PixArt Imaging Inc.

ADNS-7550

Integrated molded lead-frame DIP Sensor

Data Sheet

Lead (Pb) Free
RoHS 6 fully
compliant

Theory of Operation

The ADNS-7550 integrated molded lead-frame DIP sensor comprises of sensor and VCSEL in a single package.

The advanced class of VCSEL was engineered by PixArt Imaging to provide a laser diode with a single longitudinal and a single transverse mode. In contrast to most oxide-based single-mode VCSEL, this class of PixArt VCSEL remains within single mode operation over a wide range of output power. It has significantly lower power consumption than a LED. It is an excellent choice for optical navigation applications.

The sensor is based on Laser technology, which measures 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. 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 sensor serial port. The microcontroller then translates the data into PS2, USB, or RF signals before sending them to the host PC or game console.

Features

- Wide operating voltage: 4.0V-5.25V.
- Small form factor, integrated molded lead-frame chip-on-board package
- Laser Technology
- High speed motion detection up to 30 ips and 8g
- Enhanced SmartSpeed self-adjusting frame rate for optimum performance
- Motion detect pin output
- 12-bits motion data registers.
- Internal oscillator – no clock input needed.
- Selectable 400, 800, 1200, 1600, 2000 cpi resolution.
- Four wire serial port
- Minimal number of passive components
- Laser fault detect circuitry on-chip for Eye Safety Compliance
- Advanced Technology VCSEL chip
- Single Mode Lasing operation
- 832-865 nm wavelength

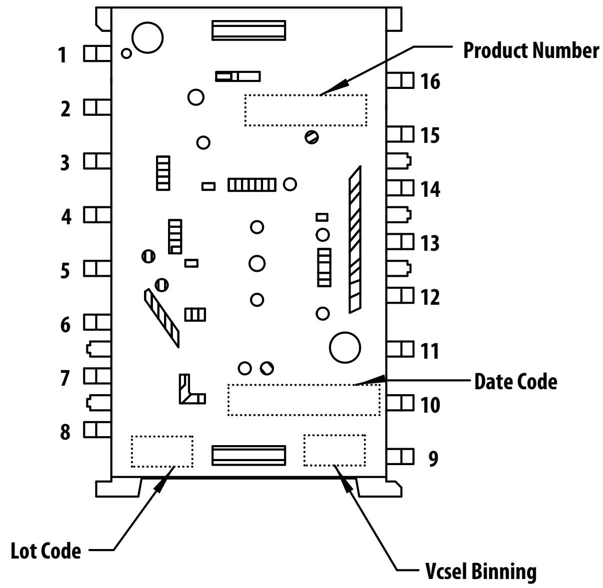
Applications

- Laser Mice
- Optical trackballs
- Integrated molded lead-frame input devices

PixArt Imaging Inc.
E-mail: fae_service@pixart.com.tw

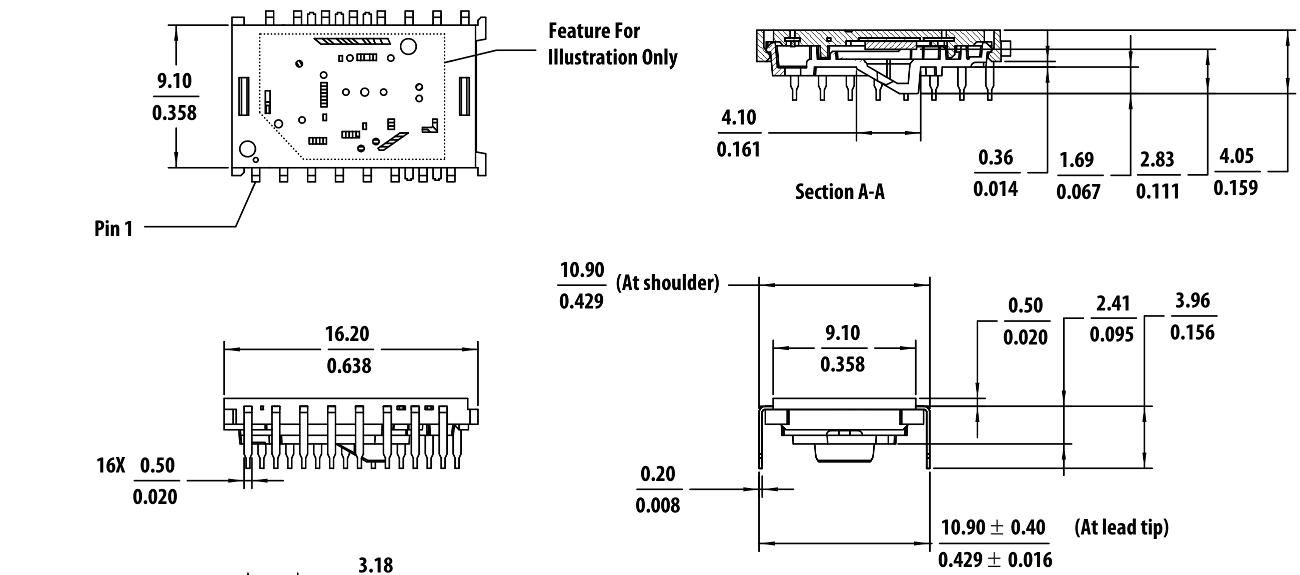
Pinout of ADNS-7550 Optical Mouse Sensor

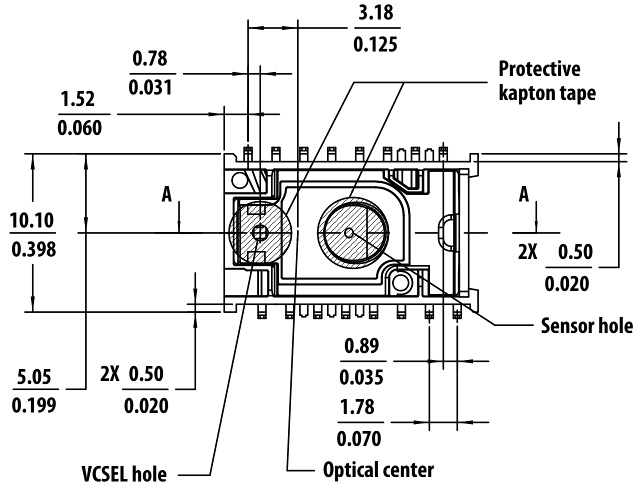
Pin	Name	Description
1	VCSEL+VE	Positive Terminal of VCSEL
2	LASER_NEN	LASER Enable (Active LOW)
3	NCS	Chip select (active low input)
4	MISO	Serial data output (Master In/Slave Out)
5	SCLK	Serial clock input
6	MOSI	Serial data input (Master Out/Slave In)
7	MOTION	Motion Detect (active low output)
8	XYLASER	XYLASER
9	VDD5	5V Input
10	NC	No Connection
11	GND	Ground
12	RefB	3V output
13	RefA	1.8V regulator output
14	DGND	Digital Ground
15	VDDIO	IO Voltage input (1.65~3.6V)
16	VCSEL-VE	Negative Terminal of VCSEL



Item	Marking	Remarks
Product Number	A7550	
Date Code	XYYWWZV	X = Subcon Code YYWW = Date Code Z = Sensor Die Source V = VCSEL Die Source
VCSEL Binning	KL	
Lot Code	VVV	Numeric

Figure 1. Device pin-out for ADNS-7550





Notes:
1. Dimensions in milimeter / inches.
2. Dimensional tolerance: ±0.1mm.
3. Coplanarity of lead: 0.1mm
4. Lead pitch tolerance: ±0.15mm.
5. Non-cumulative pitch tolerance: ±0.15mm.
6. Maximum flash: ±0.2mm.
7. Angular tolerance: 3°
8. Chamfer (25° x2) on the taper side of the lead.
9. Brackets () indicate reference dimension.
10. Document Number: LSR_INT_16A_Pkg_001

Figure 2. 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*

Assembly Recommendation

1. Insert the integrated molded lead-frame DIP sensor and all other electrical components into the application PCB.
2. This sensor package is only qualified for wave-solder process.
3. Wave-solder the entire assembly in a no-wash solder process utilizing a solder fixture. The solder fixture is needed to protect the sensor during the solder process. The fixture should be designed to expose the sensor leads to solder while shielding the optical aperture from direct solder contact.
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 the optical aperture of the sensor and VCSEL respectively. Care must be taken to keep contaminants from entering the aperture.
6. Insert the PCB assembly over the lens onto the base plate. The sensor package should self-align to the lens. The optical position reference for the PCB is set by the base plate and lens. The alignment guide post of the lens locks the lens and integrated molded lead-frame DIP sensor together. Note that the PCB motion due to button presses must be minimized to maintain optical alignment.
7. Optional: The lens can be permanently locked to the sensor package by melting the lens' guide posts over the sensor with heat staking process.
8. Tune the laser output power from the VCSEL to meet the Eye Safe Class I Standard as detailed in the LASER Power Adjustment Procedure.
9. Install the mouse top case. There must be a feature in the top case (or other area) to press down onto the sensor to ensure the sensor and lenses are interlocked to the correct vertical height.

Design considerations for improving ESD Performance

For improved electrostatic discharge performance, typical creepage and clearance distance are shown in the table below. Assumption: base plate construction as per the PixArt supplied IGES file and ADNS-6150, ADNS-6160-001 or ADNS-6170-002 lens:

Lens	ADNS-6150	ADNS-6160-001	ADNS-6170-002
Creepage	12.0 mm	13.50 mm	20.30 mm
Clearance	2.1 mm	1.28 mm	1.28 mm

Note that the lens material is polycarbonate and therefore, cyanoacrylate based adhesives or other adhesives that may damage the lens should NOT be used.

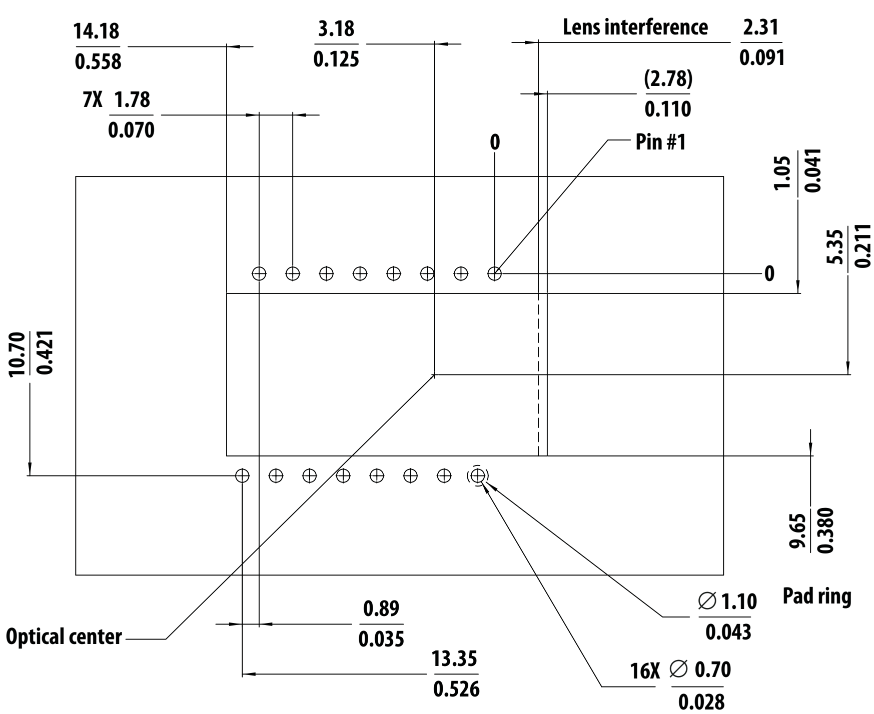


Figure 5. Recommended PCB mechanical cutouts and spacing

Application Circuit

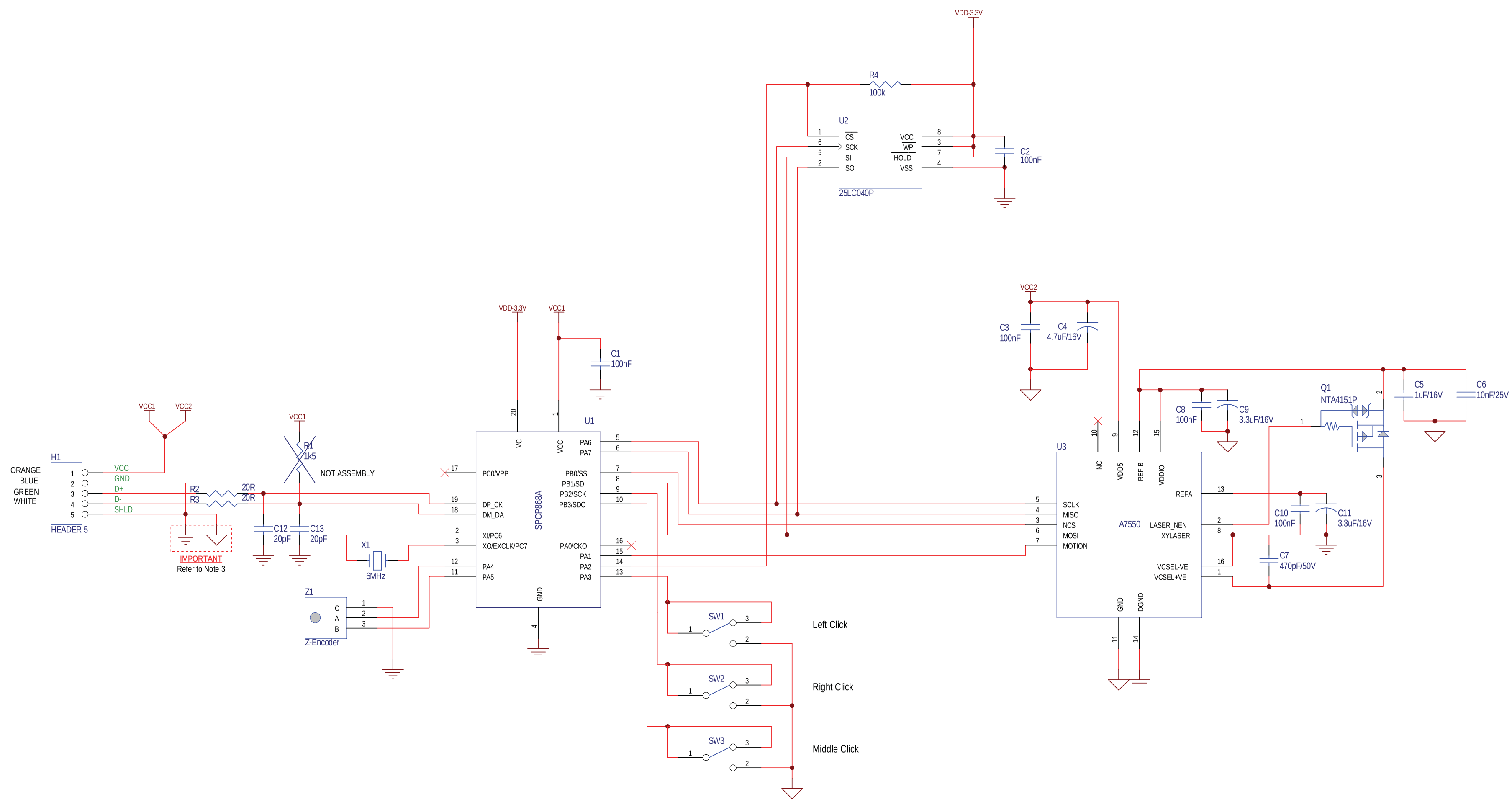


Figure 6. Schematic Diagram for 3-Button Scroll Wheel Corded Mouse

Notes
1. The supply and ground paths should be laid out using a star methodology.
2. Level shifting is required to interface a 5V micro-controller to the ADNS-7550. If a 3V micro-controller is used, the 74VHC125 component shown may be omitted
3. All grounds MUST be correctly separated into digital and analog grounds. The digital and analog ground lines MUST be reconnected as far away as possible at either the negative terminal of the battery or at the USB connector.

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units	Notes
Storage Temperature	T_S	-40	85	ºC	
Lead Soldering Temperature	T_{Solder}		260	ºC	For 10 seconds, 1.8mm below seating plane. See soldering reflow profile in Figure 9
Supply Voltage	V_{DD3}	-0.5	3.7	V	
	V_{DDIO}	-0.5	3.7	V	
ESD (Human-body model)	V_{ESD}		2	kV	All pins
Input Voltage	V_{IN}	-0.5	V_{DDIO}+0.5		
Latchup Current	I_{OUT}		20	mA	All pins

VCSEL Die Source Marking		V = A,V		V = C,D			
Parameter (For VCSEL only)	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Units**	**Notes**
DC Forward current	I_F		12		7.0	mA	
Peak Pulsing current	I_P		19		9	mA	Duration = 100ms, 10% duty cycle
Power Dissipation	P		24		24	mW	
Reverse voltage	V_R		5		8	V	I = 10µA
Laser Junction Temperature	T_J		150		170	ºC	

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 maximum ratings do not reflect eye-safe operation. Eye safe operating conditions are listed in the power adjustment procedure section.
3. 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_{DD5}	4.0	5.0	5.25	Volts	Including noise.
Power supply rise time	V_{RT5}	1		100	ms	0 to 5.0V
Supply noise (Sinusoidal)	V_{NA}			100	mVp-p	10kHz-50MHz
Serial Port Clock Frequency	f_{SCLK}			1	MHz	Active drive, 50% duty cycle
Distance from lens reference plane to surface	Z	2.18	2.40	2.62	mm	Results in +/- 0.22 mm minimum DOF. See Figure 8.
Speed	S			30	in/sec	
Acceleration	A			8	g	
Load Capacitance	C_{out}			100	pF	MOTION, MISO

Optical/Electrical Characteristics (at Tc = 5°C to 45°C):

VCSEL Die Source Marking		V = A,V			V = C				
Parameter	**Symbol**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Units**	**Notes**
Peak Wavelength	λ	832		865	832		865	nm	
Maximum Radiant Power	LOPmax		4.5			4.0		mW	Maximum output power under any condition. This is not a recommended operating condition and does not meet eye safety requirements.
Wavelength Temperature coef-ficient	dλ/dT		0.065			0.065		nm/ºC	
Wavelength Current coefficient	dλ/dI		0.21			0.3		nm/mA	
Beam Divergence	θFW@1/e^2		15			16		deg	
Threshold current	Ith		4.2			3.0		mA	
Slope Efficiency	SE		0.4			0.35		W/A	
Forward Voltage	VF		2.1	2.4		2.1	2.4	V	At 500uW output power

Comments:

1. VCSELs are sorted into bins as specified in the power adjustment procedure. Appropriate binning register data values are used in the application circuit to achieve the target output power. The VCSEL binning is marked on the integrated molded lead-frame DIP sensor package.
2. When driven with current or temperature range greater than specified in the power adjustment procedure section, eye safety limits may be exceeded. The VCSEL should then be treated as a Class IIIb laser and as a potential eye hazard.
3. Over driving beyond LOP_{max} limit will cause the VSCEL to enter into on unstable region. Any LOP reference point in the laser power calibration process.

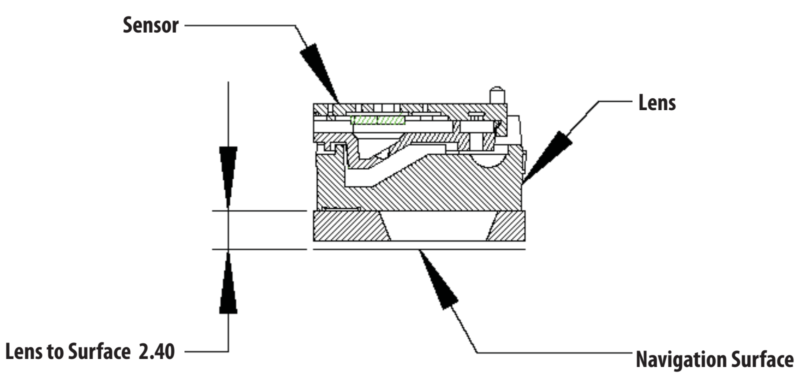


Figure 8. Distance from lens reference plane to surface, Z

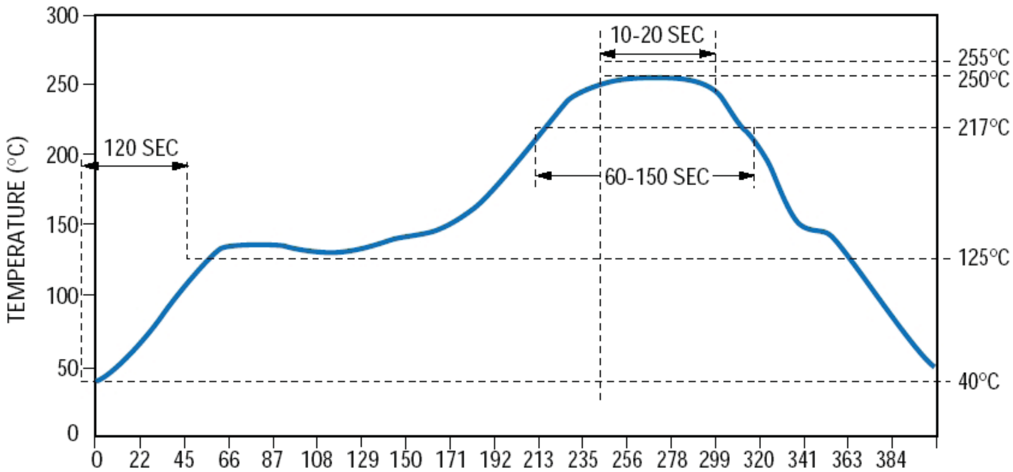


Figure 9. Recommended Soldering Reflow Profile

DC Electrical Specifications

Electrical Characteristics over recommended operating conditions. (Typical values at 25 °C, V_{DD}=5.0 V, V_{DDIO}= 2.8V)

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes
DC Supply Current in various modes	I_{DD_RUN}		2.8	3.5	mA	Average current, including LASER current. No load on MISO, MOTION.
Peak Supply Current				40	mA	
Shutdown Supply Current	$I_{DDSTDWN}$		150	200	µA	NCS, SCLK = V_{DDIO} MOSI, MISO = Hi-Z
Input Low Voltage	V_{IL}			0.2V_{DDIO}	V	SCLK, MOSI, NCS
Input High Voltage	V_{IH}	0.8V_{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*VDDIO , SCLK, MOSI, NCS
XY_LASER Current	I_{LAS}		0.8		mA	V_{XY_LASER} >=0.3V LSRPWR_CFG0 = 0xFF LSRPWR_CFG 1 = 0x00
Laser Current (fault mode)	I_{LAS_FAULT}			300	uA	XY_LASER $R_{leakage}$ < 75kOhms to Gnd
Output Low Voltage, MISO, MOTION	V_{OL}			0.2*V_{DDIO}	V	Iout=1mA, MISO, MOTION
Output High Voltage, MISO, MOTION	V_{OH}	0.8*V_{DDIO}			V	Iout=-1mA, MISO, MOTION
Output Low Voltage, LASER_NEN	V_{OL}			0.2*V_{REFB}	V	Iout= 1mA, LASER_NEN
Output High Voltage, LASER_NEN	V_{OH}	0.8*V_{REFB}			V	Iout= -0.5mA, LASER_NEN
Input Capacitance	C_{in}			10	pF	MOSI, NCS, SCLK

PixArt Imaging Inc.
E-mail: fae_service@pixart.com.tw

Registers

The ADNS-7550 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	Read/Write	Default Value
0x00	Product_ID	R	0x32
0x01	Revision_ID	R	0x03
0x02	Motion	R/W	0x00
0x03	Delta_X_L	R	0x00
0x04	Delta_Y_L	R	0x00
0x05	Delta_XY_H	R	0x00
0x06	SQUAL	R	0x00
0x07	Shutter_Upper	R	0x00
0x08	Shutter_Lower	R	0x64
0x09	Maximum_Pixel	R	0xd0
0x0a	Pixel_Sum	R	0x80
0x0b	Minimum_Pixel	R	0x00
0x0c	CRC0	R	0x00
0x0d	CRC1	R	0x00
0x0e	CRC2	R	0x00
0x0f	CRC3	R	0x00
0x10	Self_Test	W	NA
0x11	Reserved		
0x12	Configuration2_Bits	R/W	0x28
0x13-0x19	Reserved		
0x1a	LASER_CTRL0	R/W	0x00
0x1b	Reserved		
0x1c	LSRPWR_CFG0	R/W	0x00
0x1d	LSRPWR_CFG1	R/W	0x00
0x1e	Reserved		
0x1f	LASER_CTRL1	R/W	0x00
0x20-0x2d	Reserved		
0x2e	Observation	R/W	0x00
0x2f-0x34	Reserved		
0x35	Pixel_Grab	R/W	0x00
0x36	H_RESOLUTION	R/W	0x04
0x37-0x39	Reserved		
0x3a	POWER_UP_RESET	W	NA
0x3b	Shutdown	W	NA
0x3c	Reserved		
0x3d	Shut_thr	R/W	0x56
0x3e	Inverse_Revision_ID	R	0xfc
0x3f	Inverse_Product_ID	R	0xcd
0x42	Motion_Burst	R	0x00