PAW3395DM-T6QU: Optical Gaming Navigation Chip

General Description

The PAW3395DM-T6QU is PixArt Imaging's new low-power high-end gaming navigation chip with an illumination source in a 16-pin molded lead-frame DIP package. It provides the best-in-class gaming experience with the enhanced features of high speed, high resolution, high accuracy, and selectable lift detection height to fulfill professional gamers' needs. It is designed to be used with LM19-LSI or L0AE-LSI1 to achieve optimum performance.

Key Features

- Low power consumption of typical 1.7 mA in run mode (HP Mode)
- 16-pin molded lead-frame DIP package with 850nm illumination source
- Enhanced programmability
  - Gaming Mode
    - High Performance Mode (HP Mode)
    - Low Power Mode (LP Mode)
    - Corded Gaming Mode
  - Lift detection options
    - 1mm and 2mm setting
    - Manual lift cut-off calibration
- Selectable resolutions up to 26000 cpi with 50 cpi step size
- Angle snapping
- Angle tunability
- Resolution error of 0.4% (typical) at 5000cpi on QCK up to 200ips
- High speed motion detection 650ips* and acceleration 50g*
- Self–adjusting variable frame rate for optimum performance
- Internal oscillator — no clock input needed
- 4-wire serial port interface (SPI)
- Motion interrupt output

Applications

- Corded and cordless optical gaming mice
- Integrated input devices

Key Parameters

Parameter	Value
Power supply Range	VDD: 1.8 to 2.1V VDDIO: 1.8 to 3.3V
Lens Magnification	1:1
Interface	4-wire Serial Port Interface
Typical Operating Current @ VDD = 1.9V **Note:** includes LED current	Run: 1.7 mA (HP Mode) Run: 1.3 mA (LP Mode) Rest1: 580 µA Rest2: 11 µA Rest3: 6 µA Power Down: 4 µA
Resolution	Up to 26000 cpi
Tracking Speed	650* ips
Acceleration	50* g
Assembled Solution Size (Package Assemble with lens)	LM19-LSI: 18.85 x 21.15 x 9.81mm^3 L0AE-LSI1: 10.90 x 16.80 x 9.81mm^3

Note: * - HP Mode

Ordering Information

Part Number	Description	Package Type	Packing Type	MOQ
PAW3395DM-T6QU	Optical Gaming Navigation Chip	16-pin DIP	Tube	1,000
LM19-LSI	Round Lens	Round Lens	Tray	1,000
L0AE-LSI1	Trim Lens	Trim Lens	Tray	1,000

RoHS compliant

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

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1.0 Introduction

1.1 Overview

The PAW3395DM-T6QU is an optical navigation chip targeted for high-end cordless and corded gaming mouse. It contains a picture element array as Image Acquisition System (IAS), a Digital Signal Processing (DSP), a 4-wire serial port, a power control circuit, and a built-in LED driver integrated with IR LED in a package as shown in the block diagram. The chip measures changes in position by optically acquiring sequential surface images (frames) and mathematically determining the direction and magnitude of movement. The IAS acquires microscopic surface images via the lens and illumination system. The DSP processes these images to determine the direction and distance of motion and calculates the Δx and Δy relative displacement values. An external microcontroller reads the Δx and Δy information from the chip serial port. The microcontroller then translates the data into USB or RF signals before sending them to the host PC or game console.

Notes: Throughout this document, the PAW3395DM-T6QU is referred as the "chip".

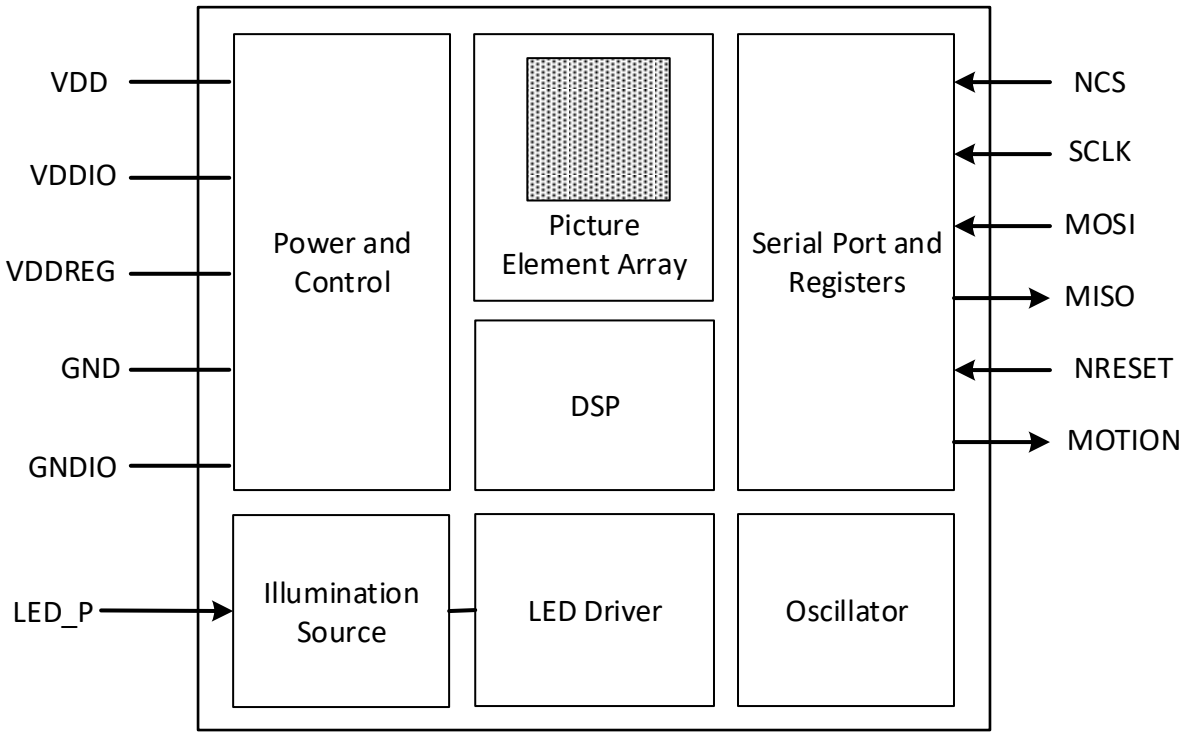


Figure 1. Block Diagram

1.2 Pin Configuration

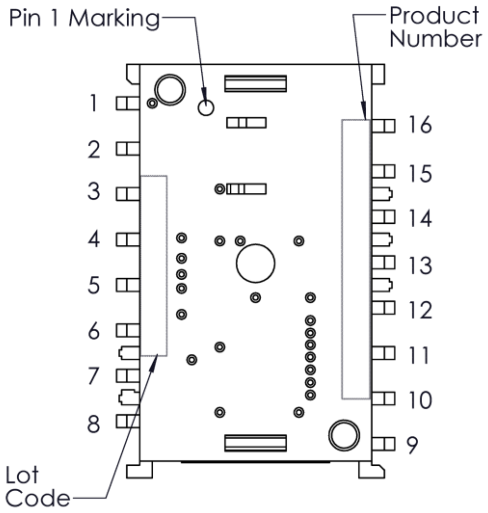


Figure 2. Device Pinout

Table 1. Pin Definition

Pin No.	Function	Symbol	Type	Description
1	Reserved	NC	NC	No connection
2	Reserved	NC	NC	No connection
3	Supply Ground	GND	Ground	Ground
4	Supply Voltage	VDD	Power	Input power supply
5	LDO Output	VDDREG	Power	LDO output for digital core (only for internal usage)
6	Reserved	NC	NC	No connection
7	I/O Voltage	VDDIO	Power	I/O power supply
8	I/O Ground	GNDIO	Ground	I/O Ground
9	Motion Output	MOTION	Output	Motion detection
10	4-wire SPI	SCLK	Input	Serial data clock
11		MOSI	Input	Serial data input
12		MISO	Output	Serial data output
13		NCS	Input	Chip select (Active Low)
14	Reset Control	NRESET	Input	Chip reset (Active Low)
15	LED	LED_P	Input	LED Anode
16	Reserved	NC	NC	No connection

2.0 Electrical Specification

2.1 Regulatory Requirement

- Passes FCC “Part15, Subpart B, Class B”, “ICES-003:2016 Issue 6, Class B” and “ANSI C63.4:2014” when assembled into a mouse with shielded USB cable using ferrite bead and following PixArt’s recommendations.
- Passes IEC 62471: 2006 Photo biological safety of lamps and lamp systems.

2.2 Absolute Maximum Rating

Table 2. Absolute Maximum Rating

Parameter	Symbol	Min.	Max.	Unit	Note
Storage Temperature	T_S	-40	85	°C	
Lead Solder Temperature	T_{SOLDER}		260	°C	For 7 second, 1.6mm below seating plane
Supply Voltage	VDD	-0.5	2.1	V	
	VDDIO	-0.5	3.3	V	
ESD	ESDHB		2	kV	Human Body Model on all pins
Input Voltage	V_{IN}	-0.5	3.3	V	All I/O pins

Notes:

1. At room temperature.
2. Maximum Ratings are those values beyond which damage to the device may occur.
3. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute maximum-rated conditions is not implied.

2.3 Recommended Operating Condition

Table 3. Recommended Operating Condition

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Operating Temperature	T_A	0		40	°C	
Power Supply Voltage	VDD	1.8	1.9	2.1	V	Excluding supply noise
	VDDIO	1.8	1.9	3.3	V	Excluding supply noise. (VDDIO must be the same or greater than VDD)
Power Supply Rise Time	t_{RT}	0.15		20	ms	0 to VDD min
Supply Noise peak to peak	V_{NA}			100	mV	10 kHz to 75 MHz
Serial Port Clock Frequency	f_{SCLK}			10	MHz	50% duty cycle
Distance from Lens Reference Plane to Tracking Surface	Z	2.2	2.4	2.6	mm	
Speed ▪ High Performance Mode ▪ Low Power Mode ▪ Corded Gaming Mode ▪ Office Mode	S	 650 480 650 200			ips	In run mode at 45 degree
Acceleration ▪ High Performance Mode ▪ Low Power Mode ▪ Corded Gaming Mode ▪ Office Mode	A	 50 40 50 10			g	
Resolution Error ▪ High Performance Mode ▪ Low Power Mode ▪ Corded Gaming Mode	Res_{Err}		 0.4 0.4 0.4		%	Up to 200ips on QCK at 5000cpi
Lift Cut-off 1mm setting	$Lift_{1mm}$		1		mm	PixArt standard gaming surface
Lift Cut-off 2mm setting	$Lift_{2mm}$		2		mm	PixArt standard gaming surface

2.4 AC Electrical Specification

Table 4. AC Electrical Specification

Chip electrical characteristics over recommended operating conditions. Typical values are at 25°C, VDD = 1.9V and VDDIO=1.9V

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Motion Delay After Reset	$t_{MOT-RST}$	50			ms	From reset to valid motion, assuming motion is present
Shutdown	t_{STDWN}			500	ms	From Shutdown mode active to low current
Wake from Shutdown	t_{WAKEUP}	50			ms	From Shutdown mode inactive to valid motion. **Note:** A RESET must be asserted after a shutdown. Refer to section "Notes on Shutdown"
MISO Rise Time	t_{r-MISO}		6		ns	C_L = 20pF
MISO Fall Time	t_{f-MISO}		6		ns	C_L = 20pF
MISO Delay After SCLK	$t_{DLY-MISO}$			35	ns	From SCLK falling edge to MISO data valid C_L = 20pF
MISO Hold Time	$t_{hold-MISO}$	25			ns	Data held until next falling SCLK edge
MOSI Hold Time	$t_{hold-MOSI}$	25			ns	Amount of time data is valid after SCLK rising edge
MOSI Setup Time	$t_{setup-MOSI}$	25			ns	From data valid to SCLK rising edge
SPI Time Between Write Commands	t_{SWW}	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}	5			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}	2			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	$t_{NCS-SCLK}$	120			ns	From last NCS falling edge to first SCLK rising edge
SCLK To NCS Inactive (For Read Operation)	$t_{SCLK-NCS}$	120			ns	From last SCLK rising edge to NCS rising edge, for valid MISO data transfer

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
SCLK To NCS Inactive (For Write Operation)	$t_{SCLK-NCS}$	1			µs	From last SCLK rising edge to NCS rising edge, for valid MOSI data transfer
NCS To MISO High-Z	$t_{NCS-MISO}$			500	ns	From NCS rising edge to MISO high-Z state
MOTION Rise Time	$t_{r-MOTION}$		300		ns	C_L = 20pF
MOTION Fall Time	$t_{f-MOTION}$		300		ns	C_L = 20pF
Input Capacitance	C_{in}		10		pF	SCLK, MOSI, NCS
Load Capacitance	C_L			20	pF	MISO, MOTION
Transient Supply Current	I_{DDT}			70	mA	Maximum supply current during the supply ramp from 0V to VDD with minimum 150 µs and maximum 20ms rise time. (Does not include charging currents for bypass capacitors)
	I_{DDTIO}			60	mA	Maximum supply current during the supply ramp from 0V to VDDIO with minimum 150 µs and maximum 20ms rise time. (Does not include charging currents for bypass capacitors)

2.5 DC Electrical Specifications

Table 5. DC Electrical Specifications

Chip electrical characteristics over recommended operating conditions. Typical values are at 25°C, VDD = 1.9V, VDDIO = 1.9V, and with LED current at 50mA.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
DC Supply Current (High Performance Mode)	IDD_{RUN} IDD_{REST1} IDD_{REST2} IDD_{REST3}		1.7 580 11 6		mA µA µA µA	Up to 200ips ▪ IDD_{RUN}: Average current consumption, including LED current with 1ms polling ▪ IDD_{REST}: Average current consumption, including LED current
DC Supply Current (Low Power Mode)	IDD_{RUN} IDD_{REST1} IDD_{REST2} IDD_{REST3}		1.3 580 11 6		mA µA µA µA	Up to 200ips ▪ IDD_{RUN}: Average current consumption, including LED current with 1ms polling ▪ IDD_{REST}: Average current consumption, including LED current
DC Supply Current (Corded Gaming Mode)	IDD_{RUN}		10		mA	Up to 650ips IDD_{RUN}: Average current consumption, including LED current with 0.125ms polling
DC Supply Current (Office Mode)	IDD_{RUN}*1 IDD_{RUN}*2 IDD_{REST1} IDD_{REST2} IDD_{REST3}		0.6 0.4 70 11 6		mA mA µA µA µA	▪ IDD_{RUN}: Average current consumption, including LED current with 8ms polling IDD_{RUN}*1: Up to 200ips IDD_{RUN}*2: Up to 30ips ▪ IDD_{REST}: Average current consumption, including LED current
Shutdown Current	I_{PD}		4		µA	
Input Low Voltage	V_{IL}			0.3xVDDIO	V	SCLK, MOSI, NCS
Input High Voltage	V_{IH}	0.7xVDDIO			V	SCLK, MOSI, NCS
Input Hysteresis	V_{I_HYS}		100		mV	SCLK, MOSI, NCS
Input Leakage Current	I_{leak}		±1	±10	µA	V_{in}=VDDIO or 0V, SCLK, MOSI, NCS
Output Low Voltage	V_{OL}			0.45	V	I_{out} = 1mA for MISO I_{out} = 0.1mA for MOTION
Output High Voltage	V_{OH}	VDDIO-0.45			V	I_{out} = -1mA for MISO I_{out} = -0.1mA for MOTION

3.0 Mechanical Specification

This section covers chip's guidelines and recommendations in term of chip, lens & PCB assemblies.

3.1 Chip Package Dimension

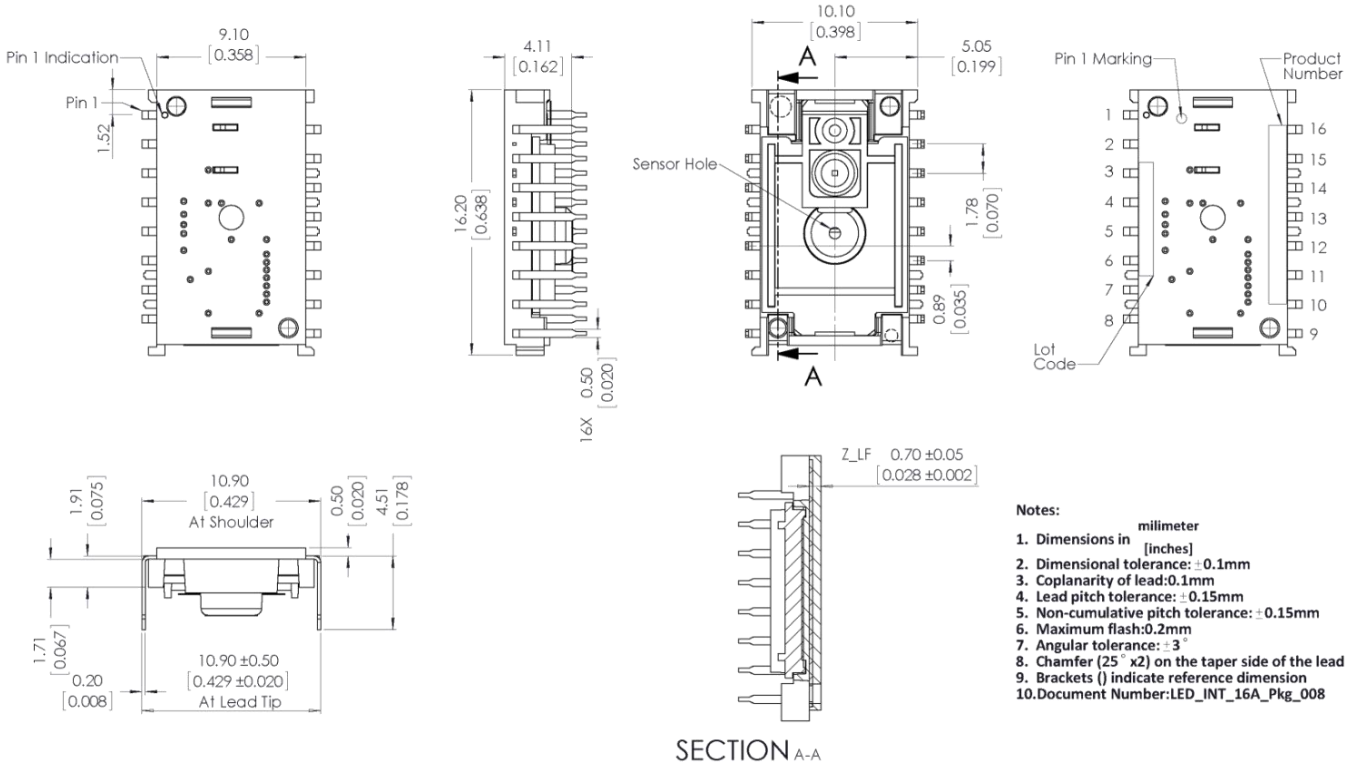


Figure 3. Packages Outline Drawing

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.

3.2 Package Marking

Table 6. Package Marking Description

Items	Marking	Remark
Product Number	PAW3395DM-T6QU	
Lot Code	AYWWXXXXX	A: Assembly house Y: Year WW: Week XXXXX: PixArt reference

3.3 Chip Assembly Drawing

It is highly recommended to follow the chip orientation in Figure 4 to achieve optimum tracking performance.

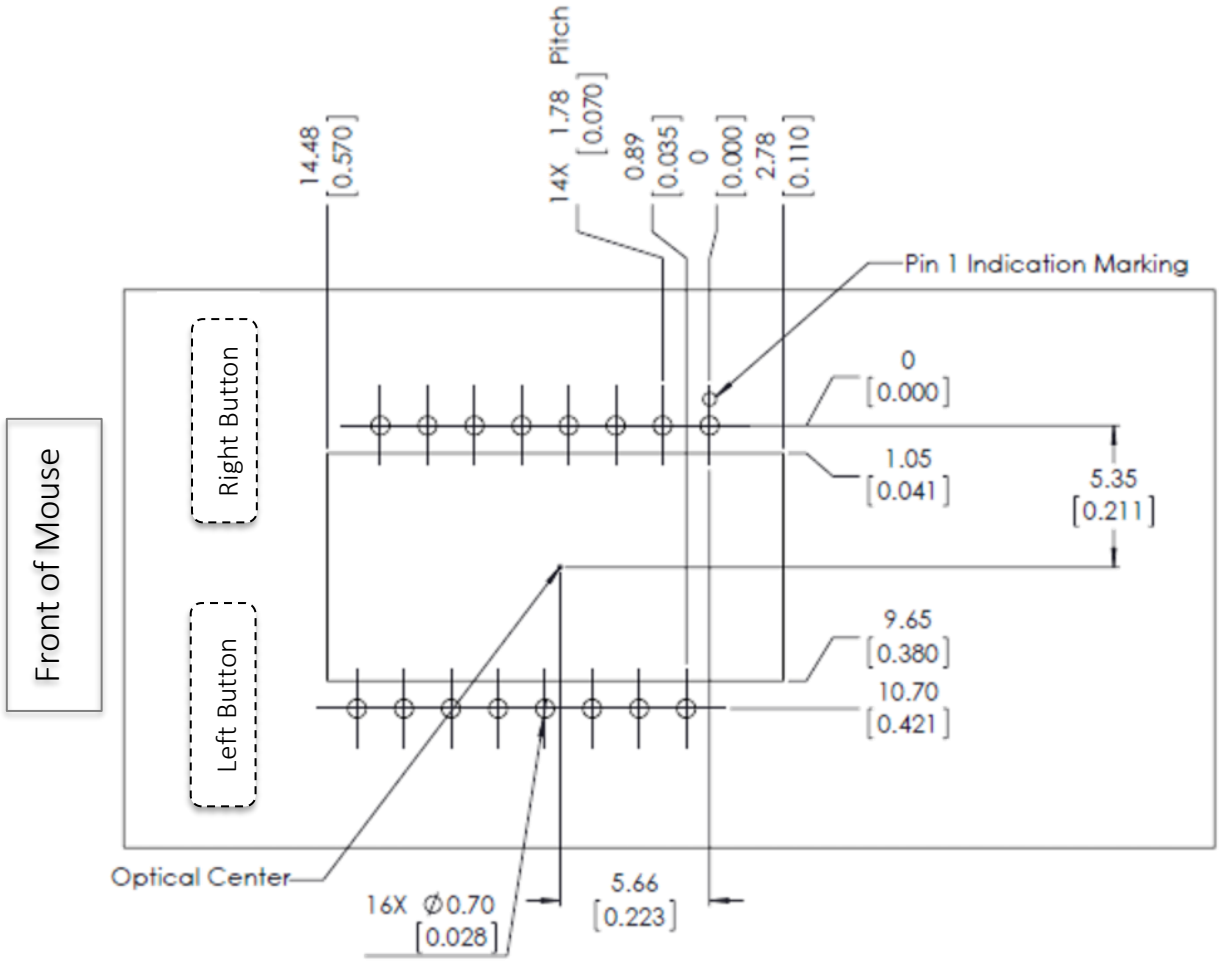


Figure 4. Recommended Chip Orientation, Mechanical Cutouts and Spacing (Top View)

3.4 Lens Assembly Drawing

3.4.1 Assembly with LM19-LSI Lens

Refer to the LM19-LSI lens datasheet for the detail.

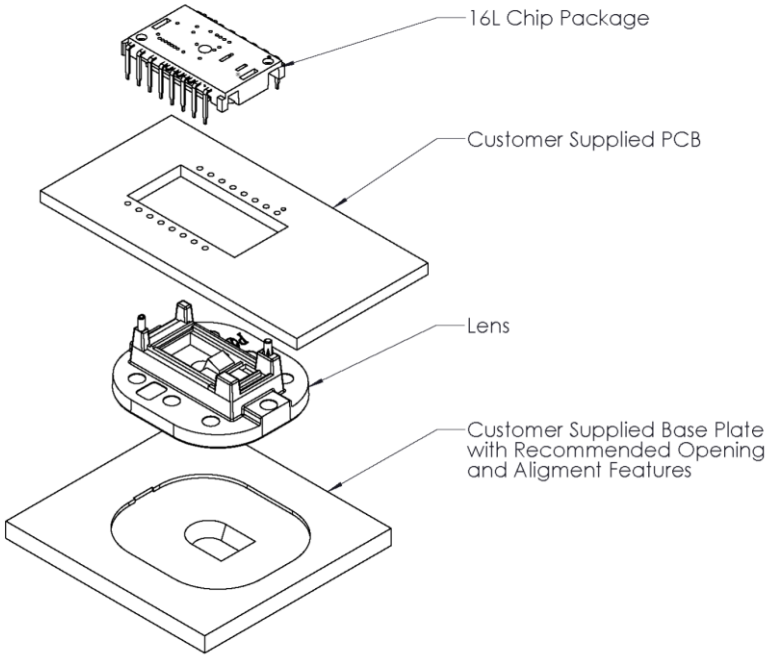


Figure 5. Exploded View of Assembly with LM19-LSI Lens

3.4.2 Assembly with L0AE-LSI1 Lens

Refer to the L0AE-LSI1 lens datasheet for the detail.

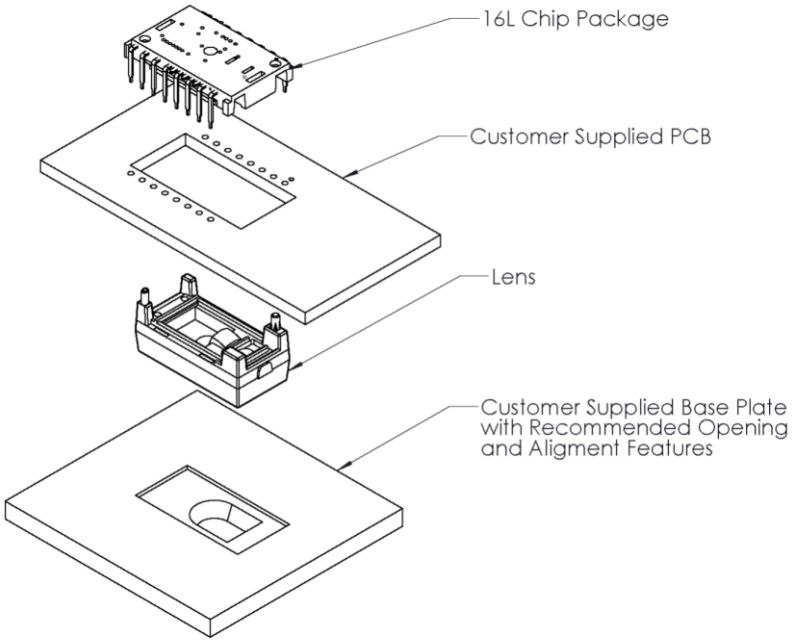


Figure 6. Exploded View of Assembly with L0AE-LSI1

3.5 PCB Assembly Recommendations

1. Insert the integrated chip and all other electrical components into PCB.
2. Wave-solder the entire assembly in a no-wash solder process utilizing solder-fixture. A solder-fixture is required to protect the chip from flux spray and wave solder paste.
3. Avoid getting any solder flux onto the chip body as there is potential for flux to seep into the chip package, the solder fixture must be designed to expose only the chip leads to flux spray & molten solder while shielding the chip body and optical apertures. The fixture must also set the chip at the correct position and height on the PCB.
4. Place the lens onto the base plate. Care must be taken to avoid contamination on the optical surfaces.
5. Remove the protective Kapton tapes from optical apertures of the chip. Care must be taken to prevent contaminants from entering the apertures. Do not place the PCB with the chip facing up during the entire mouse assembly process. Hold the PCB vertically when removing Kapton tape.
6. Insert PCB assembly over the lens onto the base plate aligning post to retain PCB assembly. The chip package will self-align to the lens via the guide posts. The optical position reference for the PCB is set by the base plate and lens. Note that the PCB motion due to button presses must be minimized to maintain optical alignment.
7. Recommendation: The lens can be permanently secured to the chip package by melting the lens' guide posts over the chip with heat staking process. Refer to Application Note titled "LM19-LSI Lens: PCB Assembly & Lens Heat Staking Recommendations" for details and recommendation on the lens heat staking process.
8. Install mouse top case. There must be a feature in the top case to press down onto the PCB assembly to ensure all components are stacked or interlocked to the correct vertical height.
9. It is recommended to place mouse feet around the base plate opening to stabilize mouse tracking on the surface.

3.6 Packing Information

Item	Description
Product number	PAW3395DM-T6QU
Package type	16L DIP
Quantity per tube	25 pcs
Inner box quantity	1,000 pcs
Shipping box quantity	12,000 pcs
Tube size	500 x 13.5 x 7.0 mm^3
Inner box size	89 x 540 x 58 mm^3
Shipping box size	310 x 560 x 270 mm^3

3.6.1 Packing Tube

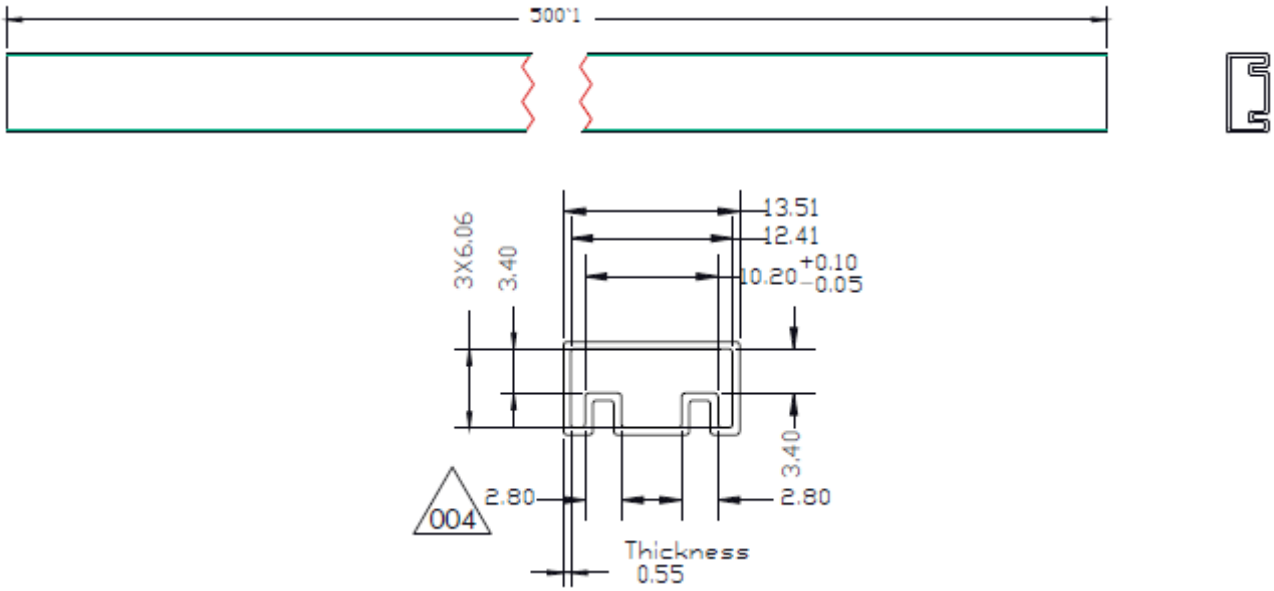
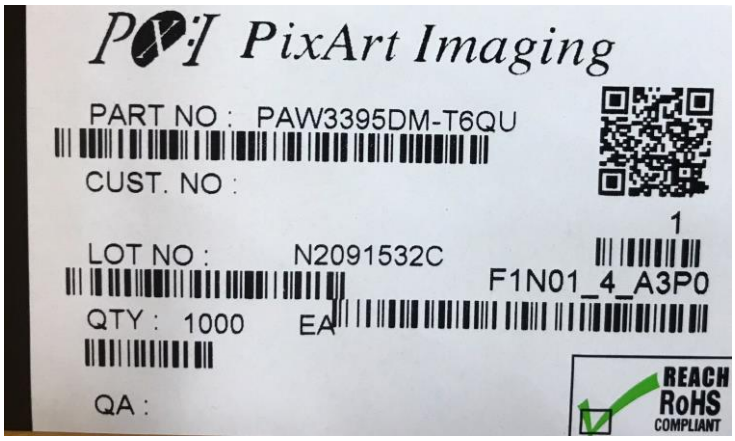


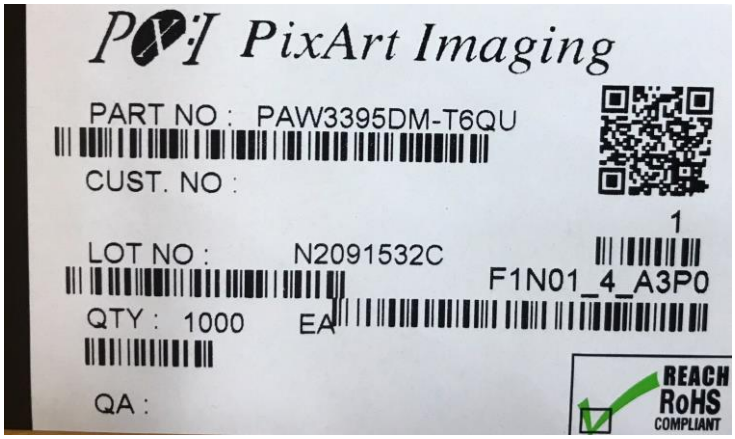
Figure 7. Packing Tube

3.7 Package Handling Information

3.7.1 Sample of Inner Box Label



3.7.2 Sample of Shipping Box Label



4.0 Reference Schematics

It is recommended not to leave the NRESET pin floating, it must be constantly driven by an output pin from the microcontroller to establish its state.

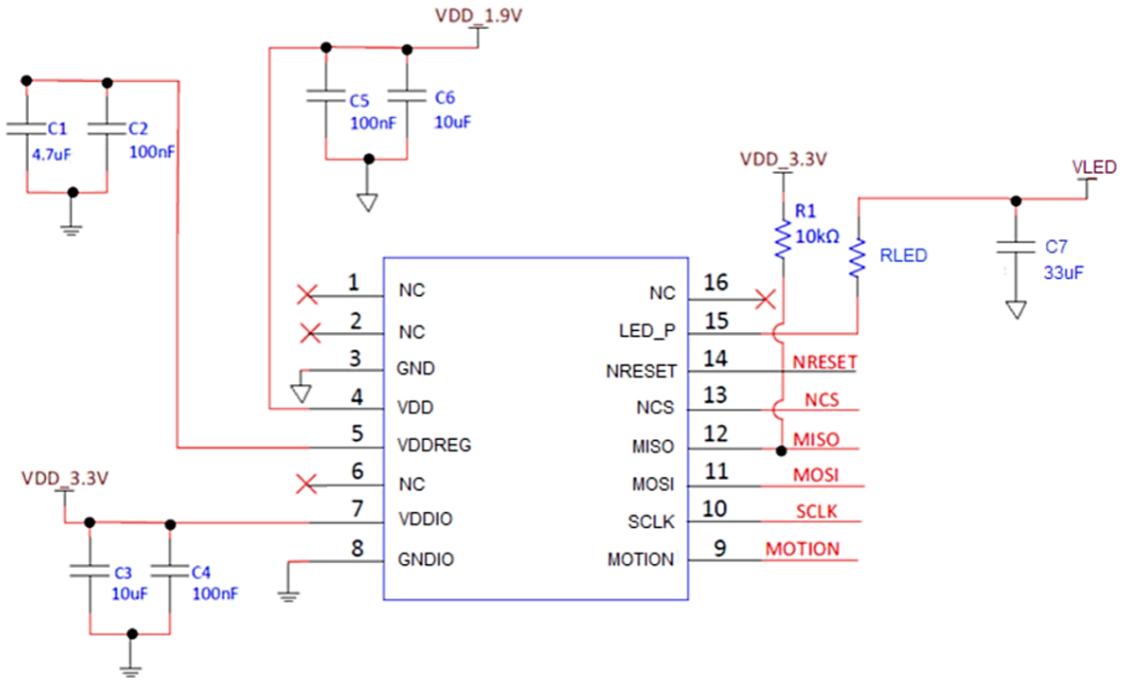


Figure 8. Reference Schematic Diagram

Table 7 shows the recommended value of R_{LED} and V_{LED} to obtain 50mA current for LED. Recommend to use R_{LED} with 1% tolerance.

Table 7. Recommended R_{LED}

V_{LED} (V)	Recommended R_{LED} (Ω)
1.9V	5.6
2.0V	6.8

Revision History

Revision Number	Date	Description
1.2	15 Nov 2022	Initial Release