		°	
Minimum Illuminance (@ Crimson Carpet, Grey Vinyl & Light Grey Cement surfaces)	L_{XM0}		60		lux	Mode 0: Bright Mode
	L_{XM1}		30		lux	Mode 1: Low Light Mode (Default Mode)
	L_{XM2}		9		lux	Mode 2: Super Low Light Mode
Frame Rate	F_{RM0}		126		fps	Mode 0: Bright Mode
	F_{RM1}		126		fps	Mode 1: Low Light Mode (Default Mode)
	F_{RM2}		50		fps	Mode 2: Super Low Light Mode
Speed	S			7.4	rad/s	Mode 0 & 1

Note: PixArt does not guarantee the performance of the system beyond the recommended operating condition limits.

2.3 DC Characteristics

Table 4. DC Electrical Specifications

Parameters	Symbol	Min.	Typ.	Max.	Unit	Conditions
Supply Current	I_{DD_RUN}		6		mA	Average current. No load on MISO, MOTION.
Power Down Current	I_{PD}		12		uA	
Input Low Voltage	V_{IL}			$0.3 \cdot V_{DDIO}$	V	SCLK, MOSI, NCS
Input High Voltage	V_{IH}	$0.7 \cdot V_{DDIO}$			V	SCLK, MOSI, NCS
Input Hysteresis	V_{I_HYS}		100		mV	SCLK, MOSI, NCS
Input Leakage Current	I_{LEAK}		± 1	± 10	uA	$V_{in} = V_{DDIO}$ or $0V$, SCLK, MOSI, NCS
Output Low Voltage	V_{OL}			0.45	V	$I_{OUT} = 1mA$, MISO, MOTION
Output High Voltage	V_{OH}	$V_{DDIO} - 0.45$			V	$I_{OUT} = -1mA$, MISO, MOTION

Note: All the parameters are tested under operating conditions: $V_{DD} = 2.0V$, $V_{DDIO} = 2.0V$, $T_A = 25^\circ C$.

2.4 AC Characteristics

Table 5. AC Electrical Specifications

Parameters	Symbol	Min.	Typ.	Max.	Unit	Conditions
Motion Delay After Reset	$t_{MOT-RST}$	50			ms	From reset to valid motion, assuming motion is present
Shutdown	t_{STDWN}			500	us	From Shutdown mode active to low current
Wake from Shutdown	t_{WAKEUP}	50			ms	From Shutdown mode inactive to valid motion. Notes: A RESET must be asserted after a shutdown. Refer to section "Notes on Shutdown", also note $t_{MOT-RST}$.
MISO Rise Time	t_{r-MISO}		50		ns	$C_L = 100pF$
MISO Fall Time	t_{f-MISO}		50		ns	$C_L = 100pF$
MISO Delay After SCLK	$t_{DLY-MISO}$			120	ns	From SCLK falling edge to MISO data valid, no load conditions
MISO Hold Time	$t_{hold-MISO}$	200			ns	Data held until next falling SCLK edge
MOSI Hold Time	$t_{hold-MOSI}$	200			ns	Amount of time data is valid after SCLK rising edge
MOSI Setup Time	$t_{setup-MOSI}$	120			ns	From data valid to SCLK rising edge
SPI Time Between Write Commands	t_{Sww}	10.5			μs	From rising SCLK for last bit of the first data byte, to rising SCLK for last bit of the second data byte.
SPI Time Between Write And Read Commands	t_{SWR}	6			μs	From rising SCLK for last bit of the first data byte, to rising SCLK for last bit of the second address byte.
SPI Time Between Read And Subsequent Commands	t_{SRW} t_{SRR}	1.5			μs	From rising SCLK for last bit of the first data byte, to falling SCLK for the first bit of the address byte of the next command.
SPI Read Address-Data Delay	t_{SRAD}	2			μs	From rising SCLK for last bit of the address byte, to falling SCLK for first bit of data being read.

NCS Inactive After Motion Burst	t_{BEXIT}	500			ns	Minimum NCS inactive time after motion burst before next SPI usage
NCS To SCLK Active	$t_{\text{NCS-SCLK}}$	120			ns	From last NCS falling edge to first SCLK rising edge
SCLK To NCS Inactive (For Read Operation)	$t_{\text{SCLK-NCS}}$	120			ns	From last SCLK rising edge to NCS rising edge, for valid MISO data transfer
SCLK To NCS Inactive (For Write Operation)	$t_{\text{SCLK-NCS}}$	2			μs	From last SCLK rising edge to NCS rising edge, for valid MOSI data transfer
NCS To MISO High-Z	$t_{\text{NCS-MISO}}$			500	ns	From NCS rising edge to MISO high-Z state
MOTION Rise Time	$t_{\text{r-MOTION}}$		50		ns	$C_L = 100\text{pF}$
MOTION Fall Time	$t_{\text{f-MOTION}}$		50		ns	$C_L = 100\text{pF}$
Input Capacitance	C_{in}		50		pF	SCLK, MOSI, NCS
Load Capacitance	C_L			100	pF	MISO, MOTION
Transient Supply Current	I_{DDT}			70	mA	Max supply current during the supply ramp from 0V to V_{DD} with min 150 μs and max 20 ms rise time (does not include charging currents for bypass capacitors).
	I_{DDTIO}			70	mA	Max supply current during the supply ramp from 0V to V_{DDIO} with min 150 μs and max 20 ms rise time (does not include charging currents for bypass capacitors).

Note: All the parameters are tested under operating conditions: $V_{\text{DD}} = 2.0\text{V}$, $V_{\text{DDIO}} = 2.0\text{V}$, $T_A = 25^\circ\text{C}$.

3.0 Mechanical Specifications

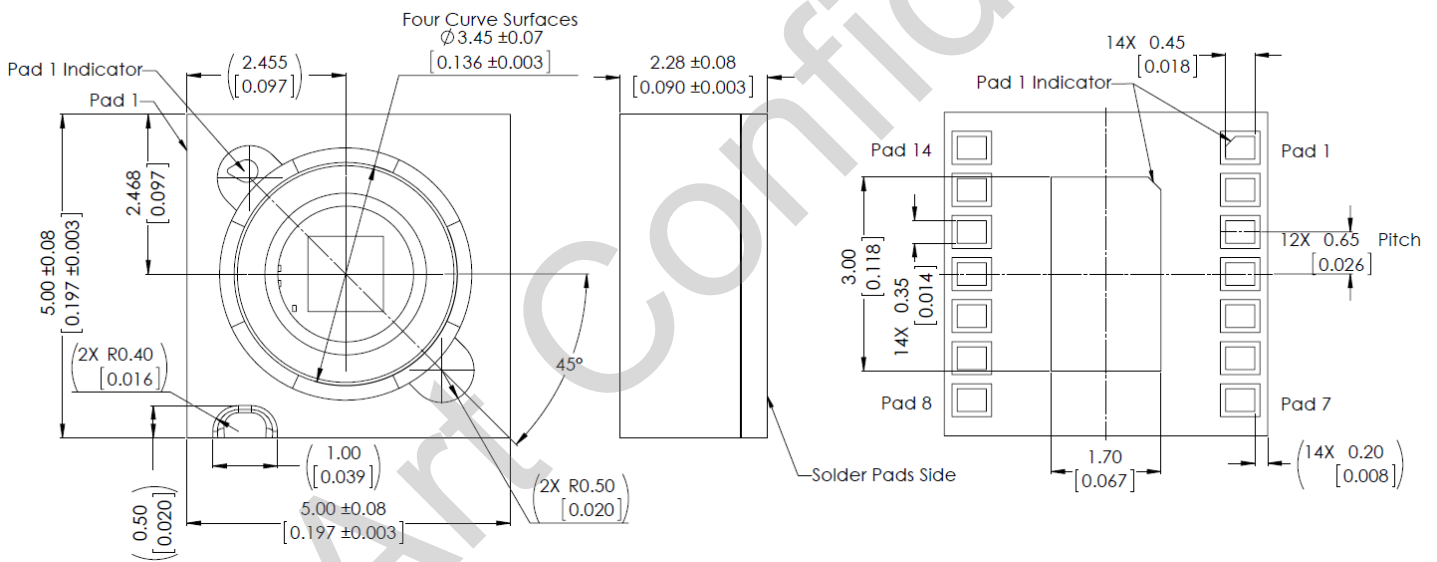
3.1 Package Marking

Refer Figure 1. Pin Configuration for the code marking location on the device package.

Table 6. Code Identification

Code	Marking	Description	Note
Product Number	P3902	Part number label	Marking on bottom of package
Date Code	YWX	Y: Year W: Week X: Reserved as PixArt reference	Marking on bottom of package
Date Code	W	W: Week	Marking on top of package

3.2 LGA Package Outline Drawing

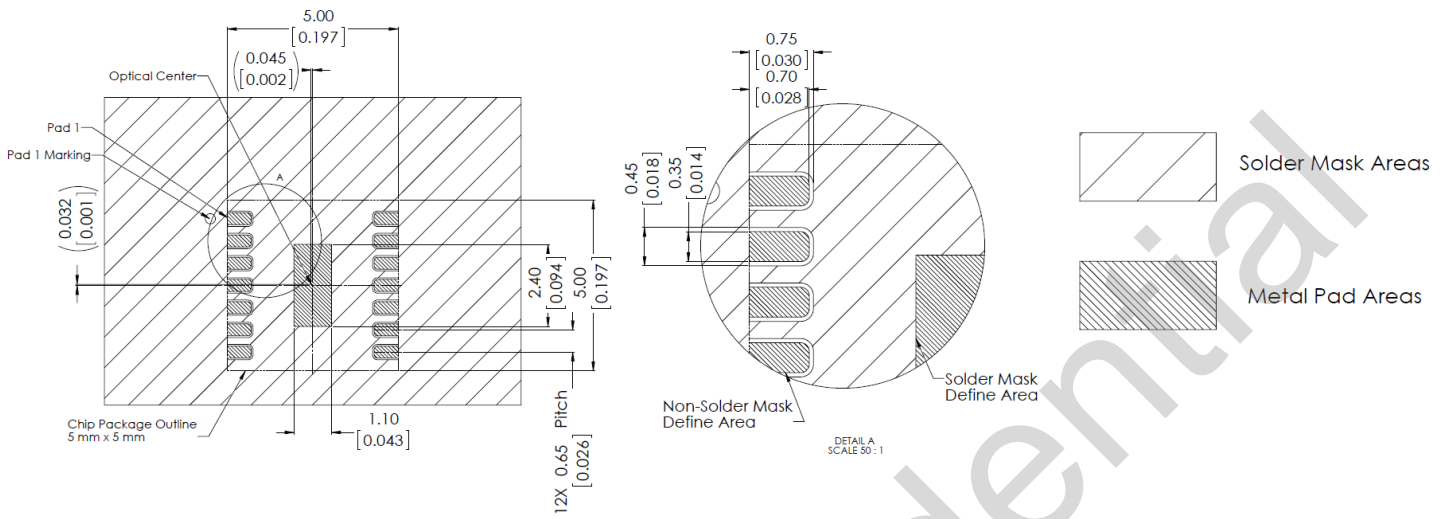


Notes:

1. Dimensions in millimeter [inches]
2. Coplanarity of pads: 0.08 mm
3. Non-cumulative pad pitch tolerance: ±0.10 mm
4. Maximum flash: ±0.20 mm
5. Dimensional tolerance: ±0.10 mm unless otherwise stated
6. Package Reference: 14L-5X5-LGA_003

CAUTION: It is advised that normal static discharge precautions be taken in handling and assembling of this component to prevent damage and/or degradation which may be induced by ESD.

Figure 2. LGA Package Outline Drawing



Note: Bottom center pad of LGA package must be connected to circuit ground.

Figure 3. Recommended PCB Layout

3.3 L214-ZSZ Lens Assembly Drawings

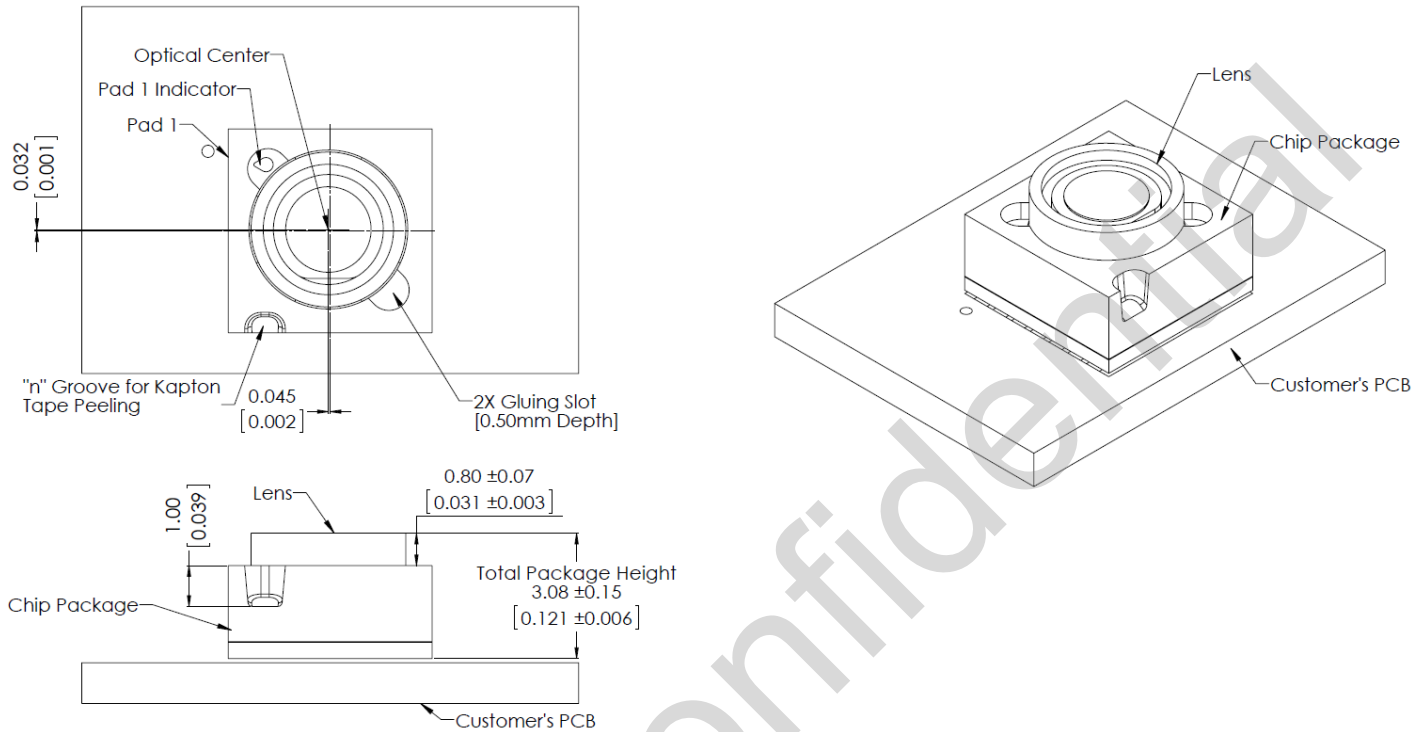


Figure 4. System Assembly View with L214-ZSZ

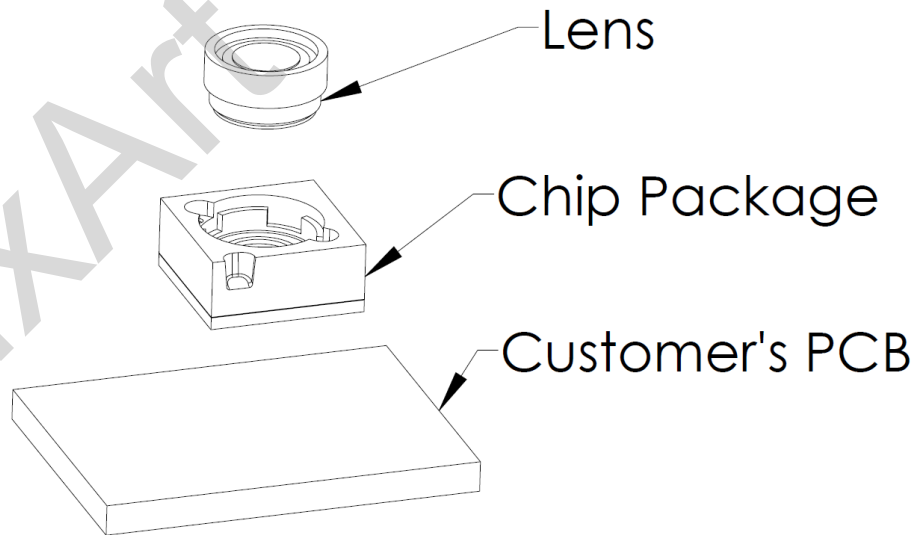


Figure 5. Exploded View of System Assembly

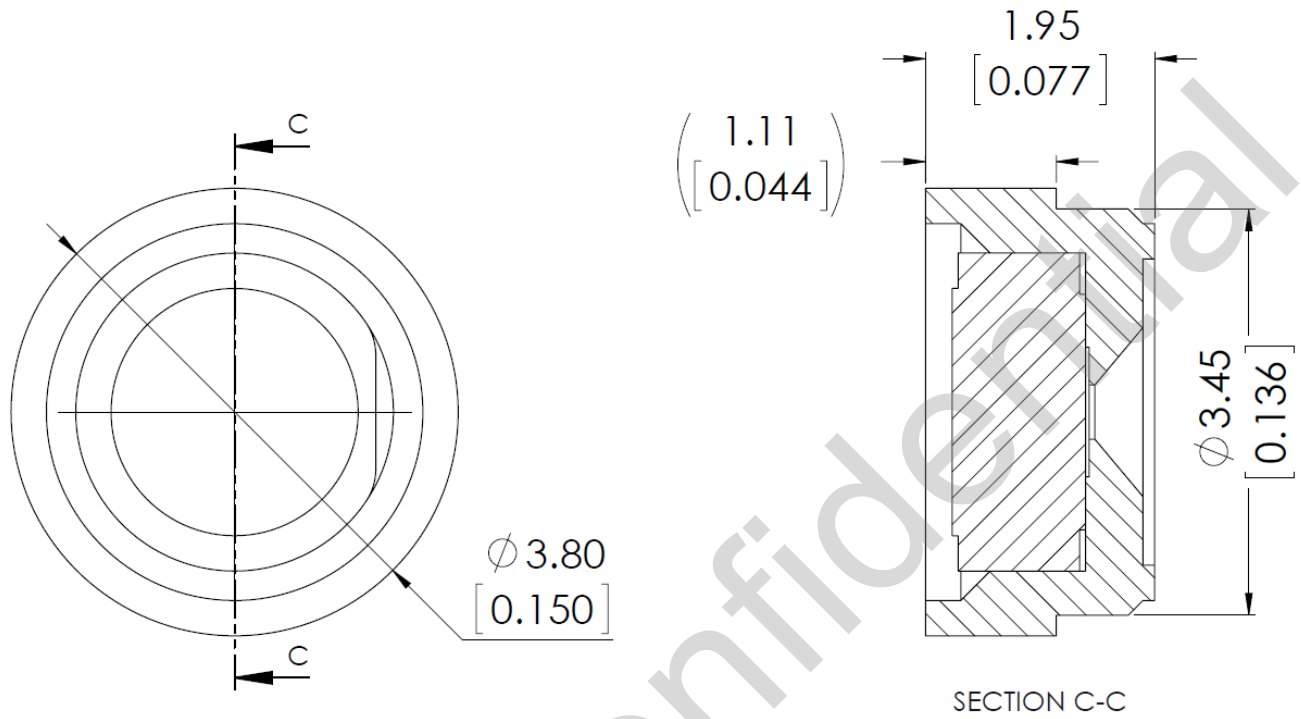
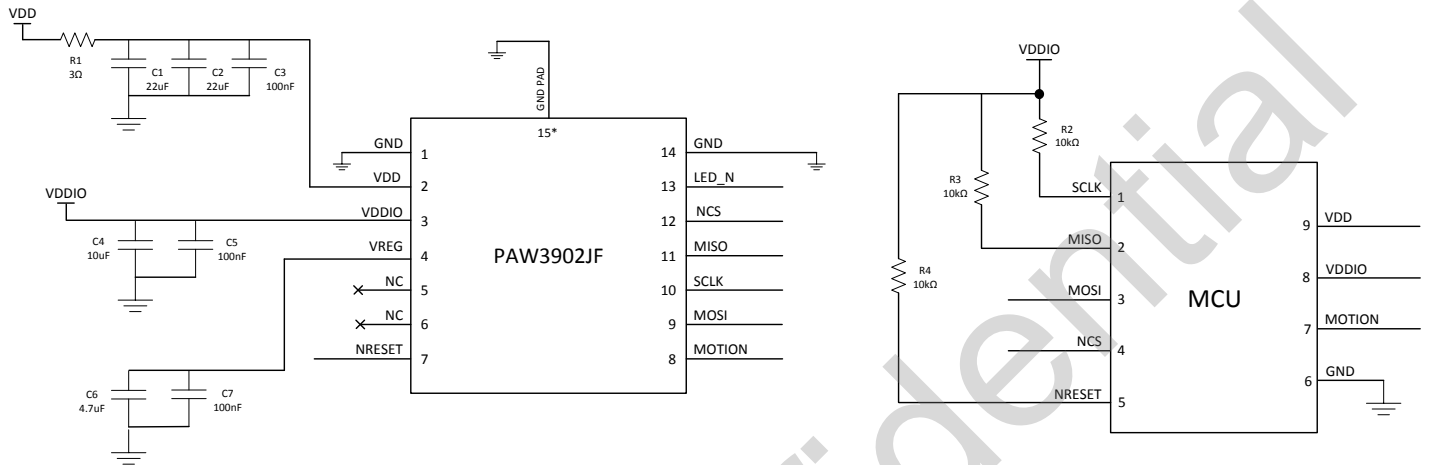


Figure 6. L214-ZSZ Lens Outline Drawing

4.0 System Level Description

4.1 Reference Schematic



Note:

1. All capacitors must be placed as close as possible to VDD, VDDIO & VREG pins.
2. Ceramic non-polarity capacitors are recommended.

Figure 7. PAW3902JF Reference Schematics

5.0 Registers

5.1 Registers List

PAW3902JF registers are accessible via the serial port. The registers are used to read motion data and status as well as to set the device configuration.

Table 7. Register List

Address	Register Name	Access	Reset	Address	Register Name	Access	Reset
0x00	Product_ID	RO	0x49	0x0B	Shutter_Lower	RO	0x00
0x01	Revision_ID	RO	0x01	0x0C	Shutter_Upper	RO	0x00
0x02	Motion	R/W	0x00	0x15	Observation	R/W	0x00
0x03	Delta_X_L	RO	0x00	0x16	Motion_Burst	RO	0x00
0x04	Delta_X_H	RO	0x00	0x3A	Power_Up_Reset	WO	N/A
0x05	Delta_Y_L	RO	0x00	0x3B	Shutdown	WO	N/A
0x06	Delta_Y_H	RO	0x00	0x4E	Resolution	R/W	0x14
0x07	Squal	RO	0x00	0x58	RawData_Grab	R/W	0x00
0x08	RawData_Sum	RO	0x00	0x59	RawData_Grab_Status	RO	0x00
0x09	Maximum_RawData	RO	0x00	0x5B	Orientation	R/W	0xE0
0x0A	Minimum_RawData	RO	0x00	0x5F	Inverse_Product_ID	RO	0xB6