

# B91 Wearable EVK V5.0 User Guide

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## Keyword

Features, Pin layout, Audio, Amoled

## Brief

This is a user guide for B91 wearable EVK V5.0. This document is dedicated for wearable application development based on TLSR9518A SoC.



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# **Revision History**

### Version 0.2 (2020-09-29)

Section	Change Description

### Version 0.1.0 (2020-08-26)

This is the Initial release.



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# **1**. Product Introduction

This is a user guide document for Telink B91 wearable EVK5.0. A 454\*454 amoled screen is placed on the EVK, which users can use to develop GUI. At the same time, a g-sensor chip is placed to facilitate user development of scenes. In addition, heart rate interface and motor interface are reserved. EVK also supports audio scene development.

## 1.1 General Description

The EVK is based on Telink TLSR9518A platform, provides a Bluetooth Classic and Bluetooth Low Energy wireless system.

The TLSR9518A integrates a powerful 32-bit RISC-V (RISC-Five) MCU, DSP, AI Engine, 2.4 GHz ISM Radio, 256 KB SRAM, stereo audio codec, 14 bit AUX ADC, analog and digital Microphone input, PWM, flexible IO interfaces, and other peripheral blocks required for advanced audio applications.

The TLSR9518A also includes multi-stage power management design with near-threshold level power consumption allowing ultra-low power operation and making it the ideal candidate for wearable and power-constraint applications.





Power Managment		Clock	<	Memory
RESET	LDO/DCDC	24MHz Crystal	24MHz RC	SPAM
POWER-ON	POWER	Oscillator	Oscillator	SKAIT
BROWN OUT	CONTROLLER	32.768kHz Crystal Oscillator	32kHz RC Oscillator	FLASH
Auc	dio	Core	Inter	face
Dual DMIC	125	32bit RISC-V MCU	GPIO	Swire
Dual AMIC	Stereo Audio Codec	(with DSP Extension)		
Timer		FPU	I2C	Flash I/F
Timer/ Watchdog	Sustam	AI Engine	SPI M/S	JTAG
32kHz LTIMER	Timer	;	SPI Slave	PWM
Radio		Security	USB	
Bluetooth/ 802.15.4/ 2.4GHz Radio		AES/PKE		Aux ADC
		TRNG	UART	

Figure 1-1 TLSR9518A Block diagram (without internal flash)





#### Figure 1-2 EVK Hardware interface

## 1.2 Key Features

- 1. TLSR9518A Embedded 32-bit RISC-V micro-controller
  - Better power-balanced performance than ARM M4
  - Instruction and Data cache controller
  - Maximum running speed up to 96 MHz
  - Integrated DSP extensions instructions
  - Integrated "F" standard extensions for single-precision floating-point
- 2. Bluetooth Compliant
  - BR, EDR 2 Mbps and 3 Mbps
  - BLE 1 Mbps and 2 Mbps, Long Range 125 kbps and 500 kbps
- 3. External RF PA support, TX power up to +20dbm
- 4. Up to 256 KB SRAM including up to 64 KB retention SRAM
- 5. Mass storage



- Placed 16MB external nor flash
- Placed 256MB external nand flash
- 6. Rich peripheral modules and interfaces
  - A amoled screen is playced on the EVK, up to 454\*454 resolution
  - Two LEDs for state indicator
  - Two buttons for scene development
  - A MCU reset button
  - A motor interface
  - Two speaker interfaces for audio
  - Two kinds of heart rate interfaces support for different FPC module
  - Two analog mems mic for audio
  - Placed a g-sensor chip, model is DA217
  - A usb2.0 interface
  - Two types of debug interfaces, SWIRE and JTAG

## **1.3** Mechanical and PCB Fabrication Specifications

PCB dimension: 64.25mm\*101.45mm\*1.6mm

PCB layer: 4 layers









#### Figure 1-4 Mechanical dimensions

## 1.4 Pin layout

## 1.4.1 Debug interface



Figure 1-5 Debug pin layout



Pin definition is shown as the Table 1-1 and Table 1-2:

Table 1-1 J58 JTAG pin header

Pin No	Pin Name	Pin Description
1	NA	NC
2	NA	NC
3	NA	Connect to GND of TLSR9 DEV KEY
4	NA	Connect to TMS of TLSR9 DEV KEY
5	NA	Connect to GND of TLSR9 DEV KEY
6	NA	Connect to TCK of TLSR9 DEV KEY



7	NA	TLSR9 DEV KEY 3V3 reference voltage input from EVK
8	NA	TLSR9 DEV KEY 5V voltage output to EVK
9	NA	Connect to GND of TLSR9 DEV KEY
10	NA	Connect to GND of TLSR9 DEV KEY
11	NA	Connect to TDO of TLSR9 DEV KEY
12	NA	Connect to TDI of TLSR9 DEV KEY

### Table 1-2 J75 SWS pin header

Pin No	Pin Name	Pin Description
1	NA	Telink Burning Board 5V voltage output to EVK
2	NA	Telink Burning Board 3V3 voltage output to EVK
3	NA	Connect to SWM of Telink Burning Board
4	NA	Connect to GND of Telink Burning Board



### 1.4.2 Screen Interface



Figure 1-6 Screen pin layout

Pin definition is shown as the Table1-2 and Table1-3 and Table1-4:

### Table 1-3 J22 LCD screen connector

Pin No	Pin Name	Pin Description
1	LEDK1	LED negative pole
2	LEDK2	LED negative pole
3	GND	Ground
4	GND	Ground



5	TE	NC
6	SDA	HSPI_SDO
7	AO	HSPI_SDI
8	SCLK	HSPI_SCLK
9	CS	HSPI_CS
10	RESET	Signal is active low
11	IOVCC18	3.3V supply
12	VCC28	3.3V supply
13	VCC28	3.3V supply
14	LEDA1	3.3V supply
15	LEDA2	3.3V supply

### Table 1-4 CON1 LCD TP connector

Pin No	Pin Name	Pin Description
1	VDD	3.3V supply
2	TP_SCL	I2C_SCL
3	TP_SDA	I2C_SDA
4	TP_INT	TP module IRQ output
5	TP_RST	Signal is active low



6	GND	Ground
7	GND	Ground
8	GND	Ground
9	GND	Ground
10	GND	Ground

### Table 1-5 J56 Amoled Screen connector

Pin No	Pin Name	Pin Description	
1	RESET	Device reset signal(O:enable;1:disable)	
2	VCI_EN	Enable signal for pwr IC control(1:enable)	
3	MTP_PWR	NC	
4	DO	Bit data bus/Input data bus for QSPI	
5	TE	Output a frame head pulse signal	
6	D1	Bit data bus/Input data bus for QSPI	
7	CSX	Chip select signal input	
8	D2	Bit data bus	
9	SCL	Serial interface clock	
10	D3	Bit data bus	
11	DCX	Data/Command select signal	



12	D4	Bit data bus	
13	SD1	Serial input signal in serial interface mode	
14	D5	Bit data bus	
15	SDO	Serial output signal in serial interface mode	
16	D6	Bit data bus	
17	IM1	Interface type selection	
18	D7	Bit data bus	
19	IMO	Interface type selection	
20	ΙΟΥCC	Power Supply for I/O system	
21	VBAT	Driver analog power supply	
22	GND	Ground	
23	VBAT	Driver analog power supply	
24	GND	Ground	

### 1.4.3 Heart Rate Interface

EVK provides two type of heart rate interfaces to support a variety of heart rate modules.



Figure 1-7 Heart rate pin layout



Pin definition is shown as the Table1-5 and table1-6:

Table 1-6 J4 heart rate connector

Pin No	Pin Name	Pin Description
1	NA	Ground
2	NA	IRQ output
3	NA	NC
4	NA	3.3V supply
5	NA	I2C_SDA
6	NA	I2C_SCL



### Table 1-7 J7 heart rate connector

Pin No	Pin Name	Pin Description
1	NC	Ground
2	NC	3.3V supply
3	NC	IRQ output
4	NC	I2C_SDA
5	NC	I2C_SCL
6	NC	Ground



### 1.4.4 Motor Interface



Figure 1-8 Motor pin layout

Pin definition is shown as the Table1-7:

#### Table 1-8 J3 Motor pin header

Pin No	Pin Name	Pin Description
1	NC	Connect to motor
2	NC	Connect to motor

## 1.4.5 Speaker Interface

EVK has 2 speaker connectors, one is the 9518A main chip analog output (Speaker1), and the other is the i2s interface through smartPA output (Speaker2)





Figure 1-9 Speaker pin layout

Pin definition is shown as the Table1-8 and Table1-9:

Table 1-9 J14 speaker pin header

Pin No	Pin Name	Pin Description
1	NC	Left channel negative headphone output
2	NC	Left channel positive headphone output

#### Table 1-10 J59 speaker pin header

Pin No	Pin Name	Pin Description
1	NC	OUTP of TFA9894
2	NC	OUTN of TFA9894





## 1.4.6 Lion-Battery Interface



Figure 1-10 Lion-Battery pin layout

Pin definition is shown as the Table1-9:

#### Table 1-11 J9 battery pin header

Pin No	Pin Name	Pin Description
1	NC	Lion-Battery positive
2	NC	Lion-Battery negative



# 2. Jumper Connection Guide

There are 3 parts of EVK that use jumper, namely power supply, LED, RF PA.

## 2.1 Power Supply

There are four methods supported to supply power for the EVK.

- Via Telink Burning Board
- Via TLSR9 DEV KEY
- Via usb
- Via li battery

### 2.1.1 Via Telink Burning Board Power Supply

TLSR9518A power supply:

- 1. 3V3/SWS/GND of J75 corresponds to Burning Board 3V3/SWM/GND;
- 2. J74 short connection;
- 3. J19 short connection;

Simultaneously supply power to peripheral modules (3V3):

- 4. Connect 5V of J75 to Burning Board 5V;
- 5. J65 short connection;
- 6. Short connect the "BAT\_LDO\_3V3" of J5;
- 7. According to the silk screen on the back of J5, short connect correspondingly to supply power to the peripheral module;







## 2.1.2 Via TLSR9 DEV KEY Power Supply

TLSR9518A power supply:

- 1. J58 connects to TLSR9 DEV KEY through proprietary DuPont wires;
- 2. J65 short connection;
- 3. Short connect the "TL\_VBAT" of J5;
- 4. Short connect the "BAT\_LDO\_3V3" of J5;
- 5. J19 short connection;

Simultaneously supply power to peripheral modules (3V3):

6. According to the silk screen on the back of J5, short connect correspondingly to supply power to the peripheral module;





#### Figure 2-2 Via TLSR9 DEV KEY Power Supply

## 2.1.3 Via USB

- 1. J8 is connected to a power adapter or PC through a USB cable;
- 2. J65 short connection;
- 3. Short connect the "TL\_VBAT" of J5;
- 4. J19 short connection;
- 5. Short connect the "BAT\_LDO\_3V3" of J5;
- 6. According to the silk screen on the back of J5, short connect correspondingly to supply power to the peripheral module;







## 2.1.4 Via LI Battery

- 1. Connect J9 to LI battery (note the positive and negative poles);
- 2. Short connect "TL\_VBAT" of J5;
- 3. J19 short connection;
- 4. Short connect "BAT\_LDO\_3V3" of J5;
- 5. According to the silk screen on the back of J5, short connect correspondingly to supply power to the peripheral module;









## 2.2 LED

Short J16 to light D14, short J18 to light D16.



Figure 2-5 LED Jumper

## 2.3 RF PA

In order to facilitate manual debugging of the PA, EVK reserves TXEN, RXEN, BYPASS up and down jumpers.

- Pin1 and pin2 of J70 are short-circuited, PD7 is pulled up to 3V3 (TXEN=1), pin2 and pin3 are short-circuited, and PD7 is pulled down to GND (TXEN=0).
- Pin1 and pin2 of J71 are shorted, PD6 is pulled up to 3V3 (RXEN=1), pin2 and pin3 are shorted, PD6 is pulled down to GND (RXEN=0).
- Pin1 and pin2 of J72 are shorted, PD5 is pulled up to 3V3 (BYPASS=1), pin2 and pin3 are shorted, PD5 is pulled down to GND (BYPASS=0).

TX_EN	RX_EN	Bypass	Mode

#### Table 2-1 Manual controller table

1	х	Х	TX Mode
0	1	NC/0	RX Mode
0	1	1	Bypass Mode
0	0	0	Shutdown

### Note

EVK is soldered by KCT8201L by default. If it is another type of chip, the control logic will be different from the above table.



# 3. Bluetooth RF path selection

EVK has designed two RF paths, one is from the 9518 ANT pin to the onboard antenna through the LC matching circuit. The other is that the 9518 ANT pin comes out through the RF PA to the SMA connector, and then connects to the 2.4G whip antenna.

## 3.1 Chose onboard antenna

R51 does not place components (NC), R52 and L7 place OR resistors.





## 3.2 Chose 2.4G whip antenna

No components (NC) are placed on R52, OR resistors are placed on R51, and whip antennas are connected to J1.









# 4. Download Firmware

## 4.1 Download Via Telink Burning Board

Follow the steps below to download the program to the TLSR9518A chip:

- 1. Connect to EVK via Telink Burning Board(refer to 2.1.1);
- 2. From Telink website Download the BDT tool;
- 3. Download the BIN file according to the introduction of Step2 on the page;

#### Note

http://wiki.telink-semi.cn/wiki/IDE-and-Tools/Burning-and-Debugging-Tools-for-all-Series/;

## 4.2 Download Via TLSR9 DEV KEY

Follow the steps below to download the program to the TLSR9518A chip:

- 1. Connect to EVK via TLSR9 DEV KEY(refer to 2.1.2);
- 2. From Telink website Download Download Telink\_v323\_rds\_official\_windows, and install;
- 3. Download the BIN file according to the introduction on the page;

#### Note

http://wiki.telink-semi.cn/wiki/IDE-and-Tools/Burning-and-Debugging-Tools-for-TLSR9-Series/;



# 5. Demo Firmware Instruction

Currently, two demo firmwares are provided, and users can realize simple functions after burning them to EVK.

## 5.1 "\_proj\_smart\_watch\_ nosniff.bin"

Feature:

- Realize the connection with the mobile phone to make calls and play music operations.
- Realize the connection with the headset and make a call.

### 5.1.1 How to connect EVK to phone

1. Download the BIN file to EVK(refer to chapter4);

#### Figure 5-1 Firmware download success

Flash Sector (4K) Erase at address 4d000 Flash Page Program at address 4d000 Flash Page Program at address 4d400 Flash Page Program at address 4d800 File Download to Flash at address 0x000000: 318060 bytes Total Time: 26120 ms

- 2. Re-power on EVK or short press sw1 (reset) to let the chip program run;
- Use the phone to connect, turn on the phone's Bluetooth, scan and find the device with the Bluetooth name "tlk\_dev";



Figure 5-2 Find the device

✔设置	蓝牙	
其他设备		
18-0010		
19-0014		
19-0030		
B85_demo		
B85_demo		
Mobile Phone		
Onn 2k TV stick		
Redmi		
shen		
smardd		

4. Connect the device on the mobile phone;



#### Figure 5-3 Connect device success



5. Make calls and play music operations;

### 5.1.2 How to connect EVK to headset

- 1. First, re-power on EVK or short press sw1 (reset) ;
- 2. Leave the headset in pairing state;
- 3. Double-click sw4, EVK will start scanning and automatically connect the headset;
- 4. Double click SW5, EVK and headset realize the call, single click SW5 to hang up;

Figure 5-4 Audio components



Note



Currently, this program does not support local music playback, and will support it in the future. If users need ,please confirm with Telink FAE.

## 5.2 "B91\_SPI\_Demo.bin"

Feature:

• Realize amoled screen display.

### Intructions:

1. Download the BIN file to EVK(refer to chapter4);

#### Figure 5-5 Firmware download success

Flash Sector (4K) Erase at address 3000 Flash Page Program at address 3000 File Download to Flash at address 0x000000: 12752 bytes Total Time: 1072 ms

- 2. Power on peripheral modules(Refer to 2.1.1);
- 3. Re-power on EVK or short press sw1 (reset) to let the chip program run;
- 4. Check the display;



Figure 5-6 Amoled display





# 6. Reference Design

## 6.1 Schematic



Figure 6-1 Schematic









((TL\_P82\_LCM\_SD(A0))
((TL\_P83\_LCM\_SDO(SDA))
((TL\_P84\_LCM\_SCLK))
((TL\_P86\_LCM\_RES))
((TL\_P86\_LCM\_RES))
((TL\_P86\_LCM\_SCS))
((TL\_P86\_LCM\_SCS))
((TL\_P86\_LCM\_SIO2))
((TL\_P81\_LCM\_SIO2))
((TL\_P80\_LCM\_SIO3))

(<TL\_PC0\_TP\_RST
 </pre>(<TL\_PC3\_TP\_INT(BCLK)
 </pre>(<TL\_PC2\_TP\_SDA
 </pre>(<TL\_PC1\_TP\_SCL







</TL\_PA5\_DM
</TL\_PA6\_DP
</pre>









#### ANT+PA (GC1101B/KCT8201L)









## 6.2 Bill Of Materials

#### Table 6-1 BOM table

Reference	Part	PCB Footprint	Quantity
Con1	OK-20F010-04	ok_20f_10pin_0p4	1
C2,C16,C39,C40,C50,C54,C77,C78, C79,C80	O.1uF	4020	10
С3	2.2uF	0402	1
C5,C6,L7,R8,C9,C11,R13,L20,C20,C 21,C24,C25,R41,R44,R52,R60,R63, R75,C86,C87,C88	NC	0402	21
C10,C13,C14,C15,C17,C18,C19,C22, C27,C28,C29,C30,C31,C33,C34,C3 7,C38,C44,C45,C51,C55,C62,C63,C 64,C69,C71,C73,C81,C82,C85,C89	1uF	0402	31
C23	4.7uF/10V	0402	1
C32	NC/10uF	0603C	1
C35,C36	10uF	0603C	2
C53	10pF	0402	1
C70,C90	220pF	0402	2
C72	33uF	0402	1
C74	22uF	0402	1



C83,C84	10uF	0402	2
D3	SMAJ15CA	sod-123	1
D14	Blue	0603-LED	1
D16	Green	0603-LED	1
J1	RFIN	SMA-H	1
J3	MOTOR	hdr254f-1x2x850	1
J4,J7	OK-F501-06325	heart_con	2
J5	SMT 12X2	smd254m-2x12_rx1_30y2_40	1
8L	USB_MiniABF	USB-MINI-F5	1
9L	Battery	hdr254f-1x2x850	1
J14,J59	SPEAKER	hdr254f-1x2x850	2
J16,J18,J19	con	HDR254F-1X2X850	3
J17	5V to MCU	HDR254F-1X2X850	1
J21,J23,J24,J25,J66,J67	GND	hdr254f-1x1x850	6
J22	XSJ178HYB1504A1	FPC270H_015_0P6_0P8	1
J56	OK-14F-024-04	ok_14f_24pin_0p4	1
J58	JTAG	hdr254f-2x6x850	1
J60	OE	HDR254F-1X2X850	1



J62	HEADER 8	hdr254f-1x8x850	1
J65	3V7	HDR254F-1X2X850	1
J69	SWS	HDR254F-1X3X850	1
J70,J71,J72	HEADER 3	HDR254F-1X3X850	3
J73	UART	hdr254f-1x2x850	1
L1,L3,L8,R47,R49,R51,R61,R62,R66 ,R71	OR	0402	10
L4,L5	4.7uH	0805L	2
L6	1uH	0805L	1
Q1,Q3	SI2302	mos_sot-23	2
R4,R7,R73,R74	2.2K	0402	4
R11	33	0402	1
R15	1M	0402	1
R17	OR	0402R	1
R23,R24	33	0402R	2
R32,R39,R45,R46,R67,R68	4.7K	0402	6
R35	100К	0402	1
R48	NC/3.3K	0402	1



R55	10R	0402	1
R57,R58,R72	1К	0402	3
R59	10К	0402	1
R70	1.96К	0402	1
SW1	SW4PIN_4.5x4.5	BUTDIP4P_5P0X3P0	1
SW4,SW5	Key1	BUTDIP4P_5POX3PO	2
U1	TLSR9518A	qfn_9x9_80pin_0p4_6p10x6p1 0	1
U3,U22	MWW7037AT2	ga_bfa423_a83	2
U4	NC/TXS0101	sc70-6	1
U5	NC/GD25Q16E	W25X10_20_40BL	1
U9	CE1132_33M	sot-23-5	1
U11	XT26G04AWSEGA	WSON8	1
U13	P25Q8OU	sop8_208mil	1
U15	DA217	MC3413	1
U16	GC1101B/KCT8201L	qfn_3x3_16pin_0p5_1p70x1p7 0	1
U17	TFA9894BUK/N1	bga_3p5x2p55_48pin_0p4	1
U18,U19	SGM4587	tqfn_3x3_20pin_0p4_1p50x1p5	2



		0	
U20	CE1132_18M	sot-23-5	1
U21	LM1117-ADJ	sot-223	1
Y1	32.768KHz - 9pf - 20ppm	OSC_2x6	1
Y2	24MHz-12pF-20ppm	OSCCC250X320X110	1