



a module solution provider

# MM5D91E00

MM5D91-00 Presence Detection

Evaluation Kit

**User Guide**

**Revision 3.0**

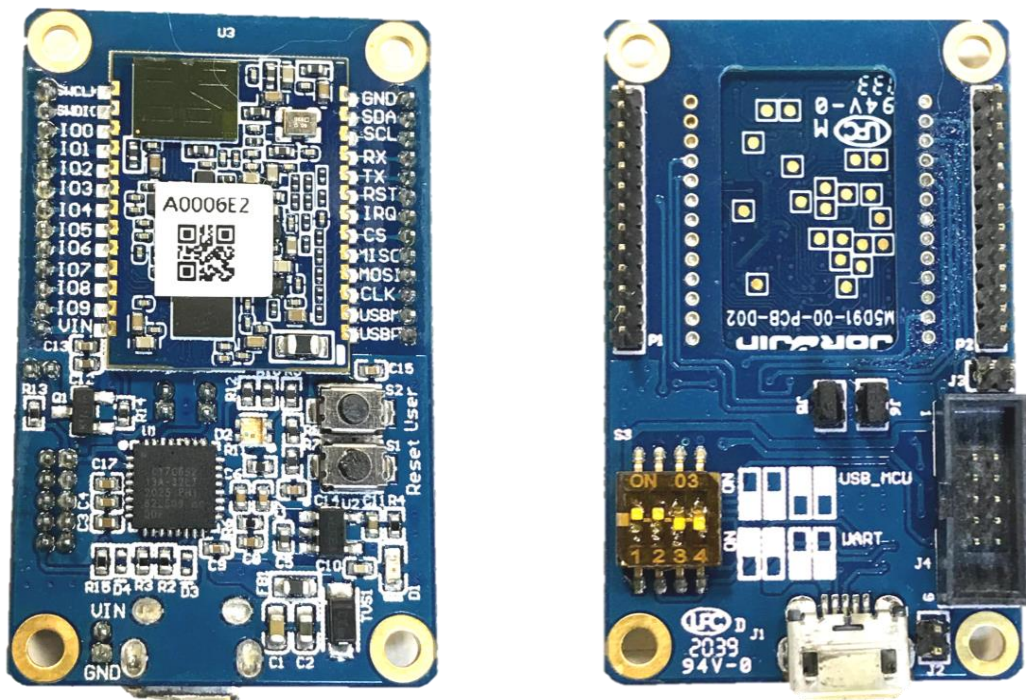
## Index

<b>1. INTRODUCTION .....</b>	<b>2</b>
<b>2. HARDWARE DESCRIPTION.....</b>	<b>3</b>
2.1. HARDWARE OVERVIEW.....	3
2.2. SCHEMATIC DIAGRAMS.....	4
2.3. DIMENSIONS .....	6
<b>3. SOFTWARE DESCRIPTION.....</b>	<b>7</b>
3.1. MODULE CONFIG SOFTWARE.....	7
3.2. SET AND GET CONFIGURATION .....	8
3.3. PRESENCE EVENT OUTPUT .....	12
3.4. MACRO AND MICRO THRESHOLD TUNING .....	13
3.5. FIRMWARE UPDATE .....	14
<b>4. HISTORY CHANGE .....</b>	<b>15</b>

## 1. INTRODUCTION

The MM5D91-00 is the presence detection sensor module which integrates 60GHz mmWave technology. The module simplifies the implementation of mmWave sensors in the band of 61.0 to 61.5GHz, and it includes the ARM Cortex-M4F based processor system, 1Tx 3Rx antenna and onboard regulators. This presence detection sensor module targets low power and high resolution presence detection in smart home, office, security and diverse applications.

The Jorjin mmWave Radar sensor evaluation kit MM5D91E00 shows as below. Based on the MM5D91-00 Radar sensor module, evaluation board is built to demonstrate the function of presence detection of the 60 GHz radar sensor with its sophisticated radar presence detection algorithms. This evaluation kit is easy for demo and development for customer.



TOP side

Bottom side

Figure 1-1. MM5D91E00 mmWave Radar Evaluation Kit

## 2. HARDWARE DESCRIPTION

### 2.1. Hardware Overview

The following figure and table describe physical sections of the board.

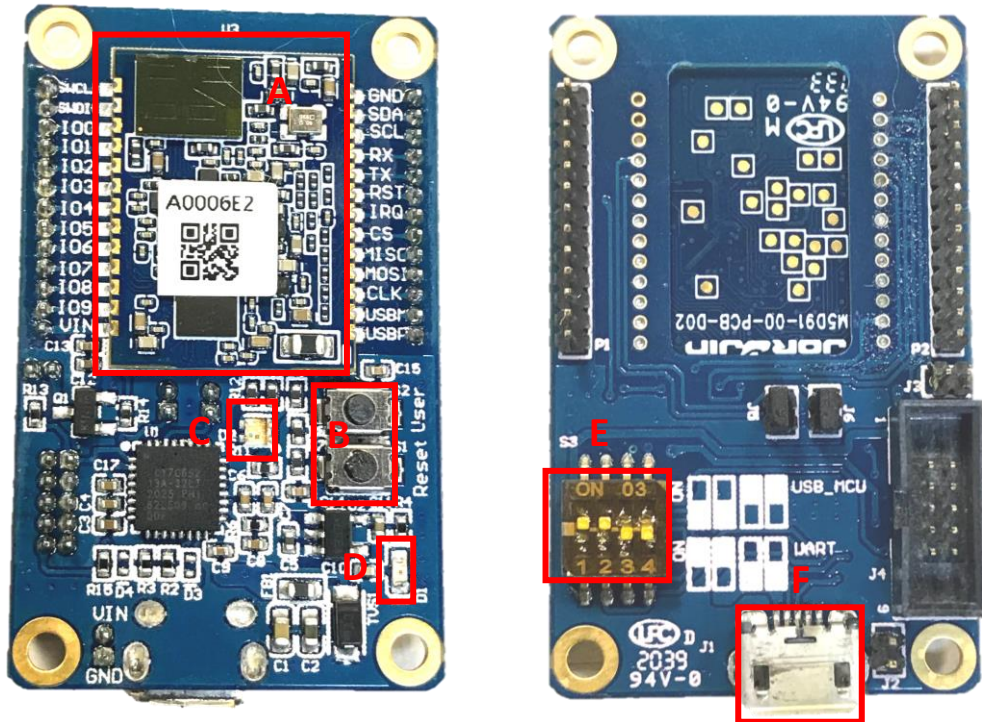


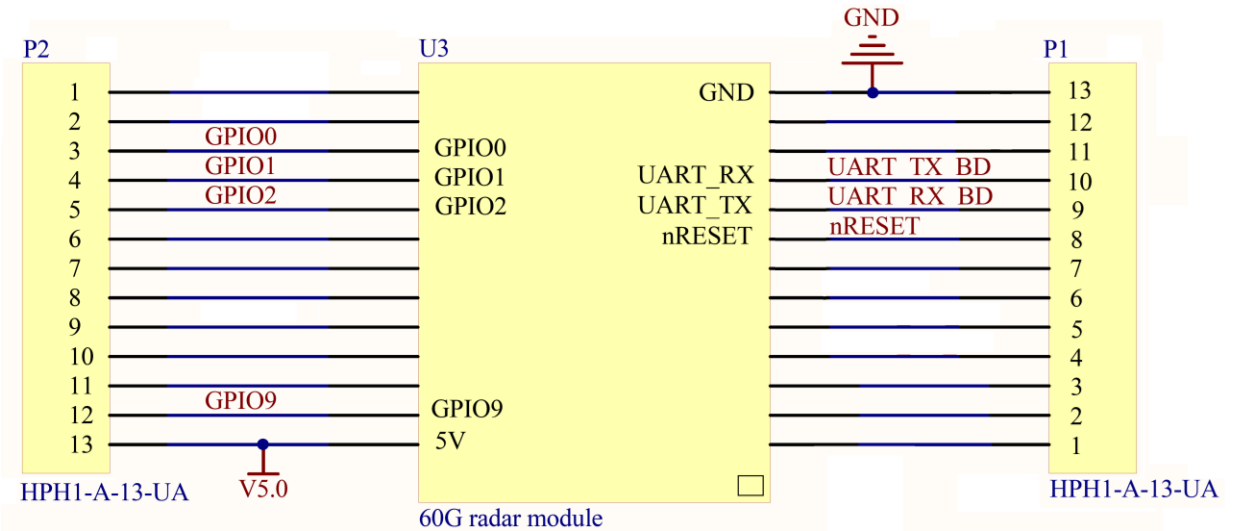
Figure 2-1. Hardware description of Evaluation Kit

Table 2-1. Evaluation Kit component descriptions list

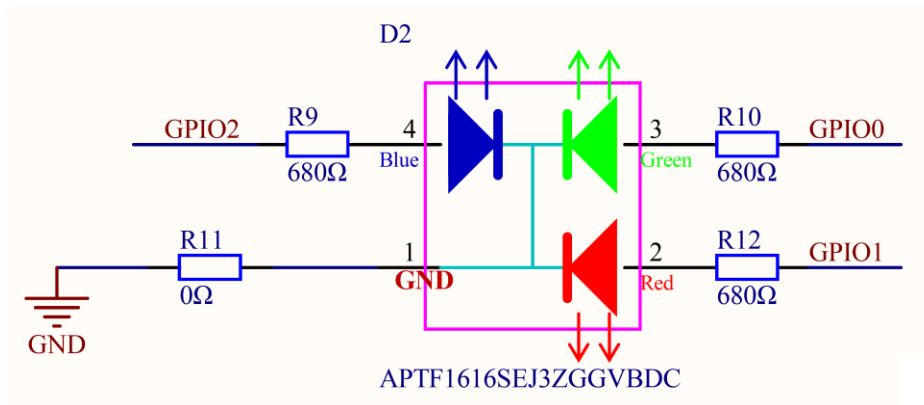
Region	Description
A	Jorjin mmWave Radar sensor module.
B	User - Press the button and power up or reset to enter bootloader mode. Reset - Radar sensor module reset switch.
C	LED of radar detect status: - Green color: No presence. - Red color: Presence detected.
D	Red LED light when the evaluation kit is power on.
E	Interface setting: Turn up of left two / Turn down of right two. Please keep the setting always.
F	Micro USB connector. Connected to PC (config tool) or power bank to demo.

## 2.2. Schematic Diagrams

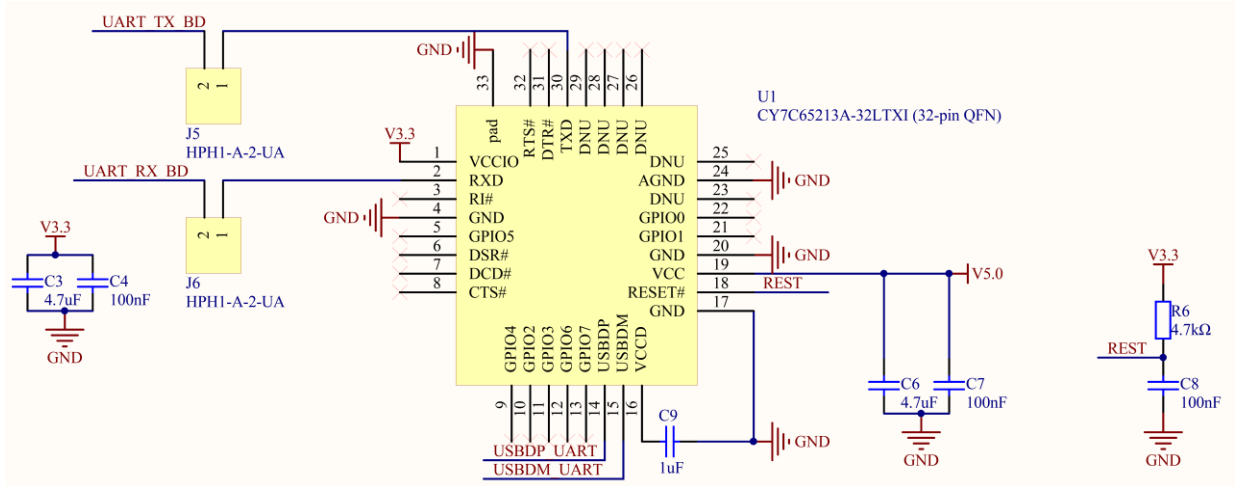
Pin assignment of P1 and P2:



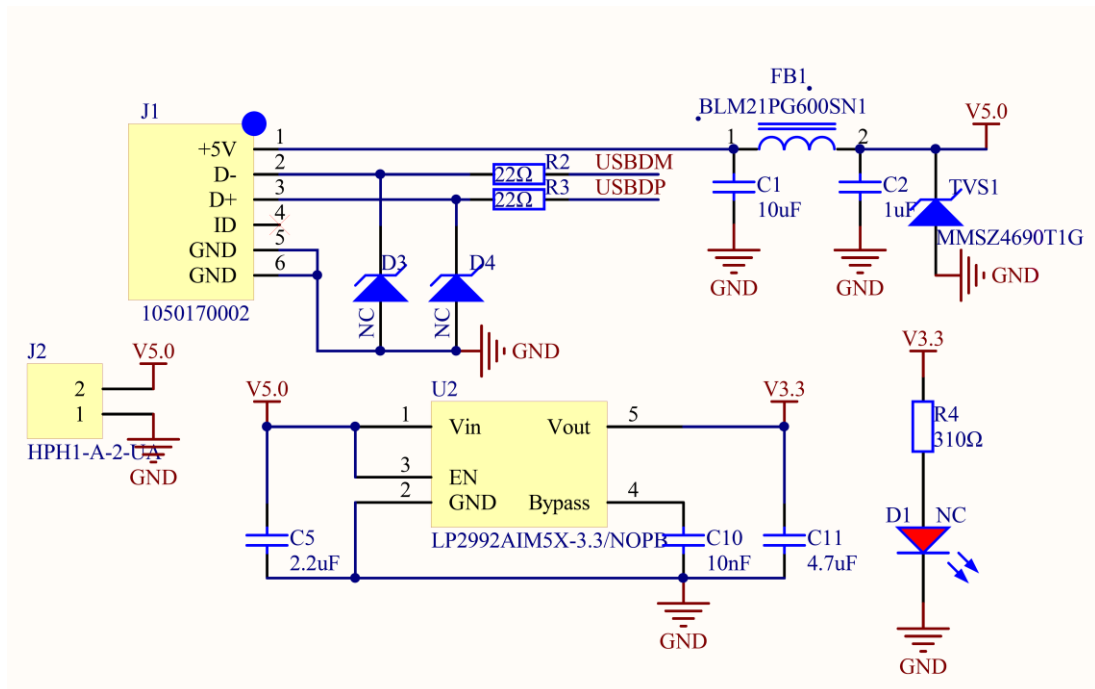
LED indication for presence detection:



UART to USB Conversion:

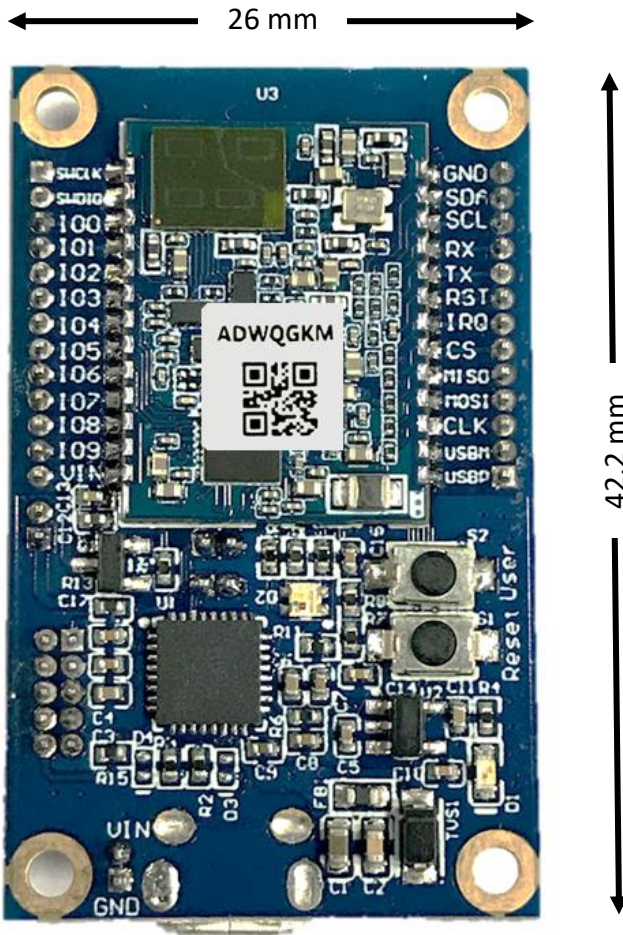


USB circuit:



### 2.3. Dimensions

MM5D91E00 Board Dimensions.



### 3. SOFTWARE DESCRIPTION

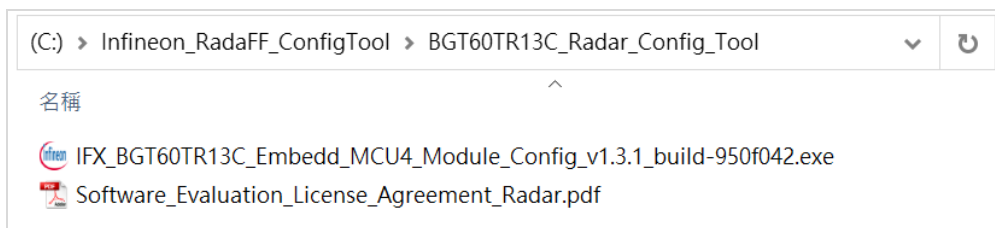
The module can be connected with UART serial interface (Baudrate 115200, 8N1) for command communication. There is a converter chip on the mother board to convert the UART interface to USB for PC connection.

#### 3.1. Module Config Software

The Presence detection Config tool in the link : [Infineon's website](#).

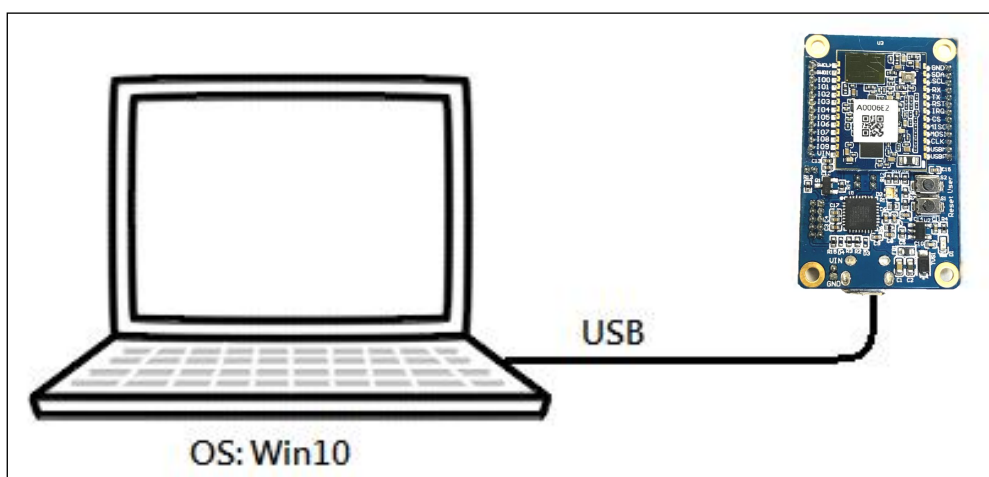
Please find the default file path "C:\Infineon\_RadaFF\_ConfigTool" after download and Setup. This archive contains following files after extracting in the folder:

- IFX\_BGT60TR13C\_Embedd\_MCU4\_Module\_Config\_v1.x.x\_build-xxxxxxx.exe
- Software\_Evaluation\_License\_Agreement\_Radar.pdf



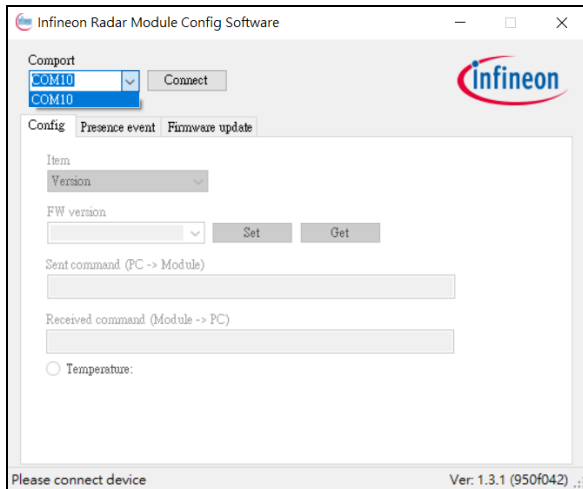
Connect the radar board to PC through USB, open the config tool.

If the OS is Windows 7 or lower, please find the USB driver in the [link](#).

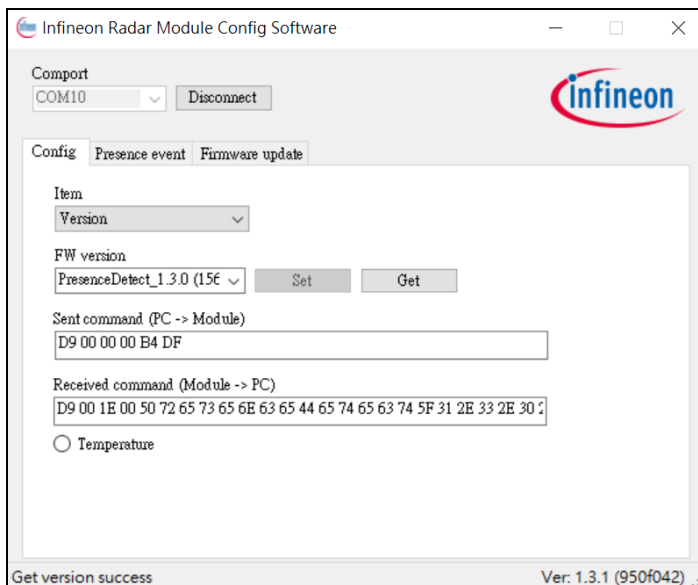




Select the correct COM port number (e.g. COM10) and press **Connect** button.



If the board is successfully connected, a firmware version would be shown in the box. Otherwise, a fail message would be shown at bottom.



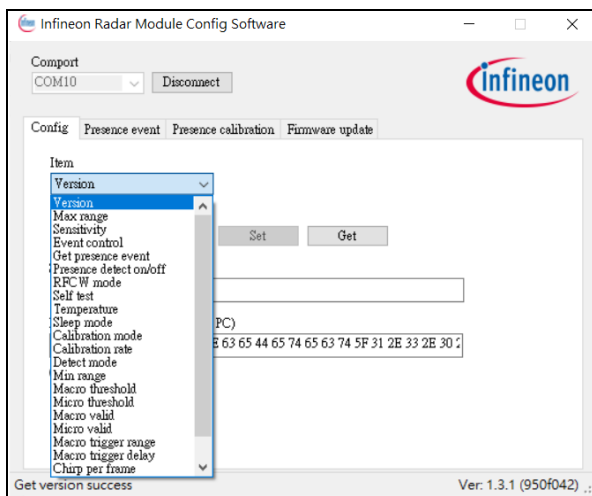
### 3.2. Set and Get Configuration

User can set or get the configuration of the radar at the **Config** tab page. Currently following items are available:

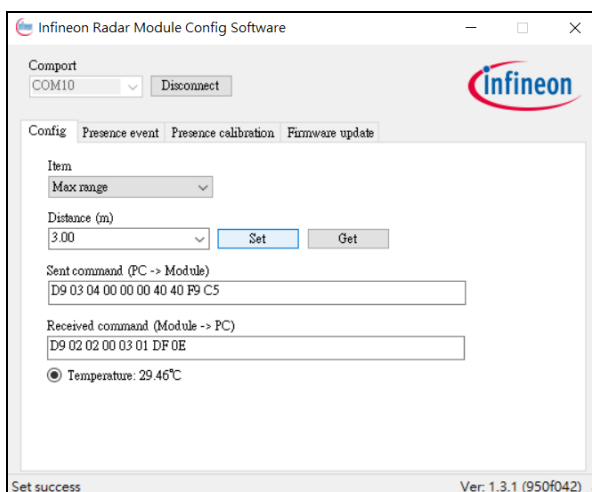
Item	Description
Version	Get the firmware version in MCU.
Max range [ 1.0 – 10.0 ]	Get or set the maximum detection distance of presence detection. Setting would store in flash, default is 1.00m.
Sensitivity	Get or set the sensitivity level presence detection, higher sensitivity means more sensitive to small movement. Changing sensitivity would change the Macro and Micro threshold value. Setting would store in flash, default is medium.  <b>Note:</b> User is recommended to use high sensitivity setting for optimal performance at angles and for use cases such as a person sitting on a chair behind the table.
Get presence event	Get current presence detection result.
Presence detect on/off	Set presence detection on or off. Default is on. When set to off, radar chip power would also set to off.
RFCW mode	Enable or disable the RF continuous wave mode for FCC test. Presence detection needs to be off before enabling this mode. Disable: Disable RFCW mode. <ul style="list-style-type: none"> <li>- Low: Set RFCW output at 61.02GHz</li> <li>- Mid: Set RFCW output at 61.25GHz</li> <li>- High: Set RFCW output at 61.48GHz</li> <li>- Low TX off: Set RFCW test at 61.02GHz with TX off</li> <li>- Mid TX off: Set RFCW test at 61.25GHz with TX off</li> <li>- High TX off: Set RFCW test at 61.48GHz with TX off</li> </ul>
Temperature	Get temperature on radar chip (°C)
Sleep mode	Set the radar module into deep sleep mode. The module would wake up again when data received at UART RX pin. A preamble byte such as 0x00 is needed to add in the next command to have the command correctly received at the module (to compensate wakeup delay time).
Calibration mode	Enable/disable active output command of calibration message. A calibration message would output periodically when enabled. The message would contain the activity level used to compare with the macro/micro threshold value at that time. This mode is mainly used for measuring the background noise of macro and micro detection, in order to tune for an optimum threshold value for the environment.
Calibration rate [1 to 4]	Set the update rate of the calibration message output. Selection is 1 to 4. For example, setting the value to 4 would change the

	output message rate to 4 Hz.
Detect mode	<p>Set presence detection detect mode. Setting would store in flash, default is Macro then micro.</p> <ul style="list-style-type: none"> <li>- Macro then micro: Radar would first detect macro motion for presence, and enter micro motion detect mode when the object movement becomes small.</li> <li>- Macro only: Radar would only detect macro movement.</li> <li>- Micro only: Radar would only detect micro movement.</li> <li>- Macro and micro: Radar would always detect both macro and micro movement, either one kind of motion exceeding the threshold would be treated as presence.</li> </ul>
Min range [ 0.00 – 1.00 less than Max range ]	Get or set the minimum detection distance of presence detection. User needs to ensure this value is smaller than Max range. Setting would store in flash, default is 0.00m.
Macro threshold [ > 0.0 ]	Threshold value using in macro movement detection. After changing this value, Sensitivity would become customize. Setting would store in flash, default is 1.00.
Micro threshold [ > 0.0 ]	Threshold value using in micro movement detection. After changing this value, Sensitivity would become customize. Setting would store in flash, default is 25.00.
Macro valid [ 0.5 – 30.0 ]	Timeout value (second) using for judging the motion is no longer macro movement. For example, if value is 1, it means detected value below macro threshold for continuous 1 second would be treated as no macro movement. Setting would store in flash, default is 1.
Micro valid [ 1.5 – 30.0 ]	Timeout value (second) using for judging the motion is no longer micro movement. Judging criteria is same as in Macro valid value. Setting would store in flash, default is 4.
Macro trigger range [1 - 64]	Get or set the macro trigger range for macro movement detection. Setting a higher value, user need to enter the detection zone inner to trigger presence. Value is multiple of 0.33m. Setting would store in flash, default is 1.
Macro trigger delay [0 - 255]	Get or set the trigger delay for macro movement detection. Input value is multiple of 0.25s. For example, setting value to 3, radar will determine the motion as macro movement for continuous 0.75s of major motion. Setting would store in flash, default is 0.
Chirp per frame	Chirp per frame of presence detection. Setting a higher value,

[1 - 4]	radar will send out more chirps in a frame and use for coherent integration, resulting in a better signal to noise ratio. Notice that power consumption will also increase for setting higher value, as the RF active time will also increase. Setting would store in flash, default is 1.
Unique ID	Get the unique ID of the module.
Reset config	Reset all setting storing in flash to default.



After pressing **Set** or **Get** button, the relevant binary command would be shown in the command textbox. Developer can use that command for reference or checking. The temperature button can enable periodic polling of the radar chip temperature.

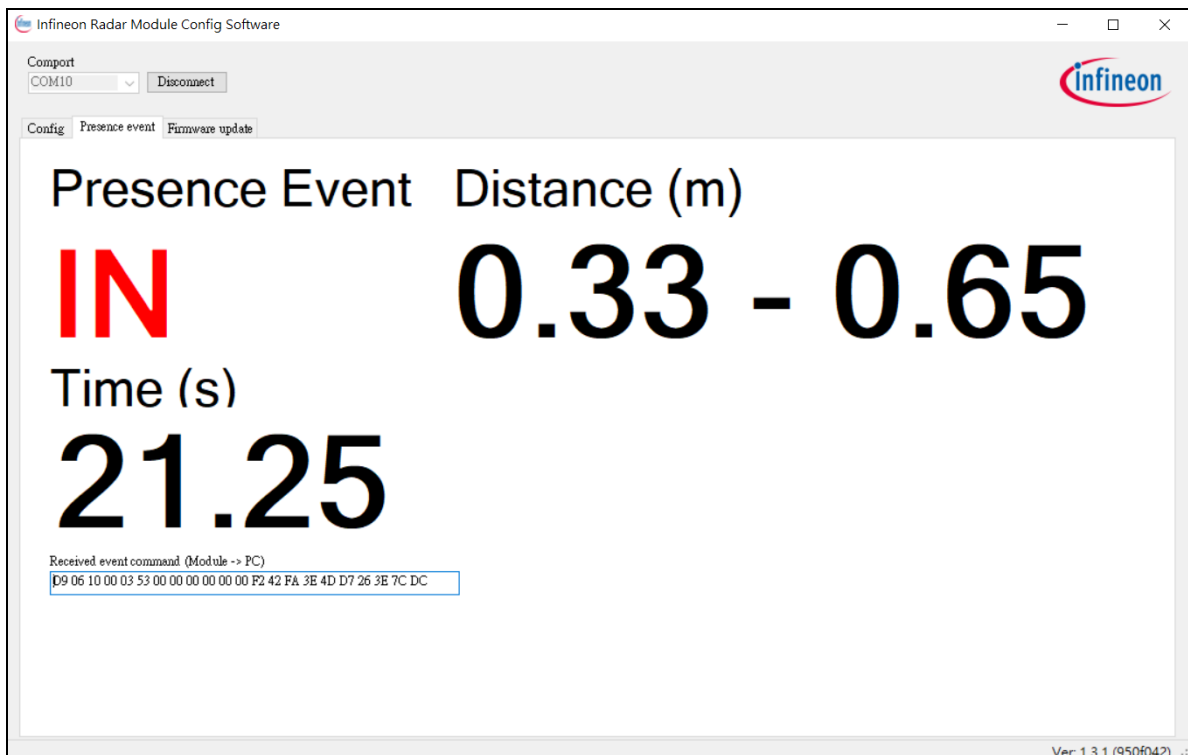


### 3.3. Presence event output

When event control is turned on, the presence detection result would be shown at **Event** tab page.

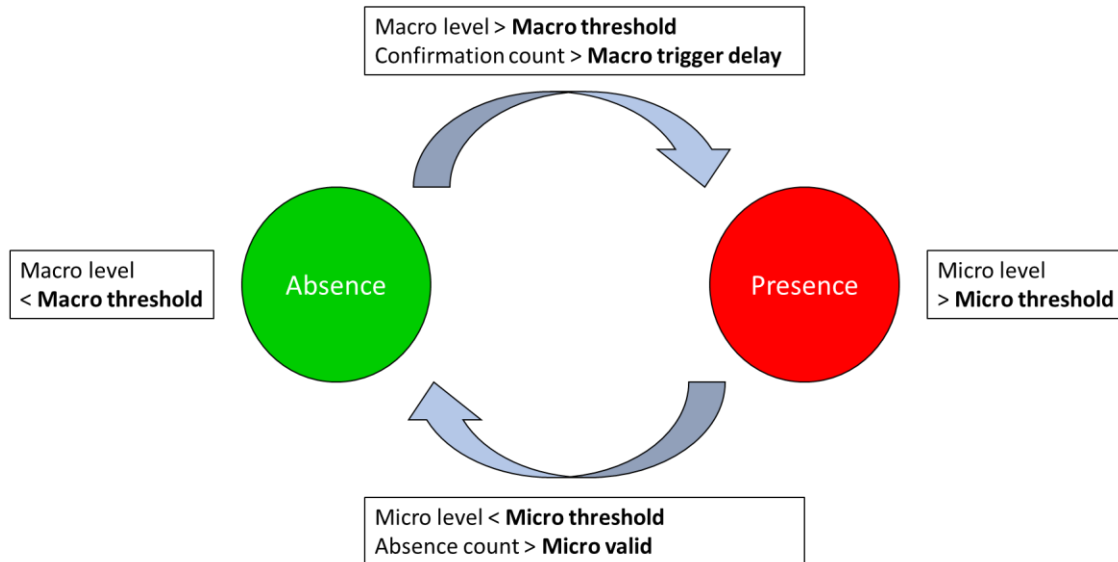
Item	Description
Presence Event	Presence detection result. <ul style="list-style-type: none"> <li>- IN: moving object detected in the zone</li> <li>- OUT: no moving object detected in the zone</li> </ul>
Distance (m)	Detected distance range of the closest moving object, in meter.
Time (s)	Relative event time, in second. This is the time starting from power on, not an absolute time.

Received event command would be shown in the command textbox for reference.



### 3.4. Macro and micro threshold tuning

In presence detection solution, there is a macro and micro mode concept. The macro then micro detection mode could be illustrated using a state machine.



When the detection is in absence state, it would check the marco level. If marco level is higher than marco threshold, macro trigger confirmation count will increase by 1. If confirmation count exceeds macro trigger delay, state would transit from absence to presence.

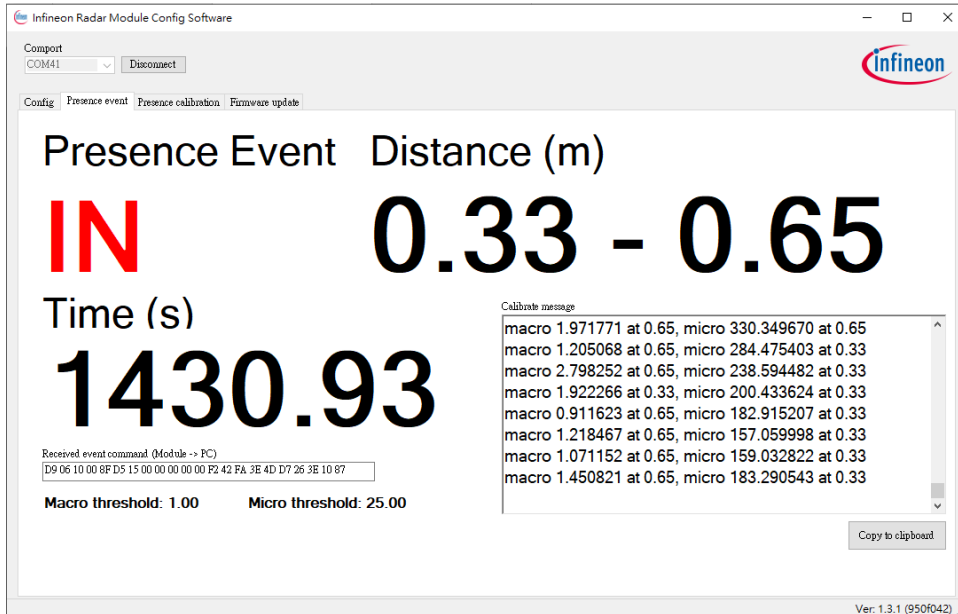
For presence state, state remains in presence when micro level is higher than the micro threshold. When the micro level is lower than the micro threshold, absence count will increase by 1. If absence count exceeds micro valid, the state would go back to absence.

Sensitivity setting (High, Medium and Low) have pre-defined macro and micro threshold value. If user find the sensitivity is not enough even with high sensitivity, they can manually set the micro and macro threshold value to fit their use case.

- **Reading the macro and micro level**

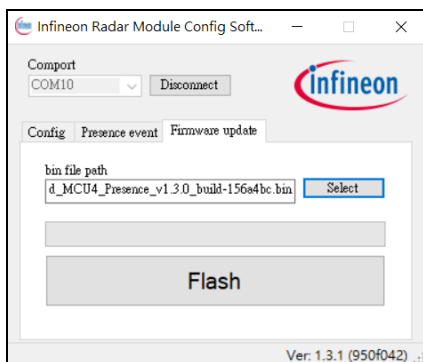
Following steps are used to enable macro and micro level tuning.

1. Turn **Calibration mode** to **On**.
2. Set **Detection mode** to **macro and micro**
3. Set **Calibration** rate to **4**, so the solution will report the update rate as fast as possible.

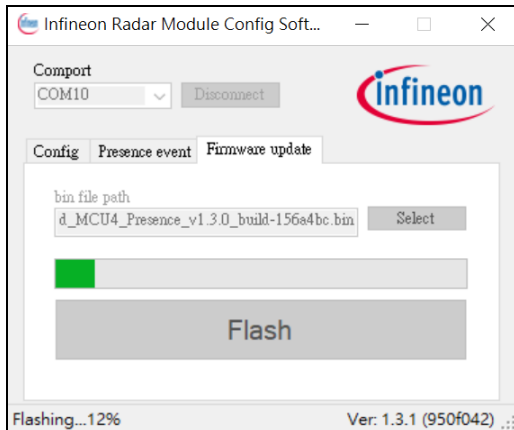


### 3.5. Firmware update

Firmware update can be done in the **Firmware update** tab page. Select the target .bin file by pressing **Select** button. Bootloader mode would be entered automatically during the update process. In case a non-working firmware is loaded, user can manually force the module to enter bootloader mode by pressing the user button on the mother board after power up or reset. The LED would change to blue color when bootloader mode is entered.



Then press **Flash** button to start the firmware update. Whole update process would take around 30 seconds. Although protection mechanism is added in the update process, it is recommended not unplugging the USB or power off the board to prevent any unexpected error.



#### 4. HISTORY CHANGE

Revision	Date	Description
Draft 0.1	2020-07-23	Draft version.
Draft 0.2	2020-07-31	Correct hardware description Region C and D on Table 2-1.
Draft 0.3	2021-03-11	<ol style="list-style-type: none"> <li>1. Add hardware description Region B.</li> <li>2. Add software description information.</li> </ol>
Revision 1.0	2021-10-06	Add UART communication.
Revision 2.0	2022-01-26	<ol style="list-style-type: none"> <li>1. Add calibration mode description</li> <li>2. Add Macro and micro threshold tuning</li> </ol>
Revision 3.0	2022-03-07	Update the setting range of value in section 3-2.