Datasheet for Telink TLSR8510/TLSR8513

DS-TLSR8510/TLSR8513-E9

Ver 1.8.0

2019/6/11

Keyword:

Features; Package; Pin layout; Mouse/Dongle features; Specification; Test mode; Pairing; Electrical specification; Application.

Brief:

This datasheet is dedicated for Telink 2.4G wireless mouse / USB Dongle ROM SoCs TLSR8510/TLSR8513.

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Revision History

Version	Major Changes	Date	Author
1.0.0	Initial release	2016/9	Z.J.S., X.S.J., L.Y., W.W.X., Cynthia
1.1.0	Updated pin layout and reference design for TLSR8510EP16. Added bonding diagram and schematic for DICE packages.	2016/12	L.J.R., W.W.X., Cynthia
1.2.0	Updated ordering information.	2017/3	X.S.J., Cynthia
1.3.0	Updated section 3.1 Compatible sensors.	2017/7	Z.J.S., Cynthia
1.4.0	Updated section 3.1 Compatible sensors.	2017/9	Z.J.S., Cynthia
1.5.0	Updated section 3.1 Compatible sensors.	2018/4	LB, Cynthia
1.6.0	Updated section 2.1 Frequency points, 4 Mouse Test Mode.	2018/4	LB, Cynthia
1.7.0	Updated section 3.1 Compatible sensors, 5 Pairing Mode.	2018/5	LB, Cynthia
1.8.0	Updated section 4 Test Mode.	2019/6	LB, Cynthia

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1　Overview

The TLSR8510/TLSR8513 are Telink-developed low-power, high-integration 2.4G wireless mouse/USB Dongle ROM SoCs, respectively.

The TLSR8510 Mouse can be used in combination with TLSR8516 or TLSR8366 Dongle. The TLSR8513 USB Dongle chip can only be used with TLSR8510 mouse.

Both chips are RoHS-compliant and 100% lead (Pb)-free.

1.1　Block diagram

The TLSR8510/TLSR8513 is designed to offer high integration, ultra-low power mouse/USB dongle application. It integrates an advanced 2.4GHz RF transceiver, a powerful 32-bit MCU, 6KB on-chip SRAM, 10KB ROM, a quadrature decoder (QDEC), flexible I/O interfaces, and nearly all of the peripheral blocks needed to construct wireless mouse solution.

The system's block diagram is as shown in Figure 1-1:
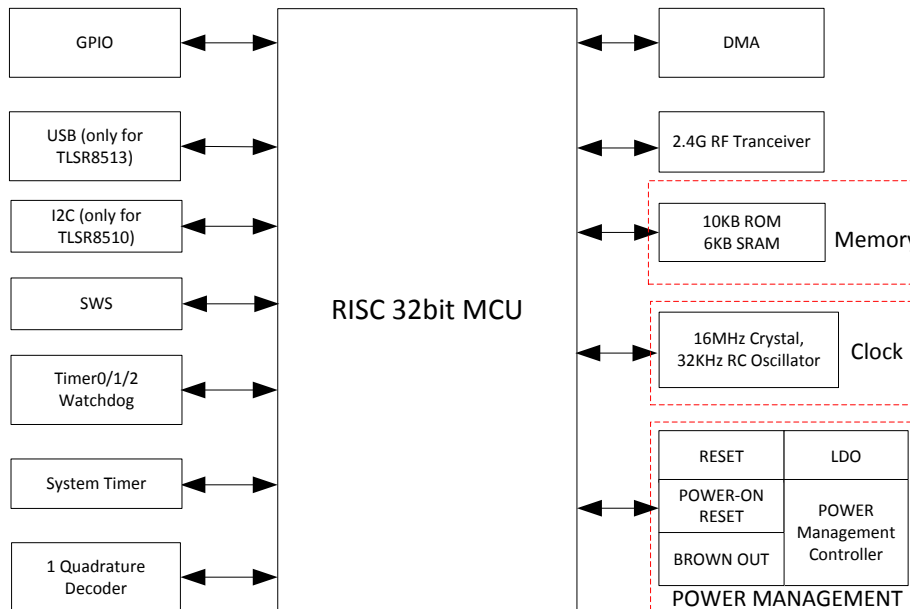
Figure 1- 1　Block diagram of the system

Based on the TLSR8510/TLSR8513 with high-volume-assembly and high integration, few external components are needed to satisfy customers' ultra-low cost requirement.

1.2 Key features

1.2.1 General features

General features are as follows:

1) Embed 32-bit high performance MCU.

2) Data memory: 6KB on-chip SRAM.

3) 16MHz Crystal.

4) USB interface (only TLSR8513): DM, DP.

5) I2C interface (only TLSR8510): GP3-SCLK, GP4-SDIO.

6) Embeds one quadrature decoder (QDEC), used for Z wheel decoding.

7) Operating temperature: -40℃~+85℃ industrial temperature range.

1.2.2 RF Features

RF features include:

1) 2.4GHz RF transceiver embedded, working in worldwide 2.4GHz ISM band.

2) Adaptive frequency hopping.

3) RF link data rate: 2Mbps.

4) Rx Sensitivity: -84dBm at 2Mbps mode.

5) Tx output power: +4dBm.

6) Auto acknowledgement and retry.

7) Single-pin antenna interface.

1.2.3 Features of power management module

Features of power management module include:

1) Power supply of 1.9V~3.6V.

2) Embedded LDO.

3) Multiple stage power management to minimize power consumption for mouse application

- ✧ Active mode current: 7~8mA
- ✧ Suspend1 (Power-saving 1) mode current: 2mA

✧ Suspend2 (Power-saving 2) mode current: 0.3mA

✧ Deep sleep mode current: <20uA

1.2.4 USB features

USB features include:

1) Compatible with USB2.0 Full speed mode.

2) Composite device: Wireless mouse is used in combination with USB Dongle.

1.3 Ordering information

Table 1- 1   Ordering information

Product Series	Package Type	Temperature Range	Product Part No.	Packing Method	Ordering Number	Minimum Order Quantity
TLSR8510	16-pin SOP16L_ 10x6.04mm	-40℃ ~ +85℃	TLSR8510EP16	TR	TLSR8510EP16R	3000
	DICE	-40℃~+85℃	TLSR8510ED	Tray	TLSR8510EDY	80000
TLSR8513	8-pin eSOP8L_ 4.902x6.02mm	-40℃ ~ +85℃	TLSR8513EP8	TR	TLSR8513EP8R	3000
	DICE	-40℃~+85℃	TLSR8513ED	Tray	TLSR8513EDY	80000

*Note: Packing method "TR" means tape and reel.

1.4 Package

Package dimensions for the TLSR8510EP16 and TLSR8513EP8 are shown as below.
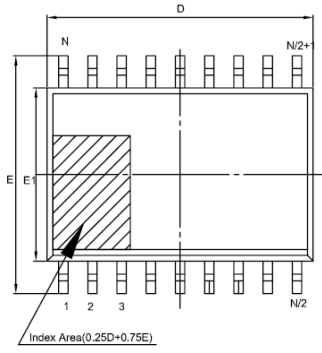
TOP View
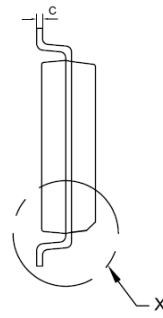
Side View
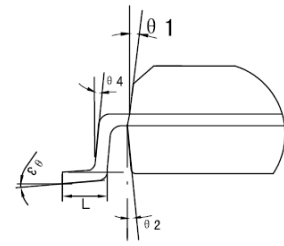
Detail "X"
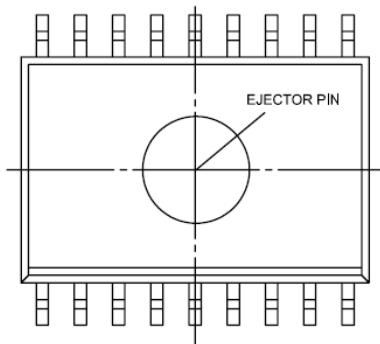
BTM View
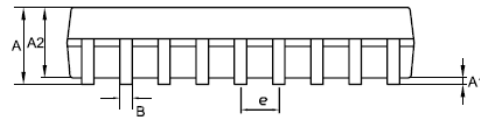
Side View

Symbol	SOP16		
	Min	Nom	Max
A	1.40		1.73
A1	0.05		0.18
A2	1.35		1.55
E	5.84		6.24
E1	3.84		4.04
D	9.90		10.10
L	0.40		0.70
e		1.27TYP	
B	0.36		0.46
C		0.2TYP	
θ1		8° TYP	
θ2		8° TYP	
θ3	0°		8°
θ4		15° TYP	

Figure 1- 2 Package dimension for the TLSR8510EP16 (Unit: mm)
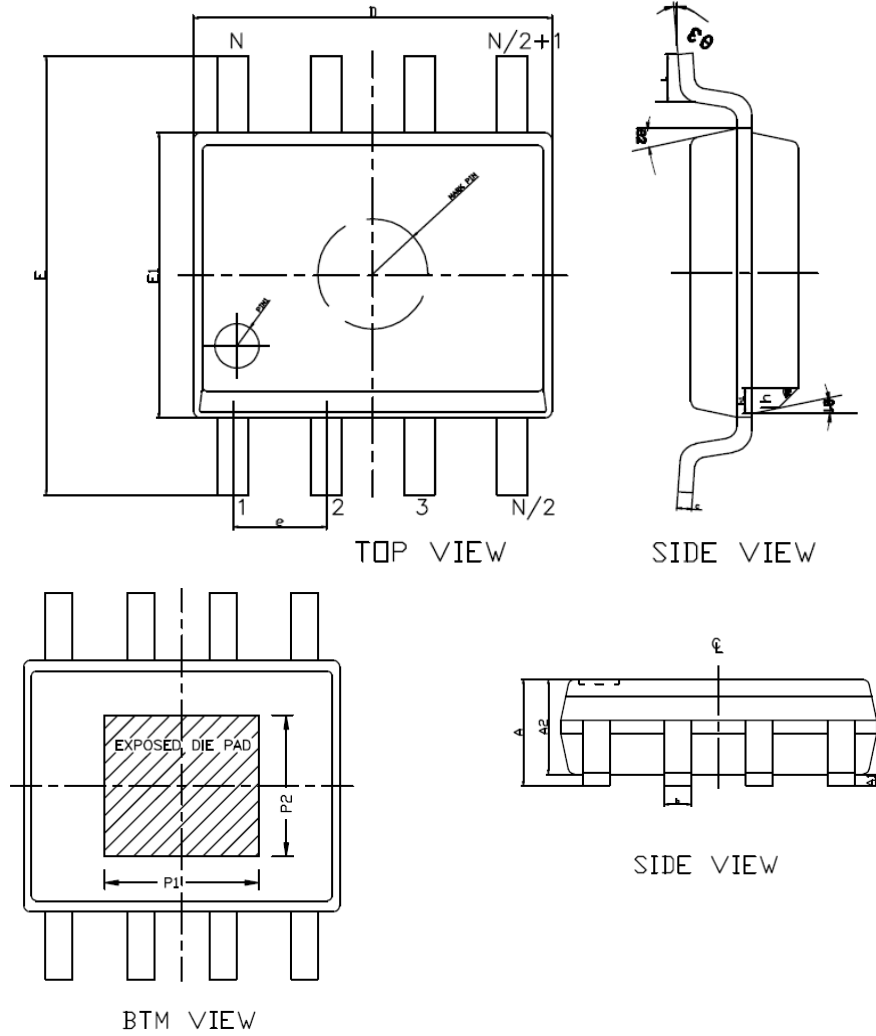
Symbol	SOIC-EP8(150MIL)	
	Min	Max
Pad Size	2.413x3.302	
P1	2.972	3.200
P2	2.082	2.311
A	1.422	1.700
A1	0.025	0.127
A2	1.397	-
E	5.842	6.198
E1	3.877	3.997
D	4.852	4.952
L	0.406	0.889
e	1.27TYP	
b	0.406TYP	
c	0.2TYP	
θ1	12°TYP	
θ2	12°TYP	
θ3	0	8
θ4	45	
h	-	-
h1	0.254	0.457

Figure 1- 3 Package dimension for the TLSR8513EP8 (Unit: mm)

1.5   Pin layout

1.5.1   TLSR8510 pin layout

Pin assignment for the TLSR8510EP16 is as shown in Figure 1- 4:
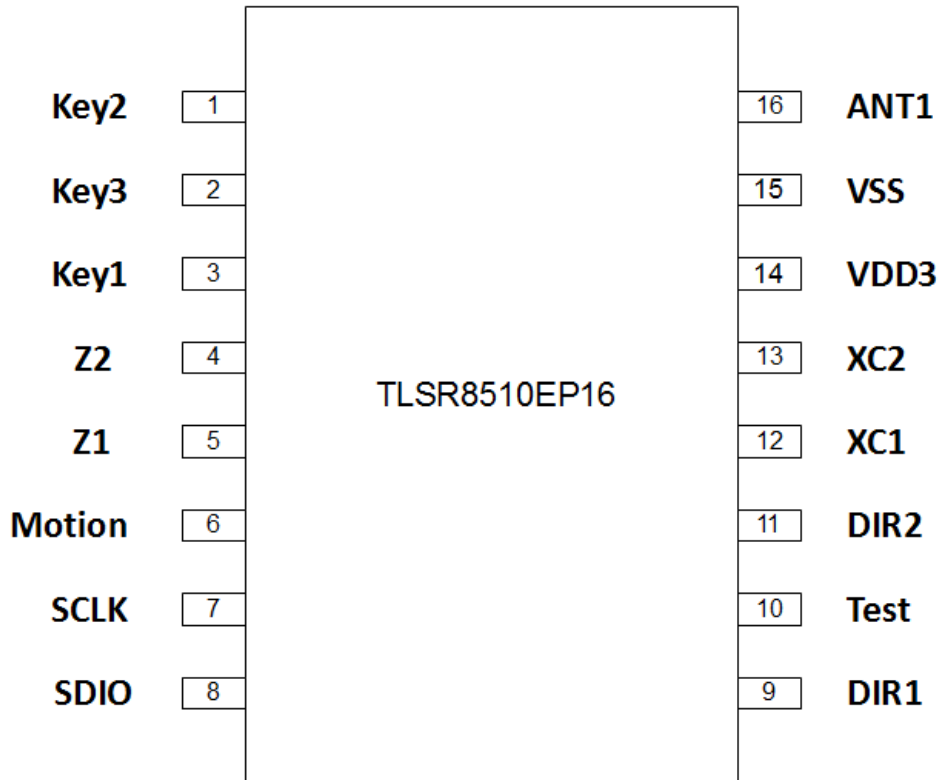
Figure 1- 4   Pin assignment for the TLSR8510EP16

Functions of 16 pins for the TLSR8510EP16 are described in Table 1-2:

Table 1- 2   Pin functions for the TLSR8510EP16

SOP16L_10X6			
No.	Pin Name	Type	Description
1	Key2	Digital I/O	Key input 2 (GP5)
2	Key3	Digital I/O	Key input 3 (GP6)
3	Key1	Digital I/O	Key input 1 (GP7)
4	Z2	Digital I/O	Z wheel 2 (GP1)

No.	Pin Name	Type	Description
			SOP16L_10X6
5	Z1	Digital I/O	Z wheel 1 (GP2)
6	Motion	Digital I/O	Motion connected to sensor
7	SCLK	Digital I/O	I2C SCK (GP3)
8	SDIO	Digital I/O	I2C SDA (GP4)
9	DIR1	Digital I/O	Sensor direction select 1
10	Test	Digital I/O	Test pin (MSDI)
11	DIR2	Digital I/O	Sensor direction select 2
12	XC1	Analog I	16MHz crystal input+
13	XC2	Analog I	16MHz crystal input-
14	VDD3	PWR	3.3V supply
15	VSS	GND	LNA ground
16	ANT1	Analog I/O	RF input 1

1.5.2 TLSR8513 pin layout

Pin assignment for the TLSR8513EP8 is as shown in Figure 1- 5:
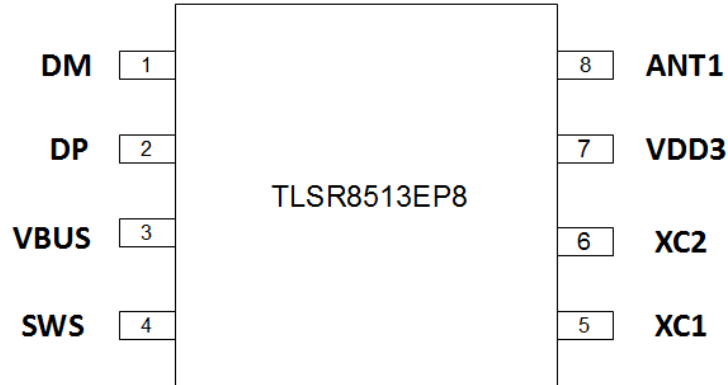
Figure 1- 5   Pin assignment for the TLSR8513EP8

Functions of 8 pins for the TLSR8513EP8 are described in Table 1- 3:

Table 1- 3   Pin functions for the TLSR8513EP8

No.	Pin Name	Type	Description
SOP16L_10X6			
1	DM	Digital I/O	USB data minus
2	DP	Digital I/O	USB data positive
3	VBUS	PWR	USB 5V supply
4	SWS	Digital I/O	single wire slave
5	XC1	Analog I	16MHz crystal input+
6	XC2	Analog I	16MHz crystal input-
7	VDD3	PWR	3.3V supply
8	ANT1	Analog I/O	RF input 1

1.6   Bonding diagram for DICE

1.6.1   TLSR8510ED bonding diagram

Figure 1- 6 shows bonding diagram of TLSR8510ED for user reference.
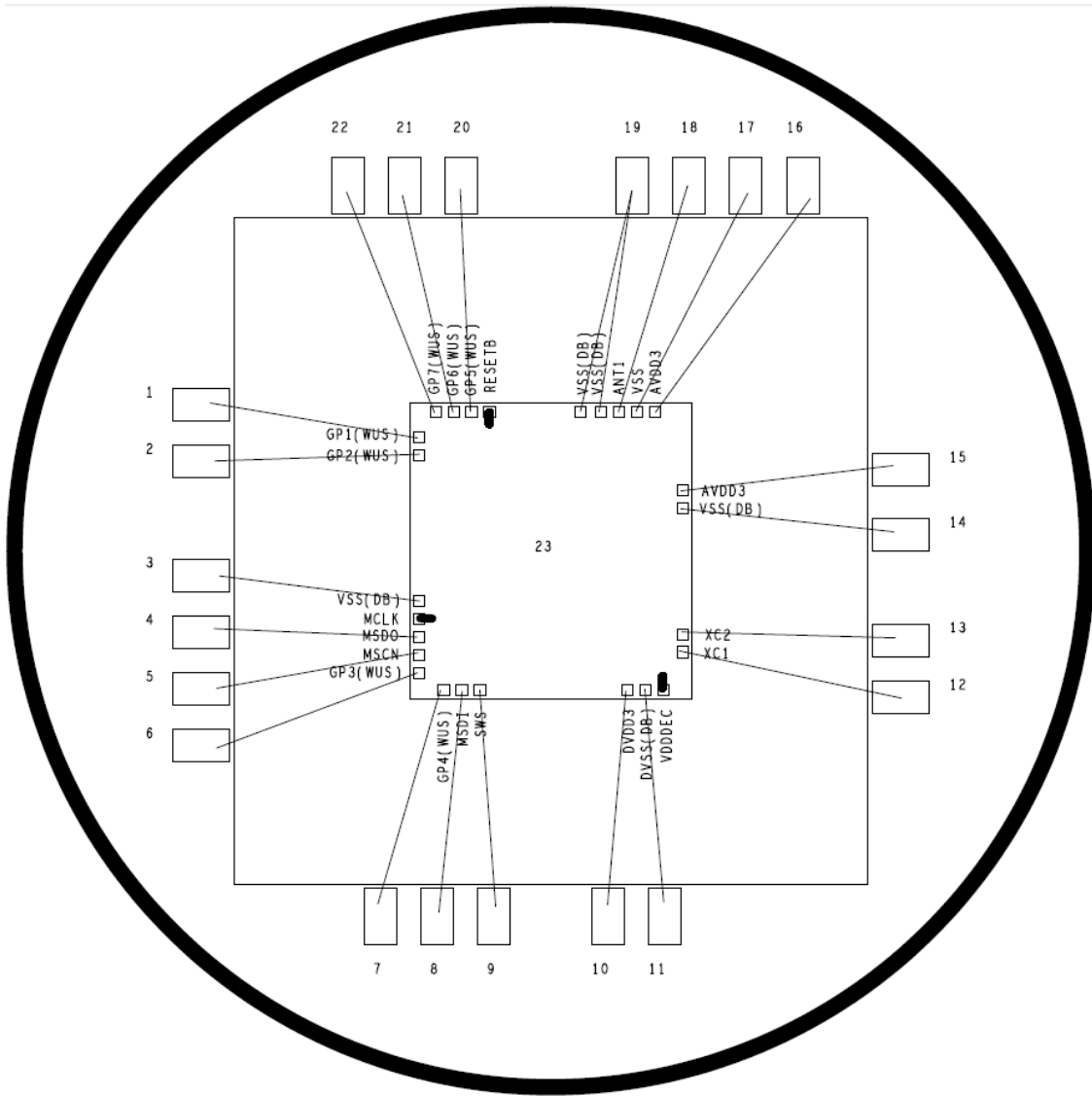
Figure 1- 6   Reference bonding diagram for TLSR8510ED

1.6.2 TLSR8513ED bonding diagram

Figure 1- 7 shows bonding diagram of TLSR8513ED for user reference.
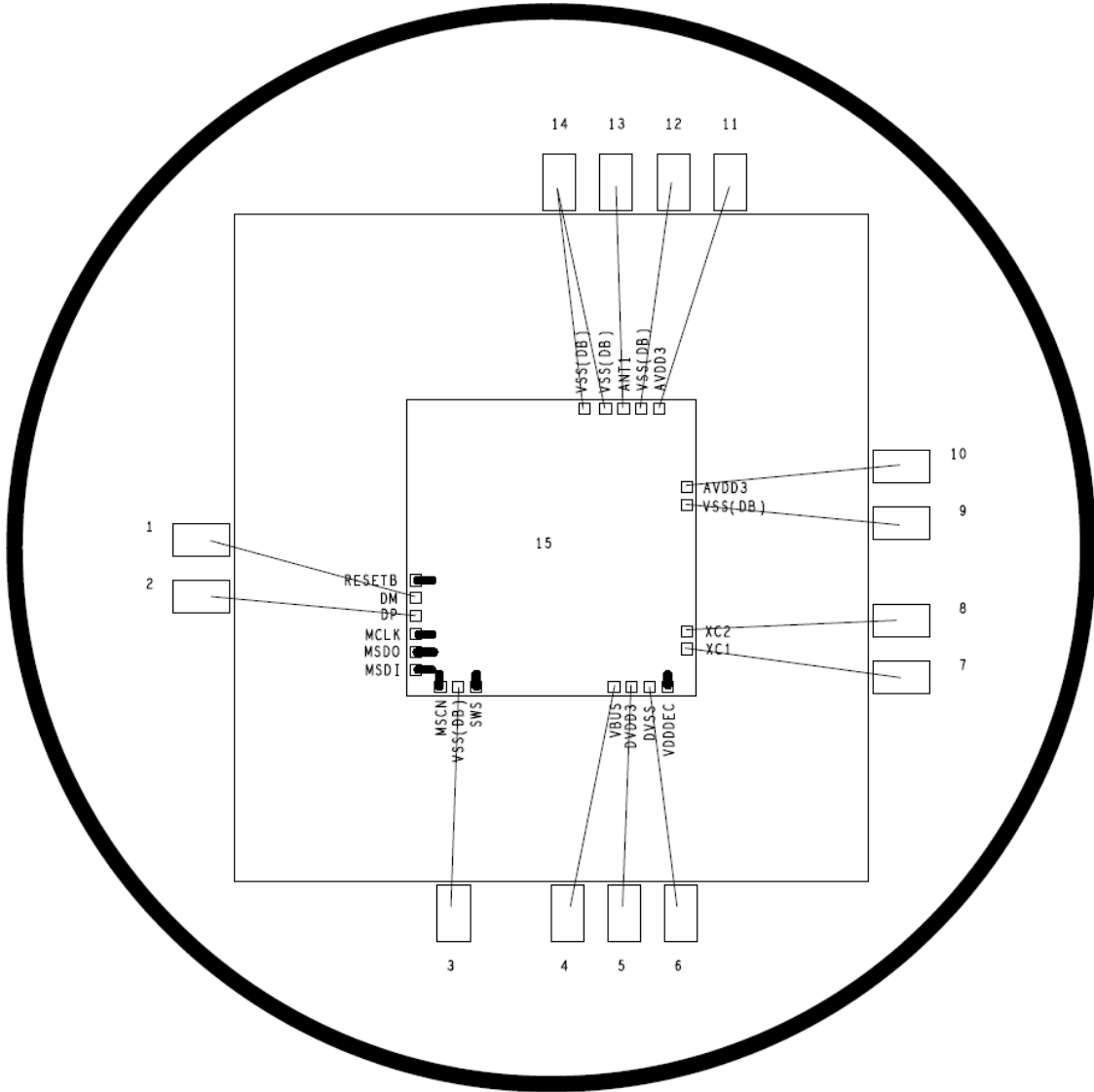
Figure 1- 7   Reference bonding diagram for TLSR8513ED

2　Mouse/Dongle Features

2.1 Frequency points

Telink wireless single mouse product works in worldwide 2.4GHz ISM band. As shown in Table 2- 1, 16 frequency points are supported, and the eight frequency points in the left column are currently adopted.

Table 2- 1　Frequency points (Unit: MHz)

2,405	2,408
2,411	2,414
2,417	2,448
2,451	2,454
2,457	2,460
2,463	2,466
2,469	2,472
2,475	2,478

2.2 Channel bandwidth

Bandwidth: 2MHz.

2.3 USB interface

Telink wireless single mouse product is compatible with USB 2.0 Full speed mode.

2.4 System compatibility

Telink wireless single mouse product supports operating systems as follows: WinXP/Win7/Win8/Linux/Mac OS.

2.5 RF transmitting power

Without external RF PA (Power Amplifier), RF transmitting power for Telink wireless single mouse product can reach typical value of +4dBm.

2.6 Communication distance

Telink wireless single mouse supports communication distance up to 25 meters.

3 Product Specification

3.1 Compatible sensors

Telink wireless single mouse product is compatible with mainstream types of sensors, as shown below:

Table 3- 1   Compatible sensors

Firmware Version	Supported Sensors	Note
v0.1.7	1. Pixart(3204DB,3204L,3204LL,3204UL,3205,3207) 2. Sigma 8630/8630A/8640/8650A 3. OM15,0M16 4. PAW3212 5. VT108/KA8 6. FCT3065/FCT3065-XY-D 7. FH8835 8. YS8008 9. S8321	Deleted NST8589, Added FCT3065-XY-D and PAW3212
v0.1.6	1. Pixart(3204DB,3204L,3204LL,3204UL,3205,3207) 2. Sigma 8630/8630A/8640/8650A 3. OM15,0M16 4. NST8589 5. VT108/KA8 6. FCT3065 7. FH8835 8. YS8008 9. S8321	
v0.1.1	1. Pixart(3204DB,3204L,3204LL,3204UL,3205,3207) 2. Sigma 8630/8630A/8640/8650A 3. NST8589	

Firmware Version	Supported Sensors	Note
	4. VT108	
v0.1.0	1. Pixart(3204DB,3204L,3204LL,3204UL,3205,3207) 2. Sigma 8630/8630A/8640/8650A 3. NST8589 4. VT108	

*Notes:

1) If the sensor PAW3212 is used, the SDIO pin of the TLSR8510 should be connected with external 10kohm pull-up resistor. For the other sensors, this pull-up resistor is not needed.

2) Compatible sensors may vary depending on Firmware version. Customer must check the preloaded Firmware version to get the final sensor support information, and carry out small-scale production verification before mass production.

Sensor direction is customizable via specific hardware circuit, as shown below.
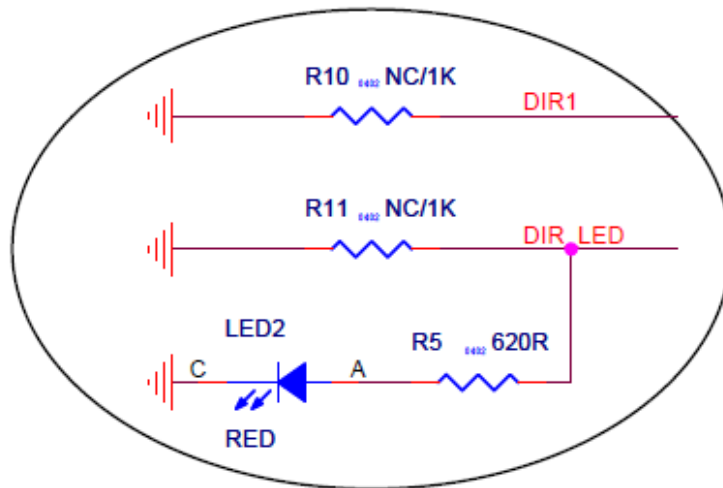

Figure 3- 1 Sensor direction selection circuit

*Note: In Figure 3- 1, R10 and R11 are external resistors that determine sensor direction, and the values depend on actual application. R5 and LED2 are reserved for LED indication function.

Table 3- 2　　Sensor direction selection description

R10 (corresponding to DIR1)	R11 (corresponding to DIR2/DIR_LED)	Sensor direction (Default, customizable)
1	1	CLOCK_12
1	0	CLOCK_9
0	1	CLOCK_6
0	0	CLOCK_3
Note: "1" indicates connect, "0" indicates NC.		

3.2 Button function

Telink wireless single mouse supports six button functions including left button, right button, middle button, forward button, back button, and DPI selection button.

As shown in Table 3- 3, the DPI value is switchable among three rates. On every DPI button click, the DPI value changes to the next available value in the list. For each rate switch, the indicating LED light will blink with the frequency of 1Hz, and the blinking times depend on the rate, i.e. the blinking times equal Rate number+1. For example, when the DPI value changes to Rate1, the indicating LED light will blink two times with the frequency of 1Hz.

Table 3- 3　　DPI value switch

Sensor	Rate0 (Default)	Rate1	Rate2
Pixart(3204DB,3204L,3204LL, 3204UL,3205,3207)	1000	1200	1600
Sigma 8630/8630A/8640	1000	1200	1600
OM15, OM16	1000	1200	1600
NST8589	1000	1200	1600
VT108	1000	1200	1600
FCT3065	1000	1200	1600
FH8835	1000	1200	1600
YS8008	1000	1200	1600

3.3 Operating voltage

Telink wireless single mouse product supports single battery (1.5V) or dual battery (3V) for power supply.

3.4 Power saving mode

Table 3- 4   Power saving mode and wakeup

Power-saving mode	Method for entering	Wakeup method
Power-saving 1 (Suspend 1)	Stop moving the mouse, and release all the buttons.	Move the mouse, press button or slide the wheel
Power-saving 2 (Suspend 2)	Keep the mouse static for at least 2 seconds.	Move the mouse, press button or slide the wheel
Deep sleep	The mouse enters deep sleep mode after 10 minutes of no action, and the sensor is shutdown in this mode.	Press left/right/middle button

4 Test Mode

4.1 Mouse test

Common method for entering EMI test mode is as follows:

Press the left, middle and right buttons at the same time when power on.

Then release all the buttons to enter EMI test mode.

After entering EMI test mode, both test mode and frequency point are switchable. Four test modes are supported.

1) Press the middle button to switch mode:

Carry --> Carry + Data --> RX --> Carry --> ···;

2) Press the left/right button to switch frequency point:

Left button: (2451MHz --> 2405MHz --> 2475MHz --> 2451MHz) loop;

Right button: (2451MHz --> 2475MHz --> 2405MHz --> 2451MHZ) loop.

4.2 Dongle test

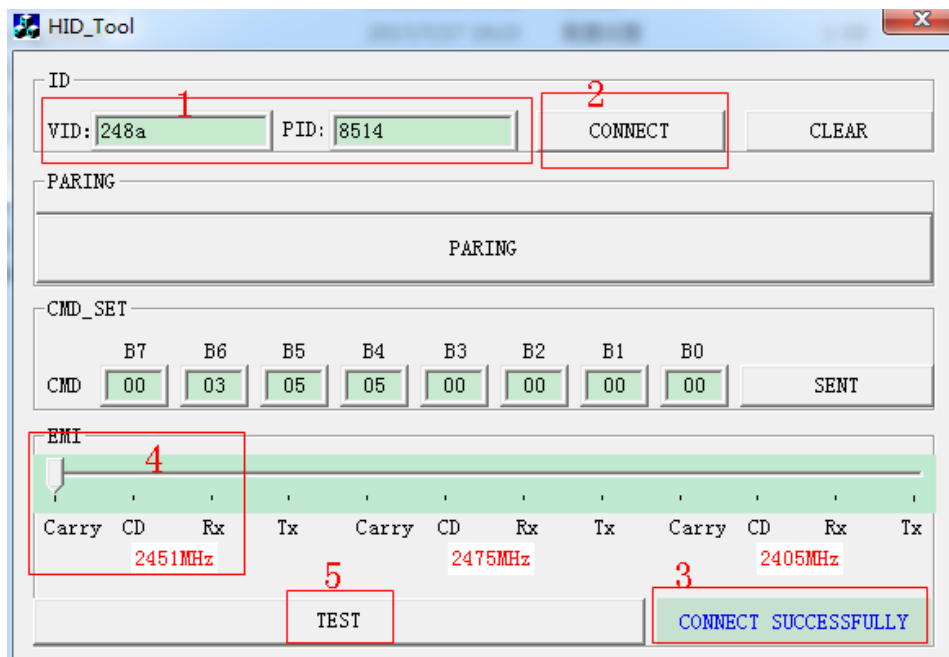For the dongle side, EMI test is executed via the "HID_Tool" software on PC side; its interface is shown as below.

Figure 4- 1 Interface of Dongle EMI test tool

Test procedure is as follows:

1) Plug the USB dongle under test into PC USB, and start the "HID_Tool" on PC side.

2) Read out the dongle's PID and VID data from the "device manager" of the computer, and respectively enter the data in the corresponding input boxes ("PID" and "VID"), as shown in mark 1 of Figure 4- 1.

3) Click the "CONNECT" button (as shown in mark 2 of Figure 4- 1) to establish connection. A "CONNECT SUCCESSFULLY" information will be available on the lower right corner of the tool interface to indicate successful connection (as shown in mark 3 of Figure 4- 1).

4) There are three selectable frequency points: 2451MHz, 2475MHz and 2405MHz. For each frequency point, there are four types of test modes: "Carry", "CD (Carry + Data, continuous transmission of modulated data)", "Rx", and "Tx".

Both frequency point and test mode are switchable via dragging the button as shown in mark 4 of Figure 4- 1. The indication information for the chosen frequency point and test mode will be available on the lower right corner.

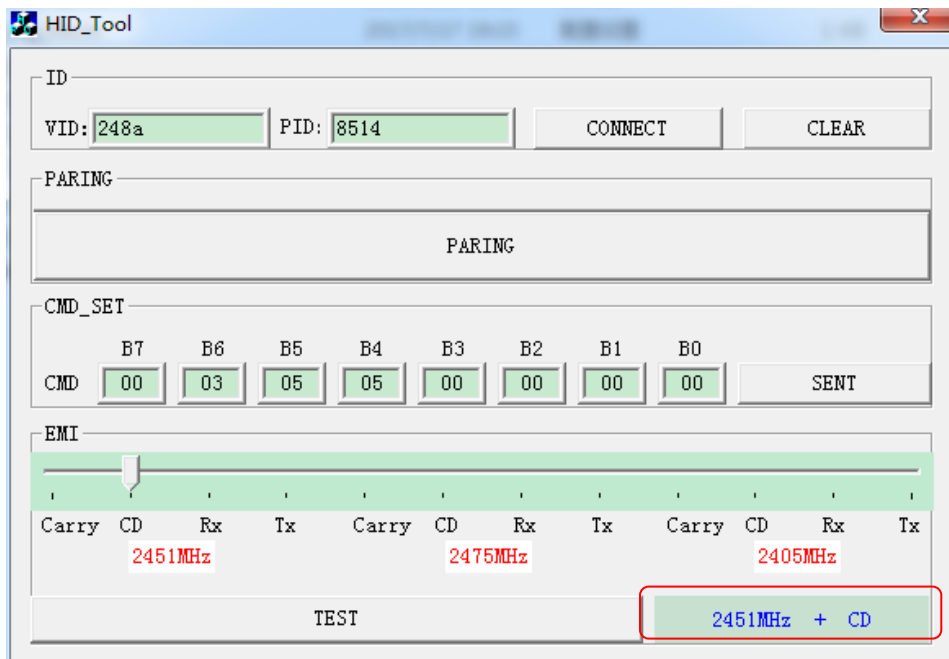As shown in Figure 4- 2, current test mode and frequency point are "CD" and "2451MHz", respectively.

Figure 4- 2 Current test mode and frequency point indication

*Note: In "Carry" or "CD" mode, packets are continuously transmitted; while in "Tx" mode, packets are transmitted with certain interval.

5) After the frequency point and test mode are selected, click the "TEST" button to start testing, as shown in mark 5 of Figure 4- 1.

5   Pairing Mode

The TLSR8510 mouse is set as pairing-free mode by default. Any mouse and any dongle can be combined into a pair after power on, with no need for pairing process.

The dongle is only allowed to be paired within 1 minute after power on.

In pairing-free mode, recombination of mouse and dongle is supported after power cycle.

The TLSR8510 mouse also supports manual pairing method when paired with TLSR8366 dongle.

It's needed to customize the dongle as the **TLSR8510 channel** (see Table 2- 1).

The manual pairing process is as follows:

1. For the first time of pairing, first plug the dongle into PC USB.

2. Press the left and right buttons of the mouse when power on. Then release both the buttons to enter pairing mode.

3. Once successfully paired, the mouse will be paired with the dongle automatically after power cycle.

To pair a new mouse with the dongle, follow the steps 2~3. After the new mouse is successfully paired, the old mouse cannot be used.

6　Key Electrical Specifications

6.1 Absolute maximum ratings

Table 6- 1　Absolute Maximum Ratings

Characteristics	Sym.	Min.	Max	Unit	Test Condition
Supply Voltage	V_{Bus}	-0.5	6.5	V	Only VBUS pin is tested, and all VDD pins leave open
	VDD	-0.3	3.9	V	
Voltage on Input Pin	V_{In}	-0.3	VDD +0.3	V	
Output Voltage	V_{Out}	0	VDD	V	
Storage temperature Range	T_{Str}	-65	150	ºC	
Soldering Temperature	T_{Sld}		260	ºC	

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

6.2 Recommended operating condition

Table 6- 2　Recommended operation condition

Item	Sym.	Min	Typ.	Max	Unit	Condition
Power-supply voltage	VDD	1.9	3.3	3.6	V	
	V_{Bus}	4.5	5.0	5.5	V	
Operating Temperature Range	T_{Opr}	-40	27	85	ºC	

6.3 DC characteristics

Table 6- 3   DC characteristics

Parameter	Mnemonic	Min.	Typ.	Max.	Unit	Condition
Current in active work mode	I$_{Active}$		7~8		mA	Single battery for power supply. Tested on A4 paper surface. Depend on sensor used.
Current in suspend 1 mode	I$_{Susp1}$		2		mA	
Current in suspend 2 mode	I$_{Susp2}$		0.3		mA	
Current in sleep mode	I$_{Sleep}$			20	uA	

6.4 AC characteristics

Table 6- 4   AC Characteristics

Item	Sym.	Min	Typ.	Max	Unit	Condition
Digital inputs/outputs						
Input high voltage	VIH	0.7VDD		VDD	V	
Input low voltage	VIL	VSS		0.3VDD	V	
Output high voltage	VOH	VDD-0.3		VDD	V	
Output low voltage	VOL	VSS		0.3	V	
USB characteristics						
USB Output Signal Cross-over Voltage	V$_{Crs}$	1.3	-	2.0	V	

Item	Sym.	Min	Typ.	Max	Unit	Condition
RF performance						
RF_Rx performance						
Sensitivity	2Mbps		-84		dBm	
Frequency Offset Tolerance		-300		+300	KHz	
RF_Tx performance						
Output power			4		dBm	
16MHz crystal						
Nominal frequency (parallel resonant)	f_{NOM}		16		MHz	
Frequency tolerance	f_{TOL}	-60		+60	Ppm	
Load capacitance	C_L	5	12	18	pF	Programmable on chip load cap
Equivalent series resistance	ESR		50	100	ohm	

7   Applications

7.1 Application example for TLSR8510EP16
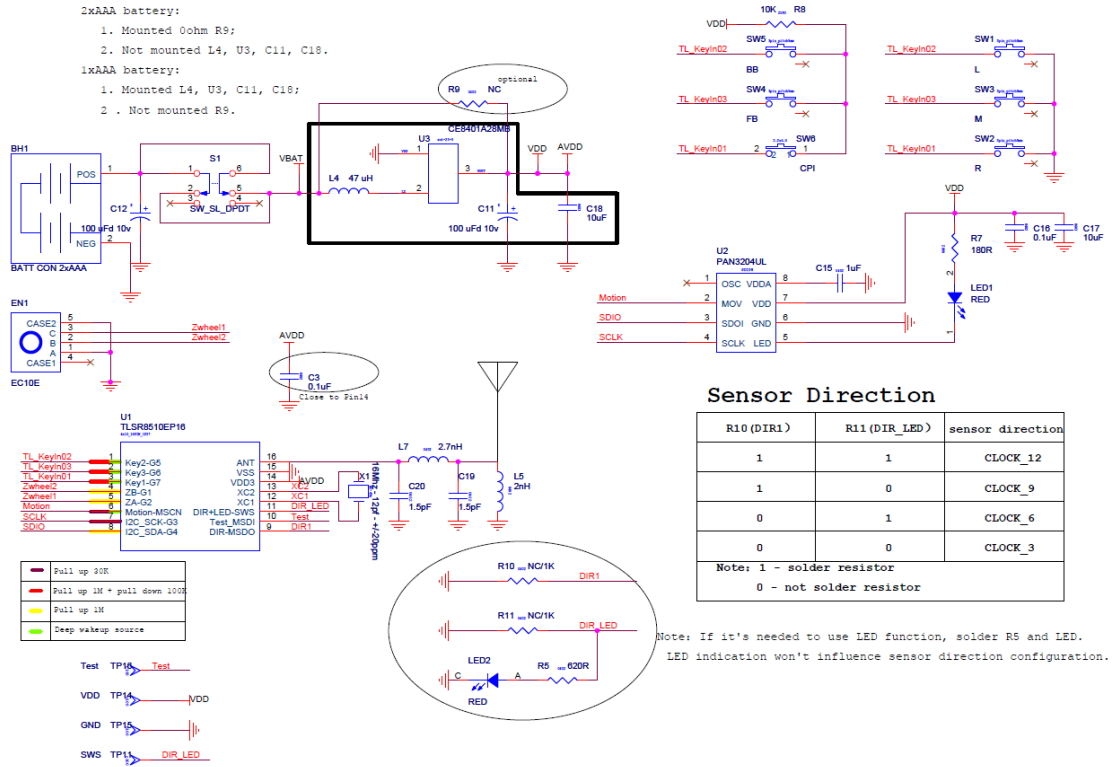
7.1.1   Schematic

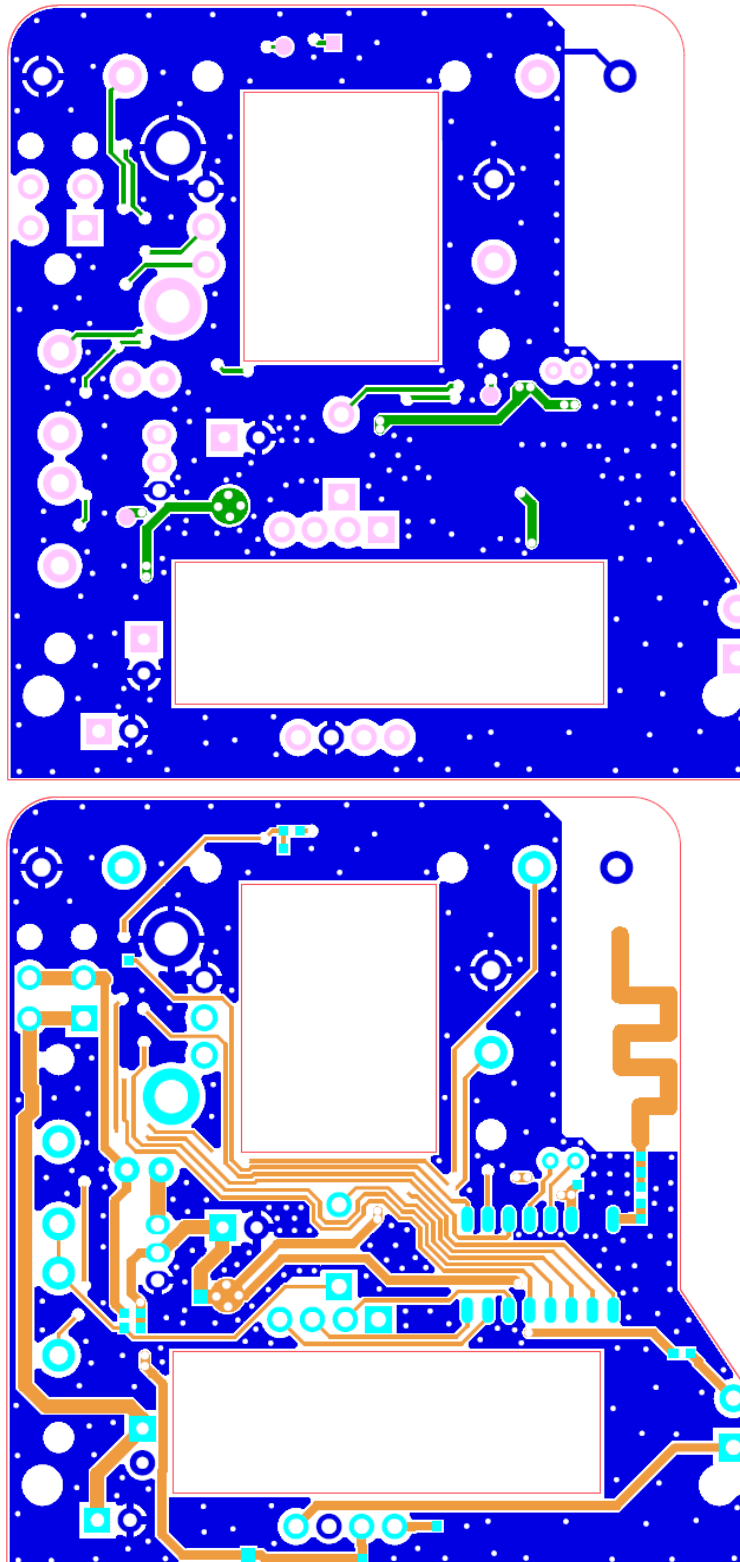Figure 7- 1   Schematic for TLSR8510EP16

7.1.2 Layout

Figure 7- 2   Layout for TLSR8510EP16

(Up: Top view; Down: Bottom view)

7.1.3 BOM (Bill of Material)

Table 7- 1   BOM table for TLSR8510EP16

Quantity	Reference	Value	Spec
2	C11	100 uFd 10v	100UF10V-ELECT
	C12	100 uFd 10v	100UF10V-ELECT
2	C3	0.1uF	0402
	C16	0.1uF	0402
1	C15	1uF	0402
2	C17	10uF	0603
	C18	10uF	0603
2	C19	1.5pF	0402
	C20	1.5pF	0402
1	EN1	EC10E	ENCODER-BTC-MOUSE
1	LED1	RED	LED_TH_3MM_2PIN
1	LED2	RED	0603-LED
1	L4	47 uH	L-TH-IND2MM
1	L5	2nH	0402
1	L7	2.7nH	0402
1	R5	620R	0402
1	R7	180R	0402
1	R8	10K	0402
1	R9	0	0402
2	R10	NC/1K	0402
	R11	NC/1K	0402
1	SW1	L	
1	SW2	R	
1	SW3	M	
1	SW4	FB	
1	SW5	BB	
1	SW6	CPI	
1	S1	SW_SL_DPDT	
1	U1	TLSR8510EP16	sop_16pin
1	U2	PAN3204UL	SDIP8
1	U3	CE8401A28MB	SOT23-3
1	X1	16Mhz - 12pf - +/-20ppm	osc_2x6

7.2 Application example for TLSR8513EP8

7.2.1 Schematic

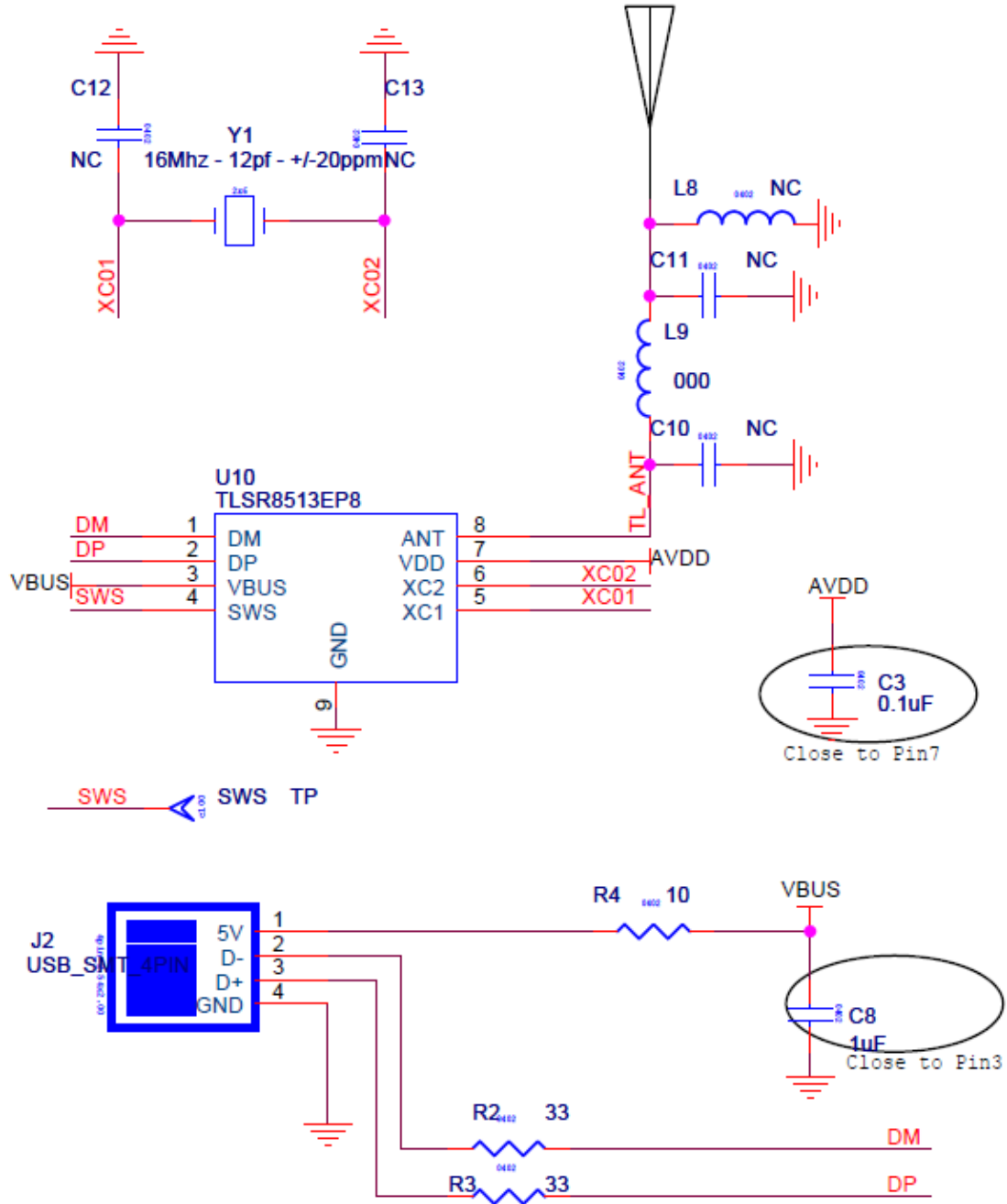

Figure 7- 3 Schematic for TLSR8513EP8
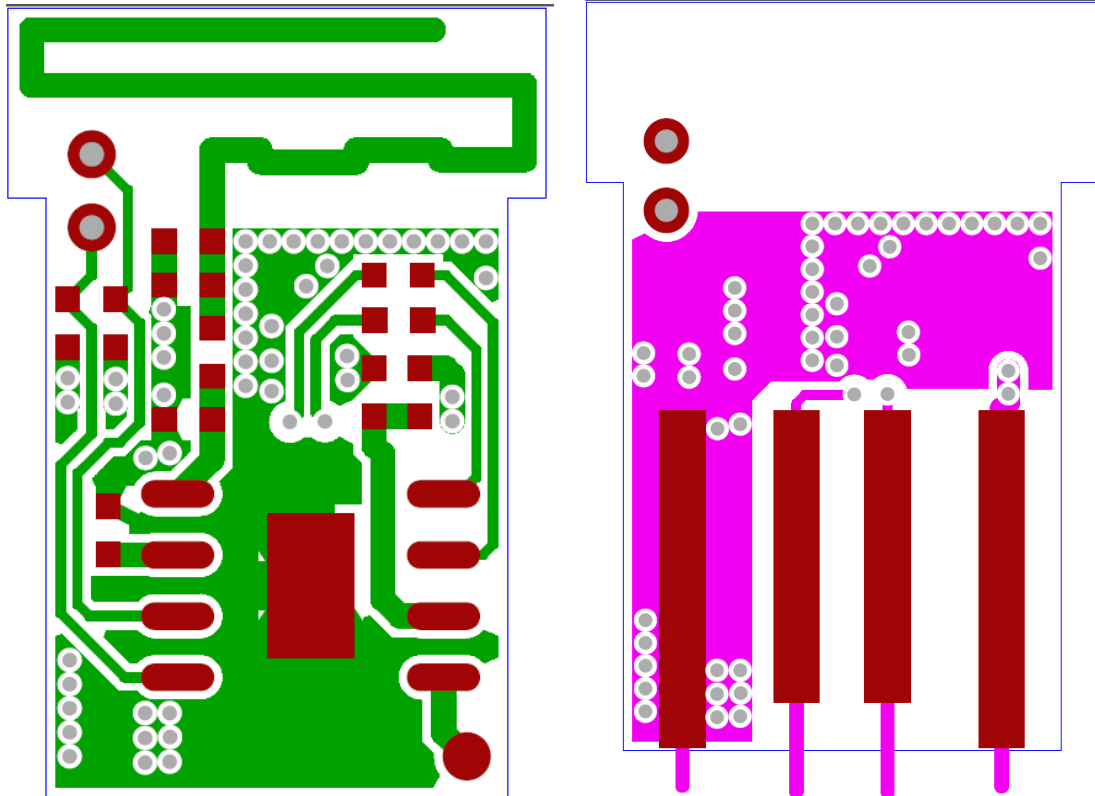
7.2.2 Layout

Figure 7- 4   Layout for TLSR8513EP8

(Left: Top view; Right: Bottom view)

7.2.3 BOM (Bill of Material)

Table 7- 2   BOM table for TLSR8513EP8

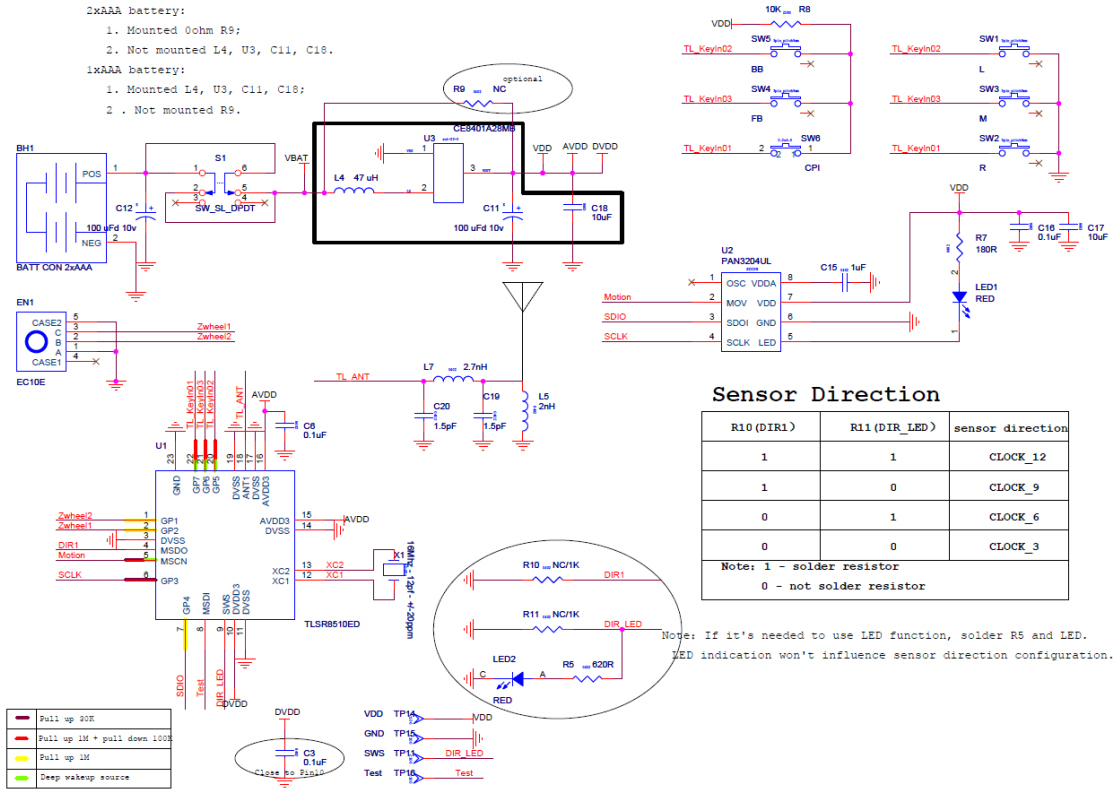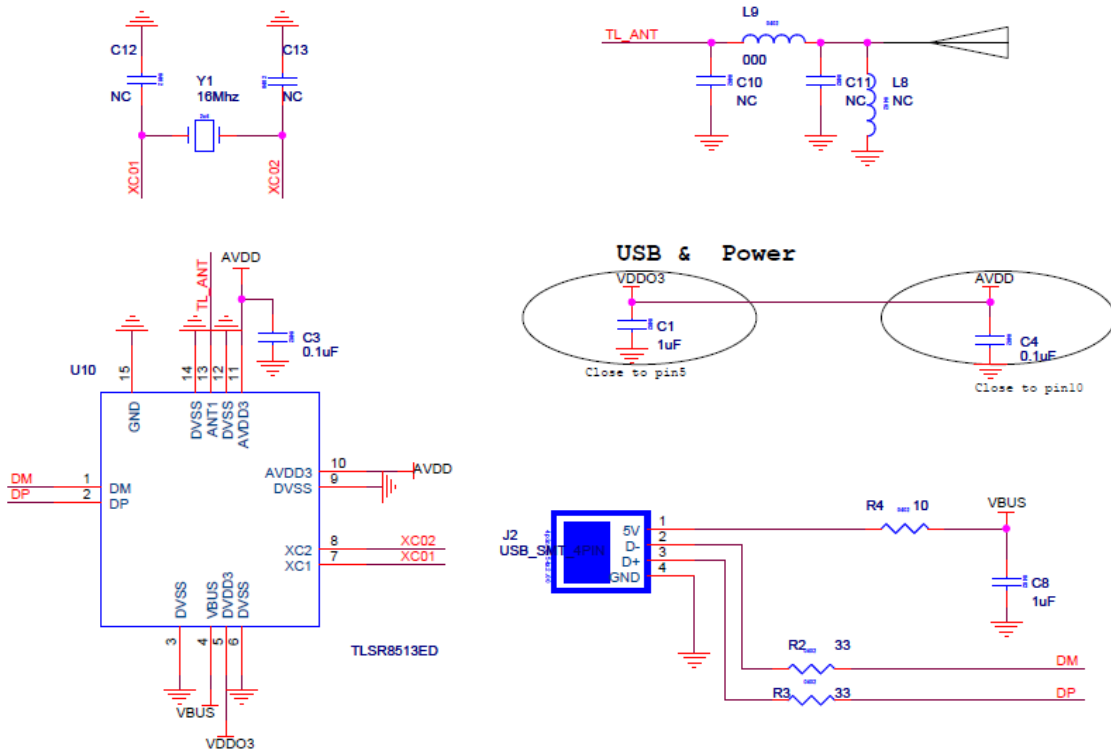| Quantity	Reference	Value	PCB Footprint
1	C3	0.1uF	0402
1	C8	1uF	0402
1	L9	0	0402
2	R2	33	0402
	R3	33	0402
1	R4	10	0402
1	U10	TLSR8513EP8	ESOP_8PIN_4X5_1P27
1	Y1	16Mhz - 12pF - ±20ppm	OSC_2x6

7.3 Application examples for DICE

Figure 7- 5   Schematic for TLSR8510ED

Figure 7- 6   Schematic for TLSR8513ED