Prosens Technology

PROSENS

WT-8589S

New Low Power Wireless Mouse Sensor

Lead (Pb) Free
RoHS 6 fully
compliant

Description

The Prosens Technology WT-8589S is a new low power, small form factor optical mouse sensor. It has a brand new low-power architecture and automatic power management modes, along with the third generation optical lens WT-8511, making it ideal for battery, power-sensitive applications – such as cordless input devices.

The WT-8589S is capable of high-speed motion detection – up to 32ips and 8G. In addition, it has an on-chip oscillator and LED driver to minimize external components.

The WT-8589S along with the WT-8511 3'rd generation trim lens, LED clip, and HLMP-ED80 LED form a complete and compact mouse tracking system. There are no moving parts and this translates to high reliability and less maintenance for the end user. In addition, precision optical alignment is not required, facilitating high volume assembly.

The sensor is programmed via registers through a four-wire serial port. It is housed in an 8-pin staggered dual in-line package (iDIP).

Features

- Low Power and the 3'rd Generation Optical Architecture
- Small Form Factor
- Programmable Periods / Response Times and Downshift Times from one mode to another for the Power-saving Modes
- 'Smart' LED Current Switching depending on surface brightness
- High Speed Motion Detection up to 32ips and 8G
- External Interrupt Output for Motion Detection
- Internal Oscillator – no clock input needed
- Selectable Resolution up to 1600cpi
- Wide Operating Voltage: 2.3 - 3.3V
- Two wire Serial Port Interface
- Minimal number of passive components

Applications

Performance Wireless Optical Mice

Theory of Operation

The WT-8589S is based on Optical Navigation Technology, which measures changes in position by optically acquiring sequential surface images (frames) and mathematically determining the direction and magnitude of movement.

The WT-8589S 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 and translates the Δx and Δy information from the sensor serial port into PS2, USB, or RF signals before sending them to the host PC.

Package Pinout

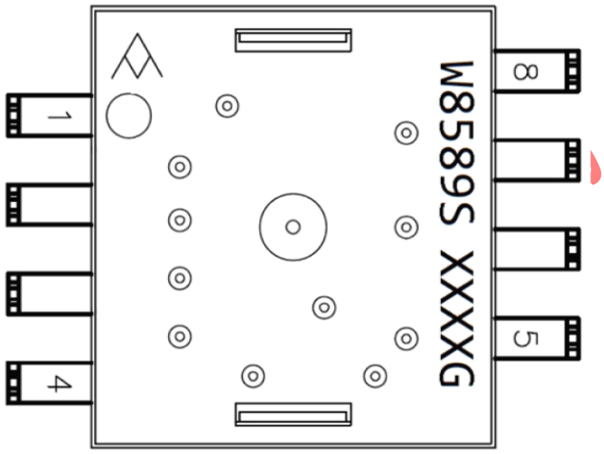


Figure1. Device Pinout

Pin	Name	Type	Description
1	NC	OUT	Reserve for test mode. Must be kept floating
2	Motion	I/O	Motion detection (active low)
3	SDIO	IN	SPI bi-directional data
4	SCLK	OUT	SPI clock
5	LED	GND	LED control
6	VSS	PWR	Chip ground
7	VDD	PWR	Power supply for I/O and internal output
8	RSVD	OUT	Reserve for test mode. Must connect through a 1uF capacitor to ground

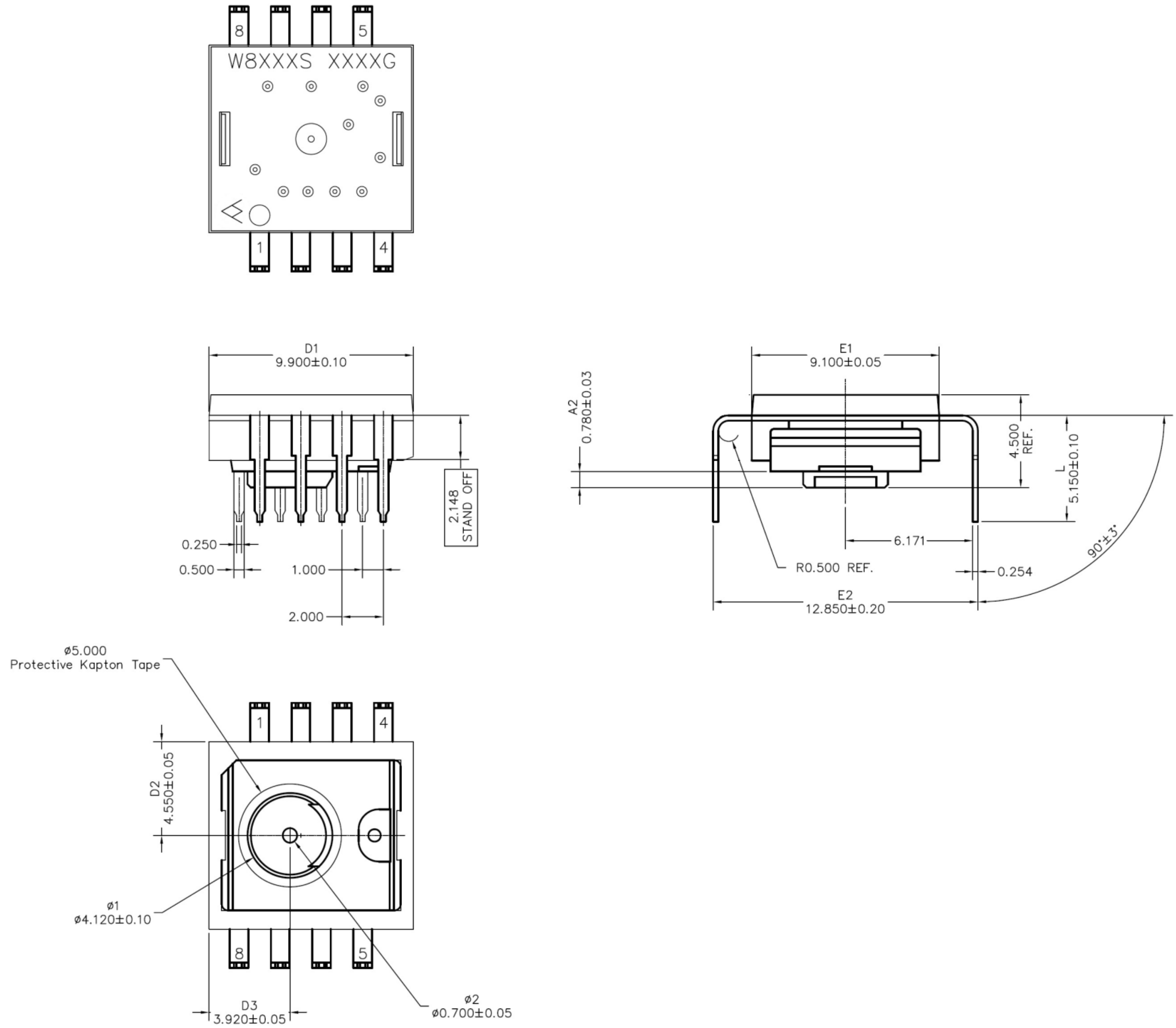


Figure2. Package Outline Drawing

Overview of Optical Mouse Sensor Assembly

Prosens Technology provides an IGES file drawing de scribing the base plate molding features for lens and PCB alignment. The WT-8589S sensor is designed for mounting on a through-hole PCB. There is an aperture stop and features on the package that align to the lens. The WT-8511 lens provides optics for the imaging of the surface as well as the illumination of the surface at the optimum angle. Features on the lens align it to the sensor, base plate, and clip with the LED. The clip holds the LED in relation to the lens. The LED must be inserted into the clip and the LED leads formed prior to loading on the PCB.

The HLMP-EG3E LED is recommended for illumination.

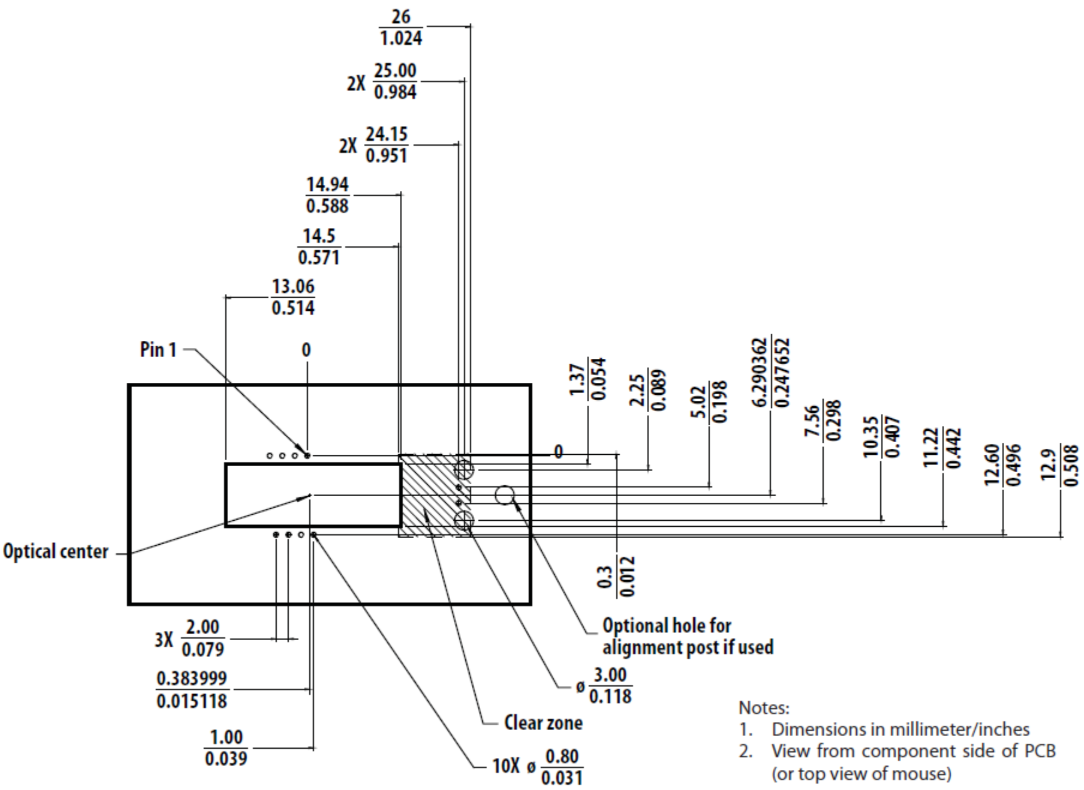
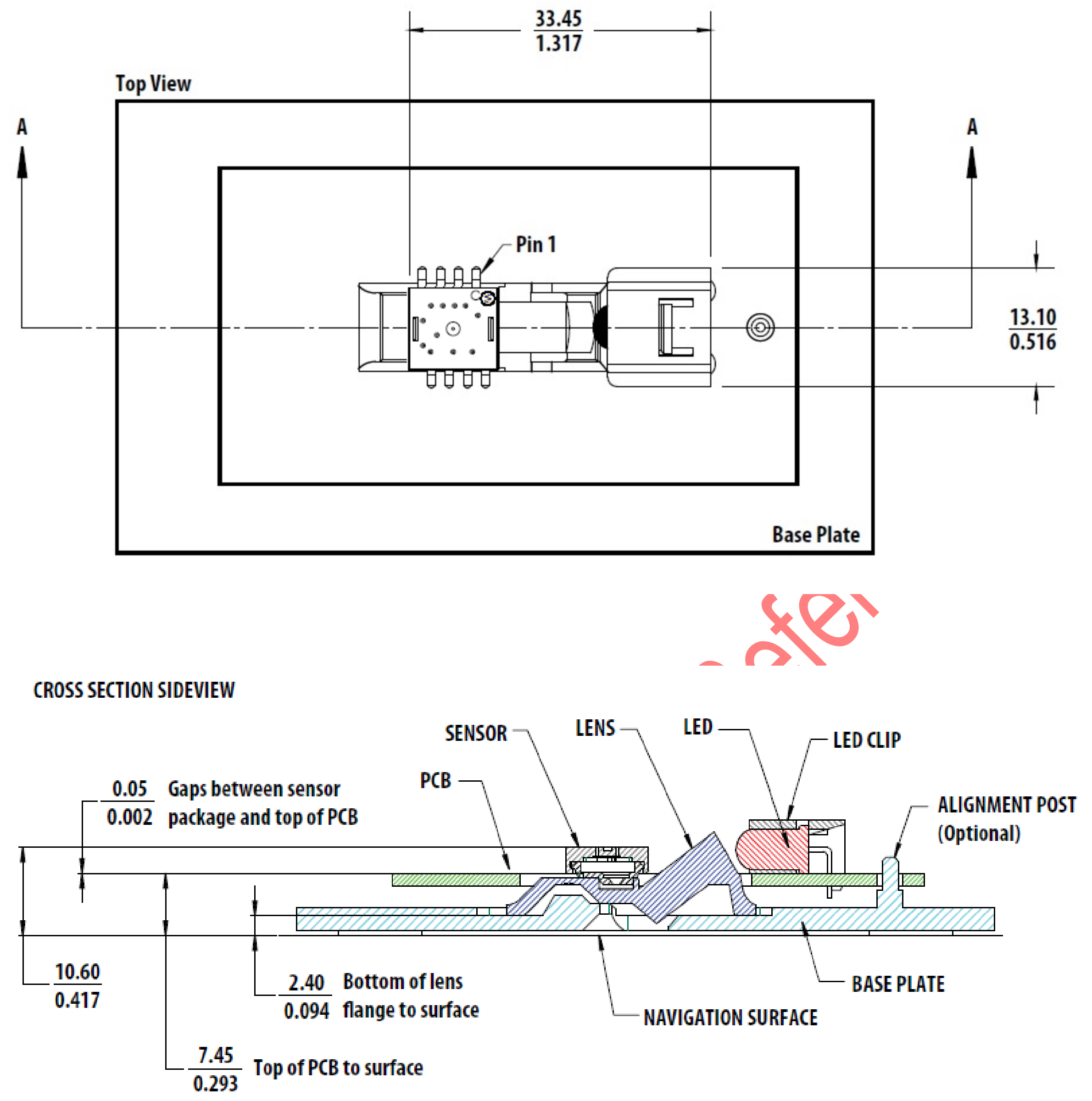
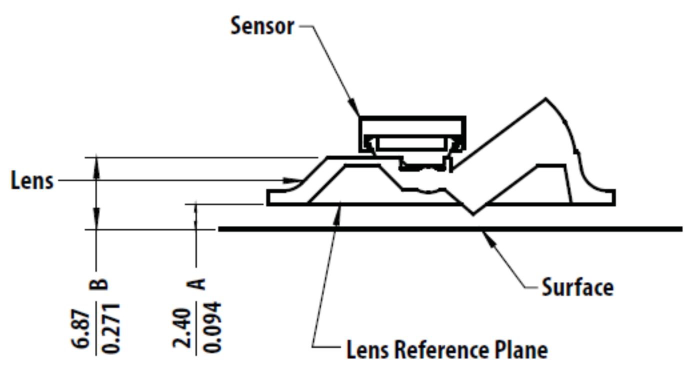


Figure3. Recommended PCB Mechanical Cutouts and Spacing



NOTE: Dimensions in mm/Inches
Important Note: Pin 1 of sensor should be located nearest to the LED

Figure4. 2D Assembly Drawing of Sensor (Top and Side View)



Note:
A – Distance from object surface to lens reference plane
B – Distance from object surface to sensor reference plane

Figure5. Distance from Lens Reference Plane to Tracking Surface (Z)

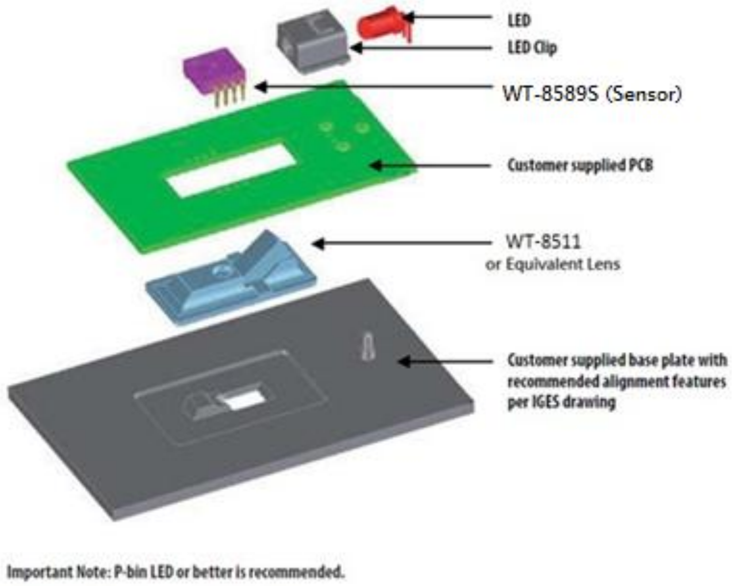


Figure6. Exploded View of Assembly

PCB Assembly Considerations

1. Insert the sensor and all other electrical components into PCB.

2. Insert the LED into the assembly clip and bend the leads 90 degrees.

3. Insert the LED clip assembly into PCB.

4. Wave solder the entire assembly in a no-wash solder process utilizing solder fixture. The solder fixture is needed to protect the sensor during the solder process. It also sets the correct sensor-to-PCB distance as the lead shoulders do not normally rest on the PCB surface. The fixture should be designed to expose the sensor leads to solder while shielding the optical aperture from direct solder contact.

5. Place the lens onto the base plate.

6. Remove the protective Kapton tape from optical aperture of the sensor.

Care must be taken to keep contaminants from entering the aperture. Recommend not to place the PCB facing up during the entire mouse assembly process. Recommend to hold the PCB first vertically for the Kapton removal process.

7. Insert PCB assembly over the lens onto the base plate aligning post to retain PCB assembly. The sensor aperture ring should self-align to the lens.

8. 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.

9. 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 interlocked to the correct vertical height.

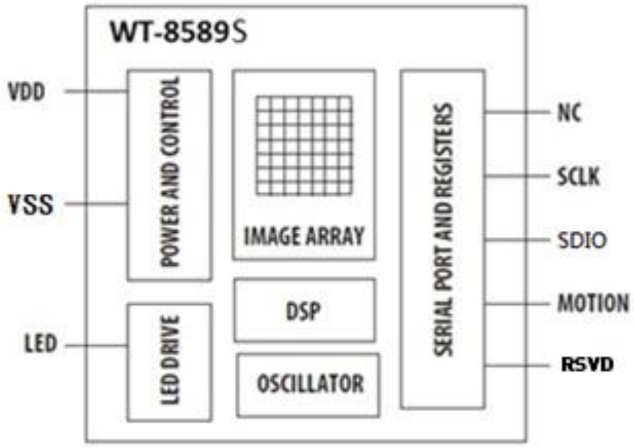


Figure7. Block diagram of WT-8589S optical mouse

Design considerations for improving ESD Performance

The table below shows typical values assuming base plate construction per the Prosens Technology supplied IGES file and WT-8511 trim lens. Stand-off of the base plate shall not be larger than 5 mm.

Typical Value	Distance (mm)
Creepage	15.43 mm
Clearance	7.77 mm

Note that the lens material is polycarbonate or polystyrene HH30, therefore, cyanoacrylate based adhesives should not be used as they will cause lens material deformation

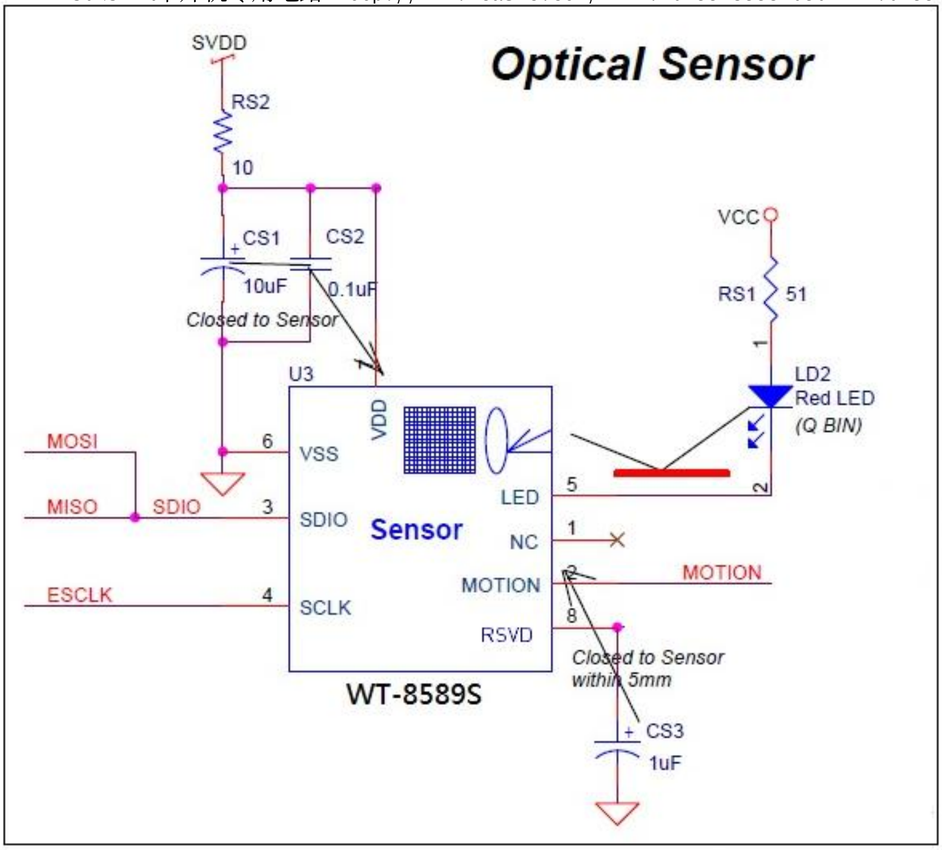


Figure 8. Sensor Circuitry

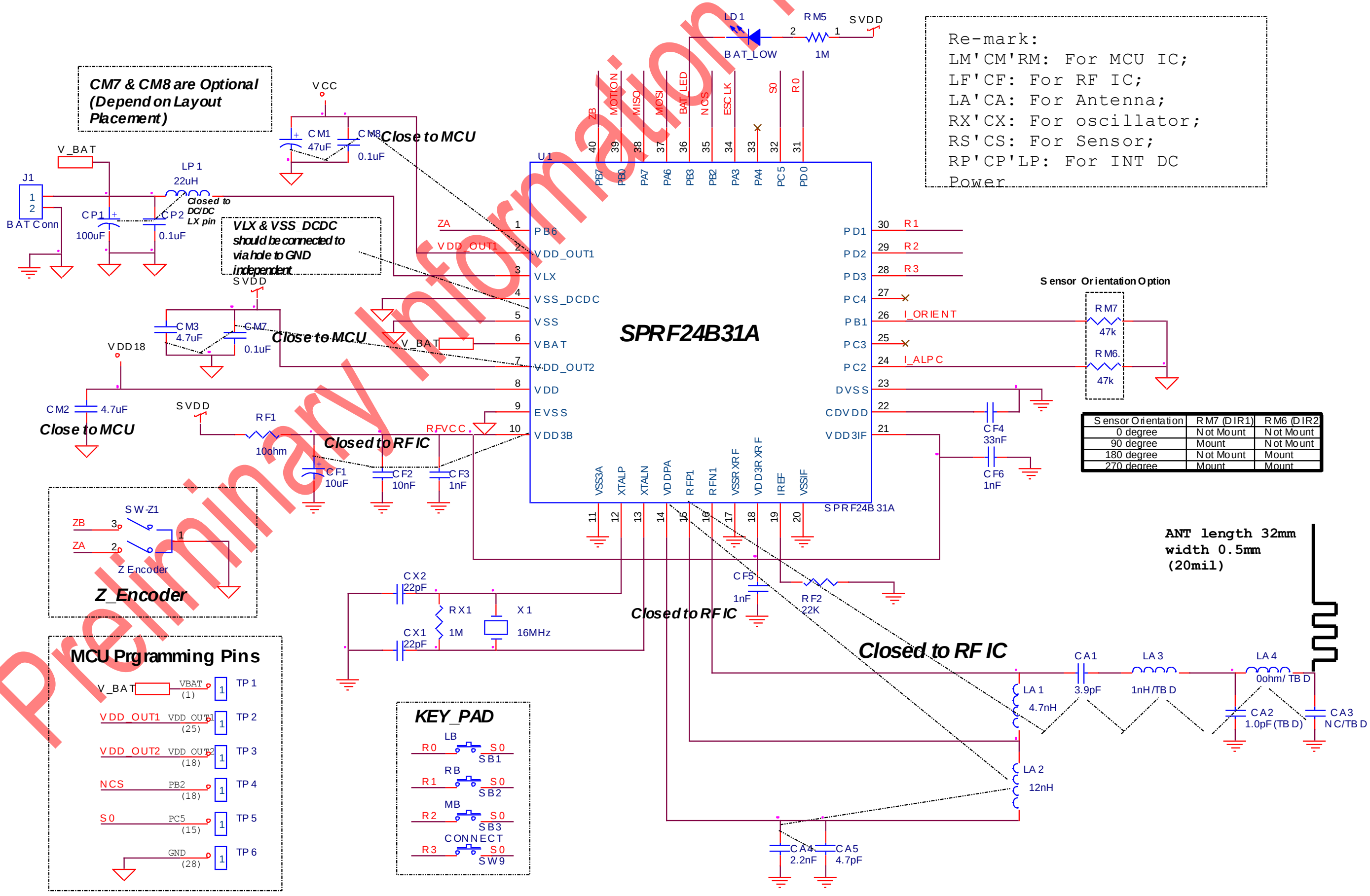


Figure 9. Reference Design Circuitry

Regulatory Requirements

- Passes FCC B and worldwide analogous emission limits when assembled into a mouse with shielded cable and following Prosens Technology recommendations.
- Passes EN61000-4-4/IEC801-4 EFT tests when assembled into a mouse with shielded cable and following Prosens Technology recommendations.
- UL flammability level UL94 V-0.

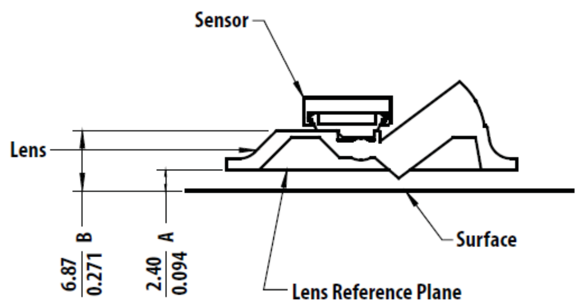
Electrical Specifications and Characteristics

Absolute Maximum Rating

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Storage Temperature	T_{STR}	-40	-	85	ºC	
Operating Temperature	T_{opt}	-15		55	ºC	
Voltage Rating on Input	V_{IN}	-0.3	-	VDD+0.3	V	
Voltage Rating on VDD		-0.3	-	3.6	V	
ESD				2	KV	

Recommended Operating Conditions

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Operating Supply Voltage	V_{supply}	2.3	2.8	3.3	V	
Operating Temperature	T_{opt}	0		40	ºC	
Supply Noise	V_{NOISE}			100	mV	
Resolution	R	400	1000	1600	CPI	
Serial Port Clock Frequency	F_{SCK}			3	MHz	
Frame Rate	FR			3000	FPS	
Speed	Speed			32	IPS	
Acceleration	A			8	G	At the normal mode and 3000 fps.



Note:
A – Distance from object surface to lens reference plane
B – Distance from object surface to sensor reference plane

Figure10. Distance from Lens Reference Plane to Tracking Surface (Z)

AC Characteristics

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Power up time	T_{pup}	40	50	60	ms	
SPI re-sync. low level time	T_{RSYNCL}	1			us	
SPI re-sync. time	T_{RSYNC}	1.7			ms	

DC Characteristics

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Supply current at normal mode	I_{nor}		2		mA	VDD = 3.0V T = 25 degree
Supply current at sleep 1 mode	I_{slp1}		100		uA	VDD = 3.0V T = 25 degree
Supply current at sleep 2 mode	I_{slp2}		30		uA	VDD = 3.0V T = 25 degree
Supply current at power down mode	I_{pd}		5		uA	VDD = 3.0V T = 25 degree
Type: MOTION, SCLK, SDIO						
Input Voltage High	V_{IH}	2.0			V	VDD = 3.0V
Input Voltage Low	V_{IL}			0.8	V	VDD = 3.0V
Output Voltage High	V_{OH}	2.4			V	VDD = 3.0V I_{OH} = 2mA
Output Voltage Low	V_{OL}			0.4	V	VDDI = 3.0V I_{OL} = 2mA
Type: LED						
Output Voltage Low	V_{OL-LED}			380	mV	VDD = 3.0V I_{OL} = 25mA

Serial Peripheral Interface (SPI)

The serial peripheral interface is used by an external controller to read/write the register blocks and OPMS registers inside WT-8589S.

SCLK (Serial Clock)

This serial clock line is always generated by the external controller.

SDIO (Serial Data)

The serial data line is used by the external controller to read and write data.

Write Operation

Write operation, data going from the external controller to WT-8589S, is always initiated by the external controller and consists of two-byte message blocks. The first byte of a message block contains the address (7 bits) and has a '1' as its MSB to indicate data direction. The second byte contains the data to be written. The SDIO data transfer is synchronized by SCLK. The external controller changes SDIO on falling edges of SCLK. The WT-8589S reads SDIO on rising edges of SCLK. The write operation protocol is illustrated in Figure 11..

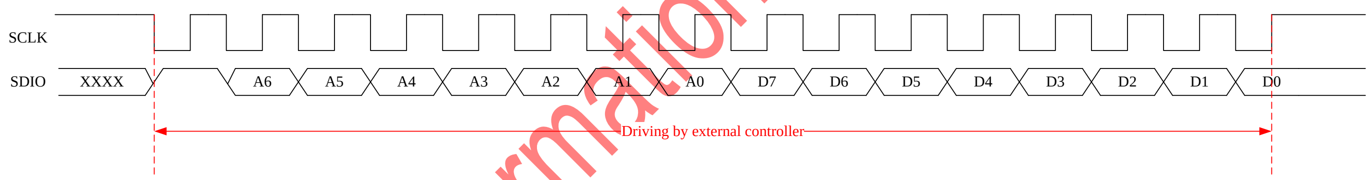


Figure. 11 SPI Write Operation

Read Operation

Read operation, data going from WT-8589S to the external controller, is always initiated by the external controller and consists of two-byte message blocks. The first byte of a message block contains the address written by the external controller and has a '0' as its MSB to indicate data direction. The second byte contains the data and is driven by WT-8589S. The SDIO data transfer is synchronized by SCLK and SDIO is changed by WT-8589S on falling edges of SCLK. The external controller reads SDIO data on every rising edge of SCLK. The SDIO pin of the External Controller must go to a high Z state after the last address bit (A0) has been sent by the external controller. And the SDIO pin of WT-8589S will go to high Z state after the last data bit has been output. The read operation protocol is illustrated in **Figure**..

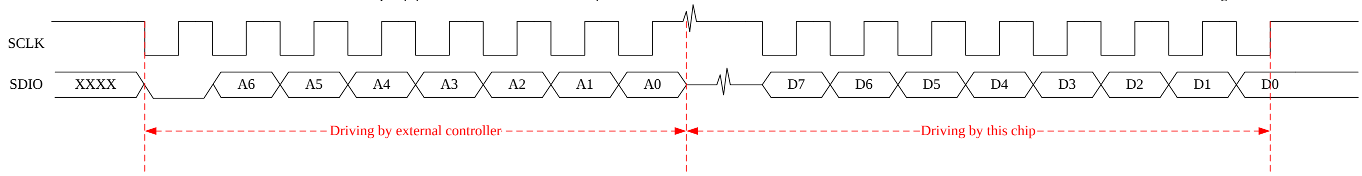


Figure.12 SPI Read Operation

Re-synchronization

If the external controller and the WT-8589S are out of synchronization, the data access from/to the registers will be incorrect. In such a case, the external controller drives the SCLK to '0' for at least T_{RSYNCL} time period, and then drives the SCLK to '1' for at least T_{RSYNC}-T_{RSYNCL} time period to get WT-8589S synchronized with the external controller.

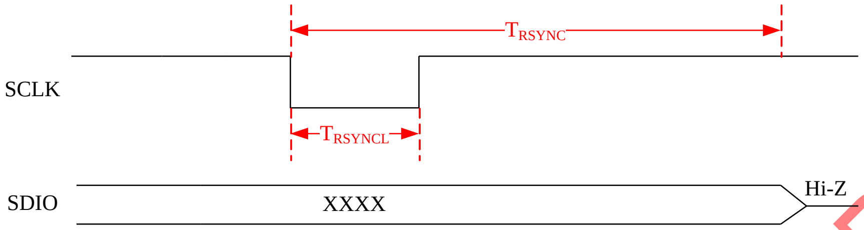


Figure 13. Re-synchronization Operation

Registers

PIDL: Product ID Low Byte ($0000h)

Bit	Default	R/W	Name	Description
B7:0	30h	R	PIDL	Product identifier low byte. It can be read across serial communication interface to check if the link is OK.

PIDH: Product ID High Byte ($0001h)

Bit	Default	R/W	Name	Description
B7:0	50h 49h	R	PIDH	Product identifier high byte. It can be read across serial communication interface to check if the link is OK. If the value of the Wr_Prot is 0xA5, the data is 0x49h. If the value of the Wr_Prot is not 0xA5, the data is 0x50h.

M_Status: Motion Status ($0002h)

Bit	Default	R/W	Name	Description
B7	0	R	MOTION	Motion flag since last report: note1 0: No motion 1: Motion occurred
B6	0	R		Reserved
B5	0	R		Reserved
B4	0	R	DYOVF	Motion at Y direction overflow flag: note1 0: No overflow 1: Overflow has occurred
B3	0	R	DXOVF	Motion at X direction overflow flag: note1 0: No overflow 1: Overflow has occurred
B2	1	R	R_MIR[2]	Resolution in count per inch. The data is copied from the B2:0 of Config register ($0006h).
B1	0	R	R_MIR[1]	
B0	0	R	R_MIR[0]	

Note1: When both Delta_X and Delta_Y are overflowed with value to be -128 (0x80), only DXOVF and DYOVF is set. The Motion pin/register is not active.

Delta_X: X movement ($0003h)

Bit	Default	R/W	Name	Description
B7:0	00h	R	Delta_X	X movement since last report. Reading this register will also clear its content. The movement report range is from -128 to 127. If the total movement is overflowed, DXOVF becomes "1".

Delta_Y: Y movement ($0004h)

Bit	Default	R/W	Name	Description
B7:0	00h	R	Delta_Y	Y movement since last report. Reading this register will also clear its content. The movement report range is from -128 to 127. If the total movement is overflowed, DYOVF becomes 1.

Op_Mode: Operation Mode ($0005h)

Bit	Default	R/W	Name	Description
B7	1	A	LEDsht_En	LED shutter enable: 0: Disable 1: Enable
B6	0	R		Reserved
B5	1	R		Reserved
B4	1	A	Slp_En	Sleep mode enable: 0: Disable 1: Enable
B3	1	A	Slp2_En	Sleep mode 2 enable: 0: Disable 1: Enable
B2	0	A	Slp2_Mu	Enter sleep mode 2 manually. Set "1" and it will be cleared to "0" automatically.
B1	0	A	Slp1_Mu	Enter sleep mode 1 manually. Set "1" and it will be cleared to "0" automatically.
B0	0	A	Wakeup	Wake up from sleep mode manually. Set "1" and it will be cleared to "0" automatically.

Config: Configuration ($0006h)

Bit	Default	R/W	Name	Description
B7	0	A	M_RST	Manual reset for whole chip: 0: Disable 1: Enable Set "1" and it will be cleared to "0" automatically.
B6	0	A	Mot_OSel	MOTION pin output function select. 0: Level sensitive. If MOTION pin is at low level, it means that Delta_X and/or Delta_Y register has data. The mouse controller can read M_Status, Delta_X and Delta_Y sequentially to get the motion result. After the Delta_X/Delta_Y registers have been read, Delta_X/Delta_Y registers will be cleared (zero) and the level of MOTION pin will become high. 1: Edge sensitive. If there is motion being detected, MOTION pin will generate one low pulse to inform the mouse controller.
B5	0	R		Reserved
B4	0	R		Reserved
B3	0	A	PD_En	Power down mode enable 0: Disable 1: Enable
B2	1	A	RES[2]	Output resolution setting. 000: 400 001: 500 010: 600 011: 800 100: 1000 101: 1200 110: 1600 111: Reserved
B1	0	A	RES[1]	
B0	0	A	RES[0]	

Img_Qua: Image Quality ($0007h)

Bit	Default	R/W	Name	Description
B7:0	00h	R	Img_Qua	Image Quality register indicates the quality level of the captured images.

Op_State: Operation State ($0008h)

Bit	Default	R/W	Name	Description
B7	0	R		Reserved
B6	0	R		Reserved
B5	0	R		Reserved
B4	0	R		Reserved
B3	0	R	Slp_St	Sleep state. This bit is effective if the Op_St is 3’b100. 0: Sleep timer is at sleep1 state 1: Sleep timer is at sleep 2 state
B2	0	R	Op_St[2]	Operating state of the WT-8589S 000: Normal Mode 001: Entry sleep 1 processing 100: Sleep mode (See Slp_St for more information) Others: Reserved for future use
B1	0	R	Op_St[1]	
B0	0	R	Op_St[0]	

Wr_Prot: Write Protect ($0009h)

Bit	Default	R/W	Name	Description
B7:0	00h	A	Wr_Prot	Write protect for $000A to $000E. 00: The registers after $0009 are read only 5A: The registers after $0009 to $000E can be read/written

Slp1_Set: Sleep 1 mode setting ($000Ah)

Bit	Default	R/W	Name	Description
B7	0	A	Slp1_Fr[3]	Set the wake-up period time of the sleep 1 mode. Time scale is 4ms. Setting the value to be 0~15 will achieve time intervals to be 4ms ~ 64ms or (n+1) x 4ms. Default is 32ms.
B6	1	A	Slp1_Fr[2]	
B5	1	A	Slp1_Fr[1]	
B4	1	A	Slp1_Fr[0]	
B3	0	R		Must always be 0
B2	0	R		Must always be 0
B1	1	R		Must always be 1
B0	0	R		Must always be 0

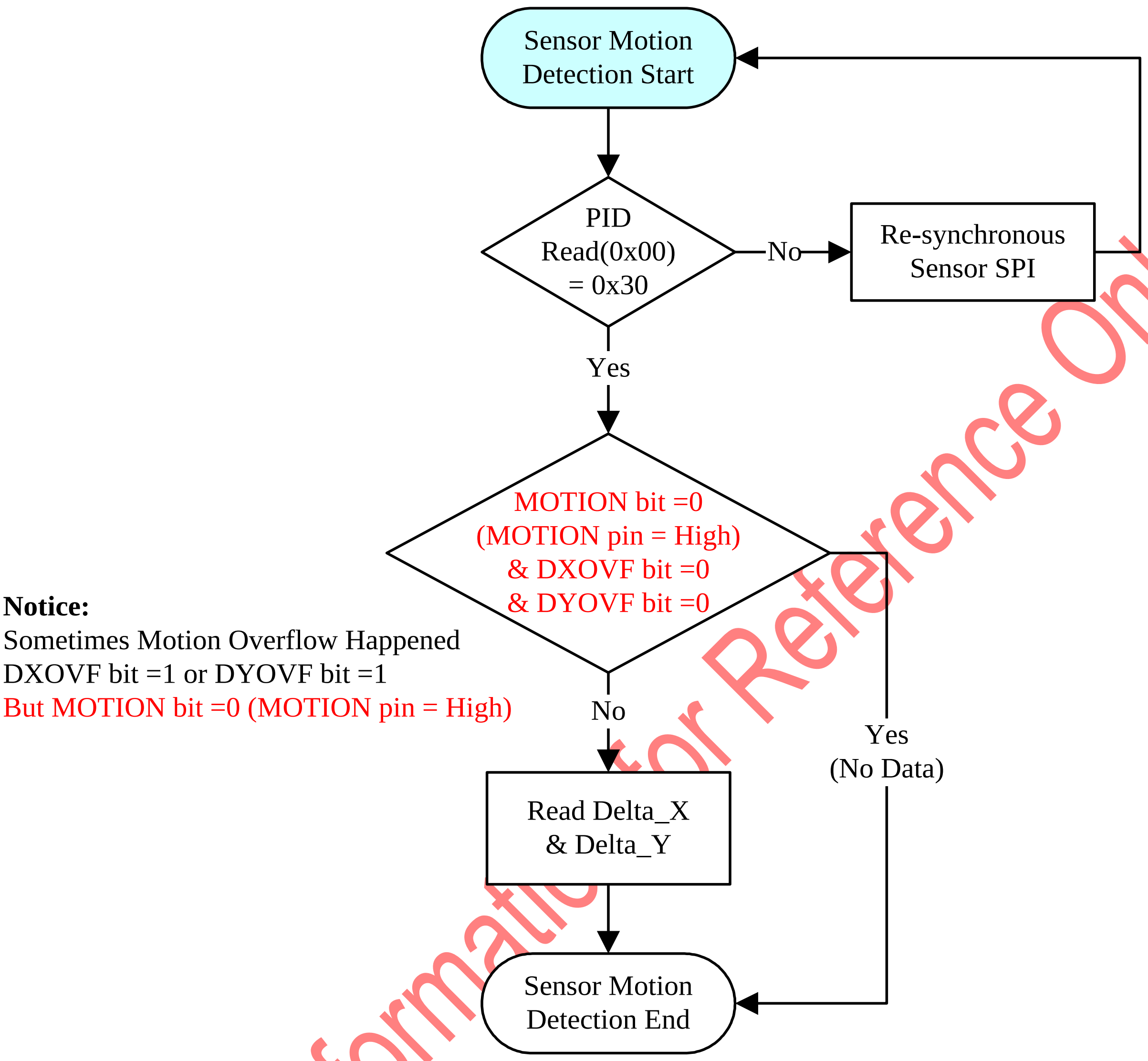
Ent_Time: Sleep Mode Enter Time ($000Bh)

Bit	Default	R/W	Name	Description
B7	0	A	S1_Ent[3]	Set sleep mode 1 entering time. Time scale is 128ms. Setting the value to be 0~15 will achieve time intervals to be 128ms ~ 2048ms or (n+1) x 128ms. Default is 256ms.
B6	0	A	S1_Ent[2]	
B5	0	A	S1_Ent[1]	
B4	1	A	S1_Ent[0]	
B3	0	A	S2_Ent[3]	Set sleep mode 2 entering time. Time scale is 20480ms. Setting the value to be 0~15 will achieve time intervals to be 20480ms ~ 327680ms or (n+1) x 20480ms. Default is 61440ms.
B2	0	A	S2_Ent[2]	
B1	1	A	S2_Ent[1]	
B0	0	A	S2_Ent[0]	

Slp2_Set: Sleep 2 mode setting ($000Ch)

Bit	Default	R/W	Name	Description
B7	1	A	Slp2_Fr[3]	Set the wake-up period time of the sleep 2 mode. Time scale is 32ms. Setting the value to be 0~15 will achieve time intervals to be 32ms ~ 512ms. Default is 620ms or (n+1) x 32ms.
B6	0	A	Slp2_Fr[2]	
B5	0	A	Slp2_Fr[1]	
B4	1	A	Slp2_Fr[0]	
B3	0	R		Must always be 0
B2	0	R		Must always be 0
B1	1	R		Must always be 1
B0	0	R		Must always be 0

Sensor Motion Detection Flow Chart



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