Data Sheet

PAW3370DM-T4QU: Low Power Optical Gaming Navigation Chip

General Description

PAW3370DM-T4QU is PixArt Imaging's new low power gaming navigation chip suitable for wired and wireless gaming application. It has the latest state-of-the-art low-power architecture and automatic power management modes, making it ideal for battery-operated, power-sensitive cordless gaming devices. It provides excellent gaming experience with the features of high speed and high resolution even in low power mode to fulfill gamers' need. It is packaged in 16pin staggered dual-in-line package (DIP) and designed to be used with LM19-LSI lens to achieve optimum performance.

Key Features

- Low power consumption of typical 1.5mA @ run mode
- Programmable rest modes
- 16 pin molded lead-frame DIP package with 850nm illumination source
- High speed motion detection 400ips* and acceleration 50g*
- Selectable resolutions up to 19,000cpi
  - 50cpi step size from 50cpi to 10,000cpi
  - 100cpi step size from 10,100cpi to 19,000cpi
- Four-wire serial port interface (SPI)
- Internal oscillator — no clock input needed
- Customizable response time and downshift time for rest modes
- Angle snapping
- Lift detection options
  - 1mm setting
  - 2mm setting
  - Manual Lift Cut Off Calibration

Applications

- Wired and wireless Gaming Optical Mouse
- Trackball application

Key Parameters

Parameter	Value
Power Supply Voltage (V)	VDD: 1.8 – 2.1V VDDIO: 1.8 – 3.3V
Interface	4-wire Serial Peripheral Interface
Supply Current @ VDD & VDDIO = 1.9V *Note: includes LED current*	Low Power Gaming Mode 1 Run: 1.5 mA Power Down: 3 uA
Resolution (cpi)	Up to 19000
Tracking Speed (ips)	400*
Acceleration (g)	50*
Package Size (mm)	10.90 x 16.20 x 5.01

Note: * - Low Power Gaming Mode 1

Ordering Information

Part Number	Package Type
PAW3370DM-T4QU	16pin-DIP
LM19-LSI	Lens

RoHS compliant

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

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1.0 Introduction

1.1 Overview

The PAW3370DM is an optical navigation chip targeted for high-end corded gaming mouse. It contains an image array as Image Acquisition System (IAS), a Digital Signal Processor (DSP), a four wire serial port, a power control circuit and built-in LED driver integrated with Illumination source 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. These images are processed by the DSP to determine the direction and distance of motion. The DSP 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.

Note: Throughout this document PAW3370DM-T4QU is referred to as the chip.

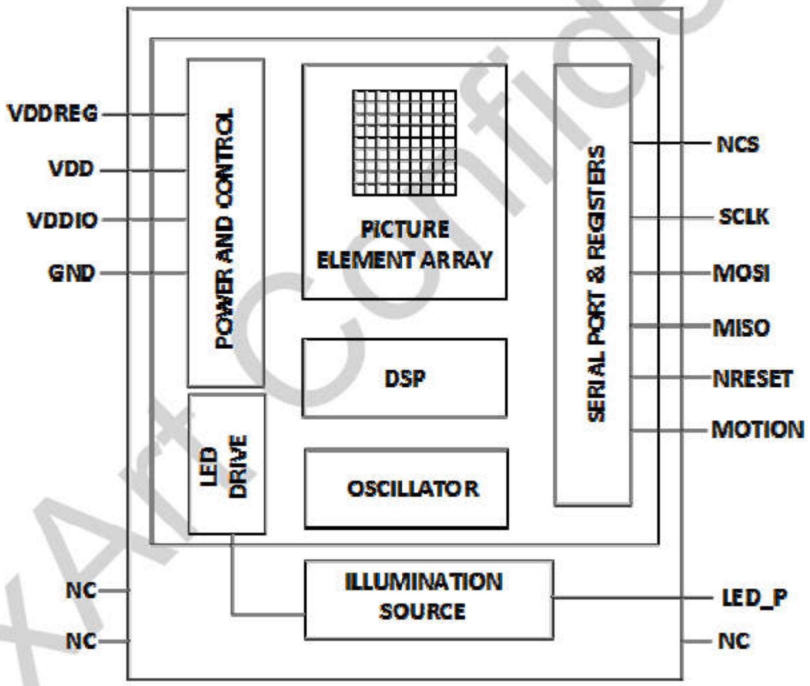


Figure 1. Functional Block Diagram

1.2 Terminology

Term	Description
DSP	Digital Signal Processing
LED	Light Emitting Diode
NCS	Chip Select
VDDREG	LDO output (only for sensor internal usage)
VDD	Supply voltage
VDDIO	I/O power supply
SCLK	Serial Clock
MOSI	Serial Data Input
MISO	Serial Data Output
NRESET	Chip reset
SPI	Serial Peripheral Interface
GND	Ground
MOTION	Motion Detect

1.3 Pin Configuration

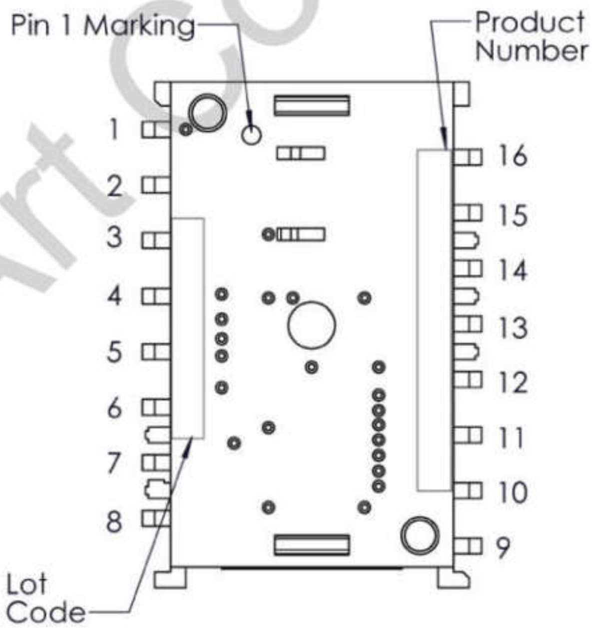


Figure 2. Device Pinout

Table 1. Pins Description

Pin No.	Function	Symbol	Type	Description
1	Reserved	NC	NC	No connection
2	Reserved	NC	NC	No connection
3	Supply Voltage and I/O Voltage	VDDREG	Power	LDO output (only for sensor internal usage)
4		VDD	Power	Power supply
5		VDDIO	Power	I/O power supply
6	Reserved	NC	NC	No Connection
7	Reset Control	NRESET	Input	Chip reset (Active Low)
8	Ground	GND	GND	Ground
9	Motion Output	MOTION	Output	Motion detect
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	Reserved	NC	NC	No connection
15	LED	LED_P	Input	LED Anode
16	Reserved	NC	NC	No connection

2.0 Operating Specifications

2.1 Regulatory Requirements

- Passes FCC "Part15 Subpart, 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 Ratings

Table 2. Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units	Notes
Storage Temperature	T_S	-40	85	°C	
Lead Solder Temperature	T_{SOLDER}		260	°C	For 7 seconds, 1.6mm below seating
Supply Voltage	V_{DD}	-0.5	2.10	V	
	V_{DDIO}	-0.5	3.30	V	
ESD	ESD_{HBM}		2	kV	Human Body Model on All pins
Input Voltage	V_{IN}	-0.5	V_{DDIO}	V	All I/O pins.

Notes:

1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are the stress ratings only and functional operation of the device at these or any other condition beyond those indicated for extended period of time may affect device reliability.
2. The inherent design of this component causes it to be sensitive to electrostatic discharge. The ESD threshold is listed above. To prevent ESD induced damage, take adequate ESD precautions when handling this product

2.3 Recommended Operating Conditions

Table 3. Recommended Operating Conditions

Description	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Temperature	T_A	0		40	°C	
Power Supply Voltage	V_{DD}	1.8	1.9	2.1	V	Including 100mVp-p supply noise
	V_{DDIO}	1.8	1.9	3.3	V	Including 100mVp-p supply noise (V_{DDIO} must be same or greater than V_{DD})
Power Supply Rise Time	t_{RT}	0.15		20	ms	0 to VDD & VDDIO
Supply Noise	V_{NA}			100	mV_{p-p}	10kHz – 75MHz
Serial Port Clock Frequency	f_{SCLK}			8	MHz	Active drive, 50% duty cycle
Distance from Lens Reference Plane to Tracking Surface	Z	2.20	2.40	2.60	mm	
Speed Low Power Gaming Mode 1 Low Power Gaming Mode 2 Office Mode	S	 400 200 30			ips	Tested on QCK

Description	Symbol	Min.	Typ.	Max.	Unit	Notes
Acceleration Low Power Gaming Mode 1 Low Power Gaming Mode 2 Office Mode	A	 50 40 10			g	In run mode Tested on QCK
Load Capacitance	C_L			20	pF	MISO, MOTION
Lift Cutoff 1mm setting	$Lift_{1mm}$		1		mm	LM19-LSI
Lift Cutoff 2mm setting	$Lift_{2mm}$		2		mm	LM19-LSI
Lift Cutoff (Manual Calibration)	$Lift_{CAL}$		1		mm	LM19-LSI
Resolution Error	Res_{Err}		0.5		%	In Low Power Gaming Mode 1 Up to 200ips at 3000cpi on QCK

Note: PixArt does not guarantee the chip performance if the operating temperature is beyond the specified limit.

2.4 Thermal Specifications

Table 4. Thermal Specifications

Parameters	Symbol	Min.	Typ.	Max.	Unit	Notes
Storage Temperature	T_S	-25	-	80	°C	
Lead-free Solder Temperature	T_P	-	-	260	°C	For 10 seconds, 1.6mm below seating plane for wave soldering

2.5 DC Characteristics

Table 5. DC Electrical Specifications

Parameters	Symbol	Min.	Typ.	Max.	Unit	Condition
DC Supply Current (Run mode)						Average Run current on QCK
Low Power Gaming Mode 1	I_{DD_RUN} [LPGM1 mode]		1.5		mA	Measured at 1ms polling rate
Low Power Gaming Mode 2	I_{DD_RUN} [LPGM2 mode]		1.2		mA	Measured at 8ms polling rate
Office Mode	I_{DD_RUN} [Office mode]		0.5		mA	Measured at 8ms polling rate
Note: Includes I_{LED}						
DC Supply Current (Rest mode)						Average Rest current
Low Power Gaming Mode 1	I_{DD_REST1} (LPGM1 mode)		610		uA	
	I_{DD_REST2} (LPGM1 mode)		25		uA	
	I_{DD_REST3} (LPGM1 mode)		5		uA	

Parameters	Symbol	Min.	Typ.	Max.	Unit	Condition
Low Power Gaming Mode 2	$I_{DD\_REST1\ (LPGM2\ mode)}$		160		uA	
	$I_{DD\_REST2\ (LPGM2\ mode)}$		25		uA	
	$I_{DD\_REST3\ (LPGM2\ mode)}$		5		uA	
Office Mode	$I_{DD\_REST1\ (Office\ mode)}$		75		uA	
	$I_{DD\_REST2\ (Office\ mode)}$		10		uA	
	$I_{DD\_REST3\ (Office\ mode)}$		5		uA	
Note: Includes I_{LED}						
Power Down Current	I_{PD}		3		uA	
Input Low Voltage	V_{IL}			0.3* V_{DDIO}	V	SCLK, MOSI, NCS
Input High Voltage	V_{IH}	0.7* V_{DDIO}			V	SCLK, MOSI, NCS
Input Hysteresis	V_{I_HYS}		100		mV	SCLK, MOSI, NCS,
Input Leakage Current	I_{LEAK}		± 1	± 10	uA	Vin=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
Input Capacitance	C_{in}		10		pF	SCLK, MOSI, NCS

Note: All the parameters are tested under recommended operating conditions. Typical values at 25 °C, V_{DD} & V_{DDIO} = 1.9 V & LED current = 24mA

2.6 AC Characteristics

Table 6. 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	ms	From Shutdown mode active to low current This timing could be affected by Rest3 period
Wake up 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 "5.2 Power Down Sequence", also note $t_{MOT-RST}$.
MISO Rise Time	t_{r-MISO}		6		ns	C_L = 20pF
MISO Fall Time	t_{f-MISO}		6		ns	C_L = 20pF

Parameters	Symbol	Min.	Typ.	Max.	Unit	Conditions
MISO Delay After SCLK	$t_{DLY-MISO}$			38	ns	From SCLK falling edge to MISO data valid, C_L = 20pF with 10kOhm pull up resistor.
MISO Hold Time	$t_{hold-MISO}$	31.25			ns	Data held until next falling SCLK edge
MOSI Hold Time	$t_{hold-MOSI}$	31.25			ns	Amount of time data is valid after SCLK rising edge
MOSI Setup Time	$t_{setup-MOSI}$	31.25			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 1st 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 1st data byte, to falling SCLK for the 1st bit of data being read.
SPI Read Address-Data Delay	t_{SRAD}	2			µs	From rising SCLK for last bit of the address byte, to falling SCLK for the 1st 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 1st SCK rising edge.
SCLK To NCS Inactive (For Read Operation)	$t_{SCLK-NCS\ read}$	120			ns	From last SCLK rising edge to NCS rising edge, for valid MISO data transfer.
SCLK To NCS Inactive (For Write Operation)	$t_{SCLK-NCS\ write}$	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
Transient Supply Current	I_{DDT}		70		mA	Max supply current during the supply ramp from 0V to V_{DD} with min 150us and max 20ms rise time. (Does not include charging currents of bypass capacitors)

Parameters	Symbol	Min.	Typ.	Max.	Unit	Conditions
	I_{DDTIO}		60		mA	Max supply current during the supply ramp from 0V to V_{DDIO} with min 150us and max 20ms rise time. (Does not include charging currents of bypass capacitors)

Note: All the parameters are tested under recommended operating conditions. Typical values at 25 °C & VDD & VDDIO =1.9V

3.0 Mechanical Specifications

This section covers PAW3370's guidelines and recommendations in term of chip, lens & PCB assemblies.

3.1 Chip Package Dimension

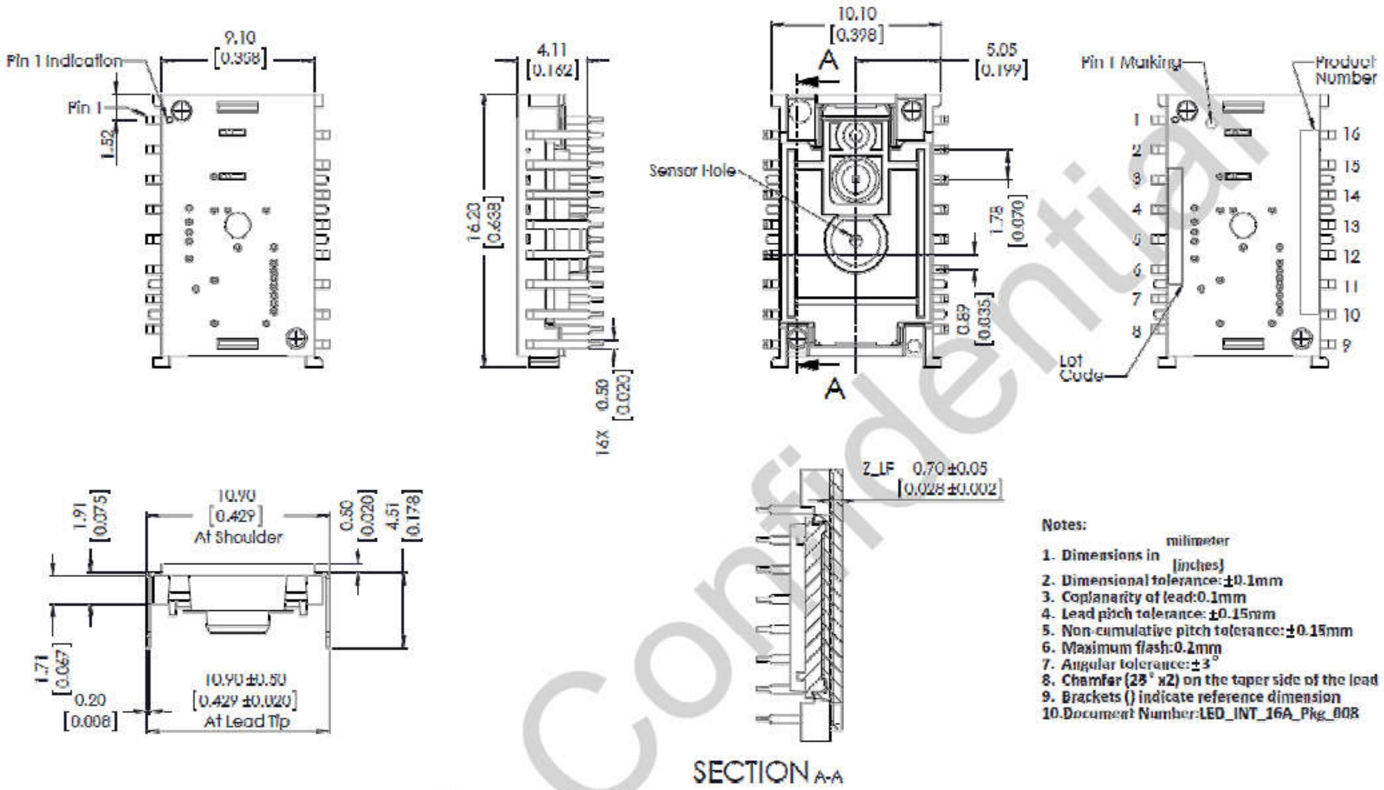


Figure 3. Package Outline Drawing

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 Identification

Refer to Figure 2. Pinout

Table 7. Package Marking Description

Items	Marking	Remark
Product Number	PAW3370DM-T4QU	
Lot Code	AYWWXXXXX	A: Assembly house Y: Year WW: Week XXXXX: PixArt reference

3.3 Packing Information

3.3.1 Packing Tube

- Quantity: 25 units per tube
- Size : 500 mm X 13.5 mm X 7.0 mm

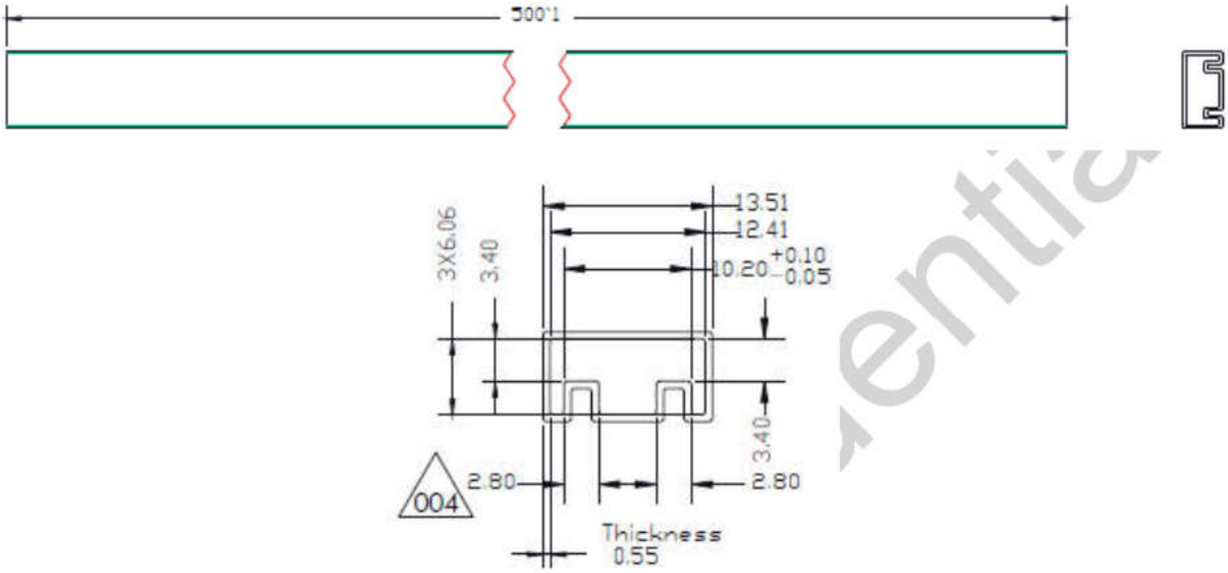
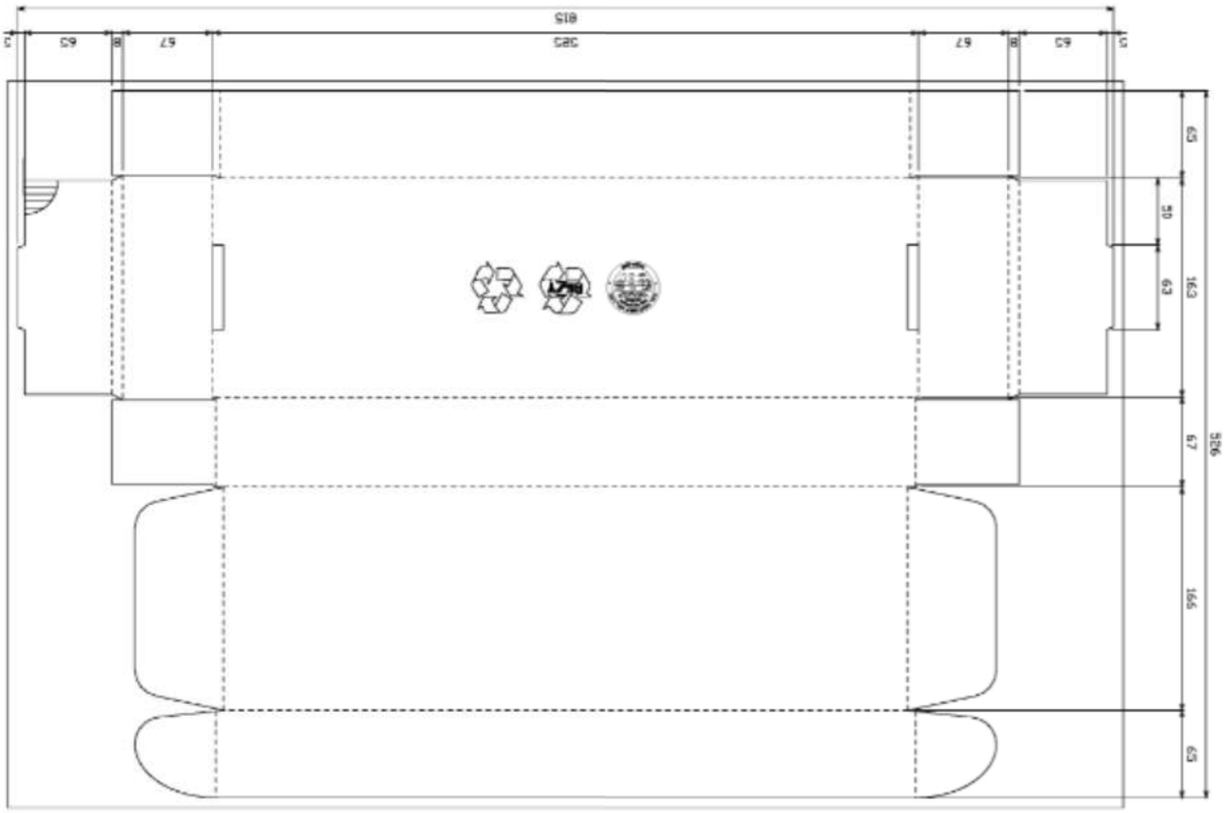


Figure 4. Packing Tube

3.3.2 Inner Box

- Quantity: 1000 units per box
- Size : 163 mm X 525 mm X 67 mm)

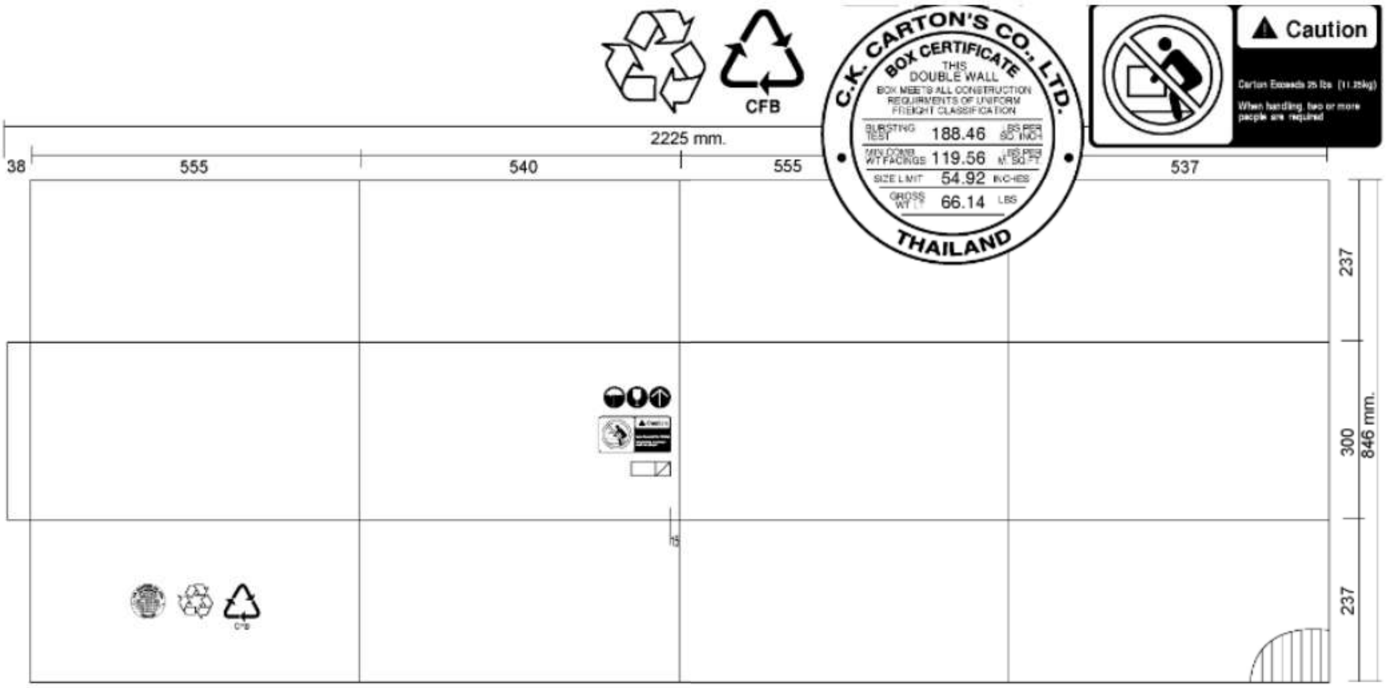


Note: All dimensions are in mm

Figure 5. Inner Box Dimension

3.3.3 Shipping Carton

- Quantity: 12,000 units per carton
- Size : 540 mm X 550 mm X 300 mm



Note: All dimensions are in mm

Figure 6. Shipping Carton Dimension

4.0 Design References

4.1 Reference Schematic

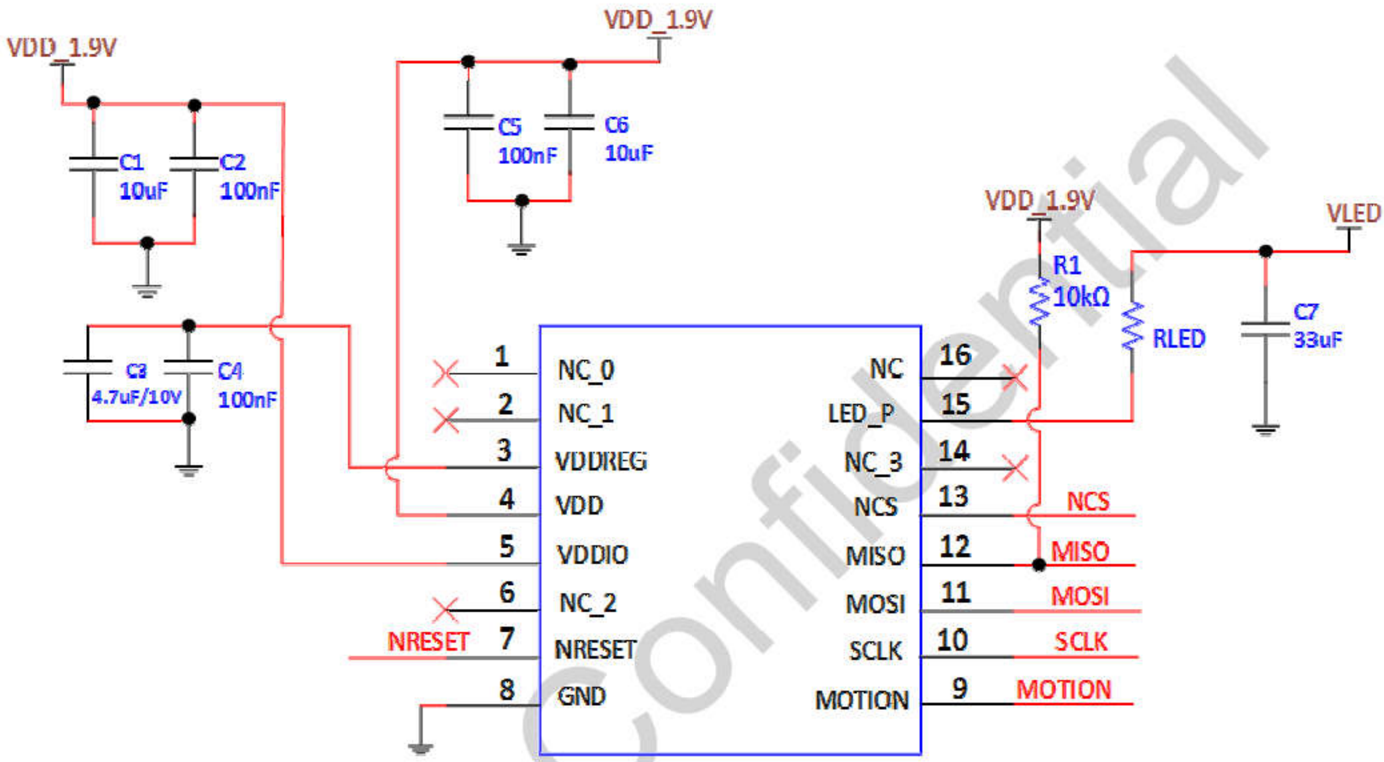


Figure 7. Schematic diagram for PAW3370DM-T4QU Chip

Table 8. Recommended R_{LED}

V_{LED} (V)	Recommended R_{LED} (Ω)
1.9	16

4.2 Recommended PCB Footprint

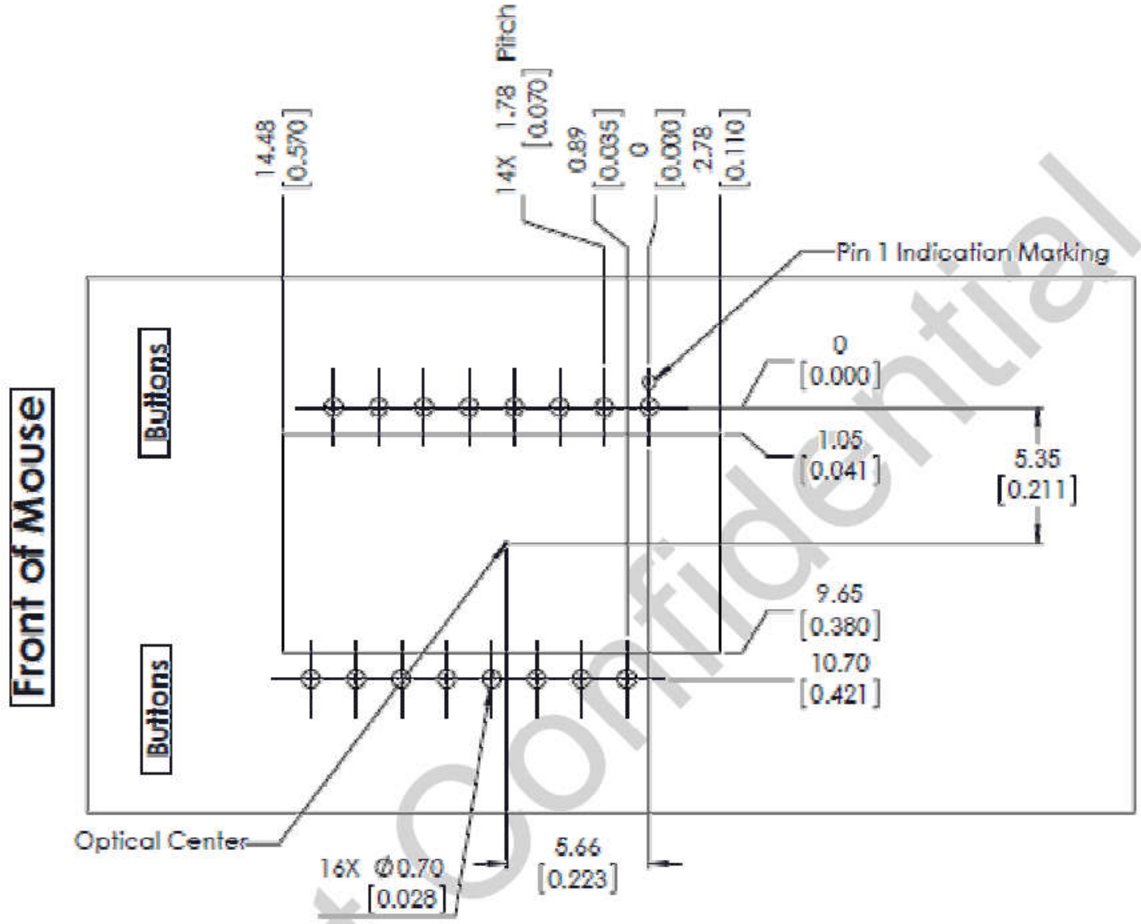


Figure 8. Recommended chip orientation, mechanical cutouts & spacing (Top View)

4.3 Assembly Guide

4.3.1 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.
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 should be designed to expose only the chip leads to flux spray & molten solder while shielding the chip body and optical apertures. The fixture should 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 product assembly process. Hold the PCB vertically when removing Kapton tape.
6. 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.
7. 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.
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

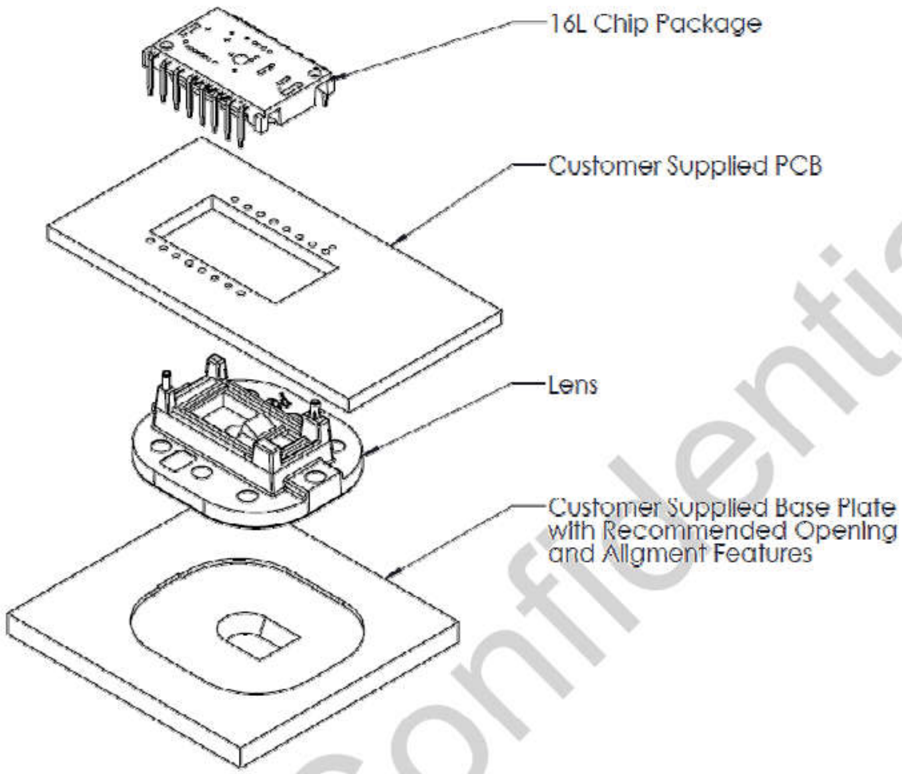


Figure 9. Exploded View of Assembly with LM19-LSI Lens