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ADNS-7630

One-Chip Bluetooth® SoC LaserStream™ Navigation Sensor

AVAGO TECHNOLOGIES

Data Sheet

Lead (Pb) Free RoHS 6 fully compliant

Description

ADNS-7630 is the world's first one-chip Bluetooth (BT) 2.1 System-on-Chip (SoC) LaserStream navigation sensor chip for laser-illuminated navigation system Driven by Avago's LaserStream navigation technology and proprietary optimized cum efficient RF transceiver architecture, it provides a fully integrated and feature-rich navigation system for wireless mouse applications and other integrated input devices. This compact, laser navigation sensor engine from Avago, integrates a BT transceiver, stand-alone baseband processor and VCSEL illumination into a single chip package to provide a complete SoC solution that provides fast and secure connectivity, and easy integration into mouse designs.

ADNS-7630 complies with Bluetooth specification version 2.1 and HID profile version 1.0. The built-in radio provides low-power, low-cost and robust communications for applications operating in the 2.4-GHz unlicensed ISM band. Additionally, this new laser sensor has several features that can be configured via an external EEPROM to simplify mouse and provide flexibility for product customization.

This chip is available in 58-pin custom designed QFN package and designed to be used with the ADNS-7100-001 laser mouse lens to achieve the optimum performance featured in this document. These parts provide a complete and compact navigation system with no moving parts and precise optical alignment to facilitate high volume assembly. Avago has pre-calibrated the laser power prior shipment to meet IEC/EN 60825-1 Class 1 Eye Safety Standard, thus no laser power calibration is required at manufacturer site, therefore reducing assembly time and associated cost.

Applications

- Bluetooth cordless laser mice
- Integrated input devices

Features

- One-chip Bluetooth SoC LaserStream navigation sensor optimized for laser mouse performance
- Bluetooth HID profile version 1.0 compliant.
- Bluetooth specification version 2.1 compatible.
- Compliance to IEC/EN 60825-1 Class 1 Eye Safety
- Fast data transmission through synchronized timing between sensor and Bluetooth system
- Extended battery life with low power architecture and LaserStream navigation technology
  - Extended inquiry response to enable fast discovery of device and to reduce latency
  - Sniff Sub Rating to reduce power consumption for HID.
  - Secure Simple Pairing, which supports "Just Works" and to enhance ease of use user experience.
  - Encryption Pause Resume where better protection through encryption key refreshed during long connection period of use.
- Excellent receiver sensitivity
- Optimized Adaptive Frequency Hopping (AFH) to minimize interference disturbance
- Programmable output power control meets Bluetooth Power Class 2 or Class 3 requirements
- On-chip Power On Reset (POR)
- High speed motion detection at 30 inches per second (ips) & acceleration up to 8g
- Support up to 10 I/O pins for flexible configuration
  - 3-key or 5-key mouse
  - LED indicators
  - Media buttons for audio control
  - KeyMap (KM) for keyboard shortcut key (supported in Bluetooth version 2.0 only)

(continued on next page)

Features (continued)

- Mechanical and optical Z-Wheel interface for vertical scroll
- Tilt-Wheel function for horizontal scroll
- 12-bit Bluetooth HID motion data reporting
- Customizable SDP Service Name, Service Description, Provider Name, VID, PID, & Bluetooth Address
- 4-axis sensor rotations: 0°, 90°, 180° or 270°
- Resolution:
  - Programmable from 250-3000 counts per inch (cpi) with 250cpi incremental step
  - Up to 10 selections of On-the-Fly (OTF) resolution mode setting

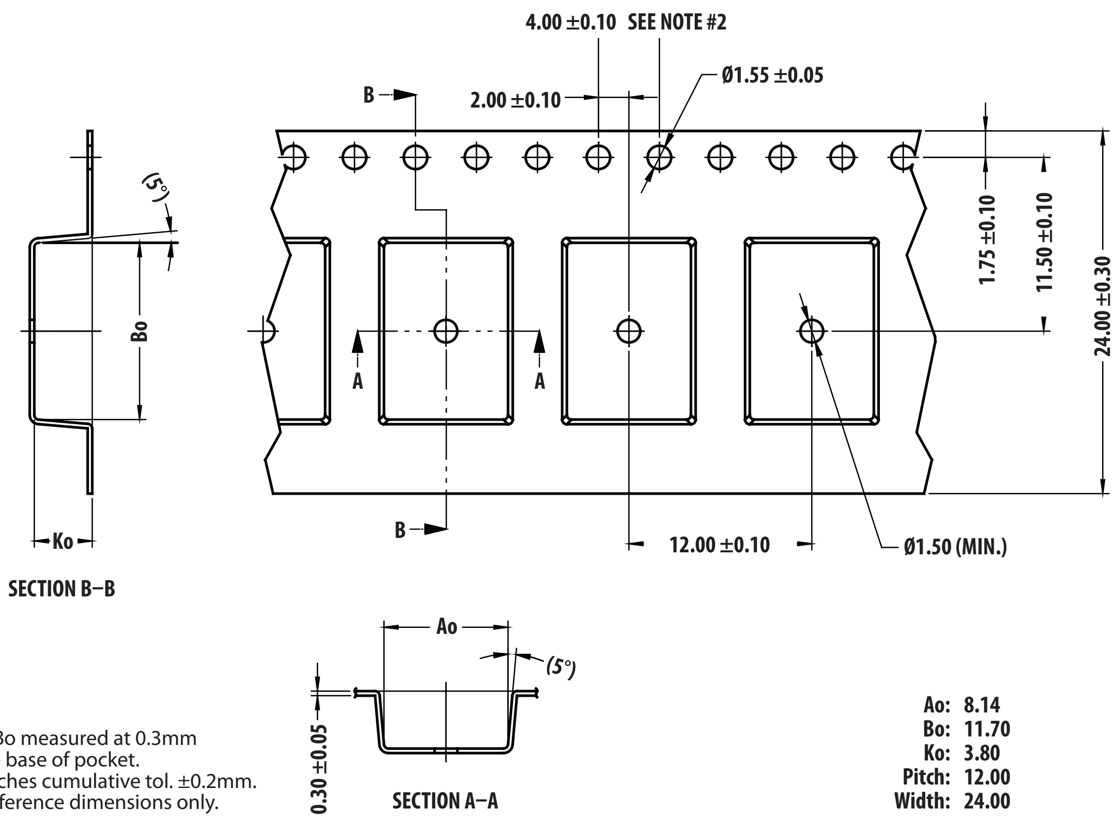
Disclaimer: All designers and manufacturers of final product with tilt wheel enabled must assure that they have all necessary intellectual property rights.

Theory of Operation

ADNS-7630 is based on LaserStream navigation technology that measures changes in position by optically acquiring sequential surface images (per frames) and mathematically determining the direction and magnitude of motion movement. It contains an Image Acquisition System (IAS), a Digital Signal Processor (DSP) and Bluetooth HID stream output. Images acquired by the IAS are processed by the DSP to determine the direction and distance of motion. The DSP generates the Δx and Δy relative displacement values which are converted to Bluetooth HID data. The motion data and buttons input status are then transmitted in wireless mode to the Bluetooth.

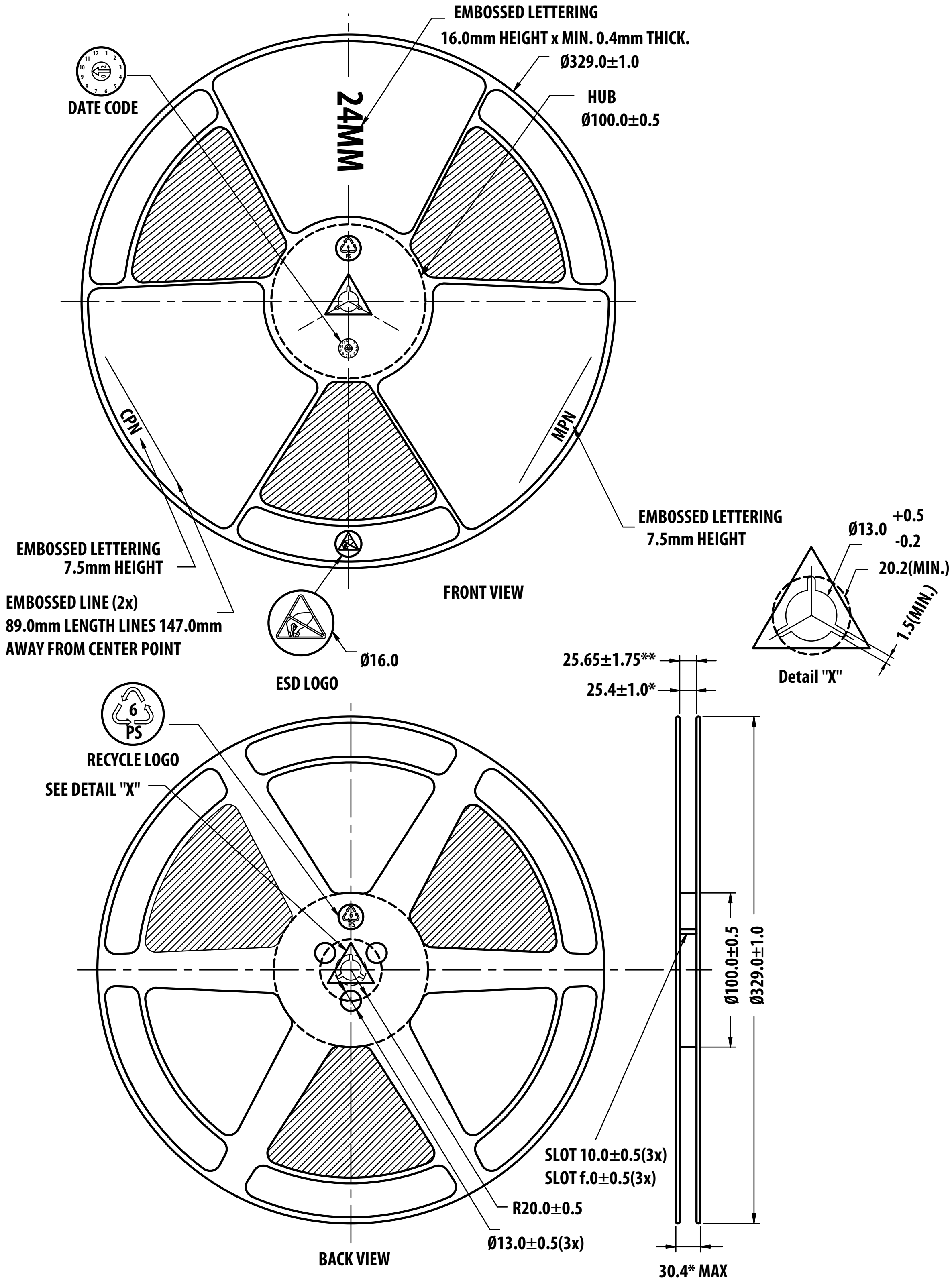
Ordering Information

Part Number	Packaging Type	Minimum Order Quantity
ADNS-7630	Tube	1000 units per tube
ADNS-7630-TR	Tape and Reel	4000 units per roll



Notes:
1. Ao & Bo measured at 0.3mm above base of pocket.
2. 10 pitches cumulative tol. ±0.2mm.
3. ( ) Reference dimensions only.

Figure 1a. ADNS-7630-TR Tape and Reel Packaging Dimension



Notes:
1. Unless otherwise specified. Dimensions are in millimeters.
2. * – Measured at hub area.
3. ** – Measured at outer edge.
4. Flange and hub ultrasonic welded.

Figure 1b. ADNS-7630-TR Reel Packaging Dimension

Package Pinout

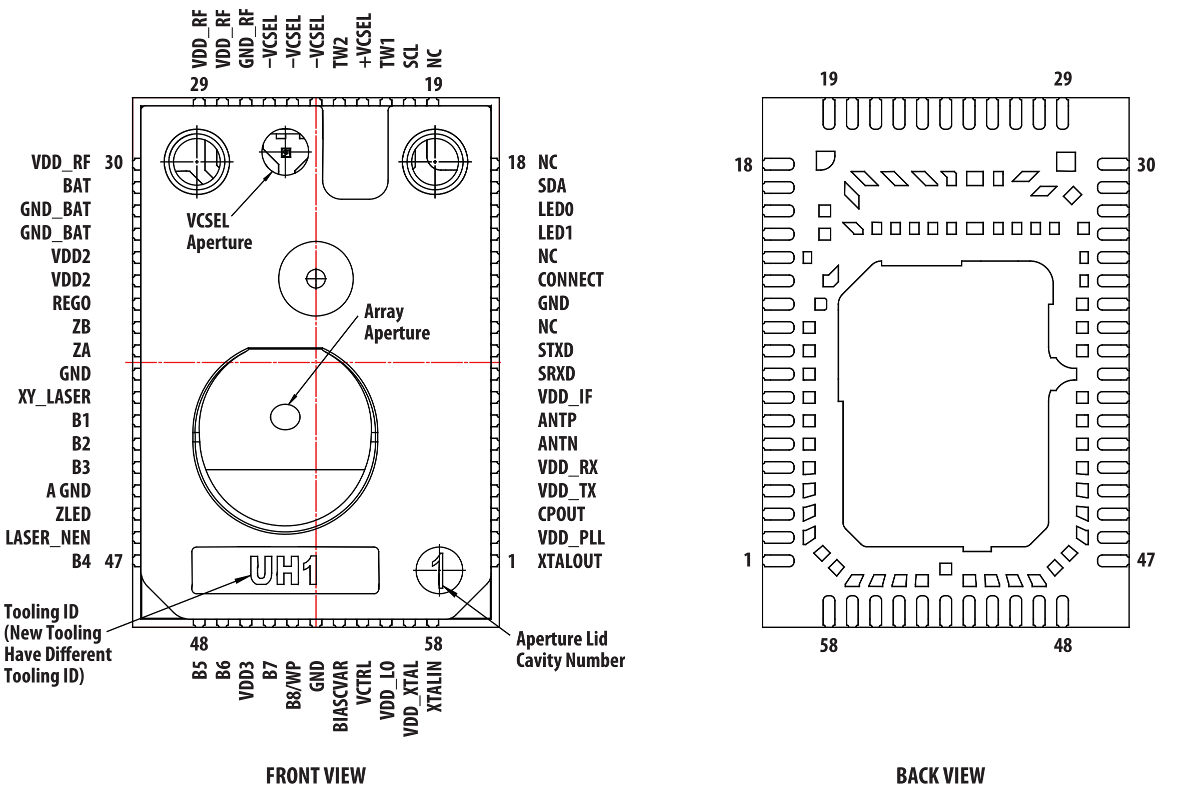


Figure 2. ADNS-7630 QFN Package Pinout

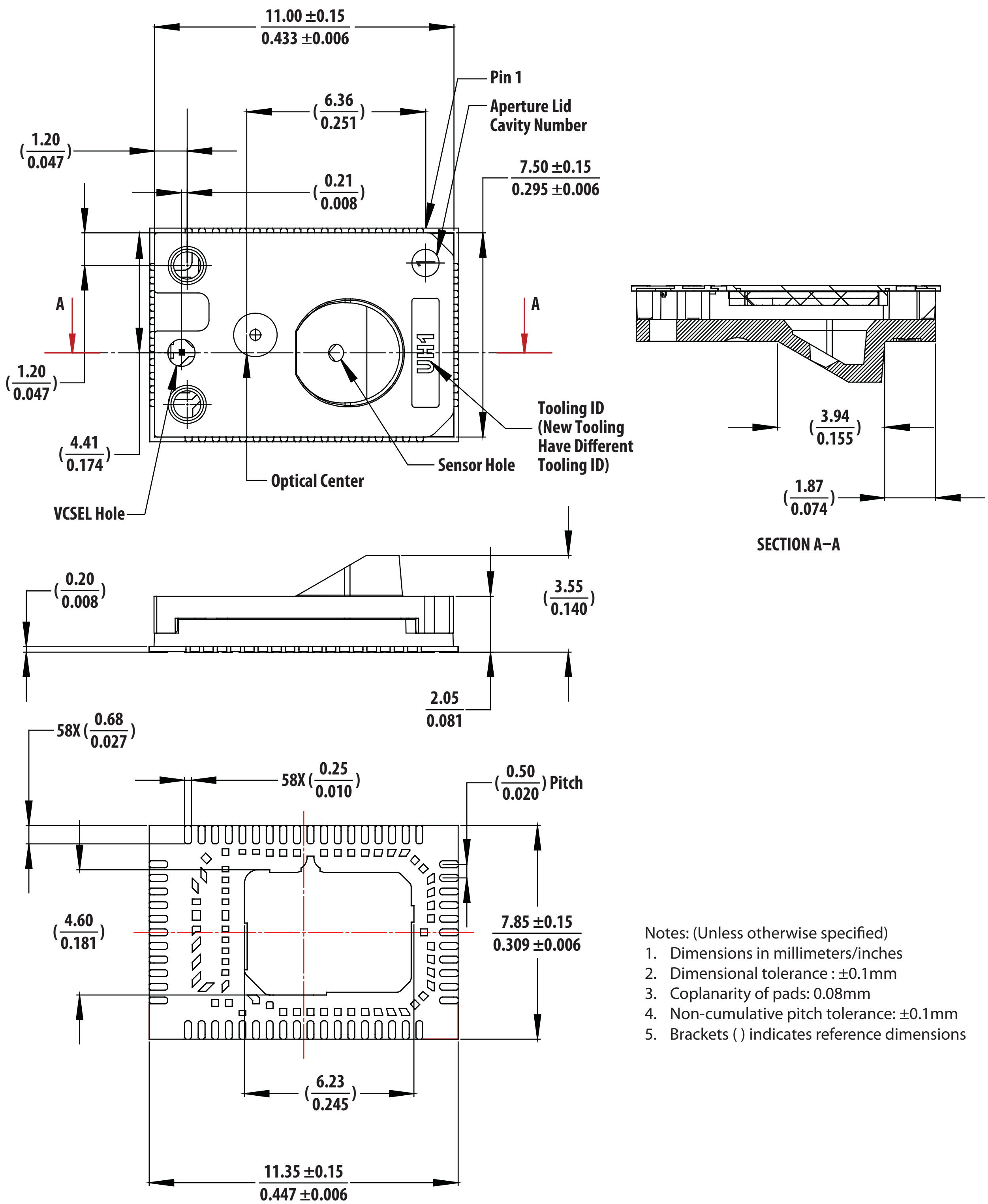
Table 1. ADNS-7630 Pinout Device Configuration

Pin	Name	Description	Type
1	XTAL_OUT	Crystal output	I/O
2	VDD_PLL	Power supply for frequency synthesizer	Power
3	CPOUT	Charge pump output pin for digital clock PLL	I/O
4	VDD_TX	Power supply for RF transmitter	Power
5	VDD_RX	Power supply for RF receiver	Power
6	ANTN	Negative port for antenna	I/O
7	ANTP	Positive port for antenna	I/O
8	VDD_IF	Power supply for IF	Power
9	SRXD	Serial Port transfer out to Host	I/O
10	STXD	Serial Port receive in from Host	I/O
11	NC	No Connect	–
12	GND	Ground	GND
13	CONNECT	Bluetooth Connect button	I/O
14	NC	No Connect	–
15	LED1 (GPIO6)	Bluetooth Connect Status / Battery LED Indicator	I/O
16	LED0 (GPIO5)	Bluetooth Connect Status / Battery LED Indicator	I/O
17	SDA	Serial Control Data to/from EEPROM	I/O
18	NC	No Connect	–
19	NC	No Connect	–
20	SCL	Serial Control Clock to/from EEPROM	I/O
21	TW1 (GPIO3)	Left Tilt Wheel / Programmable LED indicator	I/O
22	+VCSEL	Positive Terminal of VCSEL	Power
23	TW2 (GPIO4)	Right Tilt Wheel / Programmable LED indicator	I/O
24	-VCSEL	Negative Terminal of VCSEL	Power
25	-VCSEL	Negative Terminal of VCSEL	Power

Table 1. ADNS-7630 Pinout Device Configuration (continued)

Pin	Name	Description	Type
26	-VCSEL	Negative Terminal of VCSEL	Power
27	GND_RF	RF regulator GND	GND
28	VDD_RF	1.8V supply voltage to RF block	Power
29	VDD_RF	1.8V supply voltage to RF block	Power
30	VDD_RF	1.8V supply voltage to RF block	Power
31	BAT	Battery Voltage Monitor	I/O
32	GND_BAT	Battery Ground	GND
33	GND_BAT	Battery Ground	GND
34	VDD2	Power 2.1V input	Power
35	VDD2	Power 2.1V input	Power
36	REGO	Regulator Output	Power
37	ZB	Z-Wheel quadrature input	I/O
38	ZA	Z-Wheel quadrature input	I/O
39	GND	Ground	GND
40	XY_LASER	VCSEL current source	I/O
41	B1	Button 1 input (Left Button)	I/O
42	B2	Button 2 input (Middle Button)	I/O
43	B3	Button 3 input (Right Button)	I/O
44	AGND	Analog GND	GND
45	ZLED	Optical Z-Wheel IR LED input	I/O
46	LASER_NEN	Laser Enable (active low)	I/O
47	B4 (GPIO11)	Programmable Button 4 / LED input	I/O
48	B5 (GPIO12)	Programmable Button 5 / LED input	I/O
49	B6 (GPIO13)	Programmable Button 6 / LED input	I/O
50	VDD3	Power 3V input	Power
51	B7 (GPIO14)	Programmable Button 7 / LED input	I/O
52	B8/WP (GPIO15)	Programmable Button 8 / LED input / EEPROM Write Protect	I/O
53	GND	Ground	GND
54	BIASCVAR	Filter capacitor pin for VCO	I/O
55	VCTRL	VCO control signal	I/O
56	VDD_LO	Power supply for local oscillator	Power
57	VDD_XTAL	Power supply for crystal oscillator	Power
58	XTAL_IN	Crystal input	I/O

Disclaimer: All designers and manufacturers of this design must assure that they have all necessary intellectual property rights.

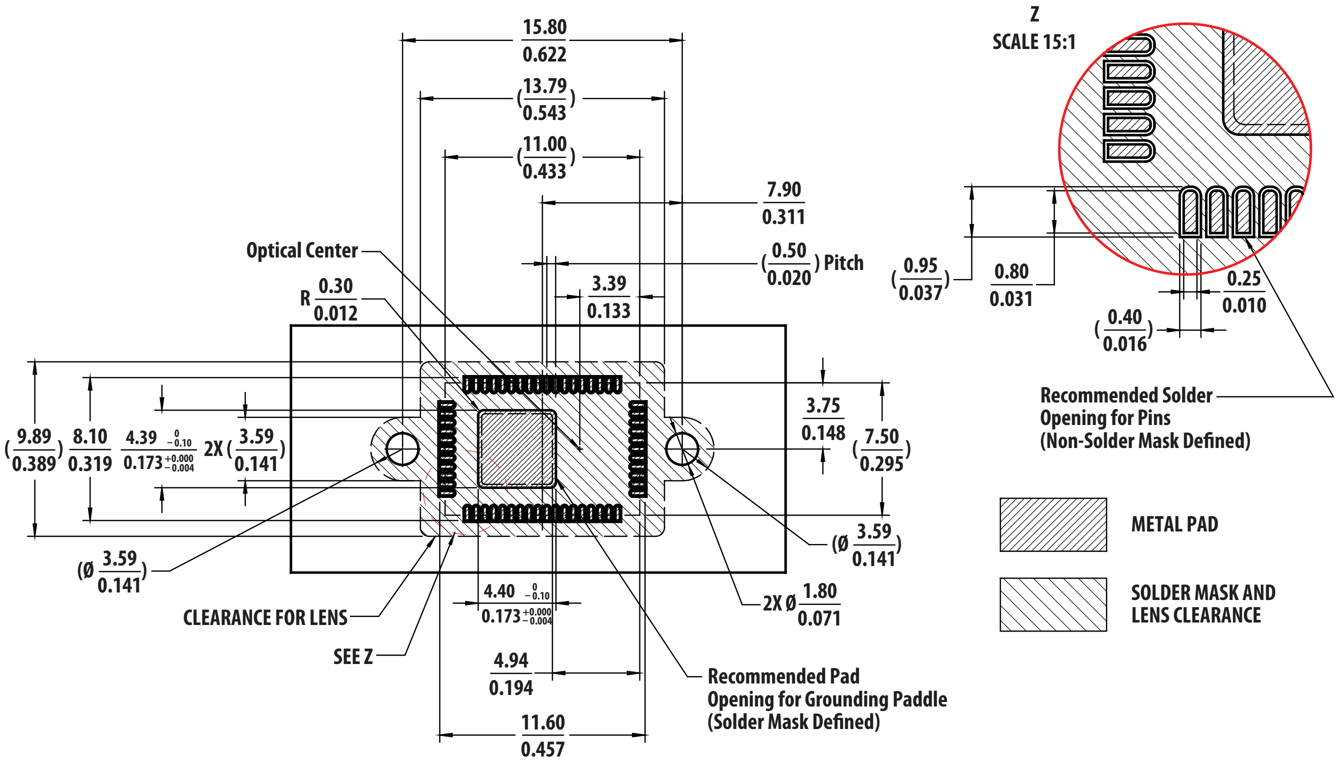


Notes: (Unless otherwise specified)

1. Dimensions in millimeters/inches
2. Dimensional tolerance : ±0.1mm
3. Coplanarity of pads: 0.08mm
4. Non-cumulative pitch tolerance: ±0.1mm
5. Brackets ( ) indicates reference dimensions

Figure 3. Package outline drawing

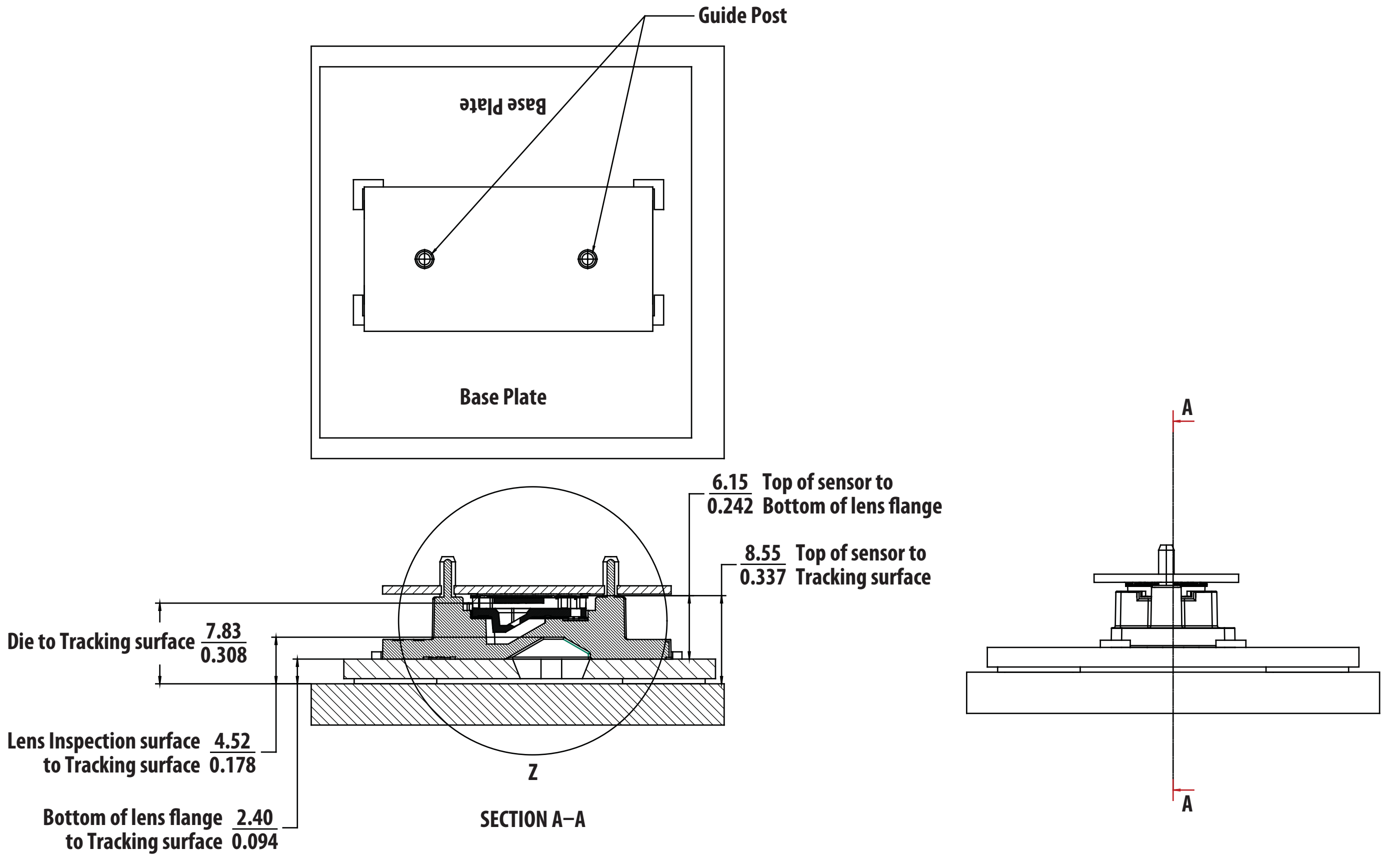
CAUTION: *It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.*



Note:

1. Dimensions in millimeters/inches

Figure 4. Recommended PCB mechanical cutouts and spacing (Top view)



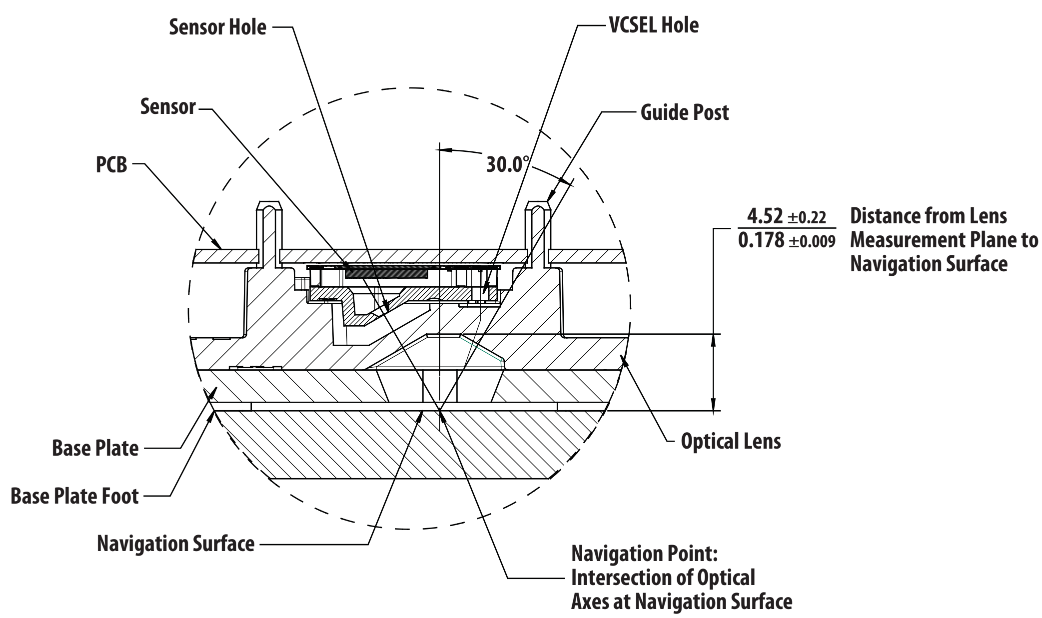


Figure 5. 2D assembly drawing of ADNS-7630 sensor coupled with ADNS-7100-001 lens, PCB & base plate

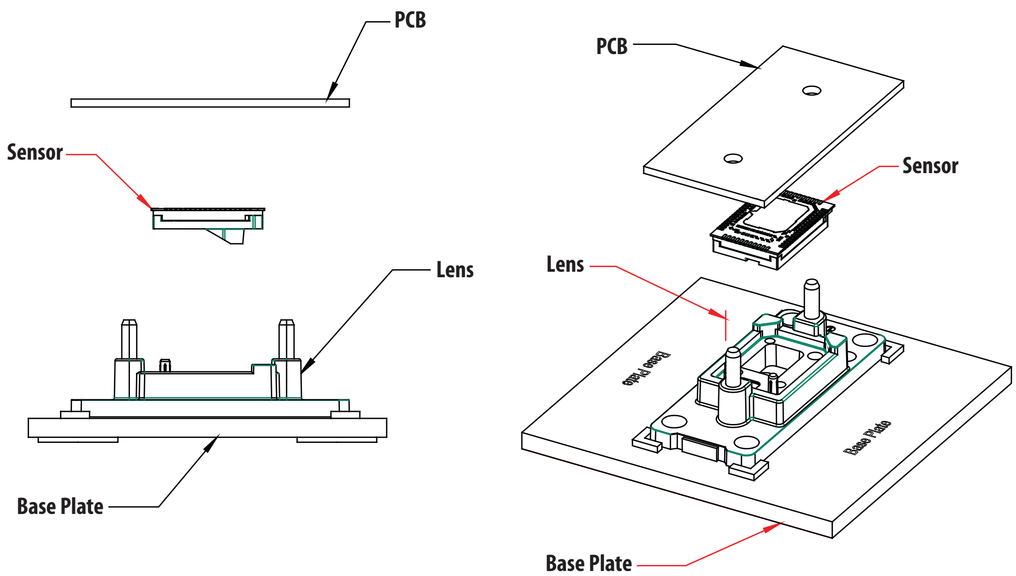


Figure 6. Exploded view drawing of ADNS-7630 sensor coupled with ADNS-7100-001 lens, PCB & base plate (front view and top side view)

As shown above, the components self align as they are mounted onto defined features on the base plate. There should be guide holes on the PCB to align the ADNS-7100-001 lens to the ADNS-7630 sensor's aperture stop. The ADNS-7630 sensor is designed for mounting on the bottom side of a PCB, looking down.

The integrated VCSEL is used for the illumination, provides a laser diode with a single longitudinal and a single transverse mode. Together with the VCSEL contained in the sensor package, the ADNS-7100-001 lens provides directed illumination and optical imaging necessary for the operation of the sensor. The lens is a precision molded optical component and should be handled with care to avoid scratching and contamination on the optical surfaces.

3D drawing files in STEP or IGES format for the sensor, lens and base plate describing the components and base plate molding features for the lens and PCB alignment is available.

Design considerations for improving ESD Performance

The table below shows typical values assuming base plate construction per the Avago Technologies supplied IGES file for ADNS-7100-001 lens. Note that the lens material is polycarbonate and therefore, cyanoacrylate based adhesives should not be used as they will cause lens material deformation.

Typical Distance	Millimeters (mm)
Creepage	11.87
Clearance	10.05

PCB Assembly Considerations and Soldering Profile

1. Prior to PCB assembly, handling precaution must be taken for ADNS-7630 sensor that is classified as MSL-3. (For more information, please refer to IPC/JEDEC J-STD-033B.1: Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices)
2. Surface-mount the sensor package and all other electrical components onto PCB.
3. Reflow the entire assembly with a no-wash solder flux process (refer to Figure 7 below).
4. Remove the protective kapton tapes from both optical apertures on the ADNS-7630 sensor by using flat-headed tweezer. Care must be taken to keep contaminants from entering the aperture. Recommend not to place the PCB facing up during the entire assembly process. Recommend to hold the PCB vertically for the kapton tapes removal process.
5. Place the PCB over the lens onto base plate. The sensor package should be self-aligned to the lens. The optical center reference for the PCB is set by base plate and lens. Note that the PCB movement due to button presses must be minimized to maintain good optical alignment.
6. Recommended: The lens can be permanently located by heat-staking or ultrasonic-staking the lens' guide posts over the PCB board.
7. Then, install the mouse top case. There MUST be feature in the top case (or other area) to press down onto the PCB assembly to ensure the sensor and lens are interlocked to correct vertical height.

Refer to Figure 7 and Table 2 for the recommended solder reflow profile for PCB using Pb-free solder paste LF310.

Table 2. Recommended Solder Reflow Profile

Description	Specification
Max Ramp-Up Rate,	3°C/sec
Max Ramp-Down Rate,	6°C /sec
Preheat temperature minimum, Tsmin	150°C
Preheat temperature maximum, Tsmax	200°C
Preheat Duration(Tsmin to Tsmax), t_S	60-120 sec
Liquidus Temperature, T_L	220°C
Time Above Reflow (T_L=220°C), t	30-90 sec
Peak Temperature, Tp	250°C
Time within 5°C of the specified classification temperature (Tc=250°C), tp	10 sec
Time 25°C to peak temperature	8 mins maximum

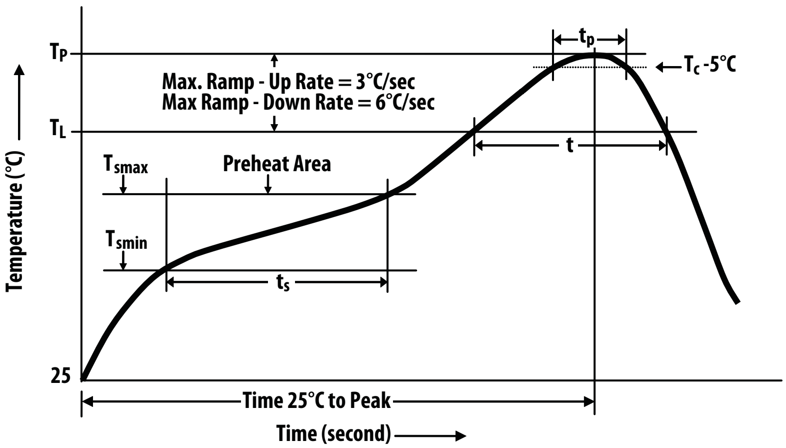


Figure 7. Solder Reflow Profile for PCB

Critical and Non-critical Areas of QFN Soldering

As ADNS-7630 is a QFN package, it is designed to be a contact-down package. Refer to Figure 7 and 8 on the critical and non-critical areas for QFN soldering. The critical area for soldering ADNS-7630 is on the terminal undersides, while the terminal sides are deemed as non-critical area, and thus not intended to be wettable. The non-wetting of the terminal sides are due to exposed copper on the package side (which is expected and accepted), occurred after the singulation step, which is a standard process in QFN assembly. This is inline with the Industry Standard (for more information, please refer to IPC-A-610D: Acceptability of Electronics Assemblies).

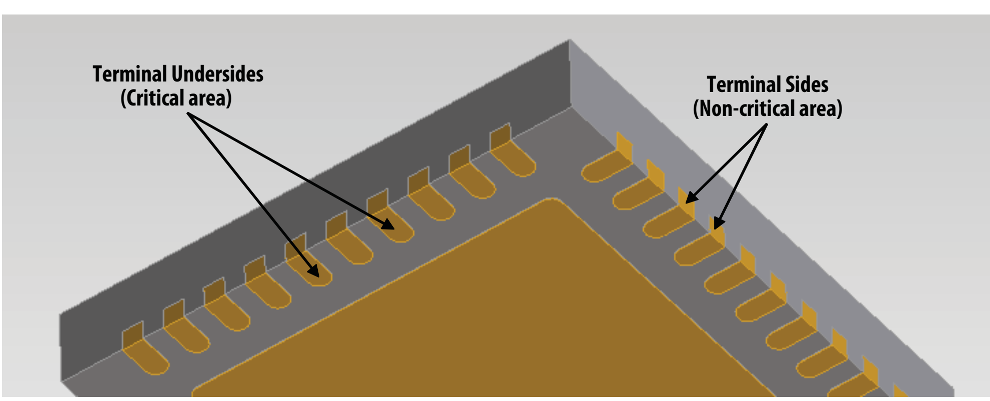
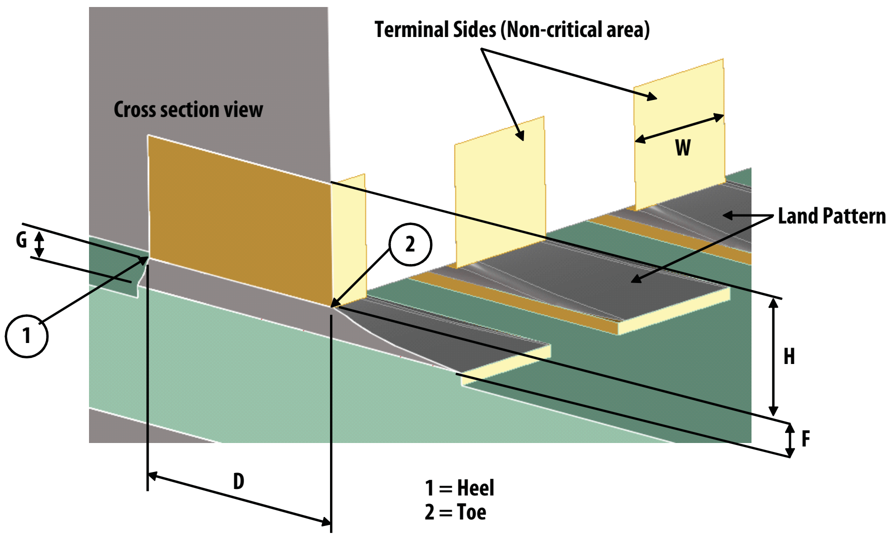


Figure 8. Critical and Non-critical areas (Bottom view)



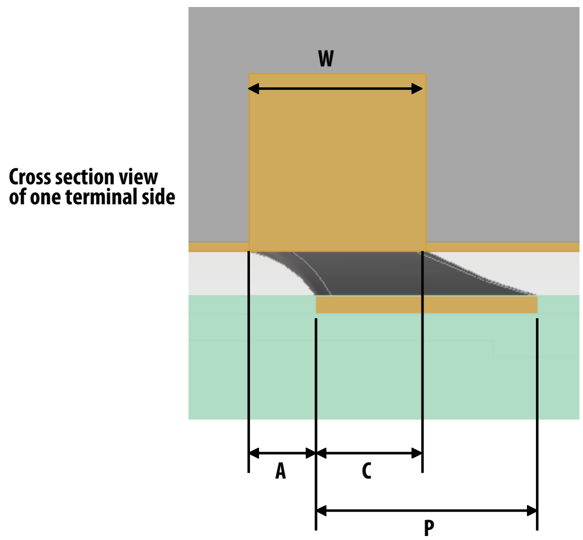


Figure 9. Critical and Non-critical areas (Cross sectional views)

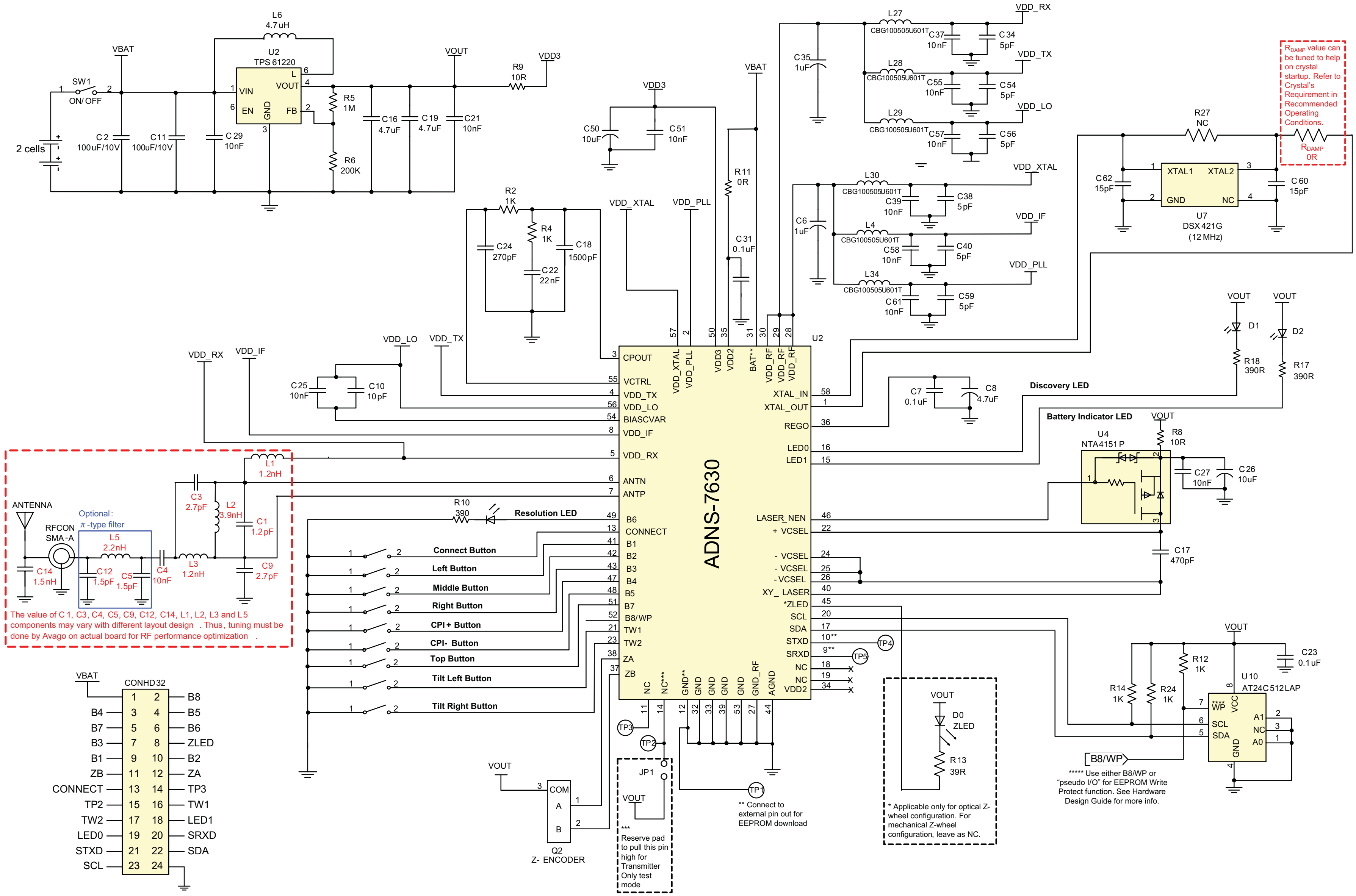
Table 3. Dimensional Criteria

Feature	Dimension	Class 1	Class 2	Class 3
Maximum Side Overhang	A	50% W, Note 1	25% W, Note 1	25% W, Note 1
Minimum End Joint Width	C	50% W	75% W	75% W
Minimum Side Joint Length	D	Note 4	Note 4	Note 4
Minimum Fillet Height	F	Notes 2, 5	Notes 2, 5	Notes 2, 5
Solder Fillet Thickness	G	Note 3	Note 3	Note 3
Termination Height	H	Note 5	Note 5	Note 5

Notes:
1. Should not violate minimum electrical clearance.
2. Unspecified parameter. Variable in size as determined by design.
3. Good wetting is evident.
4. Is not a visual attribute for inspection.
5. Terminal sides are not required to be solderable. Toe fillets are not required.

All data and information is provided to and as a reference in the application of Avago Technologies' product, but the responsibility for proper design of printed circuit SMT process design still lies with the SMT assembly company. Avago Technologies has no liability for customer's design.

Application Schematic



Note: Due to complexity of RF board design, technical assistance on the PCB layout design and RF performance buy off is provided. Please contact Avago Technologies' sales representative during design stage.

Figure 10. ADNS-7630 Application Schematic

PCB Layout Requirements:

1. Recommended to use 4-layer PCB board, with second layer as GND plane and third layer as power plane.
2. Cut the copper beneath the antenna pattern on the GND plane, power layer and the bottom layer; no signal line is allowed beneath the antenna pattern at all of the layers. Antenna pattern is highly recommended to be located at one of the board edges, furthest away from palm coverage.
3. Keeping any metallic objects (eg. Battery terminal plates) at least 15mm away from the antenna as this is the distance of the near field for electromagnetic field.
4. Power lines should be thick and short. Big via holes are recommended whenever needed.
5. C37 and C34, C55 and C54, C57 and C56, should be placed as near as possible to pin 5, pin 4 and pin 56 respectively for effective decoupling.
6. C39 and C38, C61 and C59, C58 and C40, should be placed as near as possible to pin 57, pin 2 and pin 8 respectively for effective decoupling.
7. The ground pad beneath the centre of the ADNS-7630 QFN package should have sufficient via holes down to the same ground plane (2nd layer of the PCB). Use solder mask to prevent any unwanted short circuit. Prepare necessary area of solder pads only.
8. Components connected to CPOUT (pin 3) and VCTRL (pin 55) must as close as possible to ADNS-7630 IC. It is recommended to complete the loop within the same PCB layer.
9. Keep sufficient clearance between RF Trace class_1 (from pin ANTN to Antenna) and Ground copper (if applicable) on the top side 3 times larger than h (height of top layer to GND layer); the same requirement is needed for RF Trace class_2 (from pin ANTP to Antenna) and Ground copper (if applicable). Keep a clearance between VDD_RX (pin 5) and ANTN (pin 6) traces, as well as between ANTP (pin 7) and VDD_IF (pin 8) traces.
10. Keep ANTN and ANTP traces (from IC to antenna) parallel, short and as straight as possible without many curves. Recommended to have differential impedance between ANTN and ANTP to be 100Ω, and unbalanced trace (from C4 to ANTENNA) impedance controlled to 50Ω.
11. Keep a clearance between antenna and ground.
12. Ensure large grounding plane and more via holes at GND (pin 27, pin 32 and pin 33) down to the ground plane (2nd layer of the PCB).
13. Components connected to the pins below MUST complete the loop within the same PCB layer (no usage via holes allowed).
    a. BIASVAR (pin 54)
    b. REGO (pin 36)
    c. VDD3 (pin 31, 35, 50)
14. C17 must be as close as possible to the ADNS-7630 IC.
15. All separate AGND, GND_RF and GND paths MUST be via down to the same ground plane (2nd layer of the PCB). Ensure large grounding plane on the PCB layout for better performance on ESD and EFTB.
16. All caps MUST be as close to the power pins as possible, with the smaller capacitors nearer to the ADNS-7630 IC.
17. Frequency tolerance of crystal oscillator should follow the specification of +/- 20PPM. Recommended to use TST TZ0683B 12MHz crystal. Crystal should be placed less than 10mm (must not be more than 15mm) from ADNS-7630 XTALIN and XTALOUT pins.
18. Ceramic non-polarity caps and tantalum polarity capacitors are recommended.
19. Capacitors connected to VDD3 MUST have less than 0.2Ω ESR.
20. It is optional but highly recommended for customers to route some signals to a 2mm pin header (only to be soldered when troubleshooting is needed) on the mouse board to ease Avago's technical support in future. Refer to Design Guide – Hardware for more information.
21. Ensure that no component is placed at the lens clearance area as shown in Figure 4 so that the lens is interlocked to the PCB at the correct vertical height.
22. Add an optional π-type filter at antenna circuit to suppress 4.8G/7.2GHz harmonics.

Block Diagram

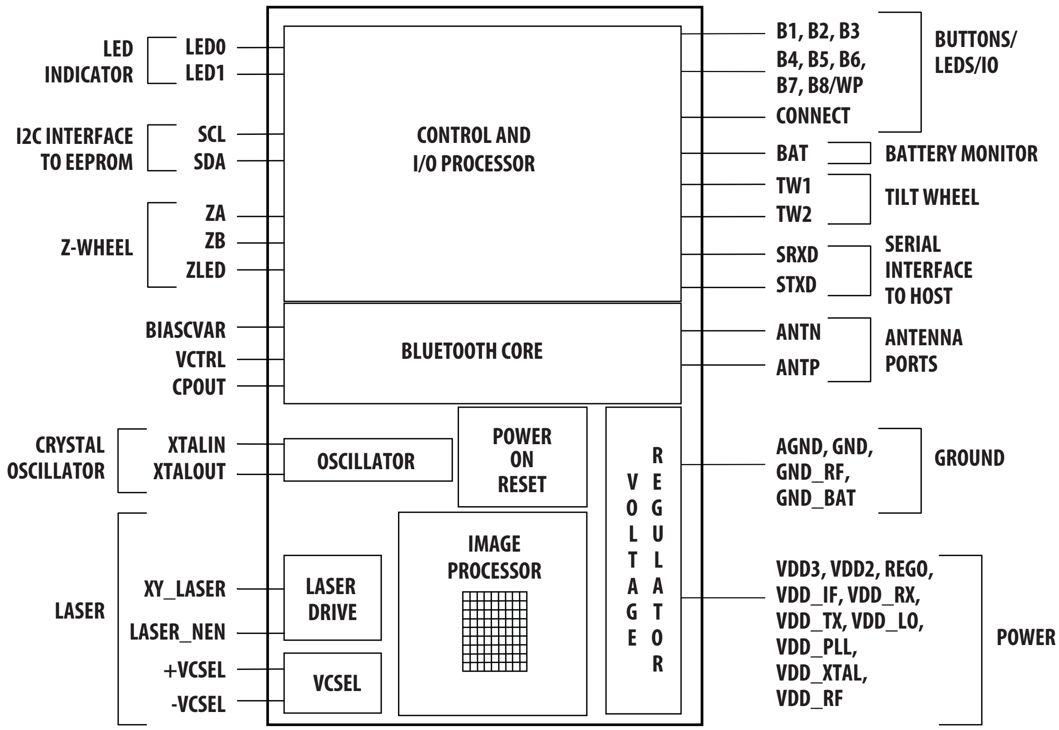


Figure 11. ADNS-7630 Block Diagram

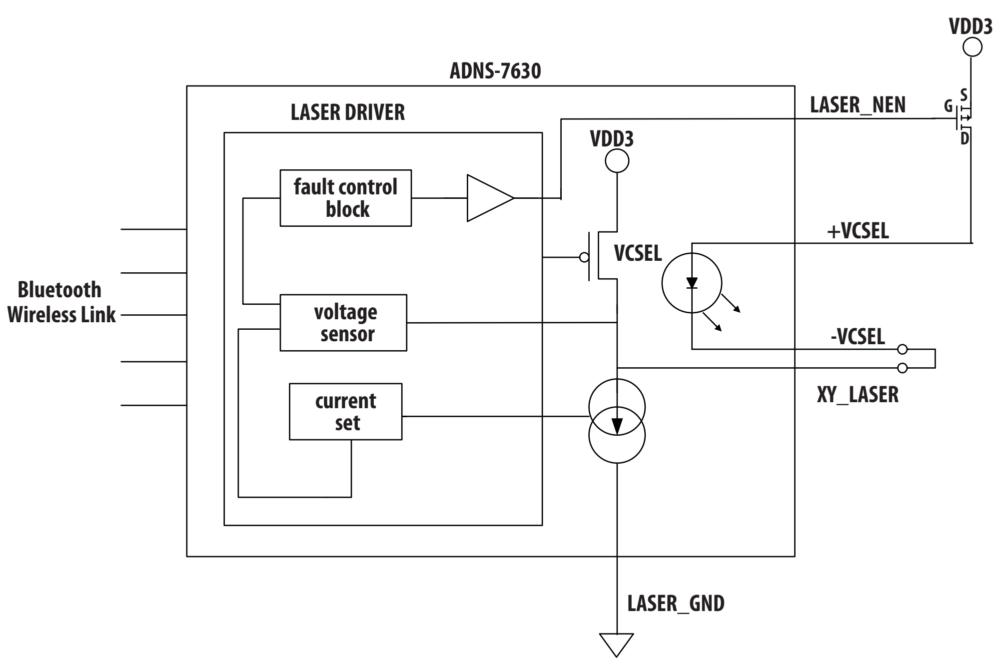


Figure 12. Single Fault Detection and Eye Safety Feature

Eye Safety

ADNS-7630 SoC sensor and the associated components in the schematic of Figure 9 are intended to comply with Class 1 Eye Safety requirements of IEC/EN 60825-1. Avago Technologies pre-calibrate sensor laser output power (LOP) to Class 1 eye safety level prior shipping out, thus no laser output power calibration is required at mouse manufacturer site.

ADNS-7630 SoC sensor is designed to maintain the laser output power using ADNS-7100-001 lens within Class 1 requirements over components manufacturing tolerances under the recommended operating conditions and application circuit of Figure 9 as specified in this document. Under normal operating conditions, the sensor generates the drive current for the VCSEL. For more information, please refer to Eye Safety Application Note.

Single Fault Detection

ADNS-7630 SoC sensor is able to detect a short circuit or fault condition at the –VCSEL pin, which could lead to excessive laser power output. A path to ground on this pin will trigger the fault detection circuit, which will turn off the laser drive current source and set the LASER_NEN output high. The system will prevent excess laser power for a resistive path to ground at -VCSEL by shutting off the laser. In addition to the ground path fault detection described above, the fault detection circuit is continuously checking for proper operation by internally generating a path to ground with the laser turned off via LASER_NEN. If the –VCSEL pin is shorted internally to VDD3, this test will fail and will be reported as a fault.

Regulatory Requirements

- Passes FCC C and worldwide analogous emission limits when assembled into a mouse and following Avago Technologies recommendations.
- Passes IEC-61000-4-2 Electrostatic Discharge Immunity Test (ESD) and provides sufficient ESD creepage/clearance distance to withstand up to 15 kV discharge when assembled into a mouse with ADNS-7100-001 trim lens.
- Passes IEC/EN 60825-1 Class 1 Eye Safety when ADNS-7630 is driving the laser using ADNS-7100-001 lens with the laser output power pre-calibrated by Avago Technologies under recommended operating conditions.

Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units	Notes
Storage Temperature	T_S	-40	85	ºC	MSL 3 level
Lead Solder Temperature	T_p		260	ºC	MSL 3 level refer to Solder Reflow Profile in Figure 7
Power Supply Voltage	V_{DD21}	-0.5	3.7	V	
	V_{DD3}	-0.5	3.7	V	
	V_{DD_RF}	-0.5	2.1	V	
ESD (Human body model)[1,2]			2	kV	All Pins.
Input Voltage	V_{IN}	-0.5	V_{DDIO}+ 0.5	V	All I/O Pins
Latch-up Current	I_{OUT}		20	mA	All Pins
Laser Output Power	LOP_{max}		716	μW	Class 1 Eye Safety Limit

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

Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes
Operating Temperature	T_A	0		40	°C	
Power Supply Voltage	V_{DD21}	2.1	2.8	3.6	V	For digital core. Including noise.
	V_{DD3}	2.7	2.8	3.6	V	For sensor core. Including noise.
RF Regulator Output Voltage	V_{DD_RF}	1.7	1.8	1.9	V	For RF Core. Output from REG0 & VDD_RF
Power Supply Rise Time	V_{RT}	2		100	ms	V_{DD21} is tied to VDD3 and ramp from 0 to 2.8V
Latch-Up Current			10		mA	All pins
Supply Noise (Sinusoidal)	V_{NA}			80	mV_{p-p}	With RC filter (10Ω+10uF) for 10kHz~50MHz Except 25kHz~35kHz that max is 35mVp-p Without RC filter will degrade Carrier Drift
Distance From Lens Reference Plane To Surface	Z	2.18	2.40	2.62	mm	Results in +/- 0.22 mm minimum DOF. See Figure 13
Speed	S			30	in/sec	
Acceleration	A			8	g	
Vcsel Peak Wavelength	λ	832		865	nm	
Laser Output Power	LOP			506	μW	Under operating temperature, 25°C± 5°C. Class 1 eye safety level when ADNS-7630 is driving the laser using ADNS-7100-001 lens based on application circuit in Figure 10

Crystal's Requirement	Symbol	Minimum	Typical	Maximum	Units	Notes
Nominal Frequency	F_{CLK}		12		MHz	±20ppm
Equivalent Series Resistor (ESR)	X_{RES}			100	Ω	
Shunt Capacitance	C_o		3	7	pF	
Load Capacitance	CL			12	pF	
Drive Level	P_{DL}	10		50	μW	
Damping Resistor	R_{DAMP}	0		18	Ω	See Figure 10 on R_{DAMP} connection and Figure 14 to fine tune the R_{DAMP} value to match with the drive level of crystal used.
Clock Ready Time	T_{XAL_RDY}			2	ms	See Figure 14

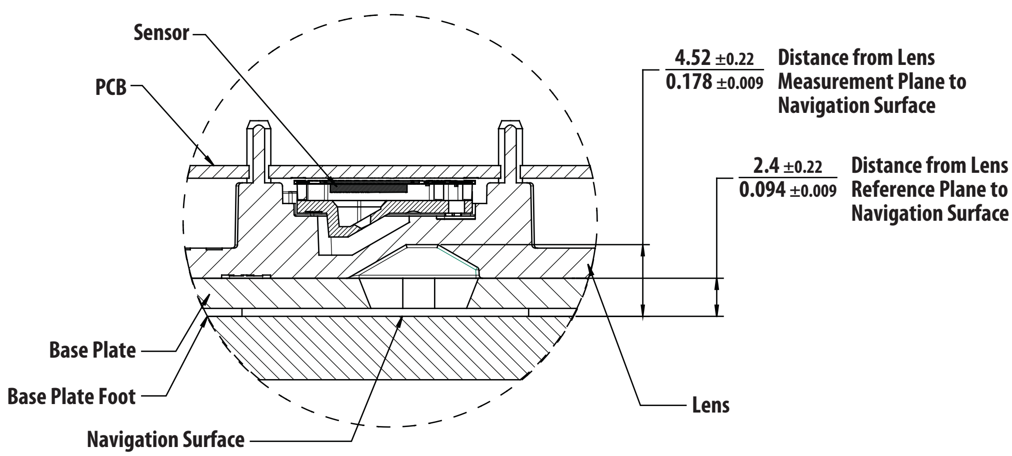


Figure 13. Distance from lens reference plane to object surface, Z

AC Electrical Specifications

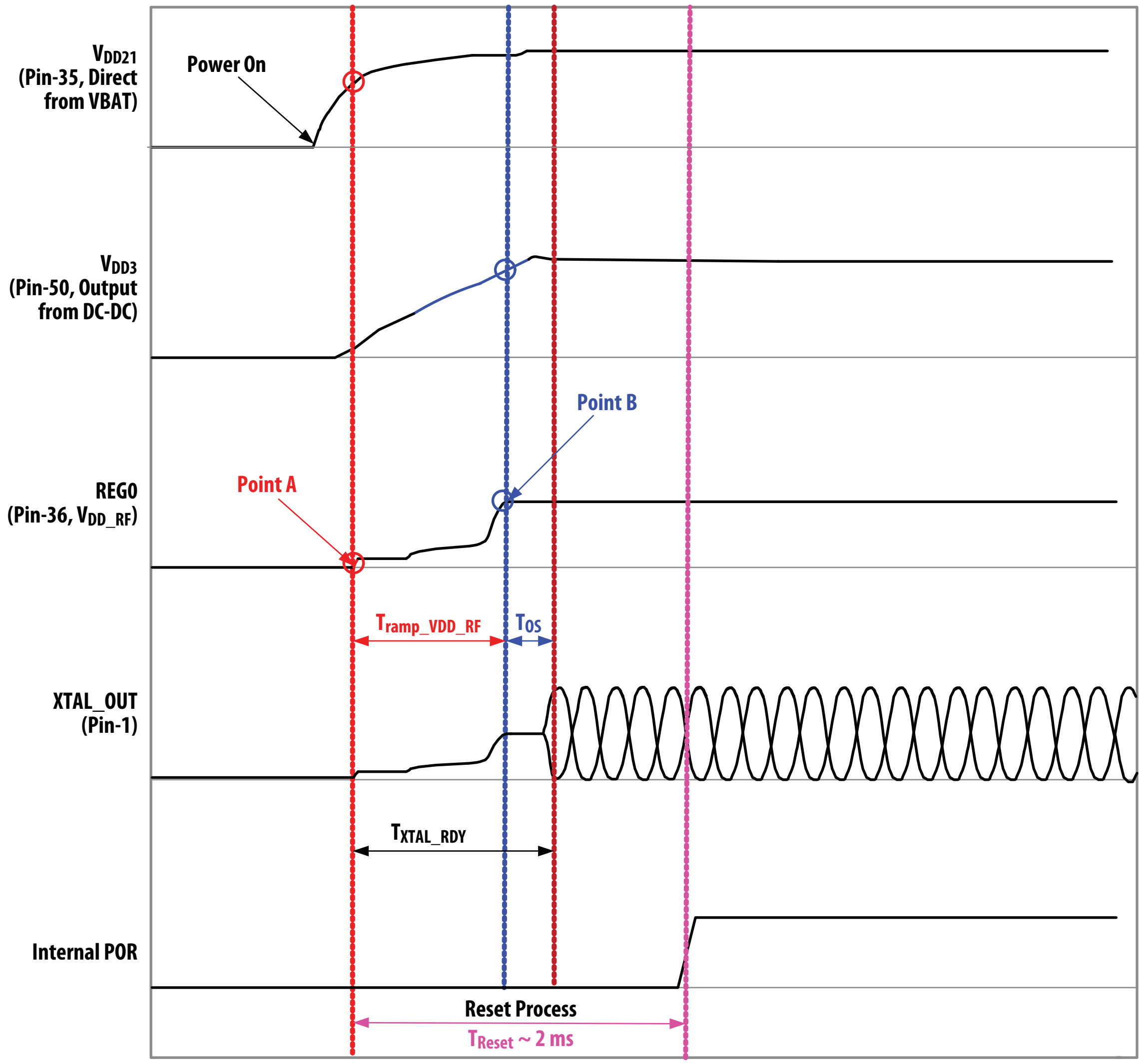
Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, V_{DD21} = 2.8V, V_{DD3} = 2.8V

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes
Debounce delay on button inputs	t_{DBB}		6	7.9	ms	
Scroll wheel sampling period	t_{SW}	1.9	2.0	2.8	ms	ZA & ZB Pins.
Transient Supply Current	I_{DDT}			100	mA	V_{DD21} is tied to V_{DD3}. Max supply current during a ramp from 0 to 2.8V

DC Electrical Specifications

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, V_{DD21} = 2.8V, V_{DD3} = 2.8V

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes
Tx Current	I_{Tx}		53	57.5	mA	Transmitter and baseband are fully ON, navigation core is OFF. Buttons and I/Os are floating, LED pins pull to low
Rx Current	I_{Rx}		47	51	mA	Receiver and baseband are fully ON, navigation core is OFF. Buttons and I/Os are floating, LED pins pull to low
DM1 Tx mode Current	I_{DM1_Tx}		24.7		mA	RF sends a longest DM1 packet every 1.25ms
DM1 Rx mode Current	I_{DM1_Rx}		24.2		mA	RF receives a longest DM1 packet every 1.25ms
Sniff mode 11.25ms Current	$I_{sniff\_11.25ms}$		10	12	mA	System average current includes VCSEL current. Sniff_TimeOut = 0, Sniff_Attempt = 1
Sniff mode 67.5ms Current	$I_{sniff\_67.5ms}$		1.4	2	mA	System average current includes VCSEL current.
Sniff mode 300ms Current	I_{sniff_300ms}		0.335	0.785	mA	System average current includes VCSEL current.
Deep Sleep Current	I_{DSleep}		110	280	µA	Disconnected, wake on sensor motion. State preserved.
			80	250	µA	Disconnected, wake on button clicked. State preserved.
Input Hysteresis	V_{HYST}		285		mV	Pins: B1-B8, TW1, TW2
Button Pull-up Current	I_{PULLUP}	100	300	500	µA	Pins: B1-B8, TW1, TW2
Input Low Voltage	V_{IL}			0.2* V_{DD3}	V	Pins: B1-B8, TW1, TW2, ZA, ZB
Input High Voltage	V_{IH}	0.8* V_{DD3}			V	Pins: B1-B8, TW1, TW2, ZA, ZB
Input Leakage Current	I_{leak}		±1	±10	µA	Vin = 0.7* V_{DD3}
Output Low Voltage, LASER_NEN	V_{OL}			0.2* V_{DD3}	V	Iout= 1mA, LASER_NEN
Output High Voltage, LASER_NEN	V_{OH}	0.8* V_{DD3}			V	Iout= -0.5mA, LASER_NEN
Input Capacitance	C_{in}			10	pF	



Notes:

1. Point A = Ramp start point of REG0/V_{DD_RF} that triggers internal reset process.
2. Point B = Stable point of REG0/V_{DD_RF} that crystal will start its oscillation.
3. $T_{ramp\_VDD\_RF}$ = Ramp up time og REG0/V_{DD_RF}.
4. T_{OS} = Crystal startup time. Depends on crystal's drive level and load capacitance.
5. T_{Reset} = ADNS-7630's internal Power On Reset (POR) process duration.
6. $T_{XTAL\_RDY} < T_{Reset}$.

Figure 14. Power-Up Timing Diagram

Receiver RF Specifications

Electrical Characteristics over recommended operating conditions based on Avago Technologies' ADNK-7633 reference design mouse.Typical values at 25 °C, V_{DD21} = 2.8V, V_{DD3} = 2.8V

Parameter	Minimum	Typical	Maximum	Units	Mode and Conditions
Receiver Section					
RX sensitivity	-90	-85	-80	dBm	GFSK, 0.1%BER, 1 Mbps
Maximum input power	-20	-10		dBm	
Interference Performance					
C/I co-channel		7.5	11	dB	GFSK, 0.1%BER
C/I 1MHz adjacent channel		-3.5	0	dB	GFSK, 0.1%BER
C/I 2MHz adjacent channel		-31	-30	dB	GFSK, 0.1%BER
C/I ≥ 3MHz adjacent channel		-41	-40	dB	GFSK, 0.1%BER
C/I Image channel		-39	-9	dB	GFSK, 0.1%BER
C/I 1MHz adjacent to image channel		-37	-20	dB	GFSK, 0.1%BER
Out-of-Band Blocking Performance (CW)					
30 MHz to 2000 MHz	-10			dBm	0.1% BER
2000 MHz to 2400 MHz	-27			dBm	0.1% BER
2500 MHz to 3000 MHz	-27			dBm	0.1% BER
3000 MHz to 12.75 GHz	-10			dBm	0.1% BER
Intermodulation Performance					
BT, Delta F = 3MHz	-39	–36		dBm	
Spurious Emission					
30 MHz to 1 GHz		-77	-57	dBm	
1 GHz to 12.75 GHz		-64	-47	dBm	

Transmitter RF Specifications

Electrical Characteristics over recommended operating conditions based on Avago Technologies' ADNK-7633 reference design mouse. Typical values at 25 °C, V_{DD21} = 2.8V, V_{DD3} = 2.8V

Parameter	Minimum	Typical	Maximum	Units	Notes
Transmitter Section					
Spectrum frequency range	2400		2483.5	MHz	
Output power	-6	0	4	dBm	
In-Band Spurious Emission					
+/-500 kHz			-20	dBC	
Out-of-Band Spurious Emission					
30 MHz to 1 GHz		-60	-36	dBm	
1 GHz to 12.75 GHz			-30	dBm	
1.8 GHz to 1.9 GHz		-80	-47	dBm	
5.15 GHz to 5.3 GHz		-90	-47	dBm	
Lo Performance					
Lock time		130	180	µs	
Initial carrier frequency tolerance		±25	±75	kHz	
Frequency Drift					
DM1 packet		±20	±25	kHz	
DH1 packet		±20	±25	kHz	
Drift rate		10	20	kHz/50 µs	
Frequency Deviation					
Average deviation in payload (sequence used is 00001111)	140	168	175	kHz	
Maximum deviation in payload (sequence used is 10101010)	115			kHz	
Channel spacing		1		MHz	

Z-Wheel

ADNS-7630 can support both mechanical and optical Z-wheel design. Selection of Mechanical or Optical Z-Wheel interface can be set from EEPROM Z_Selection register (0x0137). The Z-Wheel reporting format which determines the vertical scroll resolution can be configured to Z/2 or Z/4 format when using different sensitivity optical Z-Wheel via EEPROM Z_Configuration register (0x0138). For mechanical Z-Wheel, Z/2 format is widely used as most of the commonly available mechanical Z-Wheel encoders come with low sensitivity. Optical Z-Wheel can utilize either the Z/2 or Z/4 format according to the desired sensitivity. Z_Negate (0x0139) enables correct Z-Wheel orientation in case ZA and ZB are swapped.

For mechanical Z-Wheel design, only ZA and ZB pins are connected to the physical mechanical encoder. ZLED pins should be floated (No Connect). For optical Z-Wheel design, connect all ZA, ZB and ZLED pins appropriately to the physical optical encoder system.

The direction of the Z-Wheel (positive or negative) based upon the Z-Wheel's quadrature output is shown in the state diagram below. State is shown in the form ZB ZA. Z-Wheel counts are reported only for transitions with + or - signs.

Tilt-Wheel

ADNS-7630 can support Tilt Wheel function via TW1 and TW2 pins by activating it through EEPROM register Tilt_Wheel_Enabled (0x0114). For applications without Tilt-Wheel, TW1 (GPIO3) and TW2 (GPIO4) pins can be configured as LED GPIO via the same register above.

Disclaimer: All designers and manufacturers of final product with tilt wheel enabled must assure that they have all necessary intellectual property rights.

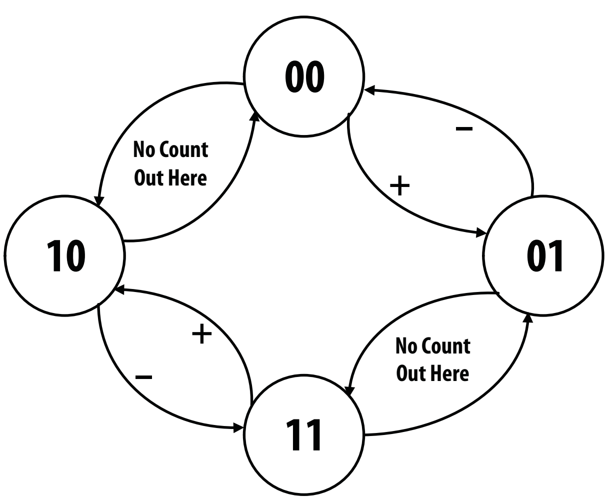


Figure 15. State Diagram for Z-Wheel

Connect Button

It is a must to have a "Connect" button in a Bluetooth mouse design to enable end users to initiate pairing/unpairing with any Bluetooth host. Connect_Button_Press_Duration register (0x00a4-0x00a5) allows mouse manufacturers to define duration needed for the "Connect" button to be held for a valid button pressed.

Connect "Connect" button to CONNECT pin (pin 13) for this feature.

Discover LED Indicator

It is highly recommended for mouse manufacturers to include a discover LED indicator in a Bluetooth mouse design as it enables end users to know if the mouse has entered discoverable mode successfully. See registers 0x0115-0x0119 to enable/disable discover LED support, to assign GPIO pin to be used, to define GPIO state to turn on the discover LED as well as the LED's duty cycle.

Connect the physical discover LED to LED0 (GPIO5) pin or LED1 (GPIO6) pin for this feature.

Battery LED Indicator

It is highly recommended for mouse manufacturers to include a battery LED indicator in a Bluetooth mouse design as it alerts end users when the battery power is running low, and also to remind end users to change the batteries. See registers 0x011a-0x011e, 0x0238-0x23d and 0x248 for the following configuration:

- enable/disable battery LED support
- assign GPIO pin to be used
- define GPIO state to turn on the battery LED, the LED's duty cycle, the blink/rest duration, active sniff modes and total duration
- define whether the LED is disabled before connection is established.

Connect the physical battery LED to LED0 (GPIO5) pin or LED1 (GPIO6) pin for this feature.

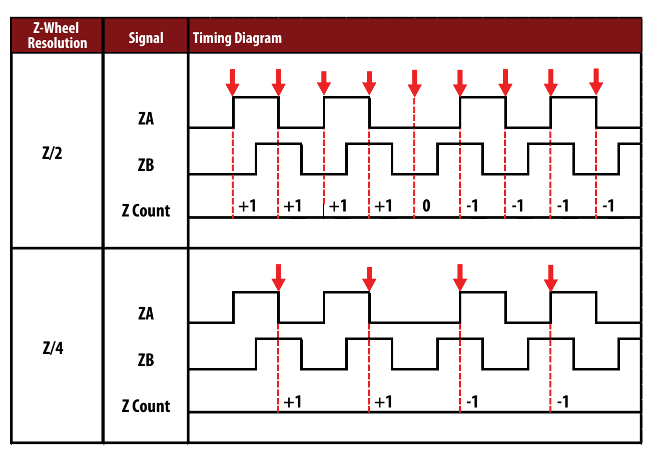


Figure 16. Timing Diagram for Z/2 and Z/4 settings

Basic Buttons & Programmable Buttons

There are a total of 3 basic buttons supported by ADNS-7630, namely B1 (left button), B2 (middle button) and B3 (right button). B4 (GPIO11) through B8/WP (GPIO15) are General Purpose Input/Output pins programmable to be buttons, LED indicator, or EEPROM write protect enabler. Access EEPROM register, Programmable_Buttons_Total (0x00d1) to define the total number of programmable buttons to be used in the mouse design. For all available programmable buttons, manufacturer can assign each button to a GPIO pin, as well as its function when the button is clicked once, double clicked or pressed for a specified duration.

Buttons, B1 through B8, TW1 and TW2 are connected to a Schmidt trigger input with 100µA current sources pulling up to +3V during run and rest modes. When used as buttons, the minimum time between button presses is T_{DBB}. T_{DBB} is programmable via the EEPROM (0x021e). The buttons are sampled every 4ms (default), typically. Five consecutive low values create a button press event. Five consecutive high values create a button release event. This is applicable to all single button click function.

ADNS-7630 also support double-click and button long-press features. The double click interval and long-press duration of each programmable button is configurable via EEPROM registers. However, button double click is functional only if SPP is disabled. Long-press duration should be programmed significantly longer than the single click duration so that end users will not be confused between single click and long press functions.

To define explicit functions single click, double click and long press functions for each programmable buttons, manufacturers can either assign the On-the-Fly (OTF) Resolution Mode or KeyMap (KM) feature through Keyboard Code A and Keyboard Code B. Refer to next section on detail description on KeyMap and On-the-Fly (OTF) Resolution Mode implementation.

On-the-Fly (OTF) Resolution Mode

The ADNS-7630 sensor is enhanced with programmable On-the-Fly (OTF) resolution mode, in which user is able to switch resolution setting anytime with OTF button single click, double click or long press. Any two available GPIOs between GPIO11-GPIO15 can be used to configure as the OTF resolution buttons. There are two types of OTF resolution mode:

a. Step by step increment or decrement using CPI+ and CPI- buttons:

   This method requires two GPIOs namely CPI+ and CPI- programmable buttons to increase or decrease the resolution setting step by step. There is a maximum of 10 resolution settings which can be enabled through EEPROM. If the current resolution setting is either in maximum or minimum level, any new button press will remain at the respective maximum or minimum level.

b. Rotational state change using CPI rotation button:

   This method requires only one GPIO to be programmed as CPI rotation button for incremental state change of resolution settings as configured in EEPROM. There is a maximum of 10 resolutions which can be enabled through EEPROM.

This OTF Resolution Mode can be enabled or disabled through EEPROM register Resolution_Selection_Method (0x0141). The OTF resolution mode types, step by step increment or decrement or rotational state change can be configured through SingleClick, LongPress or DoubleClick function in Button Configuration.

Mouse manufacturers can limit the total possible resolution settings to maximum of ten via EEPROM Resolution_Selection _Total register (0x0142). To define all resolution settings, access registers 0x0144-0x014d. The values must be valid resolution range from 250cpi to 3000cpi.

The OTF current resolution state can be displayed with LED indication via any available GPIO between GPIO3-GPIO6 and GPIO11-GPIO15. These GPIOs can be configured to be active high output and the blinking duty cycle can also be determined via EEPROM.

Mouse manufacturers can use up to 4 GPIO to support resolution LED indicators. Refer to registers 0x011f-0x0123 for total GPIO to be used and each GPIO assignment. As there is a maximum of ten possible resolution settings, there is also a maximum of ten possible resolution LED indicator settings via registers 0x0124-0x012d. Duration for resolution LEDs to be lighted up can also be programmed via Resolution_LED_Duration (0x012e). For optimized power saving purposes, it is recommended that the LEDs are lighted up for a short moment once there is a change in the resolution setting. To define GPIO state to turn on the resolution LED indicator as well as the LED's duty cycle, access EEPROM registers 0x012f-0x0131.

KeyMap (KM)

The KeyMap is only supported in Bluetooth version 2.0 firmware. KM enables any available GPIO between GPIO11-GPIO15 to be assigned as keyboard shortcut key. User_Defined_Function_n_A/B/C registers (where, n=1, 2, 3, 4 or 5) allow configuration of User_Defined_Function_n_A/B/C registers (where, n=1, 2, 3, 4 or 5). Thus, the sensor can be customized to implement standard Microsoft keyboard shortcut keys or special shortcut keys used in different applications, e.g. Office, CAD, PC Games, etc.

The respective first and second byte of keyboard code A, B and C can be assigned to programmable button n (where, n=1, 2, 3, 4 or 5) in the MConfig software program. The first byte usually consists of any combinations for keys located on the either side (left or right only) of a standard keyboard as listed:

- Windows Logo Key ("**LWIN**", "**RWIN**")
- CTRL ("**LCTRL**", "**RCTRL**")
- SHIFT ("**LSHIFT**", "**RSHIFT**")
- ALT ("**LALT**", "**RALT**")

The second byte can be referred to any single keyboard key scan code available from Windows Platform Design Notes on Keyboard Scan Code Specification, which can be downloaded from:

http://www.microsoft.com/whdc/archive/scancode.mspx

Some examples of possible key combinations for programmable buttons below:

If keyboard code A of programmable button 1 is shortcut key of "**Windows Logo Key**",
Keyboard code A byte1 = "**LWin**" (or "**RWin**")
Keyboard code A byte2 = Not Support
User_Defined_Function_1_A = a1 01 08 00 03 00 00 00 00 00

If keyboard code A of programmable button 2 is shortcut key of "**Enter**",
Keyboard code A byte1 = "Not Support"
Keyboard code A byte2 = "**ENTER**"
User_Defined_Function_2_A = a1 01 00 00 28 00 00 00 00 00

If keyboard code B for programmable button 5 is shortcut key of "**Ctrl+Alt+Delete**",
Keyboard code B byte1 = "**LAlt+LCtrl**" (or "**RAlt+RCtrl**")
Keyboard code B byte2 = "**Delete**"
User_Defined_Function_5_B = a1 01 05 00 4c 00 00 00 00 00

Note: "LCtrl+RAlt" and "RCtrl+LAlt" are not supported.

EEPROM Write Protect Feature

Notice that B8/WP can either be used as a programmable button or LED indicator, or even as an I/O pin for EEPROM Write Protect function. In the event where all I/Os above are used up in a Bluetooth Mouse with tilt wheel, schematic below can be used to generate a 'pseudo I/O' for EEPROM Write Protect function. However, if all I/Os are used up in a Bluetooth Mouse without tilt wheel, there will be no EEPROM Write Protect function in the mouse. Though the possibility of EEPROM being overwritten through normal mouse operation is low, Avago Technologies highly recommends mouse makers to use either B8/WP or the "pseudo I/O" method for EEPROM Write Protect function.

Media Buttons

The Media button featuring audio control is supported in both Bluetooth version 2.0 and 2.1 firmwares. The ADNS-7630 is the first one-chip mouse sensor to support Consumer Control usages as defined in the **Consumer Page** (page 0x0C) in the *Universal Serial Bus HID Usage Tables Version 1.0 specification*. For more information, please visit http://www.usb.org/developers/hidpage/.

This feature is related to User-Defined HID Programmable Buttons listed in EEPROM registers. For example, in order to define one function of consumer page, the value should be set in the format of "a1 07 xx yy 00 00 00 00 00 00", where xx yy should be replaced by the usage ID of the target function in byte-inverted sequence, eg. "cd 00" for ID = cd and "25 02" for ID = 225. When manually setting this media button function in MConfig software program, both first and second bytes of corresponding Keyboard Code A, B or C must be set to "Not Support". The User Defined Function C for each programmable button will cease to be effective when SSP is enabled in Bluetooth-Version-2.1's firmware.

Table 15. Example of Consumer Page audio controls supported in Windows 2000.

Usage	Name	Type
0xE0	Volume*	Linear Control (LC)
0xE2	Mute*	On/Off Control (OOC)
0xE3	Bass	Linear Control (LC)
0xE4	Treble	Linear Control (LC)
0xE5	Bass Boost*	On/Off Control (OOC)
0xE7	Loudness	On/Off Control (OOC)
0xE9	Volume Increment*	Re-trigger Control (RTC)
0xEA	Volume Decrement*	Re-trigger Control (RTC)

* These controls are supported in Windows 98 (original release and Service Pack 1 release).

Note: Programmable buttons with RTC usage type controls should be assigned to single click function only. If the button is pressed continuously and not released, the event will be retriggered. Thus, there should not be any long press function assigned to these buttons. For example, if user keeps pressing the Volume Increment button, ADNS-7630 will perform the actual re-triggering of events that will lead to continuous increments of the volume until the button has been released or until the maximum volume has been reached.

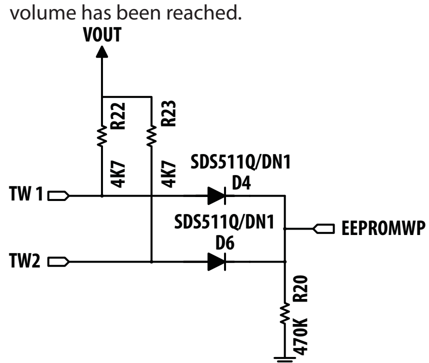


Figure 17. "Pseudo I/O" for EEPROM Write Protect Function

Typical Performance Characteristics

The following graphs are the typical performance of the ADNS-7630 sensor, assembled as shown in the 2D assembly drawing with the ADNS-7100-001 lens.

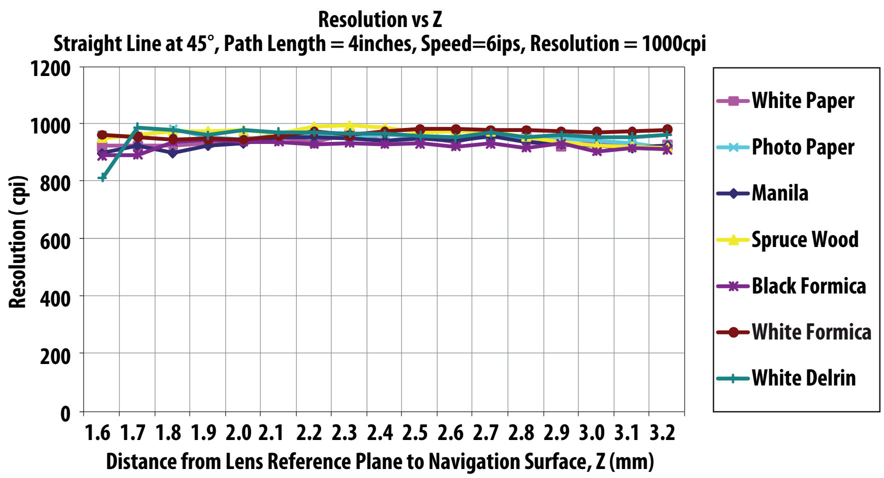


Figure 18. Mean Resolution vs. Z at 1000cpi

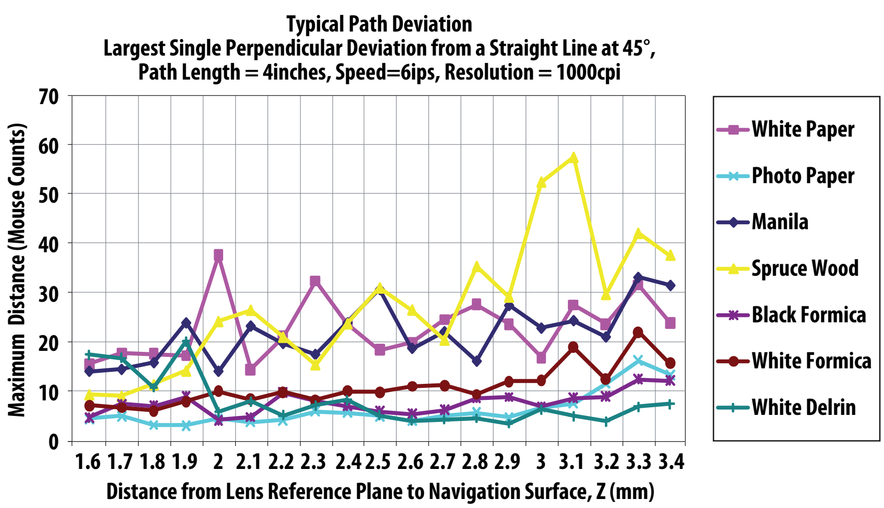


Figure 19. Average Error vs. Distance at 1000cpi (mm)

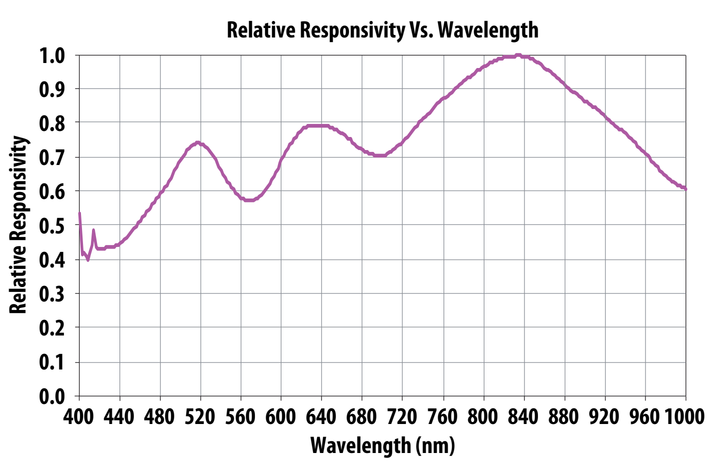


Figure 20. Wavelength Responsivity

Configuration after Power Up (Data Values)

Signal Function	Powered or Default Address or Configured	Suspended from any other states
B1	Pullup active for button use	Pullup active for button use
B2	Pullup active for button use	Pullup active for button use
B3	Pullup active for button use	Pullup active for button use
B4	Pullup active for button use	Pullup active for button use
B5	Pullup active for button use	Pullup active for button use
B6	Pullup active for button use	Pullup active for button use
B7	Pullup active for button use	Pullup active for button use
B8	Pullup active for button use	Pullup active for button use
TW1	Pullup active for button use	Pullup active for button use
TW2	Pullup active for button use	Pullup active for button use
-VCSEL	Pulsing	Pulled high (off)
ZA	Hi-Z input	Hi-Z input
ZB	Hi-Z input	Hi-Z input

Bluetooth HID Data Packet Format for 12-Bit Motion Format, 3/5 Buttons, Z-Wheel and Tilt-Wheel Mouse

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	0	0	0	FB*	BB*	MB	RB	LB
Byte 2	X[7]	X[6]	X[5]	X[4]	X[3]	X[2]	X[1]	X[0]
Byte 3	Y[3]	Y[2]	Y[1]	Y[0]	X[11]	X[10]	X[9]	X[8]
Byte 4	Y[11]	Y[10]	Y[9]	Y[8]	Y[7]	Y[6]	Y[5]	Y[4]
Byte 5	Z[7]	Z[6]	Z[5]	Z[4]	Z[3]	Z[2]	Z[1]	Z[0]
Byte 6	TW[7]	TW[6]	TW[5]	TW[4]	TW[3]	TW[2]	TW[1]	TW[0]

* For 3 buttons mouse, FB = BB = 0.

Bluetooth HID Data Packet Format for 12-Bit Motion Format, 3/5 Buttons, Z-Wheel, Non Tilt-Wheel Mouse

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	0	0	0	FB*	BB*	MB	RB	LB
Byte 2	X[7]	X[6]	X[5]	X[4]	X[3]	X[2]	X[1]	X[0]
Byte 3	Y[3]	Y[2]	Y[1]	Y[0]	X[11]	X[10]	X[9]	X[8]
Byte 4	Y[11]	Y[10]	Y[9]	Y[8]	Y[7]	Y[6]	Y[5]	Y[4]
Byte 5	Z[7]	Z[6]	Z[5]	Z[4]	Z[3]	Z[2]	Z[1]	Z[0]

* For 3 buttons mouse, FB = BB = 0.