



# Peplink BLE Module User Manual

**Peplink Products:**  
BLE module 2 - pcb antenna

June 2020

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## 1. Introduction ( BLE module 2 - pcb antenna )

The BLE module is used nRF51822 ultra-low power 2.4 GHz wireless System on Chip (SoC) integrating the nRF51 series 2.4GHz transceiver, a 32 bit ARM Cortex™-M0 CPU, flash memory, and analog and digital peripherals. nRF51822 can support *Bluetooth* low energy and a range of proprietary 2.4 GHz protocols, such as Gazell from Nordic Semiconductor.

Fully qualified *Bluetooth* low energy stacks for nRF51822 are implemented in the S100 series of SoftDevices.

The S100 series of SoftDevices are available for free and can be downloaded and installed on nRF51822 independent of your own application code.

## 2. Product Features

- 2.4 GHz transceiver
- -93 dBm sensitivity in *Bluetooth* low energy mode
- 250 kbps, 1 Mbps, 2 Mbps supported data rates
- TX Power -20 to +4 dBm in 4 dB steps
- TX Power -30 dBm Whisper mode
- 13 mA peak RX, 10.5 mA peak TX (0 dBm)
- 9.7 mA peak RX, 8 mA peak TX (0 dBm) with DC/DC
- RSSI (1 dB resolution)
- ARM Cortex™-M0 32 bit processor
- 275  $\mu$ A/MHz running from flash memory
- 150  $\mu$ A/MHz running from RAM
- Serial Wire Debug (SWD)
- S100 series SoftDevice ready
- Memory
- 256 kB or 128 kB embedded flash program memory
- 16 kB or 32 kB RAM
- On-air compatibility with nRF24L series
- Flexible Power Management
- Supply voltage range 1.8 V to 3.6 V
- 4.2  $\mu$ s wake-up using 16 MHz RCOSC
- 0.6  $\mu$ A at 3 V OFF mode
- 1.2  $\mu$ A at 3 V in OFF mode + 1 region RAM retention
- 2.6  $\mu$ A at 3 V ON mode, all blocks IDLE

- 8/9/10 bit ADC - 8 configurable channels
- 31 General Purpose I/O Pins
- One 32 bit and two 16 bit timers with counter mode
- SPI Master/Slave
- Low power comparator
- Temperature sensor
- Two-wire Master (I2C compatible)
- UART (CTS/RTS)
- CPU independent Programmable Peripheral Interconnect (PPI)
- Quadrature Decoder (QDEC)
- AES HW encryption
- Real Timer Counter (RTC)
- Package variants
- QFN48 package, 6 x 6 mm
- WLCSP package, 3.50 x 3.83 mm
- WLCSP package, 3.83 x 3.83 mm
- WLCSP package, 3.50 x 3.33 mm

#### Applications

- Computer peripherals and I/O devices
- Mouse
- Keyboard
- Multi-touch trackpad
- Interactive entertainment devices
- Remote control
- Gaming controller
- Beacons
- Personal Area Networks
- Health/fitness sensor and monitor

#### devices

- Medical devices
- Key-fobs + wrist watches
- Remote control toys

Click **Save** and then **Apply Changes**, located at the top right corner, to complete the process.

### 3. Power Specifications.

#### Power supply

The nRF51 supports three different power supply alternatives:

- Internal LDO setup
- DC/DC converter setup
- Low voltage mode setup

See *Table* for the voltage range on the different alternatives.

Symbol	Parameter	Notes	Min.	Typ.	Max.	Units
VDD	Supply voltage, internal LDO setup		1.8	3.0	3.6	V
VDD	Supply voltage, DC/DC converter setup		2.1	3.0	3.6	V
VDD	Supply voltage, low voltage mode setup	1	1.75	1.8	1.95	V
$t_{R\_VDD}$	Supply rise time (0 V to VDD)	2			100	ms
$T_A$	Operating temperature		-25	25	75	°C

1. DEC2 shall be connected to VDD in this mode.

2. The on-chip power-on reset circuitry may not function properly for rise times outside the specified interval.

*Table* Operating conditions

*circuitry*” for details on the schematic used for the different power supply alternatives.

#### Internal LDO setup

In internal LDO mode the DC/DC converter is bypassed (disabled) and the system power is generated directly from the supply voltage VDD. This mode could be used as the only option or in combination with the DC/DC converter setup. See DC/DC converter section for more details.

#### DC/DC converter setup

The nRF51 DC/DC buck converter transforms battery voltage to lower internal voltage with minimal power loss. The converted voltage is then available for the linear regulator input. The DC/DC converter can be disabled when the supply voltage drops to the lower limit of the voltage range so the LDO can be used for low supply voltages. When enabled, the DC/DC converter operation is automatically suspended between radio events when only the low current regulator is needed internally.

This feature is particularly useful for applications using battery technologies with nominal cell voltages

higher than the minimum supply voltage with DC/DC enabled. The reduction in supply voltage level from a high voltage to a low voltage reduces the peak power drain from the battery. Used with a 3 V coin-cell battery, the peak current drawn from the battery is reduced by approximately 25%.

Low voltage mode setup Devices can be used in low voltage mode where a steady 1.8 V supply is available externally.

## Power management

The power management system is highly flexible with functional blocks such as the CPU, Radio Transceiver, and peripherals having separate power state control in addition to the global System ON and OFF modes. In System OFF mode, RAM can be retained and the device state can be changed to System ON through Reset, GPIO DETECT signal, or LPCOMP ANADETECT signal. When in System ON mode, all functional blocks will independently be in IDLE or RUN mode depending on needed functionality.

### **Power management features:**

- Supervisor HW to manage
- Power onreset
- Brownout reset
- Power fail comparator
- System ON/OFF modes
- Pin wake-up from System OFF
- Reset
- GPIO DETECT signal
- LPCOMP ANADETECT signal
- Functional block RUN/IDLE modes
- RAM retention in System OFF mode (8 kB blocks)
- 16 kB version will have 2 blocks
- 32 kB version will have 4 blocks

### System OFF mode

In system OFF mode the chip is in the deepest power saving mode. The system's core functionality is powered down and all ongoing tasks are terminated. The only functionality that can be set up to be responsive is the Pin wake-up mechanism.

One or more blocks of RAM can be retained while in System OFF mode.

### System ON mode

In system ON mode the system is fully operational and the CPU and selected peripherals can be brought into a state where they are functional and more or less responsive depending on the sub-power mode selected.

There are two sub-power modes:

- Low power
- Constant latency

### **Low Power**

In Low Power mode the automatic power management system is optimized to save power. This is done by keeping as much as possible of the system powered down. The cost of this is that you will have varying CPU wakeup latency and PPI task response.

The CPU wakeup latency will be affected by the startup time of the 1V7 regulator. The PPI task response will vary depending on the resources required by the peripheral where the task originated.

The resources that could be involved are:

- 1V7 with the startup time  $t_{1V7}$

- 1V2 with the startup time **t1V2**
- One of the following clock sources
- RC16 with the startup time **tSTART,RC16**
- XO16M/XO32M with the startup time the clock management system **txo**

### Constant Latency

In Constant Latency mode the system is optimized towards keeping the CPU latency and the PPI task response constant and at a minimum. This is secured by forcing a set of base resources on while in sleep mode. The cost is that the system will have higher power consumption.

The following resources are kept active while in sleep mode:

- 1V7 regulator with the standby current of **I1V7**
- 1V2 regulator. Here the current consumption is specified in combination with the clock source
- One of the following clock sources:
  - RC16 with the standby current of **I1V2RC16**
  - XO16M with the standby current of **I1V2XO16**
    - XO32M with the standby current of **I1V2XO32**

## 4. RF Specifications

The BLE module is used nRF51 series 2.4 GHz RF transceiver is designed and optimized to operate in the worldwide ISM frequency band at 2.400 to 2.4835 GHz. Radio modulation modes and configurable packet structure enable interoperability with *Bluetooth*R low energy (BLE), ANT™, Enhanced ShockBurst™, and other 2.4 GHz protocol implementations.

The transceiver receives and transmits data directly to and from system memory for flexible and efficient packet data management.

The nRF51 series transceiver has the following features:

- General modulation features
- GFSK modulation
- Data whitening
- On-air data rates
  - 250 kbps
  - 1 Mbps
  - 2 Mbps
- Transmitter with programmable output power of +4 dBm to -20 dBm, in 4 dB steps
- Transmitter whisper mode -30 dBm
- RSSI function (1 dB resolution)
- Receiver with integrated channel filters achieving maximum sensitivity
  - -96 dBm at 250 kbps
  - -93 dBm at 1 Mbps BLE
  - -90 dBm at 1 Mbps
  - -85 dBm at 2 Mbps
- RF Synthesizer
- 1 MHz frequency programming resolution

- 1 MHz non-overlapping channel spacing at 1 Mbps and 250 kbps
- 2 MHz non-overlapping channel spacing at 2 Mbps
- Works with low-cost  $\pm 60$  ppm 16 MHz crystal oscillators
- Baseband controller
- EasyDMA RX and TX packet transfer directly to and from RAM
- Dynamic payload length
- On-the-fly packet assembly/disassembly and AES CCM payload encryption
  - 8 bit, 16 bit, and 24 bit CRC check (programmable polynomial and initial value)

## Appendix A. Declaration

This module is designed to meet the requirements of the following regulations:

### **Federal Communication Commission**

This device complies with Part 15 of the FCC 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.

47 CFR Part 15, Subpart C 15.247

47 CFR Part 1.1307

47 CFR Part 2.1093

KDB447498D01 General RF Exposure Guidance v06

Caution:

The user is cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### **FCC Radiation Exposure Statement :**

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and your body.



#### FCC other Parts, Part 15B Compliance Requirements for Host product manufacturer

This modular transmitter is only FCC authorized for the specific rule parts listed on our grant, host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

Host manufacturer in any case shall ensure host product which is installed and operating with the module is in compliant with Part 15B requirements.

Please note that For a Class B or Class A digital device or peripheral, the instructions furnished the user manual of the end-user product shall include statement set out in *§15.105 Information to the user* or such similar statement and place it in a prominent location in the text of host product manual. Original texts as following:

For Class B

*Note: 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. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- Reorient or relocate the receiving antenna.*
- Increase the separation between the equipment and receiver.*
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- Consult the dealer or an experienced radio/TV technician for help.*

## **ISED Canada**

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:(1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux Partie 15 des règlements de la FCC et CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

RSS-Gen Issue 5, April 2018

RSS-247 Issue 2, February 2017

RSS-Gen Issue 5, April 2018

RSS-102 Issue 5 March 2015

IC Radiation Exposure Statement

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

Déclaration d'exposition aux radiations:

Cet équipement respecte les limites d'exposition aux rayonnements IC définies pour un environnement non contrôlé. Cet équipement doit être installé et mis en marche à une distance minimale de 20 cm qui sépare l'élément rayonnant de votre corps.

This radio transmitter IC: 20682-P1013 has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna Type	Brand/ manufacturer	Model No.	Max. Antenna Gain
PCB antenna	Brand: PEPXIM; PEPWAVE; peplink Manufacturer: PISMO LABS TECHNOLOGY LIMITED	P013 antenna	5dBi

**Antenna Change Notice to Host manufacturer**

If you desire to increase antenna gain and either change antenna type or use same antenna type certified, a Class II permissive change application is required to be filed by us, or you (host manufacturer) can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

Le présent émetteur radio IC: 20682-P1013 a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

**OEM Integration Instructions :**

This device is intended only for OEM integrators under the following conditions :

The module can be used to installation in other host. the transmitter module may not be collocated with any other transmit or antenna.

The module shall be only used with the integral antenna(s) that has been originally tested and certified with this module.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirement with this module installed (for example, digital device emission, PC peripheral requirements, etc.)

**RF Exposure Warning!**

This device contains transmitters and receivers which emit Radio Frequency (RF) energy. The device is designed to comply with the limits for exposure to RF energy set by the Federal Communications Commission (FCC) of the United States, Industry Canada (IC) of Canada, and the regulating entities of other countries.

**FCC:** The final end product must be labeled in a visible area with the following: "Contains FCC ID: U8G-P1013".The equipment complies with FCC RF exposure limits set forth for an uncontrolled environment. The equipment must not be co-located or operating in conjunction with any other antenna or transmitter.

**IC:** The final end product must be labeled in a visible area with the following: "Contains IC ID: 20682-P1013".The equipment complies with FCC RF exposure limits set forth for an uncontrolled environment. The equipment must not be co-located or operating in conjunction with any other antenna or transmitter.