ADNS-8020

Track-on-Glass Laser Sensor

Data Sheet

Lead (Pb) Free
RoHS 6 fully compliant

Description

The ADNS-8020 is the Track-on-Glass Laser navigation sensor empowered by PixArt Imaging that enables navigation on all surface types including glass. It is capable of sensing mouse motion with velocities up to 30 inches per second (ips) on non-glass surfaces, 10 inches per second (ips) on glass and acceleration up to 8g.

The ADNS-8020 has dual power supplies of 1.8V and 3.0V, which enables wireless application to lengthen battery life. It integrates both sensor and VCSEL chips in a single 16-pin molded lead-frame DIP package. It is designed to be used with ADNS-8100-002 lens to form a complete laser illuminated navigation system. These parts provide a complete and compact navigation system without moving parts and laser calibration process is NOT required in the complete mouse form, thus facilitating high volume assembly. Performance is not guaranteed if the ADNS-8020 sensor is paired with a lens other than the ADNS-8100-002. Additionally, performance is not guaranteed if the ADNS-8100-002 lens is used in conjunction with a different navigation sensor other than the ADNS-8020.

Theory of Operation

The sensor is based on Track-on-Glass and Laser technologies, which measure changes in position by optically acquiring sequential surface images (frames) and mathematically determining the direction and magnitude of movement. It contains an Image Acquisition System (IAS), a Digital Signal Processor (DSP), and a four wire serial port. The IAS acquires microscopic surface images via the lens and illumination system provided by the VCSEL. 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 data information from the sensor serial port, then translates the data into USB or RF signals before sending them to the host PC or game console.

Features

- Track on Glass and Laser technologies
- 16-pin molded lead-frame DIP package with integrated VCSEL
- Dual power operation, 1.8V and 3V
- High speed motion detection up to 30ips on non-glass surfaces and 10ips on glass surface, and acceleration up to 8g
- Enhanced SmartSpeed self-adjusting frame rate for optimum performance
- Motion detect pin output
- 16-bit motion data registers
- Internal oscillator – no resonator nor crystal needed
- Programmable resolution up to 1600cpi
- Four wire serial port
- Programmable rest downshift and rest period times
- Minimal number of passive components
- Compliance to IEC/EN 60825-1 Eye Safety
- Class 1 laser power output level
- On-chip laser fault detect circuitry
- Advanced technology 832-865 nm wavelength VCSEL
- Single-mode lasing operation

Applications

- Wired and Wireless Laser Mice
- Optical trackballs

NOTE: The ADNS-8020 will be referred as "sensor" and the ADNS-8100-002 as "lens" hereafter.

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Pinout

Pin	Name	Description
1	-VCSEL	Negative terminal of VCSEL
2	XY_LASER	Laser driver output
3	NC	No Connection
4	NCS	Chip select (Active Low Input)
5	MISO	Serial data output (Master In/Slave Out)
6	SCLK	Serial clock input
7	MOSI	Serial data input (Master Out/Slave In)
8	MOTION	Motion Detect (Active Low Output)
9	VDDIO	IO Voltage input (1.65-3.3V)
10	DGND	Digital Ground
11	VDD18	1.8V Input
12	VDD3	3V Input
13	AGND	Analog Ground
14	VDD3	3V Input
15	LASER_NEN	Laser enable (Active Low Output)
16	+VCSEL	Positive terminal of VCSEL

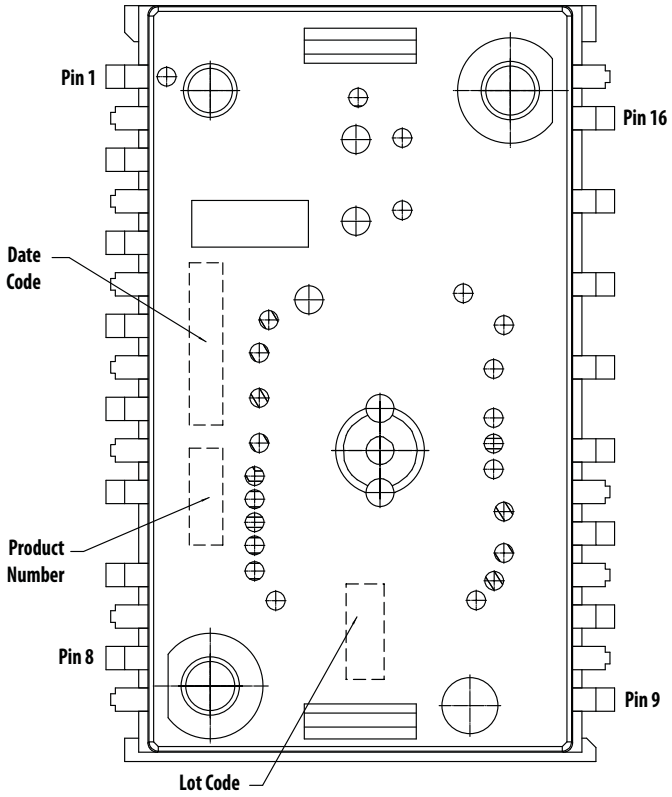

Figure 1. Device pin-out

Item	Marking	Remarks
Product Number	A8020	
Date Code	XYYWWZV	X = Subcon Code YYWW = Date Code Z = Sensor Die Source V = VCSEL Die Source
Lot Code	VVV	Numeric

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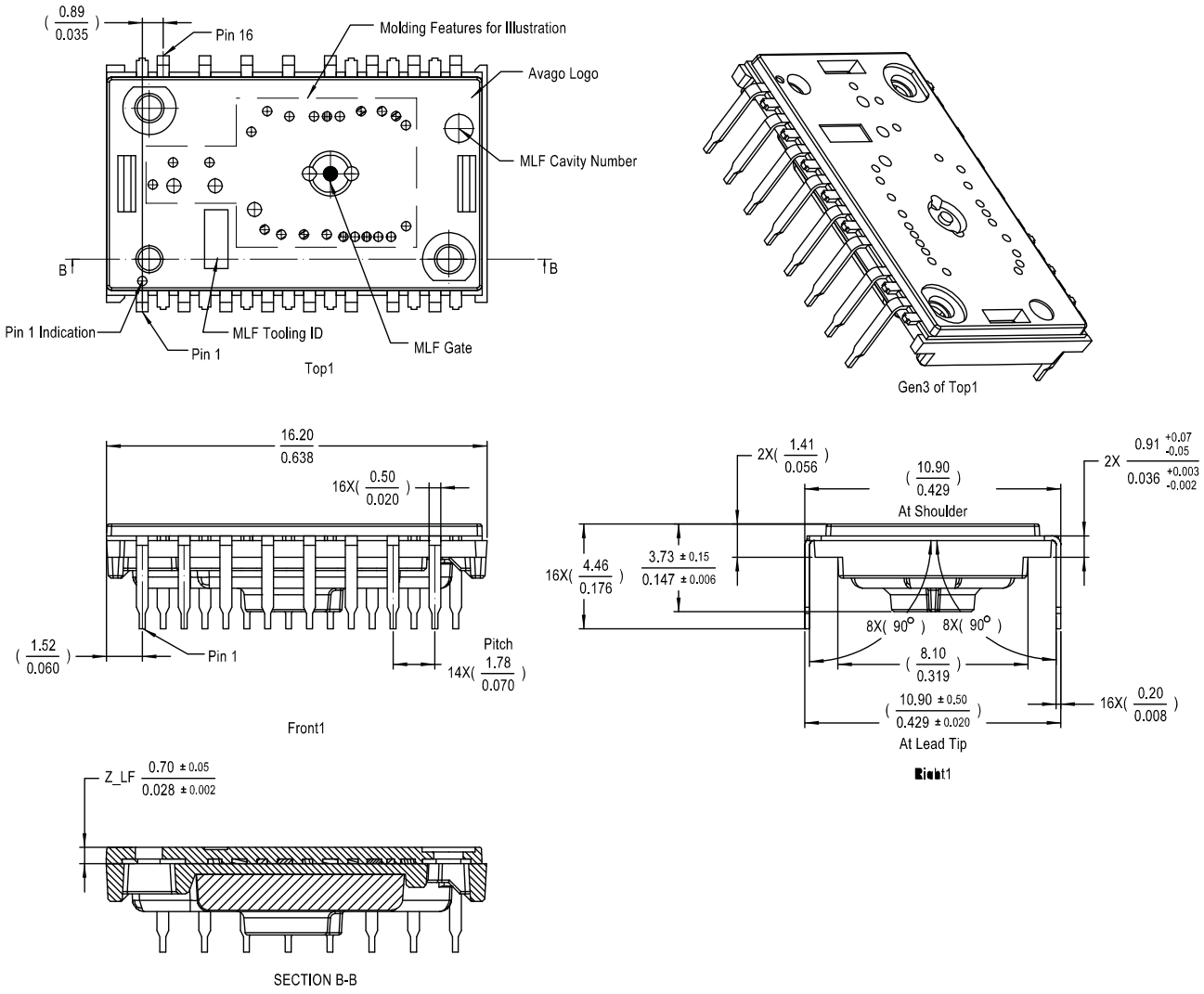

NOTES:

1.0 Dimension in millimeters / inches
2.0 Linear dimension general tolerance: ± 0.10mm unless specified otherwise
3.0 Bracket in bracket () is for reference only
4.0 Maximum flash: 0.20mm
5.0 Lead pitch tolerance: ± 0.15mm
6.0 Angular tolerance: ± 3.0°
7.0 Coplanarity of lead: 0.10mm
8.0 Reference number: LSR_INT_16B_PKG_009

Figure 2. Package outline drawing

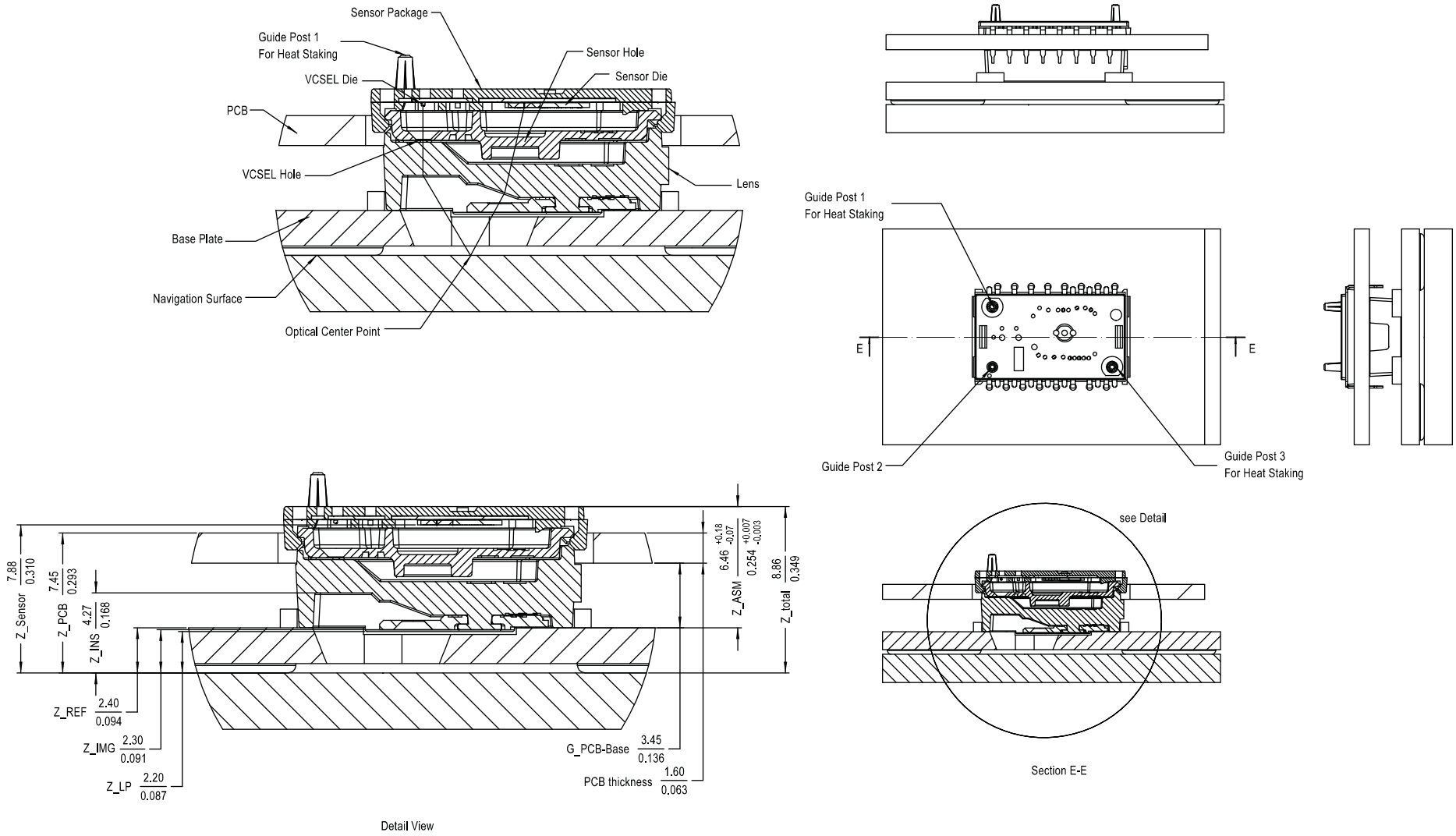

Figure 3. 2D Assembly drawing of sensor and lens coupled with PCB and base plate (Dimensions are for reference only)

Important Note: PixArt does provide 3D model drawing with the recommended mechanical specification. Please do request if from regional FAE.
Should these mechanical specifications are not adhered to PixArt cannot be held responsible for sensor performance.

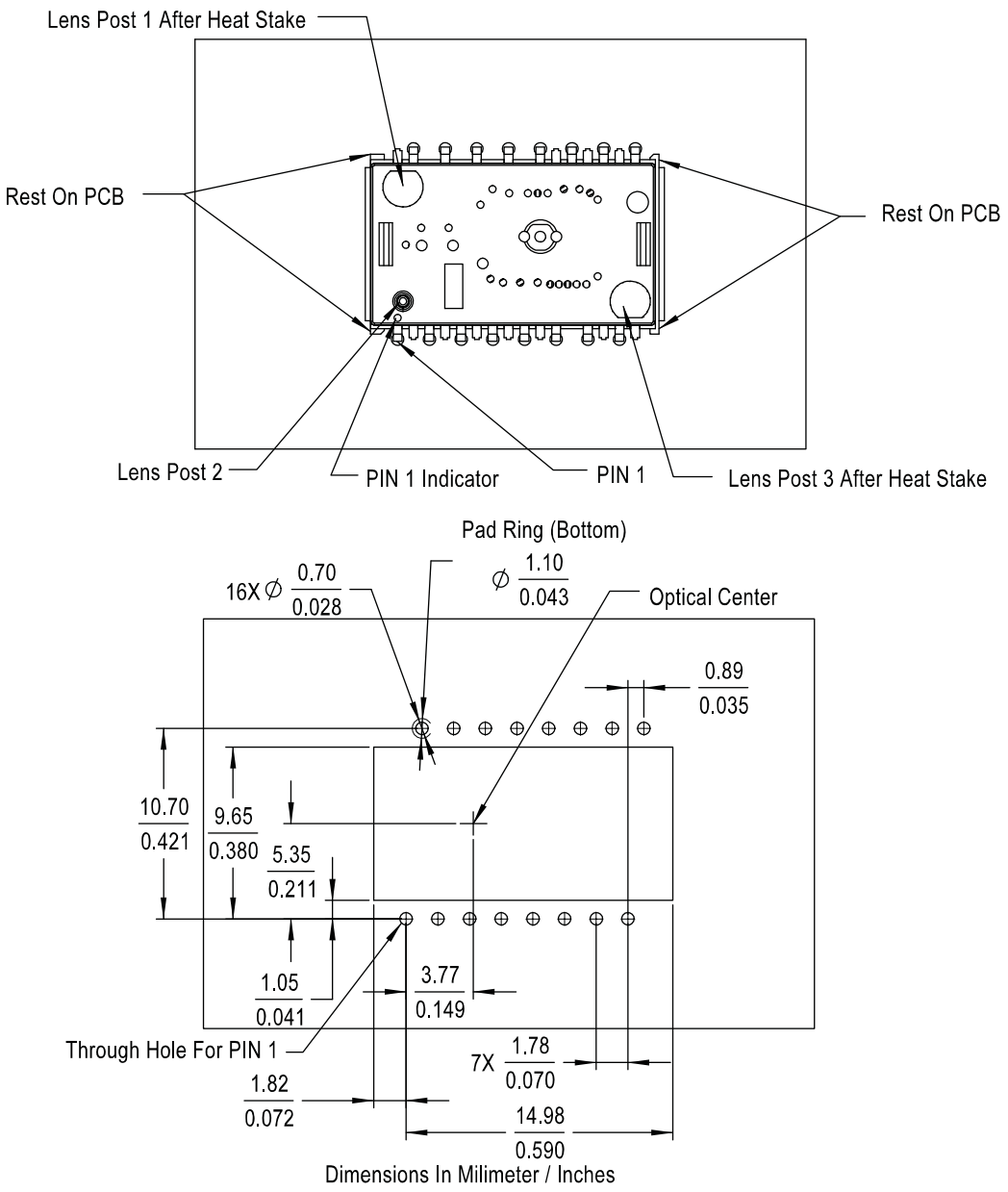

Figure 4. Recommended PCB Mechanical Cutouts and Spacing

Application Circuit

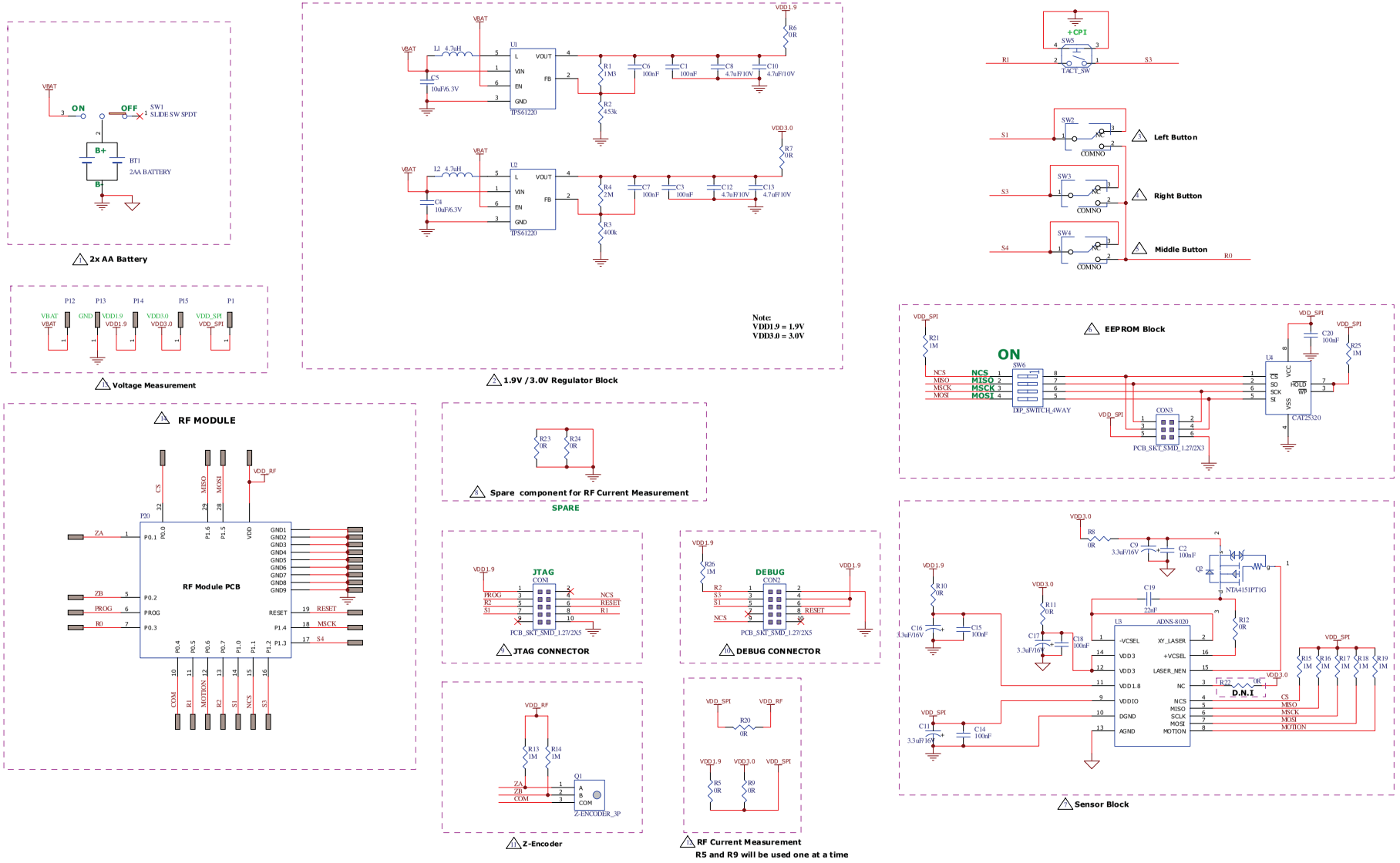

Figure 6a. Schematic Diagram for 3-Button Scroll-Wheel Cordless Mouse

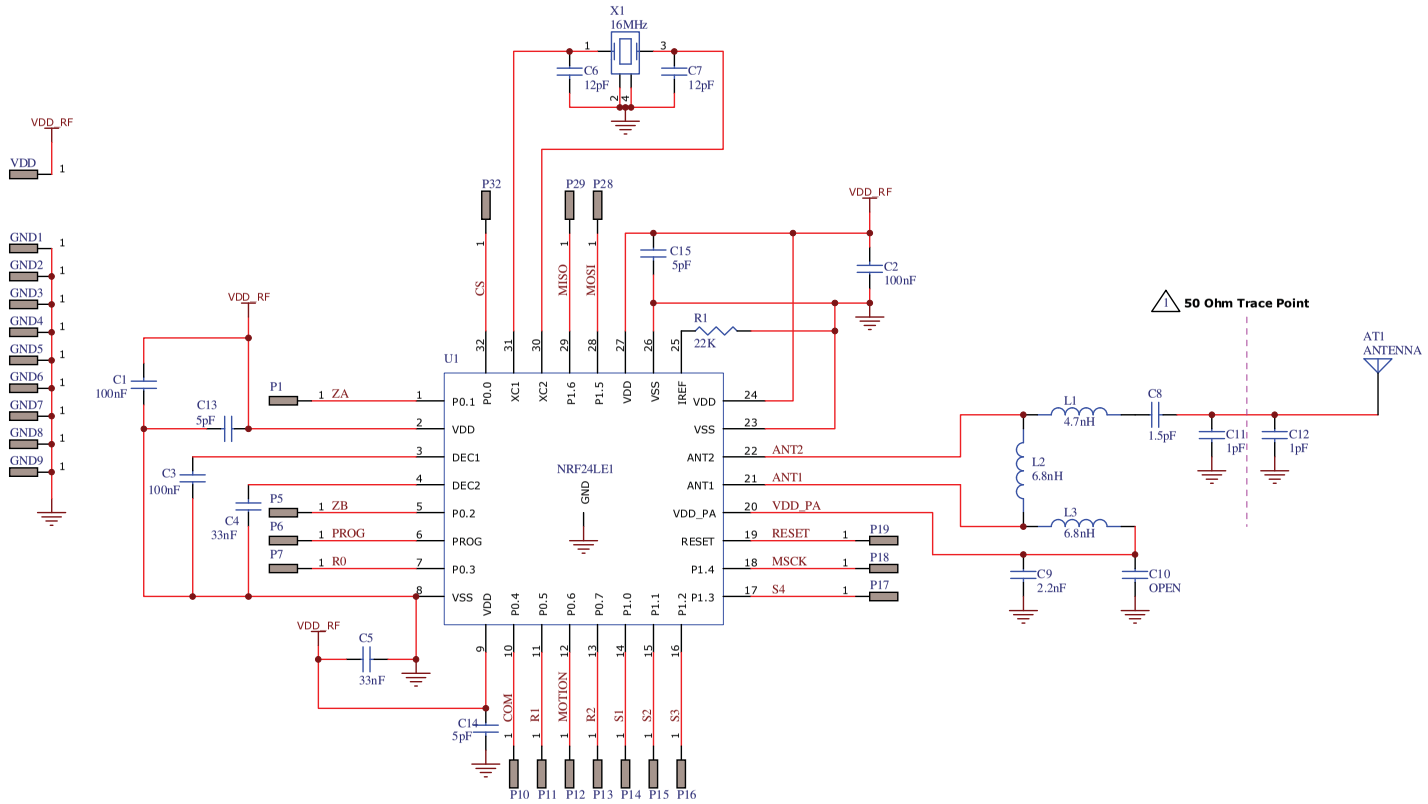

Figure 6b. Schematic Diagram for RF Module

Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units	Notes
Storage Temperature	T_S	-40	85	°C	
Lead-Free Solder Temperature			260	°C	For 7 seconds, 1.8mm below seating plane. Refer to wave soldering profile in PCB Assembly & Soldering Considerations Application Note AN-5023.
Power Supply Voltage	V_{DD3}	-0.5	3.4	Volts	
	$V_{DD1.8}$	-0.5	2.1	Volts	
	V_{DDIO}	-0.5	3.4	Volts	
ESD (Human Body Model)	ESD		2	kV	All Pins
Input Voltage	V_{IN}	-0.5	V_{DDIO} +0.5	Volts	All I/O Pins
Laser Output Power	LOP_{MAX}		716	µW	Class 1 Eye Safety AEL limit
VCSEL forward current	If		7	mA	

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	Min.	Typ.	Max.	Units	Notes
Operating Temperature	T_A	0		40	°C	
Power Supply Voltage	V_{DD3}	2. 8	3.0	3.3	Volts	Including noise. If operate outside the range, there is neither assurance of any function nor assurance of any parametric limits except for IDD ramp.
	$V_{DD1.8}$	1.7	1.8	2	Volts	
	V_{DDIO}	1.65		3.3	Volts	
Power Supply Rise Time	V_{RT3}	0.25		1000	ms	0 to 3.0V
Supply Noise (Sinusoidal)	V_{NA}			100	mVp-p	10kHz-50MHz
Serial Port Clock Frequency	f_{SCLK}			2	MHz	Active drive, 50% duty cycle
Distance From Lens Reference Plane To Navigation Surface	Z_REF	2.2	2.4	2.6	mm	Refer to Figure 3
Distance from Lens Lowest Point to Navigation Surface	Z_LP		2.2		mm	Refer to Figure 3
Speed	S			30 10	ips ips	Non-glass surfaces Reference glass of min 5mm thickness
Acceleration	A			8	g	
Load Capacitance	Cload			100	pF	MOTION, MISO
VCSEL Peak Wavelength	λ	832		865	nm	

Note: This sensor is designed to work on glass with a thickness of at least 5mm. Most glass surfaces provide enough microscopic features to allow tracking. It will not work on glass that is perfectly clean and virtually scratch-free.
The minimum requirements for the sensor to work reliably on glass is there must be at least 50 features/mm^2 at the minimum of 6 µm width and 2 µm depth.

DC Electrical Specifications

Electrical Characteristics over recommended operating conditions. (Typical values at 25 °C, VDD3=3.0 V, VDD1.8 = 1.8 V, VDDIO= 1.8V), on white paper with laser pre calibrated values.

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
VDD3 DC Supply Current	$I_{DD3\_RUN\_NG}$		0.8		mA	Average current of VDD3 includes laser current on: IDD3_XXX_NG: Non-glass surfaces IDD3_XXX_G: Glass reference surface No load on MISO, MOTION
	$I_{DD3\_RUN\_G}$		4.6		mA	
	$I_{DD3\_REST1\_NG}$		65		uA	
	$I_{DD3\_REST1\_G}$		295		uA	
	$I_{DD3\_REST2\_NG}$		20		uA	
	$I_{DD3\_REST2\_G}$		65		uA	
	$I_{DD3\_REST3\_NG}$		9		uA	
	$I_{DD3\_REST3\_G}$		17		uA	
VDD1.8 DC Supply Current	$I_{DD1.8\_RUN\_NG}$		3.2		mA	Average current of VDD1.8 on: IDD1.8_XXX_NG: Non-glass surfaces IDD1.8_XXX_G: Glass reference surface No load on MISO, MOTION
	$I_{DD1.8\_RUN\_G}$		4.2		mA	
	$I_{DD1.8\_REST1\_NG}$		205		uA	
	$I_{DD1.8\_REST1\_G}$		250		uA	
	$I_{DD1.8\_REST2\_NG}$		50		uA	
	$I_{DD1.8\_REST2\_G}$		55		uA	
	$I_{DD1.8\_REST3\_NG}$		15		uA	
	$I_{DD1.8\_REST3\_G}$		16		uA	
VDD3 DC Supply Current for Fast Frame Mode	I_{DD3_FF}		2.3		mA	Highly reflective surfaces (White tile & Glossy Formica) and Glossy Magazine. For typical rest mode current consumption refer to non glass mode.
VDD1.8 DC Supply Current for Fast Frame Mode	$I_{DD1.8\_FF}$		9.6		mA	
Shutdown Supply Current	I_{DD3_STDWN}		6	25	uA	NCS, SCLK, MOSI = VDDIO MISO = GND
	$I_{DD1.8\_STDWN}$		8	65	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	µA	Vin = $0.7*V_{DDIO}$, SCLK, MOSI, NCS
Output Low Voltage, MISO, MOTION	V_{OL}			$0.3*V_{DDIO}$	V	Iout=1mA, MISO, MOTION
Output High Voltage MISO, MOTION	V_{OH}	$0.7*V_{DDIO}$			V	Iout=-1mA, MISO, MOTION
Output Low Voltage, LASER_NEN	V_{OL}			$0.3*V_{DD3}$	V	Iout= 1mA, LASER_NEN
Output High Voltage, LASER_NEN	V_{OH}	$0.7*V_{DD3}$			V	Iout= -0.5mA, LASER_NEN
Input Capacitance	C_{in}			10	pF	MOSI, NCS, SCLK

Registers Summary

The sensor 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.

Address	Register (Before SROM download)	Access (Read = R, Write = W or Read/Write = R/W)	Reset Value
0x00	Product_ID	R	0x3a
0x01	Revision_ID	R	0x02
0x02	MOTION	R	0x02
0x03	Delta_X_L	R	0x00
0x04	Delta_X_H	R	0x00
0x05	Delta_Y_L	R	0x00
0x06	Delta_Y_H	R	0x00
0x07	SQUAL	R	0x00
0x08	Pixel_Sum	R	0x00
0x09	Maximum_Pixel	R	0x00
0x0a	Minimum_Pixel	R	0x00
0x0b	Shutter_Lower	R	Undefined
0x0c	Shutter_Upper	R	Undefined
0x0d – 0x0e	Reserved		
0x0f	Configuration_I	R/W	0x0a
0x10	Configuration_II	R/W	0x28
0x11	Reserved		
0x12	Frame_Capture	R/W	0x00
0x13	SROM_Enable	W	Undefined
0x14	Run_Downshift	R/W	0x7d
0x15	Rest1_Rate	R/W	0x01
0x16	Rest1_Downshift	R/W	0x7d
0x17	Rest2_Rate	R/W	0x09
0x18	Rest2_Downshift	R/W	0x5e
0x19	Rest3_Rate	R/W	0x31
0x1a – 0x1f	Reserved		
0x20	LASER_CTRL0	R/W	Undefined
0x21	LASER_CTRL1	R/W	Undefined
0x22	LP_CFG0	R/W	Undefined
0x23	LP_CFG1	R/W	Undefined
0x24	Observation	R/W	0x00
0x25	Data_Out_Lower	R	Undefined
0x26	Data_Out_Upper	R	Undefined
0x27- 0x29	Reserved		
0x2a	SROM_ID	R	0x00
0x2b - 0x39	Reserved		
0x3a	Power_Up_Reset	W	Undefined
0x3b	Shutdown	W	Undefined
0x3c - 0x3e	Reserved		
0x3f	Inverse_Product_ID	R	0xc5
0x40 - 0x4f	Reserved		
0x50	Motion_Burst	R	0x00
0x51-0x61	Reserved		
0x62	SROM_Load_Burst	W	Undefined
0x63	Reserved		
0x64	Pixel_Burst	R	0x00