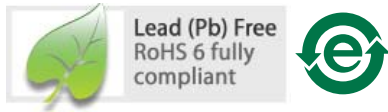


ADNS-5700

Optical Mouse Sensor



Data Sheet



Description

The ADNS-5700-XXXX is a compact, one chip USB optical mouse sensor for implementing a non-mechanical tracking engine for computer mice.

It is based on optical navigation technology that measures changes in position by optically acquiring sequential surface images (frames) and mathematically determining the direction and magnitude of movement.

The sensor is in a 18 -pin optical package that is designed to be used with the ADNS-5100-001 trim lens the ADNS-5200 Clip and the HLMP-EG3E-xxxxx LED. These parts provide a complete and compact mouse sensor. There are no moving parts, and precision optical alignment is not required, facilitating high volume assembly.

The output format is USB. This device meets HID Revision 1.11 specification and is compatible with USB Revision 2.0 specification.

Frame rate is varied internally to the sensor to achieve tracking and speed performance, eliminating the need for the use of many registers.

Default resolution is specified as 1000 counts per inch, with rates of motion up to 30 inches per second. Buttons and tilt wheel features are also available.

A complete mouse can be built with the addition of a PC board, switches and mechanical Z-wheel, plastic case and cable.

Theory of Operation

The ADNS-5700-XXXX is based on Optical Navigation Technology. It contains an Image Acquisition System (IAS), a Digital Signal Processor (DSP) and USB stream output.

The IAS acquires microscopic surface images via the lens and illumination system provided by the ADNS-5100-001 trim lens, ADNS-5200 clip and HLMP-EG3E-xxxxx LED. These images are processed by the DSP to determine the direction and distance of motion. The DSP generates the x and y relative displacement values which are converted to USB motion data.

Features

- Optical navigation technology
- Default resolution 1000cpi, selectable resolution 800cpi or 1200cpi through different part number
- High speed motion detection up to 30 inches per second (ips) and acceleration of 8g
- Accurate navigation over a wide variety of surfaces
- No precision optical alignment needed
- Wave Solderable
- Single 5.0 volt power supply
- Meets USB Revision 2.0 specification
- Meets HID Revision 1.11
- Tilt Wheel function
- Optical or Mechanical Z-Wheel function
- 12bits motion reporting
- 2 axis sensor rotation : 0° or 270°

Applications

- Mice for desktop PC's, Workstations, and portable PC's
- Trackballs
- Integrated input devices

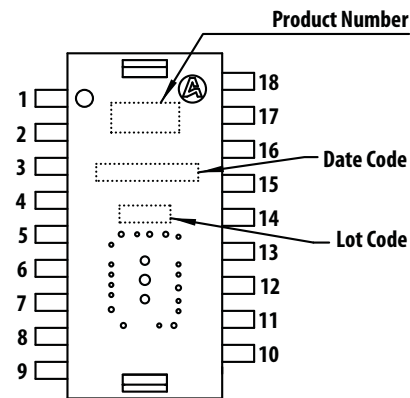
Pinout 18pin PDIP

ADNS-5700-XXXX

| Pin Number | 3 button | 5 button | |
|------------|------------------|------------------|------------------|
| | H3MB, H3NB | H4MB, H4NB | H5MD, H5ND |
| 1 | D + | D + | D + |
| 2 | D - | D - | D - |
| 3 | ZA | ZA | ZA |
| 4 | ZB | ZB | ZB |
| 5 | LED_GND | LED_GND | LED_GND |
| 6 | XY_LED | XY_LED | XY_LED |
| 7 | V _{DD5} | V _{DD5} | V _{DD5} |
| 8 | GND | GND | GND |
| 9 | REG0 | REG0 | REG0 |
| 10 | V _{DD3} | V _{DD3} | V _{DD3} |
| 11 | NC | TL | B4 |
| 12 | NC | TR | OSC_IN |
| 13 | GND | GND | GND |
| 14 | OSC_IN | OSC_IN | OSC_OUT |
| 15 | OSC_OUT | OSC_OUT | B3 |
| 16 | B3 | B3 | B2 |
| 17 | B2 | B2 | B1 |
| 18 | B1 | B1 | B5 |

Pin description table

| Pin Name | Description |
|-------------------------|-----------------------------------|
| D + | USB D+ line |
| D - | USB D- line |
| ZA | ZA Optical wheel quadrature input |
| ZB | ZB Optical wheel quadrature input |
| LED_GND | LED ground |
| XY_LED | XY_LED Input |
| V _{DD5} | 5 Volt Power (USB VBUS) |
| GND | System ground |
| ZLED | Z-Wheel LED input |
| REG0 / V _{DD3} | 3 Volt Power V _{DD3} |
| NC | No Connect |
| OSC_IN | Ceramic resonator input |
| OSC_OUT | Ceramic resonator output |
| B5 | Fifth Button |
| B4 | Fourth Button |
| B3 | Middle button input |
| B2 | Right button input |
| B1 | Left button input |



| Item | Marking | Remarks |
|----------------|---------|--|
| Product Number | A5700 | |
| Date Code | YYYWWZ | X = Subcon Code YYWW = Date Code Z = Sensor Die Source |
| Lot Code | VVV | Numeric |

Figure 1a. Package pinout

Note : See table for Part number marking

DISCLAIMER: ALL DESIGNERS AND MANUFACTURERS OF THIS DESIGN MUST ASSURE THAT THEY HAVE ALL NECESSARY INTELLECTUAL PROPERTY RIGHTS.

Strap (Jumper) Table

The PID/string strap matrix is the following:

| Part Number | Description | Resolution (dpi) | Buttons | Tilt Wheel | Z-Wheel | Sensor Position | VID | PID | Mfg String | Product String |
|----------------|--------------------|------------------|---------|------------|------------|-----------------|--------|--------|------------|-------------------|
| ADNS-5700-H3MB | Standard 3 buttons | 1000 | 3 | No | Mechanical | 0° | 0x192F | 0x0416 | Null | USB Optical Mouse |
| ADNS-5700-H4MB | Standard 3 buttons | 1000 | 3 | TW | Mechanical | 0° | 0x192F | 0x0416 | Null | USB Optical Mouse |
| ADNS-5700-H5MD | Standard 5 buttons | 1000 | 5 | No | Mechanical | 0° | 0x192F | 0x0616 | Null | USB Optical Mouse |
| ADNS-5700-H3NB | Standard 3 buttons | 1000 | 3 | No | Mechanical | 270° | 0x192F | 0x0416 | Null | USB Optical Mouse |
| ADNS-5700-H4NB | Standard 3 buttons | 1000 | 3 | TW | Mechanical | 270° | 0x192F | 0x0416 | Null | USB Optical Mouse |
| ADNS-5700-H5ND | Standard 5 buttons | 1000 | 5 | No | Mechanical | 270° | 0x192F | 0x0616 | Null | USB Optical Mouse |

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The XY motion reporting direction when is lens is attached to the sensor is shown in Fig 1b for 0° and Fig 1c for 270° sensor orientation.

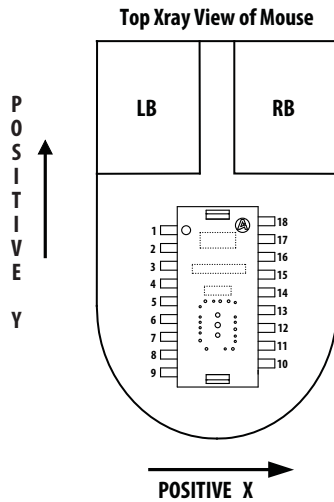


Figure 1b. Package pinout at 0°

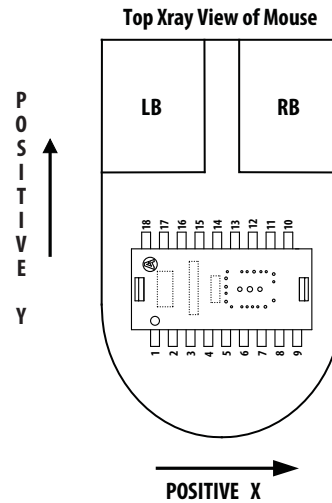


Figure 1c. Package pinout at 270°

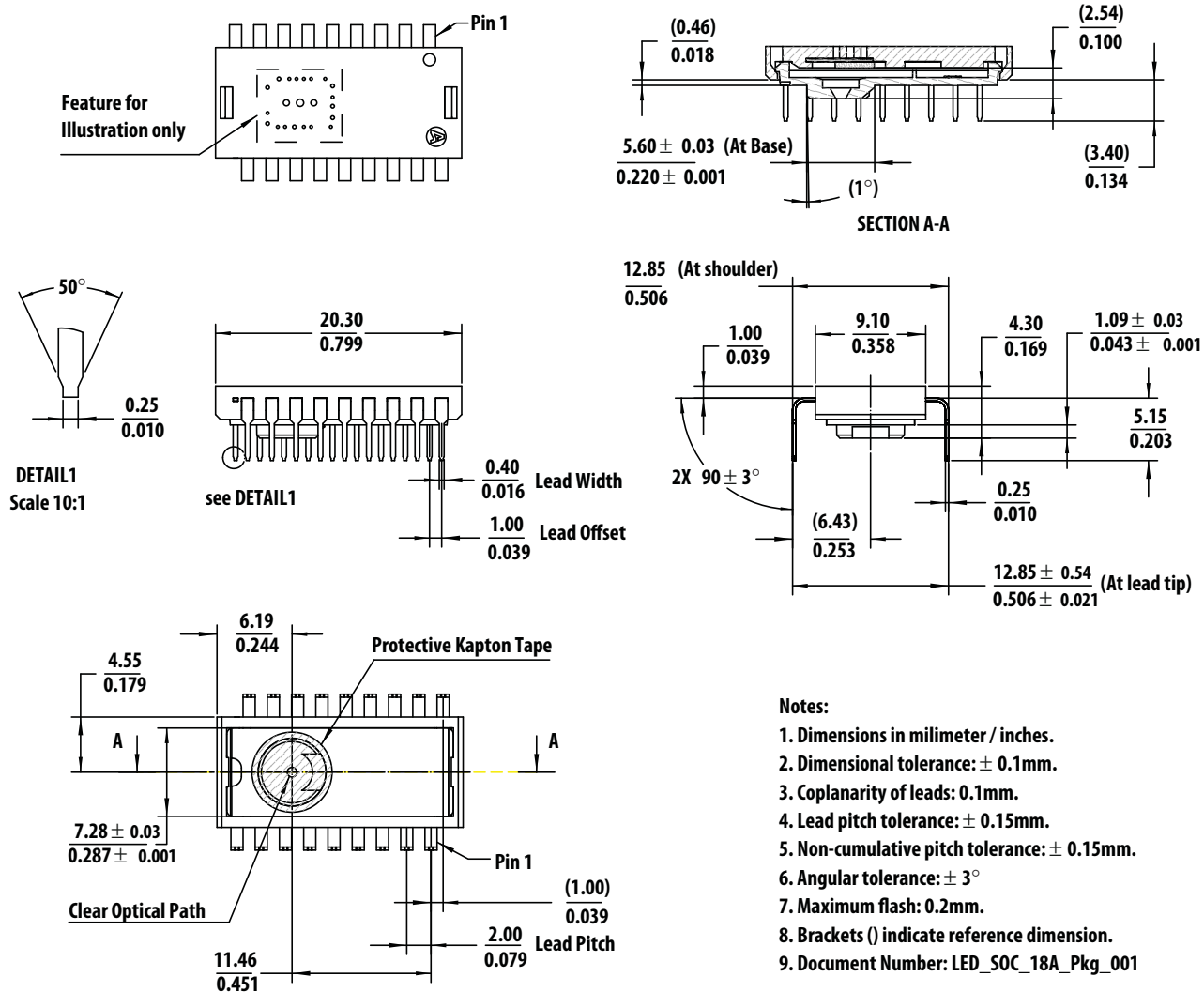
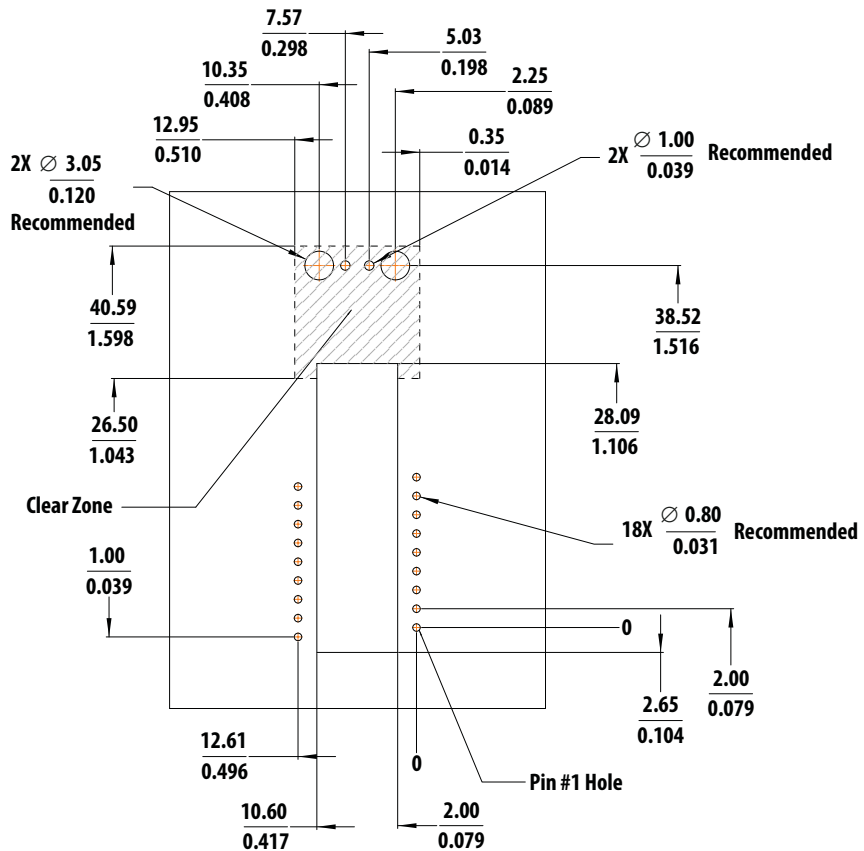


Figure 2. Package outline drawing

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.



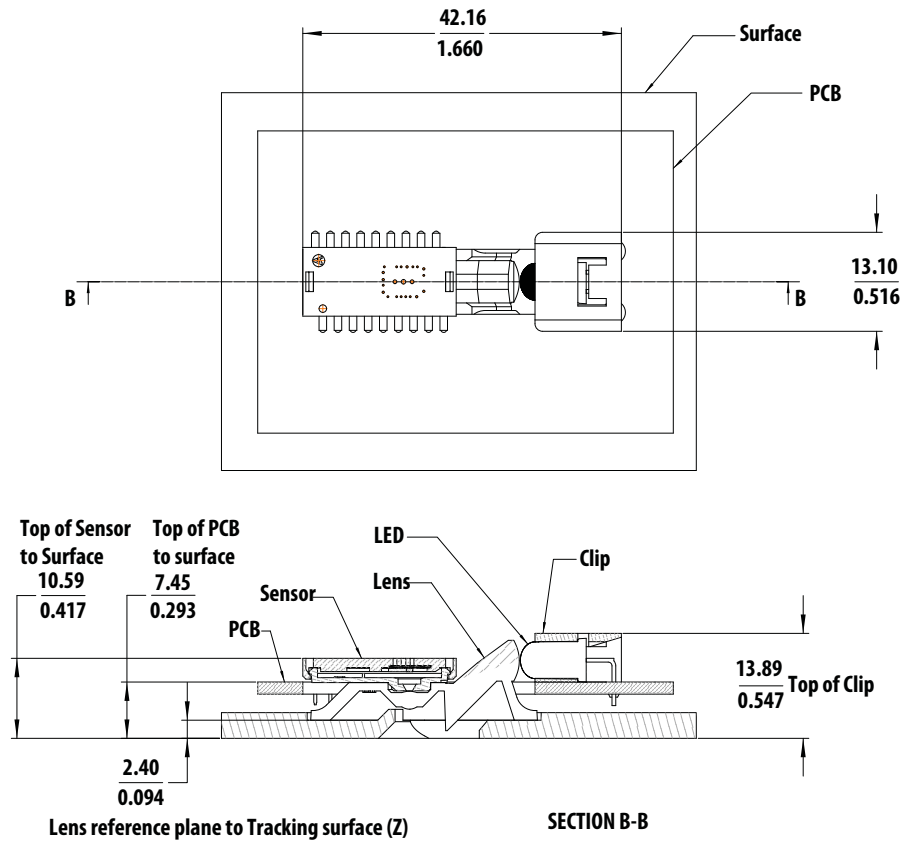
Notes:

1. Dimensions in millimeter / inches and for reference only.

Figure 3. Recommended PCB mechanical cutouts and spacing (Top view)

Note: The recommended pin hole dimension of the sensor is 0.7 mm.
Shown with ADNS-5100-001 trim lens, ADNS-5200 clip and HLMP-EG3E-xxxxx.

Avago Technologies provides an IGES file drawing describing the base plate molding features for lens and PCB alignment. Stand-off of the base plate shall not be larger than 5mm.



Notes:

1. All dimensions in millimeters/inches.
2. All tolerance ± 0.1 mm.

Figure 4. 2D assembly drawing of ADNS-5700-XXXX

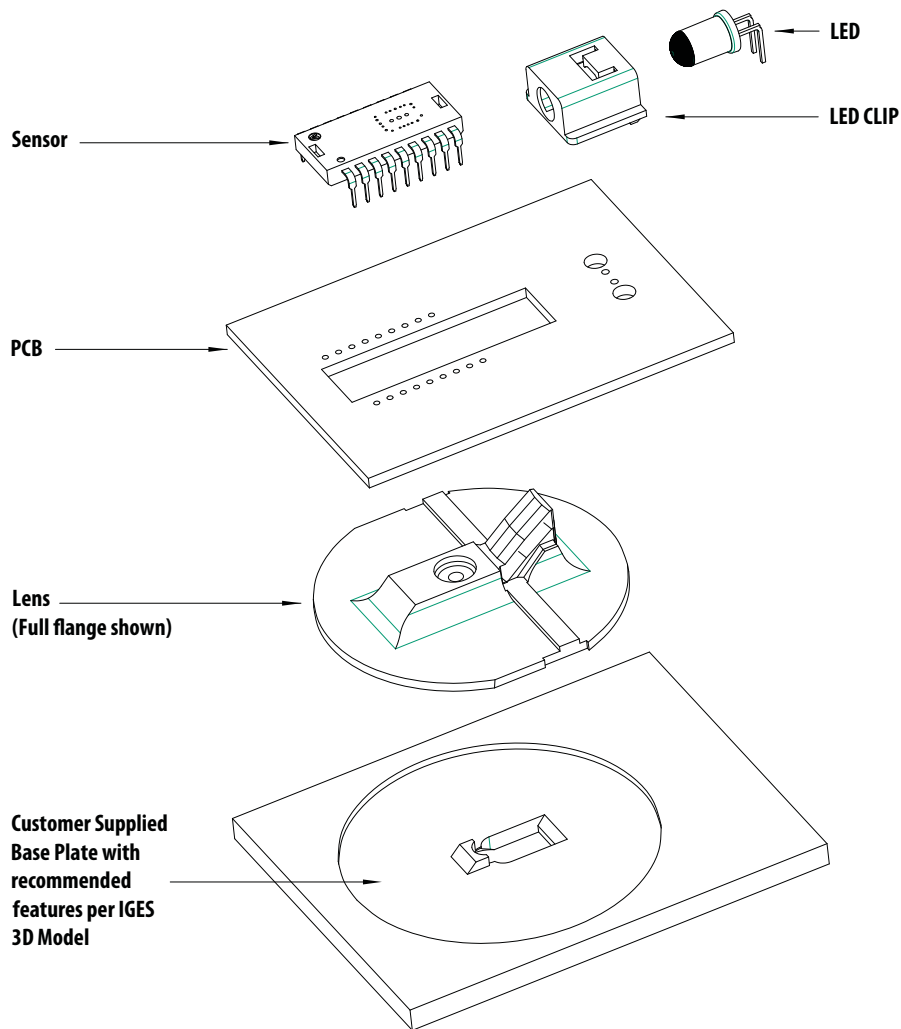


Figure 5. Exploded view drawing

The components interlock as they are mounted onto defined features on the base plate.

The ADNS-5700 sensor is designed for mounting on a through hole PCB, looking down. The aperture stop and features on the package align it to the lens (See figure 3).

The ADNS-5100-001 trim lens provides optics for the imaging of the surface as well as illumination of the surface at the optimum angle. Lens features align it to the sensor, base plate, and clip with the LED.

The ADNS-5200 clip holds the LED in relation to the lens. The LED must be inserted into the clip and the LED's leads formed prior to loading on the PCB. The clip interlocks the sensor to the lens, and through the lens to the alignment features on the base plate.

The HLMP-EG3E-xxxxx LED is recommended for illumination.

Block Diagram

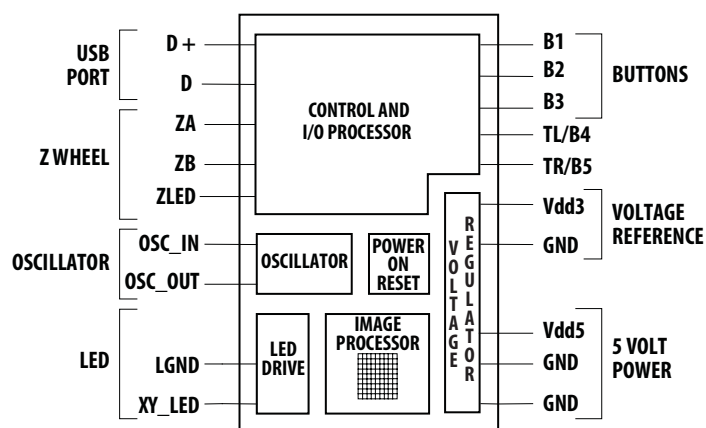


Figure 6. Block Diagram

PCB Assembly Considerations

1. Insert the sensor and all other electrical components into PCB.
2. Bend the LED leads 90 degrees and then insert the LED into the assembly clip until the snap feature locks the LED base.
3. Insert the LED/clip assembly into PCB.
4. This sensor package is only qualified for wave-solder process.
5. 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. A solder fixture MUST be used to set the correct sensor to PCB distance.
6. Place the lens onto the base plate.
7. Remove the protective Kapton tape from optical aperture of the sensor. Care must be taken to keep contaminants from entering the aperture. Recommend not placing the PCB facing up during the entire mouse assembly process. Recommend to hold the PCB first vertically for the Kapton removal process.
8. Insert PCB assembly over the lens onto base plate aligning post to retain PCB assembly. The sensor aperture ring should self-align to the lens.
9. 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.
10. Install mouse top case. There MUST be feature in the top case to press down onto the clip to ensure all components are interlocked to correct vertical height

Design considerations for improving ESD Performance

The table below shows typical values assuming base plate construction per the Avago Technologies supplied IGES file and ADNS-5100-001 trim lens. Stand-off of the base plate shall not be larger than 5mm.

| Typical Distance | ADNS-5100-001 |
|------------------|---------------|
| Creepage | 17.9mm |
| Clearance | 9.2mm |

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

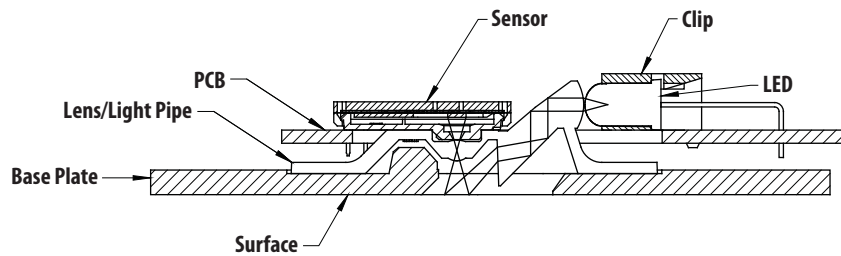


Figure 7. Typical Application

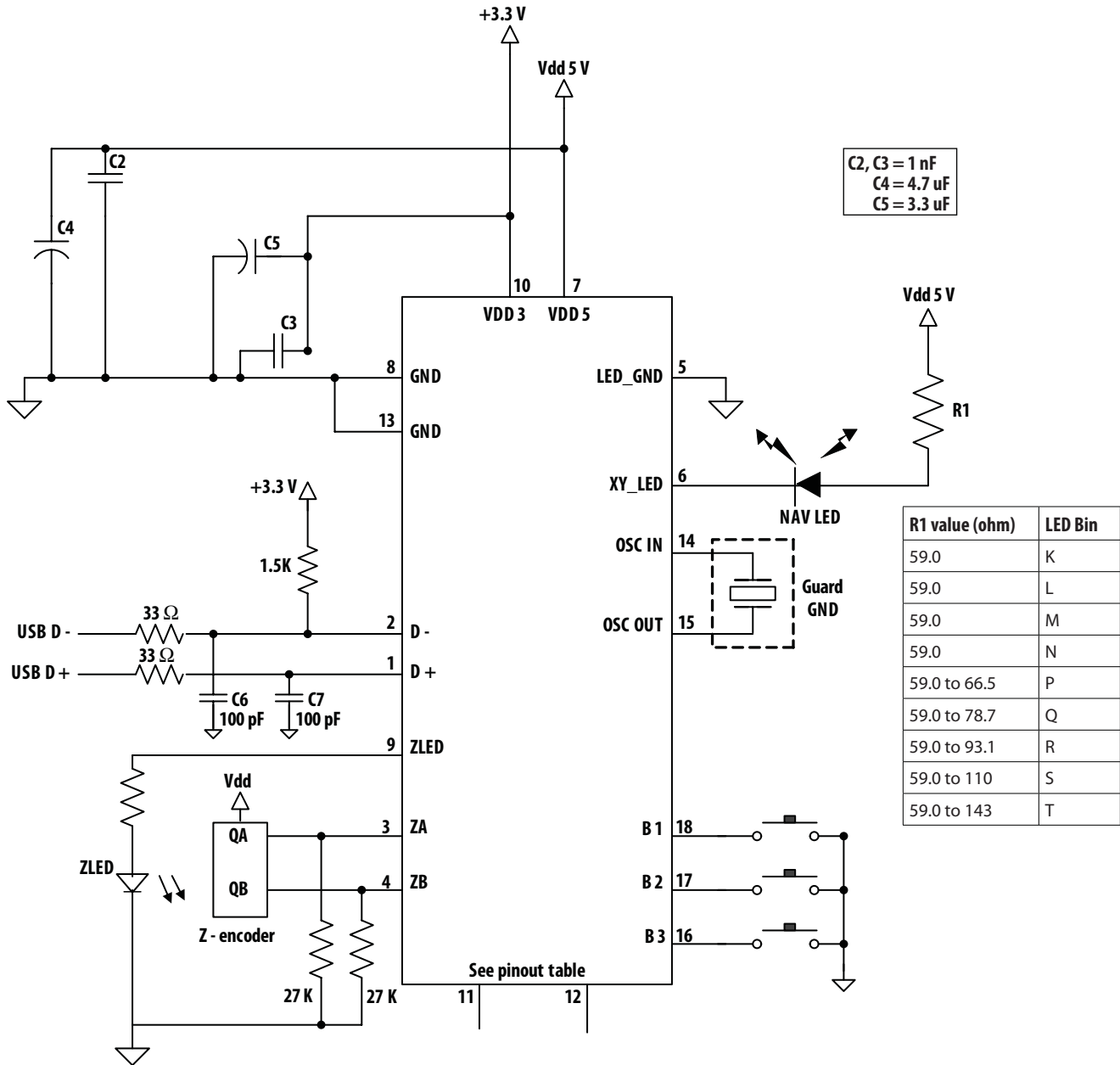


Figure 8a. Application Circuit with ADNS-5700-HxxB with Optical Z-Wheel

DISCLAIMER: ALL DESIGNERS AND MANUFACTURERS OF THIS DESIGN MUST ASSURE THAT THEY HAVE ALL NECESSARY INTELLECTUAL PROPERTY RIGHTS.

Notes:

- All caps (except C4) MUST be as close to the sensor pins as possible.
- C3 and C5 connected to pin 10 must be terminated at pin 13.
- Caps should be ceramic.
- Caps should have less than 5 nH of self inductance.
- Caps connected to VDD3 MUST have less than 0.2Ω ESR.
- 1.5k resistor should be ± 1% tolerance.

Surface mount parts are recommended.

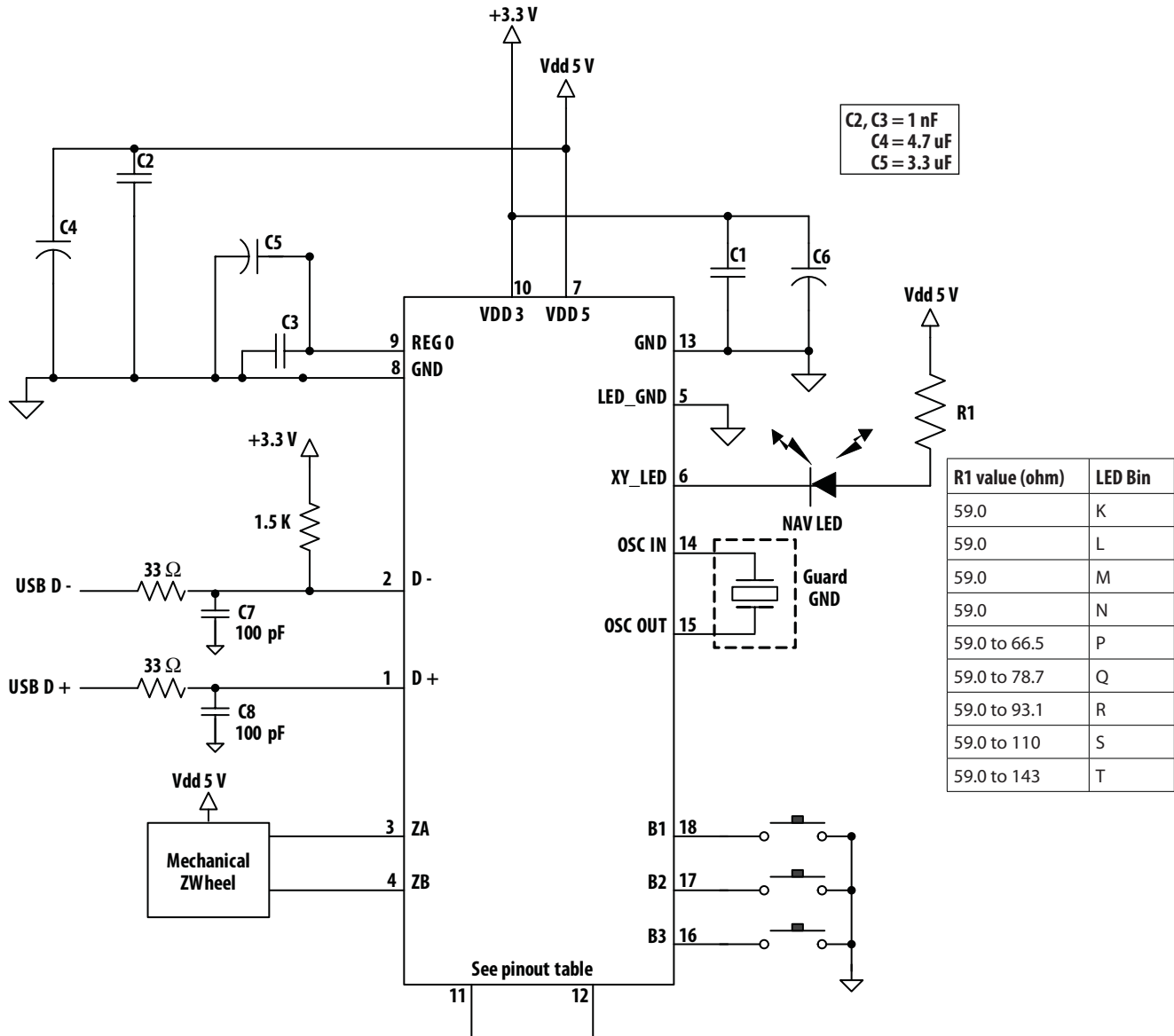


Figure 8b. Application Circuit with ADNS-5700-HxxB with Mechanical Z-Wheel

DISCLAIMER: ALL DESIGNERS AND MANUFACTURERS OF THIS DESIGN MUST ASSURE THAT THEY HAVE ALL NECESSARY INTELLECTUAL PROPERTY RIGHTS.

Notes:

- All caps (except C4) MUST be as close to the sensor pins as possible.
- C1 and C6 connected to pin 10 must be terminated at pin 13.
- C3 and C5 connected to pin 9 must be terminated at pin 8.
- Caps should be ceramic.
- Caps should have less than 5 nH of self inductance.
- Caps connected to VDD3 MUST have less than 0.2Ω ESR.
- 1.5k resistor should be ± 1% tolerance.

Surface mount parts are recommended.

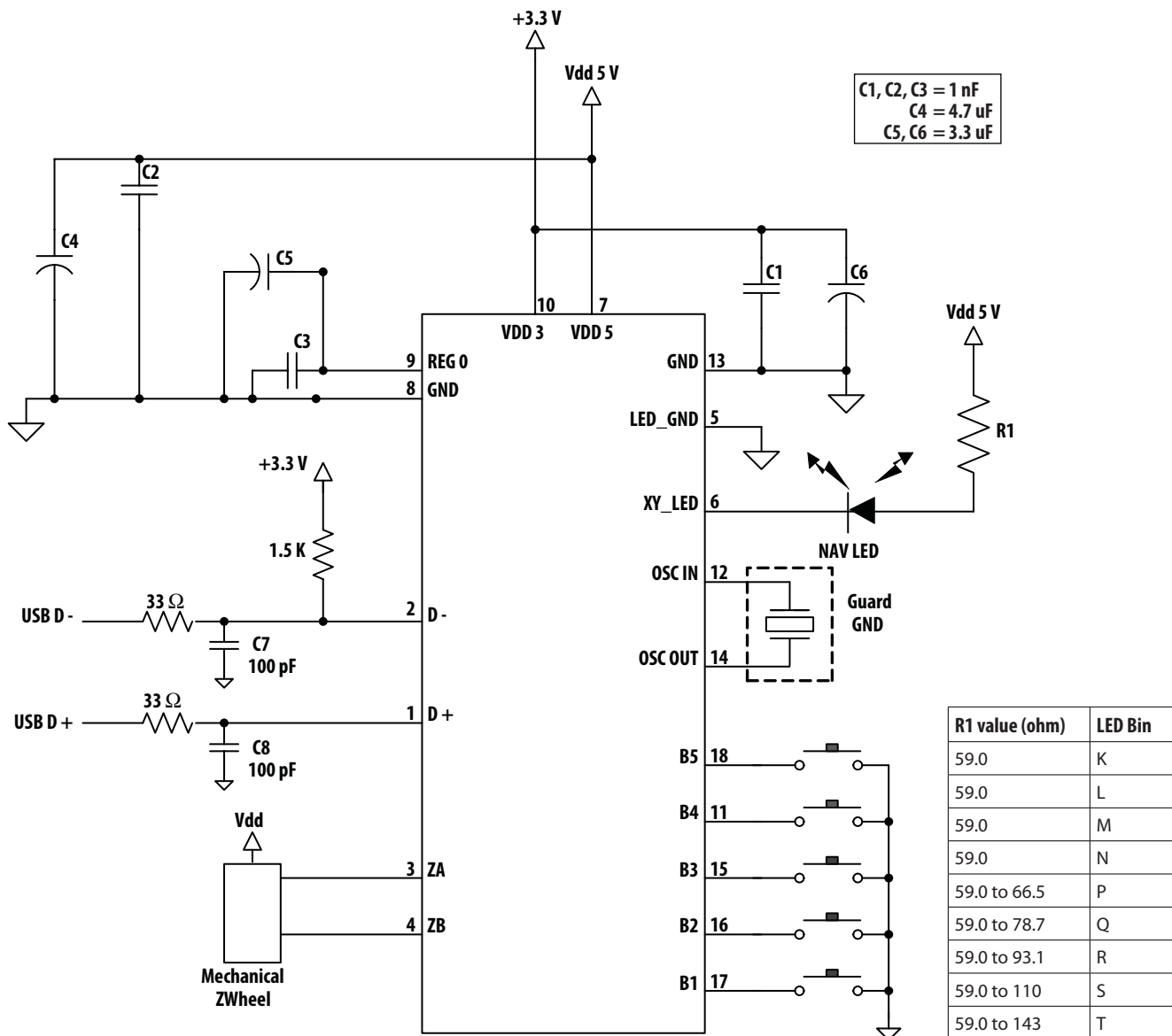


Figure 8c. Application Circuit with ADNS-5700-H5MD and ADNS-5700-H5ND with 5 Button and Mechanical Z-Wheel

DISCLAIMER: ALL DESIGNERS AND MANUFACTURERS OF THIS DESIGN MUST ASSURE THAT THEY HAVE ALL NECESSARY INTELLECTUAL PROPERTY RIGHTS.

Notes:

- All caps (except C4) MUST be as close to the sensor pins as possible.
- C1 and C6 connected to pin 10 must be terminated at pin 13.
- C3 and C5 connected to pin 9 must be terminated at pin 8.
- Caps should be ceramic.
- Caps should have less than 5 nH of self inductance.
- Caps connected to VDD3 MUST have less than 0.2Ω ESR.
- 1.5k resistor should be ± 1% tolerance.

Regulatory Requirements

- Passes FCC B and worldwide analogous emission limits when assembled into a mouse with shielded cable and following Avago Technologies recommendations.
- Passes EN61000-4-4/IEC801-4 EFT tests when assembled into a mouse with shielded cable and following Avago Technologies recommendations.
- UL flammability level UL94 V-0.
- Provides sufficient ESD creepage/clearance distance to withstand discharge up to 15kV when assembled into a mouse with lens according to usage instructions above.

Absolute Maximum Ratings

| Parameter | Symbol | Minimum | Maximum | Units | Notes |
|-----------------------------|-----------------|---------|----------------------|-------|--|
| Storage Temperature | T _S | -40 | 85 | °C | |
| Operating Temperature | T _A | -15 | 55 | °C | |
| Lead Solder Temp | | | 260 | °C | For 7 seconds, 1.6mm below seating plane. |
| Supply Voltage | V _{DD} | -0.5 | 5.5 | V | |
| ESD | | | 2 | kV | All pins, JESD22-A114 |
| Input Voltage | V _{IN} | -0.5 | V _{DD} +0.5 | V | All I/O pins except OSC_IN and OSC_OUT, D+, D- |
| Input Voltage | V _{IN} | -1.0 | 4.6 | V | D+, D-, AC waveform, see USB specification (7.1.1) |
| Input Voltage | V _{IN} | -0.5 | 3.6 | V | OSC_IN and OSC_OUT |
| Input Short Circuit Voltage | V _{SC} | 0 | V _{DD} | V | D+, D-, see USB specification (7.1.1) |

Recommended Operating Conditions

| Parameter | Symbol | Minimum | Typical | Maximum | Units | Notes |
|---|------------------|---------|---------|---------|-------|---|
| Operating Temperature | T _A | 0 | | 40 | °C | |
| Power supply voltage | V _{DD} | 4.25 | 5.0 | 5.25 | Volts | For accurate navigation and proper USB operation |
| Power supply voltage | V _{ddm} | 4 | 5.0 | 5.25 | Volts | Maintains communication to USB host and internal register contents. |
| Power supply rise time | V _{RT} | 0.003 | | 100 | ms | |
| Supply noise | V _N | | | 100 | mV | Peak to peak within 0-80 MHz bandwidth |
| Velocity | V _{el} | | 30 | | ips | |
| Acceleration | Acc | | | 8 | g | 0.5g from Rest |
| Clock Frequency | f _{clk} | 23.64 | 24 | 24.36 | MHz | Due to USB timing constraints |
| Resonator Impedance | X _{RES} | | | 55 | Ω | |
| Distance from lens reference plane to surface | Z | 2.3 | 2.4 | 2.5 | mm | See Figure 9 |
| Frame Rate | | | 4000 | | fps | Internally adjusted by sensor |

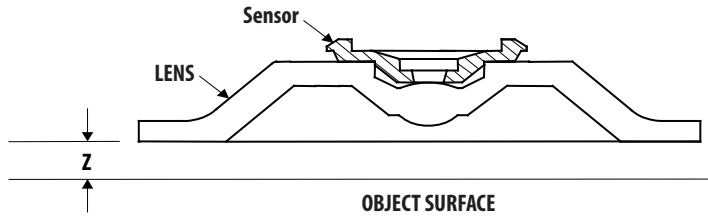


Figure 9. Distance from lens reference plane to object surface

AC Electrical Specifications

Electrical Characteristics over recommended operating conditions. Typical values at 25°C, $V_{DD}=5.0\text{ V}$

| Parameter | Symbol | Min. | Typical | Max. | Units | Notes |
|--|---------------|------|---------|------|---------------|---|
| Wakeup delay from rest mode due to motion. | T_{WUPP} | | | 2 | ms | |
| Power up delay | T_{PUP} | | | 50 | ms | |
| Debounce delay on button inputs | T_{DBB} | 5 | 10 | 17 | ms | “Maximum” specified at 8ms polling rate. |
| Scroll wheel sampling period | T_{SW} | 150 | 200 | 300 | μs | ZA PIN for optical scroll wheel |
| | | 1.9 | 2.0 | 2.8 | ms | ZA PIN for mechanical scroll wheel |
| Transient Supply Current | I_{DDT} | | | 60 | mA | Max. supply current during a V_{DD} ramp from 0 to 5.0 V with $> 500\text{ }\mu\text{s}$ rise time. Does not include charging currents for bypass capacitors. |
| Input Capacitance (OSC Pins) | C_{OSC_IN} | | 50 | | pF | OCS_IN, OSC_OUT to GND |

USB Electrical Specifications

Electrical Characteristics over recommended operating conditions.

| Parameter | Symbol | Min. | Max. | Units | Notes |
|--------------------------------------|------------|------|------|-------|---|
| Output Signal Crossover Voltage | V_{CRS} | 1.5 | 2.0 | V | $C_L = 200\text{ to }600\text{ pF}$ (see Figure 10) |
| Input Signal Crossover Voltage | V_{ICRS} | 1.2 | 2.1 | V | $C_L = 200\text{ to }600\text{ pF}$ (see Figure 10) |
| Output High | V_{OH} | 2.8 | 3.6 | V | with 15 kohm to Ground and 7.5 k Ω to Vbus on D- (see Figure 11) |
| Output Low | V_{OL} | 0.0 | 0.3 | V | with 15 kohm to Ground and 7.5 k Ω to Vbus on D- (see Figure 11) |
| Single Ended Input | V_{SEI} | | 0.8 | V | |
| Input High (Driven) | V_{IH} | 2.0 | | V | |
| Input High (Floating) | V_{IHZ} | 2.7 | 3.6 | V | |
| Input Low | V_{IL} | | 0.8 | V | 7.5k Ω to V_{DD5} |
| Differential Input Sensitivity | V_{DI} | 0.2 | | V | $ (D+)-(D-) $ See Figure 12 |
| Differential Input Common Mode Range | V_{CM} | 0.8 | 2.5 | V | Includes V_{DI} , See Figure 12 |
| Single Ended Receiver Threshold | V_{SE} | 0.8 | 2.0 | V | |
| Transceiver Input Capacitance | C_{IN} | | 12 | pF | D+ to V_{BUS} , D- to V_{BUS} |

USB Timing Specifications

Timing Specifications over recommended operating conditions.

| Parameter | Symbol | Min. | Max. | Units | Notes |
|--|--------------|--------|--------|---------|--|
| D+/D- Transition rise time | T_{LR} | 75 | | ns | $C_L = 200$ pF (10% to 90%), see Figure 10 |
| D+/D- Transition rise time | T_{LR} | | 300 | ns | $C_L = 600$ pF (10% to 90%), see Figure 10 |
| D+/D- Transition fall time | T_{LF} | 75 | | ns | $C_L = 200$ pF (90% to 10%), see Figure 10 |
| D+/D- Transition fall time | T_{LF} | | 300 | ns | $C_L = 600$ pF (90% to 10%), see Figure 10 |
| Rise and Fall time matching | T_{LRFM} | 80 | 125 | % | T_R/T_F ; $C_L = 200$ pF; Excluding the first transition from the Idle State |
| Wakeup delay from USB suspend mode due to buttons push | T_{WUPB} | | 17 | ms | Delay from button push to USB operation Only required if remote wakeup enabled |
| Wakeup delay from USB suspend mode due to buttons push until accurate navigation | T_{WUPN} | | 50 | ms | Delay from button push to navigation operation Only required if remote wakeup enabled |
| USB reset time | T_{reset} | 18.7 | | μ s | |
| Data Rate | t_{LDRATE} | 1.4775 | 1.5225 | Mb/s | Average bit rate, 1.5 Mb/s +/- 1.5% |
| Receiver Jitter Tolerance | t_{DJR1} | -75 | 75 | ns | To next transition, see Figure 13 |
| Receiver Jitter Tolerance | t_{DJR2} | -45 | 45 | ns | For paired transitions, see Figure 13 |
| Differential to EOP Transition Skew | t_{LDEOP} | -40 | 100 | ns | See Figure 14 |
| EOP Width at Receiver | t_{LEOPR} | 670 | | ns | Accepts EOP, see Figure 14 |
| Source EOP Width | t_{LEOPT} | 1.25 | 1.50 | μ s | |
| Width of SE0 interval during Differential Transition | t_{LST} | | 210 | ns | See Figure 11 |
| Differential Output Jitter | t_{UDJ1} | -95 | 95 | ns | To next transition, see Figure 15 |
| Differential Output Jitter | t_{UDJ2} | -150 | 150 | | For paired transitions, see Figure 15 |

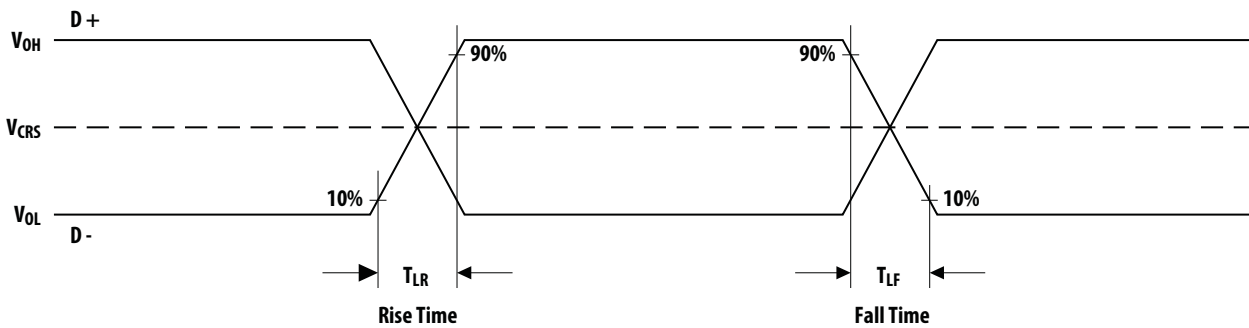


Figure 10. Data Signal Rise and Fall Times

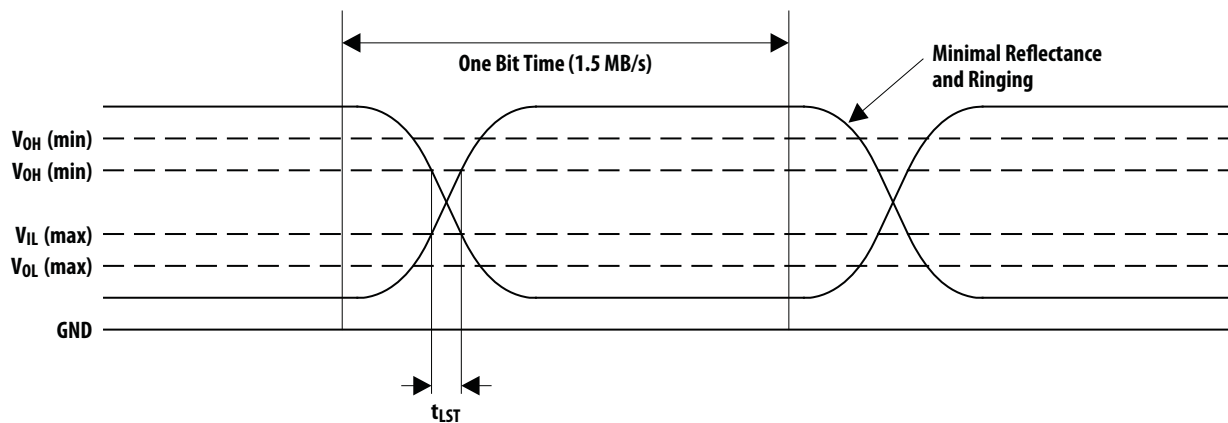


Figure 11. Data Signal Voltage Levels

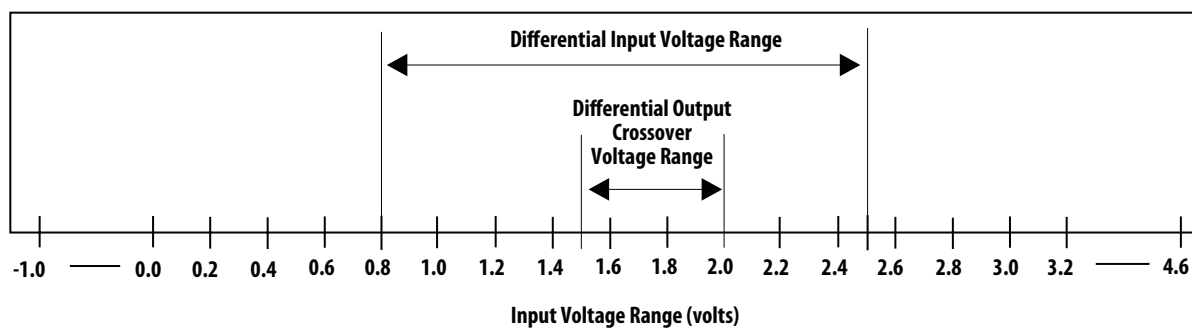


Figure 12. Differential Receiver Input Sensitivity vs. Common Mode Input Range

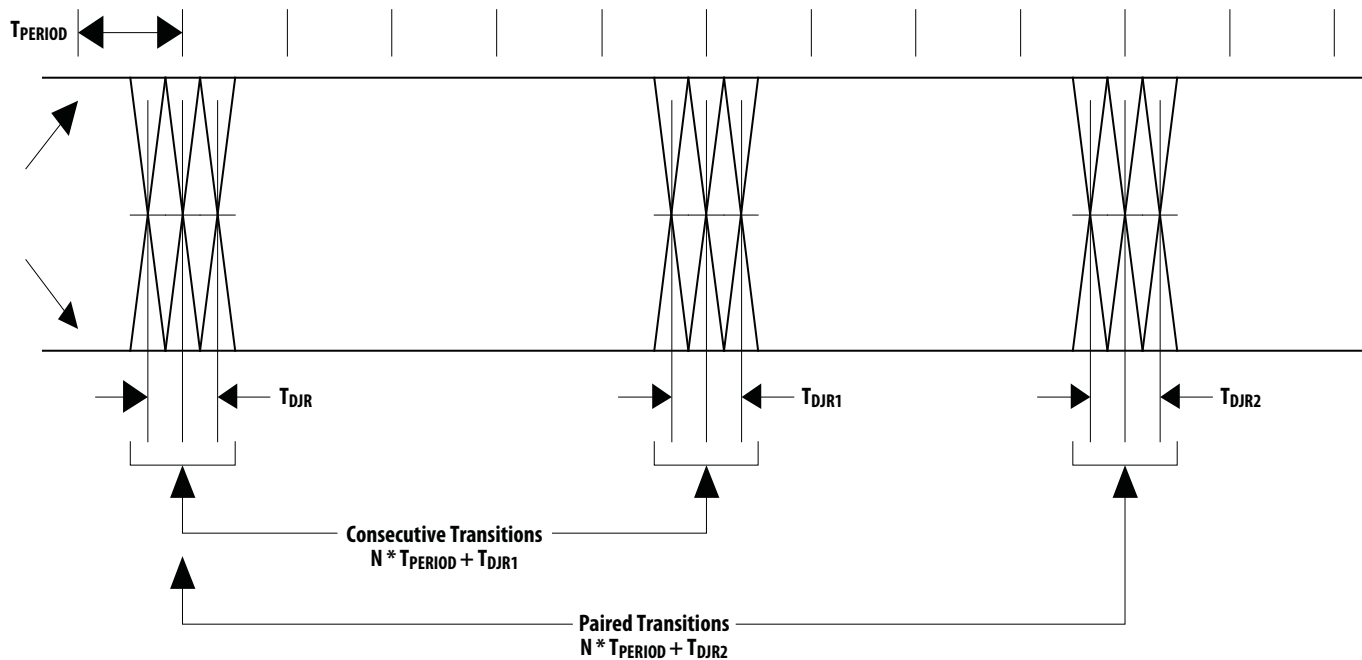


Figure 13. Receiver Jitter Tolerance

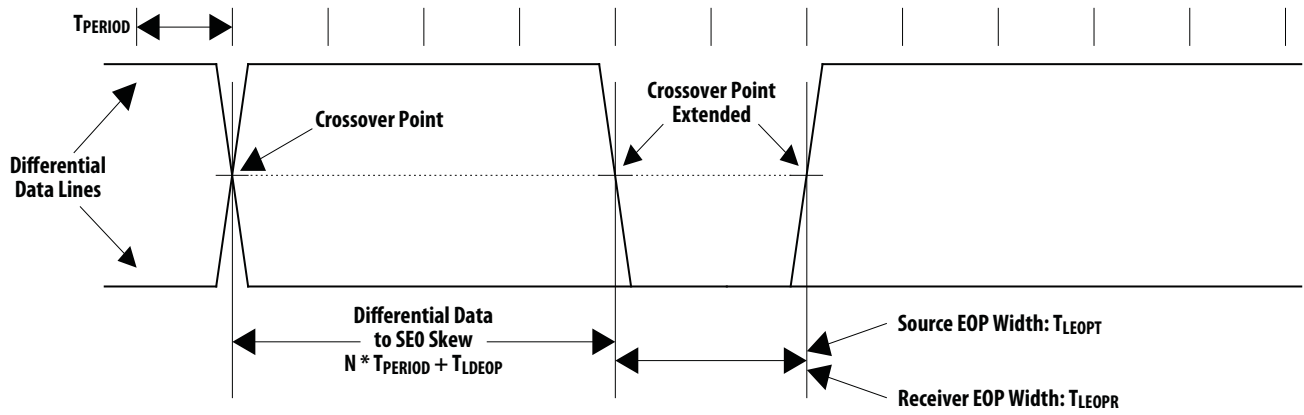


Figure 14. Differential to EOP Transition Skew and EOP Width

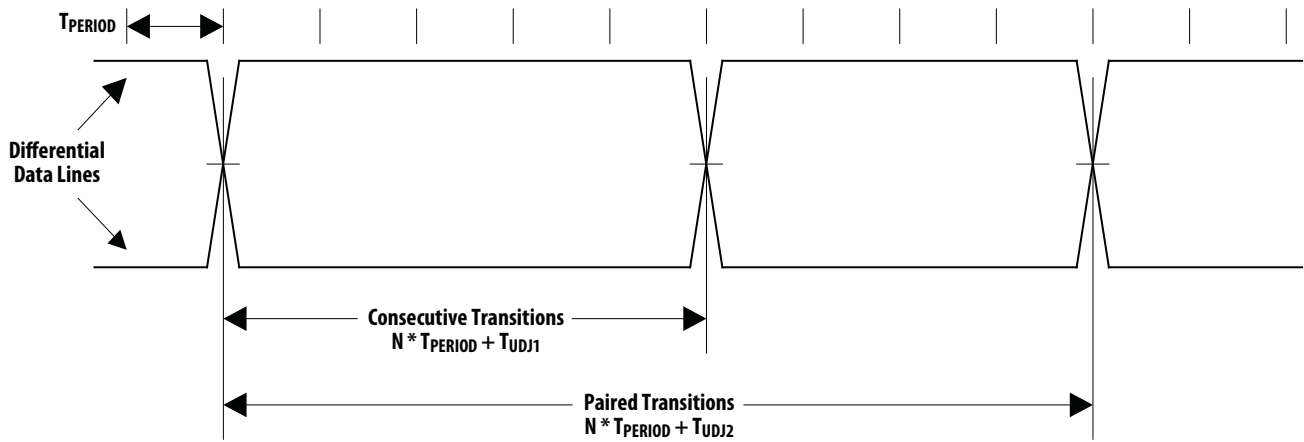


Figure 15. Differential Output Jitter

DC Electrical Specifications

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

| Parameter | Symbol | Minimum | Typical | Maximum | Units | Notes |
|---|------------|--------------------|---------|---------|---------|---|
| System Current, mouse moving | I_{DD5} | | | 100 | mA | Includes XY_LED current |
| System Current, mouse not moving | I_{DD5N} | | | 100 | mA | Includes XY_LED current |
| System current, USB suspend mode, Remote Wakeup Enabled | I_{DD5S} | | | 500 | μ A | Includes XY_LED current and D- pullup resistor. |
| Supply current (Sensor only), mouse moving | I_{DD5} | | 12 | 15 | mA | No load on B1-B5, XY-LED, ZA, ZB, D+, D- |
| Supply current (Sensor only), mouse not moving | I_{DD5N} | | 11 | 14 | mA | No load on B1-B5, XY-LED, ZA, ZB, D+, D- |
| Sensor supply current, USB suspend mode | I_{DD5S} | | | 260 | μ A | No load on B1-B5, XY-LED, ZA, ZB, D+, D- |
| XY_LED current | I_{LED} | | 40 | 49 | mA | Typical at R_{bin} 59ohm with binP LED. Maximum DC current allowed through XY_LED pin and LED. |
| XY_LED Output Low Voltage | V_{OL} | | | 1.1 | V | Refer to Figure 16 |
| Input Low Voltage | V_{IL} | | | 0.5 | V | Pins: ZA, ZB, B1-B5, V_{IL} max of $0.5V_{DC}$ is at V_{DD} min of $4V_{DC}$, with a typical of $0.8V_{DC}$ at V_{DD} of $5V_{DC}$ |
| Input High Voltage | V_{IH} | $0.6 \cdot V_{DD}$ | | | V | Pins: ZA, ZB, B1-B5 |
| Input Hysteresis | V_{HYST} | | 285 | | mV | Pins: B1-B5, OPT 0, OPT 1 |
| Button Pull Up Current | B_{IOUT} | 125 | 275 | 500 | μ A | Pins: B1-B5, OPT 0, OPT 1 |

Buttons

The minimum time between button presses is T_{DBB} . Buttons B1 through B5 are connected to a Schmidt trigger input with 100 μ A current sources pulling up to +3 volts during normal, sleep and USB suspend modes.

Debounce Algorithm

- Button inputs B1, B2, B3, B4, B5 are sampled every 2ms.
- Three consecutive low create a button press event.
- Three consecutive high create a button release event.

Typical Performance Characteristics

Performance Characteristics over recommended operating conditions. Typical values at 25 °C, $V_{DD}=5.0$ V, 24MHz

| Parameter | Symbol | Minimum | Typical | Maximum | Units | Notes |
|------------------------|-------------|---------|---------|---------|-------|---|
| Path Error (Deviation) | P_{Error} | | 0.5 | | % | Average path error as percent of total 2.5" travel on various standard surfaces |

The following graphs are the typical performance of the ADNS-5700 sensor, assembled as shown in the 2D assembly drawing with the ADNS-5100-001 trim lens/Prism, the ADNS-5200 clip, and the HLMP-EG3E-xxxxx LED.

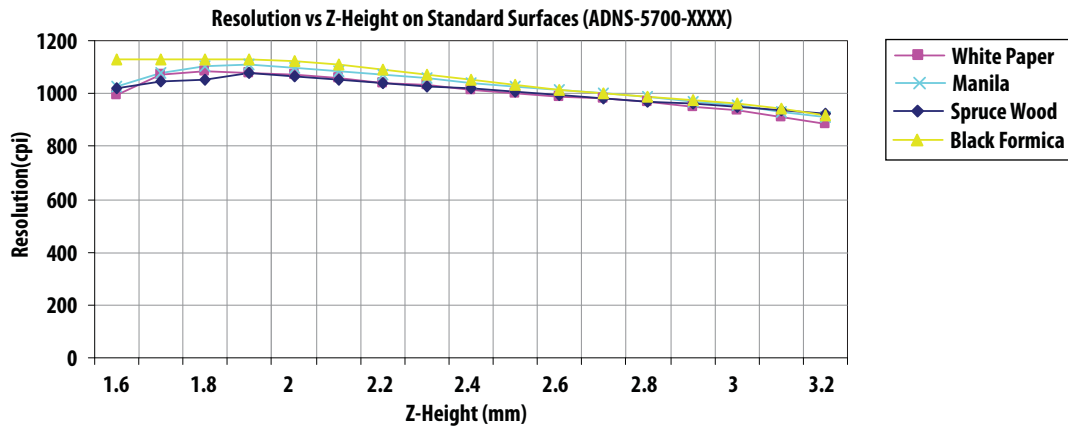


Figure 16. Typical Resolution vs. Z Height

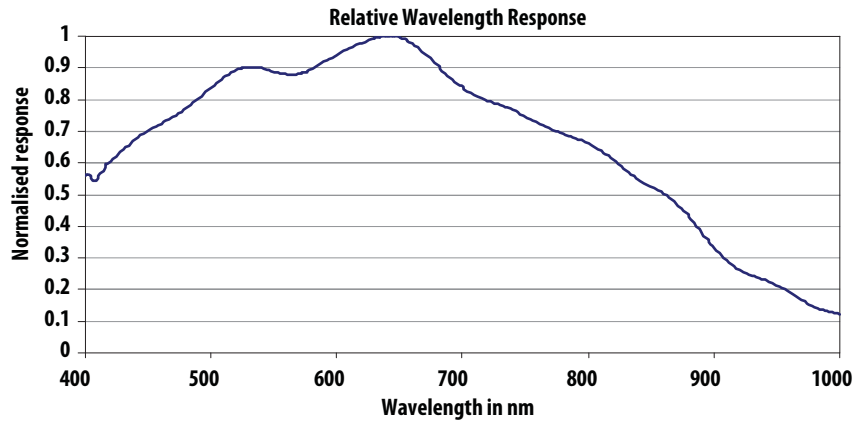


Figure 17. Wavelength responsivity.^[1] (Comparative Surfaces)

Note:

1. The ADNS-5700 is designed for optimal performance when used with the HLMP-EG3E-xxxxx (Red LED 639nm).
2. Z = distance from Lens Reference Plane to Surface.
3. DOF = Depth of Field

Configuration after Power up (Data Values)

| Signal Function | State from Figure 9-1 of USB spec: Powered or Default Address or Configured | State from Figure 9-1 of USB spec: Suspended from any other state |
|-----------------|---|---|
| B1 | V _{DD3} or GND if used as VID/PID jumper else pullup active for button use | V _{DD3} or GND if used as VID/PID jumper else pullup active for button use |
| B2 | V _{DD3} or GND if used as VID/PID jumper | V _{DD3} or GND if used as VID/PID jumper |
| B3 | V _{DD3} or GND if used as VID/PID jumper | V _{DD3} or GND if used as VID/PID jumper |
| B4 | V _{DD3} or GND if used as VID/PID jumper else pullup active for button use | V _{DD3} or GND if used as VID/PID jumper else pullup active for button use |
| B5 | V _{DD3} or GND if used as VID/PID jumper else pullup active for button use | V _{DD3} or GND if used as VID/PID jumper else pullup active for button use |
| D- | USB I/O | Hi-Z input |
| D+ | USB I/O | Hi-Z input |
| OSC_IN | 24MHz | Logic '1' |
| OSC_OUT | 24MHz | Logic '1' |
| XY_LED | Always ON / Pulsing | Pulled high (off) |
| ZB | Hi-Z input | Hi-Z input |
| ZA | Hi-Z if ZA tied to GND | Hi-Z input |
| Z_LED | Hi-Z input | Hi-Z input |

USB Commands

| Mnemonic | Command | Notes |
|----------------------|-------------------------|---|
| USB_RESET | D+/D- low > 18.7us | Device Resets; Address=0 |
| USB_SUSPEND | Idle state > 3mS | Device enters USB low-power mode |
| USB_RESUME | Non-idle state | Device exits USB low-power mode |
| Get_Status_Device | 80 00 00 00 00 00 02 00 | Normally returns 00 00, Self powered 00 00, Remote wakeup 02 00 |
| Get_Status_Interface | 81 00 00 00 00 00 02 00 | Normally returns 00 00 |
| Get_Status_Endpt0 | 82 00 00 00 xx 00 02 00 | OUT: xx=00, IN: xx=80 Normally returns 00 00 |
| Get_Status_Endpt1 | 82 00 00 00 81 00 02 00 | Normally returns 00 00, Halt 00 01 |
| Get_Configuration | 80 08 00 00 00 00 01 00 | Return: 00=not config., 01=configured |
| Get_Interface | 81 0A 00 00 00 00 01 00 | Normally returns 00 |
| Get_Protocol | A1 03 00 00 00 00 01 00 | Normally returns 01, Boot protocol 00 |
| Get_Desc_Device | 80 06 00 01 00 00 nn 00 | See USB command details |
| Get_Desc_Config | 80 06 00 02 00 00 nn 00 | See USB command details |
| Get_Desc_String | 80 06 xx 03 00 00 nn 00 | See USB command details |
| Get_Desc_HID | 81 06 00 21 00 00 09 00 | See USB command details |
| Get_Desc_HID_Report | 81 06 00 22 00 00 nn 00 | See USB command details |
| Get_HID_Input | A1 01 00 01 00 00 nn 00 | Return depends on motion & config |
| Get_Idle | A1 02 00 00 00 00 01 00 | Returns rate in multiples of 4ms |
| Get_Vendor_Test | C0 01 00 00 xx 00 01 00 | Read register xx |
| Set_Address | 00 05 xx 00 00 00 00 00 | xx = address |
| Set_Configuration | 00 09 xx 00 00 00 00 00 | Not configured: xx=00 Configured: xx=01 |
| Set_Interface | 01 0B 00 00 00 00 00 00 | Only one interface supported |
| Set_Protocol | 21 0B xx 00 00 00 00 00 | Boot: xx=00, Report: xx=01 |
| Set_Feature_Device | 00 03 01 00 00 00 00 00 | Enable remote wakeup |
| Set_Feature_Endpt0 | 02 03 00 00 xx 00 00 00 | Halt. OUT: xx=00, IN: xx=80 |
| Set_Feature_Endpt1 | 02 03 00 00 81 00 00 00 | Halt |
| Clear_Feature_Device | 00 01 01 00 00 00 00 00 | Disable Remote wakeup |
| Clear_Feature_Endpt0 | 02 01 00 00 xx 00 00 00 | Clear Halt; OUT: xx=00, IN: xx=80 |
| Clear_Feature_Endpt1 | 02 01 00 00 81 00 00 00 | Clear Halt |
| Set_Idle | 21 0A 00 rr 00 00 00 00 | rr = report rate in multiples of 4ms |
| Set_Vendor_Test | 40 01 00 00 xx yy 00 00 | Write yy to address xx |
| Poll_Endpt1 | | Read buttons, motion, & Z-wheel |

Note:

The last two bytes in a command shown as “nn 00” specify the 16-bit data size in the order of “LowByte HighByte.” For example a two-byte data size would be specified as “02 00.” ADNS-5700-XXXX will not provide more bytes than the number requested in the command, but it will only supply up to a maximum of 8 bytes at a time. The ADNS-5700-XXXX will re-send the last packet if the transfer is not acknowledged properly.

USB COMMAND DETAILS

| | |
|----------------------|---|
| USB_RESET | D+/D- low for an extended period |
| USB Spec: | A device may reset after seeing an SE0 for more than 18.7 μ S, and definitely after 10mS. |
| Notes: | <p>After power up and prior to Reset, the device will not respond to any USB commands. After the device has been given a USB Reset, the device's address will be reset to zero and the device will be in the Default state. The chip will default to Report protocol and any pending output will be flushed.</p> <p>All registers will be reset to a state that matches power-on-reset with the following exceptions: USB State register will be "Default" instead of "Attached".</p> |
| USB_SUSPEND | Idle state for an extended period |
| USB Spec: | A device may suspend after seeing an idle for more than 3mS, and definitely after 10mS. |
| Notes: | The chip will take a minimum of 5mS to start Suspend, though will definitely start after 6mS. The chip may finish the current frame if necessary before stopping the clock. Thus, an additional frame time may be used to reach Suspend mode. |
| USB_RESUME | Non-idle state |
| USB Spec: | Remote Resume signalling from a device must be between 1mS and 15mS. The host is required to send Resume signaling for 20mS plus 10mS of resume recovery time in which it does not access any devices. This allows devices enough time to wake back up. |
| Notes: | The chip can cause a Resume if Remote Wakeup is enabled and a button has been pressed. Remote resume signalling from the chip will last 11.45mS to 12.45mS. |
| Get_Status_Device | 80 00 00 00 00 00 02 00 |
| Returns: | <p>xx yy</p> <p>xx[0] = Self Powered</p> <p>xx[1] = Remote Wakeup</p> <p>xx[7:2] = 0</p> <p>yy = 00 (Reserved)</p> |
| Default: | Accept (undefined in USB Spec) |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | Use Set_Feature_Device/Clear_Feature_Device to set/clear remote wakeup. |
| Get_Status_Interface | 81 00 00 00 00 00 02 00 |
| Returns: | 00 00 |
| Default: | Stall (undefined in USB Spec) |
| Addressed: | Stall |
| Configured: | Accept |
| Notes: | Both return bytes are reserved and currently 00. |

| | |
|-------------------|--|
| Get_Status_Endpt0 | 82 00 00 00 xx 00 02 00 82 00 00 00 00 00 02 00 82 00 00 00 80 00 02 00 xx = 00 = Endpt0 OUT xx = 80 = Endpt0 IN |
| Returns: | xx yy xx[0] = Halt xx[7:1] = 0 yy = 00 (Reserved) |
| Default: | Accept (undefined in USB Spec) |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | Use Set_Feature_Endpt0/Clear_Feature_Endpt0 to (try to) set/clear Halt bit. According to USB, "It is neither required or recommended that the Halt feature be implemented for the Default Control Pipe." Since a new SETUP command will clear any Endpt0 halt bit, it is impossible to tell if there really is a halt bit. |

| | |
|-------------------|--|
| Get_Status_Endpt1 | 82 00 00 00 81 00 02 00 |
| Returns: | xx yy xx[0] = Halt xx[7:1] = 0 yy = 00 (Reserved) |
| Default: | Stall (undefined in USB Spec) |
| Addressed: | Stall |
| Configured: | Accept |
| Notes: | Use Set_Feature_Endpt1/Clear_Feature_Endpt1 to set/clear Halt bit. |

| | |
|-------------------|---|
| Get_Configuration | 80 08 00 00 00 00 01 00 |
| Returns: | xx xx = config value |
| Default: | Accept (undefined in USB Spec) – returns 00 |
| Addressed: | Accept – returns 00 |
| Configured: | Accept – returns 01 |
| Notes: | Use Set_Configuration to change. |

| | |
|---------------|--|
| Get_Interface | 81 0A 00 00 00 00 01 00 |
| Returns: | 00 |
| Default: | Stall (undefined in USB Spec) |
| Addressed: | Stall |
| Configured: | Accept – returns 00 |
| Notes: | Command has no alternate interfaces, so only valid value is 00 |

| | |
|--------------|--|
| Get_Protocol | A1 03 00 00 00 00 01 00 |
| Returns: | xx xx = 00 = Boot protocol xx = 01 = Report protocol |
| Default: | Accept |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | Defaults to Report protocol after USB Reset. Use Set_Protocol to change. |

| | |
|-----------------|---|
| Get_Desc_Device | 80 06 00 01 00 00 nn 00 80 06 00 01 00 00 12 00 |
| Returns: | 12 01 00 02 00 00 00 08 vv vv pp pp dd dd mm PP ss 01 vv vv = vendor id pp pp = product id (vendor specified) dd dd = device id (vendor specified) (bcd rev_id byte) mm = iManufacturer PP = iProduct ss = iSerialNumber (00 - no string) |
| Default: | Accept |
| Addressed: | Accept |
| Configured: | Accept Get_Desc_String will return "stall" if Manufacturer string is queried when iManufacturer = 0x00. |

```

Get_Desc_Config      80 06 00 02 00 00 nn 00
                    80 06 00 02 00 00 22 00

Returns:             09 02 22 00 01 01 00 A0
                    32 09 04 00 00 01 03 01
                    02 00 09 21 11 01 00 01
                    22 rr 00 07 05 81 03 05
                    00 0A
                    rr = HID Report descriptor length
                    47 = 12 bit motion reporting

With Z-Wheel:        09 02 22 00 01 01 00 A0
                    32 09 04 00 00 01 03 01
                    02 00 09 21 11 01 00 01
                    22 3D 00 07 05 81 03 04
                    00 0A
                    // Config Descriptor
                    | 09      //      bLength
                    | 02      //      bDescriptorType
                    | 22      //      wTotalLength (34 decimal)
                    | 00      //      high byte of WTotalLength
                    | 01      //      bNumInterfaces
                    | 01      //      bConfigurationValue
                    | 00      //      iConfiguration
                    | A0      //      bmAttributes (bus powered/remote wakeup)
                    | 32      //      MaxPower (in 100mA in 2mA units)
                    // Interface Descriptor
                    | 09      //      bLength
                    | 04      //      bDescriptorType
                    | 00      //      bInterfaceNumber
                    | 00      //      bAlternateSetting
                    | 01      //      bNumEndpoints
                    | 03      //      bInterfaceClass (HID Class)
                    | 01      //      bInterfaceSubClass
                    | 02      //      bInterfaceProtocol
                    | 00      //      iInterface
                    // HID Descriptor
                    | 09      //      bLength
                    | 21      //      bDescriptorType
                    | 11      //      bcdHID ( HID Release ##.##; HID 1.11 compliant )
                    | 01      //
                    | 00      //      bCountry
                    | 01      //      bAvailable
                    | 22      //      bType
                    | 34      //      wLength (Length of HID Report below)
                    | 00      //
                    // Endpoint Descriptor
                    | 07      //      bLength
                    | 05      //      bDescriptorType
                    | 81      //      bEndpointAddress (IN & #=1)
                    | 03      //      bmAttributes (Interrupt)
                    | 05      //      wMaxPacketSize
                    | 00      //      12bit 0x06
                    | 0A      //      bInterval (10mS)

```

Default: Accept
 Addressed: Accept
 Configured: Accept
 Notes: This is the concatenation of 4 descriptors:
 Configuration
 Interface
 HID
 Endpt

Get_Desc_String 80 06 xx 03 00 00 nn 00
 xx= 00 Language String
 01 Manufacturer String
 02 Product String

Returns: ss 03 „unicode string“
 ss = String descriptor length

These values are determined by jumper configuration on page xx:

For xx=00: 04 03 09 04 // Language ID

For xx=01: return “stall” if Manufacturer string is queried when iManufacturer = 0x00. See Get_Desc_Device section

For xx=02: 24 03 55 00 53 00 42 00 // “USB”
 20 00 4f 00 70 00 74 00 // “Opt”
 69 00 63 00 61 00 6c 00 // “ ical”
 20 00 4d 00 6f 00 75 00 // “Mou”
 73 00 65 00 // “se”

Default: Accept
 Addressed: Accept
 Configured: Accept
 Notes: A request for any other string will STALL.

Get_Desc_HID 81 06 00 21 00 00 09 00

Returns: 09 21 11 01 00 01 22 rr 00
 rr = HID Report descriptor length
 47 = 12 bit motion

Default: Accept
 Addressed: Accept
 Configured: Accept

Get_Desc_HID_Report 81 06 00 22 00 00 nn 00

Returns: This returns a report descriptor that describes how many buttons and x, y, z data.

These values are determined by jumper configuration see table on page 4:

With Tilt wheel and 12bit reporting: 05 01 09 02 A1 01 09 01
A1 00 05 09 19 01 29 05
15 00 25 01 75 01 95 05
81 02 75 03 95 01 81 01
05 01 09 30 09 31 16 01
F8 26 FF 07 75 0C 95 02
81 06 09 38 15 81 25 7F
75 08 95 01 81 06 05 0C
0A 38 02 81 06 C0 C0
// HID Report
| 05 01 // USAGE_PAGE (Generic Desktop)
| 09 02 // USAGE (Mouse)
| A1 01 // COLLECTION (Application)
| 09 01 // USAGE (Pointer)
| A1 00 // COLLECTION (Physical)
| 05 09 // USAGE_PAGE (Button)
| 19 01 // USAGE_MINIMUM (Button 1)
| 29 05 // USAGE_MAXIMUM (Button #)
| 15 00 // LOGICAL_MINIMUM (0)
| 25 01 // LOGICAL_MAXIMUM (1)
| 75 01 // REPORT_SIZE (1)
| 95 05 // REPORT_COUNT (Button #)
| 81 02 // INPUT (Data,Var,Abs)
| 75 03 // REPORT_SIZE (8 - Button #)
| 95 01 // REPORT_COUNT (1)
| 81 01 // INPUT (Cnst,Ary,Abs)
| 05 01 // USAGE_PAGE (Generic Desktop)
| 09 30 // USAGE (X)
| 09 31 // USAGE (Y)
| 16 01 F8 // LOGICAL_MINIMUM (-127)
| 26 FF 07 // LOGICAL_MAXIMUM (127)
| 75 0C // REPORT_SIZE (8)
| 95 01 // REPORT_COUNT (3)
| 81 06 // INPUT (Data,Var,Rel)
| 09 38 // USAGE (Zwheel)
| 15 81 // LOGICAL_MINIMUM (-127)
| 25 7F // LOGICAL_MAXIMUM (127)
| 75 08 // REPORT_SIZE (8)
| 95 01 // REPORT_COUNT (1)
| 81 06 // INPUT (Data,Var,Rel)
| 05 0C // USAGE_PAGE (Consumer)
| 0A 38 02 // USAGE (AC Pan)
| 81 06 // INPUT (Data,Var,Rel)
| C0 // END_COLLECTION
| C0 // END_COLLECTION

With without Tilt wheel and 12bit reporting: 05 01 09 02 A1 01 09 01
A1 00 05 09 19 01 29 05
15 00 25 01 75 01 95 05
81 02 75 03 95 01 81 01
05 01 09 30 09 31 16 01
F8 26 FF 07 75 0C 95 02
81 06 09 38 15 81 25 7F
75 08 95 01 81 06 C0 C0

```
//    HID Report
| 05 01    //    USAGE_PAGE (Generic Desktop)
| 09 02    //    USAGE (Mouse)
| A1 01    //    COLLECTION (Application)
| 09 01    //    USAGE (Pointer)
| A1 00    //    COLLECTION (Physical)
| 05 09    //    USAGE_PAGE (Button)
| 19 01    //    USAGE_MINIMUM (Button 1)
| 29 05    //    USAGE_MAXIMUM (Button #)
| 15 00    //    LOGICAL_MINIMUM (0)
| 25 01    //    LOGICAL_MAXIMUM (1)
| 75 01    //    REPORT_SIZE (1)
| 95 05    //    REPORT_COUNT (Button #)
| 81 02    //    INPUT (Data,Var,Abs)
| 75 03    //    REPORT_SIZE (8 - Button #)
| 95 01    //    REPORT_COUNT (1)
| 81 01    //    INPUT (Cnst,Ary,Abs)
| 05 01    //    USAGE_PAGE (Generic Desktop)
| 09 30    //    USAGE (X)
| 09 31    //    USAGE (Y)
| 16 01 F8 //    LOGICAL_MINIMUM (-127)
| 26 FF 07 //    LOGICAL_ MAXIMUM (127)
| 75 0C    //    REPORT_SIZE (8)
| 95 01    //    REPORT_COUNT (3)
| 81 06    //    INPUT (Data,Var,Rel)
| 09 38    //    USAGE (Zwheel)
| 15 81    //    LOGICAL_MINIMUM (-127)
| 25 7F    //    LOGICAL_ MAXIMUM (127)
| 75 08    //    REPORT_SIZE (8)
| 95 01    //    REPORT_COUNT (1)
| 81 06    //    INPUT (Data,Var,Rel)
| C0       //    END_COLLECTION
| C0       //    END_COLLECTION
```

Default: Accept

Addressed: Accept

Configured: Accept

Notes: The length of this report is needed in the HID descriptor.

| | |
|-----------------|--|
| Get_HID_Input | A1 01 00 01 00 00 nn 00 nn = 06 (with tilt wheel and 12 bit motion reporting) nn = 05 (without tilt wheel and 12 bit reporting) |
| Returns: | bb xx yy zz tw (tilt wheel) OR bb xx yy zz (Z-wheel) OR bb xx yy (if no Z-wheel present) bb = button byte xx = X motion byte yy = Y motion byte zz = Z motion byte tw = tilt wheel byte |
| Default: | Stall |
| Addressed: | Stall |
| Configured: | Accept |
| Notes: | If the device is configured, it will always respond with a report for this command, even if no motion or button changes have occurred. In this case, it would report 00 for motion and simply report the current button state. If a report is pending on endpt1, the data there will be reported and the report on endpt1 cleared. The mouse will only create new button/motion packets when it is in the Configured state See USB byte format end of this section for more detail |
| Get_Idle | A1 02 xx 00 00 00 01 00 xx = 00 All reports xx = 01 First report |
| Returns: | rr rr = rate in multiples of 4mS |
| Default: | Accept |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | The third byte of the command is to select the Report ID. There is only one for the mouse -- so, using 00 or 01 will work. See also Set_Idle. |
| Get_Vendor_Test | C0 01 00 00 xx 00 01 00 ii = ignore xx = address of register to read |
| Returns: | rr (depends on register read) |
| Default: | Accept |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | Address range (xx) is datasheet register range |

| | |
|--------------------|--|
| Set_Address | 00 05 xx 00 00 00 00 00 xx = new device address, from 00 to 7F |
| Default: | Accept |
| Addressed: | Accept |
| Configured: | Accept (undefined in USB Spec) Chip gets new address, but stays in "Configured" mode. |
| Notes: | If device is not configured, the device will be given the new address and put in the addressed state (or default if new address=00). If the device is already configured, the device will be given the new address state and remain configured. |
| Set_Configuration | 00 09 xx 00 00 00 00 00 xx = 00 = not configured xx = 01 = configured |
| Default: | Accept (undefined in USB Spec) |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | Invalid config values will cause stall. Chip will stall invalid value in configured mode, and leave device in old (configured) mode. |
| Set_Interface | 01 0B 00 00 00 00 00 00 |
| Default: | Stall (undefined in USB Spec) |
| Addressed: | Stall |
| Configured: | Accept |
| Notes: | Mouse has only one valid interface (00) and alternate setting (00). Invalid values will cause stall. Chip retains previous (valid) interface state after executing this command in configured mode even if invalid values are given and command was stalled. |
| Set_Protocol | 21 0B xx 00 00 00 00 00 xx = 00 = Boot protocol xx = 01 = Report protocol |
| Default: | Accept (Not in USB Spec) |
| Addressed: | Accept (Not in USB Spec) |
| Configured: | Accept |
| Notes: | 3 byte data packets will be reported in boot mode. These bytes are button, XX data, and YY data. Tilt wheel button 7,8 will not be reported |
| Set_Feature_Device | 00 03 01 00 00 00 00 00 |
| Default: | Accept (undefined in USB Spec) |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | This sets the remote wakeup bit. |

| | |
|----------------------|---|
| Set_Feature_Endpt0 | 02 03 00 00 xx 00 00 00 02 03 00 00 00 00 00 00 02 03 00 00 80 00 00 00 xx = 00 = Endpt0 OUT xx = 80 = Endpt0 IN |
| Default: | Stall (undefined in USB Spec) |
| Addressed: | Stall |
| Configured: | Stall |
| Notes: | This (tries to) sets the halt bit. The chip always stalls the status stage for this command. The chip never reports the halt bit set for Endpt0 with the Get_Status_Endpt0 command, as any new SETUP command will clear Endpt0 stall. |
| Set_Feature_Endpt1 | 02 03 00 00 81 00 00 00 |
| Default: | Stall (undefined in USB Spec) |
| Addressed: | Stall |
| Configured: | Accept |
| Notes: | Sets the halt bit for Endpt1. |
| Clear_Feature_Device | 00 01 01 00 00 00 00 00 |
| Default: | Accept (undefined in USB Spec) |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | This clears the remote wakeup bit. |
| Clear_Feature_Endpt0 | 02 01 00 00 xx 00 00 00 02 01 00 00 00 00 00 00 02 01 00 00 80 00 00 00 xx = 00 = Endpt0 OUT xx = 80 = Endpt0 IN |
| Default: | Accept (undefined in USB Spec) |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | The chip does NOT stall like it does for Set_Feature_Endpt0. |
| Clear_Feature_Endpt1 | 02 01 00 00 81 00 00 00 |
| Default: | Stall (undefined in USB Spec) |
| Addressed: | Stall |
| Configured: | Accept |
| Notes: | See Set_Feature_Endpt1. |

| | |
|-------------|---|
| Set_Idle | 21 0A xx rr 00 00 00 00 xx = 00 All reports xx = 01 First report rr = rate in multiples of 4mS |
| Default: | Accept |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | <p>The third byte of the command is to select the Report ID. There is only one for the mouse – so, using either 00 or 01 will work.</p> <p>The fourth byte of the command sets the rate in multiples of 4mS. The initial value for mice will be x00 which means “infinite” – that is packets only come out when there is a change in data.</p> <p>Data will only be allowed to come out when the device is configured. However, the chip will accept the command in Default or Addressed mode and use that value when the device is later configured.</p> |

| | |
|-----------------|---|
| Set_Vendor_Test | 40 01 00 00 xx yy 00 00 xx = address yy = data |
| Default: | Accept |
| Addressed: | Accept |
| Configured: | Accept |
| Notes: | Address range for “xx” should be 0x00 to 0x3F. Addresses above this are reserved for possible future use. See also Get_Vendor_Test. |

Poll_Endpt1

| | |
|--------------------------|--|
| Returns: | <p>bb xx yy zz tw bb = button byte xx = X motion byte yy = Y motion byte zz = Z motion byte (if Z-Wheel) tw = tilt wheel byte</p> |
| Default: | Ignore request |
| Addressed: | Ignore request |
| Configured: | Accept (NAK if no data; Send packet if available) |
| Notes: | <p>See also Get_HID_Input. Endpt will only stall if halt bit is set by Set_Feature_Endpt1. Details of data packet are below</p> <p>Endpt1 should be polled at least every 10 frames (mS). It is typically polled every 8 frames on Windows machines. For internal testing, Endpt1 can be continuously polled if desired.</p> <p>The chip will not generate any report packets unless in the Configured state.</p> <p>If Endpt1 is currently empty, any motion or button change will be loaded into the Endpt1 buffers. Once the Endpt1 buffers are full, any further motion events will get accumulated. When the Endpt1 buffers are later polled and emptied, the current accumulated X/Y/Z values will be loaded into the Endpt1 buffers. After transferring their data, the accumulation registers are reset so they are ready to start accumulating new motion events.</p> <p>Button information is handled a bit differently. If the Endpt1 buffers are empty, and a button change event occurs, the new button state is put into the Endpt1 buffers. At the same time, the button state that is put in Endpt1 is copied for later use. While Endpt1 is full, changes in button state are essentially ignored. When Endpt1 is emptied, if the current button state is different than that which was last loaded into Endpt1, then the new state will be loaded and a new copy saved. Basically, the button state that is loaded into Endpt1 is always the current button state at that point in time. It should also be noted that there is hardware on the chip to help de-bounce the buttons.</p> |
| Special note on wLength: | <p>The wLength paramater in commands specifies the maximum number of bytes a device should send back. The commands listed below are not able to handle a wLength of 0 correctly.</p> <p>Get_Status_Device Get_Status_Interface Get_Status_Endpt0 Get_Status_Endpt1 Get_Configuration Get_Interface</p> <p>This chip will send one byte of data rather than none when wLength=0 is requested for the above commands.</p> |

USB Data Packet Format of mouse with tilt wheel

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------|-----|-----|-----|-----|-----|--------|--------|--------|
| Byte 1 | 0 | 0 | 0 | 0 | 0 | B3(MB) | B2(RB) | B1(LB) |
| Byte 2 | X7 | X6 | X5 | X4 | X3 | X2 | X1 | X0 |
| Byte 3 | Y3 | Y2 | Y1 | Y0 | X11 | X10 | X9 | X8 |
| Byte 4 | Y11 | Y10 | Y9 | Y8 | Y7 | Y6 | Y5 | Y4 |
| Byte 5 | Z7 | Z6 | Z5 | Z4 | Z3 | Z2 | Z1 | Z0 |
| Byte 6 | TW7 | TW6 | TW5 | TW4 | TW3 | TW2 | TW1 | TW0 |

USB Data Packet Format of mouse without tilt wheel

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------|-----|-----|----|----|-----|--------|--------|--------|
| Byte 1 | 0 | 0 | 0 | 0 | 0 | B3(MB) | B2(RB) | B1(LB) |
| Byte 2 | X7 | X6 | X5 | X4 | X3 | X2 | X1 | X0 |
| Byte 3 | Y3 | Y2 | Y1 | Y0 | X11 | X10 | X9 | X8 |
| Byte 4 | Y11 | Y10 | Y9 | Y8 | Y7 | Y6 | Y5 | Y4 |
| Byte 5 | Z7 | Z6 | Z5 | Z4 | Z3 | Z2 | Z1 | Z0 |
| Byte 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

USB Data Packet Format of 5 button mouse

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------|-----|-----|----|----|-----|--------|--------|--------|
| Byte 1 | 0 | 0 | 0 | B5 | B4 | B3(MB) | B2(RB) | B1(LB) |
| Byte 2 | X7 | X6 | X5 | X4 | X3 | X2 | X1 | X0 |
| Byte 3 | Y3 | Y2 | Y1 | Y0 | X11 | X10 | X9 | X8 |
| Byte 4 | Y11 | Y10 | Y9 | Y8 | Y7 | Y6 | Y5 | Y4 |
| Byte 5 | Z7 | Z6 | Z5 | Z4 | Z3 | Z2 | Z1 | Z0 |
| Byte 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Registers

The sensor can be programmed through registers, via the USB port, and configuration and motion data can be read from these registers. Certain registers must be “enabled”

after power up but before first read or write to that register. The registers will be “disabled” by VDD going low or sending a USB reset command.

| Address | Register |
|---------|-------------|
| 0x00 | Product_ID |
| 0x01 | Revision_ID |
| 0x02 | MouseStat |
| 0x03 | Delta_X_L |
| 0x04 | Delta_Y_L |
| 0x05 | Delta_XY_H |
| 0x06 | SQUAL |
| 0x07 | Shut_Hi |

| Address | Register |
|---------|-------------|
| 0x08 | Shut_Low |
| 0x09 | Pix_Max |
| 0x0a | Pix_Accum |
| 0x0b | Pix_Min |
| 0x0c | Pix_Grabber |
| 0x0d | Dz |
| 0x0e-3f | Reserved |
| 0x40 | InvRevID |

Product_ID Address: 0x00
Access: Read Reset Value: 0x27

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Field | PID ₇ | PID ₆ | PID ₅ | PID ₄ | PID ₃ | PID ₂ | PID ₁ | PID ₀ |

Data Type: Eight bit number with the product identifier.

USAGE: The value in this register does not change; it can be used to verify that the sensor communications link is OK.

Revision_ID Address: 0x01
Access: Read Reset Value: 0x01

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Field | RID ₇ | RID ₆ | RID ₅ | RID ₄ | RID ₃ | RID ₂ | RID ₁ | RID ₀ |

Data Type: Eight bit number with current revision of the IC.

USAGE: This register contains the IC revision. It is subject to change when new IC versions are released.

MouseStat Address: 0x02
Access: Read Reset Value: Undefined

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|-----|----------|----------|------------------|------------------|------------------|------------------|------------------|
| Field | MOT | Reserved | Reserved | BUT ₅ | BUT ₄ | BUT ₃ | BUT ₂ | BUT ₁ |

Data Type: Bit field

USAGE: A "1" in the motion bit indicates that the USB endpoint has valid data. This register is included for test purposes only. For navigation use, use the USB HID defined commands. The button status bits reported are for the de-bounce signals.

| Field Name | Description |
|------------------|---|
| MOT | For Internal test purposes only |
| Reserved | Reserved |
| BUT ₅ | Reports the status of B5 0 = pin at logic 1 (Vdd3) 1 = pin at logic 0 (GND) |
| BUT ₄ | Reports the status of B4 0 = pin at logic 1 (Vdd3) 1 = pin at logic 0 (GND) |
| BUT ₃ | Reports the status of B3 0 = pin at logic 1 (Vdd3) 1 = pin at logic 0 (GND) |
| BUT ₂ | Reports the status of B2 0 = pin at logic 1 (Vdd3) 1 = pin at logic 0 (GND) |
| BUT ₁ | Reports the status of B1 0 = pin at logic 1 (Vdd3) 1 = pin at logic 0 (GND) |

Delta_X_L Address: 0x03
Access: Read Reset Value: 0x00

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Field | X ₇ | X ₆ | X ₅ | X ₄ | X ₃ | X ₂ | X ₁ | X ₀ |

Data Type: Bit field

USAGE: The value in this register reflects the last USB delta X (lower 8 bits) data output or data queued for output. This register is included for test purposes only. For navigation use, use the HID defined commands. Data is 2's complement. Absolute value is determined by the currently set resolution.

Register 0x03 must be read before register 0x04 (Delta_Y_L) and 0x05 (Delta_XY_H)

Delta_Y_L Address: 0x04
Access: Read Reset Value: 0x00

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Field | Y ₇ | Y ₆ | Y ₅ | Y ₄ | Y ₃ | Y ₂ | Y ₁ | Y ₀ |

Data Type: Bit field

USAGE: The value in this register reflects the last USB delta Y (lower 8 bits) data output or data queued for output. This register is included for test purposes only. Register 0x03 should be read before register 0x04 (Delta_Y_L) and 0x05 (Delta_XY_H), else Delta_Y_L will return 0. For navigation use, use the HID defined commands. Data is 2's complement. Absolute value is determined by the currently set resolution.

Delta_XY_H Address: 0x05
Access: Read Reset Value: 0x00

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|-----------------|-----------------|----------------|----------------|-----------------|-----------------|----------------|----------------|
| Field | X ₁₁ | X ₁₀ | X ₉ | X ₈ | Y ₁₁ | Y ₁₀ | Y ₉ | Y ₈ |

Data Type: Bit field

USAGE: The value in this register reflects the last USB delta X and Y (upper 4 bits) data output or data queued for output. This register is included for test purposes only. Register 0x03 should be read before register 0x04 (Delta_Y_L) and 0x05 (Delta_XY_H), else Delta_XY_H will return 0. For navigation use, use the HID defined commands. Data is 2's complement. Absolute value is determined by the currently set resolution.

| | | | | | | | | |
|--------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| SQUAL | | Address: 0x06 | | | | | | |
| Access: Read | | Reset Value: 0x00 | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | SQ ₇ | SQ ₆ | SQ ₅ | SQ ₄ | SQ ₃ | SQ ₂ | SQ ₁ | SQ ₀ |

Data Type: Eight bit number.

USAGE: SQUAL is a measure of the number of features visible by the sensor in the current frame. The maximum value is 128. Since small changes in the current frame can result in changes in SQUAL, slight variations in SQUAL on one surface is expected.

| | | | | | | | | |
|----------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Shut_Hi | | Address: 0x07 | | | | | | |
| Access: Read | | Reset Value: 0x00 | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | S ₁₅ | S ₁₄ | S ₁₃ | S ₁₂ | S ₁₁ | S ₁₀ | S ₁₉ | S ₁₈ |

Data Type: Eight bit number.

USAGE: The combination of Shut_Hi and Shut_Low is a 16-bit number. This is the number of clocks the shutter was open for the last image taken. The units are in main clocks ticks (nominally 24MHz). To avoid split read issues, read Shut_Hi first.

| | | | | | | | | |
|-----------------|----------------|-------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Shut_Low | | Address: 0x08 | | | | | | |
| Access: Read | | Reset Value: 0x64 | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | S ₇ | S ₆ | S ₅ | S ₄ | S ₃ | S ₂ | S ₁ | S ₀ |

Data Type: Eight bit number.

USAGE: The combination of Shut_Hi and Shut_Low is a 16-bit number. This is the number of clocks the shutter was open for the last image taken. The units are in main clocks ticks (nominally 24MHz). To avoid split read issues, read Shut_Hi first (0x06).

| | | | | | | | | |
|----------------|---|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Pix_Max | | Address: 0x09 | | | | | | |
| Access: Read | | Reset Value: 0x00 | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | 0 | MX ₆ | MX ₅ | MX ₄ | MX ₃ | MX ₂ | MX ₁ | MX ₀ |

Data Type: Eight bit number.

USAGE: This is the maximum pixel value from the last image taken.

| | | | | | | | | |
|------------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Pix_Accum | | Address: 0x0a | | | | | | |
| Access: Read | | Reset Value: 0x00 | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | AC ₇ | AC ₆ | AC ₅ | AC ₄ | AC ₃ | AC ₂ | AC ₁ | AC ₀ |

Data Type: Eight bit number.

USAGE: This is the accumulated pixel value from the last image taken. For the 19x19 raw image only the 8 most interesting bits are reported ([15:8]). To get the true average pixel value, divide this register value by 1.41.

| | | | | | | | | |
|----------------|---|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Pix_Min | | Address: 0x0b | | | | | | |
| Access: Read | | Reset Value: 0x7f | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | 0 | MN ₆ | MN ₅ | MN ₄ | MN ₃ | MN ₂ | MN ₁ | MN ₀ |

Data Type: Eight bit number.

USAGE: This is the minimum pixel value from the last image taken.

| | | | | | | | | |
|-----------------|-------|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Pix_Grab | | Address: 0x0c | | | | | | |
| Access: Read | | Reset Value: 0x00 | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | VALID | PG ₆ | PG ₅ | PG ₄ | PG ₃ | PG ₂ | PG ₁ | PG ₀ |

Data Type: Eight bit number.

USAGE: The pixel grabber captures 1 pixel per frame. If there is a valid pixel in the grabber when this is read, the MSB will be set, an internal counter will incremented to captured the next pixel and the grabber will be armed to capture the next pixel. It will take 361 reads to upload the completed image.

Any write to this register will reset and arm the grabber to grab pixel 0 on the next image. See pixel array numbering in Figure 19.

Pixel Address Map (Looking through the sensor at the surface)

| | | | | | | | | | | | | | | | | | | |
|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 19 | 38 | 57 | 76 | 95 | 114 | 133 | 152 | 171 | 190 | 209 | 228 | 247 | 266 | 285 | 304 | 323 | 342 |
| 1 | 20 | 39 | 58 | 77 | 96 | 115 | 134 | 153 | 172 | 191 | 210 | 229 | 248 | 267 | 286 | 305 | 324 | 343 |
| 2 | 21 | 40 | 59 | 78 | 97 | 116 | 135 | 154 | 173 | 192 | 211 | 230 | 249 | 268 | 287 | 306 | 325 | 344 |
| 3 | 22 | 41 | 60 | 79 | 98 | 117 | 136 | 155 | 174 | 193 | 212 | 231 | 250 | 269 | 288 | 307 | 326 | 345 |
| 4 | 23 | 42 | 61 | 80 | 99 | 118 | 137 | 156 | 175 | 194 | 213 | 232 | 251 | 270 | 289 | 308 | 327 | 346 |
| 5 | 24 | 43 | 62 | 81 | 100 | 119 | 138 | 157 | 176 | 195 | 214 | 233 | 252 | 271 | 290 | 309 | 328 | 347 |
| 6 | 25 | 44 | 63 | 82 | 101 | 120 | 139 | 158 | 177 | 196 | 215 | 234 | 253 | 272 | 291 | 310 | 329 | 348 |
| 7 | 26 | 45 | 64 | 83 | 102 | 121 | 140 | 159 | 178 | 197 | 216 | 235 | 254 | 273 | 292 | 311 | 330 | 349 |
| 8 | 27 | 46 | 65 | 84 | 103 | 122 | 141 | 160 | 179 | 198 | 217 | 236 | 255 | 274 | 293 | 312 | 331 | 350 |
| 9 | 28 | 47 | 66 | 85 | 104 | 123 | 142 | 161 | 180 | 199 | 218 | 237 | 256 | 275 | 294 | 313 | 332 | 351 |
| 10 | 29 | 48 | 67 | 86 | 105 | 124 | 143 | 162 | 181 | 200 | 219 | 238 | 257 | 276 | 295 | 314 | 333 | 352 |
| 11 | 30 | 49 | 68 | 87 | 106 | 125 | 144 | 163 | 182 | 201 | 220 | 239 | 258 | 277 | 296 | 315 | 334 | 353 |
| 12 | 31 | 50 | 69 | 88 | 107 | 126 | 145 | 164 | 183 | 202 | 221 | 240 | 259 | 278 | 297 | 316 | 335 | 354 |
| 13 | 32 | 51 | 70 | 89 | 108 | 127 | 146 | 165 | 184 | 203 | 222 | 241 | 260 | 279 | 298 | 317 | 336 | 355 |
| 14 | 33 | 52 | 71 | 90 | 109 | 128 | 147 | 166 | 185 | 204 | 223 | 242 | 261 | 280 | 299 | 318 | 337 | 356 |
| 15 | 34 | 53 | 72 | 91 | 110 | 129 | 148 | 167 | 186 | 205 | 224 | 243 | 262 | 281 | 300 | 319 | 338 | 357 |
| 16 | 35 | 54 | 73 | 92 | 111 | 130 | 149 | 168 | 187 | 206 | 225 | 244 | 263 | 282 | 301 | 320 | 339 | 358 |
| 17 | 36 | 55 | 74 | 93 | 112 | 131 | 150 | 169 | 188 | 207 | 226 | 245 | 264 | 283 | 302 | 321 | 340 | 359 |
| 18 | 37 | 56 | 75 | 94 | 113 | 132 | 151 | 170 | 189 | 208 | 227 | 246 | 265 | 284 | 303 | 322 | 341 | 360 |

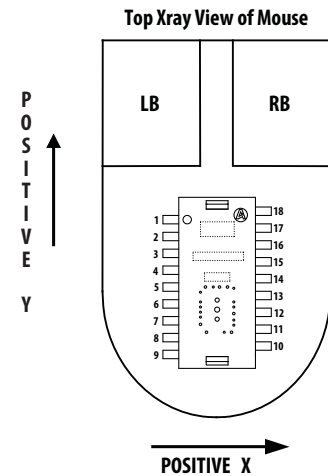


Figure 19. Pixel Map

The figure above shows the readout order of the array. Rows are read top to bottom and columns are from right to left.

| | | | | | | | | |
|--------------|----------------|-------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Dz | | Address: 0x0d | | | | | | |
| Access: Read | | Reset Value: 0x00 | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | Z ₇ | Z ₆ | Z ₅ | Z ₄ | Z ₃ | Z ₂ | Z ₁ | Z ₀ |

Data Type: Bit field

USAGE: If mouse is configured to contain a Z-wheel, this register contains the Z-wheel count. Range is from –127 to 127 decimal.

| | |
|-----------------|----------------------|
| Reserved | Address: 0x0e – 0x3f |
|-----------------|----------------------|

InvRevID
Access: Read

Address: 0x040
Reset Value: 0xfe

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Field | RRID ₇ | RRID ₆ | RRID ₅ | RRID ₄ | RRID ₃ | RRID ₂ | RRID ₁ | RRID ₀ |

Data Type: Eight bit number with current revision of the IC.

USAGE: Contains the inverse of the revision ID which is located in register 0x01.

IC Register state after Reset (power up)

| Address | Register | Default Value | Meaning |
|---------|--------------------|---------------|--|
| 0x00 | Product_ID | 0x27 | Product ID = 27 (Fixed value) |
| 0x01 | Revision_ID | 0x01 | Revision of IC (Fixed value). (For each device design revision). |
| 0x02 | MouseStat | – | |
| 0x03 | Delta_X_L | 0x00 | |
| 0x04 | Delta_Y_L | 0x00 | |
| 0x05 | Delta_XY_H | 0x00 | |
| 0x06 | SQUAL | 0x00 | |
| 0x07 | Shut_Hi | 0x00 | |
| 0x08 | Shut_Low | 0x64 | |
| 0x09 | Pix_Max | 0x00 | |
| 0x0a | Pix_Accum | 0x00 | |
| 0x0b | Pix_Min | 0x00 | |
| 0x0c | Pix_Grabber | 0x00 | |
| 0x0d | Dz | 0x00 | |
| 0x0e-3f | Reserved | – | |
| 0x40 | InverseRevision ID | 0xFE | |

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