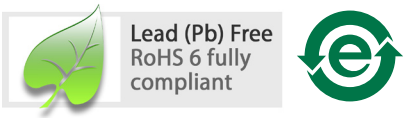
ADNK-7053-ND24

2.4GHz RF Wireless USB Laser Mouse Designer's Kit

Design Guide



Introduction

This design guide describes the design of a low power consumption optical mouse using the new Avago Technologies ADNS-7050 low power laser mouse sensor, Texas Instruments MSP430F1222 microcontroller and Nordic Semiconductor nRF2402 2.4GHz RF transmitter. The receiver dongle is implemented with a Nordic Semiconductor nRF2401A 2.4GHz RF transceiver in conjunction with a Cypress CY7C63231A enCoRe™ USB controller. This reference design kit provides a power efficient and feature-rich solution in one neat package.

The design guide discusses the reference design hardware and firmware implementation. The document starts with the basic operations of a computer mouse peripheral followed by an introduction to the Avago Technologies ADNS-7050 low power laser mouse sensor, the Nordic Semiconductor nRF2402 transmitter and nRF2401A transceiver, Texas Instruments MSP430F1222 microcontroller and Cypress CY7C63231A enCoRe™ USB controller. The software section of this application note describes the architecture of the firmware required to implement the mouse and the USB dongle functions. Included in Appendix A is the schematic for this reference design mouse and USB dongle.

The Avago Technologies ADNS-7050 Low Power Laser Mouse is the world's first laser-illuminated navigation system enabled for cordless application. Powered by Avago Technologies LaserStream technology, the mouse can operate on many surfaces that proved difficult for traditional LED-based optical navigation. The ADNS-7050 sensor along with the ADNS-6120 or ADNS-6130-001 lens, ADNS-6230-001 clip and ADNV-6340 VCSEL form a complete and compact laser mouse tracking system. There is no moving part, which means high reliability and less maintenance for the end user. In addition, precision optical alignment is not required, facilitating high volume assembly.

The ADNS-7050 Low Power Laser Mouse Data Sheet is available from the Avago Technologies web site at www.avagotech.com. The MSP430F1222 data sheet is available on the TI web site at www.ti.com. The nRF2402 transmitter and nRF2401A transceiver data sheets are available on the Nordic Semiconductor web site at www.nordicsemi.com. The CY7C63231A enCoRe™ USB microcontroller data sheet can be found on the Cypress web site: www.cypress.com.

Features

- Complete wireless laser mouse reference design kit
- Windows® 98SE, Windows 2000 and Windows XP compatibility
- USB 2.0 low-speed compliance
- User identity code to avoid conflict with other devices
- High reliability
- New LaserStream Technology
- Smooth surface navigation
- Enhanced SmartSpeed self-adjusting frame rate for optimum performance
- High speed motion detection up to 20 ips and 8 g
- 800 cpi resolution
- No mechanical moving parts
- A high data rate 2.4GHz RF link
- Transmission data rate up to 1 Mbps
- 15 meters communication distance
- Self-adjusting power-saving modes for longest battery life
- Laser fault detect circuitry on-chip for Eye Safety Compliance
- Minimal number of passive components

Optical Mouse Basics

The image-based optical mouse sensor takes snap shots of the surface it is navigating on. It measures changes in position by comparing the sequential images (frames) and mathematically determines the direction and magnitude of movement. The traditional duel-channel optical encoder generates the quadrature Z-wheel movement signals. This design guide illustrates the hardware connection of a LED-based optical mouse with standard configuration; as well as the firmware management and the handling of the USB protocols. USB protocol provides a standard way of reporting mouse movement and button presses to the PC. The Windows HID driver interprets the USB data and performs the cursor movements and mouse clicks.

The functional block diagram of the reference design mouse is shown in Figure 1. The optical sensor detects the X and Y movements. A mechanical quadrature encoder provides the Z-wheel movement. Each of the button switches is pulled up normally and provides a Ground when pressed. The TSP61070 boost regulator maintains the 2.7 V operating voltage for the reference design mouse from two regular AA Alkaline batteries in parallel. The controls and data are transmitted through 2.4GHz RF by nRF2402 transmitter and received by the nRF2401A transceiver at the dongle. The control of the mouse is managed by the MSP430F1222 microcontroller; while the dongle is controlled by CY7C63231A USB controller.

Mechanical Z-Wheel

The motion of Z-wheel is detected using the traditional method by decoding the quadrature signal generated by mechanical encoder. The Z-pinwheel is connected to the Z-encoder through its shaft. The rotational movement of the shaft is decoded into on and off levels in a quadrature output pattern. Every change in the Z-encoder outputs represents a count of mouse movement. Comparing the last state of the Z-encoder to the current state derives direction information. As shown in Figure 2, traveling in clockwise direction produces a unique set of state transitions, and traveling in counter clockwise direction produces another set of unique state transitions. In this reference design, only the motion at the Z-wheel is detected using this method.

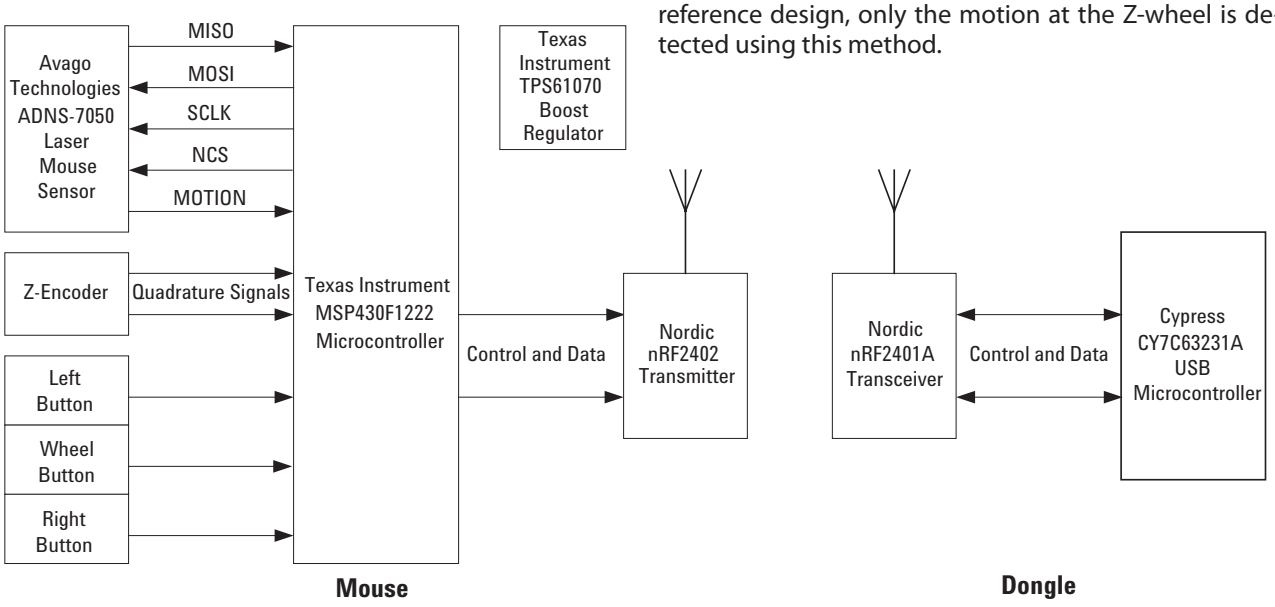


Figure 1. ADNK-7053-ND24 Reference Design Mouse Functional Block Diagram

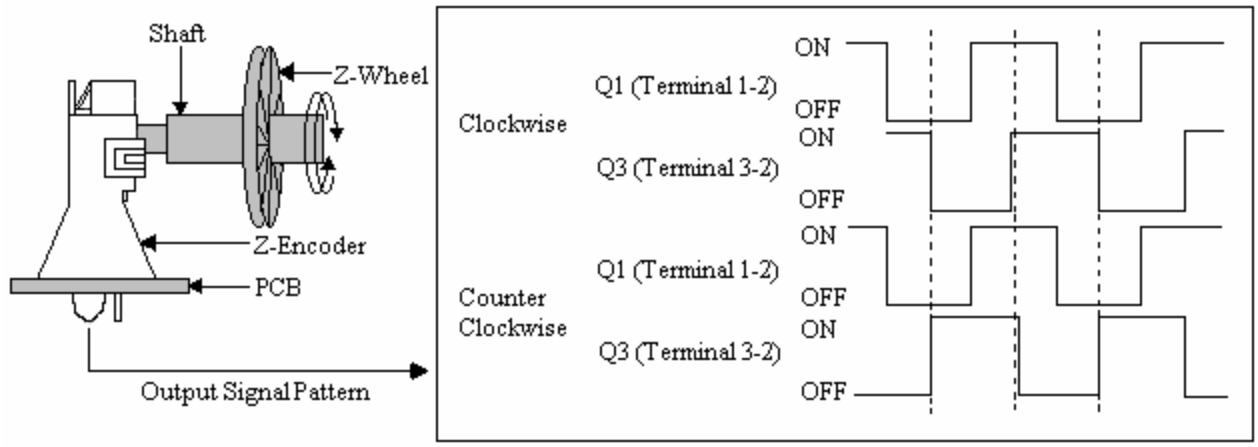


Figure 2. Mechanical Z-Wheel Output Signal Generation

Mouse Buttons

Mouse buttons are connected as standard switches. These switches are pulled up by the pull up resistors inside the microcontroller. 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 15-20ms. In this reference design there are three switches: left, Z-wheel, and right.

Avago Technologies ADNS-7050 Low Power Laser Mouse Sensor

Avago Technologies ADNS-7050 laser mouse sensor is used in this reference design as the primary navigation engine. Based on LaserStream™ Technology, the ADNS-7050 contains an Image Acquisition System (IAS), a Digital Signal Processor (DSP) and a four-wire serial port. Its high-performance, low power architecture is capable of sensing high-speed mouse motion while prolonging battery life, two performance areas essential in demanding wireless applications. The MSP430F1222 microcontroller periodically reads the ADNS-7050's Delta_X and Delta_Y registers to obtain any horizontal and vertical motion information happening as a result of the mouse being moved. The output of the ADNS-7050 laser mouse optical sensor is four-wire serial port.

This motion information will be reported to the PC through the 2.4 GHz RF and USB protocols to update the position of the cursor. The advantages of using ADNS-7050 laser mouse sensor are the efficient power management, best tracking accuracy and flexibility of programming the optical sensor via the SPI port. Besides, ADNS-7050 laser mouse sensor performs excellent tracking on difficult surfaces which conventional LED-based technology is unable to track such as glossy and smooth surfaces. In addition, the self-adjusting power-saving modes feature made the ADNS-7050 laser mouse sensor to be the choice of wireless mouse design for longest battery life.

Features

- Low power architecture
- New LaserStream technology
- Self-adjusting power-saving modes for longest battery life
- High speed motion detection up to 20ips and 8g
- Enhanced SmartSpeed self-adjusting frame rate for optimum performance
- Motion detect pin output
- Internal oscillator – no clock input needed
- Selectable 400 and 800 cpi resolution
- Wide operating voltage: 2.7V - 3.6V nominal
- Four wire serial port
- Minimal number of passive components
- Laser fault detect circuitry on-chip for Eye Safety Compliance

To learn more about sensor's technical information, please visit the Avago Technologies web site at http://www.avagotech.com.

Texas Instrument MSP430F1222 Microcontroller

The Texas Instruments MSP430 family of ultra-low power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architecture, combined with five low-power modes, is optimized to achieve extended battery life in portable measurement applications. The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that attribute to maximum code efficiency. The Digitally Controlled Oscillator (DCO) allows wake-up from low-power modes to active mode in less than 6 µsec.

The specific device used in this reference design is the MSP430F1222 with 28 pin to accommodate ample amount of I/O. It is an ultra-low power mixed-signal microcontrollers with a built-in 16-bit timer, 10-bit A/D converter with integrated reference and Data Transfer Controller (DTC), and 14 (20 pin package) or 22 (28 pin package) general purpose I/O pins. The MSP430x12x2 series microcontrollers have built-in communication capability using asynchronous (UART) and synchronous (SPI) protocols. The architecture, combined with five low power modes is optimized to achieve extended battery life on wireless application.

Features

- Low Supply Voltage Range 1.8 V to 3.6 V
- Ultralow-Power Consumption:
  - Active Mode: 200 µA at 1 MHz, 2.2 V
  - Standby Mode: 0.7 µA
  - Off Mode (RAM Retention): 0.1 µA
- Five Power Saving Modes
- Wake-Up From Standby Mode in less than 6 µs
- 16-Bit RISC Architecture, 125 ns Instruction Cycle Time
- Basic Clock Module Configurations:
  - Various Internal Resistors
  - Single External Resistor
  - 32-kHz Crystal
  - High Frequency Crystal
  - Resonator
  - External Clock Source
- 16-Bit Timer_A With Three Capture/Compare Registers
- 10-Bit, 200-ksps A/D Converter With Internal Reference, Sample-and-Hold, Autoscan, and Data Transfer Controller
- Serial Communication Interface (USART0) With Software-Selectable Asynchronous UART or Synchronous SPI
- Serial Onboard Programming, No External Programming Voltage Needed Programmable Code Protection by Security Fuse
- Supply Voltage Brownout Protection
- 4KB + 256B Flash Memory 256B RAM
- Available in 28-Pin Plastic SOWB, 28-Pin Plastic TSSOP, and 32-Pin QFN Packages

For Complete Module Descriptions, See the TI MSP430x1xx Family User's Guide, Literature Number SLAU049

Cypress CY7C63231 enCoRe™ USB Controller

The Cypress enCoRe™ USB controller is a revolutionary chip that integrates numerous common components, including breakthrough crystal-less oscillator and other external components commonly found in low-speed USB applications such as pull-up resistors, wake-up circuitry, and a 3.3V regulator. The result is an overall reduction in board components and reduced system cost. The EPROM based microcontroller allows easy firmware modification, as well as storage of Vendor and Product ID™s without an external EEPROM.

Features

- enCoRe™ USB - enhanced Component Reduction
  - Internal oscillator eliminates the need for an external crystal or resonator
  - Interface can auto-configure to operate as PS/2 or USB without the need for external components to switch between modes (no GPIO pins needed to manage dual mode capability)
  - Internal 3.3V regulator for USB pull-up resistor
  - Configurable GPIO for real-world interface without external components
- USB Specification Compliance
  - Conforms to USB Specification, Version 2.0
  - Conforms to USB HID Specification, Version 1.1
  - Supports 1 low-speed USB device address
  - Supports 1 control endpoint and 1 data endpoint
  - Integrated USB transceiver
  - 3.3V regulated output for USB pull-up resistor
- 8-bit RISC microcontroller
  - Harvard architecture
  - 6-MHz external ceramic resonator or internal clock mode
  - 12-MHz internal CPU clock
  - Internal memory
    - 96 bytes of RAM
    - 3 Kbytes of EPROM
  - Interface can auto-configure to operate as PS/2 or USB
  - No external components for switching between PS/2 and USB modes
- I/O ports
  - Up to 10 versatile General Purpose I/O (GPIO) pins, individually configurable
  - High current drive on any GPIO pin: 50 mA/pin current sink
  - Each GPIO pin supports high-impedance inputs, internal pull-ups, open drain outputs, or traditional CMOS outputs
  - Maskable interrupts on all I/O pins
  - XTALIN, XTALOUT and VREG can be configured as additional input pins
- Internal low-power wake-up timer during suspend mode
  - Periodic wake-up with no external components
- Optional 6-MHz internal oscillator mode
  - Allows fast start-up from suspend mode
- Watchdog timer (WDT)
- Low-voltage Reset at 3.75V
- Internal brown-out reset for suspend mode
- Improved output drivers to reduce EMI
- Operating voltage from 4.0V to 5.5VDC
- Operating temperature from 0 to 70 degrees Celsius
- CY7C63231 available in 18-pin SOIC, 18-pin PDIP
- Industry-standard programmer support

Nordic Semiconductor nRF2402 2.4GHz Transmitter and nRF2401A 2.4GHz Transceiver

The Nordic nRF2402 and nRF2401A are the low-power, single-chip radio transmitter and transceiver for the world wide 2.4 - 2.5 GHz ISM band. The entire transmitter and transceiver including all inductors and filters are integrated in each single chip respectively which gives the lowest cost solution to the end user. All configurations of the nRF2402 transmitter and nRF2401A transceiver are done via a standard serial interface. The nRF devices include the ShockBurst engine which allow for high datarates on air using low datarates between the microcontroller and the nRF device, it will also automatically validate the packets address and CRC, further reducing the microcontrollers processing tasks.

Features for nRF2402 2.4GHz Transmitter

- True single chip GFSK transmitter in a small 16-pin package (QFN16 4x4)
- Adjustable output power up to 0dBm
- Data rate 0 to 1Mbps
- Low Bill of Material
- Multi Channel operation
- 128 channels
- Support frequency hopping
- Channel switching time <200ms.
- Power supply range: 1.9 to 3.6 V
- CRC computation
- ShockBurst™ mode for ultra-low power operation
- Low supply current, typical 10mA peak @ -5dBm output power
- 100% RF tested

Features for nRF2401A 2.4GHz Transceiver

- True single chip GFSK transceiver in a small 24-pin package (QFN24 5x5mm)
- Data rate 0 to 1Mbps
- Only 2 external components
- Multi channel operation
- 125 channels
- Channel switching time <200ms.
- Support frequency hopping
- Data slicer / clock recovery of data
- Address and CRC computation
- DuoCeiver™ for simultaneous dual receiver topology
- ShockBurst™ mode for ultra-low power operation and relaxed MCU performance
- Power supply range: 1.9 to 3.6 V
- Low supply current (TX), typical 10.5mA peak @ -5dBm output power
- Low supply current (RX), typical 18mA peak in receive mode
- 100 % RF tested
- No need for external SAW filter

Wireless RF Technology

This reference design is implementing with one-way communication using a transmitter-receiver solution. The nRF2402 transmitter consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator and a modulator. The output power and channel are programmed through the SPI. Chip Select (CS) is used to enable the nRF2402 when the microcontroller is ready to pass it the motion or button switch data. Once the data has been loaded into its input buffer the nRF2402 manages the transmission and returns to power down mode to conserve battery power. Typical power consumption is 10 mA at -5 dBm of output power. For more detail on the Nordic 2.4GHz RF technology, please read Nordic's application notes nAN400-07 on nRF™ Radio protocol guidelines.

The nRF240x has two transmit modes:

- ShockBurst™
- Direct Mode

In this reference design ShockBurst™ is used to capitalize on its benefit. It utilizes the on-chip FIFO to accept SPI data at the microcontroller operating rate but transmit at very high rate (up to 1 Mbps). The short transmission time enables extreme power saving. For detailed description of the ShockBurst™ technology please refer to Nordic's white paper on nRF240x ShockBurst™ Technology.

High-frequency PCB layout:

A well-designed PCB is necessary to achieve good RF performance. A fully qualified RF layout for the nRF2402 and its surrounding components, including matching networks for the antenna can be downloaded from: www.nordicsemi.no.

A PCB with a minimum of two layers including a ground plane is recommended for optimum performance. The nRF2402 DC supply should be well filtered and decoupled as close as possible to the Vdd pins with high performance RF capacitors. Specifically a high-grade SMD tantalum capacitor (e.g. 4.7 µF) should be used in parallel with the smaller-value high-frequency bypassing capacitors. The nRF2402 should have its own branch of well-filtered supply voltage, routed separately from the supply voltage for the digital circuitry. Full swing digital signals should not be routed close to the crystal or the power supply lines.

The receiver is a design from Nordic that is ready to use in any wireless mouse/keyboard application based on the nRF2401A transceiver. Please read Nordic's application note nAN24-04 to learn more about the "Universal low cost USB DuoCeiver™ using nRF2401™".

Hardware Implementation

In order to provide the maximum flexibility the reference design mouse utilizes three circuit boards. Two sub boards for ADNS-7050 navigation sensor and VCSEL board while the other board is for scroll wheel and button switches. Two pin headers connect the sub boards to the main board. The MSP430F1222 microcontroller and the Nordic nRF2401A 2.4 GHz transmitter with its associated circuit including the antenna reside on the main board.

Serial Peripheral Interface (SPI)

The MSP430F1222 provides a dedicated hardware-based Serial Peripheral Interface (SPI). The three-wire interface supports byte serial communication in either Master or Slave mode. In this reference design the MSP430F1222 always acts as the master and initiates all SPI communications with external SPI device(s), in this case the ADNS-7050 and the nRF2401A.

Some details on ADNK-7053-ND24

The ADNK-7053-ND24 reference design mouse unit allows users to evaluate the performance of the Optical Tracking Engine (sensor, lens, VCSEL assembly clip, VCSEL) over a USB connection, using a Cypress USB Controller. This kit also enables users to understand the recommended mechanical assembly. (See Appendix C, D, and E)

System Requirements

PCs using Windows® 95/ Windows® 98/ Windows® NT/ Windows® 2000 with standard 3-button USB mouse driver loaded.

Functionality

3-button, scroll wheel USB-mouse.

USB Operating 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-7053-ND24 Unit

The ADNK-7053-ND24 comprises of the plastic mouse casing, printed circuit board (PCB), lens, buttons, and batteries (See Figure 4). Unscrewing the one screw located at the base of the unit can open the ADNK-7053-ND24 mouse unit. Lifting and pulling the PCB out of the base plate can further disassemble the mouse unit.

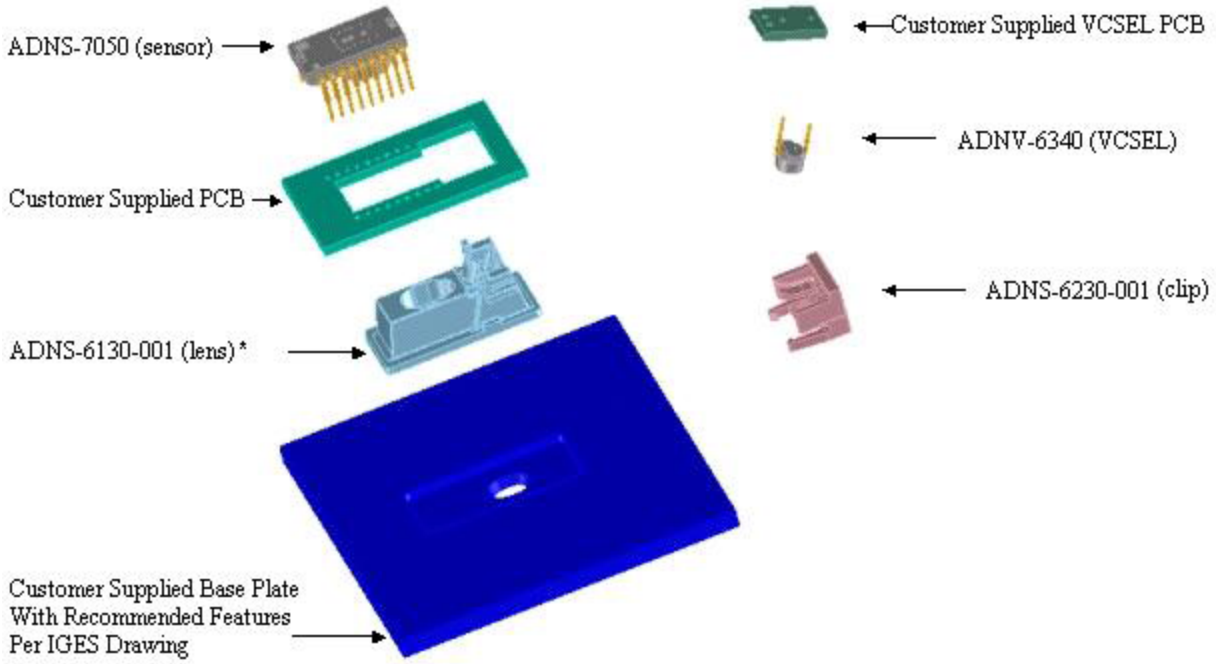


Figure 3. Exploded view drawing of optical tracking engine with ADNS-7050 laser mouse sensor

While reassembling the components, please make sure that the Z height (Distance from lens reference plane to surface) is valid. Refer to Figure 5.

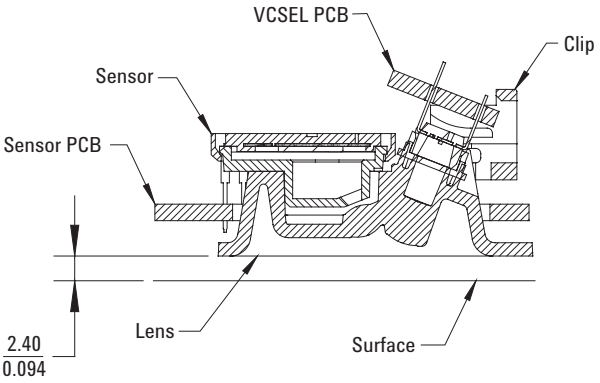


Figure 5. Distance from lens reference plane to surface

Regulatory Requirements

- Passes FCC B and worldwide analogous emission limits when assembled into a mouse with shielded cable and following Avago Technologies recommendations.
- Passes IEC-1000-4-3 radiated susceptibility level 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 avoid discharge up to 15kV when assembled into a mouse according to usage instructions above.
- For eye safety consideration, please refer to the document, Eye Safety Calculation AN5230 available on the Avago Technologies web site.

Eye Safety

The ADNS-7050 and the associated components in the schematic of Appendix A are intended to comply with Class 1 Eye Safety Requirements of IEC 60825-1. Avago Technologies suggests that manufacturers perform testing to verify eye safety on each mouse. It is also recommended to review possible single fault mechanisms beyond those described below in the section "Single Fault Detection" of ADNS-7050 datasheet. Under normal conditions, the ADNS-7050 generates the drive current for the laser diode (ADNV-6340).

In order to stay below the Class 1 power requirements, LASER_CTRL0 (register 0x1a), LASER_CTRL1 (register 0x1f), LSRPWR_CFG0 (register 0x1c) and LSRPWR_CFG1 (register 0x1d) must be programmed to appropriate values that ADNV-6340 VCSEL will gives the output beam power as close to 506uW as possible without exceeding it. The system comprised of the ADNS-7050 and ADNV-6340, is designed to maintain the output beam power within Class 1 requirements over components manufacturing tolerances and the recommended temperature range when adjusted per the procedure below and implemented as shown in the circuit in Appendix A. For more information, please refer to Eye Safety Application Note AN5230.

LASER Power Adjustment Procedure

1. The ambient temperature should be 25C± 5C.
2. Set VDD3 to its permanent value.
3. Set the Range bit (bit 7 of register 0x1a) to 0.
4. Set the Range_C complement bit (bit 7 of register 0x1f) to 1.
5. Set the Match_bit (bit 5 of register 0x1a) to the correct value for the bin designation of the laser being used.
6. Set the Match_C_bit (bit 5 of register 0x1f) to the complement of the Match_bit.
7. Enable the Calibration mode by writing to bits [3,2,1] of register 0x1A so the laser will be driven with 100% duty cycle.
8. Write the Calibration mode complement bits to register 0x1f.
9. Set the laser current to the minimum value by writing 0x00 to register 0x1c, and the complementary value 0xFF to register 0x1d.
10. Program registers 0x1c and 0x1d with increasing values to achieve an output power as close to 506uW as possible without exceeding it. If this power is obtained, the calibration is complete, skip to step 14.
11. If it was not possible to achieve the power target, set the laser current to the minimum value by writing 0x00 to register 0x1c, and the complementary value 0xff to register 0x1d.
12. Set the Range and Range_C bits in registers 0x1a and 0x1f, respectively, to choose to the higher laser current range.
13. Program registers 0x1c and 0x1d with increasing values to achieve an output power as close to 506uW as possible without exceeding it.
14. Save the value of registers 0x1a, 0x1c, 0x1d, and 0x1f in non-volatile memory in the mouse. These registers must be restored to these values every time the ADNS-7050 is reset.
15. Reset the mouse, reload the register values from non-volatile memory, enable Calibration mode, and measure the laser power to verify that the calibration is correct.

Good engineering practices such as regular power meter calibration, random quality assurance retest of calibrated mice, etc. should be used to guarantee performance, reliability and safety for the product design.

LASER Output Power

The laser beam output power as measured at the navigation surface plane is specified below. The following conditions apply:

1. The system is adjusted according to the above procedure.
2. The system is operated within the recommended operating temperature range.
3. The VDD3 value is no greater than 300mV above its value at the time of adjustment.
4. No allowance for optical power meter accuracy is assumed.

Below is the summary of the components contained in the ADNK-7053-ND24 Designer's Kit.

Laser Mousse Sensor, Lens, VCSEL Assembly Clip and VCSEL

The sensor, lens, assembly clip and VCSEL technical information are contained in the ADNS-7050 Low Power Laser Mouse Data Sheet. Additional application notes regarding Eye Safety Requirements are also available at Avago Technologies website.

RF Transmitter and Transceiver

Technical information on the Nordic Semiconductor nRF2402 and nRF2401A are detailed in the datasheets. The RF design considerations are available in the application notes that can be found in Nordic's website.

Microcontrollers

Technical information on the TI MSP430F1222 microcontroller is contained in the TI Data Sheet. Please contact your local TI office for theMSP430 development tools. These tools will allow the designer to make changes and recompile the source code; perform In-Circuit Emulation and debug new code for added features. Programming support and programmer adaptors for the MSP430 can be found through TI or through other 3rd party programming tool companies. For further information on this product, please contact Texas Instrument.

Cypress Semiconductor provides extensive development tools for the CY7C63231 USB controller used in the receiver dongle. For further information on this product, please contact Cypress Semiconductor.

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.

Overall circuit

The schematics of the overall circuit for mouse and USB dongle are shown in Appendix A of this document. Appendix B lists the bill of materials.

Reference Design Documentation – Gerber Files

The Gerber File presents detailed schematics used in ADNK-7053-ND24 in PCB layout form. See Appendix C for more details.

Firmware Implementation

The firmware for this reference design is written in the C language. The following files are required to compile the mouse firmware.

MSP430_AVAGO_ADNS-7050.c – main mouse firmware

CRC-8.c - Routines for CRC-8 generation

wm430_buttons.c - used to store button state data for tx message

wm430_system.c -

wm430_transmitter.c - Implements the RF transmitter protocol

wm430_wheel.c - Implements the logic to detect scroll wheel movement

_FSKDATAPLUSENCODING - used to enable MSP430 to shift data out via FSK scheme by toggling the RF_DATA line at specific bit periods

The user should insert the receiver dongle into an available USB port at the computer. Install two AA alkaline batteries into the battery compartment. Pay special attention to the polarities of the two batteries. The reference design mouse is designed to work with two AA batteries in parallel or just one AA battery. The USB receiver dongle will be detected by the PC as HID and any button press and mouse motion will make up the RF connection between the receiver and mouse. When the mouse is properly "connected" to the dongle, every time it receives a transmission from the mouse the green LED lights up.

Appendix A: Schematic Design of Overall Circuit

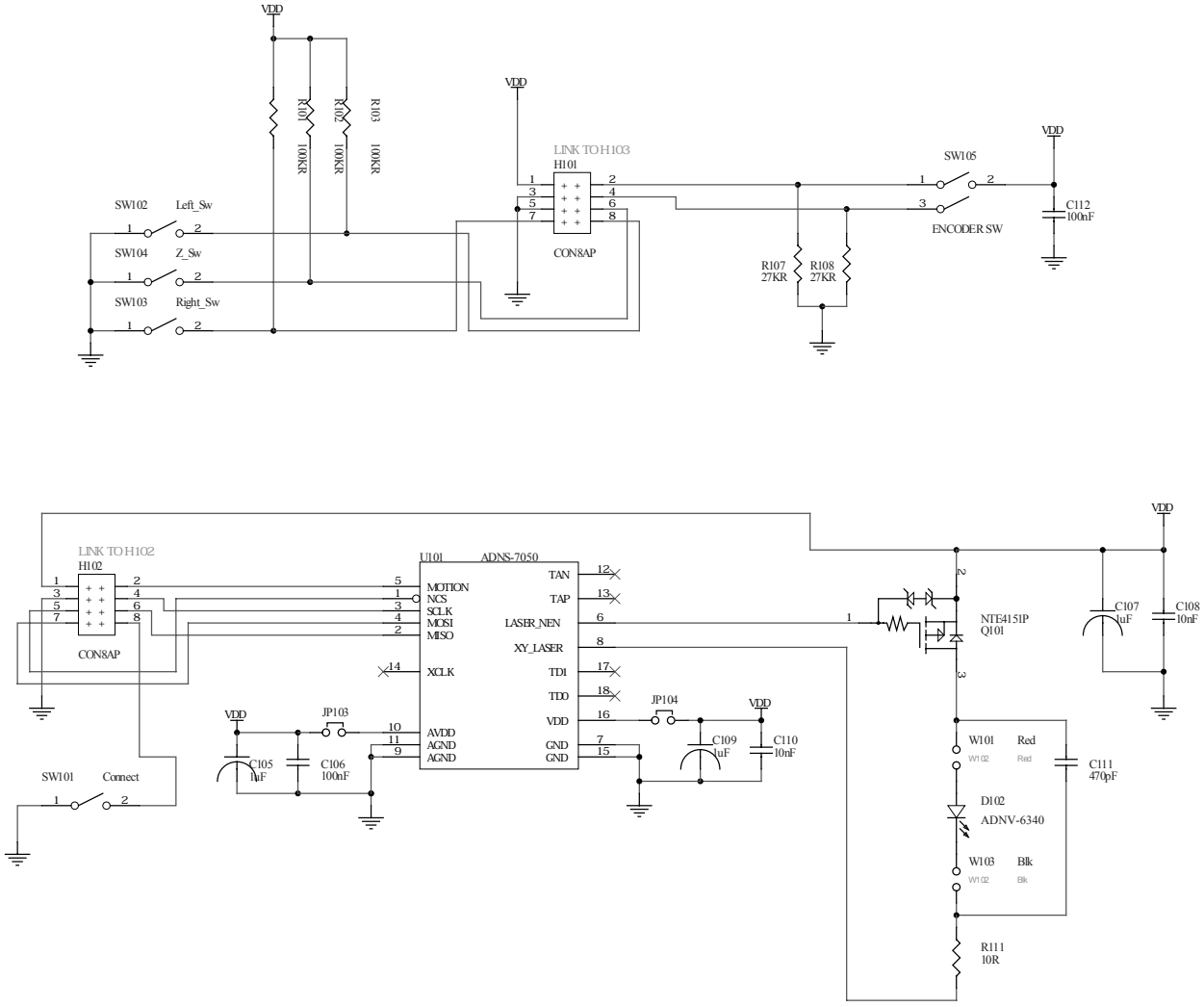


Figure A1. Circuit diagram of ADNS-7050 sensor (Sub-board 1), buttons and Z-wheel (Sub-board 2) schematic in ADNK-7053-ND24 designer's kit wireless laser mouse

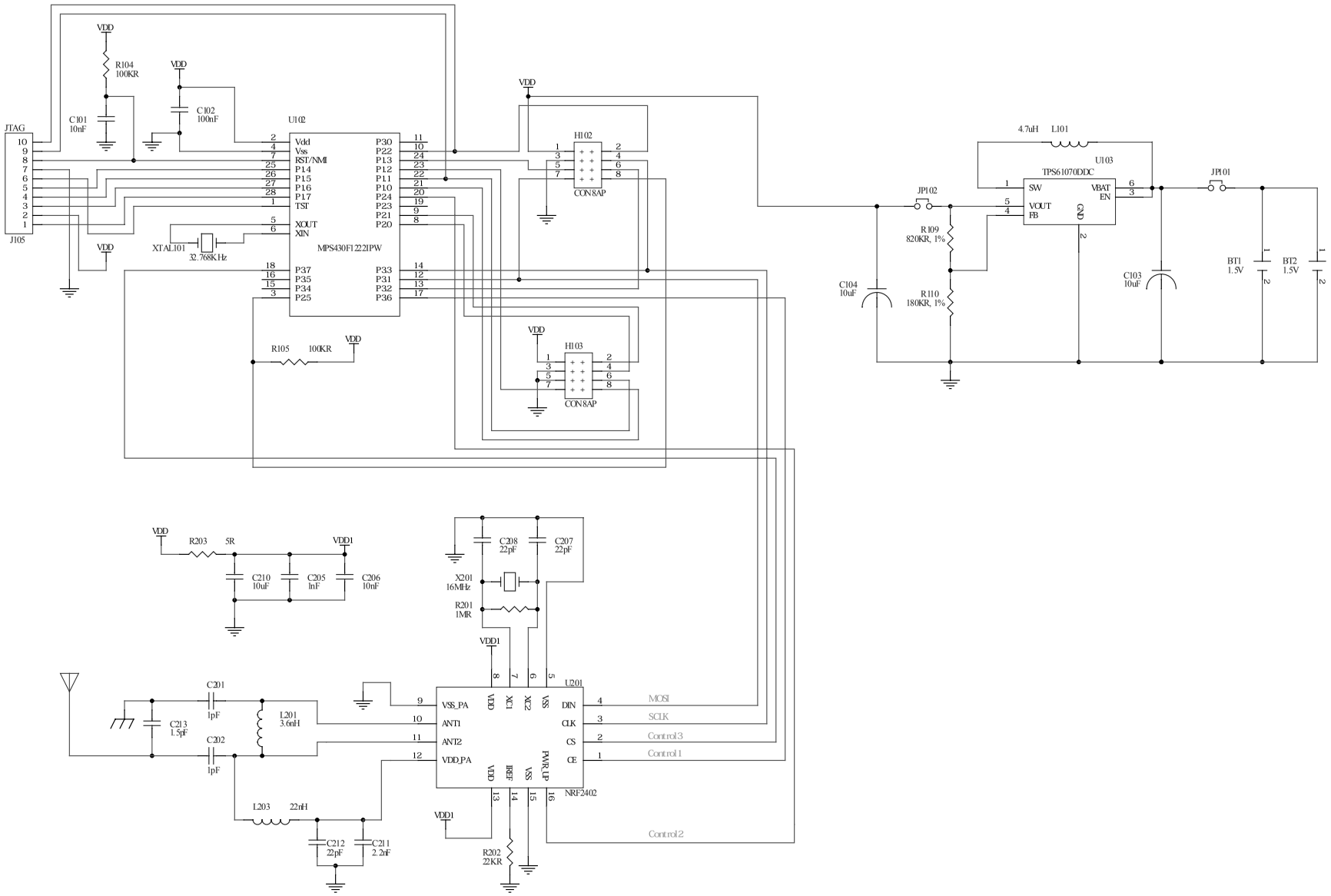


Figure A2. Circuit diagram of MSP430F1222 microcontroller and nRF2402 transmitter in ADNK-7053-ND24 wireless laser mouse designer's kit (Main Board)

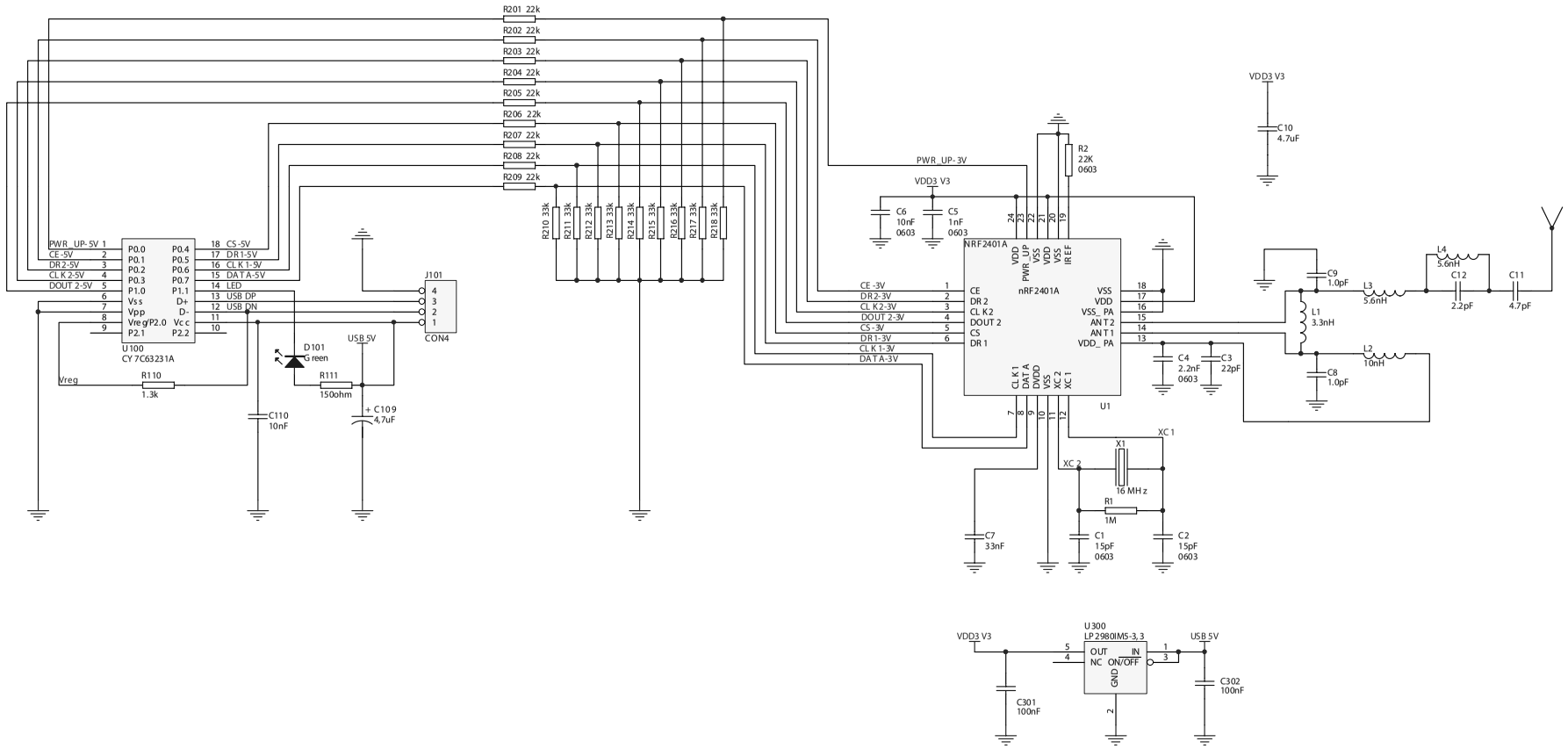


Figure A3. Circuit diagram of CY7C63231A enCoReÔ USB microcontroller and nRF2401A transceiver in ADNK-7053-ND24 wireless laser mouse designer's kit USB DuoCeiver™ Dongle

Appendix B: Bill of Materials for ADNK-7053-ND24 Wireless Laser Mouse Designer's Kit

Table B1. Bill of materials for ADNK-7053-ND24 wireless laser mouse designer's kit sub-board 1

Item	Description	Qty	Value	Reference
1	Laser Sensor Device	1		U101
2	VCSEL	1		D102
3	Laser Sensor Lens	1		
4	Transistor, FET	1	NTA4151P	Q101
5	Resistor (0805, 1%)	1	10R	R111
6	Ceremic capacitor (0603)	2	0.01uF 50V (10nF)	C108, C110
7	Ceremic capacitor (0603)	1	0.1uF 25V (100nF)	C106
8	Tantalum capacitor	3	1uF 50V	C105, C107, C109
9	Ceremic capacitor (0603)	1	470pF 25V	C111
10	Switch	1		SW101
11	PCB	1		
12	VCSEL PCB	1		
13	Sensor Socket Pin	20	1 mm	
14	Header Socket 2.54mm (2x4)	2		H102

Table B2. Bill of materials for ADNK-7053-ND24 wireless laser mouse designer's kit sub-board 2

Item	Description	Qty	Value	Reference
1	Z Encoder	1		SW105
2	Mechanical Z Wheel	1		
3	Resistor (0805, 1%)	3	100K	R101, R102, R103
4	Resistor (0805, 1%)	2	27K	R107, R108
5	Ceremic capacitor (0603)	2	0.1uF 25V (100nF)	C112
6	Switch	3	SPDT	SW102, SW103, SW104
7	PCB	1		
8	Header Socket 2.54mm (2x4)	2		H101

Table B3. Bill of materials for ADNK-7053-ND24 wireless laser mouse designer's kit main board

Item	Description	Qty	Value	Reference
1	Microcontroller	1	TI MSP430F1222IPW	U102
2	DC/DC Converter	1	TI TPS61070DDC	U103
3	Resistor (0805, 1%)	1	820K	R109
4	Resistor (0805, 1%)	1	180K	R110
5	Resistor (0805, 1%)	1	10R	R111
6	Resistor (0805, 1%)	2	100K	R104, R105
7	Ceremic capacitor (0603)	4	0.01uF 50V (10nF)	C101
8	Ceremic capacitor (0603)	1	0.1uF 25V (100nF)	C102
9	Tantalum capacitor	2	10uF 25V	C103, C104
10	Inductor	1	4.7uH	L101
11	Crystal	1	32.768 kHz	XTAL101
12	Battery Clip +	2		T102
13	Battery Clip -	2		T103
14	PCB	1		
15	Pin Header 2.54mm (2x4)	2		H102, H103
16	Header, socket, 2mm	1	2x7	J105
17	Resistor (0402, 1%)	1	22K	R202
8	Resistor (0402, 1%)	1	5.1R	R203
19	Resistor (0402, 1%)	1	1M	R201
20	Ceremic Capacitor, 50V X7R (0402)	1	1nF	C205
21	Ceremic Capacitor, 50V X7R (0402)	1	10nF	C206
22	Ceremic Capacitor, 50V NPO (0402)	1	1.5pF	C213
23	Ceremic Capacitor, 50V NPO (0402)	2	1pF	C201, C202
24	Ceremic Capacitor, 50V NPO (0402)	3	22pF	C207, C208, C212
25	Ceremic Capacitor, 50V X7R (0402)	1	2.2nF	C211
26	Ceremic Capacitor, 50V X7R (0402)	1	10uF	C210
27	Inductor	1	3.6nH	L201
28	Inductor	1	22nH	L203

Table B4. Bill of materials for ADNK-7053-ND24 wireless laser mouse designer's kit USB DuoCeiver™ dongle

Item	Part Description	Qty	Value	Reference
1	Capacitor (C0G (NP0), 50 V, ±5 %, 0603)	2	15pF	C1,C2
2	Capacitor (C0G (NP0), 50 V, ±5 %, 0603)	1	22pF	C3
3	Capacitor (X7R, 16 V, ±10 %, 0603)	1	2.2nF	C4
4	Capacitor (X7R, 16 V, ±10 %, 0603)	1	1nF	C5
5	Capacitor (X7R, 16 V, ±10 %, 0603)	1	10nF	C6
6	Capacitor (X7R, 16 V, ±10 %, 0603)	1	33nF	C7
7	Capacitor (±0.1pF, 50 V, NPO, 0603)	1	1.0pF	C8, C9
8	Tantalum Capacitor (10uF ±20%, 3216)	2	4.7uF	C10, C109
9	Capacitor (C0G (NP0), 50 V, ±5 %, 0603)	1	4.7pF	C11
10	Capacitor (±0.1pF, 50 V, NPO, 0603)	1	2.2pF	C12
11	Capacitor (X7R, 16 V, ±10 %, 0603)	1	10nF	C110
12	Capacitor (X7R, 16 V, ±10 %, 0603)	2	100nF	C301,C302
13	LED (1206)	1	Green	D101
14	ACON USB Plug (Freber: FCMP04208)	1	CON4	J101
15	Panasonic ELJRE3N3ZF2	1	3.3nH	L1
16	Panasonic ELJRE10NJF2	1	10nH	L2
17	Panasonic ELJRE5N6JF2	1	5.6nH	L3
18	Panasonic ELJRE5N6JF2	1	5.6nH	L4
19	Resistor (0.1W, 1%, 0603)	1	1M	R1
20	Resistor (0.1W, 1%, 0603)	1	22K	R2
21	Resistor (0.1W, 1%, 0603)	1	1.3k	R110
22	Resistor (0.1W, 1%, 0603)	1	150	R111
23	Resistor (0.1W, 1%, 0603)	9	22k	R201, R202, R203,R204, R205, R206,R207, R208, R209
24	Resistor (0.1W, 1%, 0603)	8	33k	R210, R211, R212R213, R214, R215,R216, R217, R218
25	Nordic Semiconductor Transceiver	1	nRF2401A	U1
26	Cypress USB Controller*	1	CY7C63231A	U100
27	3.3V Regulator	1	LP2980IM5-3,3	U300
28	Crsytal (LxWxH = 4.0x2.5x0.8, Cl=9pF, tol + drift =30 ppm)	1	16 MHz	X1

*Note: Must be programmed before assembly

Appendix C: PCB Layout

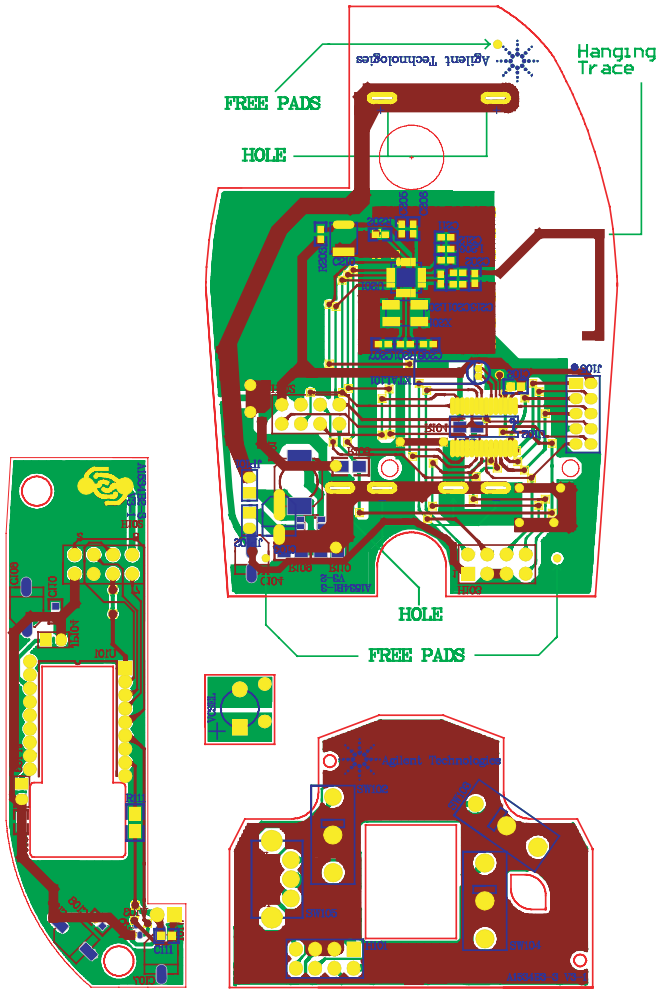


Figure C1. PCB layout for main board, sub-board 1 and sub-board 2 of ADNK-7053-ND24 wireless laser mouse designer's kit

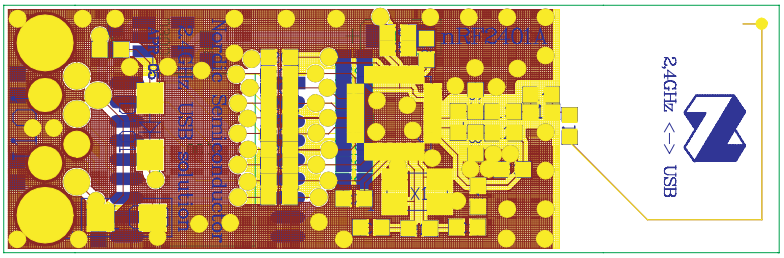


Figure C2. PCB layout ADNK-7053-ND24 wireless laser mouse designer's kit USB DuoCeiver™ dongle

Appendix D: Base Plate Feature

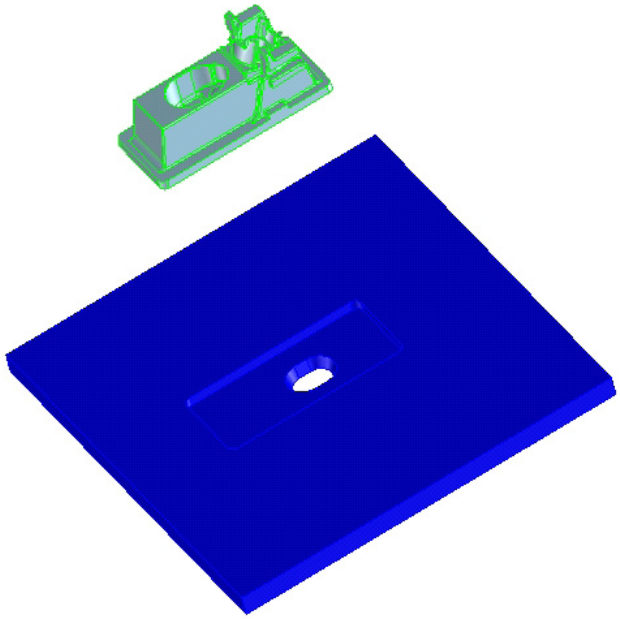


Figure D1. Illustration of base plate mounting features for ADNS-6130-001 laser mouse trim lens

Appendix E: Sectional view of PCB assembly

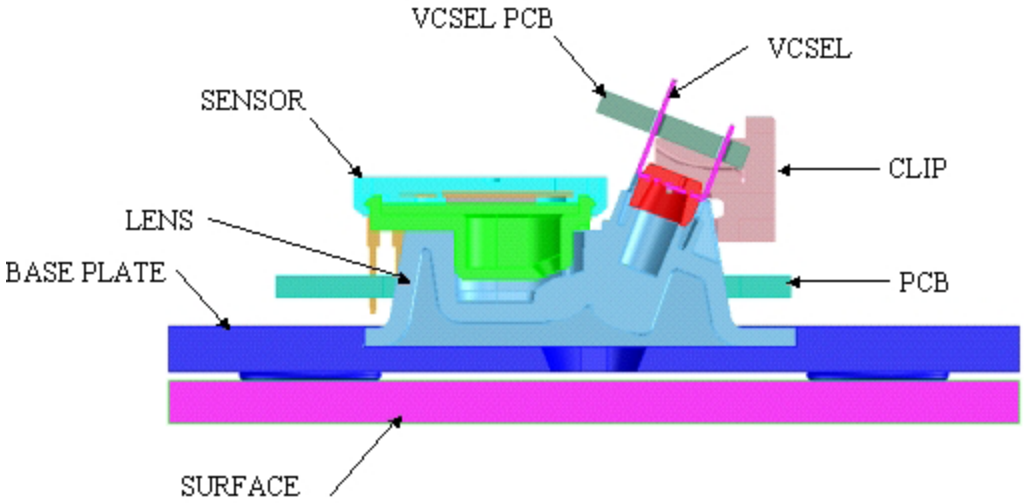
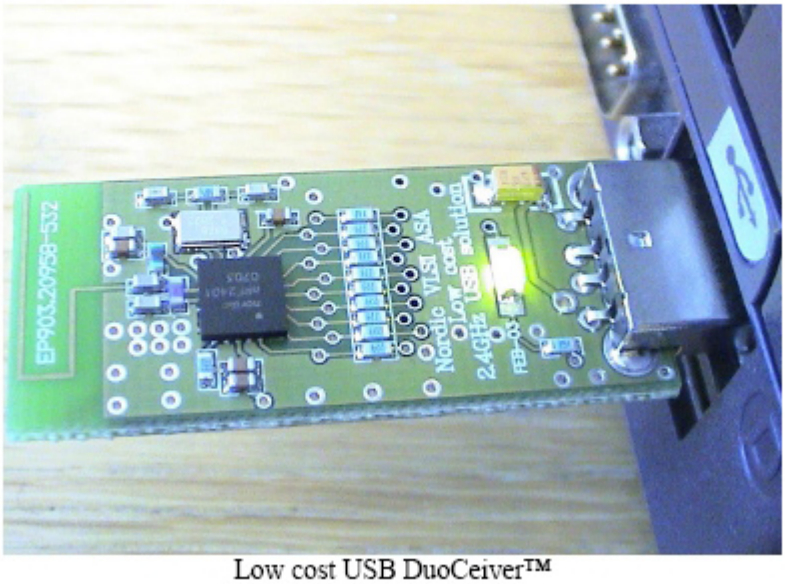


Figure E1. Sectional view of PCB assembly highlighting all laser mouse components (laser mouse sensor, clip, lens, VCSEL, PCB, and base plate)

Appendix F: USB Receiver dongle Implementation

The USB receiver dongle for this reference design is supplied by Nordic Semiconductor. The following Nordic application note nAN24-04 details the hardware design and firmware implementation. The application note can be found in the CD-ROM and Nordic Semiconductor website.

Universal low cost USB DuoCeiver™ **nAN24-04**
using nRF2401™



Low cost USB DuoCeiver™

Appendix G: Kit Components

Part Number	Description	Name	Quantity
ADNK-7053-ND24 Mouse Set	a. Wireless Laser Mouse b. USB Dongle	Reference Design Mouse Set	1
ADNS-7050	Laser Mouse Sensor	Sensor	5
ADNS-6120	Laser Mouse Round Lens Plate	Lens	5
ADNS-6130-001	Laser Mouse Trim Lens Plate	Lens	5
ADNS-6230-001	Laser Mouse VCSEL Assembly Clip	VCSEL Clip	5
ADNV-6340	Single Mode Vertical Cavity Surface Emitting Laser	VCSEL	5
ADNK-7053-ND24 CD-ROM	Includes Documentation and Support Files for ADNK-7053-ND24 Documentations a. ADNS-7050 Low Power Laser Mouse Data Sheet b. ADNS-6120 Round Lens Data Sheet. c. ADNS-6130-001 Trim Lens Data Sheet. d. ADNS-6230-001 VCSEL Assembly Clip Data Sheet. e. ADNV-6340 VCSEL Data Sheet. f. ADNK-7053-ND24 Laser Mouse Designer's Kit Design Guide g. Avago Technologies ADNS-7050 Laser Mouse Eye Safety Calculation Application Note 5407 h. Nordic Semiconductor nRF2401A RF Transceiver Datasheet i. Nordic Semiconductor nRF2402 RF Transmitter Datasheet j. Nordic Semiconductor nRFTM Radio protocol guidelines Application Notes nAN400-07 k. Nordic Semiconductor nRF240x ShockBurst™ Technology White Paper l Nordic Semiconductor Universal low cost USB DuoCeiver™ using nRF2401™ Application Note nAN24-04 m. Texas Instrument MSP430F1222 Microcontroller Datasheet Hardware Support Files a. ADNK-7053-ND24 BOM List b. ADNK-7053-ND24 Schematic c. ADNK-7053-ND24 Gerber File d. 3D Model IGES Files Software Support Files a. Mouse Firmware - Texas Instrument MSP430F1222 Microcontroller b. USB Dongle Firmware - Cypress CY7C63231A enCoRe USB microcontroller		1

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