

How to use the STEVAL-BLUEPIRV1 evaluation board for Bluetooth® Low Energy wireless motion detector based on a PIR sensor

Introduction

The **STEVAL-BLUEPIRV1** evaluation board is an application example design of a wireless motion detector based on a passive infrared (PIR) sensor and featuring Bluetooth® Low Energy wireless connectivity.

The passive infrared sensors are the most used sensors for motion detection, thanks to their low-power consumption and price.

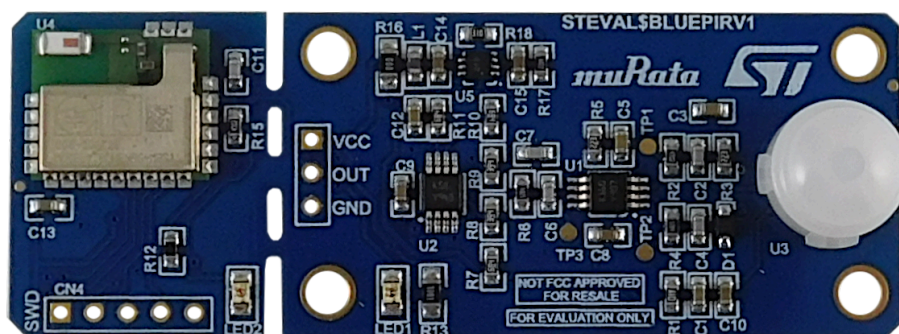
The **STEVAL-BLUEPIRV1** evaluation board uses IRA-S210ST01 by Murata. The detection range of the IML-0688 Fresnel lens is up to 5 m.

The on-board low-power **TSU102** CMOS op-amp and **TS883** comparator perform the analog signal conditioning with a power consumption in a sub- μ A range.

The embedded **BlueNRG-M2SA** FCC and IC certified radio module (FCC ID: S9N-BNRGM2S and IC: 8976C-BNRGM2SA), which integrates an application microcontroller based on an Arm®Cortex®-M0 core, features the Bluetooth® Low Energy connectivity.

The whole design has been built by focusing on low-power consumption. Even though powered via a CR2032 coin-cell battery, the board expected lifetime is around a year.

Figure 1. STEVAL-BLUEPIRV1 evaluation board



1 Overview

The STEVAL-BLUEPIRV1 evaluation board comes ready-to-use and working out-of-the-box. It provides all the functionality expected from a wireless motion detector.

Some LEDs show the Bluetooth® Low Energy status and motion detection. Then, using the STBLESensor app, you can visualize the battery status and signal strength as well as the motion indication.

The Bluetooth® Low Energy module is separable to allow the designer to use the analog part only.

The supply and output reading are available on a separate header and all the analog signals are placed on a testing point.

The STEVAL-BLUEPIRV1 features:

- BlueNRG-M2SA module for Bluetooth® Low Energy communication
- Connectivity with the STBLESensor app
- Analog signal conditioning based on the TSU102 operational amplifier
- Window comparator based on the TS883 open-drain comparator
- Power management based on the STLQ020 ultra-low quiescent LDO
- Powered by a single CR2032 coin cell battery

Figure 2. STEVAL-BLUEPIRV1 block diagram

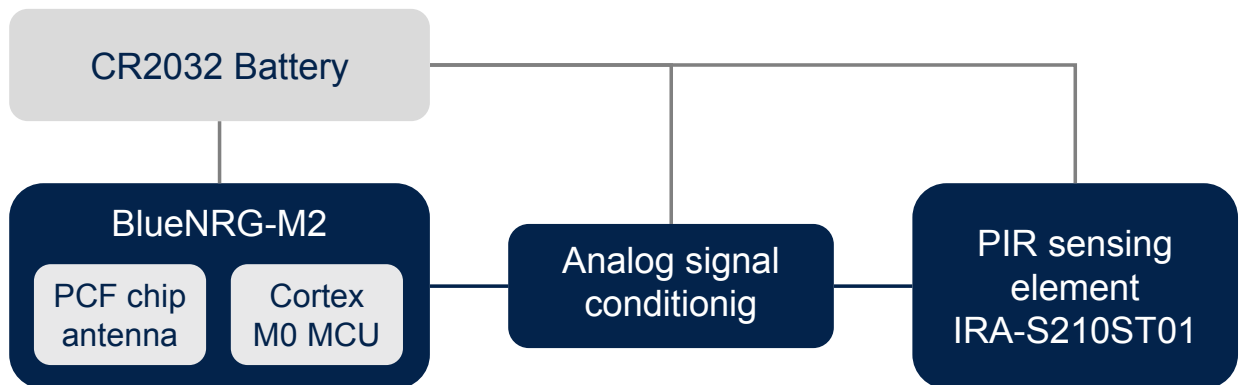
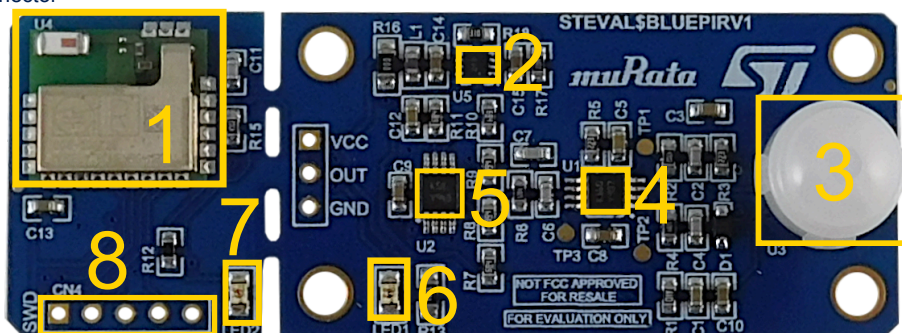


Figure 3. STEVAL-BLUEPIRV1 overview (top side)

1. BlueNRG-M2SA module
2. Power management (STLQ020)
3. PIR sensor
4. Signal conditioning (TSU102)
5. Signal conditioning (TS883)
6. Motion LED
7. Bluetooth® Low Energy status LED
8. SWD connector



2 Getting started

To use the STEVAL-BLUEPIRV1, you just need to insert the battery and download the STBLESensor app on your smartphone.

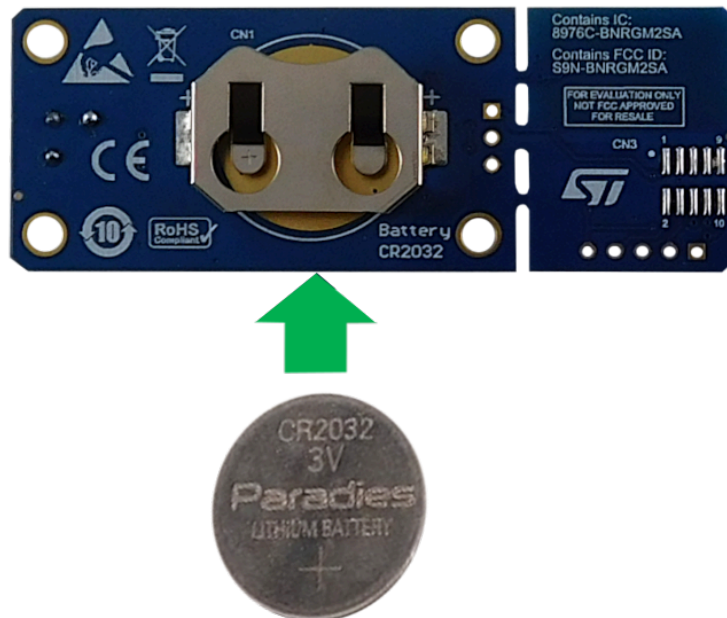
2.1 Battery

The STEVAL-BLUEPIRV1 is powered through a CR2032 coin cell battery. Insert the battery into the holder placed at the board bottom.

Important: Use CR2032 lithium 3 V batteries only. Insert the battery with the positive (+) terminal facing out.

Caution: Risk of fire or explosion if the battery is replaced by an incorrect type or if the battery polarity is inverted. Use only IEC 62133 certified CR2032 batteries.

Figure 4. STEVAL-BLUEPIRV1 battery insertion



2.2 Indication LEDs

There are two indication LEDs available on the board. The orange LED indicates the movement whereas the blue LED indicates the connection over Bluetooth® Low Energy.

The orange LED lights up right after the battery is inserted. It takes around 10 seconds to stabilize the analog circuitry and perform the proper movement indication. The orange LED is switched off shortly after the movement stops.

The blue LED periodically blinks only when the Bluetooth® Low Energy connection is set up.

2.3 STBLESensor application

The **STBLESensor** application shows the data exported by a Bluetooth® Low Energy device using the BlueST protocol.

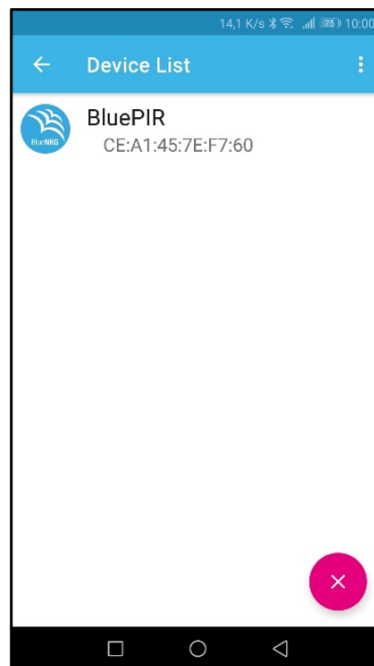
The app shows various panels with the application data. It is available at Google Play and App Store.

Figure 5. STBLESensor app QR codes



When the device scanning is performed with the **STEVAL-BLUEPIRV1** active in the smartphone range, the board should appear in the list as **BluePIR**.

Figure 6. Device list

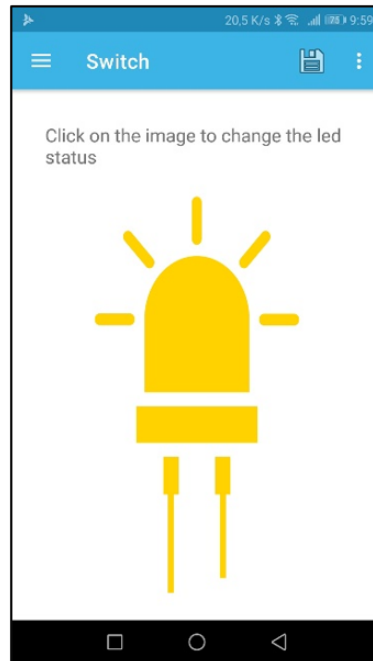


By clicking on **BluePIR**, the smartphone connects to the **STEVAL-BLUEPIRV1**. The user interface with board information then appears.

There are two panels available when successfully connected to **STEVAL-BLUEPIRV1**.

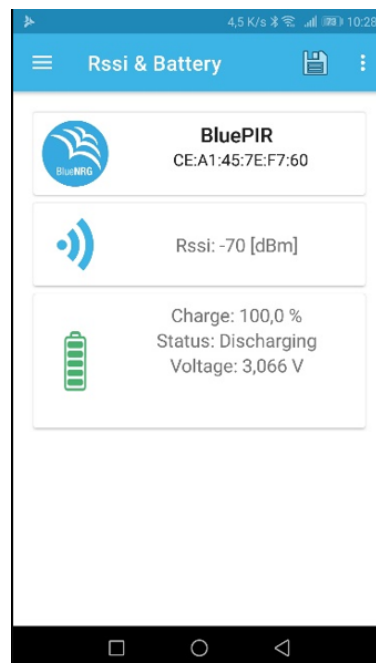
The first panel with the LED indicates the movement. There is a small delay before the LED switches off to prevent flickering.

Figure 7. LED switch panel



The other panel shows the Bluetooth® Low Energy Mac address, the signal strength, and the battery voltage with the rough state of charge information.

Figure 8. Battery status panel



3 Firmware

The evaluation board comes flashed with a firmware based on the [STSW-BLUENRG1-DK](#). This software package contains several project examples, such as the *BLE_SensorDemo_BlueMSapp* with few modifications:

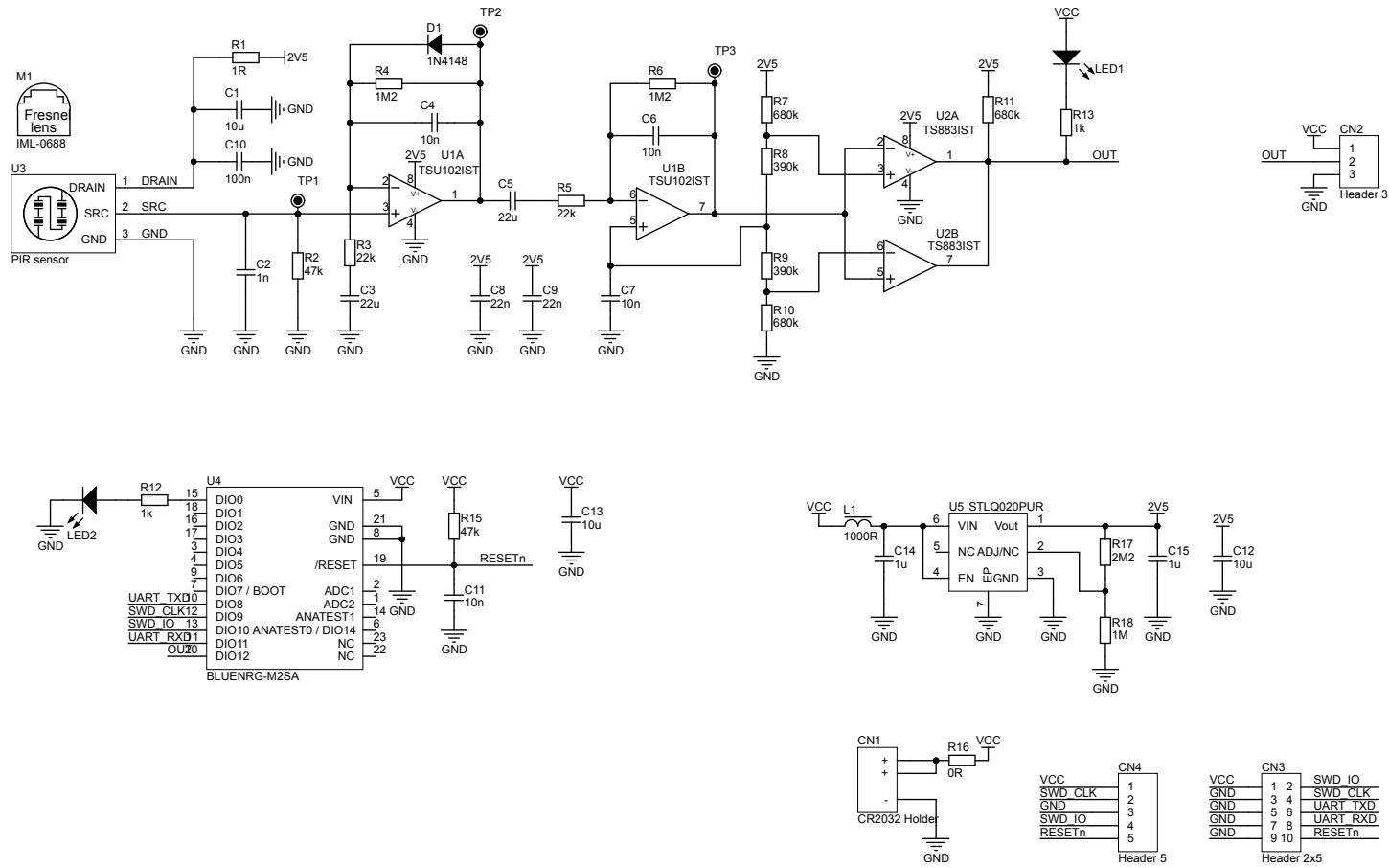
- low-power mode selected to achieve sub μA power consumption when idle
- Bluetooth[®] Low Energy messages modified to show only the LED panel in the [STBLEsensor](#) app
- ADC to measure the battery voltage

You can modify the firmware according to your needs. Then, load it into the [BlueNRG-M2SA](#) module via the SWD available on the board and use the [STSW-BNRG1STLINK](#) software package.

Note: *The Bluetooth[®] Low Energy module is used in low-power mode and the SWD peripheral is disabled. The [STSW-BNRG1STLINK](#) is able to connect only after the device reset.*

4 Schematic diagrams

Figure 9. STEVAL-BLUEPIRV1 circuit schematic



5 Bill of materials

Table 1. STEVAL-BLUEPIRV1 bill of materials

Item	Q.ty	Ref.	Value	Description	Manufacturer	Order code
1	1	CN2 N.A.	Header 3, HDR1X3	Header, 3-Pin, 2.54 mm (not assembled)	-	-
2	1	CN4 N.A.	Header 5, HDR1X5	Header, 5-Pin, 2.54 mm (not assembled)	-	-
3	1	U1	TSU102IST, MiniSO-8	Nanopower (580 nA) rail-to-rail I/O 5 V CMOS op-amp	ST	TSU102IST
4	1	U2	TS883IST, MiniSO-8	Rail-to-rail 0.9 V nanopower, open drain dual comparators	ST	TS883IST
5	1	U5	STLQ020PUR, DFN6 2x2	200 mA ultra-low quiescent current LDO	ST	STLQ020PUR
6	1	CN3 N.A.	Header 2x5, Header 2x5 1.27 SMD	Header 2x5 1.27 SMD	Harwin	M50-3600542R
7	1	U3	PIR sensor	IRA-S210ST01	Murata	IRA-S210ST01
8	4	C4, C6, C7, C11	10n, 0603_C, 50 V, 5 %	5%, 50V, C0G	Murata	GRM1885C1H103JA01 D
9	1	C2	1n, 0603_C, 50 V, 5 %	5%, 50V, C0G	Murata	GRM1885C1H102JA01 D
10	2	C8, C9	22n, 0603_C, 50 V, 10 %	10%, 50V, X7R	Murata	GRM188R72A223KAC4 D
11	1	C10	100n, 0603_C, 50 V, 10 %,	10%, 50V, X7R	Murata	GRM188R72A104KA35 D
12	3	C1, C12, C13	10u, 0603_C, 10 V, 20 %	10V, X5R, 20%	Murata	GRM188R60J106ME47 D
13	2	C14, C15	1u, 0603_C, 10 V, 20 %	10V, X5R, 20%	Murata	GRM188R60J105MA36 D
14	2	C3, C5	22u, 0603_C, 10 V, 20 %	10V, X5R, 20%	Murata	GRM188C80J226ME15 D
15	1	R16	0R, 0805_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW08050000Z0EA
16	3	R7, R10, R11	680k, 0603_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW0603680KFKEA
17	2	R8, R9	390k, 0603_R, 50 V, 1 %,	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW0603390KFKEA
18	2	R2, R15	47k, 0603_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW060347K0FKEA

Item	Q.ty	Ref.	Value	Description	Manufacturer	Order code
19	2	R3, R5	22k, 0603_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW060322K0FKEA
20	1	R13	1k, 0805_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW08051K00FKEA
21	1	R17	2M2, 0603_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW06032M20FKEA
22	1	R1	1R, 0603_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW06031R00FKEA
23	2	R4, R6	1M2, 0603_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW06031M20FKEA
24	1	R18	1M, 0603_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW06031M00FKEA
25	1	R12	1k, 0603_R, 50 V, 1 %	1%, 50V, 100mW, +-100ppm/K	Vishay / Dale	CRCW06031K00FKEA
26	1	U4	BLUENRG-MS2A, BLUENRG-2 MODULE QFN, CHIP ANT	BLUENRG-2 module	ST	BLUENRG-M2SA
27	1	L1	1000R, 0603_R, 1 A, 25 %	Ferrite bead	Murata	BLM18KG102SZ1D
28	1	CN1	CR2032 holder	Battery CR2032 holder	Linx	BAT-HLD-001
29	1	LED1	LED_ORANGE, 0805_LED, 1.85 V, 2m A	LED Orange	Kingbright	APTD2012LSYCK
30	1	LED2	LED_BLUE, 0805_LED, 2.65 V, 2m A	LED Blue low Vf	Kingbright	APTD2012LQBC/D
31	1	D1	1N4148, SOD-323, 75 V, 150m A	1N4148WS	Diodes Inc	1N4148WS-7-F
32	1	M1	IML-0688, Plastic lens R10.2 x 8.5 mm	Fresnel lens	Murata	IML-0688

6 Board versions

Table 2. STEVAL-BLUEPIRV1 versions

PCB version	Schematic diagrams	Bill of materials
STEVAL\$BLUEPIRV1A ⁽¹⁾	STEVAL\$BLUEPIRV1A schematic diagrams	STEVAL\$BLUEPIRV1A bill of materials

1. This code identifies the STEVAL-BLUEPIRV1 evaluation board first version. It is printed on the board PCB.

7 Regulatory compliance information

Formal Notice Required by the U.S. Federal Communications Commission

FCC NOTICE

This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine

whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

The evaluation kit has been designed to comply with part 15 of the FCC Technical Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

Standards applied: FCC CFR 47 Part 15 Subpart B (test method applied: ANSI C63.4 v2014), FCC 47 CFR Part 15 Subpart C, §15.209 (test method applied: ANSI C63.10 v2013).

Formal Product Notice Required by Industry Canada Innovation, Science and Economic Development

Canada compliance:

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

This device has been tested with Innovation, Science and Economic Development RSS standards. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Standard applied: ICES-003 Issue 7 (2020), Class B. Test method applied: ANSI C63.4 (2014).

Cet appareil a été testé pour les normes RSS d'Innovation, Science et Développement économique. L'utilisation est soumise aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférences nuisibles, et (2) cet appareil doit accepter de recevoir tous les types d'interférence, y compris les interférences susceptibles d'entraîner un fonctionnement indésirable.

Norme appliquée: NMB-003, 7e édition (2020), Classe B. Méthode d'essai appliquée: ANSI C63.4 (2014).

Formal product notice required by EU

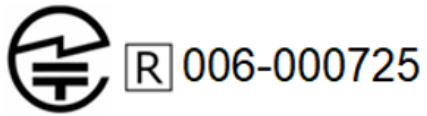
The kit STEVAL-BLUEPIRV1 is in conformity with the essential requirements of the Directive 2014/53/EU (RED) and of the Directive 2015/863/EU (RoHS). Harmonized standards applied are listed in the EU Declaration of Conformity.

Notice for Japan

当該機器には電波法に基づく、技術基準適合証明等を受けた特定無線設備を装着している。

(This equipment contains specified radio equipment that has been certified to the Technical Regulation Conformity Certification under the Radio Law.)

Construction design certification number: 006-000725 (dated May 13th, 1st year of Reiwa)



Model or name of specific radio equipment: BLUENRG-M2SA

Radio type: F1D

Frequency bands:

F1D: 2402 to 2480 MHz (2MHz bandwidth, 40 channels)

RF power:

F1D: 0.0055 W

Antenna: chip antenna with an output power of +8dBm

Revision history

Table 3. Document revision history

Date	Revision	Changes
11-Apr-2022	1	Initial release.

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