



SDNS-3988

High Performance Gaming Sensor

Description

SDNS-3988 high performance gaming sensor is a new addition to PixArt Imaging's gaming sensor family. The tracking system comprises of navigation IC, HSDL-4261 IR LED and lens. It provides enhanced features such as user calibrated lift detection, variable frame rate, programmable resolution, angle tunability, angle snap plus configurable sleep and wake up time to suit various gamers' preferences.

This gaming sensor is in a 58-pin QFN package. It is designed to be used with ADNS-2120-001 trim lens to achieve optimum performance featured in this document.

Theory of Operation

The sensor 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.

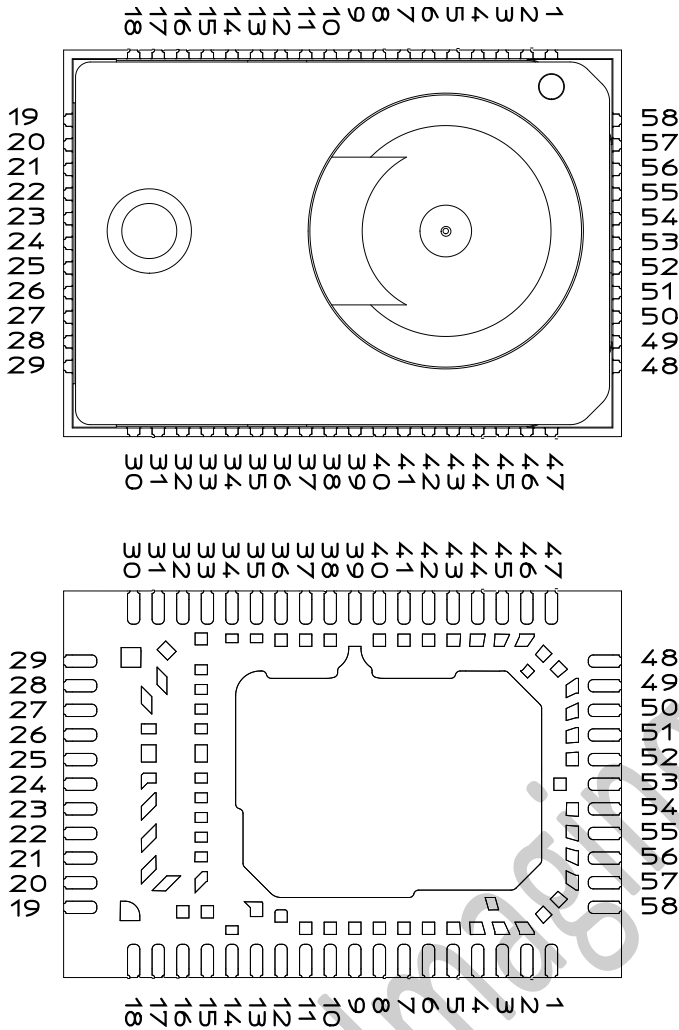
Features

- Small form factor QFN package
- VDDIO range: 1.65 – 3.3V
- 16-bits motion data registers
- Maximum speed motion detection of 200ips and acceleration up to 50g
- Variable Frame Rate for optimum power performance
- Motion detect pin output
- Internal oscillator – no external clock input needed
- Enhanced Programmability
 - Frame rate up to 12500fps
 - Lift Detection
 - Default lift cut-off height – typical 3mm from tracking surface
 - Manually calibrated lift cut-off height – optimized for individual surface
 - Resolution up to 6400cpi with step of ~50cpi
 - X and Y axis independent resolution setting
 - Register enabled Rest Modes
 - Angle Snap and Angle Tunability

Applications

- Corded and cordless gaming mice
- Motion input devices

Device Pinout



Pin No	Pin Name	Input / Output/ Power	Description
1 – 3	NC	-	
4	PWR_OPT2	IN	Refer Table 1
5	PWR_OPT1	IN	Refer Table 1
6	XYLED	IN	LED Illumination Control Input
7	VDDIO	PWR	IO Voltage
8	MOTION	OUT	Motion Detect (Active Low Output)
9	MOSI	IN	Serial Data Input (Master Out/Slave In)
10	SCLK	IN	Serial Clock Input
11	MISO	OUT	Serial Data Output (Master In/Slave Out)
12	GND	PWR	Ground
13	NCS	IN	Chip Select (Active Low Input)
14 – 33	NC	-	-
34, 45	VDD3/REFB	PWR	Refer Table 1
35 – 38	NC	-	-
39	GND	PWR	Ground
40	DGND	PWR	Ground (digital)
41 – 42	REFA/VDD1_8	PWR	Refer Table 1
43 – 44	NC	-	-
46	VDD5/VDD3	PWR	Refer Table 1
47 – 52	NC	-	-
53	GND	PWR	Ground
54 – 58	NC	-	-

Figure 1. Device Pinout of SDNS-3988

Table 1: Power Option Selections

	Low (connect with GND, 0V)	High (connect with VDD supply, 3V)
PWR_OPT1	Enable internal 5V-to-3V regulator (VDD5 input pin 46 need to be connected to 5V with REFB pin 34 and 45 connected to *bypass capacitors)	Disable internal 5V-to-3V regulator (VDD3 input pin 34, 45 and 46 need to be connected to 3V supply)
PWR_OPT2	Enable internal 3V-to-1.8V regulator (REFA pin 41 and 42 need to be connected to *bypass capacitors)	Disable internal 3V-to-1.8V regulator (VDD1_8 input pin 41 and 42 need to be connected to 1.8V supply)

* Refer to schematic for bypass capacitors value.

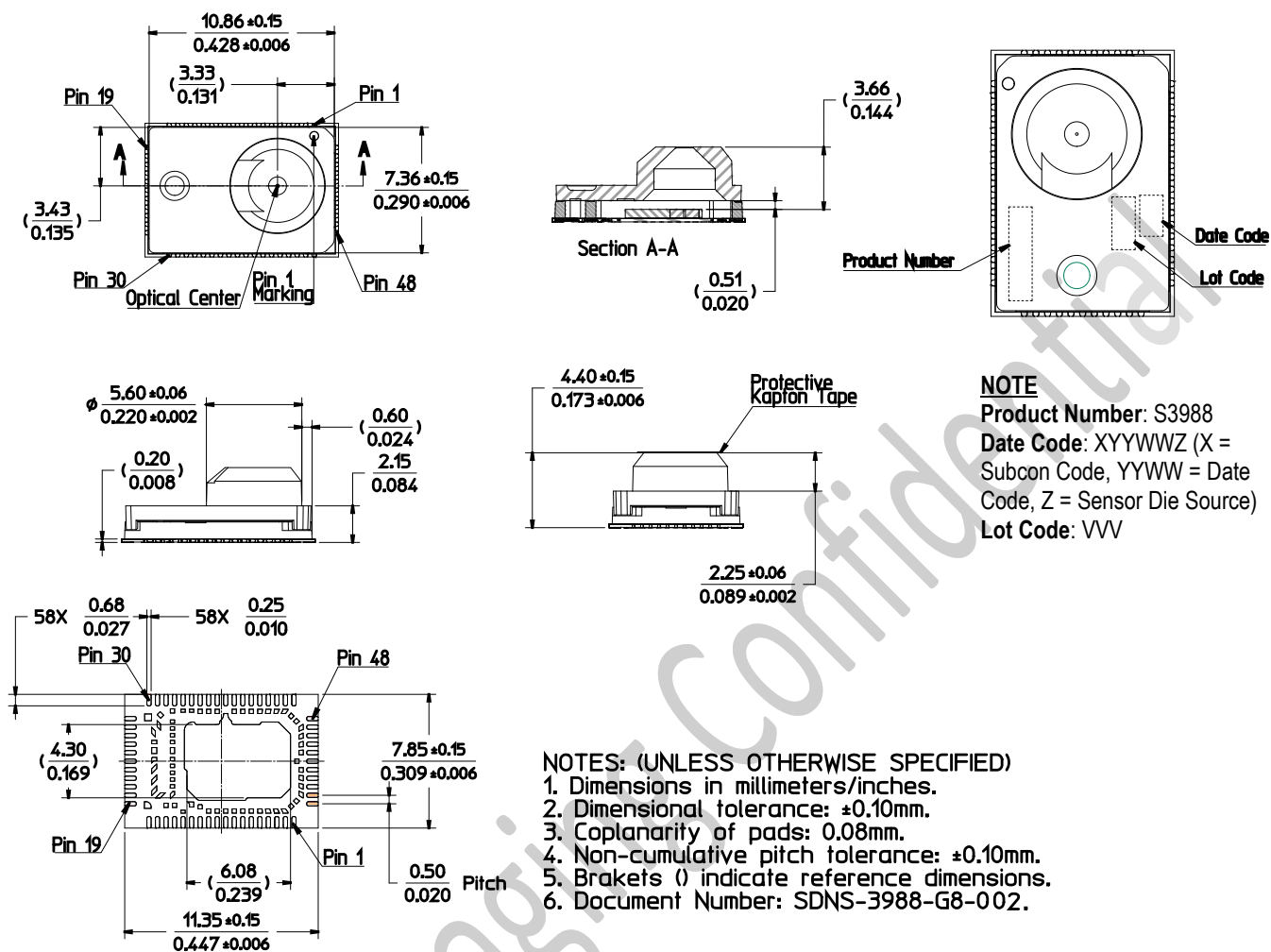


Figure 2. Package Outline Drawing

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

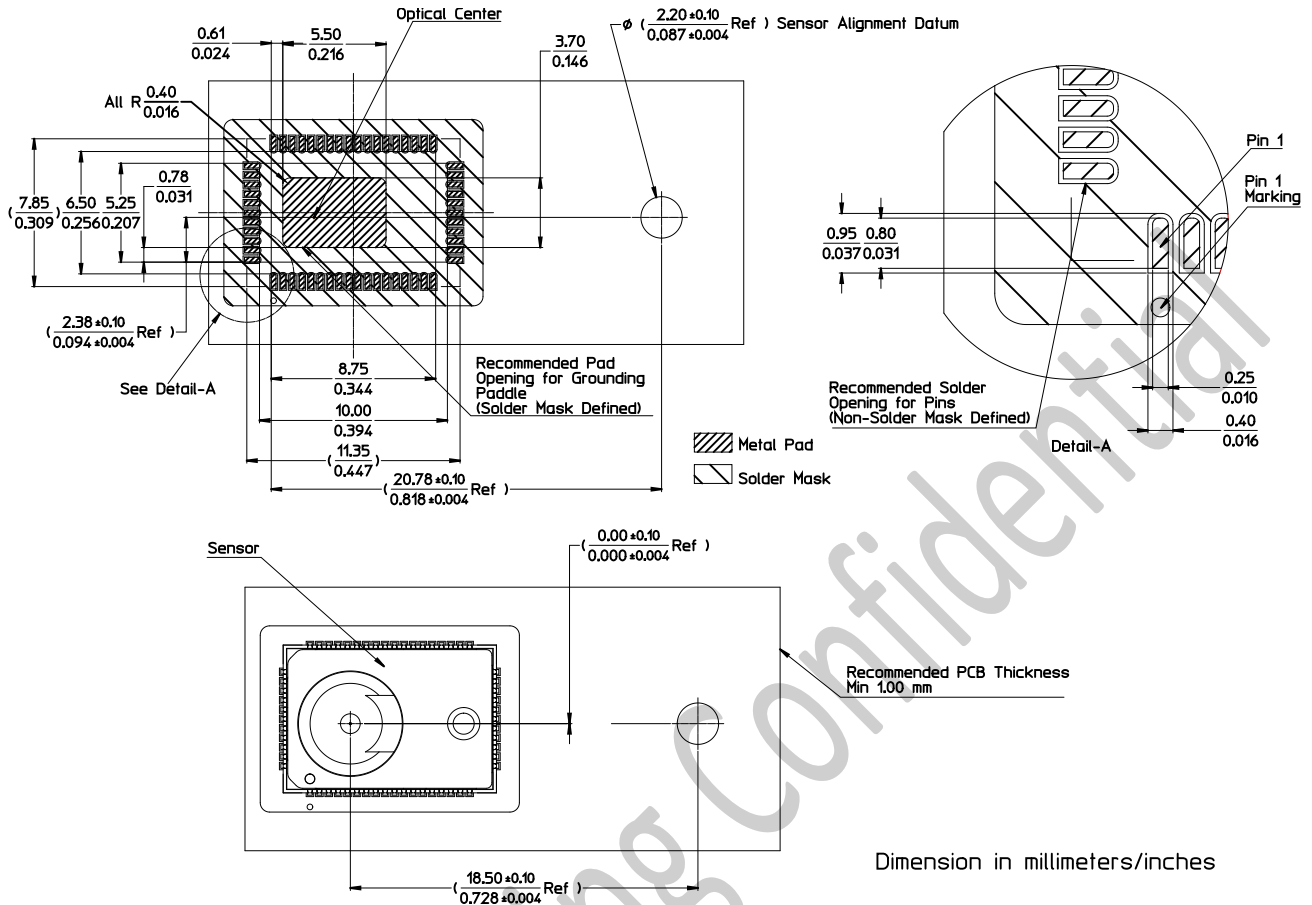
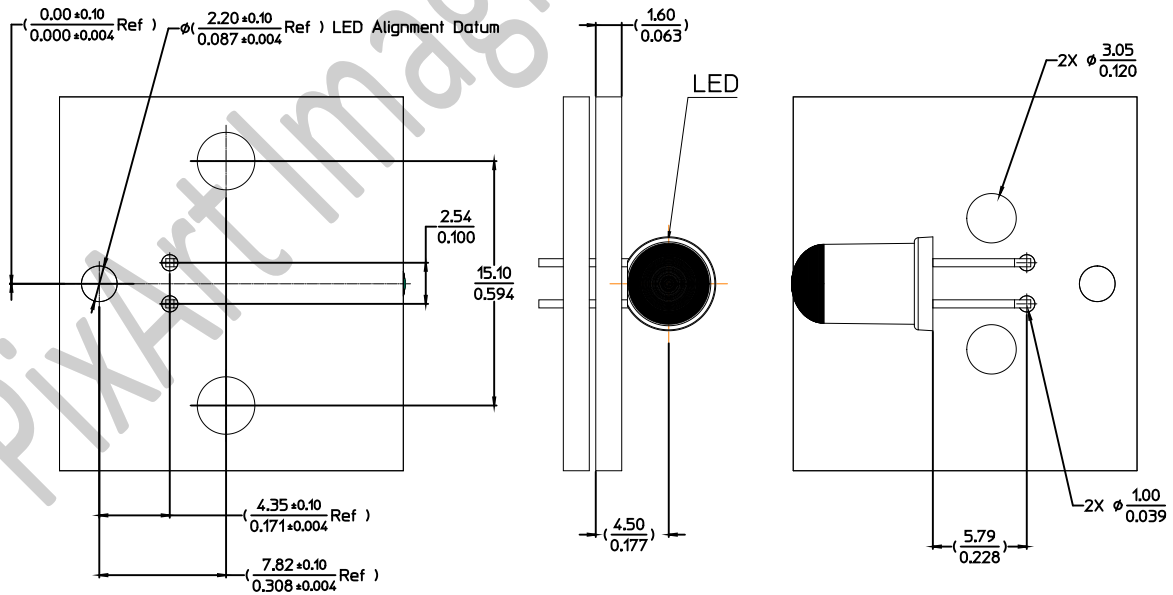


Figure 3. Recommended PCB Mechanical Cutouts and Spacing (Top View) for sensor



Dimension in millimeters/inches

Figure 4. Recommended PCB Mechanical Cutouts and Spacing (Top View) for IR LED

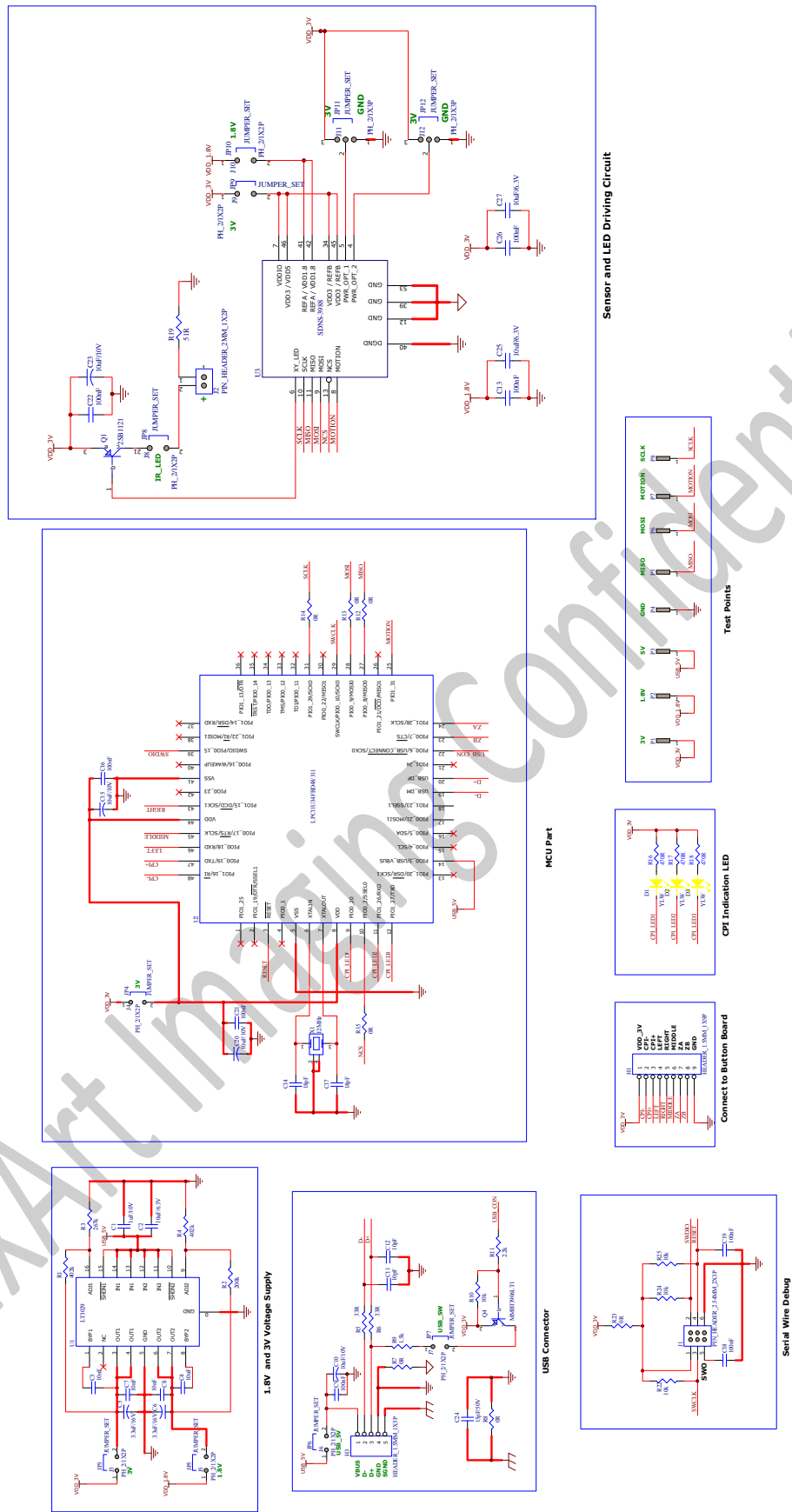


Figure 13. Schematic Diagram for 5-Button Scroll Wheel Corded Mouse (PCB Board 1)

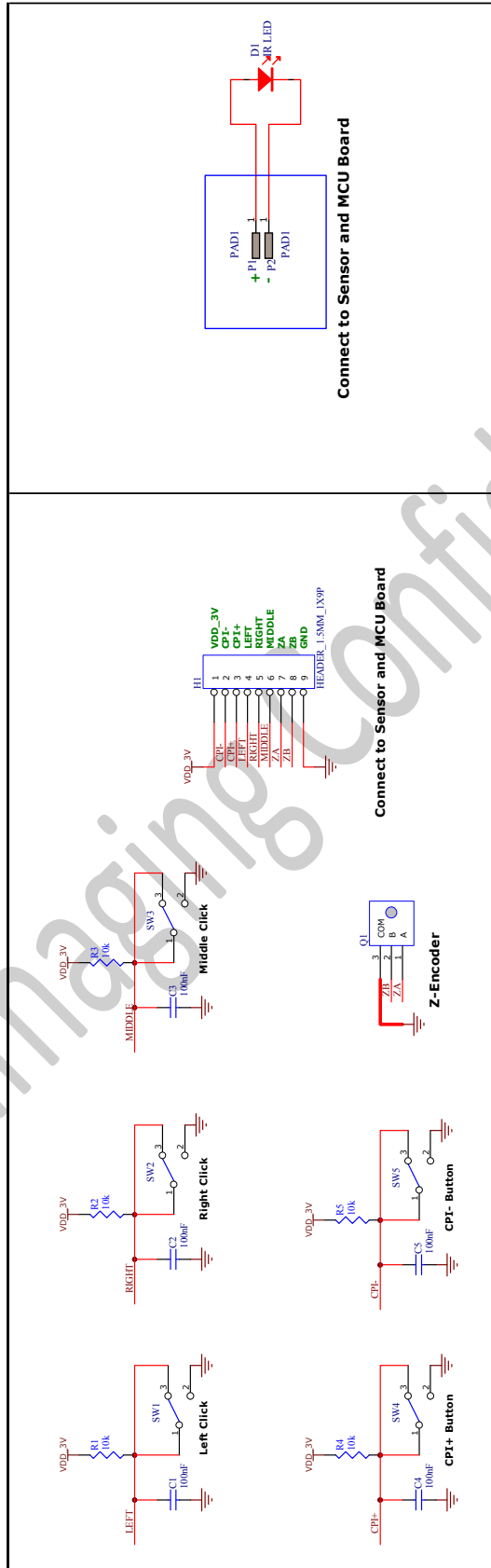


Figure 14. Schematic Diagram for 5-Button Scroll Wheel Corded Mouse (PCB Board 2 & 3)

Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units	Notes
Storage Temperature	T _S	-40	85	°C	MSL level1
Lead-Free Solder Temp			260	°C	MSL level1. Refer to soldering reflow profile in Figure 7
Supply Voltage	V _{DD3}	-0.5	3.4	V	
	V _{DD1_8}	-0.5	2.1	V	
	V _{DDIO}	-0.5	3.4	V	
ESD (Human body model)			2	kV	All Pins
Input Voltage	V _{IN}	-0.5	3.4	V	All I/O Pins

Comments:

- 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.
- 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 _{DD1_8}	1.7	1.8	2.0	Volts	Including noise.
	V _{DD3}	2.7	2.8	3.3	Volts	Including noise.
	V _{DD5}	4.0	5.0	5.25	Volts	Including noise.
	V _{DD-LED}	2.7	2.8	3.3	Volts	Including noise.
	V _{DDIO}	1.65		3.3	Volts	Including noise.
Power supply rise time	V _{RT1_8}	1		100	ms	0 to 1.8V
	V _{RT3}	1		100	ms	0 to 2.8V
Supply noise (Sinusoidal)	V _{NA}			100	mV _{p-p}	10kHz-50MHz
Serial Port Clock Frequency	f _{SCLK}			2	MHz	Active drive, 50% duty cycle
Distance from lens reference plane to surface (Z)	Z	2.7	2.9	3.1	mm	Results in +/- 0.2 mm minimum DOF. See Figure 5
Speed	S			200	ips	
Lift Cutoff (Manual Calibration)	L _C		1	2.0	mm	
Lift Cutoff (Default)	L _{wc}		3		mm	
Acceleration	A			50	g	In Run Mode only (machine tested upto 30g)
Load Capacitance	C _{out}			100	pF	MOTION, MISO

DC Electrical Specifications

Electrical Characteristics over recommended operating conditions. (Typical values at 25 °C, $V_{DD3} = 2.8\text{ V}$, $V_{DDIO} = 2.8\text{ V}$, $V_{DD1_8} = 1.8\text{ V}$)

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes
DC Supply Current	I_{DD_RUN3k}		14		mA	Average current, including 10mA LED current. No load on MISO, MOTION. RUN3k = run mode at 3000fps RUN7k = run mode at 7000fps RUN12k = run mode at 12500fps
	I_{DD_RUN7k}		26		mA	
	I_{DD_RUN12k}		38		mA	
	I_{DD_REST1}		0.30		mA	
	I_{DD_REST2}		0.15		mA	
	I_{DD_REST3}		0.08		mA	
Peak Supply Current	I_{DDPP}			65	mA	
Shutdown Supply Current	$I_{DDSTDWN}$		65		μA	NCS, SCLK, MOSI = VDDIO MISO = GND
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	$V_{in} = 0.7 * V_{DDIO}$, SCLK, MOSI, NCS
Output Low Voltage, MISO, MOTION	V_{OL}			$0.3 * V_{DDIO}$	V	$I_{out} = 1\text{ mA}$, MISO, MOTION
Output High Voltage, MISO, MOTION	V_{OH}	$0.7 * V_{DDIO}$			V	$I_{out} = -1\text{ mA}$, MISO, MOTION
Input Capacitance	C_{in}			10	pF	MOSI, NCS, SCLK

Registers

The SDNS-3988 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	0x3d
0x01	Revision_ID	R	0x01
0x02	Motion	R	0x20
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	0x7a
0x0c	Shutter_Upper	R	0x31
0x0d	Frame_Period_Lower	R	0x1a
0x0e	Frame_Period_Upper	R	0x41
0x0f	Configuration_I	R/W	0x24
0x10	Configuration_II	R/W	0x00
0x11	Configuration_III	R/W	0x00
0x12	Frame_Capture	R/W	0x00
0x13	SROM_Enable	W	0x00
0x14	Run_Downshift	R/W	0x32
0x15	Rest1_Rate	R/W	0x01
0x16	Rest1_Downshift	R/W	0x1f
0x17	Rest2_Rate	R/W	0x09
0x18	Rest2_Downshift	R/W	0xbc
0x19	Rest3_Rate	R/W	0x31
0x1a	Frame_Period_Max_Bound_Lower	R/W	0x1a
0x1b	Frame_Period_Max_Bound_Upper	R/W	0x41
0x1c	Frame_Period_Min_Bound_Lower	R/W	0xa0
0x1d	Frame_Period_Min_Bound_Upper	R/W	0x0f
0x1e	Shutter_Max_Bound_Lower	R	0x7a
0x1f	Shutter_Max_Bound_Upper	R	0x31
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-0x2e	Reserved		
0x2f	Configuration_V	R/W	0x00

Address	Register	Read/Write	Default Value
0x30-0x38	Reserved		
0x39	Configuration_IV	R/W	0x00
0x3a	Power_Up_Reset	W	NA
0x3b	Shutdown	W	NA
0x3c-0x3e	Reserved		
0x3f	Inverse_Product_ID	R	0xc2
0x40-0x41	Reserved		
0x42	Snap_Angle	R/W	0x06
0x43-0x46	Reserved		
0x47	Sensor_Mode	R/W	0x01
0x48-0x4f	Reserved		
0x50	Motion_Burst	R	0x00
0x51-0x63	Reserved		
0x54	Filter_Configuration	R/W	0x80
0x55-0x58	Reserved		
0x59	VFR_Shutter_Max_Bound_Lower	W	NA
0x5a	VFR_Shutter_Max_Bound_Upper	W	NA
0x5b	Reserved		
0x5c	ManCal_Configuration	R/W	0x00
0x5d	ManCal_Min_Squal	R	NA
0x5e	ManCal_Max_Shutter_Lower	R	NA
0x5f	ManCal_Max_Shutter_Upper	R	NA
0x60-0x61	Reserved		
0x62	SROM_Load_Burst	W	NA
0x63	Reserved		
0x64	Pixel_Burst	R	0x00