ADNK-5003
Optical Mouse Designer's Kit

Design Guide

Lead (Pb) Free
RoHS 6 fully
compliant

Introduction

The Universal Serial Bus (USB) is an industry standard serial interface between a computer and peripherals such as a mouse, joystick, keyboard, etc. This design guide describes how a cost-effective USB optical mouse can be built using the Avago Technologies ADNS-5000 optical sensor. The document starts with the basic operations of a computer mouse peripheral followed by an introduction to the Avago Technologies ADNS-5000 Optical Navigation Sensor. A schematic of the ADNS-5000 optical sensor and buttons of a standard mouse can be found in Appendix A. The ADNS-5000 data sheet is available from the Avago Technologies web site at www.avagotech.com. USB documentation can be found at the USB Implementers Forum web site at www.usb.org.

The ADNS-5000 navigation sensor along with the ADNS-5100 round lens or ADNS-5100-001 trim lens, ADNS-5200 clip and HLMP-ED80 LED form a complete and compact mouse tracking system. There are no moving parts, which means high reliability and less maintenance for the end user. In addition, precision optical alignment is not required, facilitating high volume assembly.

Optical Mouse Basics

The optical mouse measures changes in position by optically acquiring sequential surface images (frames), and mathematically determining the direction and magnitude of movement. The Z-wheel movement is done in the traditional method by decoding the quadrature signal generated by optical sensors. This design guide shows how to connect to and manage a standard configuration of mouse hardware, as well as handle the USB protocols as a standard way of reporting mouse movement and button presses to the PC.

Optical Navigation Sensor

Avago Technologies ADNS-5000 optical sensor is used in this reference design as the primary navigation engine. This Optical Navigation Technology contains an Image Acquisition System, a Digital Signal Processor and USB stream output.

The IAS acquires microscopic surface images via the lens and illumination system provided by the ADNS-5100, ADNS-5200, and HLMP-ED80-XX000. These images are processed by the DSP to determine the direction and distance of motion. The DSP generates the Δx and Δy relative displacement values which are converted to USB motion data.

Mouse Z-Wheel

The motion of Z-wheel is detected using the traditional method by decoding the quadrature signal generated by optical sensors:

For mechanical Z-wheels the following must be implemented.

1. Use a rotary switch equivalent to the Panasonic part EVQVX at http://industrial.panasonic.com/www-data/pdf/ATC0000/ATC0000CE20.pdf (The key point is stable "A" switch state in all detent positions).
2. Solder the rotary switch into the PCB such that the common pin is closest to the cable end of the mouse. (Metal plate faces to left)
3. Connect the "A" terminal of the rotary switch to "ZA" and the "B" terminal to "ZB". ZA MUST be connected to "Signal A" in Figure 2 where the z-wheel detents are mechanically stable.

As shown in Figure 2 below, traveling along the quadrature signal to the right produces a unique set of state transitions, and traveling to the left produces another set of unique state transitions.

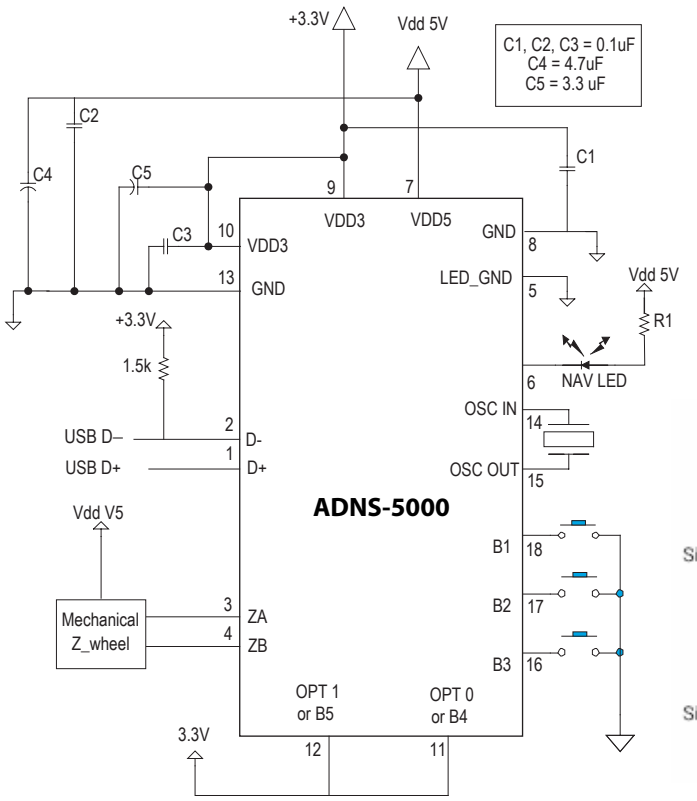


Figure 1. ADNS-5000 3 button Optical Mouse Hardware Block Diagram

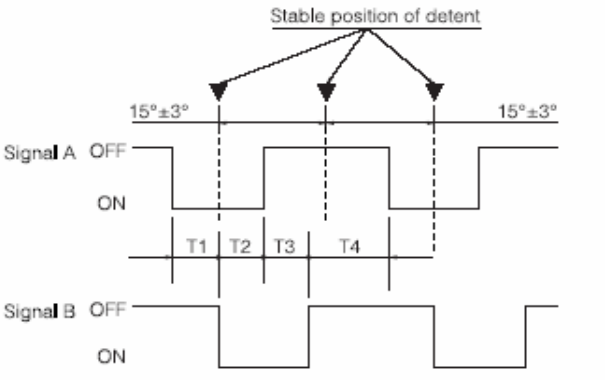


Figure 2. Optics Quadrature Signal Generation

Mouse Buttons

Mouse buttons are connected as standard switches. These switches are pulled up by the pull up resistors inside the sensor. When the user presses a button, the switch will be closed and the pin will be pulled LOW to GND. A LOW state at the pin is interpreted as the button being pressed. A HIGH state is interpreted as the button has been released or the button is not being pressed. Normally the switches are debounced in firmware for 9-17ms. In this reference design there are three switches: left, Z-wheel and right.

Some details on ADNK-5003

The ADNK-5003 reference design mouse unit allows users to evaluate the performance of the Optical Tracking Engine (sensor, lens, LED assembly clip, LED) over a USB protocol. This kit also enables users to understand the recommended mechanical assembly. (See Appendix C and D)

System Requirements

PCs using Windows® NT/ Windows® 2000 with standard 3-button USB mouse driver loaded.

- Functionality
- 3-button, scroll wheel mouse.
- Operating (For USB Mode)
- Hot pluggable with USB port. The PC does not need to be powered off when plugging or unplugging the evaluation mouse.

To Disassemble the ADNK-5003 Unit

The ADNK-5003 comprises of the plastic mouse casing, printed circuit board (PCB), lens, buttons, and USB cable. (See Figure 3) Unscrewing the one screw located at the base of the unit can open the ADNK-5003 unit. Lifting and pulling the PCB out of the base plate can further disassemble the mouse unit.

Caution: The lens is not permanently attached to the sensor and will drop out of the assembly.

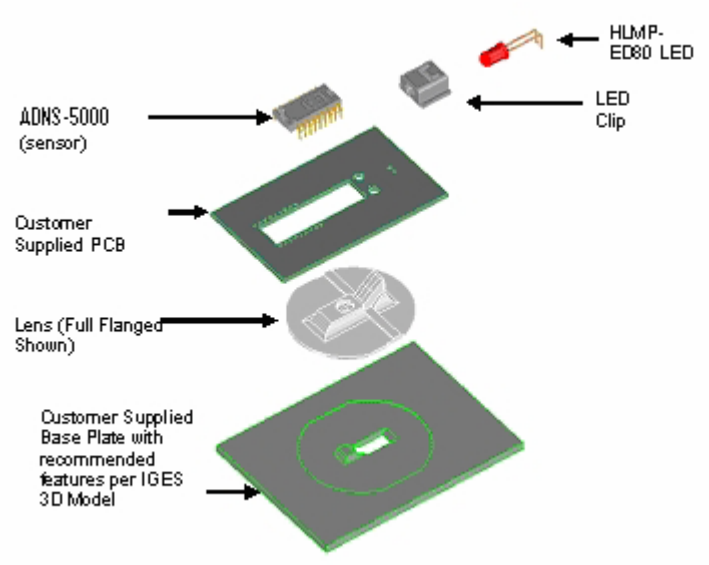


Figure 3. Exploded view drawing of optical tracking engine with ADNS-5000 optical mouse sensor.

While reassembling the components, please make sure that the Z height (Distance from lens reference plane to surface) is valid. The Z-height is from 2.3 to 2.5mm with a nominal of 2.4mm. Refer to Figure 4.

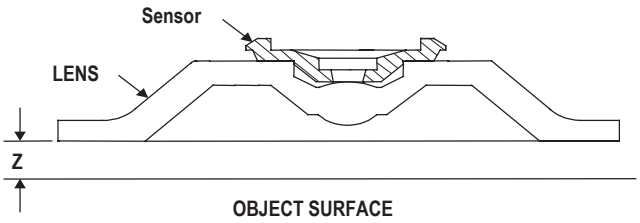


Figure 4. Distance from lens reference plane to surface

Regulatory Requirements

Passes FCC B and worldwide analogous emission limits when assembled into a mouse with unshielded 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 avoid discharge up to 15kV when assembled into a mouse according to usage instructions above.

Sensor

The sensor technical information is contained in the ADNS-5000 Data Sheet.

Lens

The lens technical information is contained in the ADNS-5100 Data Sheet. The flange on the standard ADNS-5100 lens is for ESD protection.

LED Assembly Clip

The information on the assembly clip is contained in the ADNS-5200 Data Sheet.

LED

The LED technical information is contained in the HLMP-ED80 Data.

Base Plate Feature – IGES File

The IGES file on the CD-ROM provides recommended base plate molding features to ensure optical alignment. This includes PCB assembly diagrams like solder fixture in assembly and exploded view, as well as solder plate. See Appendix D for details.

Reference Design Documentation – Gerber File

The Gerber File presents detailed schematics used in ADNK-5003 in PCB layout form. See Appendix C for more details.

Overall circuit

A schematic of the overall circuit is shown in Appendix A of this document. Appendix B lists the bill of materials.

USB Interface

All USB Human Interface Device (HID) class applications follow the same USB start-up procedure. The procedure is as follows

1. Device Plug-in

When a USB device is first connected to the bus, it is powered and running firmware, but communications on the USB remain non-functional until the host has issued a USB bus reset.

2. Bus Reset

The pull-up resistor on D– notifies the hub that a device has just been connected. The host recognizes the presence of a new USB device and initiates a bus reset to that device.

3. Enumeration

The host initiates SETUP transactions that reveal general and device specific information about the mouse. When the description is received, the host assigns a new and unique USB address to the mouse. The mouse begins responding to communication with the newly assigned address, while the host continues to ask for information about the device description, configuration description and HID report description. Using the information returned from the mouse, the host now knows the number of data endpoints supported by the mouse. At this point, the process of enumeration is completed.

USB Jumper Table

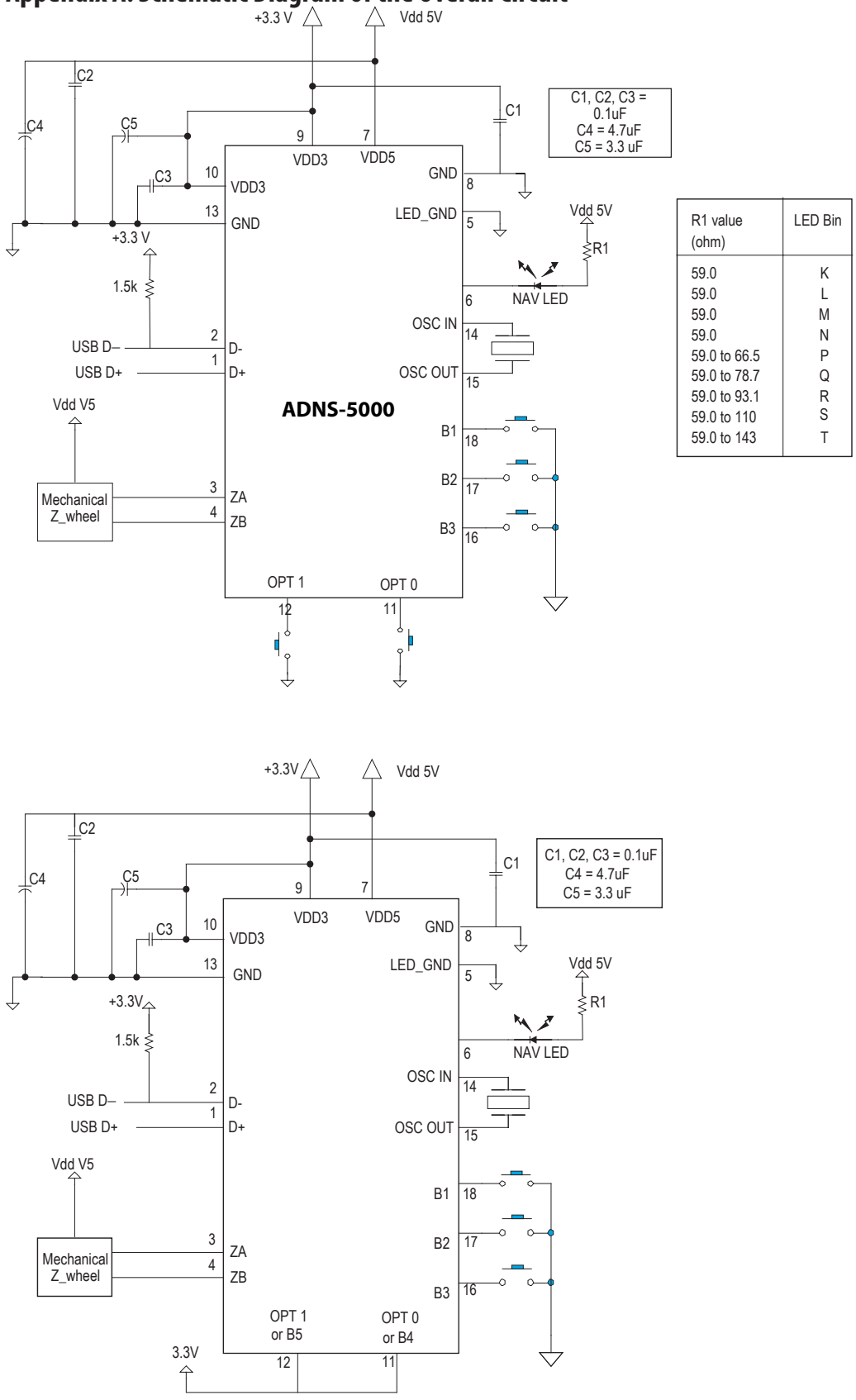
Below is the USB jumper table for ADNS-5000 sensor for both 3 button and 5 button USB mouse. Both mouse type will have different VID and PID strings. Also note the connections for OPT0 and OPT1.

Table 1. USB Strap (Jumper) Table

The PID/string strap matrix is the following:

Mouse Type	VID	PID	Manufacturing String	Product String	B1	B2	B3	OPT0	OPT1	ZA	ZB
3 button	0x192F	0x0116	“ “	USB Optical Mouse	sw1	sw2	sw3	Vdd3	Vdd3	Mech Z-wheel	Mech Z-wheel
5 button	0x192F	0x0216	“ “	USB Optical Mouse	sw1	sw2	sw3	sw4	sw5	Mech Z-wheel	Mech Z-wheel

Appendix A: Schematic Diagram of the Overall Circuit



R1 value (ohm)	LED Bin
59.0	K
59.0	L
59.0	M
59.0	N
59.0 to 66.5	P
59.0 to 78.7	Q
59.0 to 93.1	R
59.0 to 110	S
59.0 to 143	T

Figure A1. Circuit-level block diagram for ADNK-5003 designer's kit optical mouse using the Avago Technologies ADNS-5000 optical mouse

Appendix B: Bill of Materials for Components Shown on schematic

Part Type	Designator	Footprint	Description
59R	R8	AXIAL0.4	Resistor
750R	R7	AXIAL0.4	Resistor
1k	R3	AXIAL0.4	Resistor
1k	R1	AXIAL0.4	Resistor
1.5k	R9	AXIAL0.4	Resistor
10k	R2	AXIAL0.4	Resistor
10k	R4	AXIAL0.4	Resistor
22k	R5	AXIAL0.4	Resistor
22k	R6	AXIAL0.4	Resistor
100nF	C4	RAD0.1	Capacitor
100nF	C3	RAD0.1	Capacitor
100nF	C5	RAD0.1	Capacitor
3.3uF/16V	C1	RB.2/.4	Capacitor
4.7uF/16V	C2	RB.2/.4	Capacitor
Photo Transistor	LQ1	DIP	Sensor
PN2222A	Q2	TO-92	TRANSISTOR NPN General Purpose Amplifier
PN2222A	Q1	TO-92	TRANSISTOR NPN General Purpose Amplifier
24MHz	K1	DIP	Crystal
A5000	U1	DIP18	IC Mouse Sensor
HEADER 5	H1	HEADLOCK5P	FRICTION LOCKED
JUMPER-3	J1	JUMPER	PIN HEADER 2.54mm
JUMPER-3	J2	JUMPER	PIN HEADER 2.54mm
LED	D1	DIP	LED
NAV LED	D2	DIP	LED
SW SPDT	SW1	DIP	Switch
SW SPDT	SW2	DIP	Switch
SW SPDT	SW3	DIP	Switch

Appendix C: PCB Layout

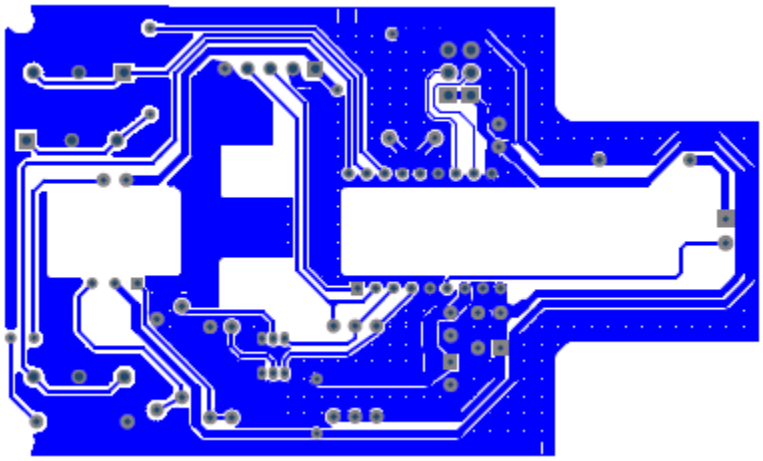


Figure C1. PCB Schematic (Bottom Layer)

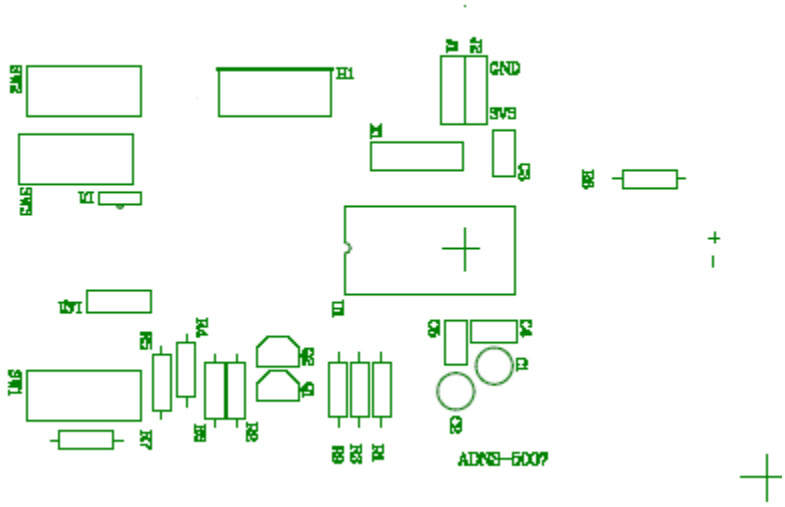


Figure C2. PCB Schematic (Top Overlay)

Appendix D: Base Plate Feature

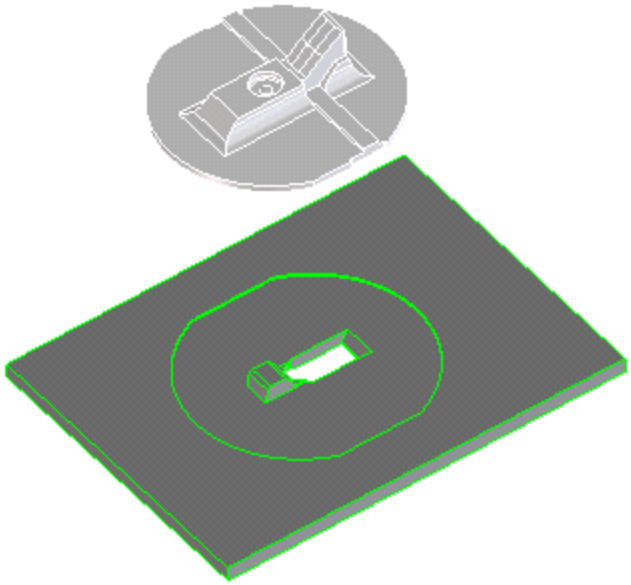


Figure D1. Overall view of base plate

Appendix E: Kit Components

The designer's kit contains components as follows:

Part Number	Description	Name	Quantity
ADNK-5003	Reference Design Mouse	Mouse	1
ADNS-5000	Solid-State Optical Mouse Sensor	Sensor	5
ADNS-5100	Round Lens Plate	Lens	5
ADNS-5100-001	Trim Lens Plate	Lens	5
ADNS-5200	LED Assembly Clip	LED Clip	5
HLMP-ED80-XX000	LED	LED	5
ADNK-5003 CD	Includes Documentation and Support Files for ADNK-5003 Documentation a. ADNS-5000 Optical Mouse Sensor Data Sheet b. ADNS-5100 Round Lens and ADNS-5100-001 Trim Lens Data Sheet c. ADNS-5200 LED Assembly Clip d. HLMP-ED80-XX000 LED Data Sheet Hardware Support Files a. ADNK-5003 BOM List b. ADNK-5003 Schematic c. 3D Model IGES Files d. Gerber File		1

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

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