# UG0702
# EV8730EAH User Guide—Evaluation Board

This document describes the evaluation board based on RTL8730EAH.

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# Contents

# 1 Overview

## 1.1 Introduction

The evaluation board (EVB) based on RTL8730EAH is designed to provide users with flexible function demonstration and usage evaluation. It builds the minimum system including power supply and clock, and provides various circuits such as Wi-Fi, Bluetooth, Audio, MIPI, ADC, SD Card, GPIO, etc. Users can configure the functions freely by using the Software Development Kit (SDK) and related tools provided by REALTEK.

## 1.2 Features

The EVB based on RTL8730EAH includes the following features:

- Embedded 64M bits PSRAM/512M bits DDR2
- Embedded 64M bits NOR Flash
- Supports for ARM's SWD and SEGGER J-Link protocol options
- 5V DC power supply and USB-to-UART communication through USB-C socket
- Buttons for chip reset and UART download
- PCB and external antennas options for Wi-Fi and Bluetooth
- SD Card, MIPI, USB, Cap-touch interfaces and related on-board circuits
- Audio circuits of 4 AMIC, 2 DMIC and power amplifier for speaker or earphone
- Optional external 12V power supply for Audio PA
- User LED and user key circuits
- GPIO Pin headers supported for function extension
- Extension sub-board interface supported

# 2 Quick Start

## 2.1 Power

The EVB based on RTL8730EAH can be powered by connecting a USB cable between PC and board in USB-C socket.

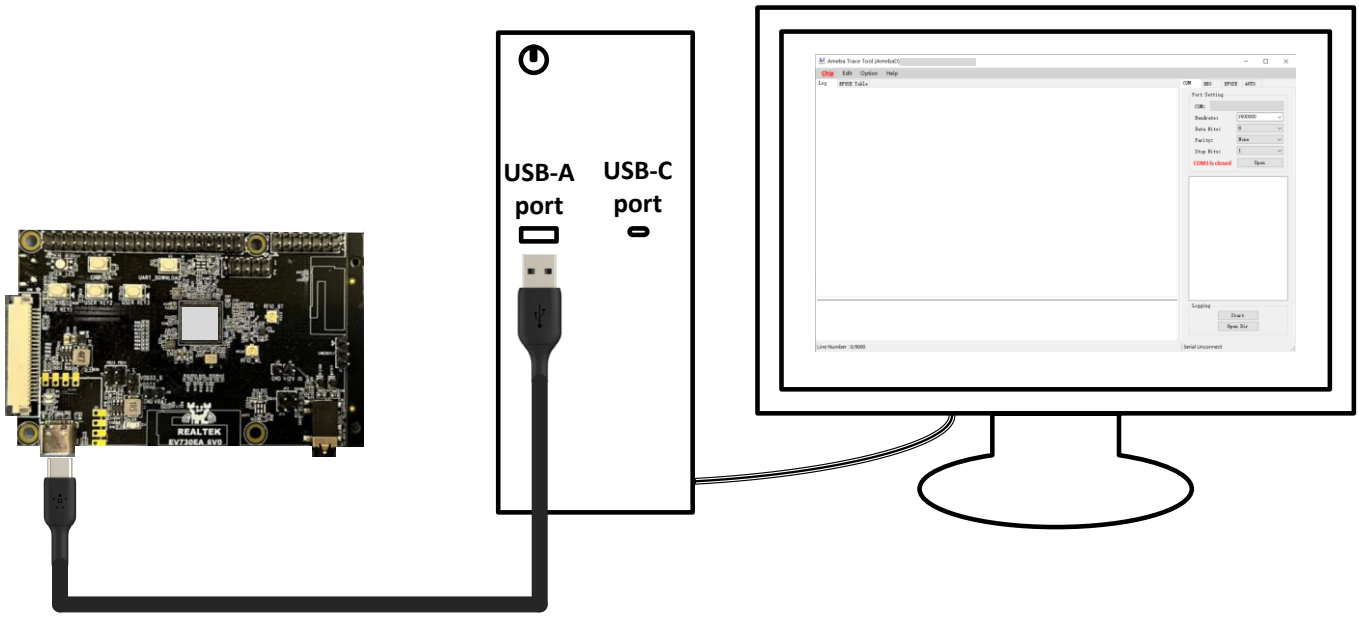


Figure 2-1 EV8730EAH power supply schematic

## 2.2 FLASH Download

Before the EVB leaving the factory, REALTEK has already downloaded default basic bin files into FLASH inside the chip. Users are allowed to download their own bin files into the FLASH through either LOGUART port or USB port of RTL8730EAH.

NOTE

*Before downloading bin files into RTL8730EAH, please refer to the application note (AN0600) for detailed instructions.*

## 2.3 Log

LOGUART is an important way for users to interact with the chip. Users can judge the working status of the code and perform online operations through the log transferred by the serial port.

The default transmission formats and transfer speed of LOGUART are: 8bits data, no parity bit, 1stop bit and 1.5Mbps respectively.

NOTE

- *The EVB has integrated a USB to UART IC on board so that the LOGUART function can be available only through a regular USB-A/USB-C to USB-C cable.*
- *Users can freely use any serial tool to communicate between PC and RTL8730EAH. If Trace Tool provided by REALTEK is chosen, please refer to the application note (AN0600) for detailed instructions.*

## 2.4 Functions

The EVB based on RTL8730EAH provides many functions for users to use freely. When users want to use a specific function, please follow the following steps:

(1) Confirm the available pin for the function through the PINMUX document.
(2) Find the location of the pin according to Figure 3-1 and Table 3-1.
(3) Connect EVB and external circuits through DuPont lines or use circuits on board such as SD Card, Audio, etc.

# 3 PCB Layout

## 3.1 Component Distribution

The EVB is a four-layer PCB board, with a size of 85mm*56mm, and a positioning hole diameter of 2.7mm. The interfaces and dimensions of the EVB based on RTL8730EAH are all compatible with the Raspberry Pi 4.

### 3.1.1 Top Layer

The top layer of the EVB is illustrated in Figure 3-1.

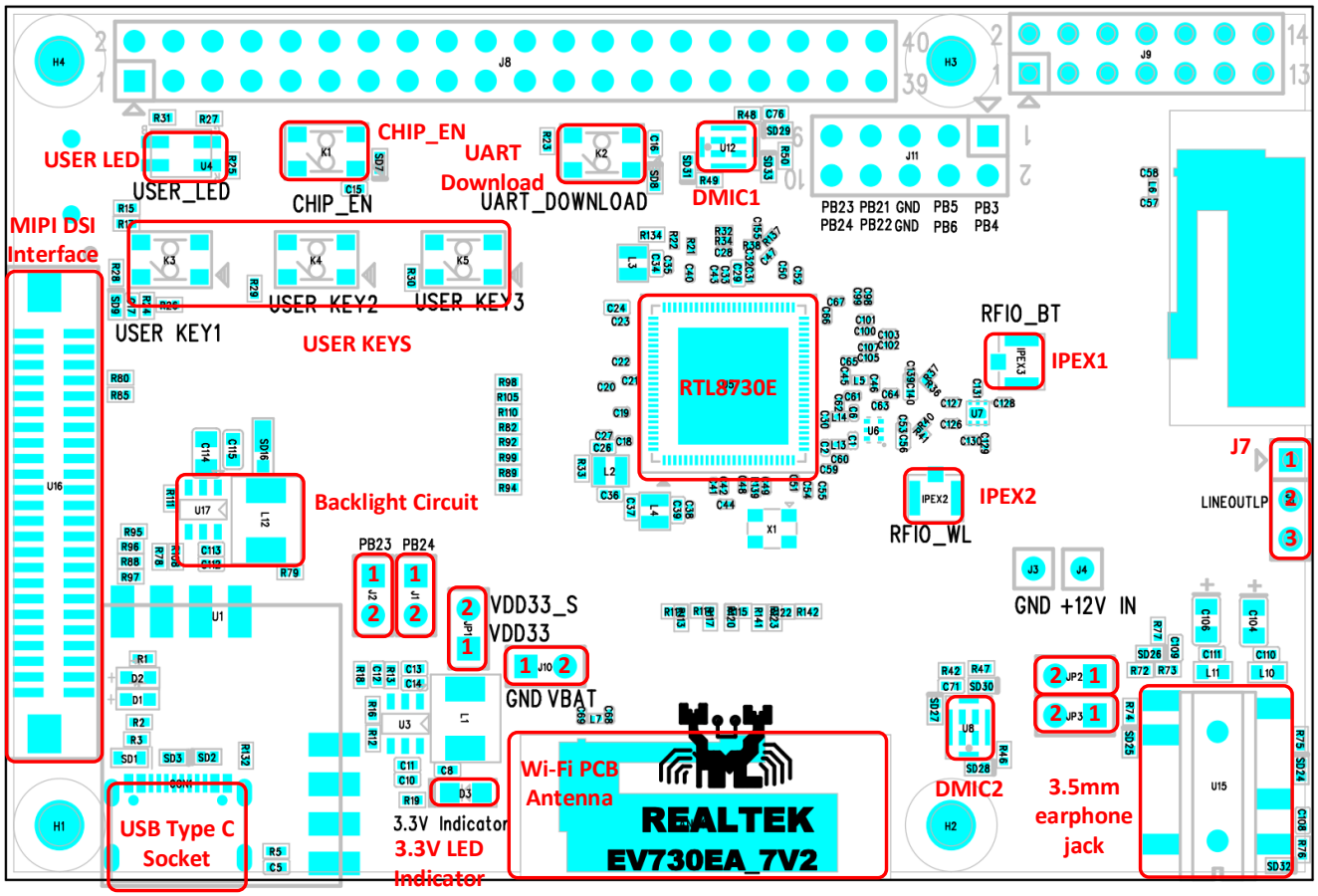


Figure 3-1 EV8730EAH – top layer

### 3.1.2 Bottom Layer

The bottom layer of the EVB is illustrated in Figure 3-2.

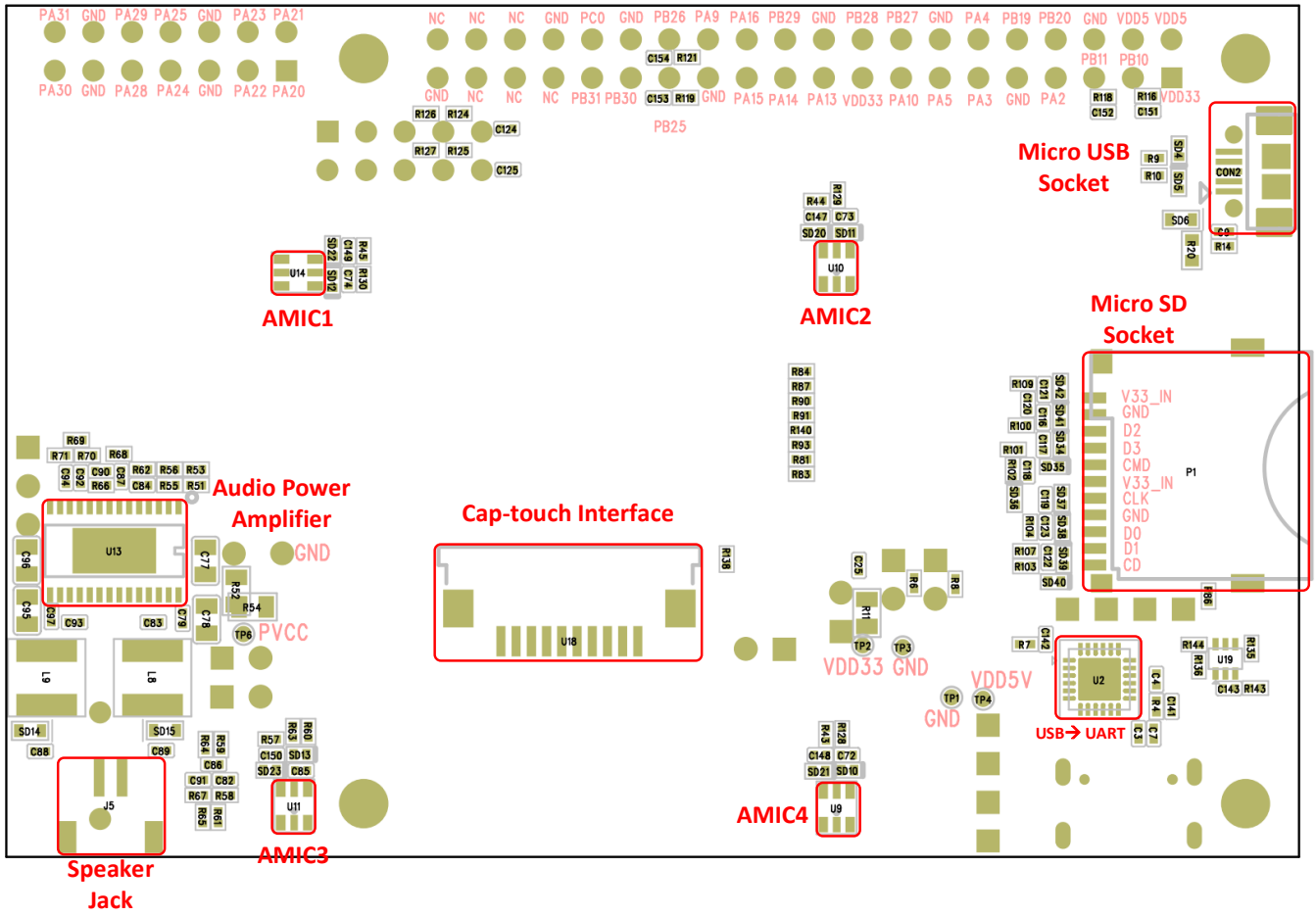


Figure 3-2 EV8730EAH – bottom layer

## 3.2 External Chips

### 3.2.1 Crystal

E1SB40E00090FE crystal of HOSONIC Technology is used as a high-precision clock source with an oscillation frequency of 40MHz with an operating temperature of -40℃ ~ +105℃.

### 3.2.2 FT232

PL2303GC of Prolific is used as a USB to UART converter. A USB-A/USB-C to USB-C cable can be used to connect the PC to the EVB and communicate with the RTL8730EAH.

### 3.2.3 Microphone

There are two kinds of MIC chips on the EVB, namely analog microphone and digital microphone. Refer to Figure 3-1 for the location on the EVB.

The model number of AMIC is SPH1642HT5H-1, and the typical parameters are:

- Sensitivity: -38dB ±1dB @ 94dB SPL 1kHz
- Signal-to-noise ratio (SNR): 65dBA

The model number of DMIC is 3SM222FMT1KA, and the typical parameters are:

- Sensitivity: -26dB ±1dB @ 94dB SPL 1kHz
- Signal-to-noise ratio (SNR): 60dBA
- Input clock frequency range:1-3.25MHz

### 3.2.4 Audio Amplifier

ESMT's high-efficiency stereo Class-D audio amplifier (AD52058) is used as the driver of external speakers or earphone. It can deliver 15W/CH output power into 4Ω loudspeaker within 10% THD+N at max 12V supply voltage without external heat sink.

CAUTION

*On the EVB, AD52058 is powered by 5V by default. If user wants to use external 12V power supply to drive higher power speakers, please confirm that R50 resistor has been removed and R55 0 ohm resistor has been soldered before power on or the PC or USB adaptor connected to the USB-C socket will be damaged. After that, user can connect J3.1 and J4.1 to the positive and negative terminals of a power supply respectively.*

### 3.2.5 RF Circuits

PCB antenna is designed as copper wire or copper foil on PCB to reduce its volume. PCB antennas on the EVB include one Bluetooth antenna and one WLAN antenna, and the isolation between them is less than -20dB.

## 3.3 Connector

Multiple connectors are provided on the EVB for the expansion of different functions of the chip. The positions of different connectors on the EVB are shown in the Figure 3-1.

NOTE

*Only connectors with numbers and the names described next to them can be configured in the Figure 3-1and Figure 3-2. Other connectors with no specific purpose are used for internal test or other reserved functions. Please do not configure them arbitrarily to avoid affecting the normal operation of the chip.*

### 3.3.1 Pin Headers

The pin multiplexing and description of each jumper is listed in Table 3-1. All designators and pins shown in the following table can be located in Figure 3-1.

Table 3-1 EV8730EAH - pin headers

| Designator | Pin number | Symbol | Description |
|---|---|---|---|
| J8 | 1 | VDD33 | 3.3V voltage supplied by 5V-to-3.3V DC-DC converter. |
| | 2 | VDD5 | 5V voltage supplied by USB interface. |
| | 3 | PB10 | Used as GPIO or other functions connected to PB10 of RTL8730EAH directly. |
| | 4 | VDD5 | 5V voltage supplied by USB interface. |
| | 5 | PB11 | Used as GPIO or other functions connected to PB11 of RTL8730EAH directly. |
| | 6 | GND | Ground. |
| | 7 | PA_2 | Used as GPIO or other functions connected to PA2 of RTL8730EAH through R112 0 ohm resistor. |
| | 8 | PB20 | Used as GPIO or other functions connected to PB20 of RTL8730EAH directly. |
| | 9 | GND | Ground |
| | 10 | PB19 | Used as GPIO or other functions connected to PB19 of RTL8730EAH directly. |
| | 11 | PA_3 | Used as GPIO or other functions connected to PA3 of RTL8730EAH through R114 0 ohm resistor. |
| | 12 | PA_4 | Used as GPIO or other functions connected to PA4 of RTL8730EAH through R115 0 ohm resistor. |
| | 13 | PA_5 | Used as GPIO or other functions connected to PA5 of RTL8730EAH through R122 0 ohm resistor. |
| | 14 | GND | Ground. |
| | 15 | PA10 | Used as GPIO or other functions connected to PA10 of RTL8730EAH directly. |
| | 16 | PB_27 | Used as GPIO or other functions connected to PB27 of RTL8730EAH through R98 0 ohm resistor (default NC). |
| | 17 | VDD33 | 3.3V voltage supplied by 5V-to-3.3V DC-DC converter. |
| | 18 | PB_28 | Used as GPIO or other functions connected to PB28 of RTL8730EAH through R105 0 ohm resistor (default NC). |
| | 19 | PA13 | Used as GPIO or other functions connected to PA13 of RTL8730EAH directly. |

| | | | |
|---|---|---|---|
| | 20 | GND | Ground. |
| | 21 | PA14 | Used as GPIO or other functions connected to PA14 of RTL8730EAH directly. |
| | 22 | PB_29 | Used as GPIO or other functions connected to PA6 of RTL8730EAH through R110 0 ohm resistor. |
| | 23 | PA15 | Used as GPIO or other functions connected to PA15 of RTL8730EAH directly. |
| | 24 | PA16 | Used as GPIO or other functions connected to PA16 of RTL8730EAH directly. |
| | 25 | GND | Ground |
| | 26 | PA9 | Used as GPIO or other functions connected to PA9 of RTL8730EAH directly. |
| | 27 | PB_25 | Used as GPIO or other functions connected to PB25 of RTL8730EAH through R89 0 ohm resistor (default NC). |
| | 28 | PB_26 | Used as GPIO or other functions connected to PB26 of RTL8730EAH through R94 0 ohm resistor (default NC). |
| | 29 | PB_30 | Used as GPIO or other functions connected to PB30 of RTL8730EAH through R82 0 ohm resistor (default NC). |
| | 30 | GND | Ground. |
| | 31 | PB_31 | Used as GPIO or other functions connected to PB31 of RTL8730EAH through R140 0 ohm resistor. |
| | 32 | PC_0 | Used as GPIO or other functions connected to PC0 of RTL8730EAH through R99 0 ohm resistor (default NC). |
| | 33 | NC | Not connected. |
| | 34 | GND | Ground |
| | 35 | NC | Not connected. |
| | 36 | NC | Not connected. |
| | 37 | NC | Not connected. |
| | 38 | NC | Not connected. |
| | 39 | GND | Ground. |
| | 40 | NC | Not connected. |
| J9 | 1 | PA20 | Used as GPIO or other functions connected to PA20 of RTL8730EAH directly. |
| | 2 | PA21 | Used as GPIO or other functions connected to PA21 of RTL8730EAH directly. |
| | 3 | PA22 | Used as GPIO or other functions connected to PA22 of RTL8730EAH directly. |
| | 4 | PA23 | Used as GPIO or other functions connected to PA23 of RTL8730EAH directly. |
| | 5 | GND | Ground. |
| | 6 | GND | Ground. |
| | 7 | PA24 | Used as GPIO or other functions connected to PA24 of RTL8730EAH directly. |
| | 8 | PA25 | Used as GPIO or other functions connected to PA25 of RTL8730EAH directly. |
| | 9 | PA28 | Used as GPIO or other functions connected to PA28 of RTL8730EAH directly. |
| | 10 | PA29 | Used as GPIO or other functions connected to PA29 of RTL8730EAH directly. |
| | 11 | GND | Ground. |
| | 12 | GND | Ground. |
| | 13 | PA30 | Used as GPIO or other functions connected to PA30 of RTL8730EAH directly. |
| | 14 | PA31 | Used as GPIO or other functions connected to PA31 of RTL8730EAH directly. |
| J11 | 1 | PB3 | Used as GPIO or other functions connected to PB3 of RTL8730EAH directly. |
| | 2 | PB4 | Used as GPIO or other functions connected to PB4 of RTL8730EAH directly. |
| | 3 | PB5 | Used as GPIO or other functions connected to PB5 of RTL8730EAH directly. |
| | 4 | PB6 | Used as GPIO or other functions connected to PB6 of RTL8730EAH directly. |
| | 5 | GND | Ground. |
| | 6 | GND | Ground. |
| | 7 | PB21 | Used as GPIO or other functions connected to PB21 of RTL8730EAH directly. |
| | 8 | PB22 | Used as GPIO or other functions connected to PB22 of RTL8730EAH directly. |
| | 9 | PB23 | Used as GPIO or other functions connected to PB23 of RTL8730EAH directly. |
| | 10 | PB24 | Used as GPIO or other functions connected to PB24 of RTL8730EAH directly. |
| J10 | 1 | GND | Ground. |
| | 2 | VBAT_MEAS | VBAT_MEAS voltage measurements input pin.(Input voltage range 0-5V) |
| J7 | 1 | AOUT_LP | Audio output LP signal to drive speaker. AOUT_LP can be driven by connecting J6.1 and J6.2. |
| | 2 | PB3 | Used as GPIO or other functions connected to PB3 of RTL8730EAH directly. |
| | 3 | AOUT_LPE | Audio output LP signal to drive earphone. AOUT_LP can be driven by connecting J6.3 and J6.2. |
| J3 | 1 | GND | Ground. |
| J4 | 1 | VDD12 | Positive terminal of 12V voltage supply connected to AD52058 which can be supplied by |

| | | | |
|---|---|---|---|
| | | | external power supply instrument. |
| J2 | 1 | PB23 | Default LOGUART RX function of RTL8730EAH. |
| | 2 | FT_LOG_TX | UART TX signal of PL2303GC. |
| J1 | 1 | PB24 | Default LOGUART TX function of RTL8730EAH. |
| | 2 | FT_LOG_RX | UART TX signal of PL2303GC. |
| JP2 | 1 | AOUT_RP | Audio output RP signal for external instrument test. |
| | 2 | GND | Ground. |
| JP3 | 1 | AOUT_LPE | Audio output LPE signal for external instrument test. |
| | 2 | GND | Ground. |

NOTE

*Not all GPIOs are connected to the pin headers. If the following GPIOs(PB25, PB26, PB27, PB28, PB30, PC0) need to be used on the pin headers, please refer to Table xx to determine the hardware changes that need to be made on the EVB board. In addition, please refer to Figure 3-1 and Figure 3-2 for the specific location of the components that need to be adjusted on the board.*

Table 3-2 Circuit modification instructions of GPIOs

| Pin name | Resistors need to be soldered | Resistors need to be removed | Note |
|---|---|---|---|
| PB25 | R89(0 ohm) | R81(27 ohms) | After R81/R83/R84/R87/R91/R93 is removed, the SDIO circuits on board cannot be used. |
| PB26 | R94(0 ohm) | R83(27 ohms) | |
| PB27 | R98(0 ohm) | R84(27 ohms) | |
| PB28 | R105(0 ohm) | R87(27 ohms) | |
| PB30 | R82(0 ohm) | R91(27 ohms) | |
| PC0 | R99(0 ohm) | R93(27 ohms) | |

### 3.3.2 USB-C socket

A standard USB-C socket is provided on the EVB. Users can use a USB-A/USB-C to USB-C cable to connect between PC and EVB for both power supply and LOGUART function.

Figure 3-3 USB-A to USB-C cable

Figure 3-4 USB-C to USB-C cable

### 3.3.3 MIPI DSI Interface

EVB has a MIPI DSI interface integrated with touch I2C interface, which can be connected with an LCD screen through FPC.

- The LCD display interface includes one pair of clock signals (MIPITX_CKP/ MIPITX_CKN), two pairs of data signals (MIPITX_DATAP_0/ MIPITX_DATAN_0, MIPITX_DATAP_1/ MIPITX_DATAN_1), LCD_RESET, VDD33_LCD, backlight LEDA and LEDK. LCD_TE and LCD_PWM are connected for future development.
- The LCD touch function interacts with RTL8730EAH through I2C protocol.
- The transmission rate of each data lane is up to 1Gbps. Data lane 0 supports bidirectional transmission and escape mode, while data lane1 only supports unidirectional transmission. The maximum XGA resolution of DSI is 1024x768 @ 60fps.

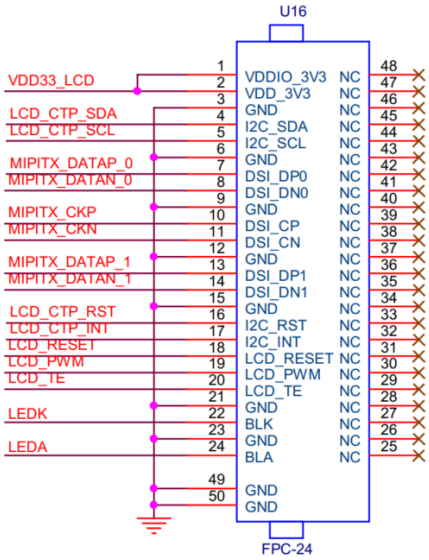


Figure 3-5 FPC signal distribution of display and touch interface

NOTE

*When using, the cable should be carefully inserted into the connector to avoid damage to the golden finger.*
*If other LCD screens are used, note that the cable size should not be too long, the time for the signal to pass through the connecting line should not exceed 2ns, and the length from the corresponding IC to the LCD screen should not exceed 25cm.*

### 3.3.4 IPEX

IPEX1 and IPEX2 are reserved for Bluetooth and Wi-Fi RF respectively on the EVB. The IPEX female connector can be connected to an external antenna or an instrument to measure the RF characteristics.

Before using Wi-Fi or BT RF functions, please follow the instructions below:

- Wi-Fi and Bluetooth use external antennas connected to IPEX2 and IPEX1 by default.
- Two PCB antennas are designed for convenient use. If users want to use BT PCB antenna, R36 0 ohm resistor should be removed and R38 0 ohm resistor should be soldered. Similarly, when using the Wi-Fi PCB antenna, users need to remove the R37 0 ohm resistor and solder on the R39 0 ohm resistor.

Figure 3-6 shows the size of IPEX female connector. Pay attention to the size matching of the adapter when using it.

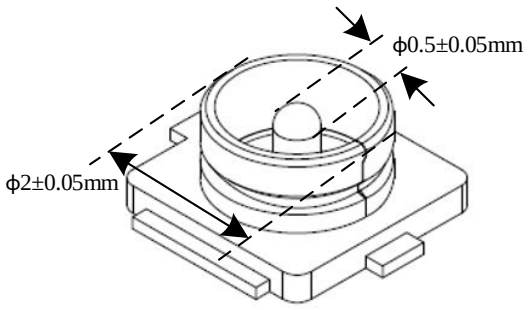


Figure 3-6 Size of IPEX female connector

### 3.3.5 Micro USB Socket

A standard micro USB socket is provided on the EVB for using USB function of RTL8730EAH.

### 3.3.6 Micro SD Socket

A standard micro SD card socket is provided on the EVB for using SD CARD storage function of RTL8730EAH.

### 3.3.7 Cap-touch Interface

A Cap-touch interface is provided on the EVB for extended use connected to a flexible PCB through FPC (10 pins total and the distance between adjacent pins is 1mm).

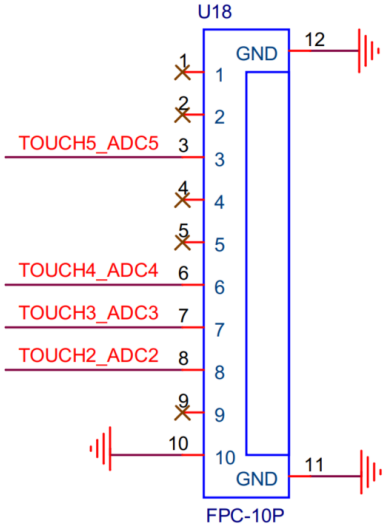


Figure 3-7 FPC signal distribution of cap-touch interface

### 3.3.8 Speaker Jack

The speaker jack provided on the EVB is a 2-pin jack with a spacing of 1.5mm, connected with the P/N output of the power amplifier.

### 3.3.9 Earphone Jack

A 3.5mm earphone jack is provided on the EVB to expand the audio function of the RTL8730EAH.It can either play sound or collect sound through the connected earphone.

# 4 Basic Usage

## 4.1 Power Supply

### 4.1.1 USB Power

The EV8730EAH can be powered by connecting PC or adaptor to USB-C socket located in the lower left corner of the board.

NOTE

- *The maximum theoretical power supply capacity of general USB-A 2.0 port is 500mA which is enough for the EVB without MIPI and Audio function under operation. If MIPI or Audio function is needed, please use a USB-C to USB-C cable and make sure the power source is enough for the consumption of EVB.*
- *If users want to drive a speaker of greater power through AD52058, please refer to the section 3.2.4 for detailed usage.*

### 4.1.2 LED Indicators

A single color LED is used to indicate whether 3.3V power supply of RTL8730EAH is available. Please refer to Figure 3-1 for the location of LED.

## 4.2 Reset

When the power supply is stable, RTL8730EAH can be reset by pressing and releasing the CHIP_EN button on the EVB, or powering the EVB off and then powering on.

The CHIP_EN button on the EVB is K1.

## 4.3 Communication

### 4.3.1 LOGUART

The EV8730EAH integrates a USB to UART chip so users can simply use a USB-A/USB-C to USB-C cable to connect EVB and PC. After that, users can communicate with RTL8730EAH through any serial tool on the PC.
Before using the serial tool, users should follow the below steps:

(1) Select the correct serial port.
(2) Configure the transmission baud rate and frame format.
(3) Open the serial port to interact with the EVB.

NOTE

*The default transmission baud rate of LOGUART is 1.5Mbps*

Take Trace Tool provided by REALTEK as an example, after the configurations above, the log window of the Trace Tool will display the data received/transmitted by PC and parse it into ASCII characters. Each line will display the time of receiving/transmitting this log.

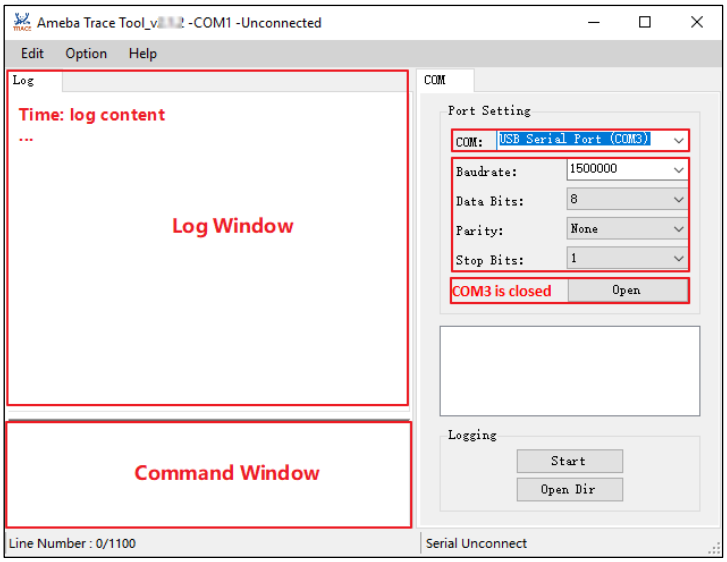


Figure 4-1 Trace Tool UI

## 4.3.2 SWD

RTL8730EAH supports 2-pins serial-wire debug (SWD) interface for users to access ARM Cortex®-M core integrated in the chip. For more information, please refer to ARM Debug Interface v6 Architecture Specification.

The default SWD function is distributed on PA13 (SWD_DAT) and PA14 (SWD_CLK).

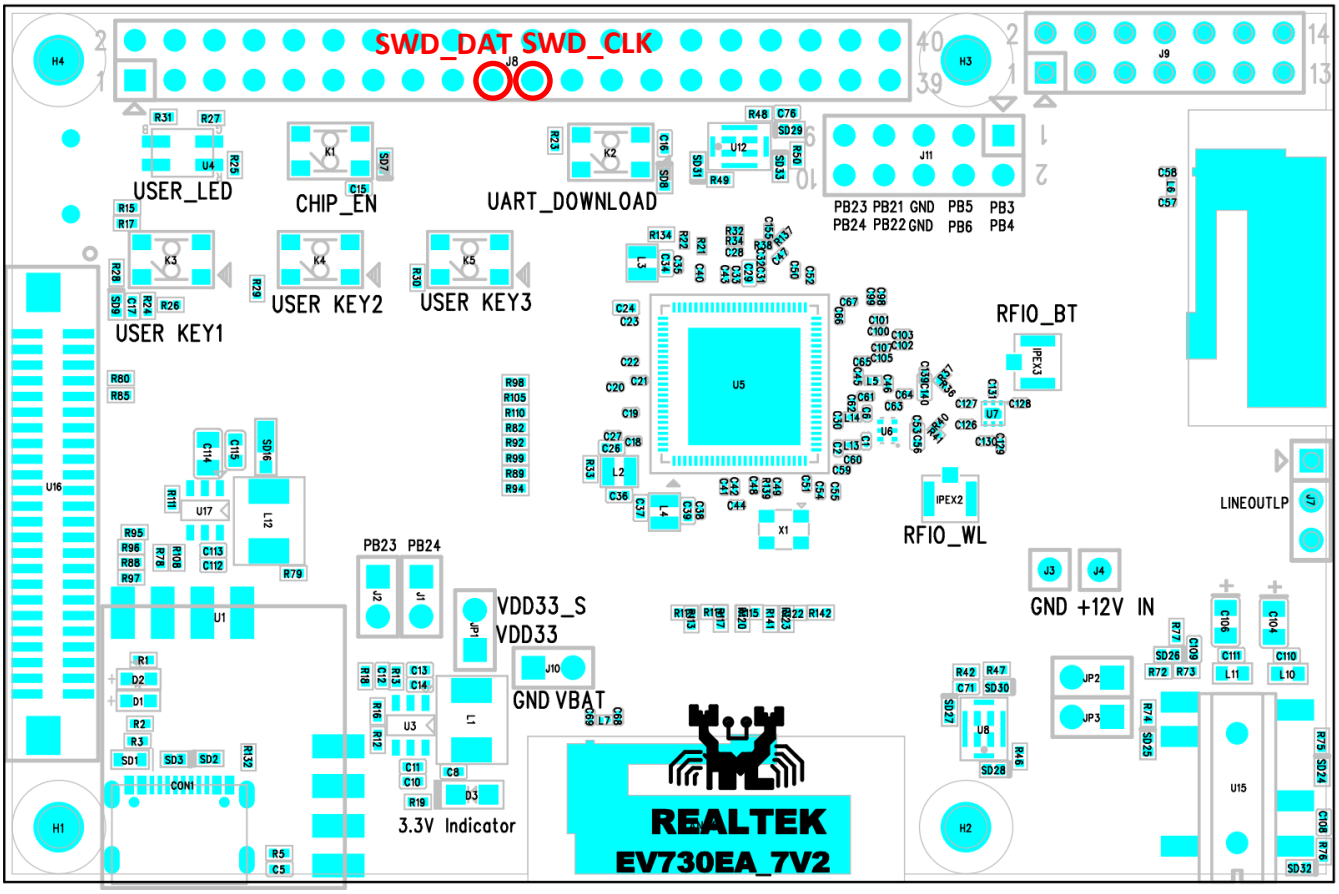


Figure 4-2 Location of SWD function on EVB

# 5 Other Functions

## 5.1 Wi-Fi

RTL8730EAH supports up to Wi-Fi 802.11ax protocol and external antenna.

## 5.2 Bluetooth

RTL8730EAH supports up to Bluetooth protocol 5.2 and external antenna.

## 5.3 USB

RTL8730EAH supports up to USB protocol 2.0.

## 5.4 Cap-touch

RTL8730EAH supports 4 channels of Cap-touch or ADC.

NOTE

*If users want to use Cap-touch interface (refer to chapter 3.3.7) on the EVB and related Cap-touch daughter board provided by REALTEK, please make the modifications in the Table 5-1. In addition, please refer to Figure 3-1 and Figure 3-2 for the specific location of the components that need to be adjusted on the board.*

Table 5-1 Circuit modification instructions of Cap-touch

| FPC pin number | Function name | Resistors need to be soldered | Resistors need to be removed | Note |
|---|---|---|---|---|
| 3 | TOUCH5_ADC5 | R113(0 ohm) | R112(0 ohm) | |
| 6 | TOUCH4_ADC4 | R117(0 ohm) | R114(0 ohm) | |
| 7 | TOUCH3_ADC3 | R120(0 ohm) | R115(0 ohm) | |
| 8 | TOUCH2_ADC2 | R123(0 ohm) | R122(0 ohm) | |

## 5.5 SD Card

RTL8730EAH supports up to SD protocol 2.0.

## 5.6 MIPI

RTL8730EAH supports MIPI Display Serial Interface (MIPI-DSI) which includes one clock lane and two data lanes. Both clock lane and data lane can operate in ultra-low-power mode.

## 5.7 Audio

### 5.7.1 Microphone

The RTL8730EAH can collect sound data through AMIC or DMIC.

### 5.7.2 Speaker

The RTL8730EAH can directly drive 4/8Ω impedance speaker with maximum power of 15W through AD52058.

### 5.7.3 Earphone

The EVB supports 32 and 16 ohms earphone audio output and earphone mic acquisition.

## 5.8 User Key

Three keys are provided on the EVB which can be detected by single ADC channel.
When different single key or keys combination are pressed, the voltage detected by ADC port is different. The relationship between keys combination and detected voltage is listed in Table 5-2.

Table 5-2 Key-pressing related detected voltage

| Keys combinations | Detected voltage by ADC(V) |
|---|---|
| None | VDD33 |
| K3 | 0.667*VD33 |
| K4 | 0.706*VD33 |
| K5 | 0.836*VD33 |
| K3&K4 | 0.522*VD33 |
| K3&K5 | 0.590*VD33 |
| K4&K5 | 0.620*VD33 |
| K3&K4&K5 | 0.473*VD33 |

NOTE

*If users want to use USER KEY circuit on the EVB, please solder on the R80 0 ohm resistor.*

## 5.9 User LED

A RGB LED and related driving circuit are provided on the EVB for free use. Users can set related pins to GPIO output mode and drive pins to low which connected to the LEDR/LEDG/LEDB ports to control the LED to emit red/green/blue colors of light. For further use, users can set related pins of RTL8730EAH to PWM function to obtain more display color combinations (see Figure 3-1 and Figure 3-2 for locations of each components).

NOTE

*If users want to use USER LED circuit on the EVB, please solder on R25, R27 and R31 of at least 470 ohm resistors (Used as current limit resistors to prevent LED from being damaged).*

## 5.10 IO

The RTL8730EAH has many other functions such as SPI, I2C, I2S, ADC, PWM, etc., which can be expanded and used through the pins drawn by the jumper. Please refer to the content in Section 3.3.1 for the pins led out through the jumper.

NOTE

*For all the contents above, please refer to the datasheet (UM0601) for more detailed information.*

# Revision History

| Date | Version | Description |
|---|---|---|
| 2022-12-06 | v1.0 | Initial release |
| 2023-11-22 | V1.1 | 1. Correct some mistakes<br>2. Add contents in 3.3.1 and 5.4 |