

***Bluetooth*[®] low energy Module**

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1. General

Q1-1: How can I order the modules, evaluation boards (EVB) and evaluation kits (EVK)?

A1-1: To order, please contact your local sales office or distributor.

TAIYO YUDEN Sales Office and distributors:

Japan: <https://www.yuden.co.jp/jp/contact/>

North America: <https://www.yuden.co.jp/ut/contact/>

Europe: <https://www.yuden.co.jp/eu/contact/>

Asia Pacific: <https://www.yuden.co.jp/ap/contact/>

China: <https://www.yuden.co.jp/cs/contact/>

Korea: <https://www.yuden.co.jp/kr/contact/>

Other region: <https://www.yuden.co.jp/or/contact/>

Distributors:

Japan: <https://www.yuden.co.jp/jp/solutions/ble/buy/>

North America: <https://www.yuden.co.jp/ut/solutions/ble/buy/>

Europe: <https://www.yuden.co.jp/eu/solutions/ble/buy/>

Asia Pacific: <https://www.yuden.co.jp/ap/solutions/ble/buy/>

China: <https://www.yuden.co.jp/cs/solutions/ble/buy/>

Korea: <https://www.yuden.co.jp/kr/solutions/ble/buy/>

Other region: <https://www.yuden.co.jp/or/solutions/ble/buy/>

Q1-2: What is Bluetooth® low energy (BLE)?

A1-2: It is a wireless personal area network technology featuring low power consumption. It was standardized in the Bluetooth® Core Specification Version 4.0 in 2010. Bluetooth® low energy uses the same 2.4GHz frequency as classic Bluetooth®, but is not compatible with the classic Bluetooth®. The major advantages of Bluetooth® low energy are low power consumption, operating for months or years with a coin cell battery, small size and compatibility with large numbers of smart phones, tablets and computers. The applications include IoT devices, healthcare, fitness, beacons, security and smart home. Bluetooth® SIG released Bluetooth® Core Specification Version 4.1 in 2013 and 4.2 in 2014. The data rate in Bluetooth v4.x is 1Mbps. Bluetooth® SIG also released Bluetooth v5 in 2016 and Bluetooth v5.1 in January 2019. Please see the next item for additional details on Bluetooth v5.x.

Q1-3: What is the difference between Bluetooth® v4.2 and v5.x?

A1-3: Bluetooth® SIG released Bluetooth v5 on December 2016 and Bluetooth v5.1 on January 2019. Bluetooth v5.x gives us several key features: capabilities of 2x the speed, 4x the range and 8x the broadcast capacity of v4.2. Longer range is achieved by increasing receiver sensitivity through error correction coding, which reduces the data rate; therefore 4x the range

and 2x the speed cannot be realized at the same time. When a Bluetooth device communicates with another device using any of the three features of Bluetooth v5.x, another device also has to support the features. If any of devices communicating together support only v4.x, the communication will conform to v4.x. The application should select the Bluetooth v5.x feature implementation that will best meet the required performance. These key Bluetooth v5.x features are not mandatory. A product can claim to be Bluetooth v5.x qualified even if it does not support any of these key features; so it's important to make sure you check with your supplier which features are supported. TAIYO YUDEN's Bluetooth v5.x modules support at least some of these key Bluetooth v5.x functions.

See also Table 1 below for the differences between Bluetooth v4.x and v5.x. To learn more about the key Bluetooth v5.x features, please refer to this TAIYO YUDEN article:

<https://www.allaboutcircuits.com/industry-articles/get-up-to-speed-on-bluetooth-5>

Q1-4: What is the difference between Classic Bluetooth® and Bluetooth® low energy?

A1-4: Compared to Classic Bluetooth®, Bluetooth® low energy has lower data rate, however is intended to provide lower power consumption. There is no compatibility between Bluetooth® low energy and Classic Bluetooth® and they have different use case scenarios. Major applications of Classic Bluetooth® are PC peripherals, mobile phone peripherals and digital consumer electronics and it is used for point-to-point communication such as key boards, mice and headsets. On the other hand, Bluetooth® low energy is better suited for small data transmission such as data communication with sensors. The application is expanding to healthcare devices, sports equipment, home electric appliances, IoT devices, etc. See Table 1 for technical items.

Table1 Comparison table

| Items | Classic Bluetooth technology | Bluetooth® Core Specification Version 4.x | Bluetooth® Core Specification Version 5.x |
|------------------------|------------------------------|---|---|
| Spectrum range | 2.400–2.4835 GHz | 2.400–2.4835 GHz | 2.400–2.4835 GHz |
| Channels | 79 ch, BW 1MHz/ch | 40 ch, BW 2MHz/ch | 40 ch, BW 2MHz/ch |
| Modulation | GFSK, $\pi/4$ DQPSK, 8DPSK | GFSK | GFSK |
| Over the air data rate | 1–3Mbps | 1Mbps | 2Mbps, 1Mbps, 500kbps, 125kbps ** |
| Active Slaves | 7 | Not defined. Depends on implementation. | Not defined. Depends on implementation. |
| Voice capability | Yes | Yes for limited applications * | Yes for limited applications * |

* The voice bandwidth usable in the application might be restricted by the over the air data rate of V4.x. Voice application needs to be developed by customer with their own profile.

** Support of 2Mbps, 500kbps and 125kbps is not mandatory.

2. Module

Q2-1: What is the difference of TAIYO YUDEN BLE modules? What types of BLE modules are available from TAIYO YUDEN.

A2-1: TAIYO YUDEN has wide range of line-up to satisfy customer's use case. There are two main types of BLE modules that are based on Nordic Semiconductor's chipset: the nRF51 series and the nRF52 series modules. These modules offer 2 software options: Basic and Software Embedded.

A Basic module has the SoftDevice (i.e. protocol stack) and the bootloader, depending on the model of modules, preprogrammed into the device and you have to develop your application software to operate BLE function. Therefore your application can be hosted right on the module eliminating the need for an external host processor. These Basic modules are available with various RAM and Flash sizes.

A Software Embedded module has TAIYO YUDEN's application preprogrammed into the module. If you are looking a simple "serial cable replacement", this module would be an excellent option. This module comes with a simple ASCII-based Application Programming Interface (API) to help you get your project up and running quickly. However, since our application is preprogrammed into the module, your application will have to be hosted on a separate host processor.

For additional details, visit:

<http://www.yuden.co.jp/or/product/category/module/lineup.html#Bluetooth>

Q2-2: What are the part numbers of the TAIYO YUDEN BLE modules?

A2-2: For a complete list of part numbers visit:

<http://www.yuden.co.jp/or/product/category/module/lineup.html#Bluetooth>

Q2-3: Is an external system clock necessary?

A2-3: No, each BLE module has an internal 32MHz crystal. Please note, Nordic's nRF51 DK (evaluation board) and nRF51 sample applications included in SDK are designed to run on a 16MHz clock. Since TAIYO YUDEN modules run on a 32MHz clock, Nordic's nRF51 sample applications will need some modification in order for it to work on TAIYO YUDEN modules. Please see a page "Notes" in Data Report for modification details.

Q2-4: What is the supported interface?

A2-4: All of the Basic modules have configurable GPIOs and the number of supported GPIO depends on the module. Some of the GPIO pins can be configured as UART, SPI, I2C, I2S, PDM or ADC by the application software. Please see Nordic's Website and the documents for details.

<https://www.nordicsemi.com/DocLib>

Q2-5: What is pre-programmed in the module?

A2-5: In each Basic type module, Nordic's SoftDevice and Bootloader, depending on the module, are preprogrammed into the module. The version of SoftDevice depends on the module. See Table 2 for the details. Please also see BLE module Overview document or the Data Report when you determine the SoftDevice version. For additional information on the different versions of SoftDevice please see Nordic's website.

<https://www.nordicsemi.com/DocLib>

Software Embedded type modules are preprogrammed with TAIYO YUDEN's application software.

Q2-6: What type of processor is inside the module?

A2-6: Though every module has ARM® Cortex® processor, the type depends on the modules and you can select the best match for your application from our line-up. See Table 2 for details.

Q2-7: What memory size does the module have?

A2-7: It depends on the modules and you can select the best match for your application from our

line-up. See Table 2 for details.

Table 2 Module Comparison

| Module Series | Nordic IC | SoftDevice | Bootloader | Processor | FLASH [Byte] | RAM [Byte] |
|---------------|-----------|-------------|------------|------------|--------------|------------|
| EYSG*NZXX | nRF51822 | S110 V8.0.0 | Y | Cortex M0 | 256k | 16k |
| EYSG*NZWY | nRF51822 | S120 V2.1.0 | Y | Cortex M0 | 256k | 32k |
| EYAGJNZXX | nRF51422 | S310 V3.0.0 | Y | Cortex M0 | 256k | 32k |
| EYSH*NZWZ | nRF52832 | S132 V5.0.0 | Y | Cortex M4F | 512k | 64k |
| EYSL*NZWW | nRF52810 | S112 V5.1.0 | N | Cortex M4 | 192k | 24k |
| EYSK*NZWB | nRF52840 | S140 V6.1.0 | Y | Cortex M4F | 1M | 256k |

Q2-8: What is the expected battery life of the BLE module?

A2-8: The power consumption completely depends on the use case and the operational conditions. In scenarios where battery consumption is kept to an absolute minimum, it should be possible to achieve a year or more of battery life with a coin cell battery.

Power Profiler Kit which is released by Nordic for measurement of BLE power consumption can be used with TAIYO YUDEN's BLE module evaluation board. Please visit Nordic's Website below for the details.

<https://www.nordicsemi.com/Software-and-Tools/Development-Kits/Power-Profiler-Kit>

Also, nRF52 Online Power Profiler provided by Nordic can be used for estimation of power consumption of nRF52 series.

<https://devzone.nordicsemi.com/b/blog/posts/nrf52-online-power-profiler>

<https://devzone.nordicsemi.com/power/>

Q2-9: What is the output power and communication distance of the module?

A2-9: In the case of the modules with nRF51 series, nRF52832 or nRF52810, Tx power is -20 to +4dBm in 4dB steps. It enables the adequate communication distance for any applications used in a room or an office.

In the case of the modules with nRF52840, Tx power is -20 to +8dBm in 4dB steps. Due to the increase of receiver sensitivity achieved by error correction coding which is one of the features of Bluetooth v5.x, 4x the communication range of v4.x can be expected.

Please be aware that the actual distance varies depending on the communication environment where the module is used.

Q2-10: Is an external 32.768kHz crystal required?

A2-10: The EYS*CN series modules come with an internal 32.768kHz crystal; therefore external 32.768kHz clock is not required. For the EYS*SN series, EYS*JN series and EYAGJNZXX, you have the option of adding an external 32.768kHz crystal or using the nRF5's built-in internal 32.768kHz RC oscillator. Generating a clock from a 32.768kHz crystal will keep the current consumption lower than using the internal RC oscillator. Using the internal RC oscillator requires the processor to periodically wake up and perform calibration (i.e. current goes up slightly). The method to enable the RC oscillator is described in a paragraph "Important notes" in Evaluation Board/Kit Manual.

Q2-11: Do the modules have Bluetooth® Qualification?

A2-11: The modules are Bluetooth® qualified as Component. The modules are Bluetooth® qualified at the PHY layer only. The QDID is provided in the Data Report. Your end products have to be Bluetooth® qualified, when our module is installed into your products. Please consult a qualification test facility or BQC (Bluetooth Qualification Consultant) to determine Bluetooth® qualification requirements for your end product. Bluetooth® qualification was done using the preprogrammed version of SoftDevice in the module with TAIYO YUDEN's shipment. Please see Q2-5 for the preprogrammed SoftDevice for each module. The customer can replace the preprogrammed SoftDevice with any version of SoftDevice (i.e. it can be a newer or older SoftDevice as long as it is a valid Nordic SoftDevice for the chip). Replacing the SoftDevice will not invalidate the Bluetooth® qualification; so if the customer decides to upgrade to a newer SoftDevice, PHY layer Bluetooth® requalification is not necessary.

The modules of EYSG*NZXX and EYSG*NZXY which use nRF51 series have respectively SoftDevice S110 and S120 preprogrammed and qualified for Bluetooth v4.1. When you need to get Bluetooth v4.2 certification on your products with these modules, SoftDevice have to be replaced to S130.

Q2-12: What regulatory certification do the modules have?

A2-12: The modules are Japan, FCC and ISED (Canada) certified. The radio certification was done using the preprogrammed version of SoftDevice in the module with TAIYO YUDEN's shipment. The customer can replace the preprogrammed SoftDevice with any version of SoftDevice (i.e. it can be a newer or older SoftDevice as long as it is a valid Nordic SoftDevice for the chip). Replacing the SoftDevice will not invalidate radio certification; so if the customer decides to upgrade to a newer SoftDevice, radio recertification is not necessary.

Conducted test report for Europe RE Directive EN 300 328 Ver2.1.1 is available. Customers should test all of Radio, Safety and Electromagnetic Compatibility except Conducted test and need to comply with RE Directive at the end product level not the module level.

Q2-13: How should we design the schematic and layout the board and the surrounding area of antenna to maximize antenna performance?

A2-13: For schematic design, please refer to the "Reference Circuit" in the Data Report and the "Evaluation board circuit schematic" in the Evaluation Board/Kit Manual. For board layout details, please refer to the "Design guide" of the Data Report. For the antenna area design, please refer to the "Antenna application note" section of the Data Report.

Q2-14: What support does TAIYO YUDEN provide for BLE modules?

A2-14: Hardware support is provided by TAIYO YUDEN. Software support is handled by Nordic on the Basic modules. Software support is handled by TAIYO YUDEN on the Software Embedded modules.

3. EVB/EVK

Q3-1: What are the part numbers of the evaluation boards and evaluation kits?

A3-1: Please see TAIYO YUDEN Website below or see BLE module Overview document.

<http://www.yuden.co.jp/or/product/category/module/lineup.html#Bluetooth>

Q3-2: What is contained in the evaluation boards and the evaluation kits?

A3-2: Evaluation board contains a circuit board (evaluation board) with a module mounted, and a document with instructions on how to download technical documents (e.g. Data Report, Evaluation manual and Quick Start Guide). Quick Start Guide is a document to understand quickly how to develop software and describes about software development environment, SDK, necessary software and basic procedure.

Evaluation kit contains an evaluation board, a document with instructions on how to download technical documents (e.g. Data Report, Evaluation manual and Quick Start Guide), and a J-Link Lite board. J-Link Lite is a JTAG/SWD (Serial Wire Debug) debug probe for Cortex-M cores used in TAIYO YUDEN's BLE modules. It is used for software development and debugging. Please see Evaluation Board/Kit Manual for details on how to use J-Link Lite.

Q3-3: What can be done with evaluation board and evaluation kit?

A3-3: The evaluation board and evaluation kit can be used to perform functional and performance testing (e.g. communication and current consumption testing). For Basic modules, J-Link Lite is necessary to program test application software on the module.

4. Software**Q4-1: What BLE profiles are available for the modules?**

A4-1: Please see table 1 in the document below for the profiles supported by nRF51 SoftDevice S110.

https://www.nordicsemi.com/-/media/DocLib/Other/SoftDevice_Spec/S110SDSv20.pdf?la=en

Please see table 1 in the document below for the profiles supported by nRF51 SoftDevice S120.

https://www.nordicsemi.com/-/media/DocLib/Other/SoftDevice_Spec/S120SDSv21.pdf?la=en

Please see table 15 in the document below for the profiles supported by nRF51 SoftDevice S130.

https://www.nordicsemi.com/-/media/DocLib/Other/SoftDevice_Spec/S130SDSv20.pdf?la=en

Please see table 1 in the document below for the profiles supported by nRF51 SoftDevice S310.

https://www.nordicsemi.com/-/media/DocLib/Other/SoftDevice_Spec/S310SDSv30.pdf?la=en

Please see the Website below for the profiles supported by nRF52 SoftDevice S132.

https://www.nordicsemi.com/DocLib/Content/SoftDevice_Spec/s132/latest/SDS/s1xx/ble_protocol_stack/profile_service_support

Please see the Website below for the profiles supported by nRF52 SoftDevice S112.

https://www.nordicsemi.com/DocLib/Content/SoftDevice_Spec/s112/latest/SDS/s1xx/ble_protocol_stack/profile_service_support

Please see the Website below for the profiles supported by nRF52 SoftDevice S140.

https://www.nordicsemi.com/DocLib/Content/SoftDevice_Spec/s140/latest/SDS/s1xx/ble_protocol_stack/profile_service_support

Please check Nordic's website for additional details on supported profiles.

<https://www.nordicsemi.com/DocLib>

Q4-2: What tools are available for software development and debugging?

A4-2: The software development environment (IDE: Integrated Development Environment) for ARM processors (MDK: Microcontroller Development Kit) is necessary. TAIYO YUDEN's BLE modules are supported by four IDEs, Seggar Embedded Studio, Keil MDK, IAR Embedded Workbench and GCC and IAR, shown in Nordic Website below.

<https://www.nordicsemi.com/Software-and-Tools/Development-Tools/IDEs-and-Toolchains>

Q4-3: How can I get SDK (Software Development Kit) for application development?

A4-3: Please visit the Nordic's website below to download the SDK.

<https://www.nordicsemi.com/Software-and-Tools/Software>

Q4-4: What resources are available other than SDK?

A4-4: A lot of resources, contents and documents are available on Nordic's Website including nRF51/52 SoftDevice, nRFgo Studio, nRF Connect, etc. Please visit Nordic's Website.

<https://www.nordicsemi.com/Software-and-Tools>

Please make sure to check Errata released by Nordic when you develop application software.

Q4-5: How do I get detailed software information and support?

A4-5: A wealth knowledge and information on RF51/52 application development are available on the following Nordic's websites:

<https://www.nordicsemi.com/Software-and-Tools>

<https://github.com/NordicSemiconductor>

<https://devzone.nordicsemi.com/>

<https://www.nordicsemi.com/Support>

TAIYO YUDEN Tutorials and Sample Code are also available in the links below:

TAIYO YUDEN YouTube channel:

<https://www.youtube.com/channel/UCVHK64avLBpCNtzEI74xbQ>

TAIYO YUDEN GitHub Page: <https://github.com/TaiyoYudenUSA>

Q4-6: How do I get started with the software development?

A4-6: A Quick Start Guide document which describes the software development environment, SDK, necessary software and the basic instructions will be provided for the customers who purchased the evaluation board. Please also see A3-2 about Quick Start Guide.

Q4-7: How do I receive the latest information of BLE chip or software and Errata form Nordic?

A4-6: Please visit Nordic's website below and register entering necessary information and click "Sign up now!" button.

<https://www.nordicsemi.com/Support#>

Please make sure to check Errata released by Nordic when you develop application software. Since Errata information is not be always distributed, please voluntarily check the latest information on Nordic's website.