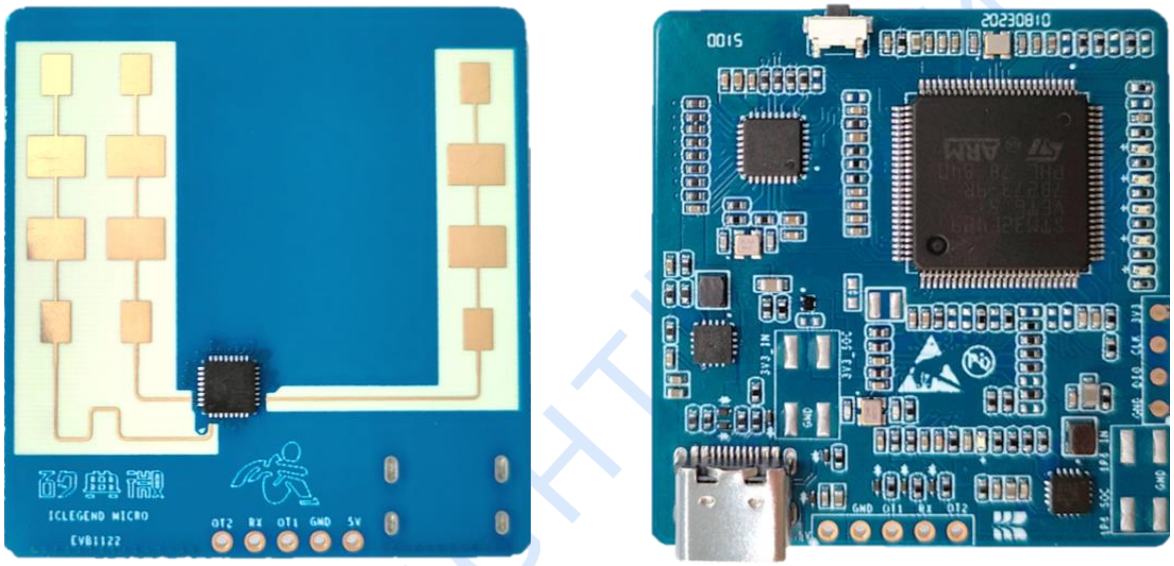
UM10034
EVB1122 Evaluation Kit User Manual

Rev.1.0 User Manual

Introduction

The EVB1122 evaluation kit enables users to quickly evaluate the performance of the ICL1122 24 GHz mmWave sensor SoC. This kit includes the EVB1122 evaluation board, firmware, waveform configuration and demonstration GUI, and other components.

The EVB1122 board provides an easy-to-use 1TX2RX mmWave sensor platform. It features three mmWave antennas, the ICL1122 24 GHz mmWave sensor chip, and an STM32F4 series microcontroller. Figure 0-1 shows the top and bottom views of the EVB1122 evaluation board.



EVB1122 board top side EVB1122 board back side

Figure 0-1 Outlooks of EVB1122 evaluation board

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1 Hardware Description

The ICL1122 is a highly integrated silicon-based 24 GHz mmWave sensor SoC intended for ISM band applications. As shown in Figure 1-1, it incorporates a full transceiver (with one transmit channel, two receive channels, PLL, mixer, etc.), baseband processing (IF amplifier, ADC, DSP hardware accelerator), power management, temperature sensor, and multiple communication interfaces (I2C/SPI/UART/GPIO). For digital processing, the ICL1122 features clutter removal capabilities and supports 1D FFT for range detection after clutter removal. It also enables multi-rate down-sampling of raw data.

The ICL1122 provides a single-chip solution suitable for AIoT consumer and industrial applications like indoor multi-human tracking and outdoor long-range target tracking. It also supports very low power and small form factor implementations.

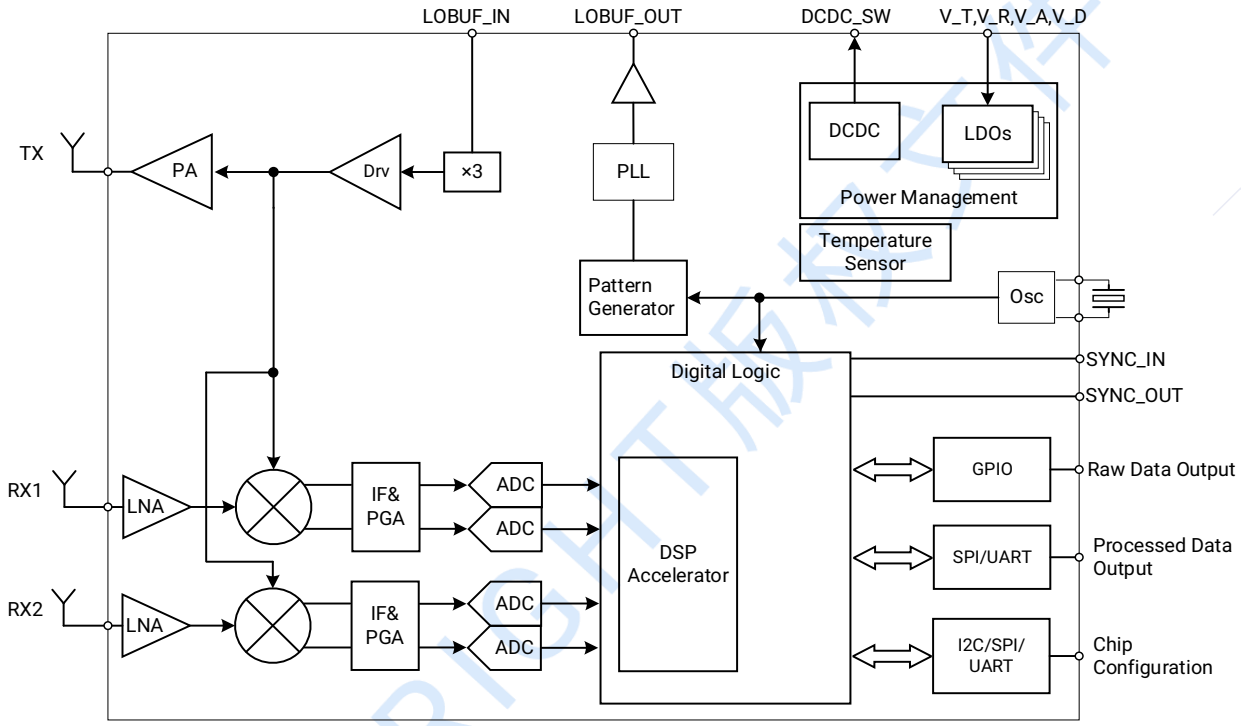

Figure 1-1 ICL1122 function block diagram

EVB1122 evaluation kit can detect moving and micro-moving targets such as human and vehicles, and it is fit for various AIoT scenarios, making it applicable across various AIoT use cases. Firmware is updatable via IAP. The EVB1122 kit includes demonstrations for:

- MmWave sensor parameter configuration and data transfer;
- Indoor Multi-Human Tracking;
- Outdoor Long-Range Target Tracking.

2 System Characteristics

2.1 System Diagram

Figure 2-1 shows a system diagram of the EVB1122 evaluation board. It consists of 24 GHz antennas, the ICL1122 SoC, an STM32F429VET6 microcontroller, external power supply, clock circuitry, peripherals, and interfaces.

The board operates as follows:

- The integrated waveform generator produces an FMCW signal which is multiplied in frequency and

transmitted via the TX antenna;

- The two RX antennas receive reflected mmWave signals from targets;
- The ICL1122 IC receiver path down converts the mmWave signals to analogue intermediate frequency (IF) baseband for digitization by the ADC;
- The data is sent to the MCU over SPI where it is processed with algorithms to detect targets in the field of view;
- Detection results are reported via the USB Type-C or UART interfaces.

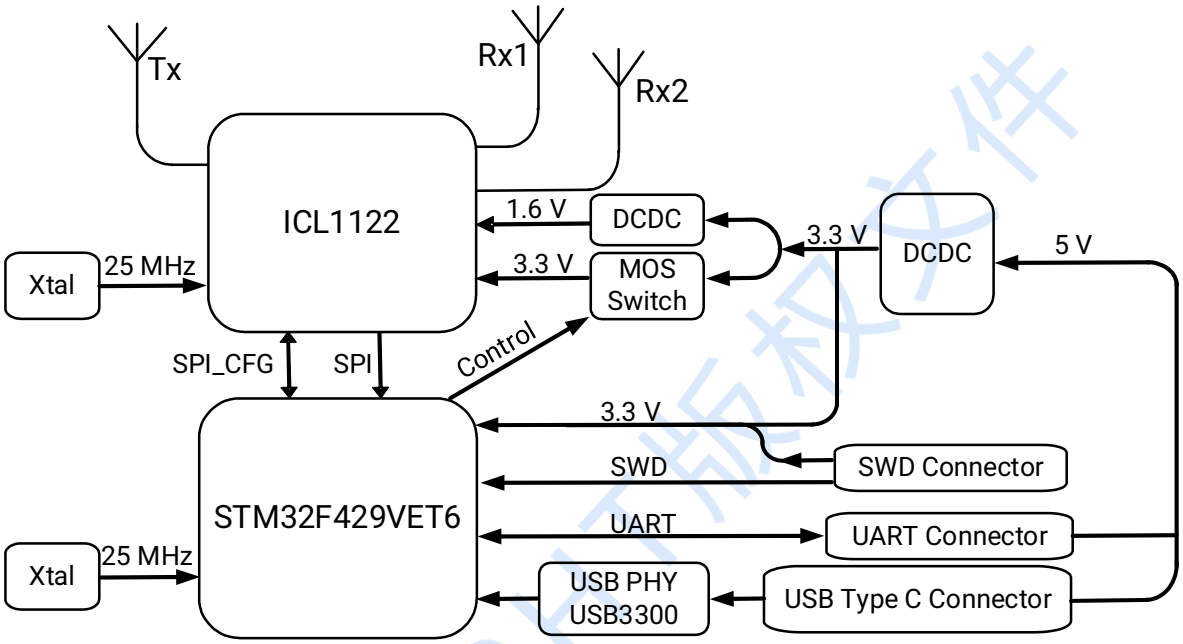

Figure 2-1 EVB1122 evaluation board system diagram

2.2 System Characteristics

Key characteristics of the EVB1122 board:

- Incorporate 24 GHz 1TX2RX microstrip patch antennas;
- Operating Frequency 24 GHz, Sweeping Bandwidth 24~25 GHz(reconfigurable);
- Equipped with Type-C interface and USB PHY chip, support USB 2.0 High Speed mode for data transfer, data rate up to 34 Mbps;
- Support mutual data communication via UART or IO interface;
- Support programming and debugging the board via hardware SWD interface or via GUI IAP function;
- Support both external and internal DCDC for ICL1122 1.6 V power supply;
- Support 2 external power supply methods: (1) USB Type-C; (2) other external power supply interface.

The basic parameters of EVB1122 evaluation board are listed in Table 2-1.

Table 2-1 EVB1122 basic parameter description

Parameter	Min.	Typ.	Max.	Unit
Operating Frequency	-	24	-	GHz
Sweeping Bandwidth	-	1	-	GHz
EIRP	-	-	22	dBm

Power Supply	4.5	5	5.5	V
Size	-	41.5 × 43.2	-	mm × mm
Operating Ambient Temperature	-40	-	85	°C

2.3 Antennas and Characteristics

The EVB1122 evaluation board integrates a 24 GHz 1Tx2Rx mmWave micro-strip antenna. The transmit-receive synthetic gain at 0° is approximately 20 dBi; the 6 dB beam width is about 86° × 28°(H×E); the field of view is -43° ~ 43° on the H-plane and -14° ~ 14° on the E-plane.

The antenna photos of the EVB1122 evaluation board are shown in Figure 2-2. The antenna radiation patterns for the H-plane and E-plane are illustrated in Figure 2-4 and Figure 2-5, respectively.

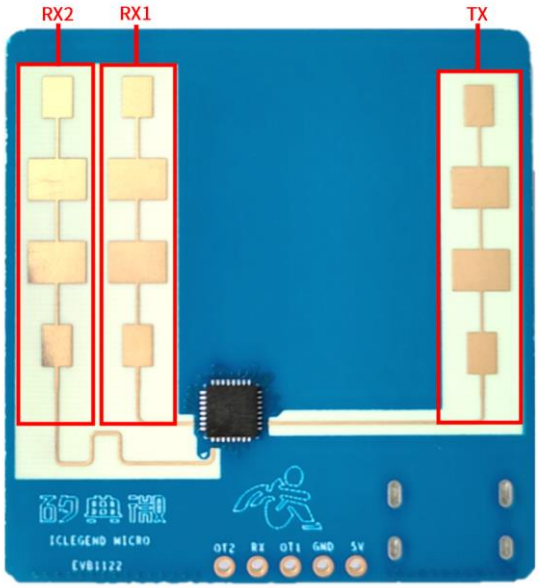

Figure 2-2 Antennas on EVB1122 evaluation board

Note: take Figure 2-2 as a reference plane, the horizontal direction is X axis(as shown in Figure 2-3), vertical is Y axis, O is the crossing point of X axis and Y axis, Z axis is the direction that is vertical to plane XOY; so E-plane denotes plane YOZ, and H-plane XOZ.

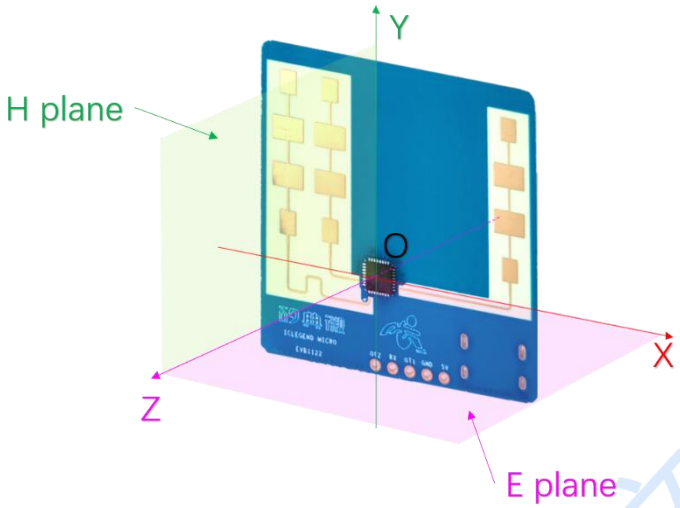

Figure 2-3 Illustration of H-plane and E-plane

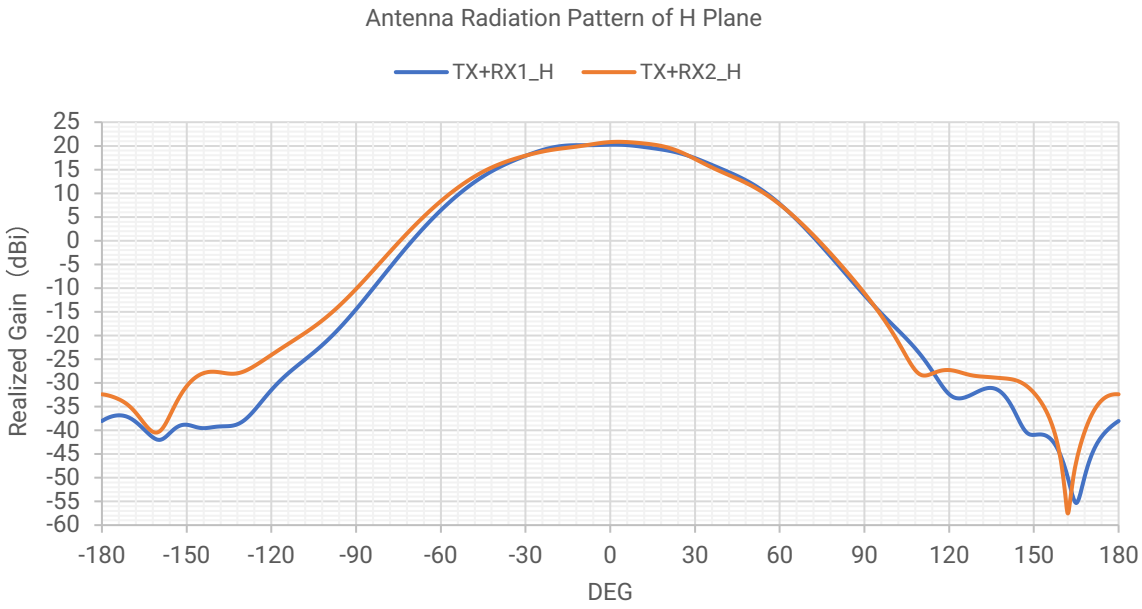

Figure 2-4 Antenna radiation pattern of the H plane

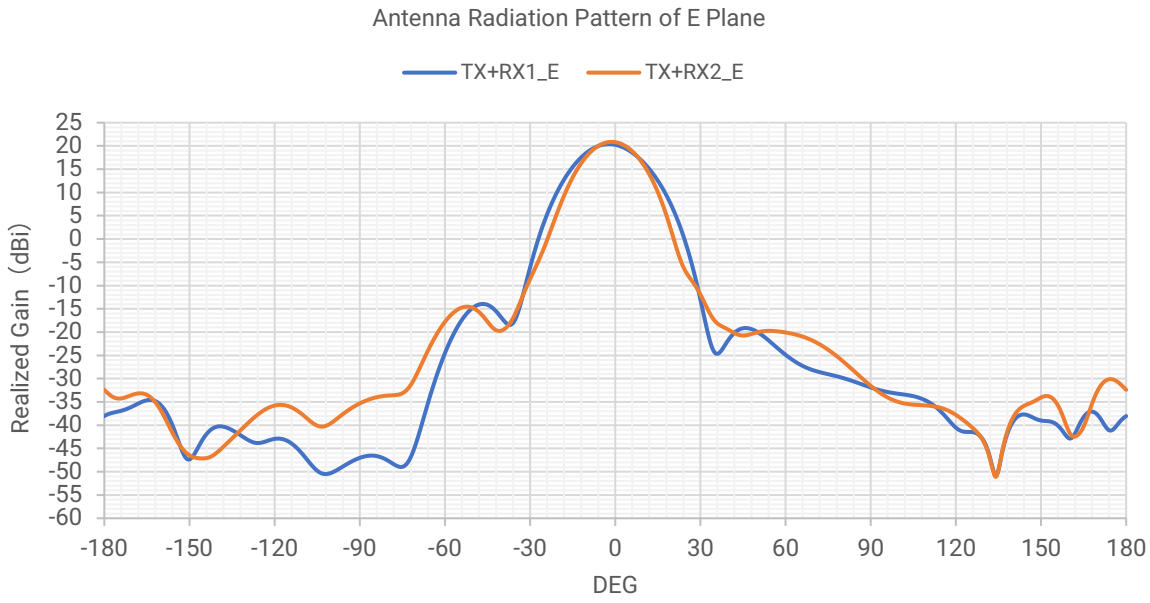

Figure 2-5 Antenna radiation pattern of the E plane

Please be aware that the value of 86° × 28° is applied to 6 dBi beam width. However, this does not mean that the mmWave sensor is not capable of detecting targets outside this angle range. The mmWave sensor sensor's effective detecting area is relative to the target's distance from the mmWave sensor as well as the target's RCS (radar cross section).

2.4 Tips on PCB Storage and Transportation

To protect the board from contamination and degradation, storage at room temperature and low humidity is recommended. Use of dry storage containers or cabinets can help maintain solderability and condition over time.

To protect the printed circuit board from taint, physical injury, humidity, and solderability degradation, it is suggested that these PCBs should be stored in places under room temperature and low humidity. It is recommended to store them in dry oven, if necessary.

ESD precautions should be followed when handling the board and components. The best way to prevent ESD damage is to make sure that the components and its surrounding environment are equipotential, and are connected to the earth ground. Detailed requirements are as follows:

- Components operating zone should be constructed with static dissipative materials and connected to earth ground;
- Components operating zone should not have electrical insulation material; if does, then ionizers should be equipped to neutralize accumulated electrostatic charges;
- Person directly touching components should wear antistatic clothing, wrist strap or anti-static shoes;
- The transmission, transport, or storage of components should be conducted through anti-static turnover box or similar anti-static carriers. The packaging material in direct contact with the components should be electrostatic dissipative.

3 System Connection Guide

3.1 Functional Interfaces

All functional interfaces on EVB1122 evaluation board are presented in Figure 3-1.

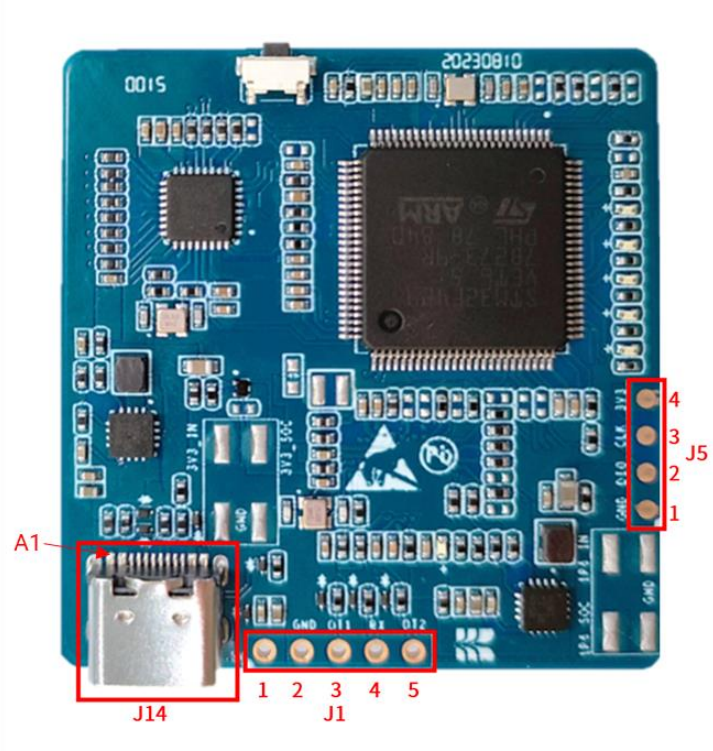

Figure 3-1 Functional interfaces on EVB1122 evaluation board

3.1.1 USB Type-C Interface

USB interface J14 is a Type-C interface which is the default configuration and communication interface of EVB1122 evaluation board. In default mode, this interface is used for both power supply and communicating with the host PC. Description of USB Type-C interface Pins is presented in Table 3-1.

Table 3-1 USB Type-C interface

PIN	Name	PIN	Name
A1	GND	B12	GND
A4	VBUS	B9	VBUS
A5	CC1	B8	SBU2
A6	DP1	B7	DN2
A7	DN1	B6	DP2
A8	SBU1	B5	CC2
A9	VBUS	B4	VBUS
A12	GND	B1	GND

3.1.2 J1 Interface

Users can also use J1 interface to supply power for the board other than using USB interface. It can also be used as a UART debug interface when debugging customized firmware developed by users. Description of J1 interface Pins is presented in Table 3-2.

Table 3-2 J1 Pin description

PIN	Name	Function	Description
1	5V	Power supply input	Vcc: 4.5 V ~ 5.5 V, Typ. 5 V
2	GND	Connect to ground	-
3	O_T1	Can be configured as UART_TX	IO voltage: 0 ~ 3.3 V

		or IO, cannot be configured as UART_TX at the same time with Pin O_T2. Default set as UART_TX	
4	RX	UART_RX	IO voltage: 0 ~ 3.3 V
5	O_T2	Can be configured as UART_TX or IO, cannot be configured as UART_TX at the same time with O_T1. Default set as IO	IO voltage: 0 ~ 3.3 V

3.1.3 SWD Interface

J5 is a SWD debugging and programming interface for MCU. J5 pin description is presented in Table 3-3.

Table 3-3 J5 Pin description

PIN	Name	Function	Description
1	GND	Connect to ground	-
2	DIO	Data input/output	IO voltage: 0 ~ 3.3 V
3	CLK	Reference clock signal input	IO voltage: 0 ~ 3.3 V
4	3V3	Reference power supply output	Reference voltage: 1.8 ~ 3.6 V, Typ. 3.3 V

3.2 Power Supply

EVB1122 evaluation kit supports power supply ranging 4.5 V ~ 5.5 V. After normal power up, D3 (power indicator LED) shows green and keeps on, and D8 (normal operating indicator LED) shows green and blinks.

EVB1122 evaluate kit supports two power supply methods, and the power connection interface is shown in Figure 3-2:

- Power supply via J14 USB interface:

  The default method to provide power for EVB1122 is via J14 USB Type-C interface.

- Exterior power supply via J1 interface:

  When J14 USB power supply is not used, users can provide power via Pin 1 and Pin 2 of J1 interface.

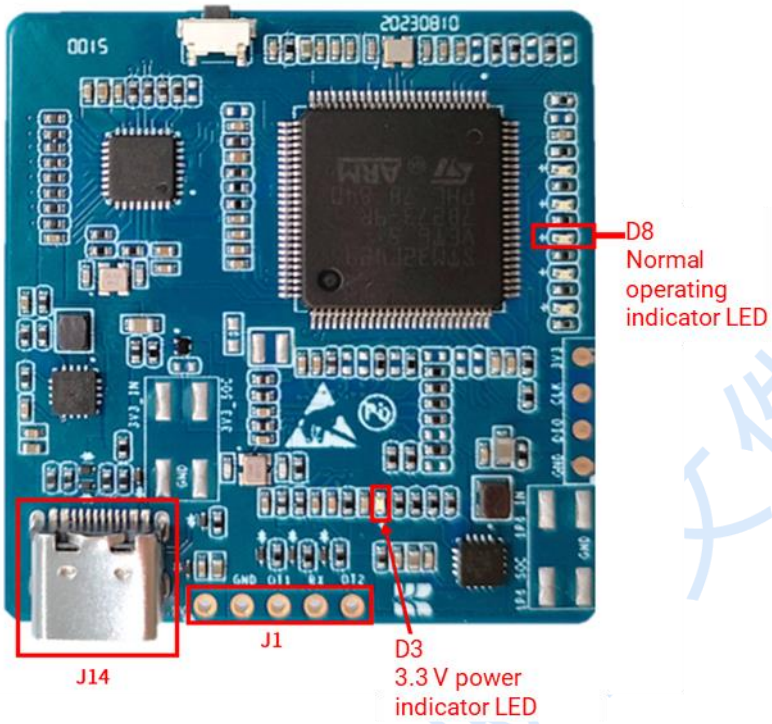

Figure 3-2 EVB1122 power connection interface

3.3 Switches and LEDs

All the switches and indicator LEDs on EVB1122 evaluation board are presented in Figure 3-3.

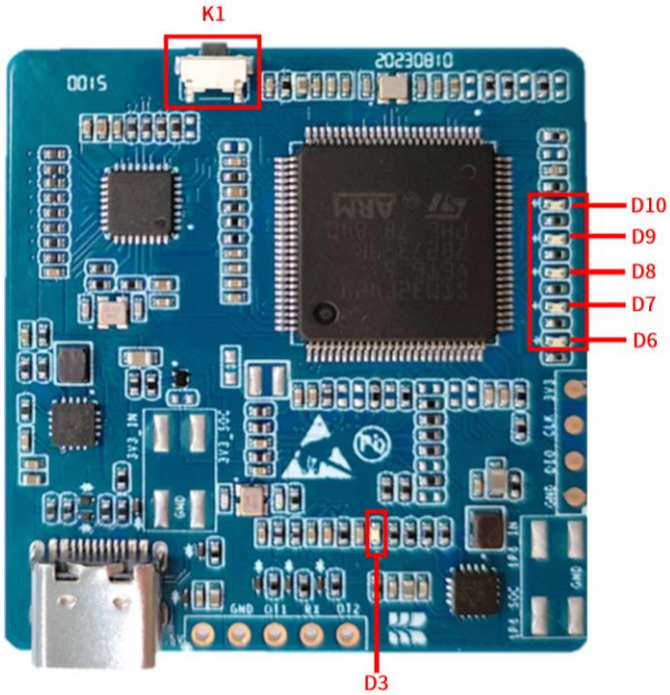

Figure 3-3 Switches and indicator LEDs on EVB1122 evaluation board

The tag number and description of the switches and indicator LEDs on EVB1122 board are presented in Table 3-4.

Table 3-4 Description of switches and indicator LEDs on EVB1122 evaluation board

Tag No.	Name	Description
K1	Switch	Reset switch
D3	Green indicator LED	3.3 V power supply indicator
D6	Green indicator LED	MmWave sensor data reception overflow indicator
D7	Green indicator LED	MmWave sensor data index error indicator
D8	Green indicator LED	Normal operating indicator
D9	Green indicator LED	MmWave sensor data transmission overflow indicator
D10	Green indicator LED	MCU indicator which indicates command reception overflow from host computer

4 Quick Start

4.1 Hardware Configuration

Connect the host PC with the EVB1122 evaluation board using a USB Type-C cable to build the power supply and data communication for EVB1122.

4.2 PC Connection and Driver Installation

Before connecting and debugging the evaluation board, users should install a driver on the host PC, the steps are as follows:

Step 1: Log in STMCU website1, download the Virtual COM Port Driver of STSW_STM32102, install the *VCP_V1.5.0_Setup_W7_x64_64bits.exe* by default settings.

Step 2: Connect the USB Type-C interface J14 of the EVB1122 evaluation board to the host PC with a USB cable, then a new COM port device can be found in host PC device manager, as shown in Figure 4-1.

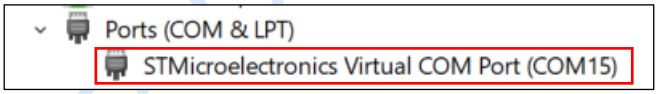

Figure 4-1 Windows device manager

When the *STMicroelectronics Virtual COM Port* is found, it means the host PC has successfully connected with the EVB1122 evaluation board. If the device is not found in the list, or a new device icon shows up in the list but with a question mark, users should check whether the driver is installed correctly or the board is correctly powered up.

4.3 Demonstration Firmware

EVB1122 provides a Four-in-One firmware that integrates data transfer, indoor multi-human tracking, and outdoor long-range target tracking. No extra configuration is needed when applying these demonstration programs.

4.4 Software Configuration

Steps for configuring the *EVB1122 Waveform Configuration and Demonstration GUI* are as follows:

Step 1: Start the *EVB1122 Waveform Configuration and Demonstration GUI.exe*, the main page will appear as shown in Figure 4-2;

[1] https://www.stmcu.com.cn/Designresource/list/STM32F4/firmware_software/firmware_software

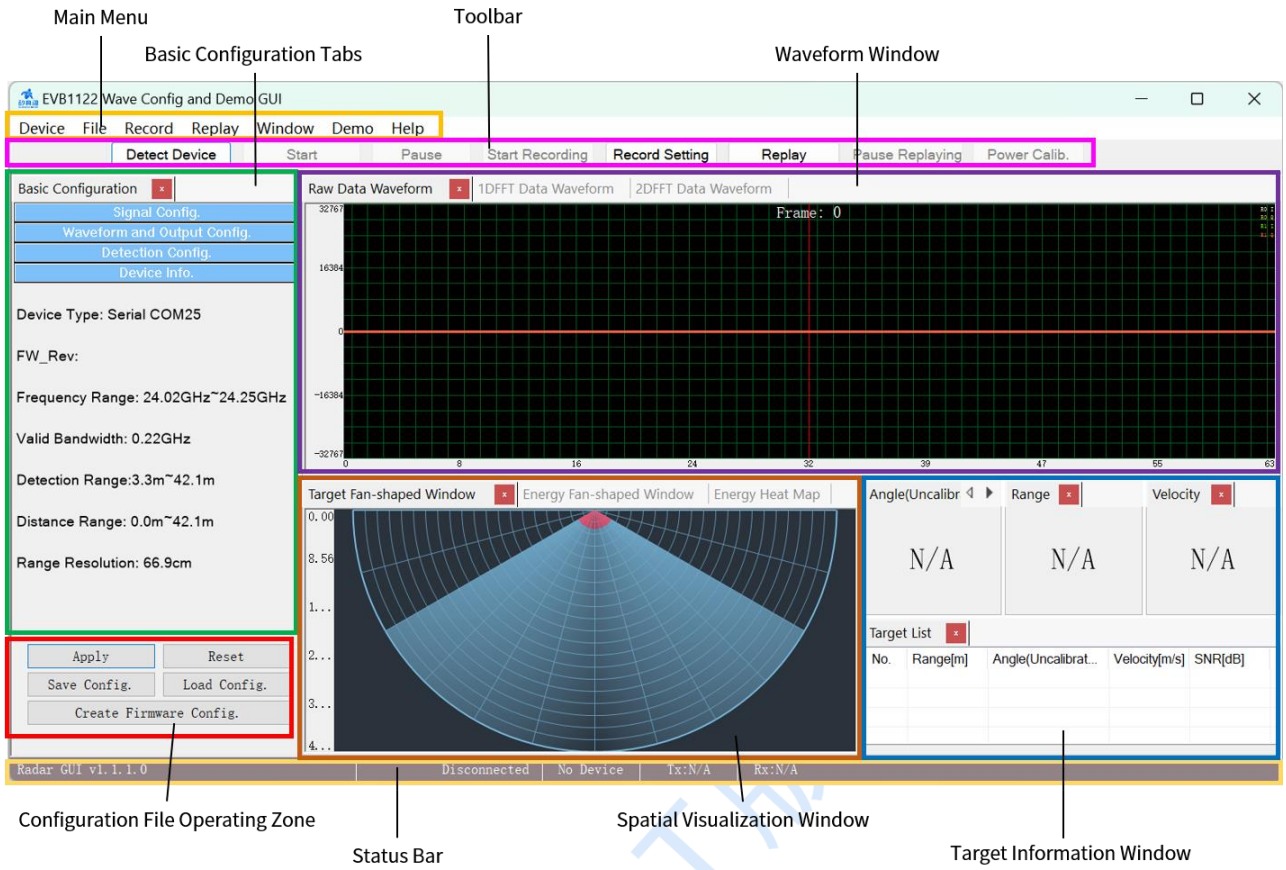

Figure 4-2 EVB1122 Waveform Configuration and Demonstration GUI

Step 2: click the ***Device*** menu (as shown in Figure 4-3), choose the *IC Total Radiated Power Display Config.* submenu to open the configuration window (as shown in Figure 4-4), check the box in front of the text *IC Total Radiated Power Display*, and configure the mmWave sensor IC as instructed below[2]; subsequently, run the GUI again, and the bottom status bar starts displaying IC temperature and total radiated power simultaneously (as shown in Figure 4-5);

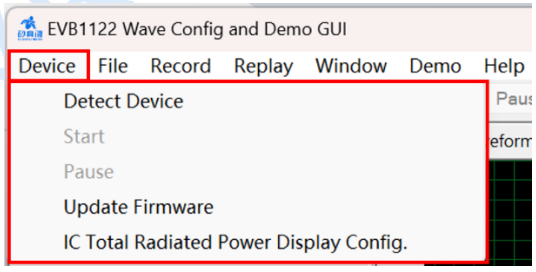

Figure 4-3 The submenus of the Device menu

[2] The EVB1122 development board has completed Power Calibration in advance.

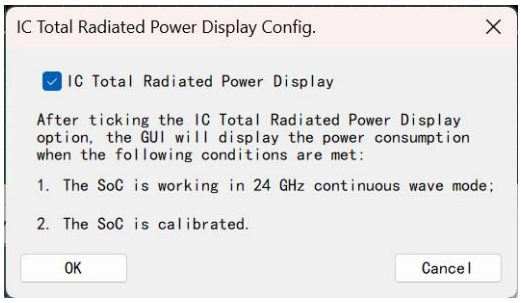

Figure 4-4 IC Total Radiated Power Display Config. window

Figure 4-5 Example of IC temperature and total radiated power display

Step 3: Click the ***Demo*** menu in the *Main Menu Bar*, choose the desired submenu (as shown in Figure 4-6) to open the corresponding program.

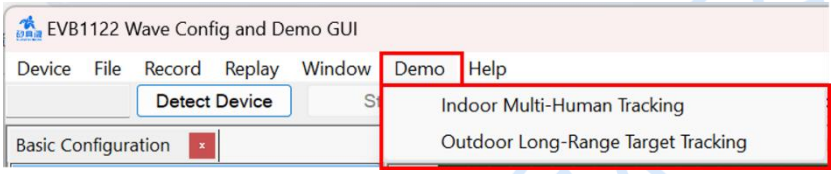

Figure 4-6 The submenu of the "Demo" menu

The EVB1122 hardware is programmed with the three-in-one firmware that integrates *Data Transfer*, the *Indoor Multi-Human Tracking*, and the *Outdoor Long-Range Target Tracking* after manufacture; in addition, this firmware supports IAP function. If user accidentally erase MCU firmware, user should firstly flash bootloader firmware EVB1122 _IAP via SWD interface, then flash other firmware image through GUI IAP. Details of GUI IAP function please refer to chapter 6 IAP Function.

4.4.1 Indoor Multi-Human Tracking Demonstration

No extra configuration is needed for running the Indoor Multi-Human Tracking demonstration. The default working mode of this program is Single Target Detection, as shown in Figure 4-7.

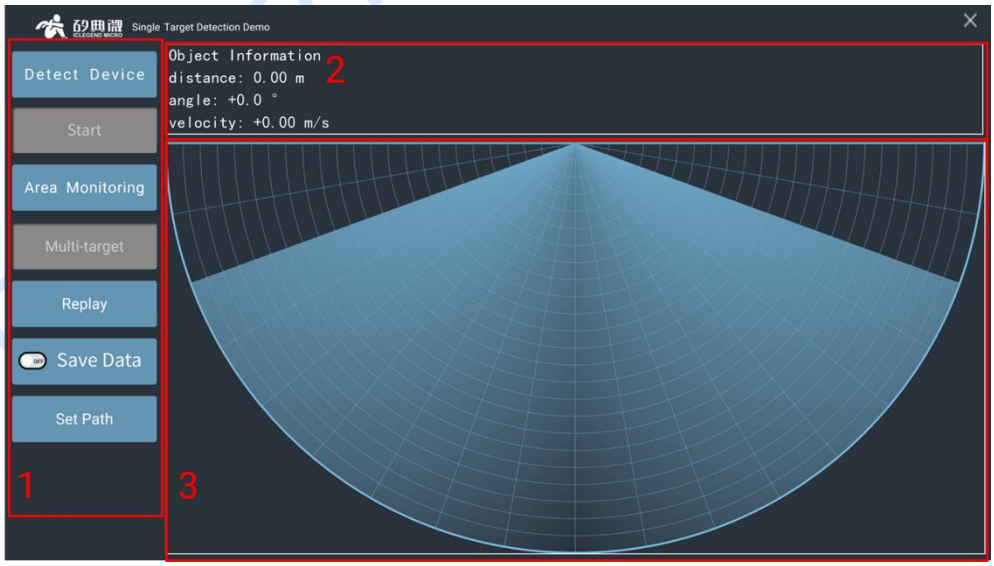

Figure 4-7 The default working mode of Indoor Multi-Human Tracking demonstration

As shown in Figure 4-7, the Indoor Multi-Human Tracking GUI can be partitioned into 3 zones: Operation Zone (1), Results Display Zone (2) and Position Display Zone (3). Functions of each zone are explained in

Table 4-1.

Table 4-1 Indoor Multi-Human Tracking GUI Description

Number	Zone	Function
1	Operation Zone	Detect Device, Area Monitor, Start or Stop detecting
2	Results Display Zone	Display range, angle and velocity values of detected targets: For Single Target Detection Demo, it displays information of the human target of the greatest moving energy; For Triple Target Detection Demo, it displays information of up to 3 human targets of the greatest moving energy
3	Position Display Zone	Display the detected moving human target's position in detection range

Functions of the buttons in Operation Zone are explained in detail in Table 4-2.

Table 4-2 The function of the buttons in Operation Zone

Name	Function
Detect Device	Detect whether EVB1122 is connected to host PC; if the connection is failed, a notice window writing *No device detected!* will appear
Start/Stop	Start / stop receiving data from the mmWave sensor and display the target's position in detection range in real time.
Area Monitoring	Set up a monitoring area, so that the color of this area changes immediately when a target enters or exits this area
Single-/Multi-Target	Switch the detection mode between Single Target Detection and Triple Target Detection
Replay/Stop	Start/stop replaying the recorded mmWave sensor data
Save Data	Turn on or off the data-saving mode of the visualization tool; when the data-saving mode is on, the host PC will save the real-time mmWave sensor data as soon as the mmWave sensor starts detecting
Set Path	Let the user select the directory of recorded mmWave sensor data

4.4.2 Outdoor Long-Range Target Tracking Demonstration

Figure 4-8 presents the GUI of the Outdoor Long-Range Target Tracking demonstration program. The GUI can be partitioned into 5 zones: Operation Button Zone (1), Target Information Configuration Zone (2), Sector Map Zone (3), Detected Results Zone (4), and RD Map Zone (5). Descriptions of each zone are listed in Table 4-3.

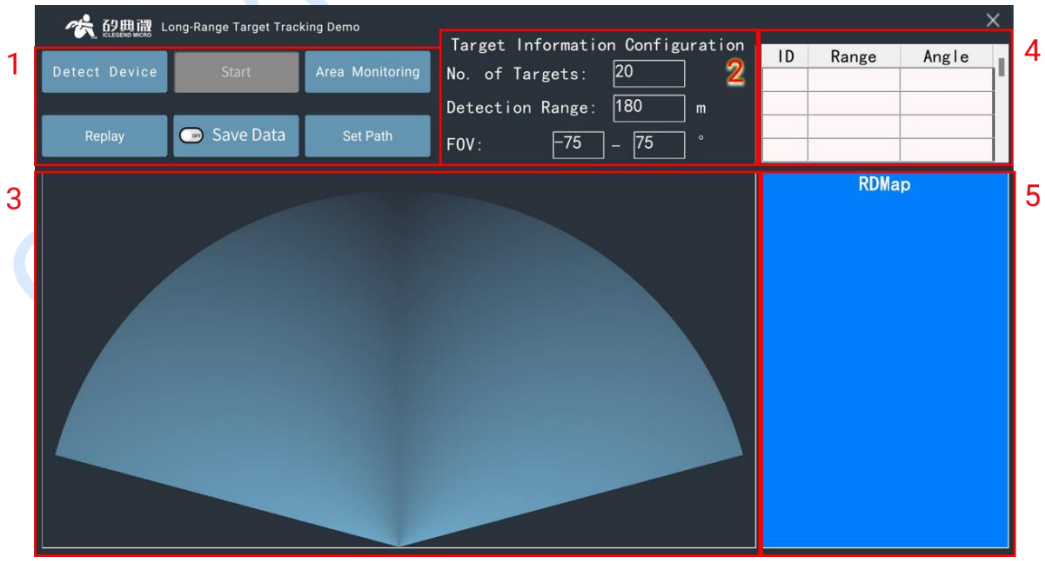

Figure 4-8 Outdoor Long-Range Target Tracking demo GUI

Table 4-3 Description of Outdoor Long-Range Target Tracking demo page

Number	Zone	Function
1	Operation Button Zone	Detect device, start or stop detecting, area monitoring, replay detecting data, turn on/off save data mode, and set save directory
2	Target Information Configuration Zone	Configure the maximum number (≤20) of targets that are going to be displayed on the GUI, the maximum detection range (≤180 m), and the sensor's field of view (up to ±75°)
3	Sector Map Zone	Display the detected targets' real-time position in the sector map
4	Detected Results Zone	Display the distance and angle information of detected targets
5	Range-Doppler Plane Zone	Display the energy distribution of targets and base noise on the Range-Doppler plane, the warmer the color, the higher the energy; The horizontal axis represents Doppler dimension, and the vertical axis represents Range.

4.5 Start and Run

4.5.1 Indoor Multi-Human Tracking Demonstration

Steps for running the Indoor Multi-Human Tracking[3] Demonstration are as follows:

Step 1: Connect the EVB1122 evaluation board to a host PC with a USB Type-C cable;

Step 2: Double click "*EVB1122 Waveform Configuration and Demonstration GUI.exe*" to start the program, click the **Demo** menu and choose the **Indoor Multi-Human Tracking** submenu, and the demonstration window will appear, as shown in Figure 4-7;

Step 3: Click the **Detect Device** button, the host PC will connect to the EVB1122 board via USB port;

Step 4: By default, the program works in Single Target Detection mode, as shown in Figure 4-9; (optional) click the **Multi-target** button to switch to Triple Target Detection mode;

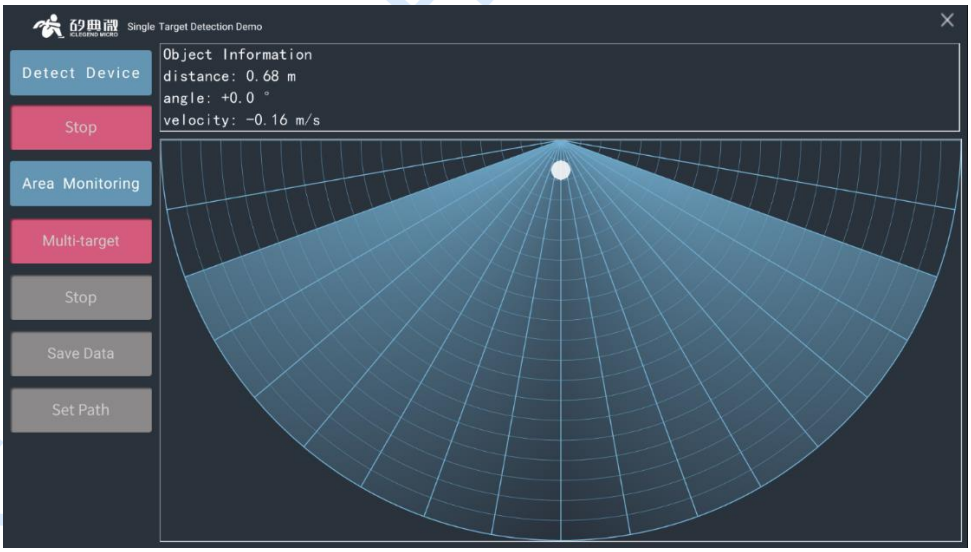

Figure 4-9 Single Target Detection GUI

Step 5: Click the **Start/Stop** toggle button, the host PC starts receiving distance and velocity information from the EVB1122 board, and presents the detected target as a white dot in the fan-shaped area; (Optional) click the **Start/Stop** toggle button to stop receiving data from the mmWave sensor;

Step 6: (Optional) When the Start/Stop toggle button displays Start, click the **Set Path** button, select a directory for saving mmWave sensor data, then click the **Save Data** button to turn on the data saving

[3] Here are steps for running Single Target Detection Demo, please refer to UM10035P_ EVB1122 Waveform Config and Demo GUI User Manual_Rev.1.1 for the guide of running Triple Target Detection Demo.

mode; click the **Start/Stop** toggle button to start receiving and saving mmWave sensor real-time data.

4.5.2 Outdoor Long-Range Target Tracking

Steps for running Outdoor Long-Range Target Tracking Demonstration are as follows:

Step 1: Connect the EVB1122 evaluation board to a host PC with a USB Type-C cable;

Step 2: Double click "*EVB1122 Waveform Configuration and Demonstration GUI.exe*" to start the program, click the **Demo** menu in Main Menu Bar, choose the *Outdoor Long-Range Target Tracking* submenu, and the demonstration window will appear, as shown in Figure 4-8;

Step 3: Click the **Detect Device** button, the program will connect to the EVB1122 evaluation board via USB serial port; after successfully connecting to the board, a prompt window writing *COM Device Detected* will appear, click the **OK** button to continue;

Step 4: Click the **Start/Stop** toggle button, the program starts reading and presenting the detection results, and each detected target will be presented by an rectangular icon with its real-time distance to the sensor tagged above, see Figure 4-10; Meanwhile, the table on the right-top displays a list of detected targets and their distances and angles relative to the evaluation board, and the RDMap area beneath it presents the energy distribution of the detected area; (Optional) Click the **Start/Stop** toggle button to stop detecting and presenting;

Step 5: (Optional) When the **Start/Stop** toggle button displays Start, and the ON/OFF icon on the Save Data button shows OFF, click the **Save Data** button to turn on the data saving mode (the icon on the button displays ON); Click the **Set Path** button to select a desired directory for saving the detecting data, if this action is skipped, the default saving path is the LRT/Save Data/ directory; Click the **Start/Stop** toggle button to start detecting, and the real-time detecting data will be saved.

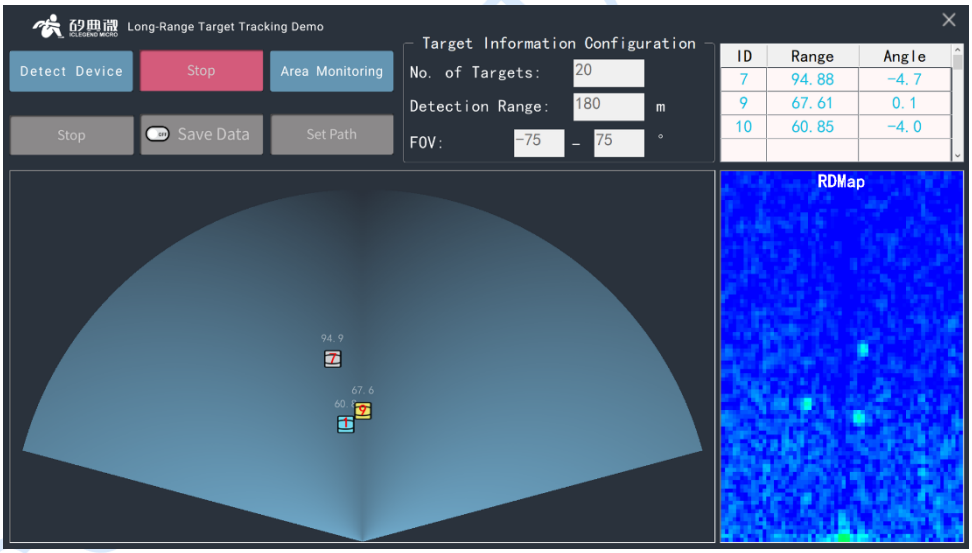

Figure 4-10 Outdoor Long-Range Target Tracking demonstration

5 Customized Firmware and Algorithm Development Guide

EVB1122 evaluation kit provides a data transmission firmware: EVB1122_*USBHS_datatransfer*. Users can modify the register configuration file via this data transfer firmware, thus they can transfer different types of data using the USB port of the evaluation board, including DS RAW, Range FFT, and Doppler FFT (also referred as 2DFFT). Users can easily develop customized algorithms based on this platform.

5.1 Data Transfer Firmware

Directory structure of EVBKS5_USBHS_datatransfer firmware is presented in Figure 5-1. The function of each folder is listed below:

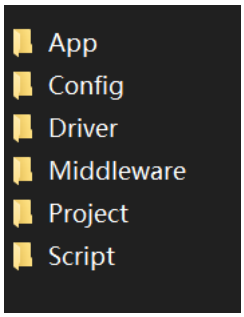

Figure 5-1 Directory structure of EVBKS5_USBHS_datatransfer firmware

App: application folder, execute application level functions, including receiving data, parsing data, implementing algorithms;

Config: configuration folder for configuring ICL1122;

Driver: official drivers' folder, for MCU platform and peripherals;

Middleware: middleware folder, for conveniently expanding to different platforms;

Project: project engineering directory;

Script: script folder.

5.2 Waveform Configuration

Users should configure the mmWave sensor sensor signal and waveform before developing customized firmware and algorithms. For detailed configuration methods please refer to Section 2.3.1 "Signal Configuration" and 2.3.2 "Waveform and Output Config." of *UM10035P_EVB1122 Wave Configuration and Demonstration GUI User Manual*, which can be obtained by clicking the **Help** menu of the EVB1122 GUI.

5.3 Data Format Configuration

The EVB1122 evaluation kit supports multiple data types such as DSRAW, Range FFT, and Doppler FFT. The data frame formats are illustrated in Table 5-1, Table 5-2, and Table 5-3. The MCU will pack each data frame before sending it out, the data pack format refers to Table 5-4

Table 5-1 DS RAW data frame format

Header[Dword 0]	'b1010 1010	[23][1]	'b 010	RAW_chirp_cnt (bit 7:0, 8) [19:11][2]	RAW_DATA_cnt[10:0][3]		
Data[Dword 1]	DS RAW real data 0[31:16]				DS RAW Imaginary data 0[15:0]		
Data[Dword 2]	DS RAW real data 1[31:16]				DS RAW Imaginary data 1[15:0]		
Data[Dword ...]	DS RAW real data ...[31:16]				DS RAW Imaginary data...[15:0]		
Data[Dword m]	DS RAW real data m-1[31:16]				DS RAW Imaginary data m-1[15:0]		
Tail[Dword m+1]	Check_sum[31:16][4]				RAW_FRAME_INDEX [15:12][5]	'b 00	CFG_MSG [9:8][6]	'b 0101 0101

Note:

[1] [23]: The value is 'b0 for RX1, 'b 1 for RX2.

[2] RAW_chirp_cnt(bit 7:0, 8)[19:11]: The chirp sequence number in one frame, start from "0" in each frame. MSB is located at Frame data's bit 11, then bit 19:12 is from MSB-1 to LSB.

[3] RAW_DATA_cnt[8:0]: The number of m (the total items of DS RAW data) in this chirp.

[4] Check_sum[31:16]: The sum of all data in this frame, and equals to the value of low 16 bits sum result.

[5] RAW_FRAME_INDEX[15:12]: The frame num counter, starts from 0.

[6] CFG_MSG[9:8]: User defined bits.

Table 5-2 Range FFT data frame format

Header[Dword 0]	'b1010 1010	[23] [1]	'b 011	FFT_chirp_index1 (bit 7:0, 8)[19:11] [2]	CFG_FFT_TX_MAX[10:0][3]
Data[Dword 1]	FFT real data 0[31:16]			FFT Imaginary data 0[15:0]	
Data[Dword 2]	FFT real data 1[31:16]			FFT Imaginary data 1[15:0]	
Data[Dword ...]	FFT real data ...[31:16]			FFT Imaginary data ...[15:0]	
Data[Dword m]	FFT real data m-1[31:16]			FFT Imaginary data m-1[15:0]	
Tail[Dword m+1]	Check_sum[31:16][4]			FFT_FRAME_INDEX [15:12][5]	'b 00	CFG_MSG [9:8][6]	'b 0101 0101

Note:

[1] [23]: The value is 0 for RX1, 1 for RX2.

[2] FFT_chirp_index1(bit 7:0, 8)[19:11]: The chirp sequence number in one frame, start from "0" in each frame. MSB is located at bit 11, then bit 19:12 is from MSB-1 to LSB.

[3] CFG_FFT_TX_MAX[8:0]: The number of m (the total FFT output points) +1 in this chirp.

[4] Check_sum[31:16]: The sum of all data in this chirp, and equals to the value of low 16 bits sum result.

[5] FFT_FRAME_INDEX[15:12]: The frame num counter, starts from 0.

[6] CFG_MSG[9:8]: User defined bits.

Table 5-3 Doppler FFT data frame format

Header[Dword 0]	'b1010 1010	[23] [1]	'b 100	DFFT_chirp_index1 (bit 7:0, 8)[19:11][2]	DW_LEN[10:0][3]
Data[Dword 1]	DFFT real data 0[31:16]			DFFT imaginary data 0[15:0]	
Data[Dword 2]	DFFT real data 1[31:16]			DFFT imaginary data 1[15:0]	
Data[Dword ...]	DFFT real data ...[31:16]			DFFT Imaginary data ...[15:0]	
Data[Dword m]	DFFT real data m-1[31:16]			DFFT Imaginary data m-1[15:0]	
Tail[Dword m+1]	Check_sum[31:16][4]			FFT_FRAME_INDEX [15:12][5]	'b 00	CFG_MSG [9:8][6]	'b 0101 0101

Note:

[1] [23]: The value is 0 for RX1, 1 for RX2.

[2] DFFT_chirp_index1(bit 7:0, 8)[19:11]: The chirp sequence number in one frame, start from "0" in each frame. MSB is located at Frame data's bit 11, then bit 19:12 is from MSB-1 to LSB.

[3] DW_LEN[10:0]: Doppler FFT data num counter, start from 0.

[4] Check_sum[31:16]: The sum of Doppler FFT data in this frame, and equals to the value of low 16 bits sum result.

[5] FFT_FRAME_INDEX[15:12]: The frame num counter, starts from 0.

[6] CFG_MSG[9:8]: User defined bits.

Table 5-4 MCU data pack format

Header (4 bytes)	Intra-Frame Data Length	Type	Channel Number	Data	Trailer
0x49, 0x43, 0x4C, 0x48	2 bytes	0x00	1 byte	Data segment	0x49, 0x43, 0x4C, 0x54

5.4 Register Configuration

After setting up mmWave sensor's waveform parameters, EVB1122 Waveform Configuration and Demonstration GUI will generate register information for ICL1122. Users can access register information (as shown in the red box in Figure 5-2) by choosing the Config. Overview submenu in the File menu.

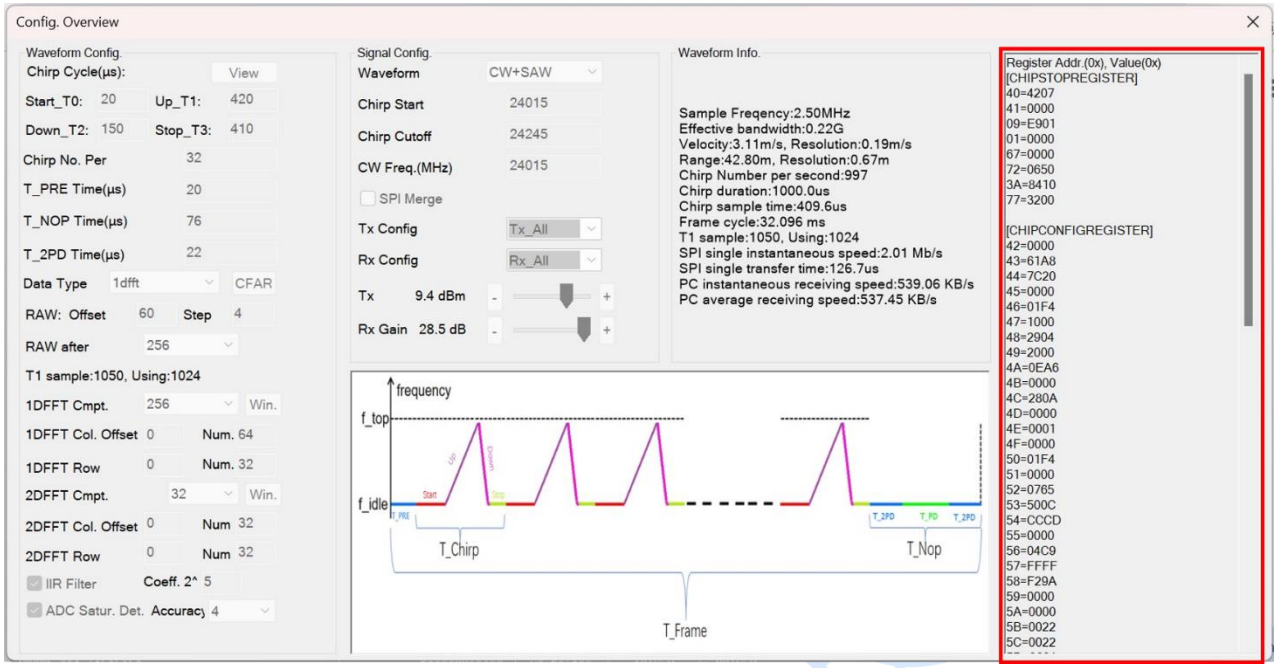

Figure 5-2 EVB1122 Register Information

There are two methods to make the new settings effective:

(1) In the Config File Operating Zone of the EVB1122 Wave Config. And Demo GUI, click the **Create Firmware Config.** button, the GUI will automatically generate the configuration file;

(2) Manually copy the register information as shown in the red rectangular in Figure 5-2 (such as 40=4207), and paste it to firmware file *\Config\mmWave sensorPara* EVB1122.*txt* to replace the original default settings (Please make sure that the data format must be the same as the original one).

5.5 Algorithm Interface

EVB1122_USBHS_datatransfer firmware reserves a specified API for users to develop and verify their own algorithms.

Development processes are as follows:

Step 1: Open file *global_conf.h*, comment OFF the macro sentence: *SUPPORT_DATA_PASSTHROUGH*;

Step 2: Users can program customized algorithm in function interface *StartAlgorithm* in file *dataprocess.c*. The customized algorithm interface parameter setting should be in accordance with those of function interface *StartAlgorithm*, as shown in Figure 5-3.

```
void StartAlgorithm(uint8_t* dataBuf, uint16_t dataLen, uint8_t channel, uint16_t index)
{
    /*do algo here*/
}
```

Figure 5-3 Algorithm function interface

Parameter definition:

- dataBuf: pointer of mmWave sensor sensor data buffer
- dataLen: length of mmWave sensor sensor data
- channel: channel of received mmWave sensor sensor data
- index: Chirp index of mmWave sensor sensor chirp

5.6 Execution and Result Output

Users need to define data output type in the compiling software. After successfully compiling, users can program it into MCU and run the software.

EVB1122 evaluation kit reserves three types of output interface for reporting results, they are UART, USB, and GPIO. Users can add or modify codes for data output to determine which interface is preferred for reporting results.

6 IAP Function

EVB1122 enables users to update firmware through the IAP function.

6.1 Flash Allocation

EVB1122 adopts the STM32F429VET6 MCU whose flash size is 512 KB. Details of flash address allocation for IAP function are shown in Table 6-1.

Table 6-1 EVB1122 flash address allocation

Start Address	End Address	Size	Function
0x0800 0000	0x0800 7FFF	32K Bytes	Bootloader firmware
0x0800 0000	0x0800 BFFF	16K Bytes	Store update flag, go-to flag etc.
0x0800 C000	0x0800 FFFF	16K Bytes	Store power value etc.
0x0801 0000	0x0801 FFFF	64K Bytes	Store data transfer firmware
0x0802 0000	0x0803 FFFF	128K Bytes	Outdoor Long-Range Target Tracking firmware
0x0806 0000	0x0807 FFFF	128K Bytes	Indoor Multi-Human Tracking firmware

6.2 Bootloader and APP Firmware

To use the IAP function of EVB1122, users should first program the bootloader firmware into the board. Then users can update the merged APP firmware through the bootloader.

EVB1122 provides one set of bootloader firmware and a merged APP firmware that combines *Data Transfer*, *Indoor Multi-Human Tracking*, and *Outdoor Long-Range Target Tracking*, they are listed below:

Bootloader firmware: EVB1122_BootLoader;

Merged APP firmware: EVB1122_ USBHS_Function_Firmware.

6.3 In Application Programming

Steps of using the IAP function of the EVB1122 are as follows:

Step 1: Ensure that the EVB1122 has programmed the bootloader firmware; connect the evaluation board and the host PC using a USB cable; Start the *EVB1122 Wave Configuration and Demonstration GUI*; Click the **Device** menu and the **Update Firmware** submenu in turn to open the Update Firmware window, as shown in Figure 6-1;

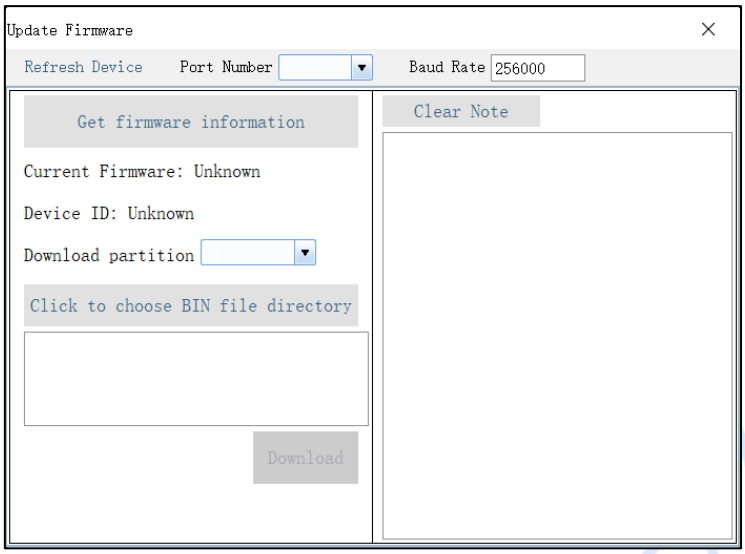

Figure 6-1 Update Firmware interface

Step 2: Click the **Refresh Device** button, choose the COM port number of the EVB1122 board, an example is shown in Figure 6-2;

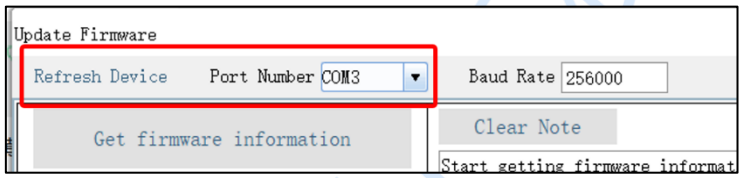

Figure 6-2 Obtain port number on Update Firmware interface

Step 3: Click the **Get firmware information** button, then GUI will display the firmware information that is running in the MCU and the device ID, as shown in Figure 6-3;

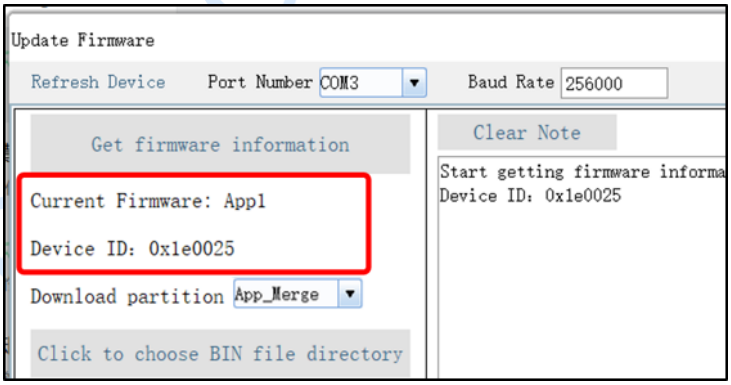

Figure 6-3 Obtain firmware information

Step 4: Since the target firmware that can be updated can only be the merged APP firmware (i.e. EVB1122_USBHS_Function_Firmware) regardless of whether the current running firmware is BootLoader or other demo, users should select the **App_Merge** from the drop-down box of the "Download partition"; Subsequently, click the **Click to choose bin file directory** button to load the bin file; Finally, click the **Download** button to start downloading.

When the download process finishes, the sensor's program will jump to the data transfer firmware and start running.

7 Abbreviations

ADC —— Analogue to Digital Conversion

DSP —— Digital Signal Processing

ESD —— Electro Static Discharge

FOV —— Field of View

GUI —— Graphic User Interface

IAP —— In Application Program

8 References

1. DS10012RN_ICL1122_Rev.1.2——Datasheet
2. UM10035P_EVB1122 Wave Config and Demo GUI User Manual_Rev.1.0

9 Revision History

Revision	Date	Modification
1.0	2024/2/28	Initial release.

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