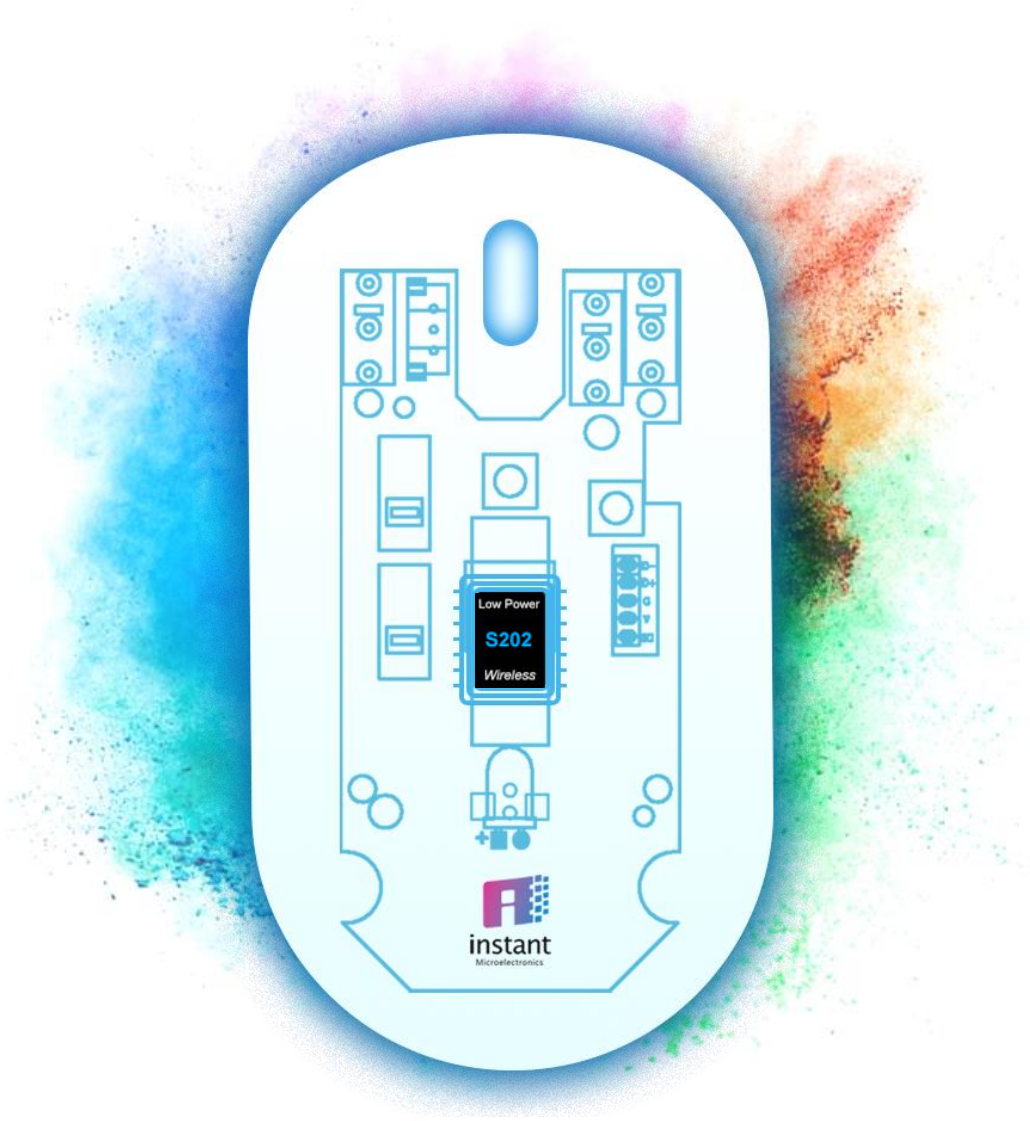
S202 Datasheet

Low Power Wireless Mouse Sensor



Version V1.01

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1. General Description

S202 is a low power optical sensor for wireless mouse application. It is based on high precision surface tracking algorithm and has built-in LED drive circuit and OSC circuit. It can provide high precision positioning ability with low power consumption. The length of motion data(DX/DY) can be selected as 8bit or 16 bit by register setting. To avoid data overflow, 16bit motion data is recommended.

2. Feature

- High precision surface tracking algorithm
- 2-wired SPI serial interface
- Single power with wide voltage range：
  - 2.1V~3.6V (VDDA connected to GND through capacitor)
- Built-in OSC circuit
- Built-in LED drive circuit
- Support multiple CPI resolution：
  - Compatible with other sensors：600/800/1000(default)/1200/1600
  - Extended：200~3200
  - Others: the CPI group selected by CPI_SEL pin
- Max Frame rate 2500 fps
- Max acceleration 8g, Max speed 30ips
- Low power LED control algorithm
- Support 8bit and 16bit motion data formats, configurable.
- Max resolution 3200 CPI
- Advanced power control method:
  - 1.5mA @ Mouse moving (Normal)
  - 50uA @ Mouse not moving (Sleep1)
  - 14uA @ Mouse not moving (Sleep2)
  - 3uA @ Power down mode (not including LED current)
- SDIP-8 package, ROHS standard

Typical application: Wireless mouse, Bluetooth mouse

3. Function Block Diagram

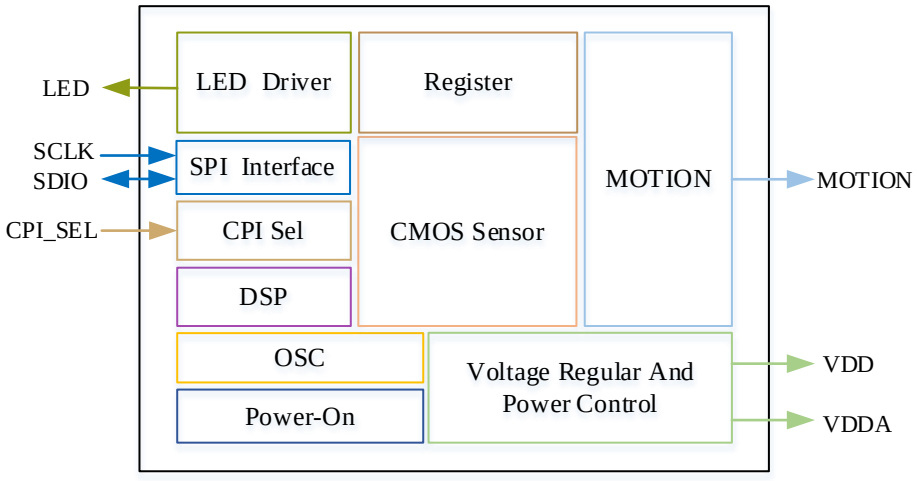


Figure3-1 Function Block Diagram

4. Sensor Orientation and Pin Description

4.1 Sensor Orientation

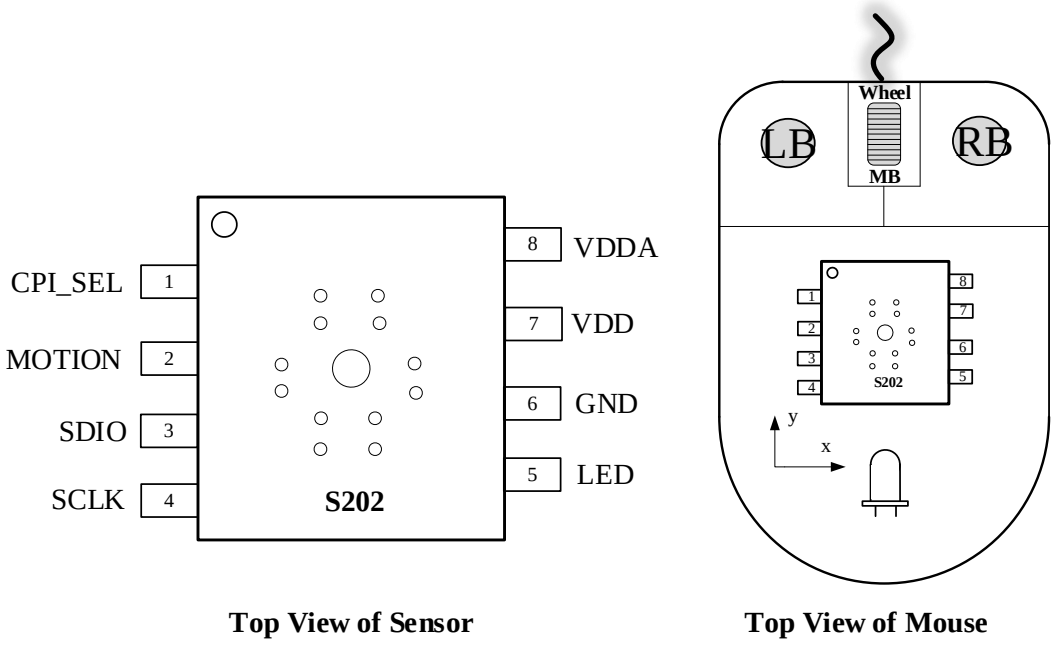


Figure4-1 Orientation Relationship between Sensor and Mouse

4.2 Pin Description

Pin	Name	Type	Description
1	CPI_SEL	IN	CPI selection input of S202
2	MOTION	IN/OUT	Motion detection output,
3	SDIO	IN/OUT	Bi-directional I/O for SPI
4	SCLK	IN	Clock input for SPI
5	LED	OUT	LED control
6	GND	GND	Chip ground
7	VDD	PWR	VDD:2.1V~3.6V，VDDA connect 4.7uF capacitor to GND
8	VDDA	PWR	

Table 4-1 Pin Description

5. Serial Interface

5.1 Serial Interface Protocol

S202 uses 2-wire SPI half-duplex transmission mode. It uses 2 bytes for read and write operations. The first byte consists of 1 bit read / write control and 7 bit address, and the second byte is data.

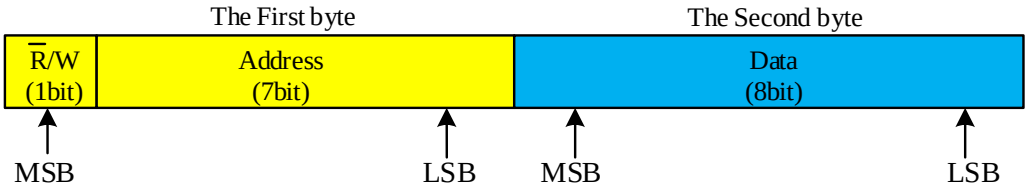


Figure 5-1 Serial Interface Transmission Format

5.1.1 Write Operation

The write operation contains two bytes, the highest bit of the first byte is 1, the last 7 bits are the address, and the second byte is the data. A write operation writes data into the register of S202 corresponding to the address. SDIO changes on the falling edge of SCLK, and S202 gets SDIO data on the rising edge of SCLK.

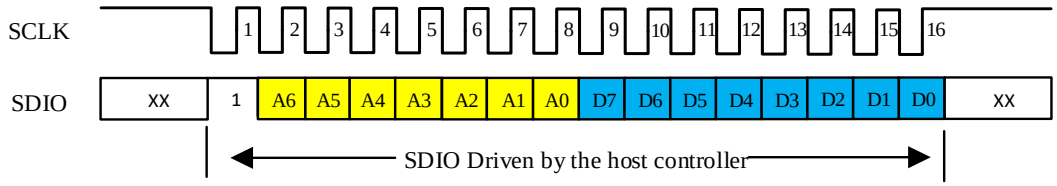


Figure 5-2 Write Operation

5.1.2 Read Operation

The read operation contains two bytes, the highest bit of the first byte is 0, the last 7bits are the address, and the second byte is the data. The register value of S202 corresponding address can be read out by one read operation. SDIO is changed by controller on the falling edges of SCLK for writing address, and then the host controller releases SDIO to high-Z state. After that, S202 output data on the falling edge of SCLK, and the host controller gets data on the rising edge of SCLK.

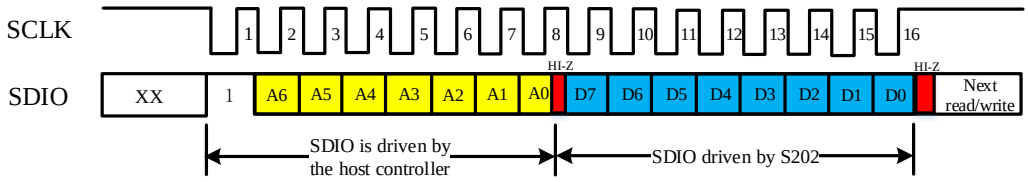


Figure 5-3 Read Operation

5.2 ReSync Serial Interface

In the process of serial interface transmission, the clock and data may be out of synchronization, and the host controller will not be able to correctly access the registers of the sensor. To recover the correct communication of SPI, the host controller must change the SCLK signal from high to low for more than 1 us, and then from low to high more than 3ms. This operation can reset the SPI circuits of S202 and re-synchronize the clock and data.

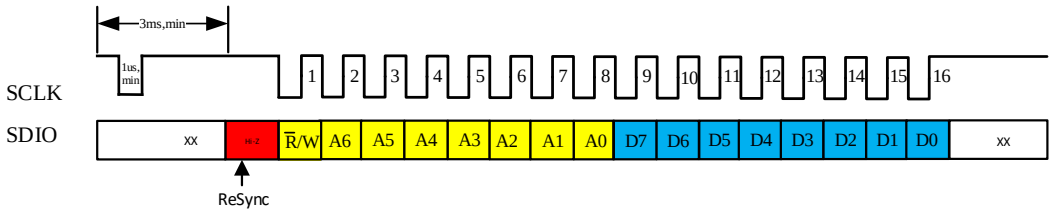


Figure 5-4 ReSync Operation

6. The Function of CPI_SEL

CPI_SEL is the Pin1 of S202. It is used to select one of the three groups of CPI. The CPI_SEL (Pin1) and Config register (0x06) are configured to get the target CPI value. See the table below for details:

CPI[2:0]	Pin1 connect to HI-Z	Pin1 connect to GND	Pin1 connect to VDD
000	600	3200	3200
001	800		
010	1000		
011	1200	1200	1200
100	1600	2400	2000
101-111	RSV	RSV	RSV

Users can realize three CPI resolution schemes by changing the voltage level of Pin1. One example is as follows：

1200(default) — 1600 — 1000/800/600 **[Pin1 connect to HI-Z]**
1200(default) — 2400 — 3200 **[Pin1 connect to GND]**
1200(default) — 2000 — 3200 **[Pin1 connect to VDD]**

7. The Function of Motion

The MOTION pin can be used to monitor the sensor motion. The MOTION pin will output “0”(low) whenever the sensor detects the occurrence of motion, when the host controller reads out all the moving data (motion data is cleared), the MOTION pin outputs “1”(high). If the motion data is not cleared, the MOTION pin will keep a low level.

8. Register

8.1 Register Summary

Address	Name	Description	R/W	Default
0x00	**PID1**	Product identifier 1 of S202	R	0x30
0x01	**PID2**	Product identifier 2 of S202	R	0xD1
0x02	**Motion_St**	Motion Status	R	-
0x03	**DeltaX**	DeltaX or the low 8bit of DeltaX	R	-
0x04	**DeltaY**	DeltaY or the low 8bit of DeltaY	R	-
0x05	**Op_Mode**	Operation mode selection of S202	W/R	0xB8
0x06	**Config**	Configuration of S202	W/R	0x02
0x07	**Img_Qa**	Quality of image	R	-
0x09	**Write_Protect**	Enable writing of other registers	W/R	0x00
0x0A	**Sleep1_Setting**	Frequency setting for Sleep1	W/R	0x70
0x0B	**Enter_Time**	Entering time from working mode to sleep1 mode	W/R	0x10
0x0C	**Sleep2_Setting**	Frequency setting of Sleep1 mode	W/R	0x70
0x20	**DeltaX_Hi**	High 8bit X-axis motion data	R	-
0x21	**DeltaY_Hi**	High 8bit Y-axis motion data	R	-
0x22	**DxDy_16bit**	16bit or 8bit length selection of DX/DY motion data output	W/R	0x00
0x23	**CPI2_Setting**	The extend setting pf CPI2	W/R	0x02
0x49	**PID3**	Product identifier 3 of S202	R	0xA1

8.2 Register Descriptions

PID1	Address: 0x00

Access: Read **Default**: 0x30

Bit	7	6	5	4	3	2	1	0
Field	PID1[7:0]							

Data Type: 8bit unsigned integer

Usage: It can be used to verify if the serial interface clock and data are synchronized.

PID2	Address: 0x01

Access: Read **Default**: 0xD1

Bit	7	6	5	4	3	2	1	0
Field	PID2[7:0]							

Data Type: 8bit unsigned integer

Usage: It can be used to verify if the serial interface clock and data are synchronized.

Motion_St	Address: 0x02

Access: Read **Default**: --

Bit	7	6	5	4	3	2	1	0
Field	Motion	RES[6:5]		DYOVF	DXOVF	RES[2:0]		

Data Type: Bit Field

Usage: In typical applications, the host controller will poll the sensor for valid motion data by checking the Motion bit. If the Motion bit is set, the motion data in Delta_X and Delta_Y registers are valid and ready to be read. Be sure to read Motion bit first before reading out Delta_X and Delta_Y registers. DXOVF bit and DYOVF bit show whether if the motion report buffers have overflowed since last read out.

Field Name	Description
Motion	**0: No motion（Default)** 1: Motion detected. data in Delta_X and Delta_Y registers are valid and ready to be read out
DYOVF	**0: Y-axis motion data is not overflow. (Default)** 1: Y-axis motion data is overflow
DXOVF	**0: X-axis motion data is not overflow. (Default)** 1: X-axis motion data is overflow

DeltaX	Address: 0x03

Access: Read **Default**: --

Bit	7	6	5	4	3	2	1	0
Field	DeltaX[7:0]							

Data Type: 8bit data

Usage: Delta_X register is the X-axis motion in counts after reading Motion_Status register. Absolute value is determined by the resolution setting CPI. If motion data mode is 16bit, this byte is the low 8 bits X-axis data. If motion data mode is 8bit, this byte reports X-axis data ranged from -127 to 128, and DeltaX[7] is the sign bit.

DeltaY	Address: 0x04

Access: Read **Default: --**

Bit	7	6	5	4	3	2	1	0
Field	DeltaY[7:0]							

Data Type: 8bit data

Usage: Delta_Y register is the Y-axis motion in counts after reading Motion_Status register. Absolute value is determined by the resolution setting CPI. If motion data mode is 16bit, this byte is the low 8 bits Y-axis data. If motion data mode is 8bit, this byte reports Y-axis data ranged from -127 to 128, and DeltaY[7] is the sign bit.

Op_Mode	Address: 0x05

Access: Write/Read **Default: 0xB8**

Bit	7	6	5	4	3	2	1	0
Field	1	0	1	Slp_en	Slp2_en	Slp2For	Slp1For	Wakeup

Data Type: Bit Field

Usage: The register is used to configure sleep function.

Field Name					Description
Slp_en	**Slp2_en**	**Slp2For**	**Slp1For**	**Wakeup**	
0	x	x	x	x	Disable Sleep function
1	0	x	x	x	Enable Sleep1, disable Sleep2
1	**1**	**x**	**x**	**x**	**Enable Sleep1, enable Sleep2(Default)**
1	1	1	0	0	Force to enter sleep2 mode
1	x	0	1	0	Force to enter sleep1 mode
1	x	0	0	1	Force to enter sleep mode

Config	Address: 0x06

Access: Write/Read **Default: 0x02**

Bit	7	6	5	4	3	2	1	0
Field	Rst	Mot	0	0	PD_en	CPI[2:0]		

Data Type: Bit Field

Usage: The register allows users to change the settings.

Field Name	Description
Rst	**0: Normal operation mode(Default)** 1: Reset the full chip
Mot	**0: Set Motion to level mode(default)**
PD_en	**0: Normal operation mode(Default)** 1: Power Down
CPI[2:0] (CPI_SEL connected to HI-Z)	000=600CPI 001=800CPI **010=1000CPI(Default）** 011=1200CPI 100=1600CPI 101-111:Reserved (See The Function of CPI_SEL)

Img_Qa	**Address: 0x07**							
Access: Read				**Default: --**				
Bit	7	6	5	4	3	2	1	0
Field	PID1[7:0]							

Data Type: 8bit unsigned integer

Usage: The register represents the image quality of the sensor.

Write_Protection	**Address: 0x09**							
Access: Write/Read				**Default: 0x00**				
Bit	7	6	5	4	3	2	1	0
Field	WP[7:0]							

Data Type: 8bit unsigned integer

Usage: The register is used to configure the writing protection of 0x0A~0x7F registers.

Field Name	Description
WP[7:0]	**0x00: The registers(0x0A~0x7F) are read only (Default)** 0x5A: The registers (0x0A~0x0C) are read /write 0xC3: The registers (0x0A~0x7F) are read /write

Sleep1_Setting	**Address: 0x0A**							
Access: Write/Read					**Default: 0x70**			
Bit	7	6	5	4	3	2	1	0
Field	Slp1_freq[3:0]				0	0	0	0

Data Type: 8bit unsigned integer

Usage: The register is used to set the frequency of Sleep1.The frequency of Sleep1 equals 4ms*(Slp1_freq[3:0]+1)，default value is 32ms (Slp1_freq[3:0]==7)

Enter_Time	Address: 0x0B

Access: Write/Read **Default: 0x10**

Bit	7	6	5	4	3	2	1	0
Field	Slp1_ent[3:0]				Slp2_ent[3:0]			

Data Type: Bit Field

Usage: The register is used to configure the waiting time before sensor enters sleep mode.

Field Name	Description
Slp1_ent[3:0]	128ms*(Slp1_ent[3:0]+1) **default=0001,256ms**
Slp2_ent[3:0]	20480ms*(Slp1_ent[3:0]+1) **default=0000,20480ms**

Sleep2_Setting	Address: 0x0C

Access: Write/Read **Default: 0x70**

Bit	7	6	5	4	3	2	1	0
Field	Slp2_freq[3:0]				0	0	0	0

Data Type: 8bit unsigned integer

Usage: The register is used to set the frequency of Sleep2.The frequency of Sleep1 equals 64ms*(Slp2_freq[3:0]+1), default value is 512ms (Slp2_freq[3:0]==7)

DeltaX_Hi	Address: 0x20

Access: Read **Default: --**

Bit	7	6	5	4	3	2	1	0
Field	DeltaX[15:8]							

Data Type: 8bit data

Usage: Only worked when DxDy_16bit is enabled. This byte provides high 8 bits motion data of X-axis. When using high CPI resolution, it is recommended to turn on 16bit data mode. DeltaX_Hi[7] is the sign bit.

DeltaY_Hi	Address: 0x21

Access: Read **Default: --**

Bit	7	6	5	4	3	2	1	0
Field	DeltaY[15:8]							

Data Type: 8bit data

Usage: Only worked when DxDy_16bit is enabled. This byte provides high 8 bits motion data of Y-axis. When using high CPI resolution, it is recommended to turn on 16bit data mode. DeltaY_Hi[7] is the sign bit.

CPI2_Setting	Address: 0x23

Access: Write/Read **Default: 0x02**

Bit	7	6	5	4	3	2	1	0
Field	CPI2_en	Rsv[6:4]			CPI2[3:0]			

Data Type: Bit Field

Usage: The register is used to enable the extend CPI resolutions configuration.

Field Name	Description
CPI2_en	**0: Using CPI(register Config)as configuration value(Default)** 1: **Using CPI2 as configuration value**
Rsv[6:4]	Reserved
CPI2[3:0]	0000=200CPI 0001=400CPI **0010=2000CPI(Default)** 0011=2400CPI 0100=3200CPI 0101: Reserved 0110: Reserved 0111=600CPI 1000=800CPI 1001=1000CPI 1010=1200CPI 1011=1600CPI 1100-1111: Reserved

PID3	Address: 0x49

Access: Read **Default: 0xA1**

Bit	7	6	5	4	3	2	1	0
Field	PID3[7:0]							

Data Type: 8bit unsigned integer

Usage: The register is used as a ID to check whether the chip is S202 or not.

9. Electrical Characteristic

9.1 Absolute Maximum Rating

Parameter	Symbol	Min	Max	Unit	Notes
Supply Voltage	V_{DD}	-0.5	3.6	V	
Operating Temperature	T_O	-20	70	℃	
Storage Temperature	T_S	-50	125	℃	
Lead Solder Temperature	T_{SOLDER}	-	260	℃	
Input Voltage	V_{in}	-0.5	VDD/VDDA	V	All I/O pins
ESD	V_{ESD}	-	2	KV	All pins, human body model

9.2 Recommend Operation Conditions

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Supply Voltage	V_{DD}	2.1	2.7	3.6	V	
Operating Temperature	T_O	0	-	40	℃	
Supply Noise	Vnpp	-	-	100	mV	Peak to Peak 10K~80MHz
Distance from the Bottom of Lens to the Working Surface	Z	2.1	2.2	2.3	mm	
SCLK Clock	Fsclk	-	-	1	MHz	
Resolution	R	200	-	3200	CPI	
Frame Rate	Fr	-	-	2500	FPS	
Speed	S	0	-	30	IPS	
Acceleration	A	0	-	8	g	

10. Typical application circuit(nRF24LE1+S202)

10.1 Typical application circuits (VDD:2.1~3.6V)

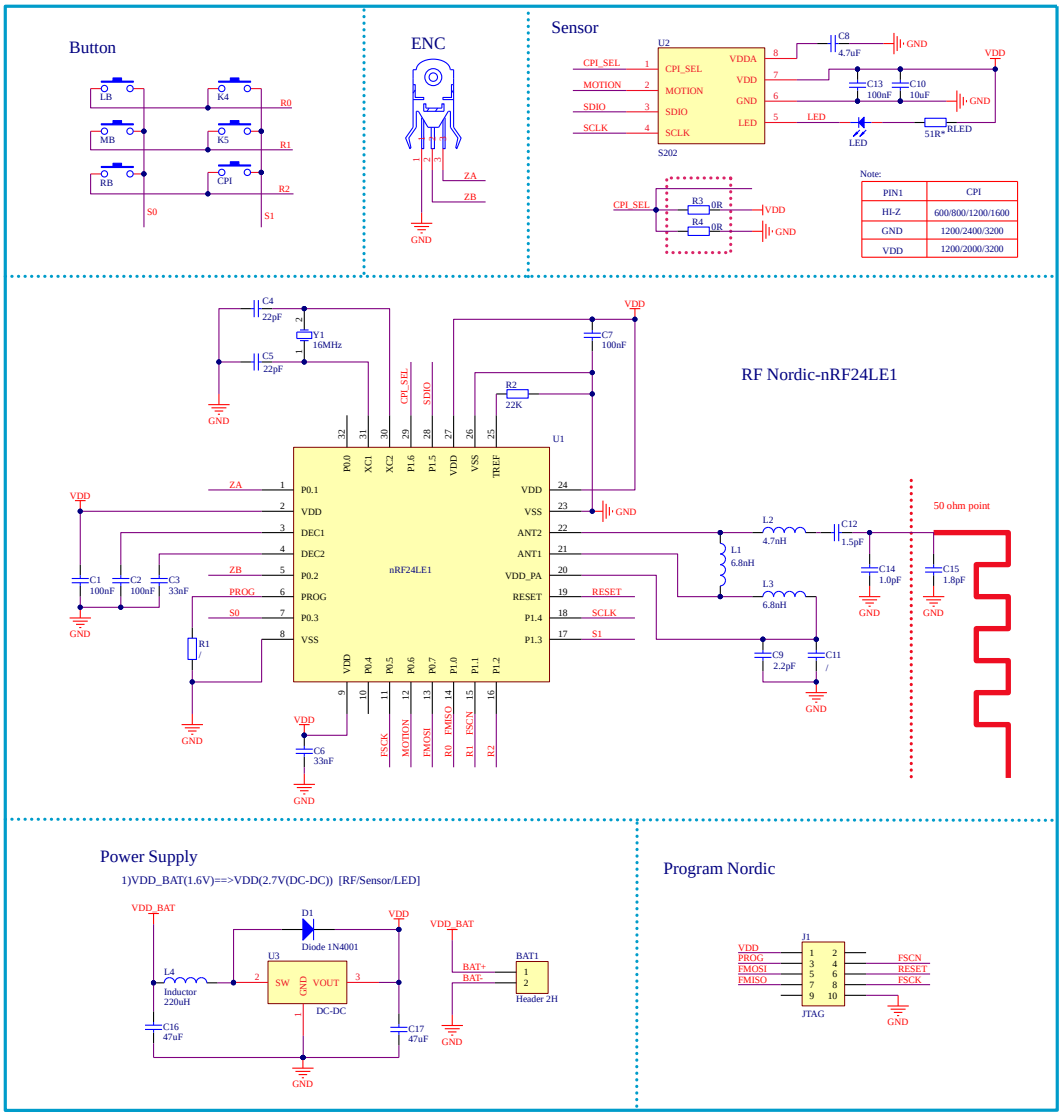
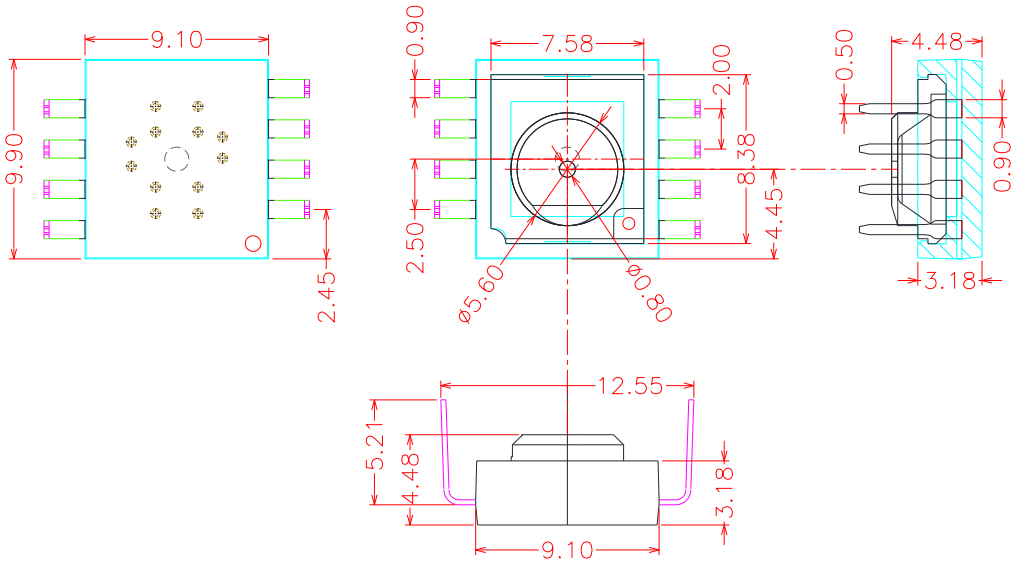
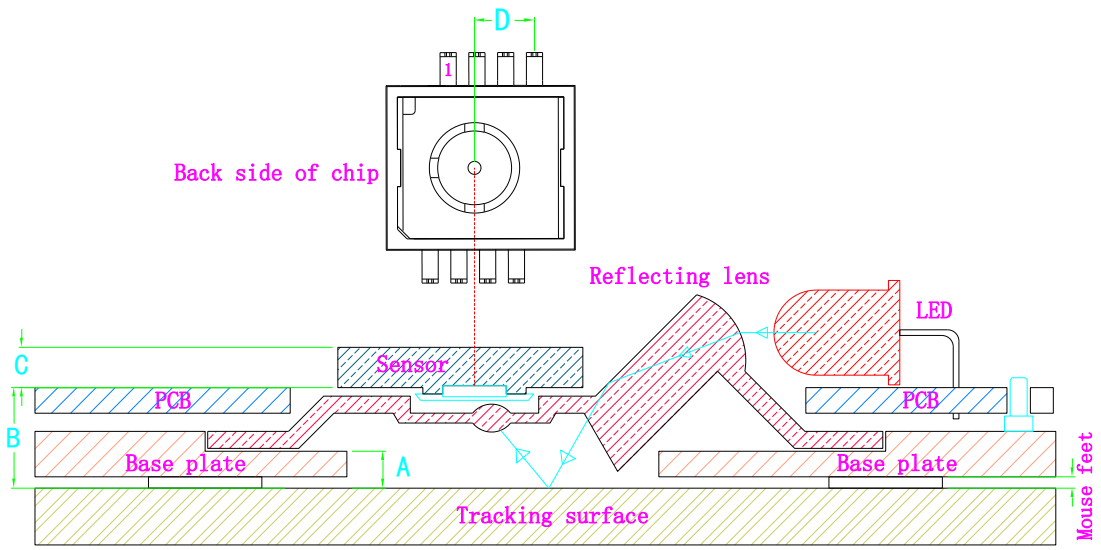


Figure 10-1 Typical Application circuit (VDD:2.1~3.6V)

11.Package


9.10
9.90
2.45
0.90
7.58
2.00
8.38
4.45
2.50
ø5.60
ø0.80
0.50
4.48
0.90
3.18
12.55
5.21
4.48
3.18
9.10

12. Assembly Drawing



Symbol	Description	Min	Typical	Max	Unit
A	Distance from the bottom of the lens to the desktop (Z-Height)	2.1	2.2	2.3	mm
B	The distance from the top of the PCB to the desktop	7.1	7.2	7.3	mm
C	The packaging thickness of the sensor	2.98	3.18	3.38	mm
D	The distance from the center of the light hole to pin4	-	4.0	-	mm

13.Revision

Versions	Date	Reviser	Description
S202_Spec_CN.V1.00	2023/10/27	Molly	Create Preliminary Version
S202_Spec_CN.V1.01	2024/8/28	Molly	Modify circuit diagram Delete 0x08 register Add CPI_SEL function description