

ADNK-2703

One Chip USB Mouse Designer's Kit



Design Guide



Description

The Universal Serial Bus (USB) is an industry standard serial interface between a computer and peripherals such as mouse, joystick, keyboard, headset, etc. The ADNK-2703 design guide describes how a cost-effective USB optical mouse can be built using the Avago Technologies ADNS-2700 one chip USB optical mouse sensor. The document starts with basic operation of USB optical mouse, followed by the assembly recommendation, USB interface, OTP configurations, system design considerations and applications circuits, BOM, and PCB layout in appendices.

ADNK-2703 consists of an ADNS-2700 USB reference design mouse, ADNS-2700 sensor along with the ADNS-5100 round lens or ADNS-5100-001 trim lens, the ADNS-5200 Clip, the HLMP-EG3E-XXXXX LED sample units and CD-ROM with all relevant technical literatures and hardware files. The on-chip One-Time-Programmable (OTP) memory provides flexibility for various configurations on resolution mode, USB motion data reporting size, customizable VID and PID. The ADNS-2700 sensor, the ADNS-5100 round lens or ADNS-5100-001 trim lens, the ADNS-5200 Clip, and the HLMP-EG3E-XXXXX LED data sheets are available from Avago Technologies website: www.avagotech.com.

USB Mouse Basic

The ADNS-2700 is the primary navigation engine of the USB optical mouse based on optical navigation technology that measures changes in position by optically acquiring sequential surface images (per frames) and mathematically determining the direction and magnitude of motion movement. 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. 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 via USB protocol to the computer to translate into the motion of a cursor pointer on a screen display.

The Z-wheel movement is done in the traditional method by encoding the quadrature signal of an optical sensor or mechanical encoder. This design guide shows how to connect to and manage the available configuration of mouse hardware via OTP programming, as well as handle the USB protocols as a standard way of reporting mouse movement and button presses to the PC.

Features

- One chip USB mouse sensor
- USB 2.0 Low Speed Compliance
- 12 bits USB motion data reporting
- Meets HID Revision 1.11
- Single 5.0 volts power supply
- High speed motion detection at 30 inches per second (ips) and acceleration up to 8 g
- Input buttons: 3 buttons
- Z-Wheel interface for vertical scroll
- Integrated oscillator
- Integrated USB D- pull-up resistor
- Product string is set to "USB Optical Mouse"
- On-chip OTP memory for device configuration flexibility without any external software driver:
 - Programmable resolution from 500 to 1250 counts per inch (cpi) with 250 cpi step.
 - Programmable sensor orientation
 - Programmable VID and PID.

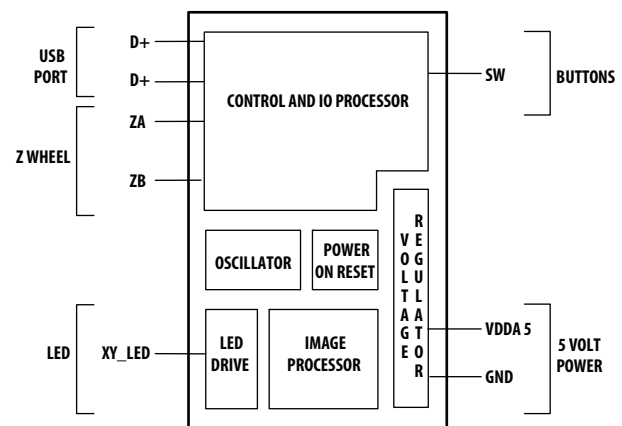


Figure 1. ADNS-2700 3 button Optical Mouse Hardware Block Diagram

Buttons

In this reference design, there are 3 standard button inputs: B1, B2 and B3 for left, right, middle button click respectively. The minimum time between button pressed is TDBB. The button connection is described in Figure 2.

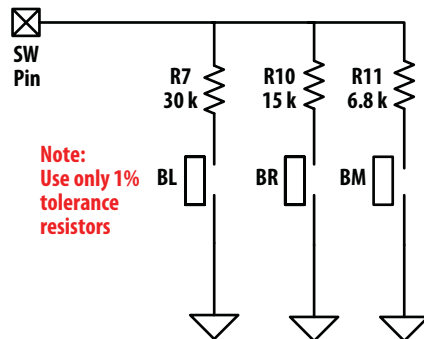


Figure 2. Button connections

Debounce Algorithm

- Button inputs B1, B2, and B3 are sampled every 6 ms.
- Two consecutive low values create a button press event.
- Three consecutive high values create a button release event.

Mechanical Z-Wheel

The motion of Z-wheel is detected using traditional method by encoding quadrature signal generated by the mechanical Z-encoder. ADNS-2700 supports only mechanical Z-Wheel for vertical scrolling. The mechanical Z-wheel will be connected to the ZA and ZB pins with the common pin connected to VDD5. Internal pulldowns on the ZA and ZB pads provide a nominal pulldown current to pull the output down when the Z-wheel switch opens.

The Z-Wheel reporting format which determines the vertical scroll resolution is $Z/2$. The following must be implemented when using with ADNS-2700. As shown in Figure 3 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.

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 "ZA" 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).

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 3 where the z-wheel detents are mechanically stable.

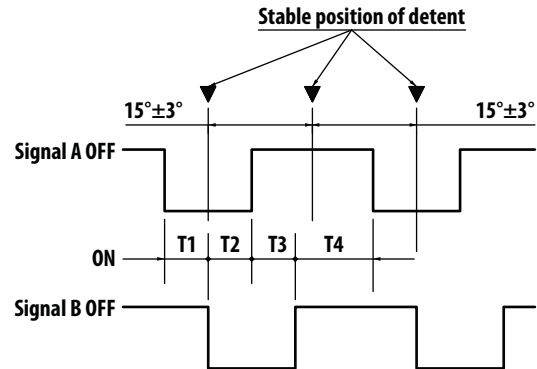


Figure 3. Optics Quadrature Signal Generation

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/IEC801-4EFT 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 15 kV when assembled into a mouse with ADNS-5100 round lens according to usage instructions above.

Some details on ADNK-2703

The ADNK-2703 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. The optical mouse uses the ADNS-2700. This kit also enables users to understand the recommended mechanical assembly. (See Appendix C and D)

System Requirements

PCs using Windows® 2003/ Windows® XP/ Windows® Vista with standard 3-button USB mouse driver loaded.

Functionality

3-button, mechanical 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.

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

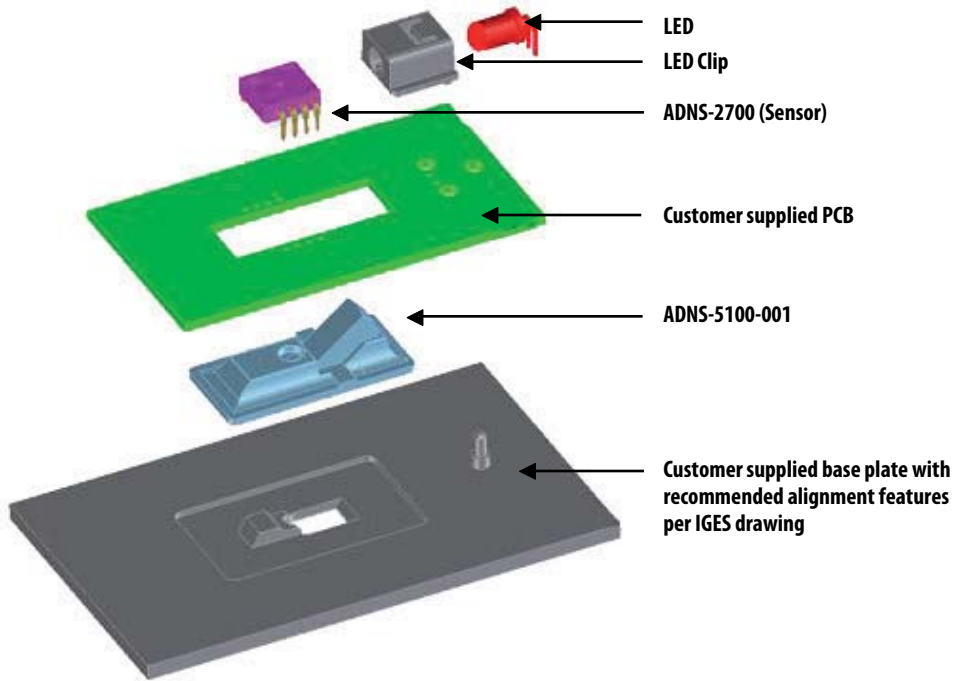


Figure 4. Exploded view drawing of optical tracking engine with ADNS-2700 optical mouse sensor.

To Disassemble the ADNK-2703 Unit

The ADNK-2703 comprises of the plastic mouse casing, printed circuit board (PCB), lens, buttons, and USB cable. (See Figure 4) Unscrewing the one screw located at the base of the unit can open the ADNK-2703 unit. Lifting and pulling the PCB out of the base plate can further disassemble the mouse unit.

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 2.5 mm with a nominal of 2.4 mm. Refer to Figure 5.

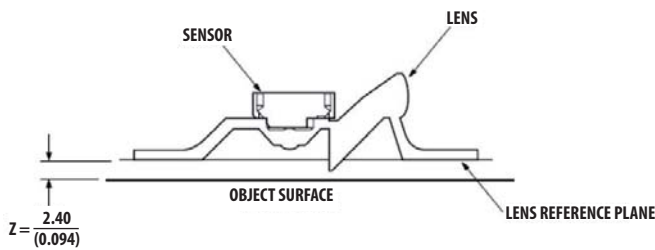


Figure 5. Distance from lens reference plane to surface

Sensor

The sensor technical information is contained in the ADNS-2700 Data Sheet.

Lens

The lens technical information is contained in the ADNS-5100 round lens or ADNS-5100-001 trim lens Data Sheet.

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-EG3E 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-2703 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 (2). At this point, the process of enumeration is completed.

Appendix A: Schematic Diagram of the Overall Circuit

A1 Schematic for main board circuit using Avago Technologies ADNS-2700 optical mouse

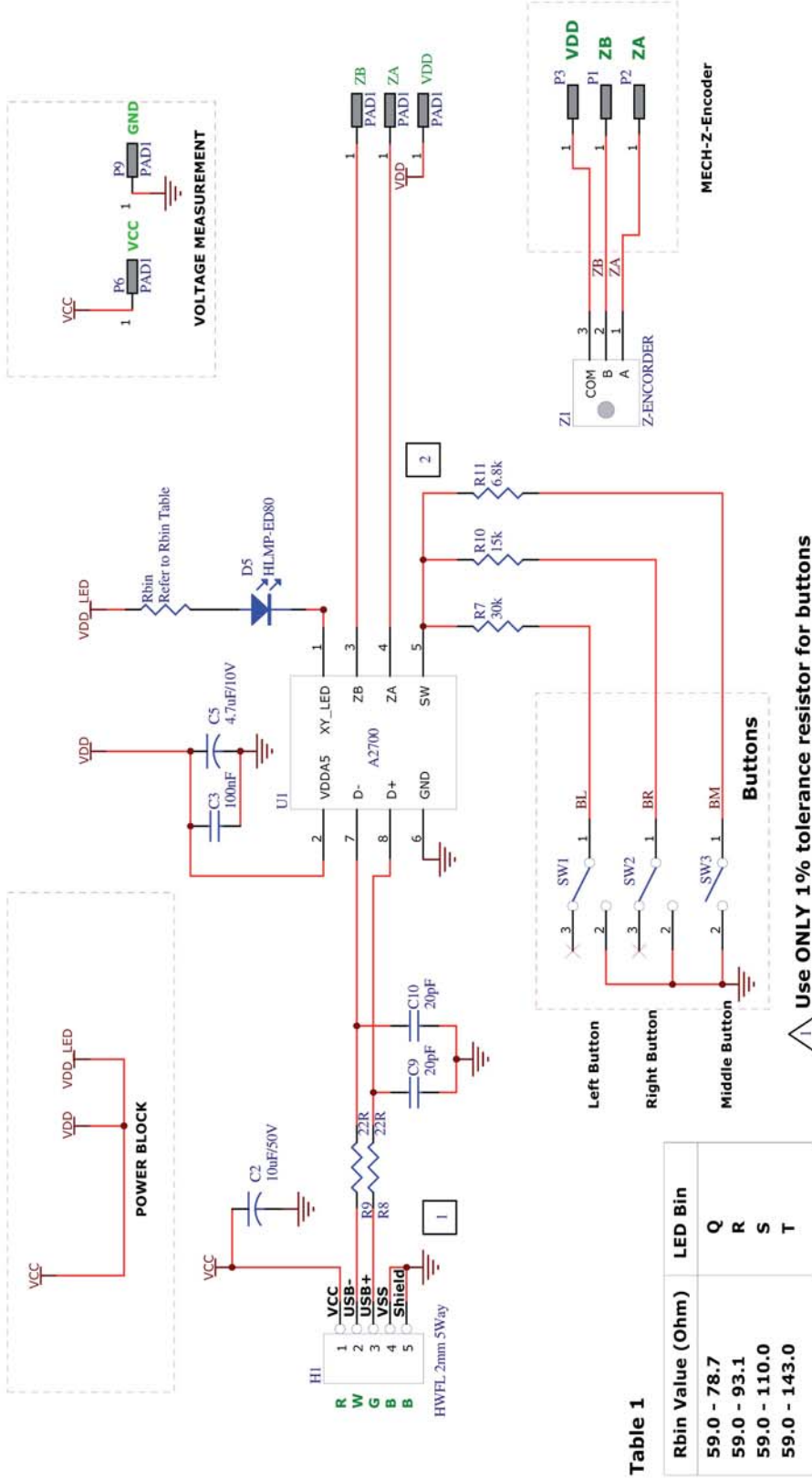


Table 1

Rbin Value (Ohm)	LED Bin
59.0 - 78.7	Q
59.0 - 93.1	R
59.0 - 110.0	S
59.0 - 143.0	T

- 1 Try to shield the HWFL with a SHIELD Plane(USB pin 5) similar size of HWFL before connect to GND.Isolate the Shield island with GND plane
- 2 Don't use jumper wire.Use resistor to jump instead.Keep the trace wide.
Keep (pin 5) away from noisy traces, GND plane & Power plane.
The 3 button trace for SW pin need to be same width, length.

Appendix B: Bill of Materials for Components Shown on schematic

No	Description	RoHS	F. Print	Designator	Qty
1	LED Clip	TBA	-	D5	1
2	Black wire single core	No	N/A	J1.J2	2
3	Cable - USB Cable A Type 5P	No	N/A	H1	1
4	Capacitor Ceramic 0603 20 pF 50 V C0G	Yes	0603	C9, C10	2
6	Capacitor Aluminium Electrolytic Radial 10 µF 50 V 20% 7.5 mm	Yes	RB2/5	C2	1
7	Capacitor Ceramic Radial 100 nF 50 V Y5 V +80%,-20% 5 mm	Yes	RAD5/6.2/2	C3	1
8	Capacitor Aluminium Radial 4.7 µF 16 V 20% 2 mm	Yes	RB2/5	C5	1
9	RCPT Pin Receptacle 1.02 mm	Yes	RCPT_1.02	U1	8
10	HWFL Header 2 mm 5way	TBA	HWFL_2/1X4	H1	1
11	PCB, P-AFX-4510M-01-Rev1, 2 Layer – ADNS-2700 Reference Design Corded Mouse (NRD-1165)	Yes	N/A	-	1
13	Resistor Axial 0R 5% 0.25 W	Yes	AXIAL_0.5H	R3	1
15	Resistor Axial 22R 1% 0.25 W Metal Film	Yes	AXIAL_0.5H	R8, R9	2
16	Resistor Axial 30k 1% 0.25 W Metal Film	Yes	AXIAL_0.5H	R7	1
17	Resistor Axial 15k 1% 0.25 W Metal Film	Yes	AXIAL_0.5H	R10	1
18	Resistor Axial 6.8k 1% 0.25 W Metal Film	Yes	AXIAL_0.5H	R11	1
19	Resistor Axial 62R 1% 0.125 W Metal Film	Yes	AXIAL_0.5H	R5	1
20	Micro Switch SPDT Pin Plunger 0.75N	Yes	TH_D2F-F	SW1, SW2	2
21	LED 5 mm Red	No	LED_5MM	D5	1
22	Tactile Switch SPNO 6 mm x 6 mm Flat Plunger (U-83 Casing) – Middle	No	U-83 TACTILE DIP SWITCH	SW3, SW4, SW5	3

Appendix D: Kit Components

The designer's kit contains components as follows:

Part Number	Description	Name	Quantity
ADNS-2700	Single Chip USB Optical Mouse Sensor	Sensor	5
ADNS-5100	Round Lens	Lens	5
ADNS-5100-001	Trim Lens	Lens	5
ADNS-5200	LED Assembly Clip Plate (Black Clip)	LED Clip	5
HLMP-EG3E	Red LED	LED	5
ADNK-2703 CD	a. ADNS-2700 Single Chip USB Optical Mouse Sensor Data Sheet b. ADNS-5100 / ADNS-5100-001 Data Sheet c. ADNS-5200 LED Assembly Clip Data Sheet d. HLMP-EG3E Red LED Data Sheet e. 3D Model IGES Files Hardware Support Files ADNK-2703 BOM List a. ADNK-2703 Schematic b. IGES Base Plate Feature File c. Gerber File Software Support Files a. OTP Programming Reference Software b. USB Mouse Programming Guide Applications Note		1

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

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