



matter

Power Management



The World of Nordic Semiconductor

Empowering Wireless Innovation

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Our Product Portfolio

-  Semiconductors
-  Passive Components
-  Electromechanical Components
-  Displays & Monitors
-  Boards & Systems
-  Storage Technologies
-  Wireless Technologies

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Vertical Markets

-  **RUTRONIK SOLUTIONS**
-  **RUTRONIK EMBEDDED**
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-  **RUTRONIK SMART**
-  **RUTRONIK AUTOMOTIVE**
-  **RUTRONIK IT ELECTRONICS**



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Who is Nordic and why Rutronik



Nordic Semiconductor

Nordic Semiconductor is a Norwegian fabless semiconductor company specializing in wireless communication technology that powers the **Internet of Things (IoT)**. Nordic was established in **1983** and has about **1,450 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 **Wi-Fi technology** in 2021.

Rutronik

Rutronik is an independent, **family-owned company** based in Ispringen near Pforzheim, Germany. The company was founded in **1973** by Helmut Rudel and has developed from a "one-man-company" into one of the **worldwide leading broadband distributors** for electronic components. In the fiscal year 2023 its more than **1,900 employees** achieved sales of **1.243 billion US-Dollar**. Thanks to the customer's approval, Rutronik looks back on a successful company history of 50 years and continues the positive economic development.

The **broad product range** includes **semiconductors, passive - and electromechanical components** as well as **embedded boards, storage technologies, displays, and wireless products**. Customers also have access to the **Rutronik24 e-commerce platform**, where all articles can be found. In addition to its comprehensive line of components, Rutronik delivers **consulting services** for technical, commercial, and logistical issues as well as unparalleled service and technical support with a **consistently high level of quality** to its customers worldwide.

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 and fitness, mobile phone accessories, consumer electronics, toys, healthcare and automation. **Nordic is a member of the ANT+ Alliance, Bluetooth® SIG, Thread Group, Connectivity Standards Alliance, Wi-Fi Alliance, and GSMA.**

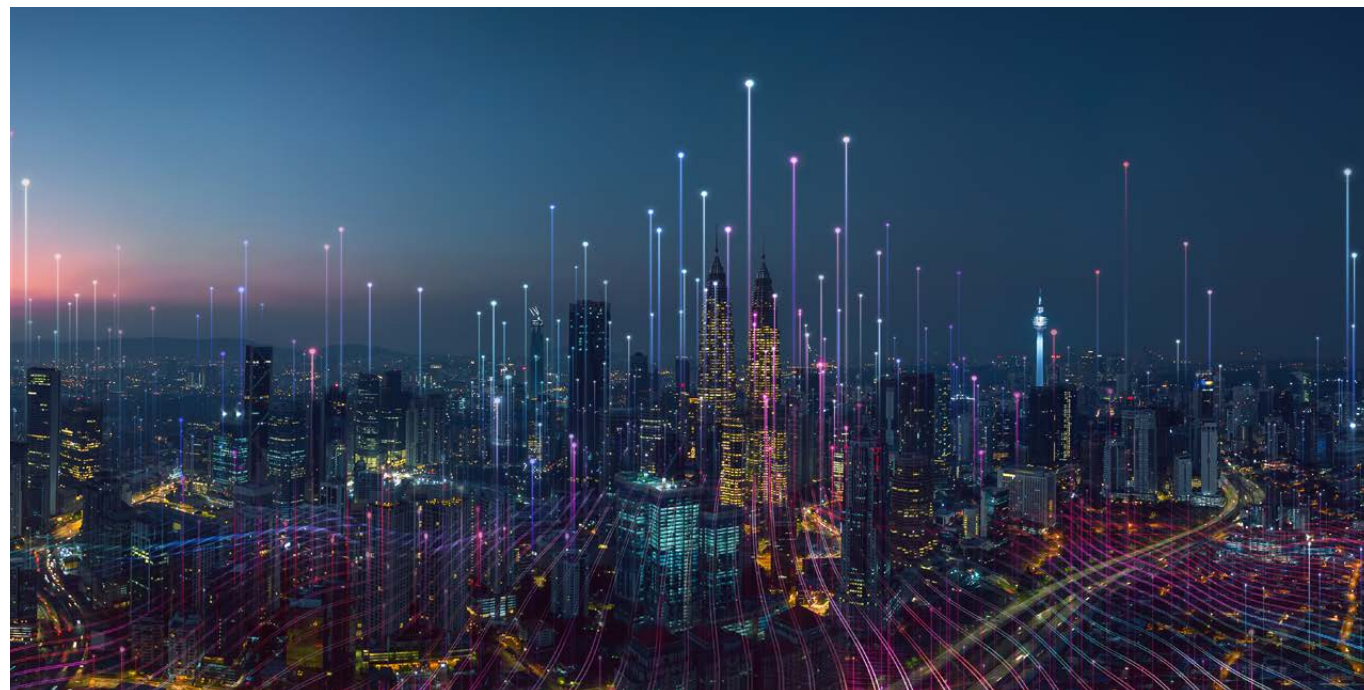
Guided by the philosophy "*committed to excellence*", the employees work tirelessly to stay the trusted solution provider for customers and partners.

Rutronik is expanding continuously in **North America, Asia and Europe**. This ensures comprehensive customer support worldwide. Besides a dense pan-European network of sales offices, the company also has locations in the US as well as in the Asian region. **Rutronik Inc.** with its **headquarter in Coral Springs, FL** serves the North American market with a **warehouse in Austin, TX**. Regional sales offices and Field Application Engineers throughout the country assist the customers in the US and Mexico locally. Rutronik's **Asian subsidiaries** with **seven offices in China, Hong Kong, Taiwan and Thailand** support customers in the Asian market.



Introduction to Cellular IoT

NB-IoT, LTE-M, and DECT-NR+



LTE

LTE is 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)

LTE-M 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. A throughput of 375 kbps downlink and 300 kbps uplink, provides approx. 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 or mobility, like asset tracking, wearables, medical, POS and home security applications.

NB-IoT (also known as Cat-NB1)

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 due to 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

GNSS - 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 (1,783.74 MHz uplink, 2,227.5 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 (1,575.42 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 1,500 bit navigation message.

The L2 frequency (1,227.60 MHz) only transmits the military P/Y-code. Optionally, 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 -158.5 dBm (for military signals -161.5 dBm), a transmission power of more than 20 W per frequency band is required.

Introduction to Cellular IoT

NB-IoT, LTE-M, and DECT-NR+

CryptoCell

CryptoCell 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' nRF9160 System-in-Package (SiP), nRF5340 and nRF52840 System-on-Chips (SoCs).

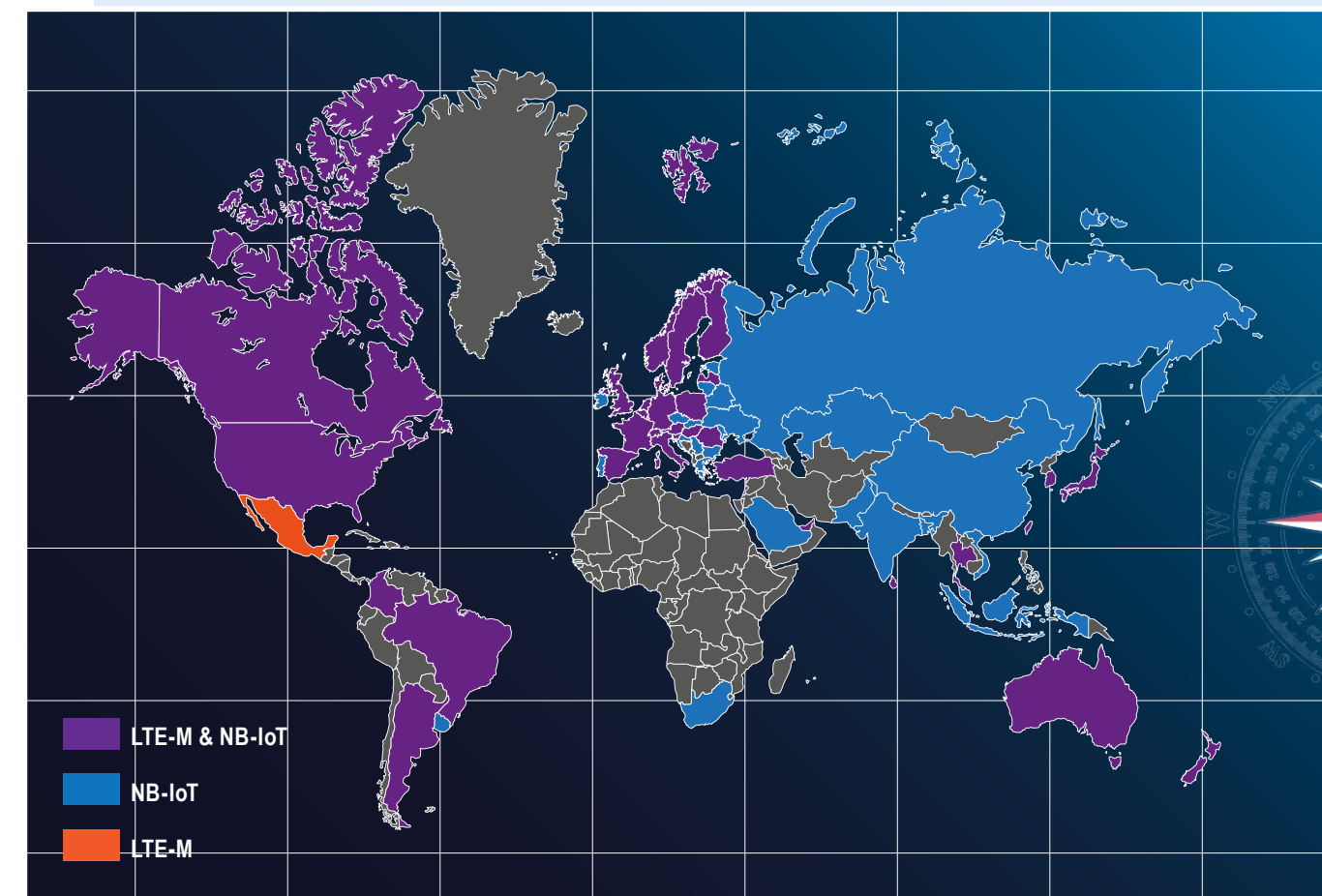
Trust Zone

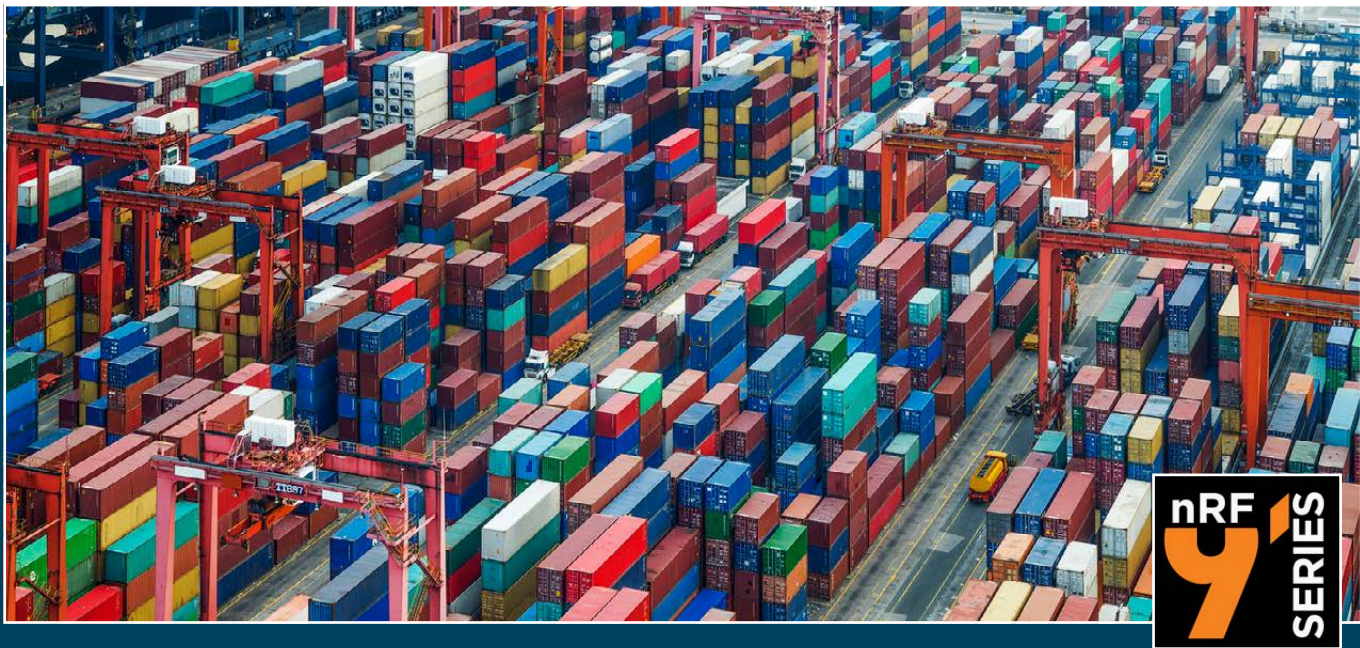
Arm TrustZone technology offers efficient, system-wide approach to security with hardware-enforced isolation built into the CPU. TrustZone is a suite of security extension IPs for creating Trusted Execution Environments (TEE). It provides the perfect starting point for establishing a device root of trust 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, nRF5340 and nRF52840 (SoCs).

DECT NR+

DECT New Radio plus, standard name DECT-2020 NR, is one of the latest radio protocols for IoT applications. This non-cellular radio standard is recently included as part of the 5G standards by the ITU. NR+ employs a self-healing, decentralized, and autonomous mesh network, making it easy to add new devices and eliminating any single points of failure. It has a flexible and highly scalable network structure that has use-cases and applications across many industries. NR+ utilizes known cellular techniques and provides a robust standardized solution that is unmatched by any other non-cellular technologies. NR+ fills a genuine gap in the IoT ecosystem in terms of large-scale machine-to-machine operations that will allow enterprise IoT customers to build their own low-cost private networks. Moreover, it is also the first non-cellular radio standard to be recognized as a radio technology fulfilling the formal IMT-2020 5G requirements, for both Ultra-Reliable Low Latency Communication (URLLC) and massive Machine Type Communication (mMTC) use cases.

NR+ can be valuable both as a low-cost alternative to existing solutions and unrealized applications. Many nextgeneration applications are being held back due to needing the reliability and low latency of a wired connection, but without the physical constraints of wires, and NR+ can offer exactly that.





Features	nRF9160	nRF9161	nRF9151	nRF9131
				
CPU	Arm® Cortex-M33 @ 64 MHz	Arm® Cortex-M33 @ 64 MHz	Arm® Cortex-M33 @ 64 MHz	Arm® Cortex-M33 @ 64 MHz
Flash / RAM	1 MB / 256 KB	1 MB / 256 KB	1 MB / 256 KB	1 MB / 256 KB
Arm Trustzone	✓	✓	✓	✓
Crypto Acceleration	Arm® Cryptocell 310	Arm® Cryptocell 310	Arm® Cryptocell 310	Arm® Cryptocell 310
Integrated PMIC, Passives & Xtral	✓	✓	✓	
Pre-certified	✓	✓	✓	
LTE-M	3GPP rel 13	3GPP rel 14	3GPP rel 14	3GPP rel 14
NB-IoT	3GPP rel 13	3GPP rel 14	3GPP rel 14	3GPP rel 14
DECT NR+		✓	✓	✓
Certified Bands	1 - 5, 8, 12, 13, 17 - 20, 25, 26, 28, 66	1 - 5, 8, 12, 13, 17 - 20, 25, 26, 28, 65, 66, 85	1 - 5, 8, 12, 13, 17 - 20, 25, 26, 28, 65, 66, 85	1 - 5, 8, 12, 13, 17 - 20, 25, 26, 28, 65, 66, 85
Frequency	700 - 2,200 MHz	700 - 2,200 MHz (LTE) 1.9 GHz (NR+)	700 - 2,200 MHz (LTE) 1.9 GHz (NR+)	700 - 2,200 MHz (LTE) 1.9 GHz (NR+)
Maximum TX Power	23 dBm	23 dBm	23 dBm	23 dBm
Power Class 5 - 20dBm			✓	
Supply Voltage Range	3.0 to 5.5 V	3.0 to 5.5 V	3.0 to 5.5 V	3.0 to 5.5 V (dep. on ref. design)
Operating Temperature	-40 to 85 °C	-40 to 85 °C	-40 to 85 °C	-40 to 85 °C
Package Options	10 x 16 x 1.04 mm LGA	10 x 16 x 1.04 LGA	11 x 12 x 1 mm LGA	7 x 11 x 0.74 mm LGA



nRF9151 - Low power SiP with integrated LTE-M/NB-IoT and DECT NR+ modem, and GNSS

The nRF9151 sets a new standard for highly integrated and compact System-in-Package (SiP) solutions, specifically designed for cellular IoT and DECT NR+ applications. Leveraging low power LTE technology, advanced processing capabilities, and robust security features, the nRF9151 offers unparalleled performance and versatility, and supports 3GPP release 14 LTE-M/NB-IoT and DECT NR+. Compared to its predecessor (nRF9161), it boasts a significant footprint reduction of 20% and brings additional support for Power Class 5 20 dBm.

Key Features

- Fully integrated SiP with 64 MHz Arm® Cortex-M33 and multimode LTE-M/NB-IoT modem with DECT NR+ support and GNSS
- 700 - 2,200 MHz LTE band support
- Power Class 5 20 dBm
- Power Class 3 23 dBm
- 1.9 GHz NR+ band support
- Certified for global operation
- Dedicated programmable application processor and memory
- 1 MB flash + 256 KB RAM
- Arm® TrustZone + Arm® CryptoCell 310

Main Benefits

- Enhanced Capabilities:** The nRF9151 surpasses its predecessor with support for Power Class 5 20 dBm output power, complementing the existing Power Class 3 23 dBm, which provides great design flexibility as it eases the requirements for battery-powered products.
- Global Connectivity and Power Efficiency:** The integrated modem of the nRF9151 enables global connectivity without regional limitations, and include new unique modem features for further power saving and ease of use.
- Unleashing the Potential of DECT NR+:** Harness the capabilities of the DECT NR+ stack, enabling massive mesh applications that prioritize reliability, secure connections, long range, and scalability.

Applications

- Asset Tracking
- Smart Metering
- Smart City
- Smart Agriculture
- Predictive maintenance
- Portable Medical Devices
- Industry 4.0

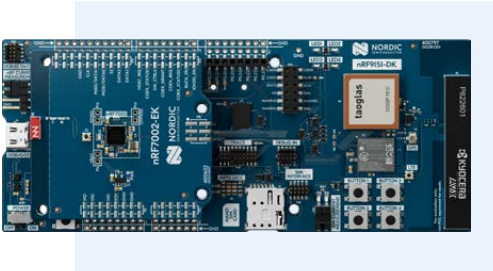


nRF9151 DK

The nRF9151 DK is an affordable, pre-certified single board development kit for evaluation and development on the nRF9151 System-in-Package (SiP) for LTE-M, NB-IoT, GNSS and DECT NR+. It has a dedicated LTE-M, NB-IoT and DECT NR+ antenna that supports a wide range of bands to operate globally.

Key Features

- Same certification coverage as nRF9151 SiP
- LTE-M/NB-IoT & GNSS antennas with respective SWF RF connectors
- SEGGER J-Link OB programmer/debugger
- Pins for measuring power consumption, e.g. with Nordic's Power Profiler Kit II
- User-programmable LEDs & buttons
- 3.0 - 5.5 V supply from external or 5 V Supply from USB
- Bundled with SIM cards from Onomondo and Wireless Logic preloaded with free data





nRF9161 – Low power SiP with integrated LTE-M/NB-IoT and DECT NR+ modem and GNSS

The nRF9161 sets a new standard for highly integrated System-in-Package (SiP) solutions, specifically designed for cellular IoT and DECT NR+ applications. Leveraging low-power LTE technology, advanced processing capabilities, and robust security features, the nRF9161 offers unparalleled performance and versatility. It offers enhanced capabilities compared to its predecessor (nRF9160), including DECT NR+ support and 3GPP release 14 LTE-M/NB-IoT support.

nRF9131 - Low power mini SiP for DECT NR+ and high volume cellular IoT products

The nRF9131 Mini SiP is a powerful solution perfect for DECT NR+ applications. It also supports cellular operations utilizing the same LTE stack as nRF9161. The nRF9131 will simplify traditional chipset-based designs, making it ideal for high-volume cellular IoT applications. With lower integration compared to the nRF9161 SiP, the nRF9131 offers a lower Bill of Materials (BOM). However, it's important to note that cellular end-product certification Non-Recurring Expenses (NRE) will increase depending on needed geographical coverage. This makes it an intriguing choice for global NR+ applications as well high-volume cellular products targeting specific regions.

Key Features

- Fully integrated SiP for cellular IoT and DECT NR+
- Multimode LTE-M/NB-IoT modem with DECT NR+ support and GNSS
- 700 - 2,200 MHz LTE band support
- 1.9 GHz NR+ band support
- Certified for global operation
- Dedicated programmable application processor and memory
- 64 MHz Arm® Cortex-M33
- 1 MB flash + 256 KB RAM
- Arm® TrustZone + Arm® CryptoCell



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 10 x 16 x 1 mm package, it offers the most compact solution for cellular IoT on the market. Targeting asset tracking, 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.

nRF9161 DK

The nRF9161 DK is an affordable, pre-certified single board development kit for evaluation and development on the nRF9161 System-in-Package (SiP) for LTE-M, NB-IoT, GNSS and DECT NR+. It has a dedicated LTE-M, NB-IoT and DECT NR+ antenna that supports a wide range of bands to operate globally. The nRF9161 DK has the same coverage as the nRF9161 SiP.

LTE bands B1 - B5, B8, B12, B13, B17 - B20, B25, B26, B28, B65, B66 and B85 are supported. An integrated patch antenna for GNSS is also included on the PCB, while SWF RF connectors are available for measuring the performance of the RF signals. Both antenna connectors also allow for the use of external antennas. All GPIOs and interfaces are available via connectors.

The kit is Arduino Uno Rev3 compatible, meaning it can easily interface with external device shields. User-programmable LEDs and buttons (4 each) are available for output and input. The nRF9161 DK has both a nano/4FF SIM card slot and an MFF2 SIM footprint, to support plug-in and soldered (e)SIMs.

The kit is shipped with a SIM card that is preloaded with free data. It also supports the use of Software SIM, further reducing power consumption.

Key Features

- Same certification coverage as nRF9161 SiP
- LTE-M/NB-IoT & GNSS antennas with respective SWF RF connectors
- SEGGER J-Link OB programmer/debugger
- Pins for measuring power consumption, e.g. with Nordic's Power Profiler Kit II
- User-programmable LEDs & buttons
- 3.0 - 5.5 V supply from external or 5 V
- Supply from USB
- Included SIM with free data



Rutronik ordering code: RFMCU2199

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 1,440 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.



Rutronik ordering code: RFMCU1497

nRF9160 DK

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.

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.



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 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.



Location Services

- Assisted and Predictive GNSS
- Single-cell and multi-cell
- SSID-based Wi-Fi locationing

Security Services

- Secure Identity
- Secure Provisioning

Device Management

- Onboarding
- Configuration & Monitoring
- Firmware-over-the-air updates

Comparing nRF Cloud Location Services

Location Feature	A-GPS	P-GPS	Wi-Fi	MCELL	SCell
Accuracy (optimal)	5 - 10 m	5 - 10 m	5 - 15 m	200 - 300 m	1,000 m
Power Consumption	High	High	Moderate	Low	Low
Use Case	Precise outdoor position	Precise outdoor position	Which house/ building	Which neighbourhood	Which city



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 4.0-6.0, 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
6.0	Bluetooth® Dual Mode or LE	Sep 24	LE up to 2 Mbit/s Classic up to 24 Mbit/s	Bluetooth® Channel Sounding
5.4	Bluetooth® Dual Mode or LE	Feb 23	LE up to 2 Mbit/s Classic up to 24 Mbit/s	New Features:PAWR & Encrypted Advertisement Data + bi-directional comm.
5.3	Bluetooth® Dual Mode or LE	Jul 21	LE up to 2 Mbit/s Classic up to 24 Mbit/s	LE Audio and Auracast™
5.2	Bluetooth® Dual Mode or LE	Jan 20	LE up to 2 Mbit/s Classic up to 24 Mbit/s	
5.1	Bluetooth® Dual Mode or LE	Jan 19	LE up to 2 Mbit/s Classic up to 24 Mbit/s	Direction finding using Angle of Arrival or Angle of Departure
5.0	Bluetooth® Dual Mode or LE	Dec 16	LE up to 2 Mbit/s Classic up to 24 Mbit/s	4x range, 2x speed, 8x broadcasting message capacity comp. to previous version
4.2	Bluetooth® Dual Mode or LE	Dec 14	LE up to 1 Mbit/s Classic up to 24 Mbit/s	Impr. privacy, increase speed, soon-to-be ratified profile will enable IP connectivity
4.1	Bluetooth® Dual Mode or LE	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
4.0 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® LE
4.0 LE	Bluetooth® Low Energy	Dec 09	220 kbit/s	Bluetooth® LE is not compatible to Classic Bluetooth®
3.0 + EDR	Enhanced Data Rate	Apr 09	3 Mbit/s	With additional Wi-Fi Hardware
3.0 + HS	Bluetooth® High Speed	Apr 09	3 - 24 Mbit/s	Add. HS-channel available; can reach a data rate of 24 Mbit/s
2.1 + EDR	Enhanced Data Rate	Aug 07	2.1 Mbit/s	Easy pairing of devices compared to older Bluetooth®-versions
1.0 - 2.0				Obsolete

What are Bluetooth® Profiles?

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	Class
SPP	Serial Port	Serial data transfer	Classic
A2DP	Advance Audio Distribution	Streaming of audio multimedia	LE
HDP	Health Device	Facilitates transmission of Medical Device Data	LE
HID	Human Interface Device	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	Support the development of accessories for Apple devices such as the iPhone or iPad.	LE
GAP	Generic Access	Provides basis for all other profiles + defines how two Bluetooth® units establish a connection with each other	LE
GATT	Generic Attribute	Provides profile discovery and description services for Bluetooth® SMART protocol	LE

Technology Introduction

Channel Sounding

The new Bluetooth Channel Sounding feature makes it possible to create products that have the ability calculate the distance between two Bluetooth devices with significantly better accuracy than could ever be produced using the RSSI and path loss first generation method. It works in an entirely different way and includes a variety of security safeguards that mitigate various types of risk. It is expected that Bluetooth Channel Sounding will benefit Find My solutions, digital key products, and many more Bluetooth connected devices.

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 be 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

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

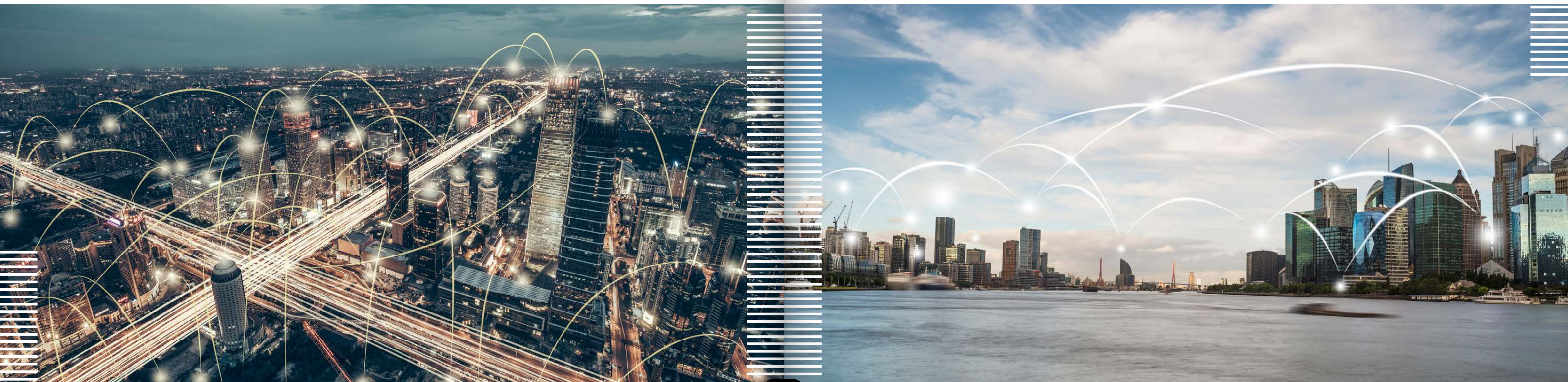
Matter aims to make it easy for developers to create secure and reliable solutions. If you want your products to be interoperable with the major smart home ecosystems, Matter is the way to go. Matter, which began as Project CHIP (Connected Home over IP) started in December 2019. The starting companies 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

Occasionally complete control of the wireless link is required for reasons such as low latency, reduced packet size or particularly unique protocol behavior. The nRF52/ 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. Main difference 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® devices are recommended.

Bluetooth Mesh

State-of-the-art mesh networking techn. extending the capabilities of Bluetooth® LE. It enables powerful concurrent multicast (many-to-many) communication in networks with thousands of nodes. The functionality is a vital update for new applications in lighting, sensor networking, predictive maintenance, asset tracking and positioning. Bluetooth® Mesh is a managed flooding mesh, which is a simple and reliable approach to distribute messages in larger networks. Reliability is ensured with multiple paths from source to destination and there is no single point of failure. The Bluetooth® Mesh technology has separate encryption for network and application layers enabling network managers to create multi-level access control mechanisms.



nRF54 Series Product Summary



Powerful and energy-efficient wireless technology, perfect for smart and connected devices.

The market-share leader in Bluetooth® LE extends its commitment to innovation with its new, fourth-generation low power wireless SoCs. Capable of supporting Bluetooth® 6.0 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 and the nRF54L15 are the first System-on-Chips (SoCs) in the nRF54H and nRF54L 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® and TSMC 22ULL® leading process nodes.

**nRF
54
SERIES**

Highlights of nRF54 Series

- Efficiency with higher performance and lower power consumption
- Modern process nodes for IoT with 22nm
- Advanced security services
- Physical attack protection and designed for PSA Certified Level 3
- New generation Nordic radio

nRF54H Series nRF54H20



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
- 1 MB RAM
- Bluetooth® Low Energy, LE Audio, Bluetooth® Mesh, Thread, Matter, 2.4 GHz proprietary (up to 4Mbps), Amazon Sidewalk
- New peripherals: High-speed USB (480Mbps), CAN FD controller, 2 x I3C and 14-bit ADC, and more
- Advanced security services
- Protection against physical attacks

Main 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

Applications

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





nRF54L15

nRF54L15 is the first System-on-Chip (SoC) in the nRF54L Series. It is an ultra-low power Bluetooth® SoC with a new best-in-class multi-protocol radio and advanced security features. nRF54L Series takes the popular nRF52 Series to the next level with excellent processing power and efficiency, expanded memory, and new peripherals, all in a more compact package.

Key Features

- 128 MHz Arm® Cortex-M33 processor
- 1.5 MB non-volatile memory
- 256 KB RAM
- Bluetooth® Low Energy, Thread, Matter, 2.4 GHz proprietary (up to 4 Mbps), Amazon Sidewalk
- **New peripherals:** Global RTC, 14-bit ADC, and a software-defined peripheral enabled by a RISC-V coprocessor
- Advanced security
- TrustZone isolation, side-channel protection, and tamper detection
- Ultra-compact packages

Main Benefits

- **Takes nRF52 Series to the next level:** A massive leap forward in performance, efficiency, and security.
- **Protects against security threats:** Advanced security with secure boot, secure firmware update, secure storage, and protection against physical attacks.
- **Supports multiple wireless protocols:** Bluetooth Low Energy, Thread and Matter, and 2.4 GHz proprietary with throughput up to 4 Mbps
- **Prolongs battery life or reduces battery size:** Efficient processing, ultra-low power radio, and minimal sleep currents.

Applications

- PC accessories, gaming controllers, and remotes
- Virtual - / Augmented reality
- Smart home and Matter
- Medical devices
- Industrial IoT



Module Partners based on nRF54L15

ISP2454 – Bluetooth® 5.4 Low Energy Module, small footprint

This ultra-compact LGA module, 8 x 8 x 1 mm, is based on the ultra-low power nRF54L15 chip that offers a multi-protocol radio and advanced security features. Its powerful Cortex-M33 processor, expanded memory and new set of peripherals, combined with Insight SiP capability for best-in-class antenna design, this module provides the perfect solution for drop-in Bluetooth® connectivity. It is also a direct upgrade to the ISP1507 / ISP1807 series with pin-to-pin compatibility.



PAN B511-1x – next gen Bluetooth® 5.4 Module, cost-effective, high performance

The PAN B511-1x is a Bluetooth® 5.4 Low Energy (LE) module based on the Nordic nRF54L15 single chip controller. It is available with an on-board chip antenna and with a RF-bottom pad. The all-in-one SoC including a superset of the most prominent nRF54 Series features combined with more performance and memory, while minimizing current consumption. In addition, the ultra-low current consumption of the PAN B511-1C makes the module an ideal choice for battery powered devices. The small size hybrid castellated holes & LGA footprint design offers the possibility for optical outgoing inspection, 2-layers designs and fast prototyping with hand soldering, while still offering more GPIOs on the bottom if needed.



ME54BS01 – High Cost Performance, Ultra-low Power Bluetooth® 5.4 LE Module

ME54BS01 is a highly flexible, ultra-low power, cost-effective Bluetooth® module based on nRF54L15. Its powerful Arm® Cortex®-M33 CPU has a core running speed of 128 Mhz. In addition, it also has 1.5 MB NVM space and 256 KB RAM. It is also designed for PSA Level 3 certification and has high security protection. The hardware is equipped with an onboard antenna, and the integrated design highlights the higher performance of the nRF54 series and provides more GPIO development and use. At the same time, the ultra-low system power consumption and excellent RF performance as well as other powerful supporting resources can provide a perfect solution for Bluetooth® connection.



Module Partners based on nRF54H20

ME54BS02 – Best-in-class, Ultra-low Power Bluetooth® 5.4 LE Module

ME54BS02 is a highly integrated, ultra-high performance, ultra-low power Bluetooth® module based on nRF54H20. It integrates multiple Arm® Cortex®-M33 processors and RISC-V coprocessors with clock frequencies up to 320 MHz, and each processor is optimized for a specific type of workload. In addition, it also comes with 2 MB non-volatile MRAM and 1 MB static RAM, and is designed for PSA Level 3 certification with high security protection. The hardware is equipped with an onboard antenna, and the integrated design highlights the higher performance of the nRF54 series and provides more GPIO development and use. At the same time, the ultra-low system power consumption and excellent RF performance as well as other powerful supporting resources are very suitable for Bluetooth® low-power applications and Bluetooth® high-end applications.



nRF53 Series **nRF5340**

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

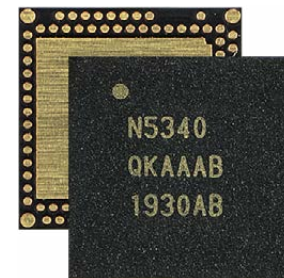
The nRF5340 is the world's first wireless SoC with two Arm® Cortex®-M33 processors. It is truly secure, and the combination of two flexible processors, the advanced feature set, and an operating temperature of up to 105 °C, make it the ideal choice for professional lighting, advanced wearables, and other 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

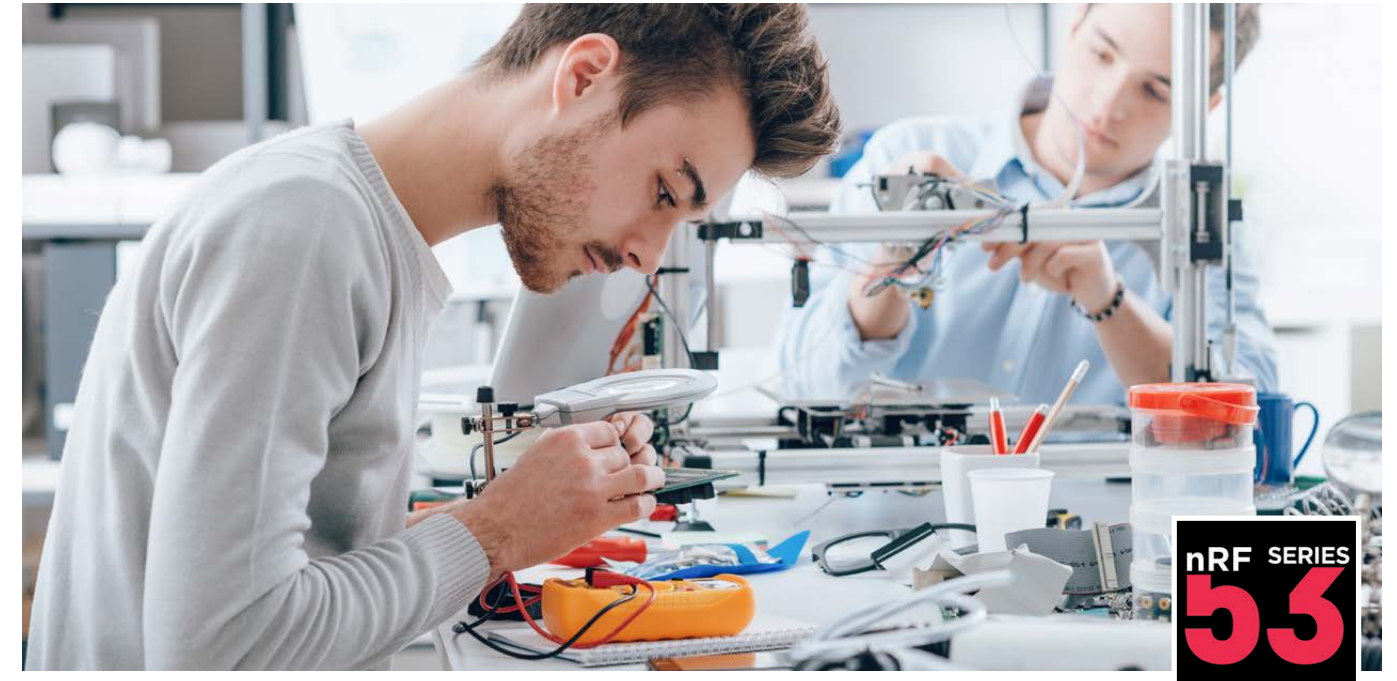
- High-performance application processor
 - 128/64 MHz Arm® Cortex®-M33 with FPU & DSP instructions
 - 1 MB Flash + 512 kB low leakage RAM
 - 8 kB 2-way set associative cache
- Fully-programmable network processor
 - 64 MHz Arm® Cortex®-M33 with 2 kB instruction cache
 - 256 kB Flash + 64 kB RAM | Ultra 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 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

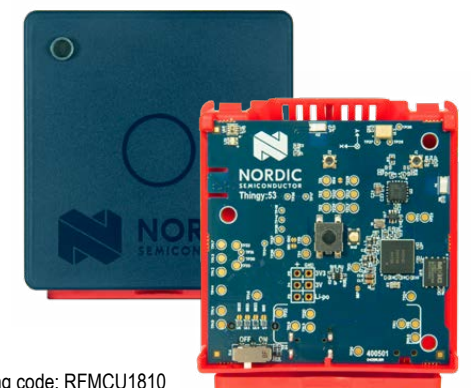
The Nordic Thingy:53 is a multi-sensor prototyping platform for Matter, embedded machine learning (ML) and other wireless IoT products. It is based on the nRF5340 System-on-Chip (SoC), Nordic's current flagship dual-core wireless SoC. The nRF Edge Impulse app enables users to connect their Nordic Thingy:53 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 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. 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 temp., 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



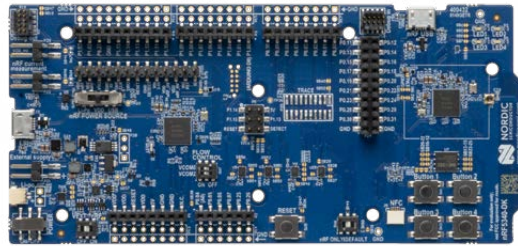
Rutronik ordering code: RFMCU1810

nRF5340 DK

A Development kit for the nRF5340 SoC, containing everything needed to get started with development, on a single board. It supports development with an extensive range of wireless protocols. It supports Bluetooth® LE and all Bluetooth® 5.3 features, incl. 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 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 to 5.0 V supply from USB, external, Li-Po battery or CR2032 coin cell battery



Rutronik ordering code: RFMCU1715

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
- 1,350 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 Guides
- 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 to ensure their Bluetooth® products comply with the Bluetooth® Patent and 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 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 an 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.

nRF52 / nRF53 Series

Product Summary

Feature	nRF52840	nRF52833	nRF52832	nRF52820	nRF52811	nRF52810	nRF52805	nRF5340
Bluetooth® LE	x	x	x	x	x	x	x	x
Bluetooth® 5.4	x	x	x	x	x	x	x	x
LE Audio								x
Direction Finding		x		x	x			x
2 Mbps	x	x	x	x	x	x	X	x
Long Range	x	x		x	x			x
Bluetooth® mesh	x	x	x	x				x
Thread	x	x		x	x			x
Matter	x							x
Zigbee	x	x		x				x
ANT	x	x	x	x	x	x	X	x
2.4 GHz Proprietary	x	x	x	x	x	x	X	x
NFC	x	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	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	128 MHz Arm® Cortex-M33, +64 MHz Arm® Cortex-M33
FPU	x	x	x					x
DSP Instruction Set	x	x	x	x	x	x	X	x
Cache	x	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	1 MB Flash, 512 kB RAM, +256 kB Flash, 64 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	64 MHz / 32 kHz	128 MHz / 64 MHz / 32 kHz
Arm Trustzone								x
Arm CryptoCell	310							312
Root-of-trust	x							x
Secure Key Storage								x
AES Encryption	x	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	2.4 GHz
Maximum TX Power	8 dBm	8 dBm	4 dBm	8 dBm	4 dBm	4 dBm	4 dBm	3 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)	-98 dBm (1 Mbps)
Antenna Interface	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended
High Speed SPI	x	X						x
TWI, SPI, UART	2x TWI/SPI, SPI, 2x UART	2x TWI/SPI, SPI, 2x UART	2x TWI/SPI, SPI, 2x UART	2x TWI/SPI, UART	TWI/SPI, SPI, UART	TWI, SPI, UART	TWI, SPI, UART	4x TWI/SPI/UART , +TWI/SPI/UART
QSPI	x							x
USB	x	x		x				x
PWM	4	4	3		1	1		4
PDM	x	x	x		x	x		x
I2S	x	x	x					x
ADC, Comparator	x	x	x	COMP	ADC, COMP	ADC, COMP	ADC	x
Timer, RTC	5, 3	5, 3	5, 3	4, 2	3, 2	3, 2	3, 2	3, 2 + 3,2
Temp. Sensor	x	x	x	x	x	x	X	x
Applications	Automation Beacon Consumer Electronics Gaming / VR + AR Healthcare & Medical Ind. 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, Ind. 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	Asset Tracking Automation Consumer Electronics, Direction Finding Gaming / VR + AR, Healthcare & Medical Ind. Systems, Mesh Networks Professional Lighting, Smart Buildings Smart City, Smart Home, Sports & Fitness Toys, Wearables
Certifications	CE, FCC	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	-40 to 105 °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	1.7 to 5.5 V
Development Kits	nRF52840 DK, nRF52840 Dongle	nRF52833 DK	nRF52 DK, Nordic Thingy:52	nRF52833 DK	nRF52840 DK	nRF52 DK	nRF52 DK	nRF5340 DK, nRF5340 Audio DK, Thingy:53
Packages	7 x 7 mm aQFN73 (48 GPIOs) 6 x 6 mm QFN48 (48 GPIOs) 3.5 x 3.6 mm WLCSP94 (48 GPIOs)	7 x 7 mm aQFN73 (42 GPIOs) 5 x 5 mm QFN40 (18 GPIOs) 3.2 x 3.2 mm WLCSP(42 GPIOs)	6 x 6 mm QFN48 (32 GPIOs) 3.0 x 3.2 mm WLCSP50 (32 GPIOs)	5 x 5 mm QFN40 (18 GPIOs) 2.53 x 2.53 mm WLCSP44 (18 GPIOs)	6 x 6 mm QFN48 (32 GPIOs) 5 x 5 mm QFN32 (17 GPIOs) 2.48 x 2.46 mm WLCSP33 (15 GPIOs)	6 x 6 mm QFN48 (32 GPIOs) 5 x 5 mm QFN32 (17 GPIOs) 2.48 x 2.46 mm WLCSP33 (15 GPIOs)	2.48 x 2.46 mm WLCSP28 (10 GPIOs)	7 x 7 mm aQFN94 (48 GPIOs) 4.4 x 4.0 mm WLCSP95 (48 GPIOs)



nRF52 Series

Related Development Tools

nRF52 DK

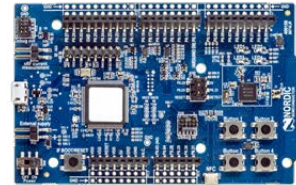
The nRF52 DK is a development kit that includes hardware, firmware source code, documentation, hardware schematics, and layout files. This kit can be used for developing for either the nRF52832 or nRF52810 SoCs. The content of the kit is the nRF52 DK, a CR2032 battery and a NFC antenna.

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 to 3.6 V, battery and USB, external

Applications

- Internet of Things (IoT) - Sensors & Hubs
- Wearables/ Accessories – Sensors & 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® 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



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, - mesh, NFC, Matter, Thread & 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

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® Cortex® TM-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



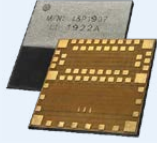
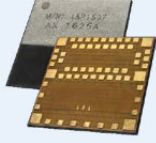
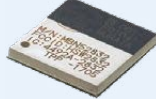
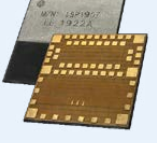
Rutronik ordering code: RFMCU1350

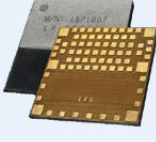
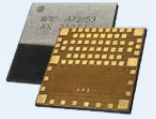
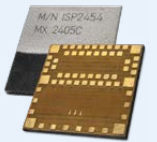
Applications nRF52840 DK and nRF52840 Dongle

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

Rutronik Module Partners based on Nordic

Overview

Nordic SoC	nRF52810	nRF52811		nRF52820	nRF52832	nRF52832		nRF52833		
Module Supplier	Minew	Insight SiP	Minew	Panasonic	Insight SiP	Murata	Minew	Insight SiP	Panasonic	Minew
Product Name	MS50SFA	ISP1907-LL	MS50SFB3	PAN1781	ISP1507-AX	MBN52832	MS50SFB	ISP1907-HT	PAN1782	MS88SF3
Product Photo										
Dimension	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	7,4 x 7 x 0,9	20 x 12 x 2	8 x 8 x 1	15,6 x 8,7 x 2	18,5 x 12,5 x 2
Flash and RAM	192 kB Flash, 32 kB RAM	192 kB Flash, 24 kB RAM		256 kB Flash, 32 kB RAM	512 kB Flash, 64 kB RAM	512 kB Flash, 64 kB RAM		512 kB Flash, 128 kB RAM		512 kB flash, 64 kB RAM
GPIOs	13	13	30	16	30	20	32	30	16	48
32 kHz Crystal	no	yes	no	yes	yes	no	yes	yes	yes	no
Certifications	CE, FCC, RoHS	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	Bluetooth EPL/QDID, FCC, CE, IC, MIC, RCM	CE RED, FCC, ISCED, MIC, KCC, ACMA, RSM	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	CE, FCC, IC, ETSI, TELEC	Bluetooth QDID, CE, FCC, IC, TELEC, RCM, WPC, RoHS, REACH	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	CE RED, FCC, ISCED, MIC, KCC, RSM	EPL/QDID, FCC, CE, IC, TELEC/MIC, RCM, WPC, RoHS, REACH
Available extra feature	LE 5.2	LE 5.2 direction finding / Pin-compatible with ISP15/18/20/24 series	Bluetooth 5.4	Bluetooth 5.3 direction finding	Pin-compatible with ISP18/19/20/24 series	Ultra Small Bluetooth® 5.0 LE Module		LE 5.2 direction finding Pin-compatible with ISP15/18/20/24 series	Bluetooth® 5.3 LE + direction finding, NFC	LE 5.2 direction finding

Nordic SoC	nRF52840				nRF5340	nRF5340		nRF54L15		nRF54H20	
Module Supplier	Insight SiP	Minew	Panasonic	iVativ	Insight SiP	Panasonic	Minew	Insight SiP	Minew	Panasonic	Minew
Product Name	ISP1807-LR	MS88SF3	PAN1770 / PAN1780	RENO/NILE	ISP2053-AX	PAN1783	MS45SF1	ISP2454 (Q1 2025)	ME54BS01 (Q1 2025)	PAN B511-1x (Q1 2025)	ME54BS02 (Q1 2025)
Product Photo											
Dimension	8 x 8 x 1	18.5 x 12.5 x 2	15,6 x 8,7 x 2	10 x 15 x 1,5	8 x 8 x 1	15,6 x 8,7 x 2	18 x 12,5 x 2	8 x 8 x 1	23.2 x 17.4 x 2	10.35 x 9.6 x 2	16.5 x 12 x 2
Flash and RAM	1 MB Flash / 256 kB RAM				1 MB Flash, 512 kB RAM 256 kB Flash, 64 kB RAM	1 MB Flash, 512 kB RAM 256 kB Flash, 64 kB RAM		1.5 MB Flash / 256 kB RAM		2 MB Flash / 1 MB RAM	
GPIOs	46	42	48	46	46		48	30	19	32	
32 kHz Crystal	yes	no	yes	yes	yes	yes	no	yes	no	yes	
Certifications	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	BQB, CE, FCC, REACH, ROHS	CE RED, FCC, ISCED, MIC, KCC, ACMA, RSM	CE, FCC, IC	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	CE RED / FCC / ISCED				CE RED, FCC, ISCED, MIC	
Available extra feature	LE 5.2 with long range, Pin-compatible with ISP15/19/20/24 series	LE 5.2 with long range	LE 5.2 with long range; without internal antenna (PAN1770), with internal antenna (PAN1780)	Zigbee and Thread certified, available in 2 different antenna options	two Cortex®-M33 processors, LE 5.3 LE Audio, Pin-compatible with ISP15/18/19/24 series	two Cortex®-M33 processors	Bluetooth 5.4 LE Audio	Bluetooth 5.4 Low Energy, Pin-compatible with ISP15/18/19/20 series	Bluetooth 5.4 Low Energy	Bluetooth 5.4 Low Energy	Bluetooth 5.4 Low Energy



Introduction to Range Extender

nRF21 Series

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

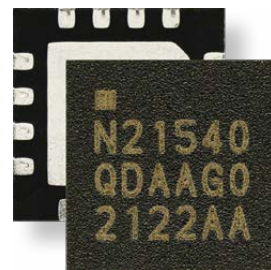
The nRF21540 is an RF front end module that improves range and connection robustness for Nordic Semiconductor's short-range wireless portfolio. As a complementary device, the nRF21540 is a "plug and play" range extender, which offers enhanced link robustness using an integrated power amplifier. It can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

Key Features

- Supports
 - Bluetooth® LE (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 to +105 °C operating temperature range
- 1.7 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



nRF21 Series

Related Development Tools

nRF21540 Development Bundle

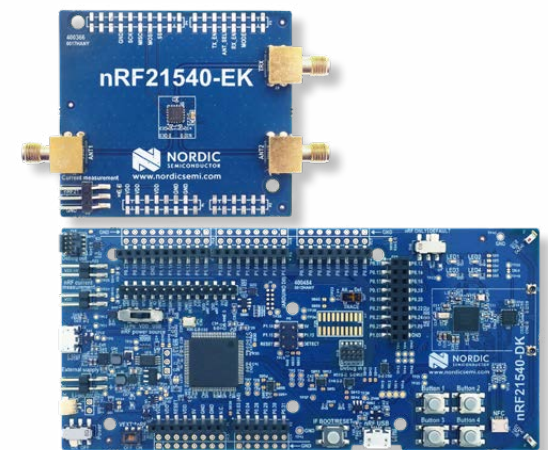
The nRF21540 DB consists of the nRF21540 development kit (DK) and the nRF21540 evaluation kit (EK). The nRF21540 DK is the perfect tool to develop products that require the range extension capabilities or link budget improvements provided by the nRF21540 RF front-end module (FEM). The nRF21540 EK can 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® 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





Power Management IC (PMIC)

Nordic Semiconductor leverages its extensive experience in ultra-low power wireless technology to develop power management ICs, enabling industry-leading low power wireless solutions.

	nPM1300	nPM1100	nPM6001
Buck regulator	2	1	4
Battery charger	✓	✓	
LDO	2		2
Load switch	2		
Termination voltage	3.5 - 4.45 V	4.1 - 4.2 V, or 4.25 - 4.35 V	
Max charging current	800 mA	400 mA	
Dynamic power-path management	✓	✓	
Thermal protection	✓	✓	
Battery compatibility	LiFePO4, Li-ion, LiPo	Li-ion, LiPo	
Input voltage	4.0 - 5.5 V	4.1 - 6.7 V	3 - 5.5 V
USB compliance	Type-C	✓	
Regulated output voltage	1.0 - 3.3 V	1.8 - 3.0 V	0.5 - 3.3 V
Max current per buck	200 mA, 200 mA	150 mA	550 mA, 200 mA, 150 mA, 150 mA
System monitoring	System, input bus and battery voltages. Battery current and temperature. Die temperature.		
Fuel gauge	✓		
Hard system reset	✓		
Timed wake-up	✓		✓
Watchdog timer	✓		✓
Ship / hibernate mode	✓	✓	✓
Brown-out detector	✓	✓	✓
LED drivers, GPIOs	3, 5	2, 0	0, 3
Control interface	TWI	Pin-configurable	TWI
Regulatory compliance	CE, JEITA, RoHS	CE, JEITA, RoHS	CE, RoHS
Operating tempetature	-40 to 85 °C	-40 to 85 °C	-40 to 85 °C
Evaluation kits	nPM1300 EK	nPM1100 EK	nPM6001 EK
Package options	5 x 5 mm QFN32, 3.1 x 2.4 mm WLCSP	4 x 4 mm QFN24, 2.1 x 2.1 mm WLCSP	2.2 x 3.6 mm WLCSP

nPM1300

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® 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



Power Management

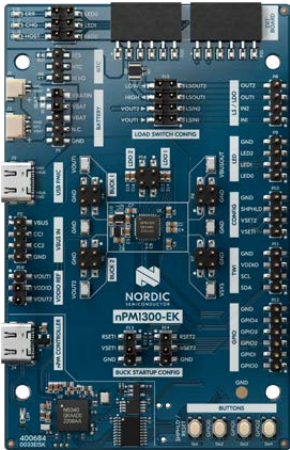
Related Development Tools

nPM1300 Evaluation Kit

The nPM1300 Evaluation Kit allows for simple evaluation and code-free configuration of the nPM1300 Power Management IC (PMIC). By connecting to the nPM PowerUP app found in nRF Connect for Desktop, all settings of the nPM1300 can easily be configured through an intuitive GUI and exported as code to be implemented in your MCUs application.

Key Features

- Male pin-headers for all pins on the nPM1300 PMIC, and battery connectors
- USB-C for power and data communication
- Three LEDs and four pushbuttons
- nPM1300 - highly efficient PMIC with advanced system management features
 - Two highly efficient buck regulators
 - 800 mA battery charger
 - USB-C compatible
 - Accurate fuel gauge with nRF SoC
 - Single- or two-button hard-reset functionality
 - Watchdog and boot timer
 - Ship- and hibernate modes
 - 40 to 85 °C operating temperature
 - Easy-to-use QFN or small WLCSP package
 - Seamless configuration through nPM PowerUP desktop software
- Seamless configuration through nPM PowerUP desktop software



Rutronik ordering code: RFMCU2142

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.



Rutronik ordering code: RFMCU1766

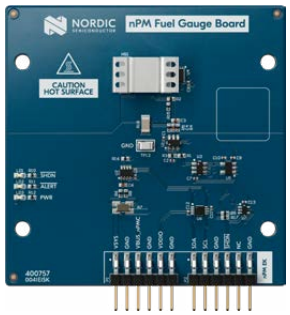
Key Features

- 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

nPM Fuel Gauge board

The nPM Fuel Gauge board (nPM FG) connects to a compatible Nordic Semiconductor evaluation kit. The purpose of the board is to act as a constant current sink device during battery profiling with nPM PowerUP desktop software. The battery model generated in nPM PowerUP can be used for evaluation of fuel gauge in nPM PowerUP and exported as an include file for use in any application using the Nordic Fuel Gauge algorithm.

To use the nPM Fuel Gauge board you also need the compatible nPM1300 Evaluation Kit.



Rutronik ordering code: ICPWM9180

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 a greater range than short-range, low-power protocols, but not the huge of range of the WAN technologies. Closer inspection reveals that 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 smart-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

Ultra-Low Power, Dual-Band

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

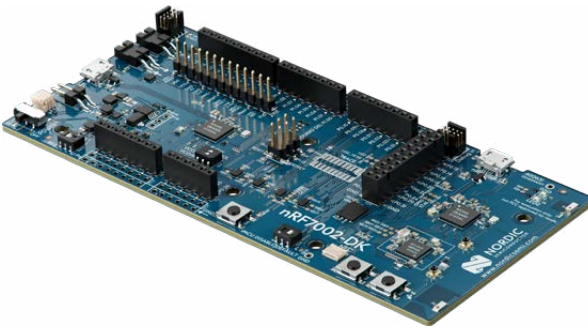
	nRF7000	nRF7001	nRF7002
			
	SSID-based Wi-Fi locationing solution	Low-power, adv. security, seamless coexistence	Low-power, adv. security, seamless coexistence
Wi-Fi 6	Yes	Yes	Yes
2.4 GHz	Yes	Yes	Yes
5 GHz	Yes	No	Yes
IEEE802.11		b/g/n/ax	a/b/g/n/ac/ax
Scanning (active & passive)	Yes	Yes	Yes
Station (STA)		Yes	Yes
SoftAP		Yes	Yes

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® LE, 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



Rutronik ordering Code: WLAN1871

nRF7002 Evaluation Kit

The nRF7002 EK is a versatile evaluation kit in the form of an Arduino shield. This kit is designed to complement our nRF52840 DK, nRF5340 DK, and nRF9160 DK, providing an easy way to evaluate and harness the power of the nRF70 Series of Wi-Fi companion ICs.

Key Features

- nRF7002 Wi-Fi Companion IC
- Arduino-shield form factor
- Antenna for 2.4 and 5 GHz
- Board support and samples in nRF Connect SDK
- SWF port for RF measurement

nRF7002 Expansion Board

The nRF7002 Expansion Board is a plug-in board for adding Wi-Fi 6 connectivity to a Nordic Thingy:53. It contains everything needed to get started developing Wi-Fi applications on the Thingy:53. The board connects with a PCB edge connector to the Thingy:53’s expansion slot and uses the Thingy’s nRF5340 multiprotocol System-on-Chip (SoC) as a host device for the nRF7002 Wi-Fi Companion IC.

Key Features

- Castellations for all pins on nRF7002
- 2.4 GHz / 5 GHz antenna
- Thingy:53 Plug-in form factor
- Upload sampling data to Edge Impulse studio over Wi-Fi



Rutronik ordering Code: WLAN1872

Software Development Kit



nRF Connect SDK

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 LE, Thread + 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 a unique integration of HomeKit Accessory Development Kit for developing products using both HomeKit over Thread + HomeKit over Bluetooth® LE. 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 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 8 KB and 512 KB.

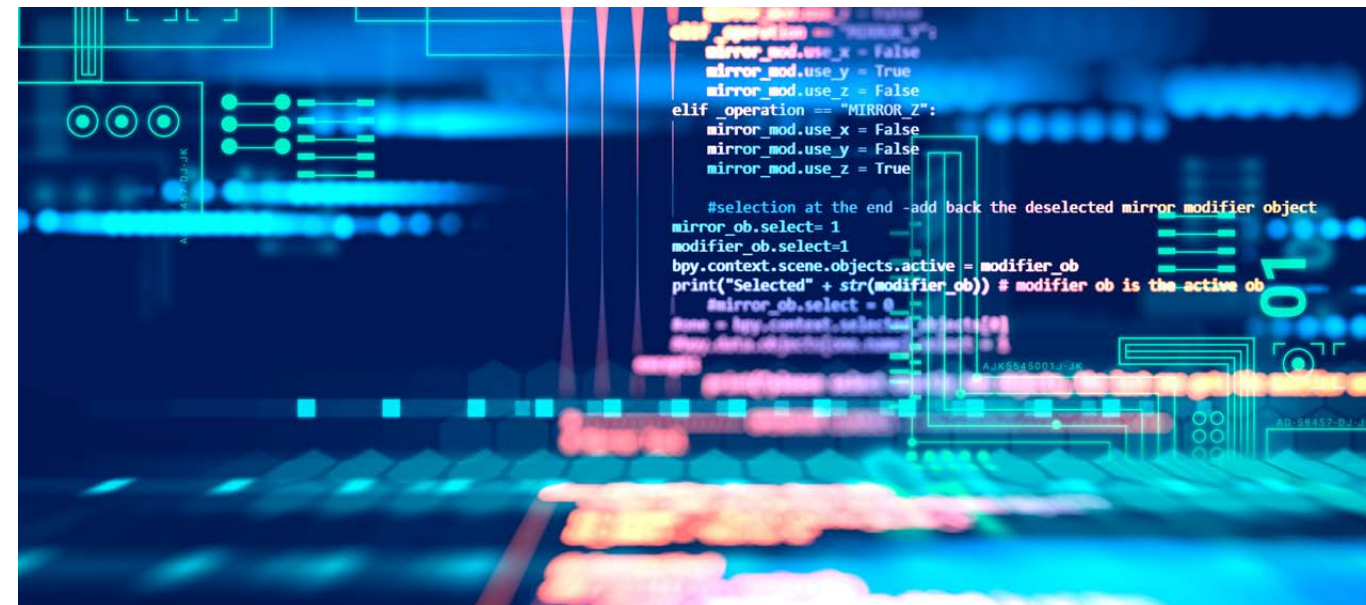
RTOS (Real-time operating system)

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 μA s to 1 A. The resolution varies between 100 nA and 1 mA 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
- 100 ksps 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

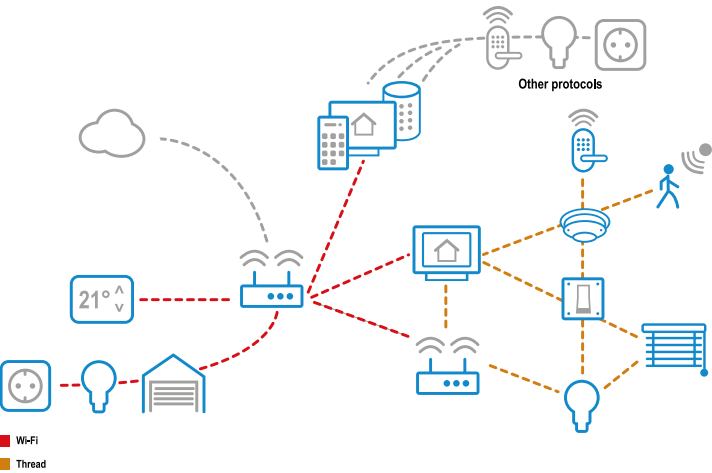


Rutronik ordering code: RFMCU1727

Matter

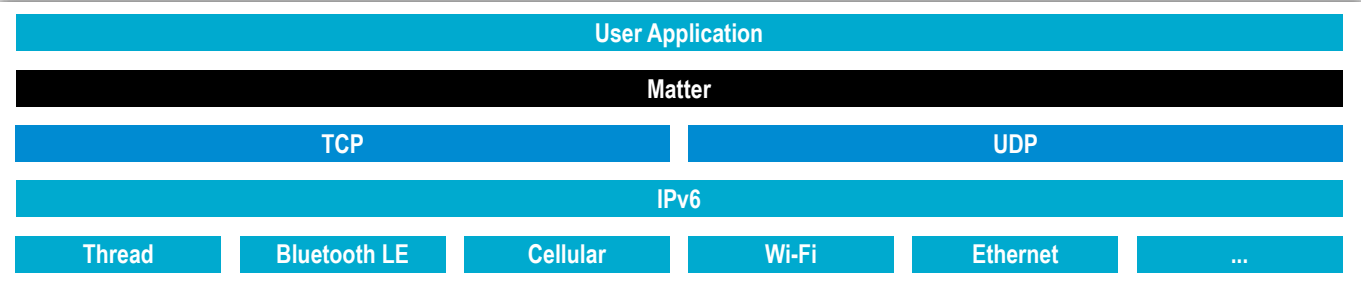
Matter

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.



The smart home market is relatively new and has an enormous potential. It has been growing slower than expected for the last years. A plethora of proprietary solutions using different protocols and application layers exist. This led to frustration with developers and consumers.

Matter steps in and provides a shared foundation on which to build an application. The goal is to have interoperability between devices and ecosystems. As the former project name suggests, it is based on the Internet Protocol (IP). The IP is the most common network layer used in homes and offices. This makes it ideal for delivering on interoperability and security to devices and services. Matter provides a standard application layer that is used with a set of wireless technologies. The focus is on Bluetooth LE, Thread, Wi-Fi and Ethernet. This will be followed by other IP-supporting protocols such as cellular.



Version	Date	Product Categories	Update
1.0	October 2022	Light Electricity Heating/HVAC Blinds Sensors Door locks Media Player Bridges (for Zigbee, z-Wave etc)	-
1.1	May 2023	-	Software Update
1.2	October 2023	Added Categories: Air Purifiers Air Quality Sensors Dishwashers Fans Laundry Washers Refrigerators Robotic Vacuums Room Air Conditioners Smoke & Carbon Monoxide Alarms	Latch & Bolt Door Locks enhancements for European markets (combined latch and bolt lock in one unit) Added support for device appearance description (your device now knows its color) Generic improvements to make the addition of future device types easier Enhancements for the Matter test Harness. The test harness ensures specification and features are properly implemented.
1.3	May 2024	Added Categories: Cook Surface Cooktop Oven Extractor Hood Microwave Oven Laundry Dryer Boolean Sensor Water Leak Detector Valve Electric Vehicle Supply Equipment (EVSE)	Better (provisional) support for Intermittently Connected Device (ICD) New/revised clusters mostly corresponding to the newly introduced device types New Cluster for diagnostic logs to enhance in-field debugging and to improve end-user experience Support for scenes to trigger several devices with one command Matter controllers can now batch multiple commands to ensure simultaneous execution (reducing popcorn-effect effect for lighting)

Locationing Overview

Locationing

Also known as localization or positioning, refers to the technology and methods used to determine the exact location of an object or person in a geographic space. This technology plays a crucial role in various applications, including navigation systems, fleet management, location-based marketing, security monitoring and more. By using sensors, wireless technologies, GPS and other positioning techniques, precise location data can be collected and analyzed to provide accurate information about the whereabouts of objects in real time.

Nordic Semiconductor offer a complete product portfolio for cellular (GNSS), Wi-Fi and nRF Cloud for accurate positioning in a wide range of areas. With the introduction of the nRF7000 Wi-Fi companion IC, Nordic Semiconductor is now established as the world's first sole supplier of a complete silicon-to-cloud locationing solution. Nordic's single-vendor solution, combined with the company's tech support, simplifies and accelerates product development of applications based on Wi-Fi locationing.

Benefits of Locationing

- **Precise Location Determination**
Precise location determination through locationing technology enables the exact localization of objects or people using advanced location algorithms and sensor technology.
- **Improved Security**
The implementation of improved security mechanisms in locationing systems strengthens data integrity and access control, leading to increased trustworthiness and robustness of the locationing process.

- **Real-Time Tracking**
Real-time tracking through locationing technologies enables the continuous and precise localization of objects or people in real time, enabling immediate response and monitoring in various application areas.

Cellular (GNSS)

The integration of cellular in locationing applications offers a variety of technical advantages and possibilities. Precise positions can be determined by using GNSS signals. The combination of GNSS and cellular enables precise location-based data transmission, which is essential for applications such as asset tracking, vehicle tracking and navigation. The nRF9160 is Nordics first low-power mobile device. It was designed to ensure the highest possible standard of energy efficiency and safety. This means that battery-powered devices can count on a longer battery life.

- **Global Coverage**
Global coverage via the cellular network ensures seamless positioning and navigation worldwide through the integration of various satellite systems and cellular networks, enabling reliable location determination in almost all regions of the world.

- **High Accuracy**
The high accuracy via cellular (GNSS) system is achieved by combining multiple satellite systems, precise signal processing algorithms and advanced reception technologies, which enables precise location determination with minimal margins of error.

- **Power Consumption**
Energy efficiency via the cellular (GNSS) system is ensured by optimized algorithms for signal processing and location determination as well as by the implementation of energy-saving modes in the receivers, resulting in extended battery life and more efficient use of resources.

Wi-Fi

The integration of Wi-Fi into locationing applications offers a number of technical advantages. Wi-Fi provides excellent coverage indoors where GNSS signals are often weak or unavailable. The Nordic nRF 70 series can detect Wi-Fi signals and use them for accurate indoor positioning, which is crucial for applications such as indoor navigation, asset tracking

in buildings or location services in shopping malls. With the Nordic nRF 70 series, Wi-Fi can be easily integrated into locationing applications. With its flexible connectivity interface and supporting software, Wi-Fi can be seamlessly integrated into existing applications, reducing development time and accelerating time to market.

- **Simple Setup**
Easy setup via Wi-Fi is made possible by user-friendly configuration processes and automatic detection methods that allow users to set up and manage their networks quickly and easily.

- **Wide Availability**
The wide availability of Wi-Fi is ensured by the widespread infrastructure of access points and routers, as well as integration with a variety of devices and applications, enabling near-universal connectivity and accessibility in different environments.

- **High-Speed**
The high speed over Wi-Fi is made possible by advanced transmission standards such as IEEE 802.11ac or 802.11ax as well as the use of MIMO technology and wider channels, which ensures fast data transmission and improved performance in wireless networks.

Short Range (Bluetooth) Received Signal Strength Indication (RSSI)

Oldest method for radio-level distance measurement is RSSI. The distance between two radio devices is calculated based on how much the signal between the two - more specifically its amplitude - has decayed over the transmission distance. RSSI give an indication of the distance between two radio transceivers, though it uses coarse estimates. It's well established as it's available in all smartphones. RSSI's basic accuracy is relatively low - in the order of multiple meters, typically three to five. A lot depends on the environment, because RSSI is susceptible to interference from external factors, such as absorption and diffraction. Just the fact that you're

holding the device in your hand can make a big difference.

Angle of Arrival / - of Departure

First introduced in Bluetooth® Core Specification v5.1, Bluetooth Direction Finding approach to AoA and AoD presents the first meaningful advance in distance ranging accuracy compared with RSSI. Both techniques don't directly measure distance but rather estimate the angle of incoming and outgoing radio signals respectively. By using trigonometry, distances can then be calculated.

AoA and AoD are capable of achieving submeter accuracy, but a lot depends on the practical circumstances. For indoor locations with a lot of obstacles and reflecting surfaces, multipath propagation (the fact that the signal reaches the receiver through indirect routes as well as potentially via a direct one) can hinder reliable measurements.

Bluetooth Channel Sounding

Unlike AoA and AoD, which require multiple antennas, increasing the chip's footprint, and can suffer from performance challenges in multipath environments, Bluetooth® channel sounding will introduce a new method to achieve accurate distance estimates known as phase-based ranging.

In phase-based ranging, a precise estimate of the distance between the two radio devices is accomplished by analyzing the radio signal's phase. Essentially, the time of flight of the radio signal, i.e., the distance between the two devices, is measured in a precise way using phase data.

To measure phase data, both devices alternately transmit and receive in a coordinated way. This is repeated multiple times over different frequencies, resolving ambiguities and improving the precision, even in the presence of reflections (multipath), as, for example, in indoor environments.



Wireless Accessories

Embedded Antennas

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

	Part	Standart	Antenna Type	Freq.	Peak Gain (dBi)	Efficiency (%)	VSWR	Antenna Size (mm)	Measured Ground Place (mm)	Temp (°C)	Comment
2J	2JL31	Wi-Fi, BT	SMD - Ceramic	2.4 GHz	~1.0	~63.4	~1.4:1	5.2 x 3.7 x 0.7	80 x 40	-40 to +85	SMT Loop Embedded Antenna
	2JL41	Wi-Fi, BT	SMD - Ceramic	2.5, 4.9 - 5.9, 5.9 - 7.1	~1.3 ~2.3 ~3.2	~64.7 ~61.5 ~59.5	~1.3:1 ~2.4:1 ~4.8:1	5.2 x 3.7 x 0.7	80 x 40	-40 to +85	SMT Loop Embedded Antenna
	2JE28	Cellular, LTE	SMD - Fiberglass	0.69 - 0.96, 1.7 - 2.1, 2.5 - 2.7	~2.5 ~3.1 ~3.5	~58 ~70 ~65	~2.6:1 ~1.8:1 ~1.5:1	40 x 8 x 3	110 x 40	-40 to +85	Wide band Antenna
KYOCERA AVX	1004795	LTE, 5G, DECT NR+	SMD - FR4	400 - 2700 MHz	1.6 dBi @ 698 - 960 MHz 3.1 dBi @ 1710 - 2400 MHz 1.7 dBi @ 2500 - 2700 MHz	64 % @ 698 - 960 MHz 55 % @ 1710 - 2400 MHz 53 % @ 2500 - 2700 MHz	< 2.5:1	36 x 9 x 3.2	125 x 45	-40 to +85	Tuning pads and Band switching available Mirror version 1004796
	P822601	LTE, 5G, DECT NR+	SMD - FR4	698 - 3800 MHz	2.6 dBi @ 698 - 960 MHz 4.4 dBi @ 1710 - 2200 MHz 3.4 dBi @ 2500 - 2700 MHz	68 % @ 698 - 960 MHz 76 % @ 1710 - 2200 MHz 46 % @ 2500 - 2700 MHz 59 % @ 3300 - 3.800 MHz	< 2.5:1	49.6 x 8.0 x 3.2	12 x 50	-40 to +85	Tuning pads available Mirror version P822602
	1001013	BLE + Wi-Fi, DECT NR+	SMD - FR4	2.4 GHz	2.6dBi	76 %	1.5:1	15 x 3.2 x 3.3	7 x 17	-40 to +85	On/Off Ground Environments
	1001312	BLE	SMD - Ceramic	2.4, 6 - 8.5 GHz	1.88 @ 2.4 GHz	62 % @ 2.4 GHz	1.8:1	2 x 1.2 x 0.55	55 x 25	-40 to +85	UWB possible
	M310220	BLE	SMD - Ceramic	2.4 GHz	1.7 dBi	67 %	2.0:1	3 x 1.5 x 1.08	40 x 60	-40 to +85	S-Band/NTN coverage
	1000146	BLE + Wi-Fi	SMD - Stamped Metal	2.4, 5, 6 GHz	1.7 @ 2.4 GHz	81 % @ 2.4 GHz	2.0:1	17.85 x 6.9 x 4.3	6.9 x 11.2	-40 to +85	Tuning pads available
	9001978	BLE, BLE + Wi-Fi	SMD - Chip	2.4 GHz or 2.4, 5 GHz	3.45 dBi @ 2.4 GHz 3 dBi @ 2.4 / 5 GHz	68 % @ 2.4 GHz 65 % @ 2.4 GHz 50 % @ 5 GHz	< 2.5:1 / 2.1:1 @ 2.4 GHz, 7:1 @ 5GHz	1.00 x 0.55 x 0.40	13 x 2.35 16 x 2.4	-55 to 125	UWB possible
	1005801	BLE	SMD - Chip	2.4 GHz	3 dBi	62 %	2.0:1	1.0 x 0.58 x 0.35	10 x 6.64	-55 to 125	Corner Placement
	W3008G	BLE	SMD - Ceramic	2.4 GHz	> 1.5 @ 2.4 GHz	> 80	< 1:6:1	3.2 x 1.6 x 1.1	80 x 37	-40 to +105	High Pefor- mance, High Temperature
Pulse	W3092G	BLE	SMD - Ceramic	2.4 GHz	> 1.5 @ 2.4 GHz	> 75	< 1:6:1	2.1 x 1.2 x 0.55	80 x 37		Low profile, high operating temperature
	W3325	NB-IoT, LTE-M	SMD - FR4	791 - 960 MHz	1.3	> 55	*	14 x 7 x 15	120 x 40	-40 to +85	small size for subGHz Antenna
	W3226	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
	W3796	3G/4G antenna	SMD	698 - 2700MHz	5 dBi @ 2.3 - 2.7 GHz	55 % - 75 %	< 3:1	40 x 7 x 3	120 x 40	-40 to +85	wide band small size Lte-M/ NB IoT Antenna
	W3415	4G/5G IoT	SMD - Composite	617 - 960, 1430 - 6000 MHz	1 - 7 dBi	40 % - 45 %	0 - 2.5 dBi	40 x 7 x 3	120 x 40	-40 to +85	Broad band contains all sub 6GHz bands
	ANT1005LL-14R2400A	BLE	SMD - Ceramic	2.4 GHz	>2.2 @ 2.4 GHz	70	0,125011574	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 @ 2.4 GHz	62	0,250011574	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 @ 2.4 GHz	-87	*	3.21 x 1.6 x 1.2	90 x 40	-40 to +105	High efficiency

Wireless Accessories

Internal Cabled Antennas

The listed antennas are distributed by Rutronik.

	Part	Standart	Antenna Type	Freq.	Peak Gain (dBi)	Efficiency (%)	VSWR	Antenna Size(mm)	Cable Length (mm)	Temp (°C)	Comment
2J	2JF0102P	BLE + Wi-Fi	FPC	2.4 / 5 GHz	~2.2 @ 2.4 GHz	~76	~1.2:1 @ 2.4GHz	39.6 x 8.4 x 0.1	Custom.	-40 to +85	Ground plane independent, customized cable + conector
	2JF0302Pa	Wi-Fi	Flexible Polymer	2.4 5.0 6.0	~3.2 ~5.0 ~5.2	~53 ~64 ~52.1	~2.4:1 ~2.2:1 ~2.5:1	22.4 x 20.6 x 0.2	Custom.	-40 to +85	
	2JF0224P	LTE	Cellular / LTE	0.69 - 0.96 1.7 - 2.1 2.5 - 2.7	~0.1 ~1.4 ~1.8	~40 ~46.1 ~53.8	~4.0:1 ~3.9:1 ~3.3:1	40.0 x 7.0 x 0.15	Custom.	-40 to +85	
	2JF0924P	LTE	FPC	700 - 2700 MHz	~4.5	~58.8	~2.5:1	120 x 8.9 x 0.15	Custom.	-40 to +85	
KYOCERA AVX	W3 Family	BLE + Wi-Fi	FPC/PCB	2.4 / 5 GHz	2.3 dBi @ 2.4 GHz	70% @ 2.4 GHz	1.4:1	35.2 x 8.5 x 0.4	100	-40 to +85	Different cable lengths and connectors available
	W1 Family	BLE	FPC/PCB	2.4 GHz	2.8 dBi @ 2.4 GHz	70% @ 2.4 GHz	1.4:1	35.2 x 8.5 x 0.4	100	-40 to +85	
	1001932FT	BLE + Wi-Fi	FPC	2.4 / 5 GHz	2.03 dBi @ 2.4 GHz	61% @ 2.4 GHz	02:01	35.2 x 8.5 x 1.6	100	-40 to +85	Tunale Antenna, Different cable lengths and connectors available
	9001815F0	LTE, DECT NR+	FPC	600 - 5850 MHz	1.5 dBi @ 617-960 MHz 4.65 dBi @ 1415-2690 MHz	35% @ 617-960 MHz 60% @ 1415-2690 MHz	2.6:1	102 x 14.5 x 0.2	200	-40 to +85	Different cable lengths and connectors available
	1002289	LTE, DECT NR+	FPC	698 - 2700 MHz	2.9 dBi @ 698-960 MHz 4.3 dBi @ 1710-2600 MHz	74% @ 698-960 MHz 58% @ 1710-260- MHz	< 2.5:1	53.6 x 25.1 x 0.2	25	-40 to +85	
Pulse	W3334xxx	BLE + Wi-Fi	FPC	2.4 / 5 GHz	Max. 5.5	50 @ 2.4 GHz	<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, 4.9- 7.125 GHz	Max. 4	60 @ 2.4 GHz	<2.0:1	35.2 x 8.5 x 0.15	50 - 140	-40 to +85	Wi-Fi 6E
	W3906B0100	LTE + GNSS	FPC	689 - 3600 MHz	1.1 - 4.0	54 - 69	*	120 x 26.8	100	-40 to +85	Broad band Antenna, LTE + GNSS Dual feed
	W3917xxxx	BLE, WiFi	FPC	2400-2500, 4900-7125	2 - 3 dBi	60 % - 70 %	<2:1	42.6 x 8.6 x 0.15	50/100	-40 to +85	Customised cable and connector
	SWA1130	2G/3G/4G/5G, WiFi, BLE	FPC	700- 6000MHz	4.14 dBi	52 % - 82 %	4:1 max	90 x 20 x 0.55	100	-40 to +85	Small size, broadband
	ANTX-200P001B24003	BLE	PCB	2.4 GHz	4.4	>50	2.0:1	18.4 x 7.5 x 0.55	200	-40 to +85	Small Size, double sided tape, Halogen free, RoHS compliant
	ANTX-100P01B24553	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	
	ANTX-100P001BWPEN3	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 / Crystals

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	5,000 cycles	1,500 cycles	5,000 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-OB	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	10,000 cycles	5,000 cycles	1,500 cycles
	SIM card detection switch Optional location peg	No SIM card detection switch No location peg	Location peg

Rutronik lists a number of crystals to support the functionality of the Nordic SoCs.

Nordic IC Series	Manufacturer Part-NR.	Freq.	Cap.	Supplier
nRF52	CX2016DB32000D0WZRC1	32MHz	8pF	Kyocera
	CX2016DB32000D0WZRC1	32MHz	8pF	Kyocera
	CX1612DB32000D0WZTC3	32MHz	8pF	Kyocera
	Q22FA1280002500	32MHz	8pF	Epson
	X1A000171000200	32KHz	9pF	Epson
	X1E000251002600	32MHz	8pF	Epson
	HKC3225SX-32MHz-38638-R4V1	32MHz	8pF	HKC
	HKC2016SX-32MHz-38639-R4V1	32MHz	8pF	HKC
nRF53	HKC1612SX-32MHz-38637-R4V1	32MHz	8pF	HKC
	CX1210SB32000D0WRZC1	32MHz	8pF	Kyocera
	CX1612DB32000D0WRZC1	32MHz	8pF	Kyocera
	CX2016SA32000D0WRQG1	32MHz	8pF	Kyocera
	Q22FA1280025900	32MHz	12,5pF	Epson
	X1A000171000200	32KHz	9pF	Epson
	HKC3225SX-32MHz-38634-R4V1	32MHz		HKC
	HKC2016SX-32MHz-38635-R4V1	32MHz		HKC
nRF54	HKC1612SX-32MHz-38636-R4V1	32MHz		HKC
	CX1210SB32000D0WRZC1	32MHz	8pF	Kyocera
	CX1612DB32000D0WRZC1	32MHz	8pF	Kyocera
	CX2016SA32000D0WRQG1	32MHz	8pF	Kyocera
	HKC3225SX-32MHz-38634-R4V1	32MHz	8pF	HKC
	HKC2016SX-32MHz-38635-R4V1	32MHz	8pF	HKC
nRF70	HKC1612SX-32MHz-38636-R4V1	32MHz	8pF	HKC
	CX1210SB32000D0WRZC1	32MHz	8pF	Kyocera
	CX1612DB32000D0WRZC1	32MHz	8pF	Kyocera
	CX2016SA32000D0WRQG1	32MHz	8pF	Kyocera
	HKC3225SX-40MHz-38640-R4V1	32MHz	8pF	HKC
	HKC2016SX-40MHz-38641-R4V1	32MHz	8pF	HKC
	HKC1612SX-40MHz-38642-R4V1	32MHz	8pF	HKC



Support

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Nordic DevZone & Support

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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.

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