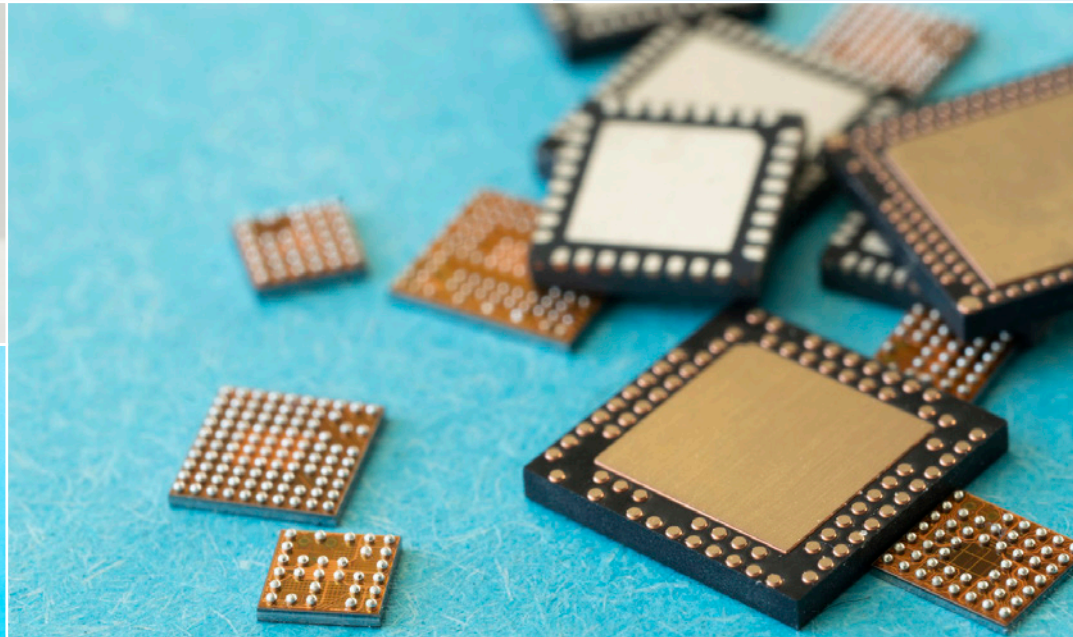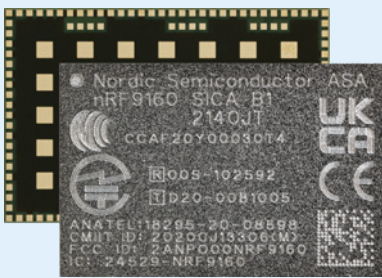# The World of Nordic Semiconductor

Future of Wireless Technology

V2.0

NORDIC
SEMICONDUCTOR

Content

Our Product Portfolio

Semiconductors

Passive Components

Electromechanical Components

Displays & Monitors

Boards & Systems

Storage Technologies

Wireless Technologies

Our Initiatives

RUTRONIK AUTOMOTIVE **RUTRONIK EMBEDDED** **RUTRONIK POWER** **RUTRONIK SMART**

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The integrated management system (IMS) encompasses quality control, information security, environmental protection, occupational health and safety.

Who is Nordic and why Rutronik

NORDIC SEMICONDUCTOR

Nordic Semiconductor
Nordic Semiconductor is a Norwegian fabless semiconductor company specializing in wireless communication technology that powers the Internet of Things. Nordic was established in 1983 and has more than 1,200 employees across the globe. Our award-winning Bluetooth® Low Energy solutions pioneered ultra-low power wireless, making us the global market leader. Our technology range was later supplemented by ANT+, Thread and Zigbee, and in 2018 we launched our low power, compact LTE-M/NB-IoT cellular IoT solutions to extend the penetration of the IoT. The Nordic portfolio was further complemented by PMIC technology in 2021 and will soon expand to include Wi-Fi 6.

We built our market reputation by supplying leading-edge wireless technologies supported by development tools that shield the designer from RF complexity, allowing anyone with a bright idea to build innovations based on the IoT platform. Today, our award-winning, high-performance, yet easy to design-in, Bluetooth® LE solutions are used by the world's leading brands in a variety of products, including wireless PC peripherals, gaming, sports & fitness, mobile phone accessories, consumer electronics, toys, healthcare and automation. Nordic is a member of the ANT+ Alliance, Bluetooth® SIG, Thread Group, CSA, Wi-Fi Alliance, and GSMA.

Rutronik
Founded in 1973 by Helmut Rudel in Ispringen (Germany) the company has developed from a "one-man-company" into one of the worldwide leading broadline distributors, engaging more than 1,800 employees. In the electronic components market, Rutronik currently ranks 11th worldwide and is the third largest European distributor. The product range includes semiconductors, passive and electromechanical components as well as embedded boards, storage technologies, displays and wireless products. The markets that the company primarily targets include automotive, medical, industrial, home appliance, energy and lighting. Rutronik operates as an independent, owner-managed company from its German headquarter. Guided by the company philosophy of "committed to excellence", Rutronik has more than 40 successful years of corporate history to look back upon with growth that is always beyond that of the market. The contract distributor has a dense pan-European network of sales offices and is represented through its own branches in all European countries, so as to guarantee an all-encompassing customer support.

The subsidiary Rutronik Inc. serves the North American market while the Asian subsidiaries with seven offices in China, Hong Kong, Taiwan and Thailand support the customers in Asia. Consulting in technical, commercial and logistical matters as well as service and technical support are available with a consistent level of quality to customers in all the countries.

The ranges **RUTRONIK EMBEDDED**, **RUTRONIK SMART**, **RUTRONIK POWER** & **RUTRONIK AUTOMOTIVE** provide customers with specific products and services in groups tailored to the respective applications. Expert technical support for product development and design-in, individual logistics and supply chain management solutions as well as comprehensive services complete its scope of performance.

RUTRONIK
ELECTRONICS WORLDWIDE

LTE

an acronym for Long-Term Evolution, commonly marketed as 4G LTE, is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements. LTE is the natural upgrade path for carriers with both GSM/ UMTS networks and CDMA2000 networks. LTE is, therefore, anticipated to become the first truly global mobile phone standard, although the different LTE frequencies and bands used in different countries will mean, that only multi-band phones will be able to use LTE in all countries where it is supported.

LTE-M (also known as eMTC or Cat-M1)

is designed for low power applications requiring higher throughput than NB-IOT. It has a narrower bandwidth of 1.4 MHz compared to 20 MHz for regular LTE, giving it longer range, but less throughput. The throughput is 375 kbps downlink and 300 kbps uplink, providing approximately 100 kbps application throughput running IP. It is suitable for TCP/TLS end-to-end secure connections. Mobility is fully supported, using the same cell handover features as in regular LTE. It is currently possible to roam with LTE-M, meaning it is suitable for applications that will operate across multiple networks. The latency is in the millisecond range offering real time communication for time-critical applications. LTE-M is perfect for throughput applications requiring low power, low latency and/or mobility, like asset tracking, wearables, medical, POS and home security applications.

NB-IoT (also known as Cat-NB1)

is a narrowband technology standard that is designed to operate in or around LTE bands and coexist with other LTE devices. It has a small bandwidth of 180 kHz, giving it lower throughput compared to LTE-M and LTE. (60 kbps downlink & 30 kbps uplink). It is suitable for static, low power applications requiring low throughput. However, the bandwidth of 180 kHz equals the width of a GSM channel and is small enough to fit into the Guard-Bands between LTE bands. Therefore it is possible to run NB-IoT in unused GSM channels or inside the aforementioned LTE Guard-Bands. Thus, NB-IoT uses the carrier frequencies of the traditional LTE but avoids interfering with it at the same time. When used with the lower LTE frequencies of 800 MHz and 900 MHz range, the signal quality improves even more. NB-IoT has a higher range than LTE-M because of two main reasons: the smaller bandwidth makes it easier for the receive filter to filter out noise, thereby improving RX sensitivity. Since there are less channels on NB-IOT compared with LTE-M, it improves RX sensitivity. This is why NB-IoT is perfect for applications requiring higher penetration like think cellars or parking garages and lower throughput.

GNSS

is the Global Navigation Satellite System for positioning. This term refers to a constellation of satellites sending positioning and timing data to GNSS receivers. Those receivers then use this data to determine their location. The most common GNSS system is the Global Positioning System (GPS). Three transmission paths are used in GPS. S-band frequencies (1783.74 MHz uplink, 2227.5 MHz downlink) are used for communication with the ground stations. Inter-satellite communication takes place in the UHF range. The third transmission path is the user link from satellite to GPS receiver. Each of the GPS satellites transmits at least two carrier signals. L1 and L2. On the L1 frequency (1575.42 MHz) the C / A – code for civil usage is sent. Orthogonal to it, the P / Y – code for military usage is sent, as well. The transmitted data signal represents a 1500-bit navigation message. The L2 frequency (1227.60 MHz) transmits only the military P / Y - code. Optionally, on this L2-Band, the C / A – code can be sent, too. By sending the C / A -code on two frequency bands, time delays caused by ionospheric effects can be compensated mathematically. This way, the accuracy of the positioning can be increased. Because the reception power of the GPS signals must not fall below the value of -158.5 dBm (for military signals -161.5 dBm), a transmission power of more than 20 W per frequency band is required.
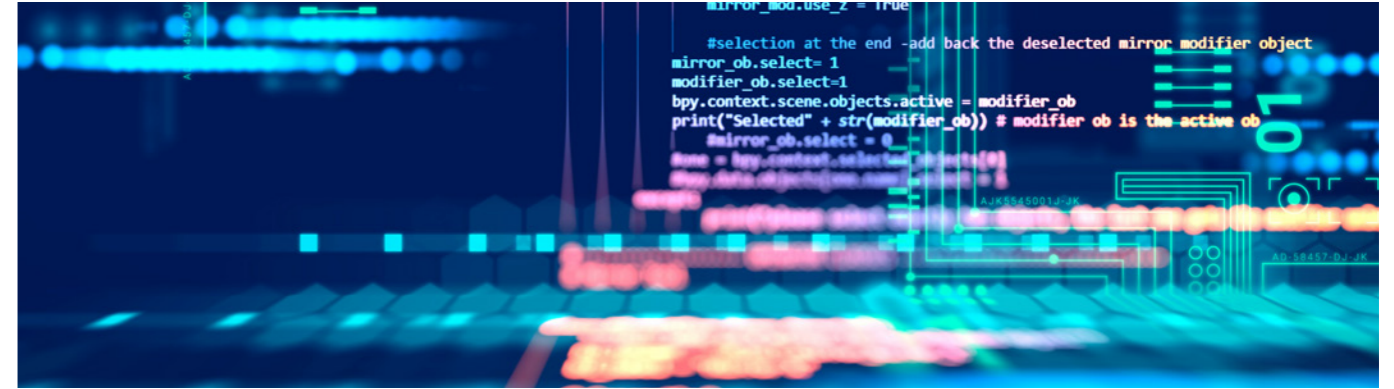
CryptoCell

Crypto Cell is a security subsystem which provides root of trust (RoT) and cryptographic services for a device. The state is controlled via a register interface. The cryptographic functions are accessible by using a software library provided in the device SDK, not directly via a register interface. The subsystem has an internal always-on (AO) power domain for retaining device secrets when CryptoCell is disabled. The CryptoCell subsystem can be instructed to operate on different cryptographic keys. CryptoCell is a feature of Nordic Semiconductors's nRF9160 System-in-Package (SiP), nRF5340 and nRF52840 System-on-Chips (SoCs).

Trust Zone

Arm TrustZone technology offers an efficient, system-wide approach to security with hardware-enforced isolation built into the CPU. TrustZone is a suite of security extension IPs for creating Trusted Execution Environments (TEE). It provides the perfect starting point for establishing a device root of trust based on Platform Security Architecture (PSA) guidelines. First available for devices using Cortex-A series cores, it has become available in an optimized form for the new Cortex-M series based on the ARMv8 architecture. TrustZone technology for Cortex-M cores is a feature of Nordic Semiconductor's nRF9160 SiP and nRF5340 and nRF52840 (SoCs).

LTE-M & NB-IoT

NB-IoT

LTE-M

nRF91 Series

Product Summary
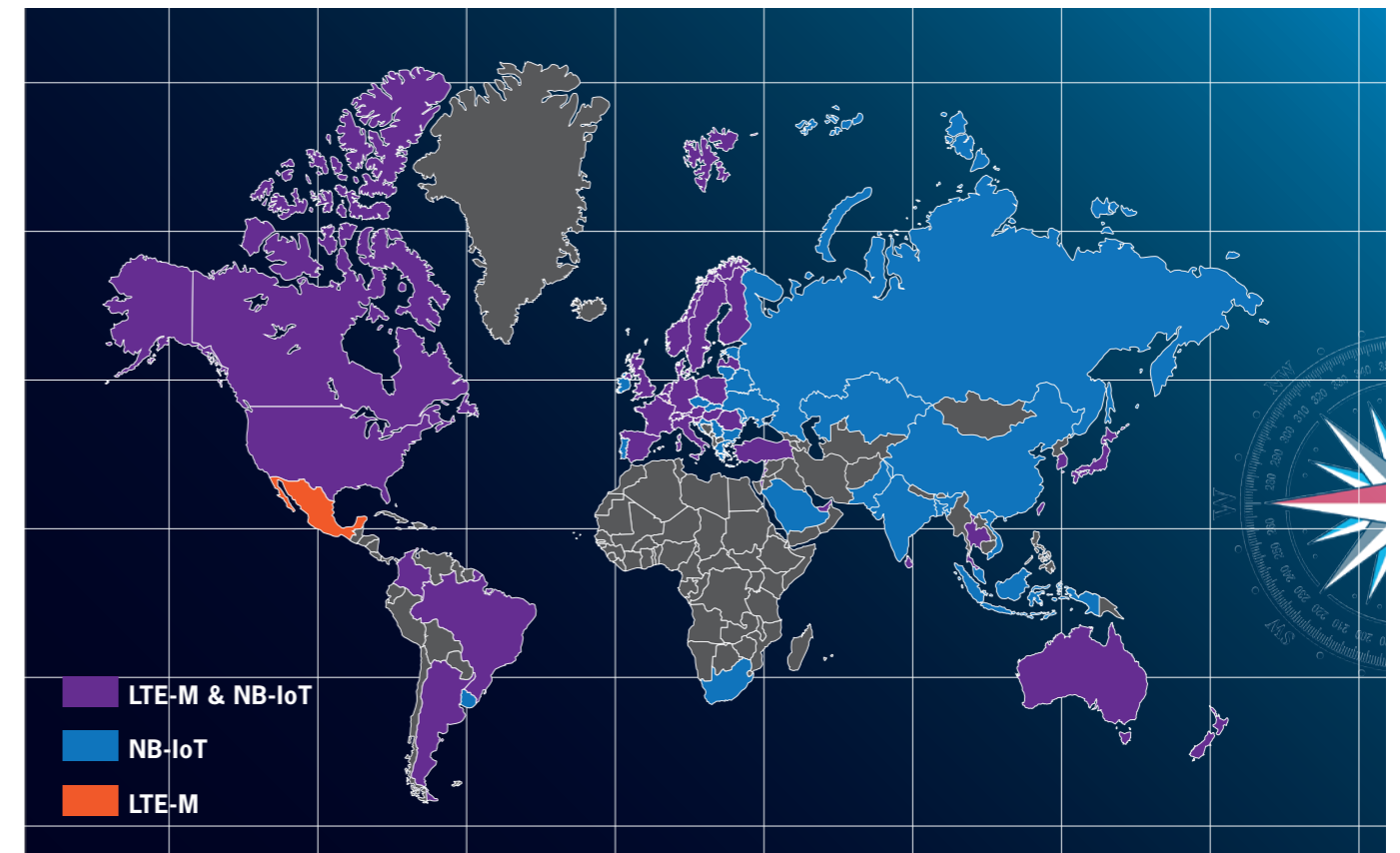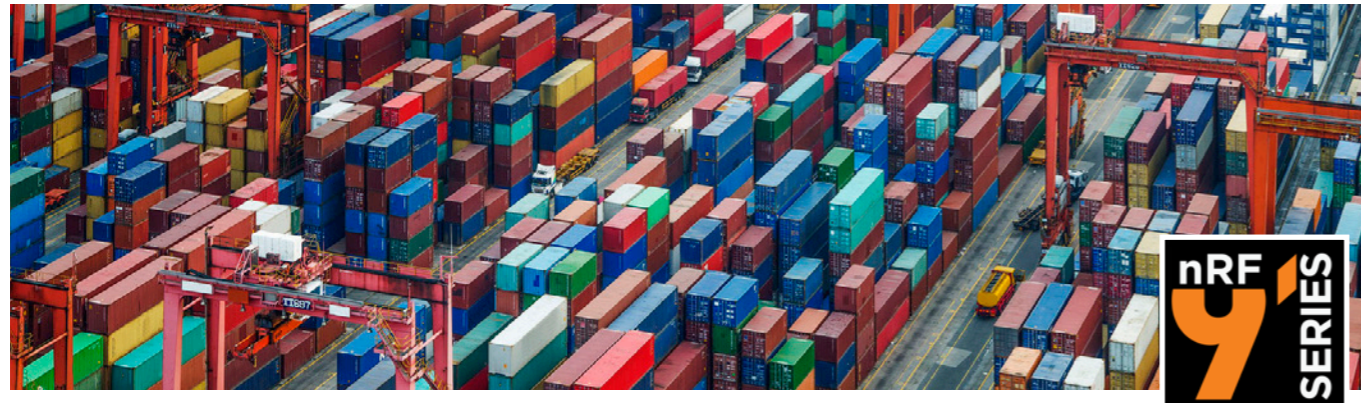
Feature	nRF9160-SIAA	nRF9160-SIBA	nRF9160-SICA
Wireless Protocol	LTE-M only product	NB-IoT only product	LTE-M/NB-IoT/GPS product
Type		System in Package	
CPU		64 MHz Arm Cortex-M33	
FPU		x	
DSP Instruction Set		x	
Cache		x	
Memory		1 MB Flash, 256kB RAM	
Clocks		64MHz / 32kHz	
Arm Trustzone		x	
Arm CryptoCell		310	
Root-of-trust		x	
Secure key storage		x	
AES encryption		x	
LTE-M/NB-IOT/GPS Modem		x	
Certified LTE Bands		1-5, 8, 12-14, 17-20, 25-26, 28, 66	
Frequencies		700-2200 MHz	
Maximum TX Power		23 dBm	
RX Sensitivity		-108 dBm (LTE-M), -114 dBm (NB-IoT), -155 dBm (GPS)	
Antenna interface		50 Ω single-ended	
TWI, SPI, UART		4xTWI/SPI/UART	
PWM		4	
PDM		x	
I2S		x	
ADC, Comparator		ADC	
Timer, RTC		3, 2	
Temperature Sensor		x	
Applications		Agriculture, Asset Tracking, Industrial Systems, Smart Buildings, Smart City, Smart Home, Smart Metering, Sports & Fitness, Wearables	
Certifications		nordicsemi.com/9160cert	
Operating Temperature		-40 to 85 °C	
Supply Voltage Range		3.0 V to 5.5 V	
Development Kits		nRF9160 DK, Thingy:91	
Packages		10x16x1.04mm LGA	

nRF91 Series

nRF9160

nRF9160 - Ultra low power SiP with integrated LTE-M, NB-IoT and GNSS

The nRF9160 SiP is making the latest LTE technology accessible for a wide range of applications and developers. Through the high integration and pre-certification for global operation, it solves the complex wireless design challenges as well as the comprehensive set of qualifications needed to utilize cellular technology. By integrating an application processor, multimode LTE-M/NB-IoT/GNSS modem, RF front end (RFFE), and power management in a 10x16x1 mm package, it offers the most compact solution for cellular IoT on the market. Targeting asset traacking, smart city, smart agriculture, predictive maintenance, industrial, wearables and medical applications, the nRF9160 SiP has built-in GNSS (GPS and QZSS) and support for nRF Cloud Location Services. These services provide built in GNSS and LTE location support with assisted GPS, predicted GPS, single-cell and multi-cell location services.

Key Features

- Fully integrated SiP for cellular IoT
- Dedicated application processor and memory
- Multimode LTE-M/NB-IoT modem with integrated RFFE
- GNSS (GPS and QZSS)
- Single variant certified for global operation:
  - AT&T, Bell, China Telecom, Deutsche Telekom, KDDI, Telstra, Verizon, Vodafone, etc.
  - GCF, PTCRB
  - FCC (USA), CE (EUR), ISED (CAN), ACMA RCM (AUS), NCC (TWN), IMDA (SGP), MIC (JPN), MSIP (KOR)
- 2.7 uA floor current in power saving mode (23 dBm TX output power, 3.7 V supply)
- 10x16x1 mm LGA package

Applications

- Agriculture
- Asset Tracking
- Industrial Systems
- Smart Buildings
- Smart City
- Smart Home
- Smart Metering
- Sports & Fitness
- Wearables

Related Development Tools
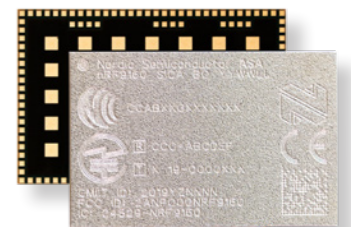
Nordic Thingy:91

The Thingy:91 is a battery-operated prototyping platform for cellular IoT, certified for global operation. It integrates the nRF9160 SiP® supporting LTE-M, NB-IoT and GNSS, and an nRF52840 board controller, supporting Bluetooth® Low Energy and NFC. Source code for firmware, hardware layout and schematics are all available for free. It is the ideal platform for rapidly developing a prototype for any cellular IoT concept, and is especially suited for any flavour of asset tracking application. An exhaustive set of sensors is included to gather data about the environment, and the movement of the Nordic Thingy:91. Temperature, humidity, air quality, air pressure, colour and light data can easily be extracted for local or remote analysis. For input, the Thingy:91 offers a user-programmable button. Visual output is achieved with user-programmable RGB LEDs, while a buzzer can provide audible output. It has one LTE-M, NB-IoT and GNSS antenna connected to the nRF9160, supporting a global range of LTE bands. It has two antennas connected to the nRF52840, a 2.4 GHz antenna for Bluetooth® LE and an NFC antenna. The Thingy:91 has a Nano/4FF SIM card slot, supporting (e)SIM. It is bundled with an eSIM card from iBasis, preloaded with 10 MB, to get connected to the cloud out of the box. A 1440 mAh rechargeable Li-Po battery is also part of the package, giving a smooth transition into prototype field-testing. LTE bands B1-B5, B8, B12-B14, B17-B20, B25-B26, B28 and B66 are enabled out of the box.

Key Features

- Battery-operated prototyping platform for the nRF9160 SiP
- 700-2200 MHz LTE band support
- Certifications: FCC (USA), CE (EUR)
- nRF52840 board controller
- LTE-M/NB-IoT/GPS, Bluetooth® LE and NFC antennas
- Nano/4FF SIM card slot
- User-programmable button and RGB LEDs
- Environmental sensors for temperature, humidity, air quality and air pressure, plus a colour and light sensor
- Low-power accelerometer and high-g accelerometer
- Buzzer
- 4 x N-MOS transistors for external DC motors or LEDs
- Rechargeable Li-Po battery with 1440 mAh capacity

Rutronik ordering code: RFMCU1497

nRF9160 DK

The nRF9160 DK is a pre-certified single board development kit for evaluation and development on the nRF9160 SiP for LTE-M, NB-IoT and GNSS. It also includes an nRF52840 board controller that can be used to build a Bluetooth® Low Energy gateway, for example. It has a dedicated LTE-M and NB-IoT antenna that supports a wide range of bands, to operate globally. LTE bands B1, B2, B3, B4, B5, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28 and B66 have been certified so far, with many more planned: nordicsemi.com/9160cert. Also included is a dedicated antenna for GNSS, and a 2.4 GHz antenna to be used with Bluetooth® LE. SWF RF connectors are available for all antennas. All GPIOs and interfaces are available via connectors. The kit is Arduino Uno Rev3 compatible, meaning it can be easily interfaced with external device shields. User-programmable LEDs (4), buttons (2) and switches (2) are available to give input and get output. The nRF9160 DK has both a nano/4FF SIM card slot and an MFF2 SIM footprint, to support both plug-in and soldered (e)SIMs. It is bundled with an eSIM card from iBasis preloaded with 10 MB. Programming and debugging is enabled through the SEGGER J-Link OB, which also supports external targets. The nRF9160 DK is supported by a full suite of development software and tools. All free to download and use commercially.

Key Features

- Single board development kit for the nRF9160 SiP
- 700-2200 MHz LTE band support
- Same certification coverage as nRF9160 SiP
- nRF52840 board controller
- Arduino Uno Rev3 compatible
- LTE-M/NB-IoT, GNSS and 2.4 GHz antennas
- SWF RF connectors for all antennas
- Nano/4FF SIM card slot and MFF2 SIM footprint
- SEGGER J-Link OB programmer/debugger
- Pins for measuring power consumption
- User-programmable LEDs(4), buttons(2) and switches(2)
- 3.0-5.5 V supply from external or 5 V supply from USB
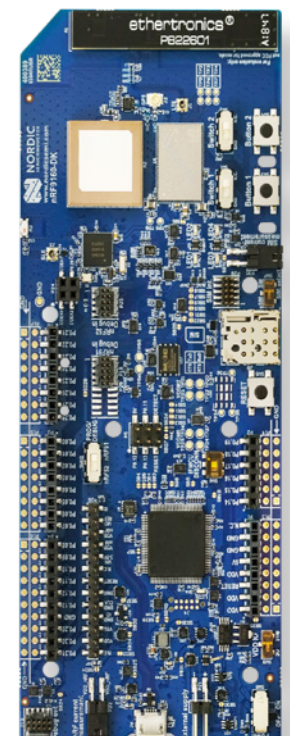
Rutronik ordering code: RFMCU1322

nRF Cloud Services

nRF Cloud is a versatile IoT connectivity enabler that can be used directly with Nordic's cellular devices or with the nRF52 and nRF53 Series via a gateway. nRF Cloud services support both Device-to-Cloud or Cloud-to-Cloud use cases. In the former, the device connects directly to nRF Cloud. In the latter, the device connects to a customer's cloud and that cloud connects to nRF Cloud's REST API. The nRF Cloud Location Services is a set of services which includes GPS and cell based location services. This enables customers customers to accurately and quickly get location data for their connected devices, thereby saving both time and energy. The GPS based location services download assistance data via the LTE network and speeding up time-to-first-fix (TTFF). The cell based location services use the cellular base stations to predict device location while using less energy compared with GPS. Furthermore, the nRF Connect SDK offers a Wi-Fi location service where the device scans nearby Wi-Fi networks without connecting to them.

Key Features
- Assisted GPS (AGPS)
- Predictive GPS (PGPS)
- Single-Cell (SCELL)
- Multi-Cell (MCELL)
- Wi-Fi
- Supports Cloud-to Cloud use cases for devices provisioned to a different cloud provider

Applications
- Industrial
- Smart appliances
- Asset tracking and RTLS

Comparing nRF Cloud Location Services

AGPS	High accuracy (≈3 meters) Lower power consumption than GPS
PGPS	High accuracy (≈3 meters) Lower power consumption than AGPS
SCELL	Low accuracy (≈1000 meters) Lower power consumption than AGPS and PGPS because GPS modem is not required
MCELL	Medium accuracy (≈300 meters, depends on nr of nearby cell towers) Lower power consumption than AGPS and PGPS because GPS modem is not required

Introduction to Bluetooth®

Bluetooth® is a wireless technology standard implemented for exchanging data over usually short distances from fixed and mobile devices, building Personal Area Networks (PANs). Here, short-wavelength microwaves in the ISM band from 2.4 to 2.485 GHz are used. Bluetooth® is managed by the Bluetooth® Special Interest Group (SIG), which today has more than 30,000 member-companies in the area of telecommunication, computing, networking, and consumer electronics. The term "Bluetooth®" covers a number of different versions which evolved over the last years. Today, classic Bluetooth® is differentiated from the latest Bluetooth® standards 4.0-5.3, which are known as Bluetooth® Low Energy / Bluetooth® Dual Mode. Actually, Bluetooth® Low Energy and Classic Bluetooth® have to be seen independently from each other (an exception are Dual Mode modules or chips, where both standards, Classic Bluetooth® and Bluetooth® Low Energy can be used). While the overall difference between the diverse versions of Classic Bluetooth® consists of an improved enhancement of the transferred data rate, the most recent Bluetooth® Low Energy standard is rather classified as an individual standard which was designed to create low data rate networks using a minimum amount of power. Furthermore, it does not only enable point-to-point connection but also mesh topology for establishing many-to-many device communications.

Common Bluetooth® Versions and their Characteristics

Version	Description	Release	Max.Data Rate	Comment
1.0 + 1.0B	Basic-Rate Mode	Jul 99	732.2 kbit/s	Obsolete
1.1	Basic-Rate Mode	Feb 01	732.2 kbit/s	Obsolete
1.2	Basic-Rate Mode	Nov 03	1 Mbit/s	Obsolete
2.0 + EDR	Enhanced Date Rate	Nov 04	2.1 Mbit/s	Obsolete
2.1 + EDR	Enhanced Date Rate	Aug 07	2.1 Mbit/s	Easy pairing of devices compared to older Bluetooth®-versions
3.0 + HS	Bluetooth® High Speed	Apr 09	3 - 24 Mbit/s	Add. HS-channel available; can reach a date rate of 24 Mbit/s
3.0 + EDR	Enhanced Date Rate	Apr 09	3 Mbit/s	With additional Wi-Fi Hardware
4.0 LE	Bluetooth® Low Energy	Dec 09	220 kbit/s	Bluetooth® Low Energy is not compatible to Classic Bluetooth®
4.0 DM	Bluetooth® Dual Mode	Dec 09	LE: up to 220 kbit/s Classic: up to 24 Mbit/s	Bluetooth® Dual Mode is compatible to Classic Bluetooth® & Bluetooth® Low Energy
4.1	Bluetooth® Dual Mode or Low Energy	Dec 13	LE: up to 220 kbit/s Classic: up to 24 Mbit/s	Seamlessly with other wireless technologies, an essential link for the IoT
4.2	Bluetooth® Dual Mode or Low Energy	Dec 14	LE: up to 1 Mbit/s Classic: up to 24 Mbit/s	Improved privacy + increase speed, soon-to-be ratified profile will enable IP connectivity
5.0	Bluetooth® Dual Mode or Low Energy	Dec 16	LE: up to 2 Mbit/s Classic: up to 24 Mbit/s	4x range, 2x speed and 8x broadcasting message capacity compared to previous version
5.1	Bluetooth® Dual Mode or Low Energy	Jan 19	LE: up to 2 Mbit/s Classic: up to 24 Mbit/s	Direction finding using Angle of Arrival or Angle of Departure
5.2	Bluetooth® Dual Mode or Low Energy	Jan 20	LE: up to 2 Mbit/s Classic: up to 24 Mbit/s	
5.3	Bluetooth® Dual Mode or Low Energy	Jul 21	LE: up to 2 Mbit/s Classic: up to 24 Mbit/s	LE Audio and Auracast™

What are Bluetooth® Profiles?

The Bluetooth® profile is an individual application layer on top of the Bluetooth® HCI (Host Controller Interface) layer. In order to use Bluetooth® technology, a device must be compatible with the subset of Bluetooth® profiles necessary to use the desired services. The way a device uses Bluetooth® technology depends on its profile capabilities. The profiles provide standards, which manufacturers follow to allow devices to use Bluetooth® in the intended manner. Bluetooth® Low Energy is using other profiles than Classic Bluetooth® – based on top of GAP and GATT, which can be user-defined.

Get Started with Bluetooth®

Profile	Bluetooth® Profiles	Application	
SPP	Serial Port Profile	Serial data transfer	Classic
A2DP	Advance Audio Distribution Profile	Streaming of audio multimedia	LE
HDP	Health Device Profile	Facilitates transmission of Medical Device Data	LE
HID	Human Interface Device Profile	For devices with which the end-user interacts directly	LE
HCI	Host Controller Interface	Interface between BT Hardware and application profiles	LE
iAP	iPhone Accessory Profile	support the development of accessories for Apple devices such as the iPhone or iPad.	LE
GAP	Generic Access Profile	Provides basis for all other profiles + defines how two Bluetooth® units establish a connection with each other	LE
GATT	Generic Attribute Profile	Provides profile discovery and description services for Bluetooth® SMART protocol	LE

LE Audio

LE Audio is a newly introduced Bluetooth® standard designed for audio transfer. It operates on the Bluetooth® Low Energy radio and therefore is bound to change the way audio is experienced and consumed. Because of its low power consumption, battery lifetimes of wireless audio devices will be significantly increased. Optionally, the size of those devices can be reduced drastically, as well. With this new standard it is also possible to mesh devices and Auracast™, where current products are only able to connect two devices at a time. As a result of this, new ways of listening to music and new applications are to be awaited.

Bluetooth® Direction Finding

As the name states, this capability enables a device to estimate the direction of an incoming signal. To determine the direction of the signal, Bluetooth® Direction Finding supports two methods: Angle of arrival (AoA) and angle of departure (AoD). Both methods are based on an antenna array. For measuring the angle of arrival, the device whose direction is to be determined needs to send a signal with a single antenna. The receiver has a number of antennas arranged in an array. Because of the special separation of the antenna, the incoming signal will arrive at different antennas at different times. This results in a measurable phase difference between the received signals. The receiving device then takes IQ samples while switching between the different antennas. One IQ-sample is a pair of in-phase and quadrature-phase samples, thus providing information about the phase shift between the different antennas. With this IQ data, the direction of the transceiver can be calculated. The angle of departure method now switches things up. Here, the device, whose direction is to measured, sends out a signal using multiple antennas arranged in an array. The receiver detects this signal using a single antenna. The receiver, again, takes IQ samples. With this data, the relative direction of the transceiver can be calculated.

Thread

Thread is based on IEEE 802.15.4. It is a reliable, secure, and scalable low-power mesh networking protocol, designed to connect low-power devices with no single point of failure. At the network and transport layers Thread uses a combination of IPv6, 6LowPAN (IPv6 over Low power Wireless Personal Area Networks), UDP (user Datagram Protocol) and DTLS (Datagram Transport Layer Security). The application layer can be defined individually. As it is using IPv6, Thread can be used to integrate home-automation devices directly to the IoT, without the need of making any protocol and address conversion. IPv6 has a strong encryption and authentication mechanism integrated – the IPsec.

ANT™

ANT™ is a practical wireless sensor network protocol. It offers protocols for ultra-low-power, short-range wireless technology running on the 2.4 GHz ISM band. It handles peer-to-peer, star, tree and fixed mesh topologies. Application examples for ad-hoc mesh techniques are also available. ANT provides reliable data communication, flexible and adaptive network operation. The ANT protocol stack is extremely compact, requiring minimal microcontroller resources and considerably reduces system costs. ANT can easily and quickly be implemented into new devices and applications. A typical ANT-enabled device consists of an application host MCU, interfaced with an ANT module, chipset or chip. The ANT protocol was created for applications in sport and fitness but has expanded into home and industrial automation. It is licenced to silicon vendors and is available in a chip and module to suit a wide variety of application needs. Nordic offers several SoCs with ANT integrated, removing the need for an external ANT module.

Zigbee

Zigbee is based on IEEE 802.15.4. The technology supports large mesh networks and operates globally in 2.4 GHz unlicensed bands. Transport and application layers are defined by the CSA which aims to create IoT standards. Zigbee is already widely adopted and includes a mature application layer called the Zigbee Cluster Library. Zigbee supports sleepy end devices, allowing for long-lived battery-powered applications. For routing mostly mains-powered devices like lightbulbs are being used. Zigbee networks can include more than a thousand devices at a time.

Matter

Matter aims to make it easy for developers to create a secure and reliable solution. If you want your products to be interoperable with the major smart home ecosystems, Matter is the way to go. Matter, which began as Project CHIP (Connected Home over IP) started in December 2019. The starting companies were Amazon, Apple, Google, and others including Nordic Semiconductor. The goal is to agree on a unified application layer standard for connected things at home. Matter is using Thread, Wi-Fi + Ethernet for transport and Bluetooth® LE for commissioning. All Matter devices based on Thread are required to feature Bluetooth® LE concurrently to enable adding new devices to a network. Wi-Fi can be used for low and high bandwidth applications. It can be used for devices in range of the local Wi-Fi. Thread is an IPv6-based mesh protocol that targets low bandwidth applications. It is the go-to option for battery-powered devices that require the best energy efficiency and for simple actuators like smart plugs or light bulbs. Most mains-connected Thread devices work as a Thread router and will expand the network's range. Thread is a self-healing low-power mesh that can adapt to new devices or to devices being removed from the network.

2,4 GHz flexibility and simplicity

There are occasions when complete control of the wireless link is required for reasons such as low latency, reduced packet size or particularly unique protocol behavior. The nRF52 and nRF53 Series wireless SoCs all support 2.4 GHz proprietary development. As multiprotocol wireless SoCs they offer simultaneous Bluetooth® Low Energy operation, or another supported protocol, if the application demands it. Whilst 2.4 GHz proprietary development does not offer the interoperability that comes with standards like Bluetooth®, it can offer special abilities to tailor both ends of a communication link for maximum efficiencies. Not only Bluetooth®, but also Wi-Fi uses the ISM 2.4 GHz bandwidth. Both provide wireless communication and use radio signals. The main difference between Bluetooth® and Wi-Fi is the purpose behind its designing and use case. While Wi-Fi provides high-speed internet access, Bluetooth® is essentially used to connect short range devices. Bluetooth® is fairly simple to use and switching between devices is easier. The frequency range of Wi-Fi also includes the 6 GHz band. For low power consumption Bluetooth® devises are recommended.

nRF54 Series

Product Summary

Coming soon!

Nordic Semiconductor announces the nRF54 Series

The market-share leader in Bluetooth Low Energy extends its commitment to innovation with its new, fourth-generation low power wireless SoCs. Capable of supporting Bluetooth 5.4 and future Bluetooth specifications, plus LE Audio, Bluetooth mesh, Thread, Matter, and more, the nRF54 Series will be the foundation for a new wave of revolutionary IoT end-products. The nRF54H20 is the first System-on-Chip (SoC) in the nRF54H Series, the "H" branch of the wider nRF54 Series. This SoC is ideal for disruptive IoT applications demanding high processing power, excellent energy efficiency, and state-of-the-art security.

Redefining leadership in Bluetooth Low Energy with the nRF54 Series

Extending the company's pioneering approach in Bluetooth® Low Energy (Bluetooth LE), the nRF54 Series follows Nordic's award-winning nRF51, nRF52, and nRF53 Series, and introduces an innovative new hardware architecture fabricated on the Global-Foundries 22FDX® leading process node.

Further highlights of nRF54H Series:

- Superior processing power and a generous amount of memory
- New exciting digital and analog interfaces
- Best-in-class multiprotocol radio with record-breaking RX sensitivity, plus offering improved robustness and longer range with 10 dBm TX power, -100 dBm RX sensitivity for Bluetooth LE and -104 dBm for 802.15.4
- State-of-the-art security, designed for PSA Certified Level 3 IoT security standard, it supports a wide range of security services including Secure Boot, Secure Firmware Update, Secure Storage and more

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nRF54H Series

nRF54H20

Coming soon!

nRF54H20

nRF54H20 is a compact ultra-low power SoC with superior processing power, a generous amount of memory, and excellent efficiency. It has a new best-in-class multiprotocol radio and state-of-the-art security features. Its unique combination of features, all integrated into a compact SoC, is ideal for creating innovative IoT applications that haven't been possible before. In addition to advanced wearables, smart home, medical, and LE Audio applications, the nRF54H20 SoC also enables applications demanding complex machine learning (ML) and support for sensor fusion at the edge.

Compact all-in-one solution

The SoC's high level of integration will enable developers to shrink their designs by replacing multiple components — for example application MCU, external memory, and wireless SoC — with just one highly compact device. In addition, its excellent energy efficiency enables smaller batteries to be used, further reducing both the design size and cost.

Key Features

- Multiple Arm Cortex-M33 processors, clocked up to 320 MHz
- Multiple RISC-V coprocessors
- 2 MB non-volatile memory
- 1MB RAM
- Bluetooth Low Energy, LE Audio, Bluetooth mesh, Thread, and Matter
- New peripherals: High-speed USB (480 Mbps), CAN FD controller, 2 x I3C and 14-bit ADC, and more
- Designed for PSA Certified Level 3 IoT security standard
- Protection against physical attacks

Applications

- Advanced wearables
- Smart home and Matter
- Medical and healthcare
- LE Audio
- Industrial
- Gaming
- Virtual reality and augmented reality
- E-mobility

Key Benefits

- Reduced design size / highly integrated SoC
- Prolonged battery life / reduced battery size
- Best-in-class multiprotocol radio (providing long range)
- State-of-the art protection against security threats

Product Summary
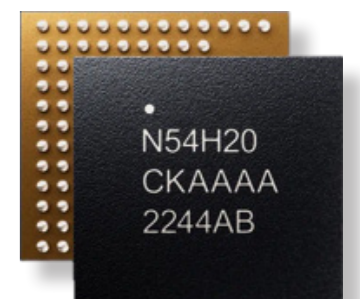
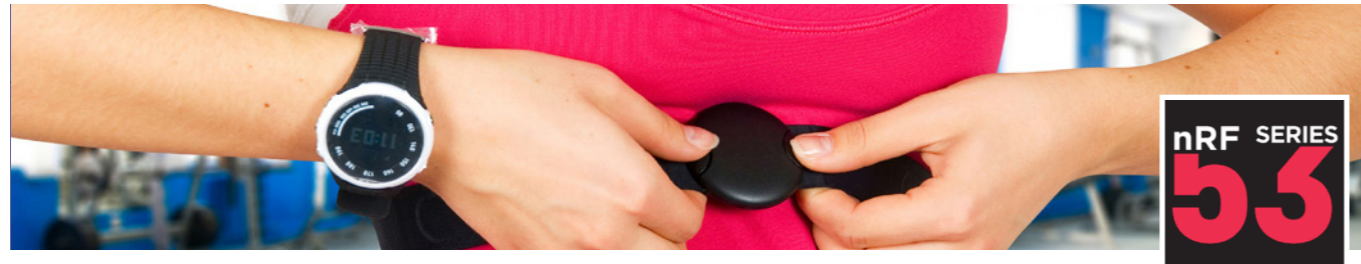| Feature	nRF5340
Bluetooth® Low Energy	x
Bluetooth® 5.3	x
LE Audio	x
Direction Finding	x
2 Mbps	x
Long Range	x
Bluetooth® mesh	x
Thread	x
Matter	x
Zigbee	x
ANT	x
2.4 GHz proprietary	x
NFC	x
Type	System-on-Chip
CPU	128 MHz Arm Cortex-M33, +64 MHz Arm Cortex-M33
FPU	x
DSP Instruction Set	x
Cache	x
Memory	1 MB Flash, 512 kB RAM, +256 kB Flash, 64 kB RAM
Clocks	128 MHz / 64 MHz / 32 kHz
Arm Trustzone	x
Arm CryptoCell	312
Root-of-trust	x
Secure key storage	x
AES encryption	x
Frequencies	2.4 GHz
Maximum TX Power	3 dBm
RX Sensitivity	-98 dBm (1 Mbps)
Antenna interface	Single-ended
High Speed SPI	x
TWI, SPI, UART	4xTWI/SPI/UART , +TWI/SPI/UART
QSPI	x
USB	x
PWM	4
PDM	x
I2S	x
ADC, Comparator	x
Timer, RTC	3, 2 + 3,2
Temperature Sensor	x
Applications	Asset Tracking, Automation, Consumer Electronics, Direction Finding, Gaming / VR + AR, Healthcare & Medical, Industrial Systems, Mesh Networks, Professional Lighting, Smart Buildings, Smart City, Smart Home, Sports & Fitness, Toys, Wearables
Certifications	CE, FCC
Operating Temperature	-40 to 105 °C
Supply Voltage Range	1.7 to 5.5 V
Development Kits	nRF5340 DK, nRF5340 Audio DK, Thingy:53
Packages	7x7 mm aQFN94 (48 GPIOs), 4.4x4.0 mm WLCSP95 (48 GPIOs)

nRF5340 - Dual processor SoC supporting Bluetooth® 5.3, Bluetooth® mesh, NFC, Thread & Zigbee

The nRF5340 is the world's first wireless SoC with two Arm® Cortex®-M33 processors. It is truly secure, and the combination of two flexible processors, the advanced feature set, and an operating temperature of up to 105 °C, make it the ideal choice for professional lighting, advanced wearables, and other complex IoT applications. The nRF5340 is an all-in-one SoC, including a superset of the most prominent nRF52 Series features. Features like USB, Bluetooth® 5.3 and more, are combined with more performance, more memory, higher integration and significantly less current consumption. Another feature of the nRF5340 is the support of LE Audio. This recently introduced new standard provides transfer of audio data at considerably less energy levels compared to classic Bluetooth® also improves audio Quality significantly compared to Classic. Thus making it possible for batteries of audio wearables to be smaller OR last longer would be a better description.

Key Features

- High-performance application processor
  - 128/64 MHz Arm Cortex-M33 with FPU & DSP instructions
  - 1 MB Flash + 512 kB low leakage RAM
  - 8 kB 2-way set associative cache
- Fully-programmable network processor
  - 64 MHz Arm Cortex-M33 with 2 kB instruction cache
  - 256 kB Flash + 64 kB RAM
  - Ultra low power
- A truly secure SoC
  - Trusted execution with Arm TrustZone
  - Root-of-trust with Arm CryptoCell-312
- Ultra-low-power 2.4 GHz multiprotocol radio
  - Bluetooth® Direction Finding
  - Long Range
  - Bluetooth® mesh, Thread and Zigbee
  - 3.2 mA in TX (0 dBm) and 2.6 mA in RX
  - -97.5 dBm RX sensitivity
- NFC
  - Full range of digital interfaces with EasyDMA y Full-speed USB
  - 96 MHz encrypted QSPI for external memory
  - 32 MHz high-speed SPI for displays and fast sensors
- -40 to 105 °C extended operating temperature
- 1.7 V to 5.5 V supply voltage range

Applications

- Professional lighting
- Industrial
- Advanced wearables
- Healthcare & Medical
- Smart Home
- Asset tracking and RTLS
- Direction Finding
- Automation
- Gaming VR + AR
- Mesh Networks

nRF53 Series

Related Development Tools

Nordic Thingy:53

The Nordic Thingy:53 is a multi-sensor prototyping platform for Matter, embedded machine learning (ML) and other wireless IoT products. It is based on the nRF5340 System-on-Chip (SoC), Nordic's current flagship dual-core wireless SoC. The nRF Edge Impulse app enables users to connect their Nordic Thingy:53 to their Edge Impulse studio account through a mobile device. It allows them to wirelessly transfer sensor data over Bluetooth® LE to the mobile device and upload it to the cloud for training and download trained ML models to the Thingy:53 for deployment and inferencing. The app also acts as the GUI for viewing inferencing results from a running ML model. The Bluetooth® Low Energy (LE) radio allows updating firmware and communication over Bluetooth LE, and the radio also supports other protocols like Bluetooth® mesh, Thread, Zigbee, and proprietary 2.4 GHz protocols. The Thread protocol compatibility also makes it a great choice when developing products for the new Matter ecosystem. Matter is a standardized application layer for connected home applications, using the Internet Protocol (IP) as the network layer. With integrated sensors for motion, sound, light and environmental factors, it is the perfect platform for building proof-of-concepts and developing new prototypes in a very short time. The Arm Cortex-M33 processor application core of the nRF5340 SoC ensures that the Thingy:53 can handle heavy computational tasks of embedded machine learning, without affecting the wireless connectivity. The application core is clocked at 128 MHz for the best possible performance, with ample room for your applications in its 1 MB of flash storage and 512 KB RAM. Wireless connectivity is handled separately by another Arm Cortex-M33 core clocked at a lower 64 MHz for more power efficient operation and without taking up any computational resources from the application core. Every Thingy:53 comes with its own debug- and current-measurement board in the box. This small PCB provides easy access to pins that would otherwise not be accessible. A helpful accessory to troubleshoot your application, for instance, in combination with our Power Profiler Kit II or other standalone debugging- or power-analyzing hardware.

Key Features

- Battery powered prototyping platform for the nRF5340 SoC
- Support for multiple wireless standards, Bluetooth® LE/Thread/Zigbee
- nRF Edge Impulse mobile app for embedded machine learning
- nRF Programmer mobile app for easily flashing firmware on the go
- User-programmable buttons and RGB LED
- Environmental sensor for temperature, humidity, air quality & air pressure
- Color and light sensor
- Low-power accelerometer and 6-axis inertial measurement unit (IMU)
- Buzzer and PDM microphone
- Connector for additional external boards and accessories
- External debug and current measurement board
- USB-C rechargeable 1350 mAh Li-Po battery
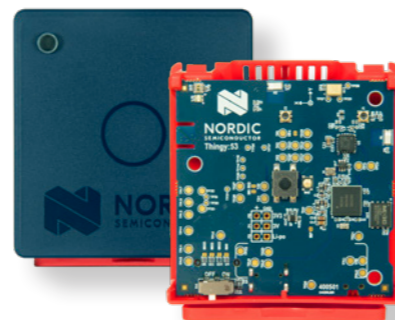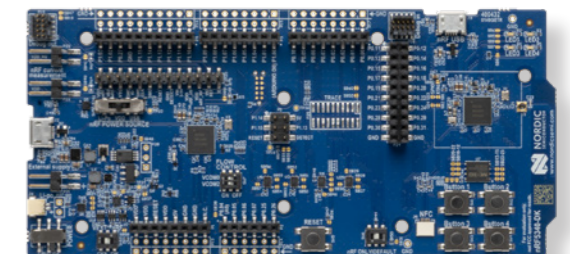

Rutronik ordering code: RFMCU1810

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nRF53 Series

Related Development Tools

nRF5340 DK

The nRF5340 DK is the development kit for the nRF5340 SoC, containing everything needed to get started with development, on a single board. The DK supports development with an extensive range of wireless protocols. It supports Bluetooth® Low Energy and all Bluetooth® 5.3 features, including Long Range, 2 Mbps and Advertising Extensions. Mesh protocols like Bluetooth® mesh, Thread and Zigbee can be run concurrently with Bluetooth® LE, enabling smartphones to provide, commit, configure and control mesh nodes. NFC, ANT, 802.15.4 and 2.4 GHz proprietary protocols are also supported. The DK is bundled with an NFC antenna that quickly enables testing of nRF5340's NFC-A tag peripheral. A SEGGER J-Link debugger is on the board, too, enabling full-blown programming and debugging, of both the nRF5340 SoC and external targets. All analogue and digital interfaces, and GPIOs are available via headers and edge connectors. The kit is Arduino Uno Rev3 hardware compatible, which means, it can be easily interfaced with external device shields, including Nordic's Power Profiler Kit II (PPK2). Four buttons and four LEDs simplify input and output to and from the nRF5340 SoC. All of them are user-programmable. An on-board external memory is connected to the 96 MHz QSPI peripheral in the nRF5340 SoC. The DK is typically powered with USB, but can be powered by a wide range of sources, within the supply range of 1.7 V to 5.0 V. In addition to USB, it can be powered with external source, but also includes a CR2032 battery holder and a Li-Po battery connector, for in-field testing. Power source is selected with the "nRF power source" switch. Current consumption can be measured by using the dedicated current measurement pins.

Key Features

- Versatile development kit for nRF5340 SoC
- Arduino Rev3 compatible
- 2.4 GHz and NFC antennas
- SWF RF connector for direct RF measurements
- User-programmable LEDs (4) and buttons (4)
- SEGGER J-Link OB programmer/debugger
- Pins for measuring power consumption
- 1.7 V to 5.0 V supply from USB, external, Li-Po battery or CR2032 coin cell battery

Rutronik ordering code: RFMCU1715

nRF53 Series

Related Development Tools

nRF5340 Audio DK

The nRF5340 Audio Development Kit (DK) is the recommended platform for Bluetooth® LE Audio products and supports all Auracast™ features. It contains everything needed to start development. The kit is configurable and can function as a USB dongle to send or receive audio data from a PC. It can also function as a Business Headset a broadcast receiver or a True Wireless Stereo (TWS) Earbud. For most use-cases, it is recommended to use two or more DKs.

The three main components of this DK are the nRF5340 SoC, nPM1100 PMIC, and Cirrus Logic's CS47L63 Audio DSP. The CS47L63's high-performance DAC and differential output driver are optimized for direct connection to an external headphone load. It is perfect for earbuds with mono-only and direct speaker output. The nRF5340 Audio DK is typically powered via USB and has a battery connector for a Li-Ion/Li-Po battery. The current consumption can be measured by using the dedicated current measurement pins. It is recommended to use Nordic's Power Profiler Kit II for that. The new "Low Complexity Communications Codec" (LC3) that replaced Bluetooth® Classic's "Low Complexity Subband Codec" (SBC) is also available for this DK. The LC3 codec has superior audio quality compared to SBC, even at about half the wireless data rate. This low data rate is a key factor in minimizing the power consumption of your products.

Key Features
- Bluetooth® LE Audio support
- Based on our nRF5340 SoC
- 2.4 GHz antenna
- Two 3.5 mm audio jacks
- Cirrus Logic Audio DSP CS47L63
- 1350 mAh Li-Po battery
- SWF RF connector for direct RF measurements
- 5 user-programmable buttons
- 4 user-programmable LEDs
- SEGGER J-Link debugger on board
- Pins for measuring power consumption
- SD-Card holder for additional storage

Applications
- LE Audio
- Headphones
- Hearing Aids
- Audio Guidles
- Office Headsets
- Audio Broadcast Solutions
- Conference Speakerphones

Rutronik ordering code: RFMCU1954
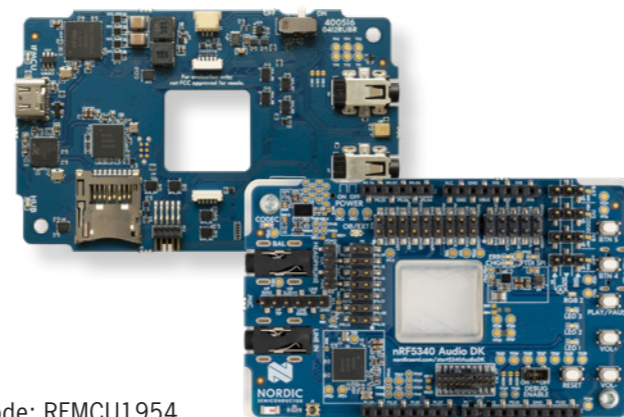
Bluetooth® Qualification

The Bluetooth® Qualification Process promotes global product interoperability and reinforces the strength of the Bluetooth® brand and ecosystem to the benefit of all Bluetooth® SIG members. Qualification helps member companies ensure their Bluetooth® products comply with the Bluetooth® Patent & Copyright License Agreement and the Bluetooth® Trademark License Agreement (collectively, the Bluetooth® License Agreement) and Bluetooth® specifications.
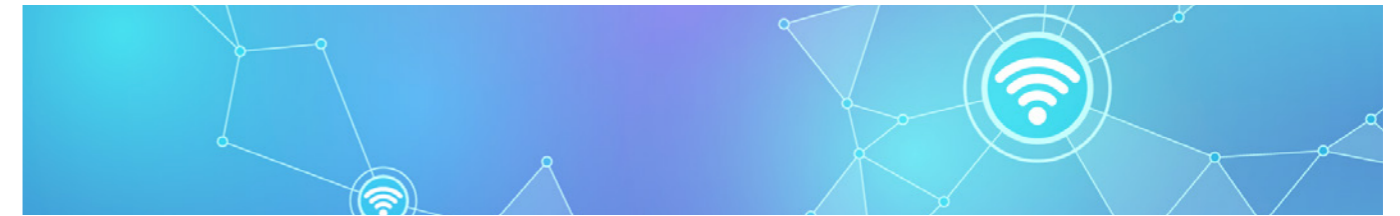
All Bluetooth® Products Must Be Qualified
- Product qualifications cannot be inherited from your supplier, you must complete the qualification of your product for yourself
- You can only qualify your products under your member company's account and only by completing the Bluetooth® Qualification Process
- It may be possible to complete product qualification by adding the product as a new model to one of your existing qualifications. Or you may need to create a new qualification which may require testing to be completed. The Bluetooth® Qualification tool, Launch Studio, can guide you through the appropriate path.

Check for Qualification if Reselling a Product
- If you are reselling another company's product (not representing the product as your own), you should ensure that the product has been properly qualified by that company
- You can check to see if a product is properly qualified by referring to the Bluetooth® Product Listing Database

Qualification Must Happen Before You Take Products to Market
- A Bluetooth® product must be qualified on or before the date that you begin to sell or distribute the product
- Details you provide for each Bluetooth® product listing must exactly match the product, its packaging markings, and marketing materials

If Your Products Are Not Qualified
- Products which appear to have not completed the Bluetooth® Qualification Process may be impounded by customs' authorities and will be subject to Bluetooth® SIG enforcement actions

Completing the Bluetooth® Qualification Process
The Qualification Process applies to products incorporating Bluetooth® designs. A design is a specific configuration of hardware and/or software implementation of adopted Bluetooth® specifications. The design is assigned a Bluetooth® product type per the definitions in the Compliance Requirements section of the Bluetooth® specifications. If an organization produces more than one product that incorporates the same Bluetooth® design, those additional products can be listed within the same qualification at no additional cost. Use the Bluetooth® Qualification tool Launch Studio to complete the Bluetooth® Qualification Process. There are two paths within Launch Studio.
- Qualification Process with No Required Testing
- Qualification Process with Required Testing

The path you use depends on whether your product uses a new or existing Bluetooth® design.

Qualification Process with No Required Testing
This path applies to the following scenarios when you are:
- Using another member organization's previously qualified Bluetooth® End-Product or Subsystem in your product with no changes or additions to the Bluetooth® design
- Purchasing a Bluetooth® product manufactured by a third party and distributing it with your organization's name or logo (also referred to as "white-labeling").
- Creating combinations involving only previously qualified Bluetooth® End Products or Subsystems and you make no design changes.

Qualification Process with Required Testing
This path applies to the following scenarios when you are:
- Creating a new design or combination that does not involve only previously qualified Bluetooth® End Products or Subsystems.
- Altering a previously qualified Bluetooth® design by changing the core configuration/functionality.
- Qualifying a design that uses a previously qualified Bluetooth® Component product type.

| Feature	nRF52840	nRF52833	nRF52832	nRF52820	nRF52811	nRF52810	nRF52805
Bluetooth® LE	x	x	x	x	x	x	x
Bluetooth® 5.3	x	x	x	x	x	x	x
LE Audio							
Direction Finding		x		x	x		
2 Mbps	x	x	x	x	x	x	X
Long Range	x	x		x	x		
Bluetooth® mesh	x	x	x	x			
Thread	x	x		x	x		
Matter	x						
Zigbee	x	x		x			
ANT	x	x	x	x	x	x	X
2.4 GHz proprietary	x	x	x	x	x	x	X
NFC	x	x	x				
Type	System-on-Chip	System-on-Chip	System-on-Chip	System-on-Chip	System-on-Chip	System-on-Chip	System-on-Chip
CPU	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4
FPU	x	x	x				
DSP Instruction Set	x	x	x	x	x	x	X
Cache	x	x	x				
Memory	1 MB Flash, 256 kB RAM	512 kB Flash, 128 kB RAM	512 kB or 256 kB Flash, 64 kB or 32 kB RAM	256 kB Flash, 32 kB RAM	192 kB Flash, 24 kB RAM	192 kB Flash, 24 kB RAM	192 kB Flash, 24 kB RAM
Clocks	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	
Arm Trustzone							
Arm CryptoCell	310						
Root-of-trust	x						
Secure key storage							
AES encryption	x	x	x	x	x	x	X
Frequencies	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz
Maximum TX Power	8 dBm	8 dBm	4 dBm	8 dBm	4 dBm	4 dBm	4 dBm
RX Sensitivity	-95 dBm (1 Mbps)	-96 dBm (1 Mbps)	-96 dBm (1 Mbps)	-95 dBm (1 Mbps)	-97 dBm (1 Mbps)	-96 dBm (1 Mbps)	-97 dBm (1 Mbps)
Antenna interface	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended
High Speed SPI	x	X					
TWI, SPI, UART	2xTWI/SPI, SPI, 2xUART	2xTWI/SPI, SPI, 2xUART	2xTWI/SPI, SPI, 2xUART	2xTWI/SPI, UART	TWI/SPI, SPI, UART	TWI, SPI, UART	TWI, SPI, UART
QSPI	x						
USB	x	x		x			
PWM	4	4	3		1	1	
PDM	x	x	x		x	x	
I2S	x	x	x				
ADC, Comparator	x	x	x	COMP	ADC, COMP	ADC, COMP	ADC
Timer, RTC	5, 3	5, 3	5, 3	4, 2	3, 2	3, 2	3, 2
Temperature Sensor	x	x	x	x	x	x	X
Applications	Automation, Beacon, Consumer Electronics, Gaming / VR + AR, Healthcare & Medical, Industrial Systems, Mesh Networks, PC Peripherals, Smart Buildings, Smart Home, Sports & Fitness, Toys, Wearables	Asset Tracking, Automation, Beacon, Consumer Electronics, Direction Finding, Gaming / VR + AR, Healthcare & Medical, Ind. Systems, Mesh Networks, PC Peripherals, Professional Lighting, Smart Buildings, Smart Home, Sports & Fitness, Toys, Wearables	Automation, Beacon, Consumer Electronics, Gaming / VR + AR, Healthcare & Medical, Mesh Networks, PC Peripherals, Smart Home, Sports & Fitness, Toys, Wearables	Asset Tracking, Automation, Consumer Electronics, Direction Finding, Gaming / VR + AR, Industrial Systems, Mesh Networks, PC Peripherals, Professional Lighting, Smart Buildings/Home	Asset Tracking, Beacon, Direction Finding, Smart Home	Automation, Beacon, Consumer Electronics, Gaming / VR + AR, Healthcare & Medical, PC Peripherals, Smart Home, Sports & Fitness, Toys, Wearables	Beacon, Consumer Electronics, Healthcare & Medical, PC Peripherals
Certifications	CE, FCC	CE, FCC	CE, FCC	CE, FCC	CE, FCC	CE, FCC	CE, FCC
Operating Temp.	-40 to 85 °C	-40 to 105 °C	-40 to 85 °C	-40 to 105 °C	-40 to 85 °C	-40 to 85 °C	-40 to 85 °C
Supply Volt. Range	1.7 to 5.5 V	1.7 to 5.5 V	1.7 to 3.6 V	1.7 to 5.5 V	1.7 to 3.6 V	1.7 to 3.6 V	1.7 to 3.6 V
Development Kits	nRF52840 DK, nRF52840 Dongle	nRF52833 DK	nRF52 DK, Nordic Thingy:52	nRF52833 DK	nRF52840 DK	nRF52 DK	nRF52 DK
Packages	7x7 mm aQFN73 (48 GPIOs) 6x6 mm QFN48 (48 GPIOs) 3.5x3.6 mm WLCSP94 (48 GPIOs)	7x7 mm aQFN73 (42 GPIOs) 5x5 mm QFN40 (18 GPIOs) 3.2x3.2 mm WLCSP(42 GPIOs)	6x6 mm QFN48 (32 GPIOs) 3.0x3.2 mm WLCSP50 (32 GPIOs)	5x5 mm QFN40 (18 GPIOs) 2.53x2.53 mm WLCSP44 (18 GPIOs)	6x6 mm QFN48 (32 GPIOs) 5x5 mm QFN32 (17 GPIOs) 2.48x2.46 mm WLCSP33 (15 GPIOs)	6x6 mm QFN48 (32 GPIOs) 5x5 mm QFN32 (17 GPIOs) 2.48x2.46 mm WLCSP33 (15 GPIOs)	2.48x2.46 mm WLCSP28 (10 GPIOs)

nRF52 Series

nRF52 DK

The nRF52 DK is a development kit that includes hardware, firmware source code, documentation, hardware schematics, and layout files. This kit can be used for developing for either the nRF52832 or nRF52810 SoCs. The content of the kit is the nRF52 DK, a CR2032 battery and a NFC antenna.

Key Features

- Affordable, Rapid prototyping and development solution for nRF52 Series SoCs
- Supports Bluetooth® LE, ANT and NFC
- 2.4 GHz and NFC antennas
- User-programmable LEDs(4) and buttons(4)
- SWF RF connector for direct RF measurements
- SEGGER J-Link OB Program/Debug supported
- Arduino Uno Rev3 form factor
- Pins for power consumption measurements
- 1.7 V to 3.6 V, battery and USB, external

Applications

- Internet of Things (IoT) - Sensors and Hubs
- Wearables – Sensors and Hubs
- Appcessories – Sensors and Hubs
- Desktop peripherals
- Remote controls
- Sports & Medical
- Smartwatch
- Smarthome sensors
- Toys
- Industrial sensors
- A4WP wireless charging control
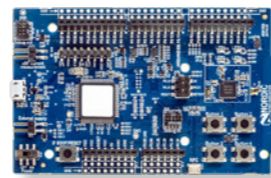
Rutronik ordering code: RFMCU1061

nRF52833 DK

The nRF52833 DK is an affordable single-board development kit for Bluetooth® Low Energy (LE), Bluetooth® mesh, Thread, Zigbee, 802.15.4 and 2.4 GHz proprietary applications using the nRF52833 multi-protocol SoC. It also supports development for the nRF52820 SoC. The kit is hardware compatible with the Arduino Uno Rev3 standard, making it possible to use a wide range of 3rd-party shields that are compatible with this standard, including the Power Profiler Kit or Power Profiler Kit II from Nordic Semiconductor. The kit has access to all 42 I/Os and interfaces via connectors. There is an integrated PCB trace antenna and an RF connector for direct RF test measurements

Key Features

- Versatile development kit for nRF52833 and nRF52820 SoCs
- 2.4 GHz and NFC antennas
- User-programmable LEDs(4) and buttons(4)
- SWF RF connector for direct RF measurements
- SEGGER J-Link OB programmer/debugger
- Arduino Uno Rev3 compatible
- Pins for measuring power consumption
- 1.7-5.0 V supply from USB, external, Li-Po battery or CR2032 coin cell battery

Applications

- Professional lighting
- Industrial
- Advanced wearables
- Medical
- Smart Home
- Asset tracking and RTLS
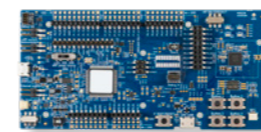
Rutronik ordering code: RFMCU1555

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nRF52 Series

nRF52840 DK

The nRF52840 DK is a development kit including hardware, firmware source code, documentation, hardware schematics, and layout files. This kit can be used for developing for either the nRF52840 or nRF52811 System on Chip (SoC)s.

Key Features

- Affordable, single-board development kit for the nRF52811 and nRF52840 SoCs
- Supports Bluetooth LE, Bluetooth mesh, NFC, Matter, Thread and Zigbee
- User-programmable LEDs(4) and buttons(4)
- 2.4 GHz and NFC antennas
- SWF RF connector for direct RF measurements
- On-board SEGGER J-Link debugger/programmer
- Arduino Uno Rev3 form factor
- Pins for power consumption measurements
- 1.7 to 5.5 V supplied from battery, external or USB

Rutronik ordering code: RFMCU1331

Applications nRF52840 DK and nRF52840 Dongle

- Advanced wearables
  - Advanced personal fitness devices
  - Connected Health
- IoT
  - Connected Home sensors & controllers
  - Industrial IoT sensors & controllers
- Interactive entertainment devices
  - Advanced remote controls
  - Gaming controllers
  - Virtual/Augmented Reality applications

nRF52840 Dongle

The nRF52840 Dongle (PCA10059) is the preferred hardware to be used with the nRF Connect for Desktop software package to develop and test your nRF-based wireless solutions. The hardware supports all the short range wireless standards available on the nRF52 family of devices, and the built-in USB device controller provides a high data throughput communication interface. The nRF52840 Dongle can also be used together with the nRF5 SDK for product development based on the nRF52840 SoC. The nRF52840 Dongle is a low-cost, versatile USB development dongle for Bluetooth® Low Energy, ANT™, 802.15.4, and user-proprietary 2.4 GHz applications using the nRF52840 SoC.
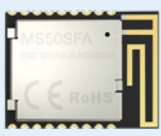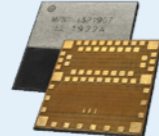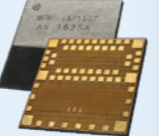
Key Features
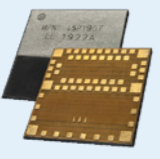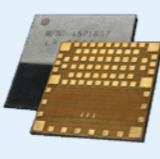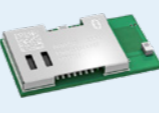
- Bluetooth® 5.3 multiprotocol radio
- IEEE 802.15.4 radio support
- Arm® CortexTM-M4 with floating point support
- DSP instruction set
- Arm CryptoCell CC310 cryptographic accelerator
- 15 GPIO available via edge castellation
- USB interface direct to nRF52840 SoC
- Integrated 2.4 GHz PCB antenna
- 1x user-programmable button / RGB LED / LED
- 1.7 V to 5.5 V operation from USB or external

Rutronik ordering code: RFMCU1350

Rutronik Module Partners based on Nordic

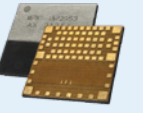| Nordic SoC	nRF52810	nRF52811		nRF52820		nRF52832				
Module Supplier	Minew	Insight SiP	Minew	Panasonic	Insight SiP	Telit	Garmin	Fujitsu	Murata	Minew
Product Name	MS50SFA	ISP1907-LL	MS50SFB3	PAN1781	ISP1507-AX	BlueMod+S50 (BLE 5.0) BlueMod+S42 (BLE 4.2)	D52	FWM7BLZ20	MBN52832	MS50SFB
Product Photo										
Dimension (mm)	15,8 x 12 x 2	8 x 8 x 1	20 x 12 x 2	15,6 x 8,7 x 2	8 x 8 x 1	17 x 10 x 2,6	14 x 9,8 x 2 20 x 20 x 2,8	15,7 x 9,3 x 1,7	7,4 x 7 x 0,9	20 x 12 x 2
	192kB flash, 32kB RAM	192kB flash, 24kB RAM		256kB flash, 32kB RAM		512kB flash, 64kB RAM				
GPIOs	13	13	32	16	30	21	24 / 30	30	20	32
32 kHz Crystal	no	yes	no	yes	yes	no	yes	yes	no	yes
Certifications	CE, FCC, RoHS	Bluetooth® SIG, CE, FCC, IC, TELEC, KCC	Bluetooth® EPL/QDID, FCC, CE, IC, MIC, RCM	CE RED / FCC / ISED MIC / KCC / ACMA / RSM	Bluetooth® SIG, CE, FCC, IC, TELEC, KCC	RED, FCC, IC (KC, MIC, RCM, Anatel)	CE, FCC, IC, Australia, New Zealand, Japan, Korea	CE, FCC, IC, Japan	CE, FCC, IC, ETSI, TELEC	Bluetooth® QDID, CE, FCC, IC, TELEC, RCM, WPC, RoHS, REACH
Available extra feature	LE 5.2	LE 5.2 direction finding Pin-compatible with ISP15/18/19/20 series	LE 5.2	LE 5 direction finding, LE long range coded PHY	Pin-compatible with ISP15/18/19/20 series	Several firmware versions available, Pin-compatible with BlueMod family	Several form factors available Up to 30 GPIOs & 3-axis MEMS accelerometer, ANT Blaze & G.FIT	LE 5.2	LE 5.2	LE 5.2

Nordic SoC	nRF52833				nRF52840			nRF5340
Module Supplier	Insight SiP	Minew	Insight SiP	Panasonic	Panasonic	iVativ	Minew	Insight SiP
Product Name	ISP1907-HT	MS88SF3	ISP1807-LR	PAN1770	PAN1780	RENO/NILE	MS88SF2	ISP2053-AX
Product Photo								
Dimension (mm)	8 x 8 x 1	18,5 x 12,5 x 2	8 x 8 x 1	15,6 x 8,7 x 2	15,6 x 8,7 x 2	10 x 15 x 1,5	23 x 17 x 2	8 x 8 x 1
	512kB flash, 128kB RAM	512kB flash, 64kB RAM		1 MB Flash, 256 kB RAM				1 MB Flash, 512 kB RAM +256kB Flash, 64 kB RAM
GPIOs	30	48	46	48	48	46	20	46
32 kHz Crystal	yes	no	yes	yes	yes	yes	no	yes
Certifications	Bluetooth® SIG, CE, FCC, IC, TELEC, KCC	EPL/QDID,FCC,CE,IC,TELEC/ MIC,RCM,WPC,RoHS, REACH	Bluetooth® SIG, CE, FCC, IC, TELEC, KCC	EU CE RED / FCC IC under preparation	EU CE RED / FCC IC under preparation	CE / FCC / IC	EPL/QDID,FCC,CE,IC,TELEC/ MIC,RCM,WPC,RoHS, REACH	Bluetooth® SIG, CE, FCC, IC, TELEC, KCC
Available extra feature	LE 5.2 direction finding, Pin-compatible with ISP15/18/19/20 series	LE 5.2 direction finding	LE 5.2 with long range, Pin-compatible with ISP15/18/19/20 series	LE 5.2 with long range, without intenal antenna	LE 5.2 with long range	Zigbee and Thread certified, available in 2 different antenna options	LE 5.2 with long range	LE 5.3 LE Audio, Pin-compatible with ISP15/ISP18/ISP19 series

Introduction to Range Extender

nRF21 Series – RF front end module (FEM)

The range and link robustness of Nordic nRF52 and nRF53 Series SoCs fulfill the requirements of most applications and use-cases, but sometimes adding an RF front-end module (FEM) is the correct choice. An RF FEM increases the range at which two wireless devices can communicate, while also enhancing link robustness. Combining the nRF21540 RF FEM with an nRF52 or nRF53 Series SoC can boost range between 6.3-10x.
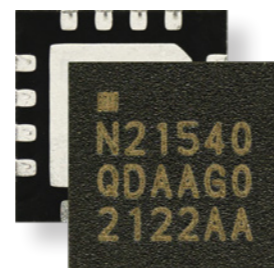
nRF21540

The nRF21540 is an RF front end module (FEM) that improves range and connection robustness for Nordic Semiconductor's short-range wireless portfolio. As a complementary device, the nRF21540 is a "plug and play" range extender, which offers enhanced link robustness using and integrated power amplifier. It can be used with the nRF52 and nRF53 Series advanced multiprotocol wireless SoCs with a minimal amount of external components required.

Key Features

- Supports
  - Bluetooth® Low Energy (incl. Bluetooth® mesh)
  - Thread and Zigbee (802.15.4)
  - Proprietary 2.4 GHz
- Adjustable output power in small increments up to +21 dBm
- +13 dB receive gain with 2.7 dB noise figure
- Two antenna ports for antenna diversity
- Control interface via GPIOs, SPI, or a combination
- -40°C to +105°C operating temperature range
- 1.7 V to 3.6 V input supply range
- 4 x 4 mm QFN16 package
- When combined with an nRF52 or nRF53 Series SoC:
  - Up to 16x range increase
  - -100 dBm RX sensitivity (Bluetooth® LE, 1 Mbps)
- Current consumption:
  - TX tuned to +10 dBm: 38 mA 110 mA
  - RX: 2.9 mA
  - Power down mode: 45 nA

Applications

- Asset tracking and RTLS
- Professional lighting
- Smart Home
- Industrial
- Toys
- Audio

nRF21540 Development Bundle

The nRF21540 DB consists of the nRF21540 development kit (DK) and the nRF21540 evaluation kit (EK). The nRF21540 DK is the perfect tool to develop products that require the range extension capabilities or link budget improvements provided by the nRF21540 RF front-end module (FEM). The nRF21540 EK can connect to lab equipment via SMA connectors to monitor the RF FEM's performance.

Key Features nRF21540 DK

- Versatile development kit for the nRF21540 RF FEM
- 2 x 2.4 GHz antennas for antenna diversity
- 2 x SWF RF ports for direct RF measurements
- Segger J-Link OB programmer/debugger
- Power and program/debug via USB interface
- Direct USB interface to nRF52840 SoC
- NFC-A tag antenna connector
- Arduino Uno Rev3 compatible
- User-programmable buttons (4) and LEDs (4)
- 1.7-5.5 V supply from USB, external or Li-Po battery
- Pins for measuring power consumption
- nRF52840 SoC w/ Bluetooth® Low Energy (LE), Thread, Zigbee and Matter (802.15.4) and 2.4 GHz proprietary protocol support:
  - Arm® Cortex™-M4 with floating point unit
  - Arm® CryptoCell-310 cryptographic accelerator

Key Features nRF21540 EK

- Versatile evaluation kit for the nRF21540 RF FEM that can be used with nRF52 & nRF53 Series DKs, as well as other devices
- ANT1 & ANT2 ports (SMA) for antennas or lab equipment
- TRX port (SMA) for connecting radio or lab equipment
- Pins for measuring power consumption
- Arduino Uno Rev3 compatible

Rutronik ordering code: RFMCU1601

Introduction to Power Management ICs
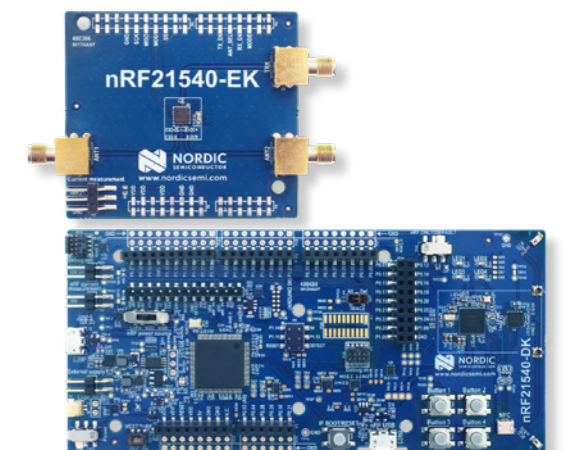
nPM1100 – Power Management IC (PMIC)

The nPM1100 is a dedicated power management IC (PMIC) with dual-mode configurable buck regulator and integrated battery charger. It is designed as a complementary component to Nordic's nRF52 and nRF53 Series SoCs to ensure reliable power delivery and stable operation, whilst maximizing battery life through high efficiency and low quiescent currents. The dual-mode regulator operates at up to 92% power conversion efficiency, prolonging battery life of any nRF52 or nRF53 SoC based application using a rechargeable battery. Hysteretic mode reduces current consumption for low load conditions, while PWM mode allows for cleaner power operation and better performance for higher loads. The regulator can deliver up to 150 mA, efficiently providing ample current for the nRF52 or nRF53 Series SoC plus additional circuitry. The device can also be used as a generic PMIC for any rechargeable application. Its extremely compact form factor makes it ideal for advanced wearables, connected medical devices, and other size constrained applications. When optimized for size, PCB area usage can be as low as 23 mm² with passive components included. This increases to approximately 27 mm² when optimized for performance.

Key Features

- Ultra-small form factor PMIC
  - 2.075 x 2.075 mm WLCSP package
- 400 mA battery charger
  - Automatic charging mode
  - For Li-ion and Li-Polymer batteries
  - Battery thermal protection
- Highly efficient regulator
  - Up to 92 % power conversion efficiency
  - Hysteretic and PWM mode
  - Selectable output voltage
  - 150 mA current limit
- Input regulator with USB support
  - SDP, CDP, DCP port detection
  - Overvoltage protection
- Ship mode that disables power output
- Drivers for charge and error LEDs
- -40°C to 85°C operating temperature

Applications

- Wearables
- Remote controls
- Personal medical devices
- Smart home sensors

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nPM1100

Related Development Tools
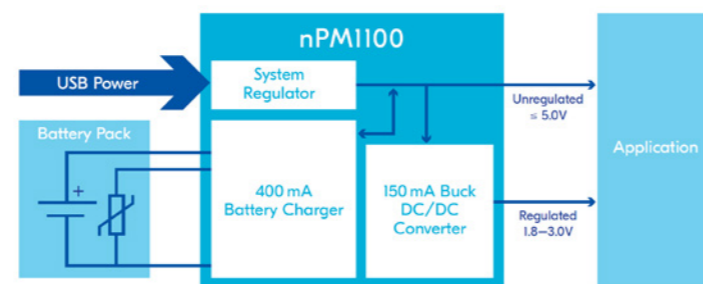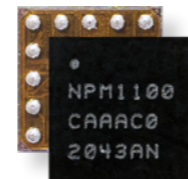
nPM1100 Evaluation Kit

The nPM1100 Evaluation Kit (EK) is a tool for evaluating the nPM1100 and its features in your application. The kit features switches for all selectable settings, buttons to enter and exit ship mode and connectors for batteries, USB and headers for all pins on the PMIC.

Key Features

- nPM1100 PMIC
  - All features enabled
  - Performance optimized layout
- 400 mA battery charger
- Highly efficient buck regulator
- Input regulator that supports USB charging
- Low quiescent currents
- Requires no software to operate
- I/O
  - Pin headers to all pins on nPM1100
  - USB connector & battery connectors
- LEDs for charge and error indication
- Switches
  - ICHRG, VTERM, ISET, VOUTB and MODE
- Buttons to enter and exit ship mode
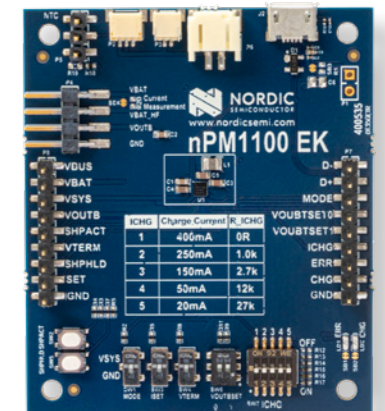
Rutronik ordering code: RFMCU1766

nPM1300

Available from mid-2023

nPM1300 – Power Management IC (PMIC)
Nordic announced the release of a third Power Management IC (PMIC) in mid-2023 to expand its PMIC portfolio. The nPM1300 PMIC simplifies system design by integrating essential functions required for embedded Bluetooth Low Energy designs into one small package, enabling longer run times and efficient battery charging with fewer components.

The nPM1300 is optimized for maximum efficiency and compact size (3.1 x 2.4 mm WL-CSP or 5 x 5 mm QFN), and is digitally configurable through an I2C-compatible Two Wire Interface (TWI). This interface enables easy access and configuration of a range of advanced system management functions, including a hardware reset functionality, battery fuel gauging, system-level watchdog, power loss warning, and recovery from failed boot. These functions are typically implemented as discrete components in Bluetooth® Low Energy (LE) embedded designs - such as hard reset, battery fuel gauge, system-level watchdog, power loss warning, and recovery from failed boot. The nPM1300 integrates them into a single, compact package, simplifying system design and reducing the number of required components.

The nPM1300 is designed to provide highly efficient power regulation for Nordic's nRF52 and nRF53 Series System-on-Chips (SoCs), supporting wireless protocols such as Bluetooth Low Energy, LE Audio, Bluetooth mesh, Thread and Zigbee. It is ideal for compact and advanced IoT products such as advanced wearables and portable medical applications.

Key Features
- 800 mA battery charger
- Two 200 mA buck DCDC regulators
- Two 100 mA Load switches / 50 mA LDOs
- Hardware reset for one- or two-buttons
- Fuel gauge
- System-level watchdog
- Intelligent power-loss warning
- Five GPIOs
- Three LED drivers
- Controlled via I2C compatible TWI
- USB-C compatible

Introduction to Wi-Fi 6

Wi-Fi 6 is enabling IoT

Power limitations
Wi-Fi appears to be the perfect option for wireless networks needing greater range than short-range, low-power protocols, but not the huge of range of the WAN technologies. Closer inspection reveals Wi-Fi has some considerable drawbacks for IoT applications. The first challenge is power consumption. Wi-Fi was designed for high throughput with little regard for power consumption. In contrast, IoT wireless technologies typically try to limit on-air time to extend battery life and hence minimize maintenance.

Interference
Second, Wi-Fi struggles in dense deployment scenarios like busy malls and libraries. For Industrial networks comprising hundreds of sensors, reliability is important.

Orthogonal frequency-division, multiple-access
Wi-Fi 6 (IEEE 802.11ax) addresses the shortcomings that have hampered the technology's widespread adoption for the IoT. Approved by the Wi-Fi Alliance in early 2021, Wi-Fi 6 was designed to meet the requirements of dense deployments, both public and industrial. The new orthogonal frequency-division, multiple-access (OFDMA) feature allows devices to use less than one channel bandwidth, sharing the bandwidth with other devices on the network, also enabling faster response to and from connected units. Where previous versions of Wi-Fi struggled to cope with more than a few sensors, Wi-Fi 6 can comfortably manage large sensor networks comprising hundreds of devices.

Target wake time
Wi-Fi 6 also brings a key technical enhancement for smart-home and -industry applications. Target wake time (TWT) is another technical enhancement to power-saving efforts of prior generations of Wi-Fi. When using TWT, client devices negotiate wake-up times with access points (APs). Therefore, the clients don't need to stay awake to maintain the wireless connection. The benefits are more efficient, contention-free channel access, and significant client-device power savings up to 80%.

Nordic's first Wi-Fi product
The potential synergy between Nordic Semiconductor's low-power wireless heritage and Wi-Fi's latest low-power evolution now enables battery-powered IoT devices. Nordic uses the decades of wireless ultra-low-power expertise and maximize Wi-Fi's low-power potential in applications such as sensor networks, smart speakers, security cameras, home appliances, robot vacuums, and more. The launch makes Nordic Semiconductor one of the few companies in the world to offer all three of the world's most popular wireless IoT technologies: Bluetooth®, Wi-Fi, and cellular IoT.

nRF7002 - Wi-Fi 6 Companion IC

Nordic's First Wi-Fi Product – nRF7002 an Ultra-Low Power, Dual-Band Wi-Fi 6 Companion IC

The nRF7002 is a companion IC, providing seamless Wi-Fi connectivity and Wi-Fi-based locationing (SSID sniffing of local Wi-Fi hubs). It is designed to be used alongside Nordic's existing nRF52® and nRF53® Series Bluetooth Systems-on-Chip (SoCs), and nRF91® Series cellular IoT Systems-in-Package (SiPs). The nRF7002 can also be used in conjunction with non-Nordic host devices.

The nRF7002 is the first device in Nordic's portfolio of unique Wi-Fi products that will combine seamlessly with Nordic's existing ultra-low power technologies. Nordic brings decades of ultra-low-power wireless IoT and silicon design expertise to Wi-Fi. With Wi-Fi 6 they bring added benefits to IoT applications including further efficiency gains that support long-life, battery-powered Wi-Fi operation. With Wi-Fi 6 all wireless protocols used in Matter, Bluetooth LE for commissioning, Thread for low power mesh, and Wi-Fi for high-throughput, are supported. Matter is a protocol championed by Apple, Amazon, Google, Nordic Semiconductor, Samsung, and hundreds of other companies in consumer IoT.

Key Features
- 2.4 GHz and 5 GHz dual-band
- Low-power and secure Wi-Fi for the IoT
- Ideal coexistence with Bluetooth LE
- Supported in nRF Connect SDK
- Target Wake Time (TWT)
- SPI / QSPI
- Wi-Fi 6 Station (STA)
- Complies with 802.11a/b/g/n/ac/ax
- 1 Spatial Stream (SS)
- 20 MHz channel bandwidth
- 64 QAM (MCS7), 86 Mbps PHY throughput
- OFDMA (Downlink and Uplink)
- BSS coloring
- Co-existence interfaces

Application Fields
- High bandwidth applications (e.g. video streaming, large file transfers)
- Applications with many devices (e.g. use cases in public hotspots or large offices)
- Applications with demanding requirements (e.g. online gaming, real-time video conferencing)
- Smart home applications (e.g. smart thermostats, security cameras, lighting systems)
- Battery operated Wi-Fi products
- Smart city & smart agriculture
- Industrial sensors
- Asset Tracking
- Wearables & medical
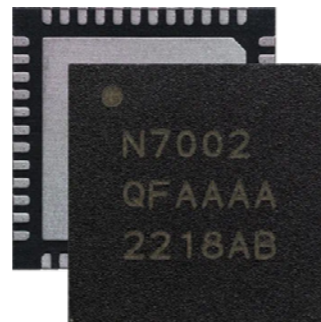
nRF7002 DK

The nRF7002 DK is the development kit for the nRF7002 Wi-Fi 6 Companion IC. It contains everything needed to get started developing on a single board and allows for evaluating the nRF7002. The DK features an nRF5340 multiprotocol System-on-Chip (SoC) as a host processor for the nRF7002. The DK supports the development of low-power Wi-Fi 6 applications and enables applications to use Wi-Fi 6 features like OFDMA, Beamforming, and Target Wake Time. To communicate with the host, SPI or QSPI can be used, and an extra coexistence feature allows for seamless coexistence with other protocols like Bluetooth Low Energy, Thread, or Zigbee. The nRF7002 is integrated and supported in Nordic's nRF Connect SDK.

Key Features
- nRF7002 companion IC
- nRF5340 SoC (host device)
- Wi-Fi 6 (IEEE 802.11 a/b/g/n/ac/ax), Bluetooth Low Energy, Bluetooth mesh, 802.15.4, Thread, Zigbee, ANT, 2.4 GHz proprietary, and NFC
- 2.4 GHz, 5 GHz, and NFC antennas
- SWF RF connectors
- SEGGER J-Link on board programmer/debugger
- User-programmable LEDs (2) and buttons (2)
- Pins for measuring power consumption
- 2.9-5.0 V supply from USB, external, or Li-Po battery
- Board support and samples in nRF Connect SDK

Software Development Kit
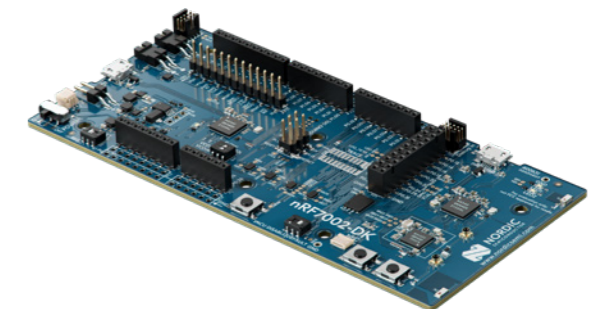
nRF Connect SDK

The nRF Connect SDK is a scalable and unified software development kit for building products based on all Nordic's nRF52, nRF53 and nRF91 Series wireless devices. It offers developers an extensible framework for building size-optimized software for memory-constrained devices as well as powerful and complex software for more advanced devices and applications. It integrates the Zephyr RTOS and a wide range of samples, application protocols, protocol stacks, libraries and hardware drivers.

For developing Bluetooth® Low Energy, Thread and Zigbee products, the nRF Connect SDK contains all needed software, including protocol stacks. For developing cellular IoT products it contains everything except the LTE modem firmware that must be downloaded separately from the nRF9160 SiP product page.

The nRF Connect SDK also offers an unique integration of HomeKit Accessory Development Kit for developing products using both HomeKit over Thread and HomeKit over Bluetooth® Low Energy. It is a highly optimized solution that enables battery-powered products with both the HomeKit Accessory Protocol (HAP) and application firmware running on a single chip.

There is a single code base for all Nordic devices and software components in the nRF Connect SDK. It simplifies porting modules, libraries and drivers from one application to another, thus reducing development time. By enabling developers to pick and choose the essential software components for their application, high memory efficiency is guaranteed.

It is publicly hosted on GitHub, offers source code management with Git and has free nRF Connect for VS Code support. Nordic runs continuous integration tests on the nRF Connect SDK code to ensure robust and secure production quality code.

Zephyr

The open-source real-time operating system Zephyr was developed by the Linux Foundation, specifically to suite Internet of Things applications. It is meant for devices, which have small and limited storage capacity and a fixed hardware configuration. Zephyr combines a Micro- and a Nanokernel to a single Uni-kernel. This way, the performance was enhanced and made real-time compatible. Another advantage of Zephyr is its small storage consumption of somewhere between 8KB and 512KB.

RTOS (Real-time operating system)

RTOS is an operating system in electronic data processing that is capable of meeting the real-time requirements of applications. That means the secure processing of requests from an application program or the arrival of signals via hardware interfaces within a pre-defined period of time.

The need for a real-time operating system arises whenever computers are connected to the physical world in a measuring and/or controlling way. This is the qualitative requirement of a real-time operating system.

The quantitative requirement of its real-time behaviour results from the application itself. It follows that not every real-time operating system is suitable for every real-time application.

Development Tools

Power Profiler Kit II (PPK2)

The Power Profiler Kit II is a standalone unit for measuring and optionally supplying all Nordic development boards and additional hardware. It enables easy and affordable power measurements for wireless product development on all Nordic DKs, in addition to aforementioned external hardware. The current supply ranges from all the way down to a few µA to up to 1 A. It supports an ampere meter mode as well as a source mode. For the ampere meter mode an external power supply needs to provide VCC levels between 0.8 V and 5.0 V to the device under test (DUT). In source mode, the PPK2 supplies levels between 0.8 V and 5.0 V, while the on-board regulator provides currents up to 1 A to the external devices. Thus it is possible to measure small sleep currents, higher active current levels and short current peaks on all Nordic DKs, as well as on external devices. In this regard, both the different protocols supported, such as Bluetooth LE, Bluetooth mesh, Thread, Zigbee, 2.4 GHZ proprietary, etc. Applications of the nRF52 and nRF53 series and the cellular IoT applications of the nRF91 Series are supported. The PPK2 has an advanced analog measurement unit with a high dynamic measurement range. This allows accurate power consumption measurements for the entire range typically seen in low-power embedded applications, all the way from single µAs to 1A. The resolution varies between 100nA and 1mA depending on the measurement range and is high enough to detect small spikes as often seen in low power optimized systems. By using digital inputs as a low-end logic analyser, it is possible to enable code-synchronized measurements, as well.

Key Features

- Current measuring range between 200 nA and 1 A
- Measurement resolution between 100 nA and 1 mA
- Ampere meter mode and source mode
- Source mode includes a built-in programmable regulator with an output range between 0.8 V and 5.0 V and output currents of up to 1 A
- 100ksps sampling rate
- 8 digital inputs for low-end logic analyser support
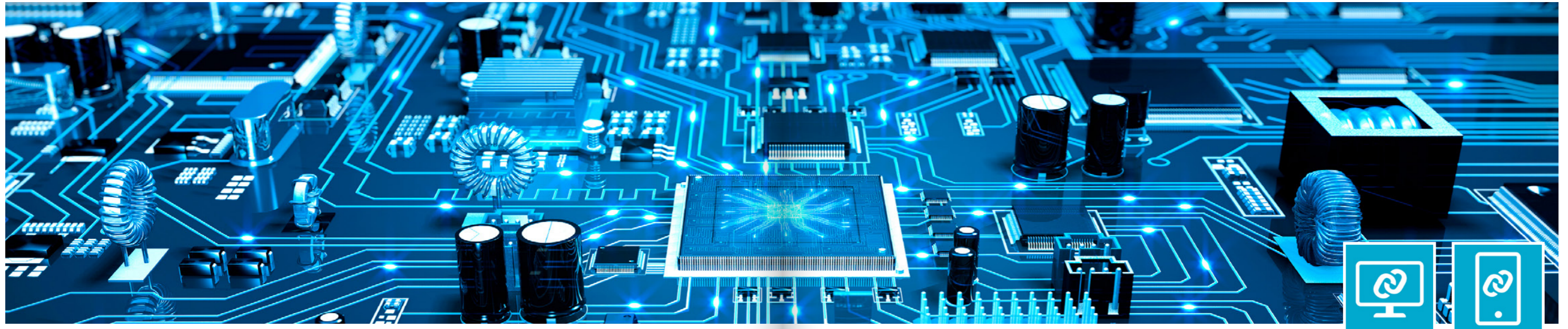- Power Profiler app in the nRF Connect for Desktop

Applications

- Power debugging of embedded applications
- Estimation of battery lifetime of completed application

Rutronik ordering code: RFMCU1727

nRF Thread Topology Monitor

nRF Thread Topology Monitor is a cross-platform tool that enables developers to visualize Thread mesh network topology in real time. The tool is supported on Windows and Linux with separate downloads for each platform. It requires a serial connection to an nRF52840 DK with Nordic's Thread solution. nRF Thread Topology Monitor uses diagnostic mechanisms of the Thread protocol to retrieve information about routing tables of each Thread Router currently attached to the network. The tool also allows to identify a particular device in the network using LEDs by interacting with the Thread BSP solution. You may assign a custom label to a Thread node and store it in persistent memory on the PC side, which helps to track topology changes.

The sniffers are useful debugging tools for seeing what the wireless protocols are actually doing on air. Nordic offers two sniffers, one for Bluetooth® LE and one for 802.15.4 (Thread and Zigbee).
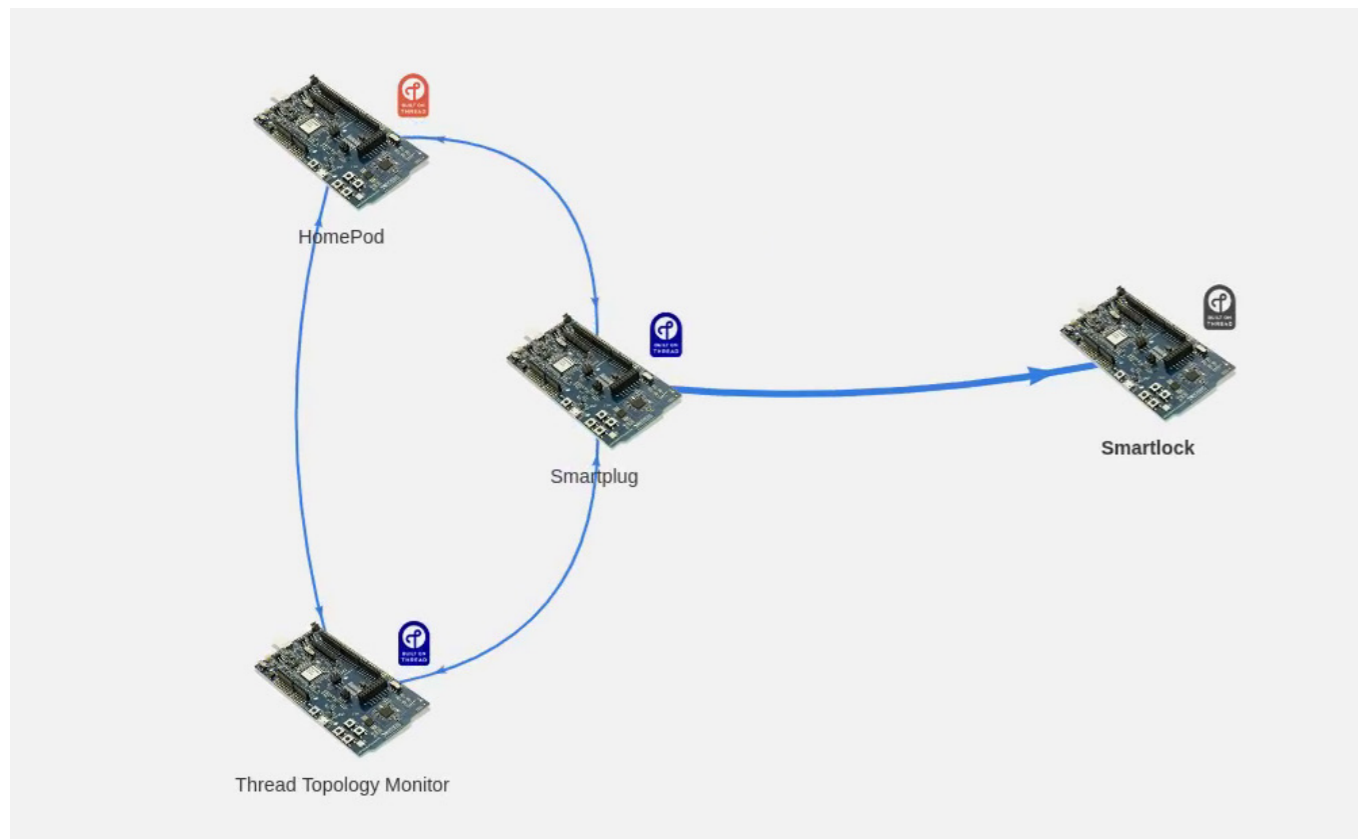
nRF Sniffer for Bluetooth® LE
nRF Sniffer for Bluetooth® LE is a useful tool for learning about and debugging Bluetooth® Low Energy applications. Allowing you to see what's happening on-air, nRF Sniffer for Bluetooth® LE provides a near real-time display of Bluetooth® LE packets. This helps you identify and fix issues quickly during the development phase.

nRF Sniffer for 802.15.4
A helpful and valuable sniffer for learning and debugging 802.15.4 protocols, like Thread and Zigbee. It offers a real-time display of what is happening on-air. With this tool, it is easy to learn, how the protocol behaves and what kind of packages are sent back and forth between devices.

nRF Connect for Desktop
Cross-platform development software for Bluetooth® LE & cellular IoT. nRF Connect for Desktop is a cross-platform tool that enables testing and development with Nordic's products for Bluetooth® Low energy and cellular IoT. It allows easy setup of connections with other devices and uses these connec-

tions to read and write the external nodes. nRF Connect is designed to be used in conjunction with the nRF51, nRF52 and nRF53 Series development kits and dongles, and nRF91 Series development kits. nRF Connect will automatically detect which kit is connected to your computer and upload the needed firmware.

nRF Connect for Mobile
Powerful generic Bluetooth® LE scanning and exploration tool nRF Connect for Mobile, previously known as nRF Master Control Panel, is a powerful generic tool that allows you to scan and explore your Bluetooth® Low Energy devices and communicate with them. nRF Connect for Mobile supports a number of Bluetooth® SIG adopted profiles, as well as the Device Firmware Update profile (DFU) from Nordic Semiconductor or Eddystone from Google.

HomePod

Smartplug

Smartlock

Thread Topology Monitor

Wireless Accessories

Embedded Antennas

The following tables give an overview of suitable antennas for Bluetooth®, GSM, GPS and Wi-Fi applications.

Manuf.	Part	Standard	Antenna Type	Frequencies	Peak Gain (dB)	Efficiency (%)	VSWR	Antenna Size	Measured Ground Place (mm)	Temp. (°C)	Comment
2J	2JL30	BLE	SMD - Ceramic	2.4 GHz	~1.1 @2.4GHz	~63.3	~1.3:1	3.2 x 1.6 x 0.5	80 x 40	-40 to +85	Low profile
	2JL40	BLE + Wi-Fi	SMD - Ceramic	2.5 / 5 GHz	~6.0 @2.4GHz	~67.1	~1.6:1	3.2 x 1.6 x 0.5	80 x 40	-40 to +85	Low profile
	2JE38	LTE	SMD - FR4	700 - 2700 MHz	~4.2	~70.1	~2.8:1	40 x 7 x 3	120 x 40.4	-40 to +85	High Performance
AVX	1001312	BLE	SMD - Ceramic	2.4 + 6 - 8.5 GHz	~1.88	62	1.8:1	2 x 1.2 x 0.55	55 x 25	*	UWB possible
	M310220	BLE	SMD - Ceramic	2.4 GHz	~1.7 @2.4GHz	~67	~2.0:1	3 x 1.5 x 1.08	40 x 60	*	-
	LSP6900 1299TR	NB-IoT/ LTE-M	SMD - FR4	698 - 2200 MHz	~1.2	42	*	35 x 9 x 3.2	60 x 40	*	Designed for small PCB
	1004795	LTE	SMD - FR4	600 - 2700 MHz	~3.1	64	2.5:1	36 x 9 x 3.2	125 x 45	-40 to +85	Mirrored version available
Molex	2119640001	BLE + Wi-Fi	SMD - Ceramic	2.4 / 5 GHz	2.7 @2.4GHz	80	*	3.2 x 1.6 x 1.2	40 x 20	-40 to +85	Single band 2.4 GHz + Dual band for Wi-Fi possible
	479480001	BLE	SMD - MID	2.4 GHz	3.7 @2.4GHz	70	*	3 x 4 x 4	100 x 40	-40 to +85	MID = Molded Inter-connect Devices
	2066490001	NB-IoT/ LTE-M	SMD - Ceramic	698 - 960 MHz	1.1	55	*	20 x 10 x 1.2	130 x 60	-40 to +125	Compact size for subGHz Frequencies
	2047740001	LTE	SMD - Ceramic	790 - 2700 MHz	4.8	70	*	33 x 6 x 3	130 x 60	-40 to +125	Low profile
Pulse	W3008G	BLE	SMD - Ceramic	2.4 GHz	>1.5 @2.4GHz	>80	<1.6:1	3.2 x 1.6 x 1.1	80 x 37	-40 to +85	High Performance
	W3092G	BLE	SMD - Ceramic	2.4 GHz	>1.5 @2.4GHz	>75	<1.6:1	2.1 x 1.2 x 0.55	80 x 37	-40 to +105	High Performance + High Temperature
	W3325	NB-IoT/ LTE-M	SMD - FR4	791 - 960 MHz	1.3	>55	*	14 x 7 x 1.5	120 x 40	-40 to +85	Small size for subGHz Antenna
	W3326	NB-IoT/ LTE-M	SMD - FR4	791 - 2170 MHz	2.3	>50	*	20 x 7 x 1.5	120 x 40	-40 to +85	Small size LTE-M/ NB-IoT Antenna
Pulse/Yageo	ANT1005LL-14R2400A	BLE	SMD - Ceramic	2.4 GHz	>2.2 @2.4GHz	70	Max. 3.0:1	1.0 x 0.5 x 0.37	40 x 20	-40 to +105	Very small form factor, small PCB
	ANT1608LL-14R2400A	BLE	SMD - Ceramic	2.4 GHz	>2.0 @2.4GHz	62	Max. 6.0:1	1.6 x 0.8 x 0.4	50 x 20	-40 to +105	Small form factor
	ANT3216LL-11R2400A	BLE	SMD - Ceramic	2.4 GHz	>3.7 @2.4GHz	~87	*	3.21 x 1.6 x 1.2	90 x 40	-40 to +105	High efficiency

Internal Cabled Antennas

The listed antennas are distributed by Rutronik.

Manuf.	Part	Standard	Antenna Type	Frequencies	Peak Gain (dB)	Efficiency (%)	VSWR	Antenna Size	Cable Length (mm)	Temp. (°C)	Comment
2J	2JF0102P	BLE + Wi-Fi	FPC	2.4 / 5 GHz	~2.2 @2.4GHz	~76	~1.2:1 @2,4GHz	39.6 x 8.4 x 0.1	100	-40 to +85	Ground plane inde-pendent, customized cable + connector
	2JF0624P	LTE	FPC	700 - 2700 MHz	~3.4	~68	~1.6:1	110.4 x 20.8 x 0.2	150	-40 to +85	Ground plane inde-pendent, customized cable + connector
	2JF0924P	LTE	FPC	700 - 2700 MHz	~4.5	~58.8	~2.5:1	120 x 8.9 x 0.15	150	-40 to +85	Ground plane inde-pendent, customized cable + connector
AVX	1003893FT	BLE	FPC	2.4 GHz	3.3	87	1.5:1	40 x 8 x 0.12	100	*	Easily tuneable
	1001932FT	BLE + Wi-Fi	FPC	2.4 / 5 GHz	4.4	71	2.0:1	35.2 x 8.5 x 1.6	100	*	Easily tuneable
	1002292	LTE	FPC	698 - 2700 MHz	~5.0	64	3.0:1	85.2 x 42.1 x 0.2	28.5	*	Different cable lengths available, designed for small PCB
	1002289	LTE	FPC	698 - 2700 MHz	~4.3	74	2.5:1	53.6 x 25.1 x 0.2	7.6	*	Different cable lengths available
Molex	1461530150	BLE + Wi-Fi	FPC	2.4 / 5 GHz	2.8 @2.4GHz	>72	*	35 x 9 x 0.1	50 - 300	-40 to +85	6 different cable lengths
	2042810150	BLE + Wi-Fi	FPC	2.4 / 5 GHz	1.8 @2.4GHz	>62	*	35 x 11 x 0.1	50 - 300	-30 to +85	6 different cable lengths
	2125700150	NB-IoT/ LTE-M	FPC	824 - 2170 MHz	~1.76	>60	*	40.4 x 15.4	100 - 200	-40 to +85	
	2133530150	LTE + GNSS	FPC	698 - 8500 MHz	Max. 7 @UWB	>60	*	120 x 20	100 - 200	-40 to +85	Dual Feed for TE + GNSS
Pulse	W3334xxx	BLE + Wi-Fi	FPC	2.4 / 5 GHz	Max. 5.5	50 @2.4GHz	<2.0:1	4.3 x 15.3 x 0.1	100 - 290	-40 to +85	Small form factor
	W3918xxx	BLE + Wi-Fi	FPC	2.4 / 5GHz	Max. 4	60 @2.4GHz	<2.0:1	35.2 x 8.5 x 0.15	50 - 100	-40 to +85	
	W3906B0100	LTE + GNSS	FPC	698 - 3600 MHz	1.1 – 4.0	54 - 69	*	120 x 26.8	100	-40 to +85	Broad Band Anten-na, LTE + GNSS Dual feed
Pulse/Yageo	ANTX200 P001B24003	BLE	PCB	2.4 GHz	4.4	>50	2.0:1	18.4 x 7.5 x 0.55	200	-40 to +85	
	ANTX100 P001B24553	BLE + Wi-Fi	PCB	2.4 / 5 GHz	4.6 / 3.9	>71	2.5:1	50 x 10 x 0.95	100	-40 to +85	
	ANTX100 P001BWPEN3	Cellular	PCB	824 - 2170 MHz	3.9 – 5.0	>55	3.0:1	50 x 20 x 0.95	100	-40 to +85	

Wireless Accessories

SIM Card Holders

To grant the nRF9160 SoCs access to all common mobile standards, it is necessary to include a SIM-Card into the system. Rutronik provides a number of SIM-Card-Holders to integrate any kind of SIM-Card to developed PCB. An overview is listed below.

Push/Push SIM Card Holder & Flip SIM Card Holder

	Push/Push SIM Card Holder		Flip SIM Card Holder
Type	CH03-DD060-A	CH03-GB060-ABR	CH03-BH060-A
Format	Mini SIM (2FF)	Micro SIM (3FF)	Mini SIM (2FF)
Number of contacts	6	6	6
Height	1.9 mm	1.5 mm	2.5 mm
Durability	5000 cycles	1500 cycles	5000 cycles
	SIM card detection switch, Optional location peg	SIM card detection switch	SIM card detection switch, Optional location peg

Push SIM Card Holder

Type	CH03-AA060-A	CH03-FB060-OBR	CH03-KB060-HAR
Format	Mini SIM (2FF)	Micro SIM (3FF)	Nano SIM (4FF)
Number of contacts	6	6	6
Height	2.4 mm	2.4 mm	1.35 mm
Durability	10000 cycles	5000 cycles	1500 cycles
	SIM card detection switch Optional location peg	No SIM card detection switch No location peg	Location peg

Crystals

Rutronik lists a number of crystals to support the functionality of the Nordic SoCs.
An overview of the Nordic SoCs and their respective fitting crystals is shown in the table below.

Nordic IC Series	Manufacturer Part-Nr.	Series	Frequencies	Capacitance	Variation	Ground Place	Supplier	Reference Design
nRF52	X1E0002510026**	FA-118T	32MHz	8pF	+/-10ppm	1.6x1.2mm	EPSON	x
	Q22FA12800025**	FA-128	32MHz	8pF	+/-10ppm	2.0x1.6mm	EPSON	x
	Q24FA20H00196**	FA-20H	32MHz	8pF	+/-10ppm	2.5x2mm	EPSON	x
	X1A0000610008**	FC-12M	32.768kHz	9pF	+/-20ppm	2.05x1.2mm	EPSON	x
	Q13FC13500003**	FC-135	32.768kHz	9pF	+/-20ppm	3.2x1.5mm	EPSON	x
	XRCGB32M000F2P10R0	XRCGB	32MHz	10pF	+/-20ppm	2.0x1.6mm	MURATA	
nRF53	X1E0002510026**	FA-118T	32MHz	8pF	+/-10ppm	1.6x1.2mm	EPSON	x
	Q22FA12800025**	FA-128	32MHz	8pF	+/-10ppm	2.0x1.6mm	EPSON	x
	X1A0000610008**	FC-12M	32.768kHz	9pF	+/-20ppm	2.05x1.2mm	EPSON	x
	Q13FC13500003**	FC-135	32.768kHz	9pF	+/-20ppm	3.2x1.5mm	EPSON	x
	HKC2016SX-32MHz-24893-R4V1	CQ	32MHz	8pF	+/-10ppm	2.0x1.6mm	HKC	
	CKM32000083BSHF0HKC	CK	32MHz	8pF	+/-10ppm	2.5x2.0mm	HKC	
nRF91	X1E0002510166**	FA-118T	32MHz	10pF	+/-10ppm	1.6x1.2mm	EPSON	x
	HKC2016SX-32MHz-30603-R4V1	CQ	32MHz	10pF	+/-10ppm	2.0x1.6mm	HKC	

Support

Nordic & Rutronik

NORDIC DEVZONE & SUPPORT
The Nordic DevZone is an open forum that gives users access to Nordic tech support, interaction with other engineers worldwide and a technical blog. More than 25.000 developers come there to ask, share and discuss.
devzone.nordicsemi.com

Rutronik Support
Check availability, pricing, useful companion products and clarify any other open question regarding your wireless idea:
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NORDIC INFOCENTER
The Infocenter is a comprehensive library containing technical documentation. **infocenter.nordicsemi.com**

GET CONNECTED BLOG
Keep up-to-date to understand the opportunities & challenges of IoT for your industry.
blog.nordicsemi.com/getconnected

Get Started
On their homepage, Nordic provides a set of useful guides to help developers get accustomed to the multitude of available features the various Nordic SoCs support. Whether the customer just wants to test some code without building hardware or wants to full on start developing new applications with the Nordic chips and the respective SDKs, Nordic provides the fitting guide for lots of situations. Should there be any further problems, the guides cannot cover for, the Nordic support service includes a forum, called DevZone. Here, the user can ask questions about the products. Other customers, as well as Nordic employees are happy to answer all kinds of questions.In case the customer does not want to share information about his project publicly, DevZone offers private contact to Nordic.Here, a team of around 40 engineers, each one appointed on a certain topic, can answer questions concerning the Hardware and Software products directly.

The Get Started guides are available under the following Link: **www.nordicsemi.com/Get-Started** - There, the user is also granted access to DevZone. To purchase Nordic products, use the Rutronik24 website. **www.rutronik24.com**

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