

# BB901S

## Ultra Low-Power Bluetooth 6.0 Module

### Introduction

BB901S is a high-performance, industrial, ultra low-power BLE6.0 module, which based on Nordic SoC nRF54L15. It integrates a 32-bit 128MHz ARM®Cortex®-M33 core and a 128 MHz RISC-V core, configurations up to 1524 KB NVM and up to 256 KB RAM. BB901S provides rich interfaces such as UART, SPI, I<sup>2</sup>S, I<sup>2</sup>C, ADC, NFC, PDM, QDEC, PWM. At the same time, it adopts a small stamp package and convenient for engineers to develop.

### Key features

- **Frequency band**
  - BLE: 2402~2480MHz
  - IEEE802.15.4: 2405~2480MHz
  - Operating frequencies: 2400~2500MHz
- **Ultra low-power consumption**
  - VDD 1.7~3.6V
  - < 5mA peak current in TX (@0dBm/1Mbps)
  - < 10mA peak current in TX(@+8dBm/1Mbps)
  - < 3.2mA peak current in RX
  - 0.6μA @3V in System OFF mode (no RAM retention)
  - 3.1μA @3V in System ON mode (256KB RAM retention, wake on RTC)
- **High sensitivity**
  - 96dBm sensitivity(1Mbps, BER<0.1%)
  - 104dBm sensitivity(125kbps, BER<0.1%)
  - 40 to +8dBm TX power (1dB step size from -8dBm to +8dBm)
- **Advanced security**
  - Including TrustZone® isolation, tamper detection, and cryptographic engine side-channel leakage protection
- **Protocol support**
  - BLE6.0 / 5.x / 4.x compatible: 2Mbps / 1Mbps / 500kbps / 125kbps
  - Proprietary 2.4GHz: 4Mbps / 2Mbps / 1Mbps
  - IEEE 802.15.4-2020: Thread, Matter, and Zigbee
- **Microprocessor & Memory**
  - 32-bit 128MHz ARM®Cortex®-M33 & 128 MHz RISC-V Coprocessor
  - 1524KB NVM & 256KB RAM
- **Interface**
  - 20\*General purpose I/O
  - 5\*I<sup>2</sup>C / 1\*I<sup>2</sup>S / 3\*PWM / 2\*PDM / 1\*NFC
  - 2\*QDEC / 7\* 32-bit timer / 2\*WDT / 1\*RTC
  - 4\*UART up to 1MHz
  - 1\*high-speed UART up to 4MHz
  - 4\*SPI up to 8MHz
  - 1\*high-speed SPI up to 32MHz
  - 1\*14bit ADC(6 channels)
- **Dimension**
  - 13mm×17.5mm×2.3mm(BB901SS)

### Applications

- Internet of things (IoT)
- Interactive entertainment devices
- Advanced computer peripherals and I/O devices

### Ordering information

| Part No. | Temperature   | Package | MOQ  | Shield | Antenna      |
|----------|---------------|---------|------|--------|--------------|
| BB901S   | -40°C ~ +85°C | SMD     | 1000 | Yes    | ANT on Board |

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# 1. Introduction

## 1.1 Description

BB901S is a high-performance, industrial, ultra low-power BLE6.0 module, which based on Nordic SoC nRF54L15. It integrates a 32-bit 128MHz ARM®Cortex®-M33 core and a 128 MHz RISC-V core, configurations up to 1524KB NVM & 256KB RAM.

The module provides rich interfaces such as UART, SPI, I<sup>2</sup>S, I<sup>2</sup>C, ADC, NFC, PDM, QDEC, PWM. At the same time, it adopts a small stamp package and convenient for engineers to develop.

## 1.2 Electrical specification

Specifications are shown in the following **Table 1.1**.

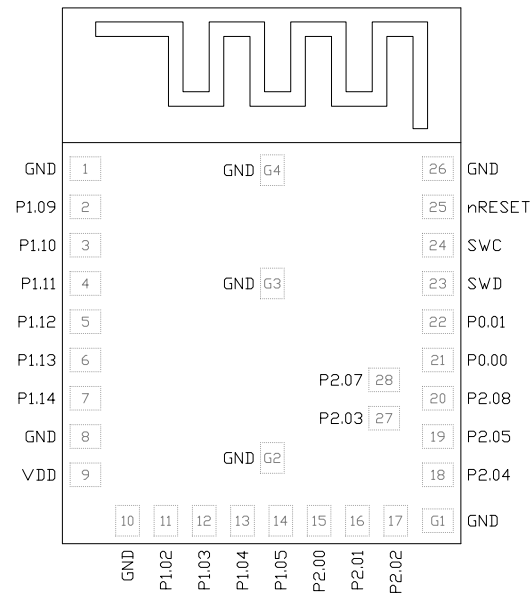
**Table 1.1 Specifications of BB901S**

| Function              | Description                                                                                                                                                                                                                                                |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Flash                 | 1524KB NVM                                                                                                                                                                                                                                                 |
| RAM                   | 256KB                                                                                                                                                                                                                                                      |
| Microprocessor        | 32-bit 128MHz ARM®Cortex®-M33<br>& 128 MHz RISC-V Coprocessor                                                                                                                                                                                              |
| Protocol support      | BLE6.0 / 5.x / 4.x                                                                                                                                                                                                                                         |
| Frequency Band        | 2402MHz ~ 2480MHz (BLE)<br>2405MHz ~ 2480MHz (IEEE 802.15.4-2020)                                                                                                                                                                                          |
| On-air data rate      | 2Mbps / 1Mbps BLE mode<br>500kbps / 125kbps Long Range mode<br>4Mbps / 2Mbps / 1Mbps Proprietary mode                                                                                                                                                      |
| TX power              | -40~+8dBm(1dB step size from -8dBm to +8dBm)                                                                                                                                                                                                               |
| Sensitivity           | -96dBm(1Mbps, BER<0.1%)@BLE<br>-104dBm(125kbps, BER<0.1%)@LongRange                                                                                                                                                                                        |
| Power consumption     | TX peak current: 10mA@+ 8dBm / 1Mbps / BLE<br>TX peak current: 5mA@0dBm / 1Mbps / BLE<br>RX peak current: 3.2mA<br>0.6 μA in System OFF mode, no RAM retention<br>0.8 μA in System OFF mode with RTC<br>3.1 μA in System ON IDLE mode, 256KB RAM retention |
| Digital interfaces    | 1*I <sup>2</sup> S / 3*PWM / 2*PDM / 2*QDEC / 1*NFC / 5*I <sup>2</sup> C(up to 400KHz)<br>4*UART up to 1MHz & 1*high-speed UART up to 4MHz<br>4*SPI up to 8MHz & 1*high-speed SPI up to 32MHz                                                              |
| Analog interfaces     | 1*14-bit ADC(6 channels)                                                                                                                                                                                                                                   |
| Timer                 | 7*32-bit timer / 1*Global RTC / 2*WDT                                                                                                                                                                                                                      |
| Advanced security     | Including TrustZone® isolation, tamper detection, and cryptographic engine side-channel leakage protection                                                                                                                                                 |
| GPIO                  | 20                                                                                                                                                                                                                                                         |
| Operation temperature | -40°C~85°C                                                                                                                                                                                                                                                 |
| Package               | SMD                                                                                                                                                                                                                                                        |
| Dimension             | W13*L17.5*H2.3mm                                                                                                                                                                                                                                           |

## 2. Pin assignments

### 2.1 Top view

Top view of BB901S is shown in **Figure 2.1**. All the pads are on the bottom layer.



**Figure 2.1 BB901S pin assignments(top view)**

### 2.2 Pin assignments

The BB901S pin assignment is shown in **Table 2.1**.

**Table 2.1 Pin assignment description**

| Pin No. | Pin name | Description                                         |
|---------|----------|-----------------------------------------------------|
| 1       | GND      | Power ground                                        |
| 2       | P1.09    | Digital I/O                                         |
| 3       | P1.10    | Digital I/O                                         |
| 4       | P1.11    | Analog input / Digital I/O                          |
| 5       | P1.12    | Analog input / Digital I/O                          |
| 6       | P1.13    | Analog input / Digital I/O                          |
| 7       | P1.14    | Analog input / Digital I/O                          |
| 8       | GND      | Power ground                                        |
| 9       | VDD      | Power input, 1.7 ~ 3.6V (Recommended voltage range) |
| 10      | GND      | Power ground                                        |
| 11      | P1.02    | Digital I/O / NFC ANT1                              |
| 12      | P1.03    | Digital I/O / NFC ANT2                              |
| 13      | P1.04    | Analog input / Digital I/O                          |

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|       |        |                                                                              |
|-------|--------|------------------------------------------------------------------------------|
| 14    | P1.05  | Analog input / Digital I/O                                                   |
| 15    | P2.00  | Digital I/O                                                                  |
| 16    | P2.01  | Digital I/O                                                                  |
| 17    | P2.02  | Digital I/O                                                                  |
| 18    | P2.04  | Digital I/O                                                                  |
| 19    | P2.05  | Digital I/O                                                                  |
| 20    | P2.08  | Digital I/O                                                                  |
| 21    | P0.00  | Digital I/O                                                                  |
| 22    | P0.01  | Digital I/O                                                                  |
| 23    | SWDIO  | Serial wire data for debug and programming                                   |
| 24    | SWCLK  | Serial wire clock input for debug and programming                            |
| 25    | nRESET | Module reset(active low) <sup>[Note]①</sup> ; Pin reset with on-chip pull-up |
| 26    | GND    | Power ground                                                                 |
| 27    | P2.03  | Digital I/O                                                                  |
| 28    | P2.07  | Digital I/O                                                                  |
| G1~G4 | GND    | Power ground                                                                 |

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① The nRESET pin of BB901S can be used according to the product requirements.

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### 3. Specifications and parameters

#### 3.1 Absolute maximum ratings

The absolute maximum ratings of BB901S is shown in **Table 3.1**.

| Item                            | Parameter |      |      | Description                                                                                                  |
|---------------------------------|-----------|------|------|--------------------------------------------------------------------------------------------------------------|
|                                 | Min       | Max  | Unit |                                                                                                              |
| VDD                             | -0.3      | 3.9  | V    | Exposure to absolute maximum ratings for prolonged periods of time may affect the reliability of the device. |
| I/O pin voltage                 | -0.3      | 3.9  | V    | VDD voltage $\leq$ 3.8V                                                                                      |
| RF input level                  | -         | 10   | dBm  | *                                                                                                            |
| Reference transmission distance | -         | 60   | m    | Module to module <sup>[Note]②</sup>                                                                          |
| Operating temperature           | -40       | +85  | °C   | *                                                                                                            |
| Storage temperature             | -40       | +125 | °C   | Normal temperature storage is recommended                                                                    |

**Table 3.1 Absolute maximum ratings**

#### 3.2 ESD parameters

The ESD parameters of BB901S is shown in Table 3.2.

**Table 3.2 ESD parameters**

| Item |                                  | Minimum | Maximum | Unit | Description |
|------|----------------------------------|---------|---------|------|-------------|
| ESD  | Human Body Model (HBM)           | -       | 1000    | V    |             |
|      | Moisture Sensitivity Level (MSL) | -       | 2       |      |             |
|      | Charged Device Model (CDM)       | -       | 500     | V    |             |

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<sup>②</sup> The reference communication distance is closely related to hardware construction, test site environment, etc, which is for reference only.

### 3.3 Operating conditions

The operating conditions of BB901S is shown in Table 3.3.

Table 3.3 Recommended operating conditions

| Item                    | Min  | Typical | Max  | Unit | Description        |
|-------------------------|------|---------|------|------|--------------------|
| Operating temperature   | -40  | +25     | +85  | °C   |                    |
| VDD                     | 1.7  | 3.3     | 3.6  | V    |                    |
| VDD <sub>POR</sub>      | -    | 1.75    | -    | V    | Power-on threshold |
| V <sub>BOR-SYSOFF</sub> | 1.56 | -       | 1.64 | V    | System OFF         |
| V <sub>BOR-SYSON</sub>  | 1.57 | -       | 1.64 | V    | System ON          |

### 3.4 Power consumption

The power consumption of BB901S is shown in Table 3.4.

Table 3.4 Reference power consumption

| Item                     | Typical | Unit | Description                                                              | Conditions                    |
|--------------------------|---------|------|--------------------------------------------------------------------------|-------------------------------|
| I <sub>tx,peak</sub>     | 10      | mA   | TX only run current, @+8 dBm,1Mbps                                       | VDD=3.3V,<br>temperature=25°C |
| I <sub>tx,peak</sub>     | 5       | mA   | TX only run current, @0 dBm,1Mbps                                        |                               |
| I <sub>Rx,peak</sub>     | 3.2     | mA   | RX only run current, @1 Mbps                                             |                               |
| I <sub>Sleep</sub>       | 3.1     | μA   | Sleep mode, System ON IDLE, 256KB RAM retention, Wake on pin+GRTC, LFXO. |                               |
| I <sub>Deep Sleep1</sub> | 0.8     | μA   | System OFF, no RAM retention. Wake-up by wake on pin+GRTC, LFXO.         |                               |
| I <sub>Deep Sleep2</sub> | 0.6     | μA   | System OFF, no RAM retention. Wake-up by wake on pin.                    |                               |

### 3.5 RF parameters

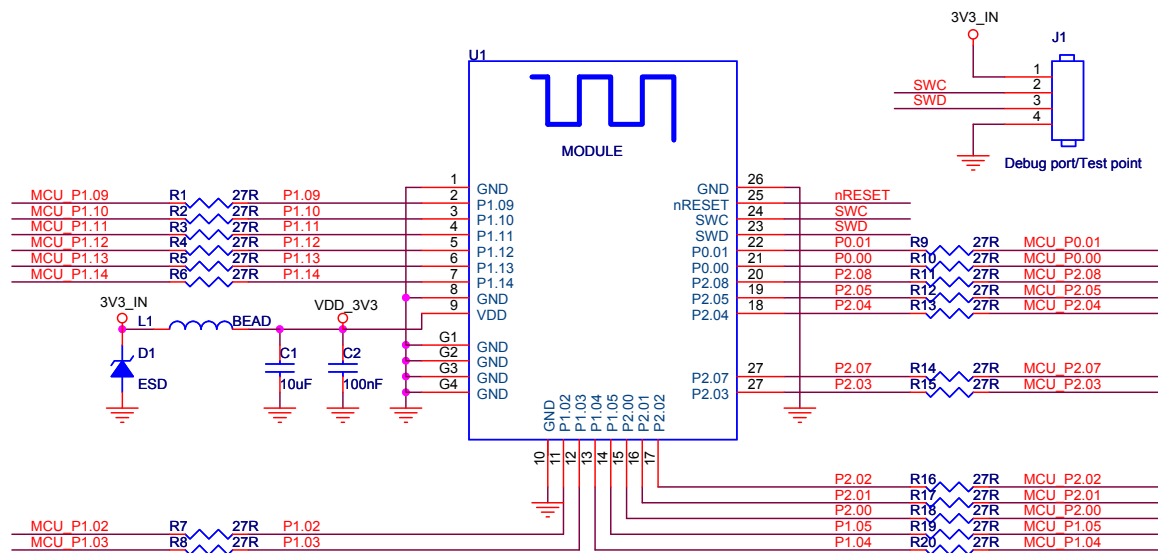
The parameters of BB901S is shown in Table 3.5.

| Item                  | Typical   | Unit | Remarks                           |
|-----------------------|-----------|------|-----------------------------------|
| Frequency band        | 2402~2480 | MHz  | BLE mode                          |
| Frequency band        | 2405~2480 | MHz  | IEEE 802.15.4-2020                |
| TX Power              | -40~+8    | dBm  | 1dB step size from -8dBm to +8dBm |
| Receiving sensitivity | -96       | dBm  | BLE mode, 1Mbps, BER<0.1%         |
| Receiving sensitivity | -104      | dBm  | LongRange mode, 125kbps, BER<0.1% |

Table 3.5 RF parameters of BB901S

## 4. Typical application

The typical application circuit of BB901S is shown in **Figure 4.1**.

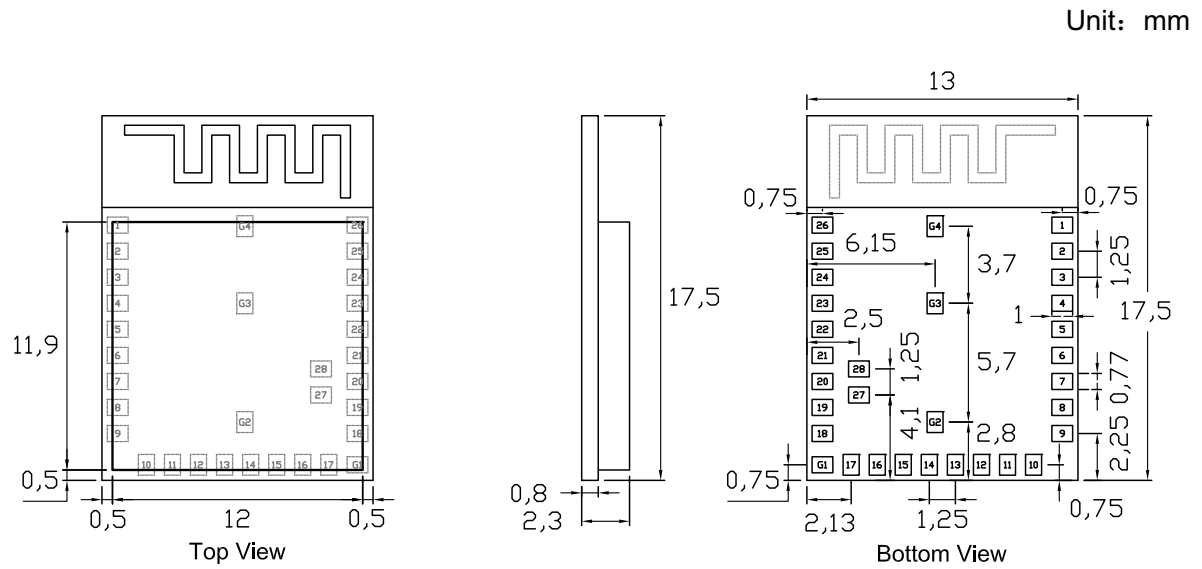


**Figure 4.1 Typical application circuit**

## 5. Mechanical specifications

### 5.1 Dimensions

The dimensions of BB901S is shown in the **Figure 5.1**.



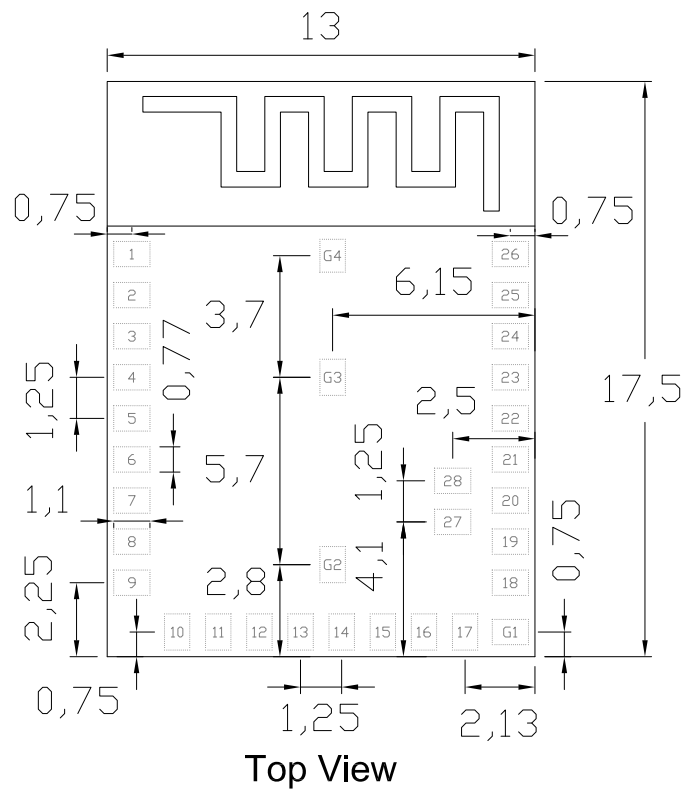
**Figure 5.1 Dimensions of BB901S**

**Table 5.1 Dimensions of BB901S**

| Model  | Length | Width | Height | PCB Thickness | PAD Size   | PIN Spacing | Shield |
|--------|--------|-------|--------|---------------|------------|-------------|--------|
| BB901S | 17.5mm | 13mm  | 2.3mm  | 0.8mm         | 0.77mm×1mm | 1.25mm      | Yes    |

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The recommended PCB footprint of BB901S is shown in **Figure 5.2**.



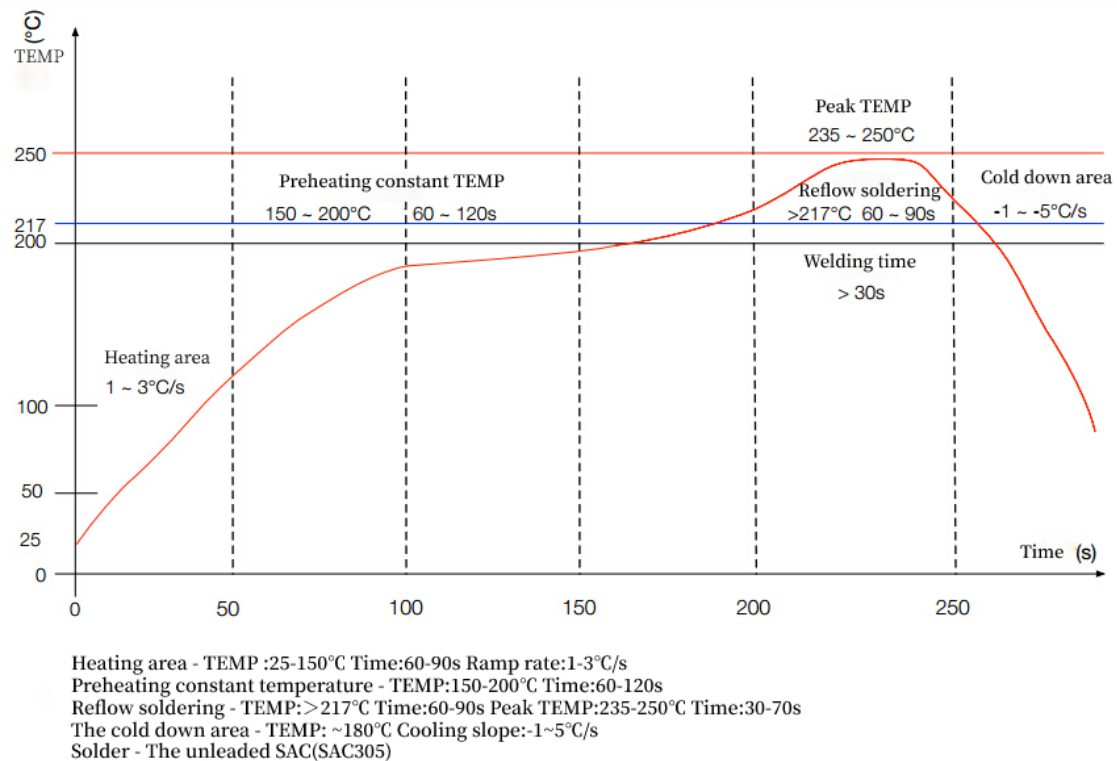
Unit: mm

**Figure 5.2 Recommended PCB footprint**

## 6. Welding instructions

### 6.1 Recommended temperature reflow profile

The recommended SMT temperature reflow profile of BB901S is shown in **Figure 6.1**.



**Figure 6.1** Temperature reflow profile

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## 7. Part number & Selections

The selection list related to BB901S is shown in **Table 7.1**.

| Part No. | Frequency band | Max transmission power | Bluetooth protocol | Dimensions    | Antenna      | Shield |
|----------|----------------|------------------------|--------------------|---------------|--------------|--------|
| BB901S   | 2.4GHz         | +8dBm                  | BLE6.0             | 13×17.5×2.3mm | ANT on board | Yes    |

**Table 7.1 List of selections**

## 8. Revision history

| Version | Date       | Description     | Reviser      |
|---------|------------|-----------------|--------------|
| V1.0    | 2025/08/04 | Initial version | Wesley/Damon |