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 **WiFi**  **LTE-M**  **NB-IoT** **NTN**  **5G NR** **Power Management**

The World of Nordic Semiconductor

Empowering Wireless Innovation

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Our Product Portfolio

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

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Who is Nordic and why Rutronik



Nordic Semiconductor

Nordic Semiconductor is a global leader in low power wireless connectivity solutions, providing the essential platform and wireless technologies that connect the world's IoT devices.

Nordic delivers world-class hardware, embedded software, development tools, power management, world-class support, and cloud lifecycle services - all simplifying development for developers to build reliable, scalable, and future-proof connected products faster.

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, Zigbee Alliance, Wi-Fi Alliance, and GSMA.

Rutronik

Rutronik is an independent family-owned company based in Ispringen near Pforzheim in Germany. The company was founded in 1973 by Helmut Rudel and has developed from a „one-man-company“ into one of the worldwide leading broadline 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 can look back on a successful company history of 50 years and continues the positive economic development.

The broad product range includes semiconductors, passive and electro-mechanical 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 for its customers as well as unparalleled service and technical support with a consistently high level of quality to its customers worldwide.

Guided by the philosophy "committed to excellence", the employees are working 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 USA as well as in the Asian region.

Rutronik Inc. with headquarters 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. The 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 Semiconductor's 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.

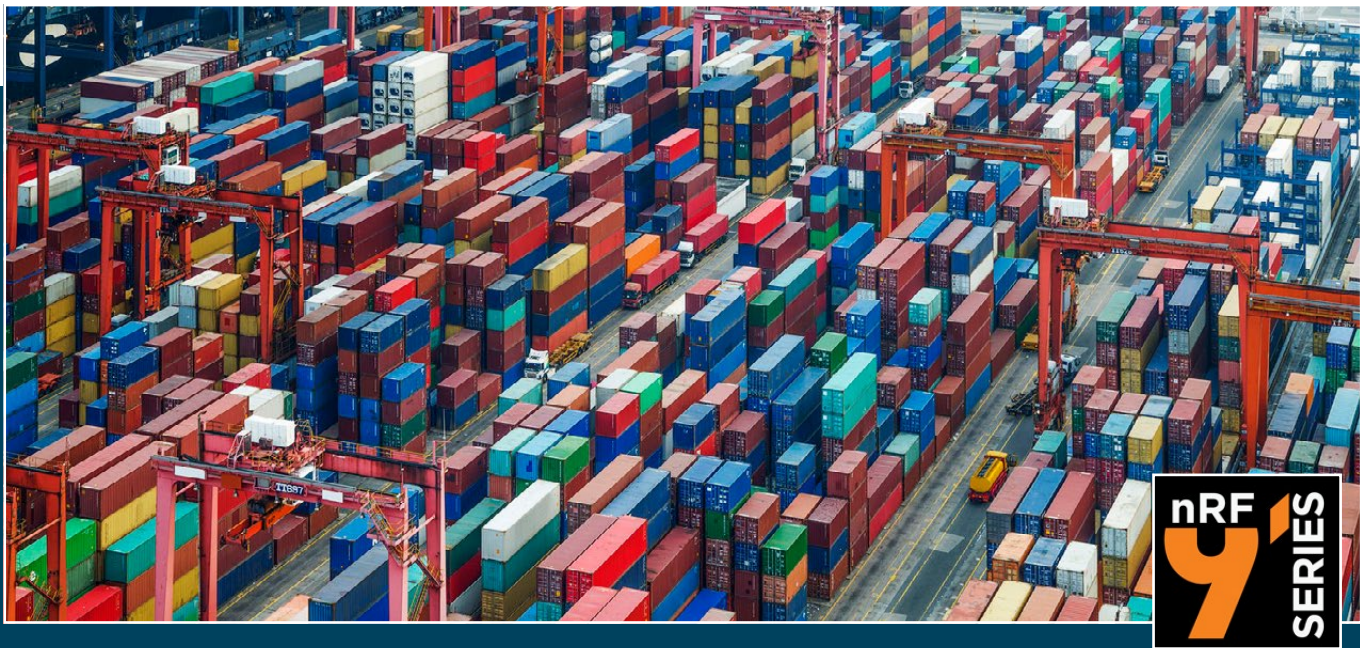


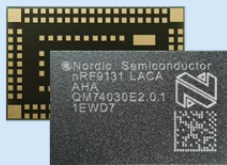
NTN coverage

Both LTE-M & NB-IoT

LTE-M only

NB-IoT only



Features	nRF9160	nRF9161	HIGHLIGHT 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

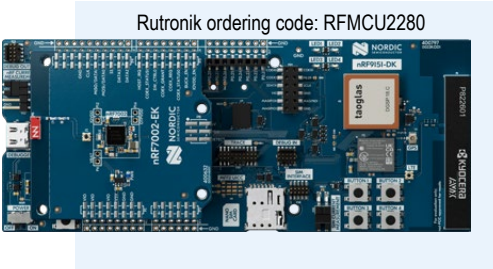


nRF9151 DK

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

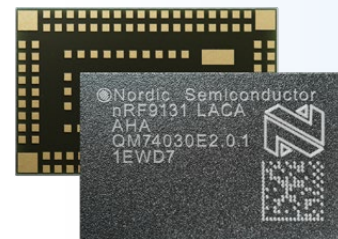
The nRF9161 sets a new standard for highly integrated System-in-Package (SiP) solutions, specifically designed for cellular IoT and DECT NR+ applications. Leveraging low-power LTE technology, advanced processing capabilities, and robust security features, the nRF9161 offers unparalleled performance and 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:91X

The Nordic Thingy:91 X is a versatile prototyping platform designed for the development of cellular IoT applications.

It is built around the nRF9151 System-in-Package (SiP) which supports LTE-M, NB-IoT, GNSS, and NR+, making it suitable for global use.

This platform is particularly ideal for asset-tracking applications due to its capability to utilize multiple location tracking methods including cellular, Wi-Fi, and GNSS in conjunction with nRF Cloud Location Services.

The device is also equipped with a comprehensive array of sensors that monitor environmental conditions and movement, enhancing its utility in various IoT applications.

Key Features

- Battery-operated prototyping platform for the nRF9151 SiP
- Certifications: FCC (USA), CE (EUR)
- LTE-M/NB-IoT/NR+, GNSS and Bluetooth LE/Wi-Fi antennas
- Wi-Fi locationing enabled by nRF7002
- User-programmable buttons and LEDs
- Environmental sensor for temperature, humidity, air quality, and air pressure, plus magnetometer
- Low-power 3-axis accelerometer
- 6-axis IMU with gyroscope
- Rechargeable Li-Po battery with 1350 mAh capacity - nPM1300 PMIC for battery charging and fuel gauging
- Board controller: nRF5340 for connectivity between USB interface and nRF9151



Rutronik ordering code: RFMCU2350

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.

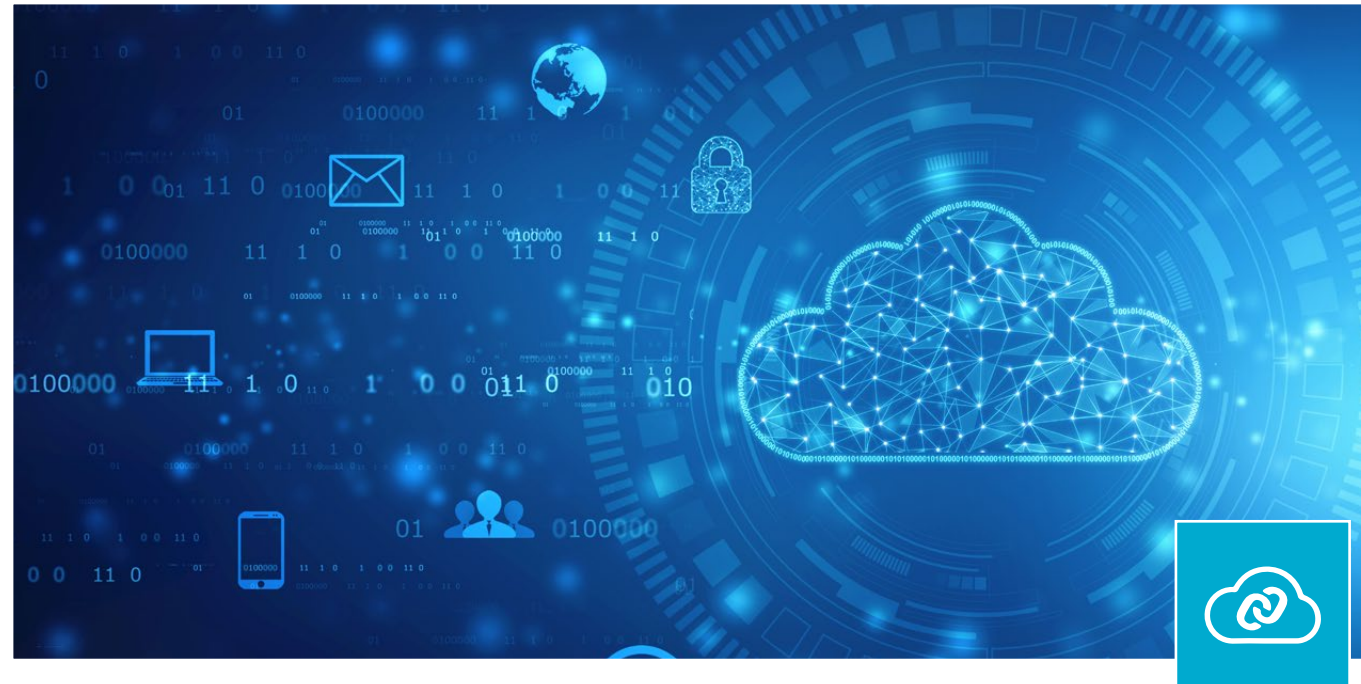
The nRF9160 DK has both a nano/4FF SIM card slot and an MFF2 SIM footprint, to support both plug-in and soldered (e)SIMs. It is bundled with an eSIM card from iBasis preloaded with 10 MB.

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 Non-Terrestrial Networks (NTN)

You select cellular technology because of the ubiquitous access to network infrastructure around the globe. While it is true that 4G/LTE technology alone covers as much as 90% of the world's population, if you look at total geographical coverage instead, only about 15% of the earth's surface is covered by LTE. If you also include older 2G/3G technologies, coverage increases to 30-35%, which is significantly better, but still far from all.

Cellular coverage is hence far less ubiquitous for IoT products that may need to operate almost anywhere, monitoring critical infrastructure, safeguard food production and life stock, or track shipments of valuable goods. Adding the fact that many regions are sunsetting 2G networks, a wide range of IoT products are facing a tough question: What technology should they adopt for coming product generations?

This is where 3GPP Non-Terrestrial Networks (3GPP NTN), along with the terrestrial 4G/5G IoT technologies LTE-M and NB-IoT, can revolutionize your ability to deploy your IoT products where they are needed.

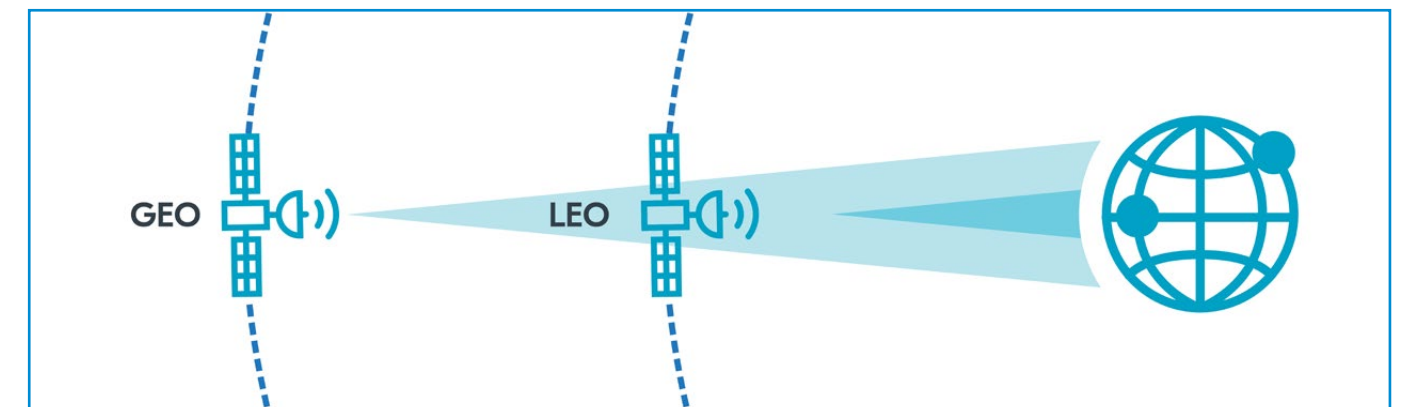
How do I access 3GPP NTN?

Whether your product is stationary in a remote location, or roaming across vast areas lacking needed coverage, 3GPP Non-Terrestrial Networks enables you to keep track of your assets and stay updated, wherever they are.

3GPP NTN providers offer two equally important parts, the satellites replacing cell towers, as well as a cellular core network. The core network means that NTN and terrestrial networks can interact, enabling your devices to roam from your home network to a non-terrestrial network, in the same way roaming on other terrestrial networks today. Ask your current connectivity provider, MNO or MVNO, what their plans for 3GPP NTN services are.

Which NTN to choose?

All 3GPP NTN are not the same, and neither are IoT applications. Which non-terrestrial network will be right for you, depends entirely on your use cases and critical design criteria. At the top level, you can split non-terrestrial networks into two main categories by the type of satellites they use: GEO (Geo synchronous/stationary Earth Orbit) or LEO (Low Earth Orbit).



GEO Satellites

Geo synchronous, and the subset Geo stationary, satellites orbit at the same speed as Earth due to the large distance (almost 36 000 km) from the Earth's surface. A GEO satellite will therefore appear stationary in the sky over a region, able to cover as much as 1/3 of the globe. This again means that the satellite is always available for your device and also always in sight of an earth station located in the same region.

LEO Satellites

Low Earth Orbit (LEO) satellites, used by multiple emerging 3GPP NTN networks, are much closer to Earth at 600-800 km. This improves the link budget for your IoT device, allowing more flexibility in antenna designs and higher data rates, up to 20-40 kbps, using the same power class 3 module and antenna.

Non-Terrestrial Network Providers

Nordic Semiconductor is working with multiple providers to offer commercial options for their NTN deployments.



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
6.1	Bluetooth® Dual Mode or LE	May 25	LE up to 2 Mbit/s Classic up to 24 Mbit/s	Randomized Resolvable Private Address (RPA)
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® Profile	Application	Standard
A2DP	Advance Audio Distribution	Streaming of audio multimedia	LE
AVRCP	Audio/Video Remote Control	Allows remote control of media playback	LE
BIP	Basic Imaging	Exchange of pictures	LE
BPP	Basic Printing	Print	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
HCI	Host Controller Interface	Interface between BT Hardware and application profiles	LE
HDP	Health Device	Facilitates transmission of Medical Device Data	LE
HFP	Hands free	hands-free calling between vehicles and headsets	LE
HID	Human Interface Device	For devices with which the end-user interacts directly	LE
HSP	Handset	Basic audio communication between headsets and phones	LE
iAP	iPhone Accessory	Support the development of accessories for Apple devices such as the iPhone or iPad	LE
MAP	Message Access	Access to text messages and email	LE
PBAP	Phone Book Access	Access to contact and address book information	LE
SPP	Serial Port	Serial data transfer	Classic

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.

Technology Introduction

Aliro

Aliro is a secure, open-standard protocol for smart access systems. It enables seamless, cross-platform communication between devices like smartphones, wearables or access readers, simplifying digital entry across homes and businesses. It provides a universal communication protocol and credential for interoperability, similar to how Wi-Fi and Matter operate for other smart devices

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



Nordic Semiconductor's nRF54 Series: Redefining Wireless SoC Performance for the IoT Era

Nordic Semiconductor's nRF54 Series represents a significant evolution in wireless System-on-Chip (SoC) technology, tailored for the rapidly expanding Internet of Things (IoT) landscape. As the fourth generation of Nordic's renowned low-power wireless platforms, the nRF54 family introduces groundbreaking improvements in processing power, memory architecture, energy efficiency, and security—setting a new benchmark for connected device performance.

A Family of High-Performance Wireless SoCs

The nRF54 Series is divided into two main families: the nRF54H and the nRF54L. Each is optimized for different application needs:



nRF54H Series

Designed for high-end applications requiring intensive processing and advanced connectivity. It features multiple powerful Arm Cortex-M33 processor, RISC-V coprocessors, and extensive memory resources. This makes it ideal for complex use cases such as medical devices, industrial sensors, and advanced wearables.



nRF54L Series:

Focused on efficient and low-power applications while still offering good performance. It supports Bluetooth LE, Thread, Zigbee, and Matter, making it perfect for smart home devices, fitness trackers, and IoT devices.

Key Features and Innovations

- **Multiprotocol Support:**
The nRF54 Series supports a wide range of wireless protocols including Bluetooth 6.0 and further Bluetooth specifications. Bluetooth LE Audio, Bluetooth Mesh, Thread, Zigbee, and Matter. This ensures compatibility with modern smart ecosystems and future-proofing for evolving standards.
- **Enhanced Security:**
Built-in hardware security features such as isolated execution environments and secure boot mechanisms protect against cyber threats and unauthorized access.
- **High Memory Capacity:**
With significantly more RAM and flash than previous generations, the nRF54 chips can handle complex firmware and edge processing tasks without external memory.
- **Energy Efficiency:**
Despite their increased capabilities, the chips maintain ultra-low power consumption, extending battery life in portable and wearable devices.
- **Software Flexibility:**
Nordic's nRF Connect SDK supports both Zephyr RTOS and the new Bare Metal variant, giving developers the choice between full-featured OS environments and lightweight, resource-efficient setups

Applications Across Industries

- **Smart Home:**
Seamless integration with Matter and Thread enables reliable, secure communication between devices from different manufacturers.
- **Healthcare:**
High-performance processing and low power consumption make it ideal for wearable medical monitors and diagnostic tools.
- **Industrial IoT:**
Robust connectivity and security features support mission-critical applications in automation and asset tracking.
- **Consumer Electronics:**
From fitness bands to wireless earbuds, the nRF54 Series powers next-gen user experiences with Bluetooth LE Audio and extended battery life.

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 22UML® leading process nodes.

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 (480 Mbps), 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



nRF54L Series

nRF54L15, nRF54L10, nRF54L05



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

Type	nRF54L15	nRF54L10	nRF54L05
Processor	128 MHz Arm Cortex-M33	128 MHz Arm Cortex-M33	128 MHz Arm Cortex-M33
NVM	1.5 MB	1.0 MB	0.5 MB
RAM	256 KB	192 KB	96 KB
Bluetooth LE version	6.0	6.0	6.0
TX power	Up to 8 dBm	Up to 8 dBm	7 dBm
RX sensitivity (1 Mbps Bluetooth LE)	-96 dBm	-96 dBm	-96 dBm
RX sensitivity (IEEE 802.15.4)	-101 dBm	-101 dBm	-101 dBm
RISC-V coprocessor	128 MHz FLPR	128 MHz FLPR	128 MHz FLPR
ADC	8ch, up to 14-bit, up to 2 MS/s	8ch, up to 14-bit, up to 2 MS/s	8ch, up to 14-bit, up to 2 MS/s
Operating temperature	-40 to +105 °C	-40 to +105 °C	-40 to +105 °C
Supply and GPIO voltage range	1.7 to 3.6 V	1.7 to 3.6 V	1.7 to 3.6 V

nRF54L Series

Related Development Tools



NRF54L15 DK – Development kit for the nRF54L15, nRF54L10, and nRF54L05 wireless SoCs

The nRF54L15 DK is the development kit for all three wireless SoC (System-on-Chip) options in the nRF54L Series.

The nRF54L15 sits on the development board, while the nRF54L10 and nRF54L05 can be emulated. The affordable single-board development kit makes all features of the wireless SoC available to the developer.

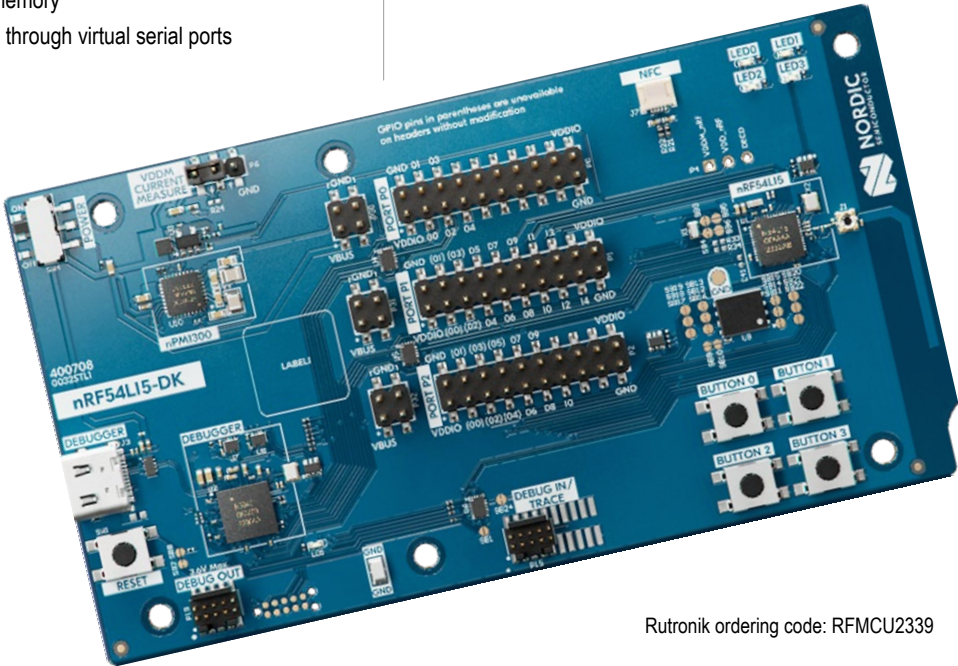
The nRF54L15 DK is supported by a comprehensive set of nRF Connect tools and has support in the nRF Connect SDK. Developers can explore the full potential of the nRF54L15 using the extensive range of software samples, modules, and libraries available within the nRF Connect SDK.

Key Features

- nRF54L15 wireless SoC
- Emulation of the nRF54L10 and nRF54L05 wireless SoCs
- 2.4 GHz and NFC antennas
- SWF RF connector
- SEGGER J-Link OB programmer/debugger
- User-programmable LEDs (4) and buttons (4)
- Pins for measuring power consumption
- 8 MB external flash memory
- Two UART interfaces through virtual serial ports

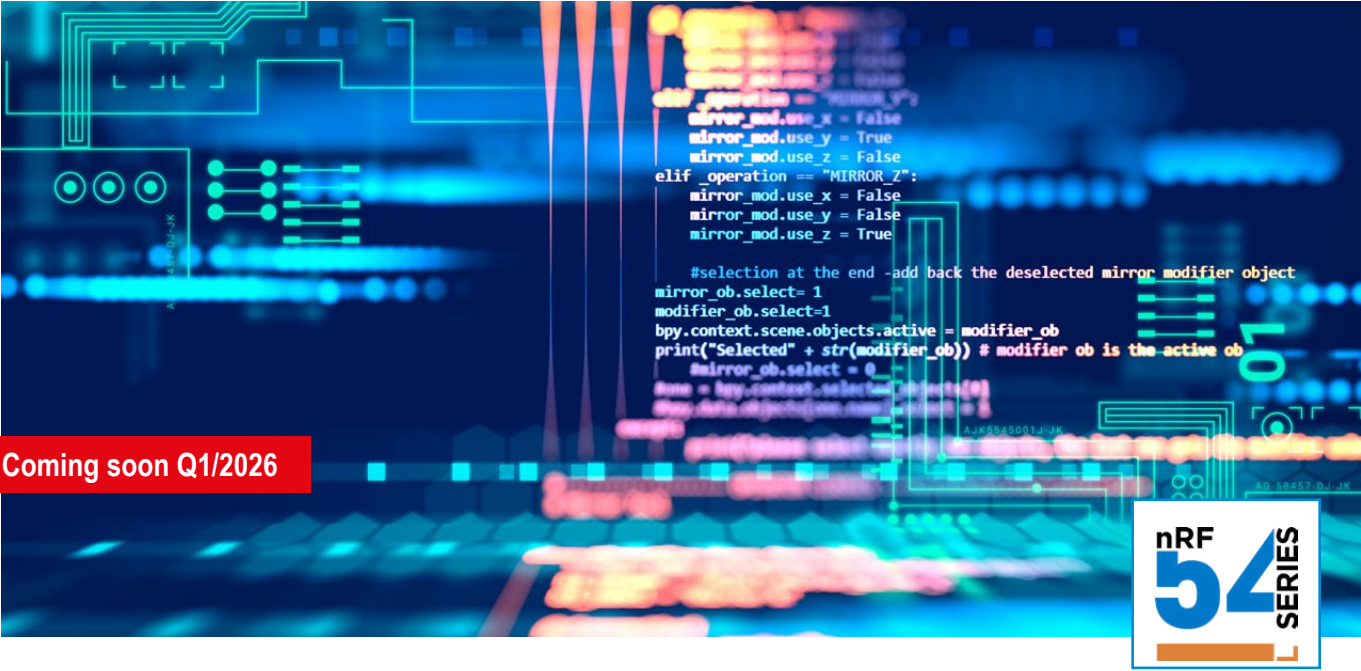
Applications

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



Rutronik ordering code: RFMCU2339





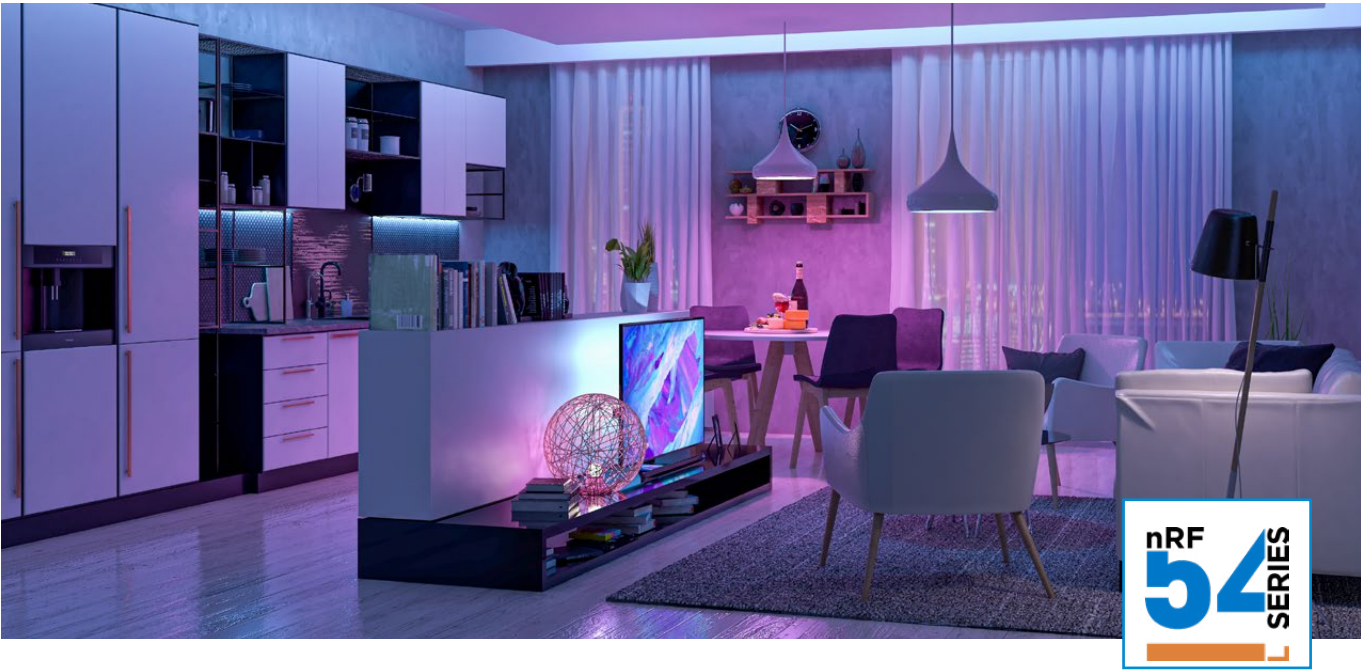
nRF54LM20A

The nRF54L Series includes multiple SoCs such as the nRF54LM20A, nRF54L15, nRF54L10, and nRF54L05. All wireless SoCs in the Series integrate an ultra-low-power 2.4 GHz radio and MCU with a 128 MHz Arm Cortex-M33 processor, a comprehensive peripheral set, and scalable memory configuration. The nRF54LM20A adds a High-Speed USB to the series and increases the maximum available NVM from 1.5 MB to 2 MB and RAM from 256 KB to 512 KB. Nordic's proprietary technologies, such as low-leakage RAM and advanced multiprotocol radio design, enable ultra-low power consumption, reducing battery size or increasing lifetime. Designed for versatility, the nRF54L Series wireless SoCs offer options for various applications. The multiprotocol 2.4 GHz radio supports Bluetooth Low Energy, Thread, Matter, Aliro, Zigbee, and proprietary protocols with up to 4 Mbps data rate. It also supports Bluetooth 6.0, including Bluetooth Channel Sounding. Available in memory and package configurations, with up to 66 GPIOs including pin-to-pin options, the nRF54L Series SoCs support cost optimization and flexibility in the design cycle.

- Key Features
- Ultra-low-power multiprotocol 2.4 GHz radio
 - Bluetooth® LE, Matter, Aliro, Zigbee, Thread, and proprietary 2.4 GHz protocols
 - Integrated multi-purpose MCU functionality
 - 128 MHz Arm Cortex-M33 processor
 - 2 MB NVM and 512 KB RAM
 - High-Speed USB
 - Comprehensive set of peripherals, including new Global RTC available in System OFF, 14-bit ADC, and high-speed serial interfaces
 - Up to 66 GPIOs
 - Secure boot, secure firmware update, secure storage
 - Cryptographic accelerator with side-channel leakage protection, tamper detectors

- Applications
- Wearables
 - Gaming peripherals
 - Smart home
 - Smart locks

Type	nRF54LM20A
	
Processor	128 MHz Arm Cortex-M33
NVM	1.5 MB
RAM	256 KB
Bluetooth LE version	6.0
TX power	Up to 8 dBm
RX sensitivity (1 Mbps Bluetooth LE)	-96 dBm
RX sensitivity (IEEE 802.15.4)	-101 dBm
RISC-V coprocessor	128 MHz FLPR
ADC	8ch, up to 14-bit, up to 2 MS/s
Operating temperature	-40 to +105 °C
Supply and GPIO voltage range	1.7 to 3.6 V

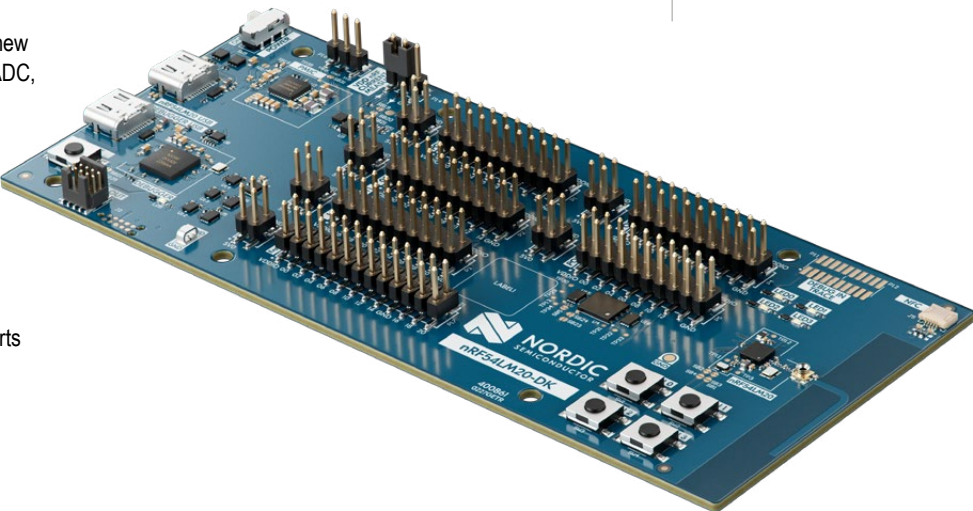


nRF54LM20 DK – Development kit for the nRF54LM20A

The nRF54LM20-DK (Development Kit) enables development with nRF54LM20A. It offers all features on a single board at an affordable price. The nRF Connect SDK and tools fully support the DK. The Quick Start tool in nRF Connect for Desktop enables easy board setup. Nordic Developer Academy provides free hands-on courses to equip developers with the technical knowledge and skills to work with Nordic solutions. Developers can explore the nRF54LM20A's potential with software samples, add-ons, and libraries from the nRF Connect SDK. The nRF54L Series includes multiple SoCs such as the nRF54LM20A, nRF54L15, nRF54L10, and nRF54L05.

- Key Features
- Affordable, versatile development kit for nRF54LM20A wireless SoC
 - Ultra-low-power multiprotocol 2.4 GHz radio
 - Bluetooth® LE, Matter, Aliro, Zigbee, Thread, and proprietary 2.4 GHz protocols
 - Integrated multi-purpose MCU functionality
 - 128 MHz Arm Cortex-M33 processor
 - 2 MB NVM and 512 KB RAM
 - High-Speed USB
 - Comprehensive set of peripherals, including new Global RTC available in System OFF, 14-bit ADC, and high-speed serial interfaces
 - Up to 66 GPIOs
 - Secure boot, secure firmware update, secure storage
 - Cryptographic accelerator with side-channel leakage protection, tamper detectors
 - 8 MB external flash memory
 - Two UART interfaces through virtual serial ports
 - 2.4 GHz antenna
 - SWF RF connector
 - NFC antenna
 - SEGGER J-Link OB programmer/debugger
 - USB-C connector for the application
 - User-programmable LEDs (4) and buttons (4)
 - Pins for measuring power consumption
 - nPM1300 PMIC (Power Management IC) providing a 1.8 V to 3.3 V userprogrammable power supply from USB
 - Supported by the Board Configurator GUI provided with nRF Connect for Desktop

- Applications
- Wearables
 - Gaming peripherals
 - Smart home
 - Smart locks



Rutronik ordering code: RFMCU2421





Type	nRF54L05	nRF54L10	nRF54L15	nRF54LM20A
Qualified against Bluetooth Core 6.0	✓	✓	✓	✓
Bluetooth PHY: 1 Mbps, 2 Mbps, Long Range	x	x	✓	✓
Bluetooth Channel Sounding	✓	✓	✓	✓
Bluetooth Mesh	✓	✓	✓	✓
Thread, Zigbee (IEEE 802.15.4-2020)	✓	✓	✓	✓
Matter, Amazon Sidewalk		✓	✓	✓
Apple Find My, Google Find My Device	✓	✓	✓	✓
Wi-Fi (with nRF70 Series companion IC)			✓	✓
ESB and 2.4 GHz proprietary protocols	up to 4 Mbps	up to 4 Mbps	up to 4 Mbps	up to 4 Mbps
CPU	Arm Cortex-M33, 128 MHz	Arm Cortex-M33, 128 MHz	Arm Cortex-M33, 128 MHz	Arm Cortex-M33, 128 MHz
NVM	0.5 MB	1.0 MB	1.5 MB	2 MB
RAM	96 KB	192 KB	256 KB	512 KB
Tx Power	7 dBm	7 dBm	7 dBm (QFN) 8 dBm (WLCSP)	7 dBm (QFN) 8 dBm (WLCSP)
Rx Sensitivity	-96 dBm (1 Mbps Bluetooth LE) -102 dBm (IEEE 802.15.4)	-96 dBm (1 Mbps Bluetooth LE) -102 dBm (IEEE 802.15.4)	-96 dBm (1 Mbps Bluetooth LE) -102 dBm (IEEE 802.15.4)	-96 dBm (1 Mbps Bluetooth LE) -101 dBm (IEEE 802.15.4)
Coprocessor	1 x RISC-V, 128 MHz	1 x RISC-V, 128 MHz	1 x RISC-V, 128 MHz	1 x RISC-V, 128 MHz
Global RTC	✓	✓	✓	✓
14-bit ADC	✓	✓	✓	✓
NFC	✓	✓	✓	✓
SPI, TWI, UART, PWM	✓	✓	✓	✓
High Speed SPI/UART	✓	✓	✓	✓
QDEC, WDT, TEMP	✓	✓	✓	✓
Comparators	✓	✓	✓	✓
Audio interfaces	I2S, PDM	I2S, PDM	I2S, PDM	I2S, PDM
GPIO	31	31	31 (QFN) 32 (WLCSP)	35 (QFN) 66 (WLCSP)
Isolation	Arm TrustZone	Arm TrustZone	Arm TrustZone	Arm TrustZone
Cryptographic accelerator	✓	✓	✓	✓
Tamper detectors	✓	✓	✓	✓
Max operating temperature	-40 to +105 °C	-40 to +105 °C	-40 to +105 °C	-40°C to +85°C
Available packages	QFN 6.0x6.0 mm	QFN 6.0x6.0 mm	QFN 6.0x6.0 mm WLCSP 2.4x2.2 mm	QFN 6.0x6.0 mm WLCSP3.85x3.67 mm
Supply Range (V)	1.7 - 3.6 V	1.7 - 3.6 V	1.7 - 3.6 V	1.7 - 3.6 V
GPIO Supply (V)	1.7 - 3.6 V	1.7 - 3.6 V	1.7 - 3.6 V	1.7 - 3.6 V

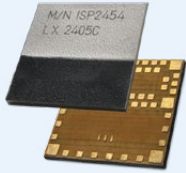
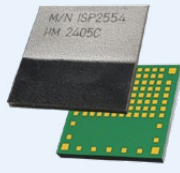
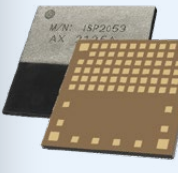
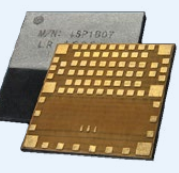


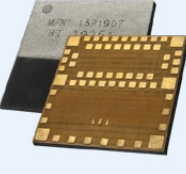
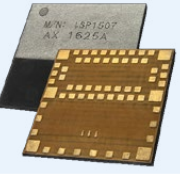
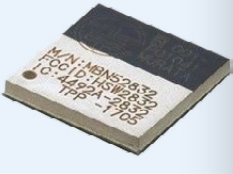
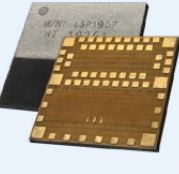
	nRF5340	nRF52840	nRF52833	nRF52832	nRF52820	nRF52811	nRF52810	nRF52805
Bluetooth 5.4	✓	✓	✓	✓	✓	✓	✓	✓
Bluetooth LE Audio	✓							
Bluetooth Direction Finding	✓		✓		✓	✓		
Bluetooth 2 Mbps	✓	✓	✓	✓	✓	✓	✓	✓
Bluetooth Long Range	✓	✓	✓		✓	✓		
Bluetooth Mesh	✓	✓	✓	✓	✓			
Thread, Zigbee, 802.15.4	✓	✓	✓		✓	Thread, 802.15.4		
Matter	✓	✓						
ANT	✓	✓	✓	✓	✓	✓	✓	✓
NFC	✓	✓	✓	✓				
CPU	128 Mhz Arm Cortex-M33 + 64 Mhz Arm Cortex-M33							64 Mhz Arm Cortex-M4
Flash / RAM	1 MB/256 KB + 256 KB/64 KB	1 MB/256 KB	512 KB/128 KB	512 or 256 KB /64 or 32 KB	256 KB/32 KB	192 KB/24 KB	192 KB/24 KB	192 KB/24 KB
SPI, TWI, UART, PWM	✓	✓	✓	✓	SPI, TWI, UART	✓	✓	SPI, TWI, UART
High Speed SPI	✓	✓	✓					
ADC, Comparators	✓	✓	✓	✓	Comparator	✓	✓	ADC
I2S, PDM	✓	✓	✓	✓		PDM	PDM	
Arm® TrustZone® CryptoCell	CC312	CC310						
USB	✓	✓	✓		✓			
QSPI	✓	✓						
GPIO	Up to 48	Up to 48	Up to 42	Up to 32	Up to 18	Up to 32	Up to 32	Up to 10
Max operating temperature	+105 °C	+85 °C	+105 °C	+85 °C	+105 °C	+85 °C	+85 °C	+85 °C
Supply Range (V)	1.7-5.5	1.7-5.5	1.7-5.5	1.7-3.6	1.7-5.5	1.7-3.6	1.7-3.6	1.7-3.6
Packages	WLCSP (4.4x4.0 mm) aQFN94 (7x7 mm)	WLCSP (3.5x3.6 mm) QFN48 (6x6 mm) aQFN73 (7x7 mm)	WLCSP (3.2x3.2 mm) QFN40 (5x5 mm) aQFN73 (7x7 mm)	WLCSP (3.0x3.2 mm) QFN48 (6x6 mm)	WLCSP (2.5x2.5 mm) QFN40 (5x5 mm)	WLCSP (2.5x2.5 mm) QFN32 (5x5 mm) QFN48 (6x6 mm)	WLCSP (2.5x2.5 mm) QFN32 (5x5 mm) QFN48 (6x6 mm)	WLCSP (2.5x2.5 mm)



Rutronik Module Partners based on Nordic

Overview

Nordic SoC	nRF54L15			nRF54H20		nRF5340			nRF52840			
Module Supplier	Insight SiP	MinewSemi	Panasonic	Insight SiP	MinewSemi	Insight SiP	Panasonic	MinewSemi	Insight SiP	MinewSemi	Panasonic	iVativ
Product Name	ISP2454	ME54BS01	PAN B611-1x	ISP2554	ME54BS02	ISP2053-AX	PAN1783	MS45SF1	ISP1807-LR	MS88SF3	PAN1770 / PAN1780	RENO/NILE
Product Photo												
Dimension	8 x 8 x 1	23.2 x 17.4 x 2	10.35 x 9.6 x 2	9 x 9 x 1	16.5 x 12 x 2	8 x 8 x 1	15.6 x 8,7 x 2	18 x 12.5 x 2	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
Flash and RAM	1.5 MB Flash; 256 kB RAM			2 MB Flash; 1 MB RAM		1 MB Flash, 512 kB RAM; 256kB Flash, 64 kB RAM			1 MB Flash; 256 kB RAM			
GPIOs	32	19	32	64	64	46	48	48	46	48	48	46
32 kHz Crystal	yes	no	yes	yes	no	yes	yes	no	yes	no	yes	yes
Certifications	Planned: CE, FCC, IC, TELEC, RoHs, Reach, POP compliant, CRA Declaration, Bluetooth SIG, CSA Matter and Thread	Planned: BQB, FCC, CE, TELEC, RoHS, REACH	CE RED, FCC, ISCED, MIC	Planned: CE, FCC, IC, TELEC, KCC, RoHS, REACH, Bluetooth SIG	Planned: BQB, FCC, CE, TELEC, RoHS, REACH	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	CE RED, FCC, ISCED	CE, FCC	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	BQB, CE, FCC, REACH, ROHS	CE RED, FCC, ISCED, MIC, KCC, ACMA, RSM	CE, FCC, IC
Available extra feature	BLE 6.0, BT Mesh, Thread, Matter, 802.15.4, NFC, Pin-compatible with ISP15/18/19/20 series	BLE 6.0	BLE 6.0, available in different versions	BLE 6.0, BT Mesh, Thread, Matter	BLE 6.0	BLE 5.3, two Cortex® -M33 processors, Pin-compatible with ISP15/18/19/24 series	BLE 5.4, NFC-A, Thread, ZigBEE, two Cortex® -M33 processors	BLE 5.4	BLE 5.2, Pin-compatible with ISP15/19/20/24 series	BLE 5.4, ANT, BT Mesh, ZigBee, Thread	BLE 5.2, w/o internal antenna (PAN1770), with internal antenna (PAN1780)	BLE 5.4, Zigbee and Thread certified, available in 2 different antenna options

Nordic SoC	nRF52833			nRF52832		nRF52820			nRF52811		nRF52810
Module Supplier	Insight SiP	Panasonic	MinewSemi	Insight SiP	Murata	MinewSemi	Panasonic	MinewSemi	Insight SiP	MinewSemi	MinewSemi
Product Name	ISP1907-HT	PAN1782	MS88SF3	ISP1507-AX	MBN52832	MS50SFB	PAN1781	MS44SF1	ISP1907-LL	MS50SFB3	MS50SFA
Product Photo											
Dimension	8 x 8 x 1	15,6 x 8,7 x 2	18,5 x 12,5 x 2	8 x 8 x 1	7,4 x 7 x 0,9	20 x 12 x 2	15,6 x 8,7 x 2	20 x 12 x 2	8 x 8 x 1	20 x 12 x 2	15,8 x 12 x 2
Flash and RAM	512kB flash 128kB RAM			512kB Flash 64kB RAM		512kB Flash 64kB RAM	256kB Flash 32kB RAM		192kB Flash 24kB RAM		192kB Flash 24kB RAM
GPIOs	30	16	42	30	20	30	16	16	13	30	13
32 kHz Crystal	yes	yes	no	yes	no	yes	yes	no	yes	no	no
Certifications	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	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	CE, FCC, IC, ETSI, TELEC	BQB, CE, FCC, IC, TELEC, RCM, WPC, RoHS, REACH	CE RED, FCC, ISCED, MIC, KCC, ACMA, RSM	BQB	Bluetooth SIG, CE, FCC, IC, TELEC, KCC	RoHS, REACH, FCC, CE, BQB, IC, TELEC, WPC, RCM, WEEE, AEC, KC	CE, FCC, RoHS, BQB, KC, REACH, SRRC, TELEC, EN50498
Available extra feature	BLE 5.2, Pin-compatible with ISP15/18/20/24 series	BLE 5.3, NFC	BLE 5.4, ANT, BT Mesh, ZigBee, Thread	BLE 5.0, ANT+, Pin-compatible with ISP18/19/20/24 series	BLE 5.0	BLE 5.4, available with 3 antenna types	BLE 5.3	BLE 5.4	BLE 5.2, Pin-compatible with ISP15/18/20/24 series	BLE 5.4	BLE 5.4, ANT

More modules based on Nordic SoCs available!

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INNOVATOR IN ELECTRONICS

Panasonic
INDUSTRY

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.

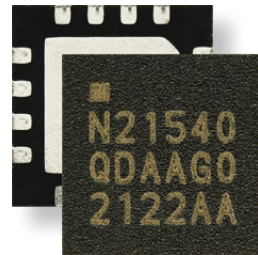
It can be used with the nRF52 and nRF53 Series advanced multiprotocol wireless SoCs with a minimal amount of external components required.

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

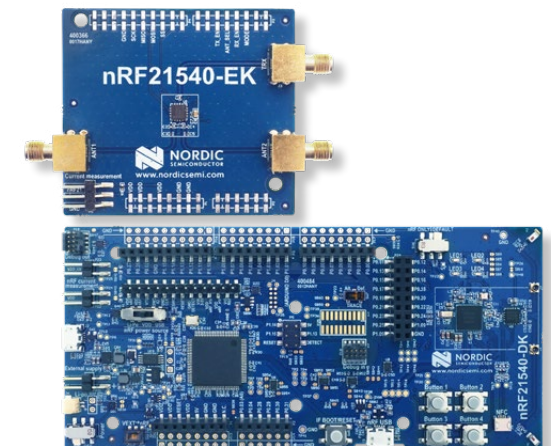
The nRF21540 DB consists of the nRF21540 development kit (DK) and the nRF21540 evaluation kit (EK). The nRF21540 DK is the perfect tool to develop products that require the range extension capabilities or link budget improvements provided by the nRF21540 RF front-end module (FEM). The nRF21540 EK can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

Introduction to Power Management ICs

Product Summary



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.

	nPM1100	nPM1300	nPM1304	nPM2100	nPM6001
Buck regulator	1	2	2	1	4
Battery charger	✓	✓	✓		
LDO		2	2	1	2
Load switch		2	2	1	
Termination voltage	4.1 - 4.2 V, or 4.25 - 4.35 V	3.5 - 4.45 V	3.5 to 4.65 V		
Min charging current	20 mA	32 mA	4 mA		
Max charging current	400 mA	800 mA	100 mA		
Dynamic power-path management	✓	✓	✓		
Thermal protection	✓	✓	✓		
Battery compatibility	Li-ion, LiPo	LiFePO4, Li-ion, LiPo	LiFePO4, Li-ion, LiPo	Primary-cells	
Input voltage	4.1 - 6.7 V	4.0 - 5.5 V	4 to 5.5 V	0.7 to 3.4 V	3 to 5.5 V
USB compliance	✓	Type-C	Type-C		
Regulated output voltage	1.8 - 3.0 V	1.0 - 3.3 V	1 to 3.3 V	0.8 to 3.3 V	0.5 - 3.3 V
Max current per buck	150 mA	200 mA, 200 mA	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.	System, input bus and battery voltages. Battery current and temperature. Die temperature.	Battery voltage, boost regulator output voltage. Die temperature	
Fuel gauge		✓	✓	✓	
Hard system reset		✓	✓	✓	
Timed wake-up		✓	✓	✓	✓
Watchdog timer		✓	✓	✓	✓
Ship / hibernate mode	✓	✓	✓	✓	✓
Brown-out detector	✓	✓	✓	✓	✓
LED drivers, GPIOs	2, 0	3, 5	3, 5	0, 2	0, 3
Control interface	Pin-configurable	TWI	TWI	TWI	TWI
Regulatory compliance	CE, JEITA, RoHS	CE, JEITA, RoHS	CE, JEITA, RoHS	CE, RoHS	CE, RoHS
Operating temperature	-40 to 85 °C	-40 to 85 °C	-40 to 85 °C	-40 to 85 °C	-40 to 85 °C
Evaluation kits	nPM1100 EK	nPM1300 EK	nPM1304 EK	nPM2100 EK	nPM6001 EK
Package options	4 x 4 mm QFN24, 2.1 x 2.1 mm WLCSP	5 x 5 mm QFN32, 3.1 x 2.4 mm WLCSP	5x5 mm QFN32, 3.1x2.4 mm WLCSP	4x4 mm QFN16, 1.9x1.9 mm WLCSP	2.2 x 3.6 mm WLCSP

Power Management ICs

nPM1304, nPM2100

nPM1304 - Highly integrated Power Management IC (PMIC) with support for small size battery product

nPM1304 is a power management IC (PMIC) that simplifies system design by integrating essential functions required for embedded Bluetooth Low Energy designs and any other applications requiring small size batteries. It features a hard reset functionality for one or two buttons, precision battery fuel gauging, system-level watchdog, power loss warning, and recovery from failed boot. These functions are typically implemented as discrete components in embedded designs, but the nPM1304 integrates them into a single, compact package, simplifying system design and reducing the number of required components. The nPM1304 is ideal for compact and advanced IoT products with small battery sizes such as smart rings, sports performance trackers and personal health care monitoring devices.

Key Features

- Highly efficient PMIC with built-in system management features
 - Supports model-based precision fuel gauge running on host
 - Watchdog and boot timer
 - Power loss warning
 - One- or two-button hard reset
- 4 - 100 mA battery charger
 - Supports Li-ion, Li-poly and LiFePO4 batteries
- Four individually controllable power rails
 - Two highly efficient buck regulators with 200 mA current limit
 - Two 100 mA load switches or 50 mA LDOs
- Input regulator with USB support
 - USB-C compatible
- Ship- and hibernate modes
- Five GPIOs and three LED drivers
- 40°C to 85°C operating temperature

Applications

- Smart rings
- Smart glasses
- Health & fitness sensors and monitoring devices
- Smart/low-energy sensors
- Computer and gaming equipment
- Asset tracking



nPM2100 - Power Management IC (PMIC) with ultra-efficient boost regulator for primary-cell batteries

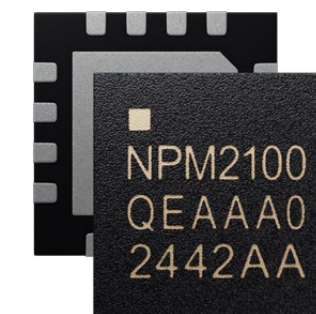
The nPM2100 PMIC enables longer run-time on every battery by implementing toolbox of power saving capabilities for primary cell batteries. It features one boost converter that can provide voltages of 1.8 to 3.3 V output, from input voltages of 0.7 to 3.4 V. Examples of supported batteries are one or two AA/AAA/LRxx batteries (in series), or one 3V LiMnO2 cell. Single- or dual-cell silver oxide and zinc-air coin-cell batteries are also supported, or any other battery that operates within the PMICs input voltage range. The 150 nA IQ internal boost regulator places itself among the most efficient boost regulators on the market today. A 35 nA ship mode allows the device to be shipped with batteries inserted without draining the battery and eliminates the plastic pull-tab method of protecting batteries during shipping and storage. Hibernate mode includes timed wakeups for applications that spend most of their time in deep sleep, lowering sleep current to 175 nA extending battery lifetimes by up to 3x.

Key Features

- Ultra-efficient boost regulator
 - 1.8 to 3.3 V output
 - 150 mA max
- LDO/Load switch supplied by the boost regulator
 - 0.8 to 3.0 V in LDO-mode
 - 50 mA max
- 35 nA Ship Mode with multiple wakeup options
- 175 nA Hibernate mode with wakeup timer
- Fuel gauge for primary cell batteries
- 0.7 to 3.4 V supply voltage
- Multiple package options
 - 1.9 x 1.9 mm WLCSP
 - 4 x 4 mm QFN16

Applications

- Computer peripherals / HID
- Remote controls
- Smart home sensors
- Bluetooth asset tracking
- Fitness accessories
- Personal medical devices



Power Management

Related Development Tools

nPM2100 Evaluation Kit

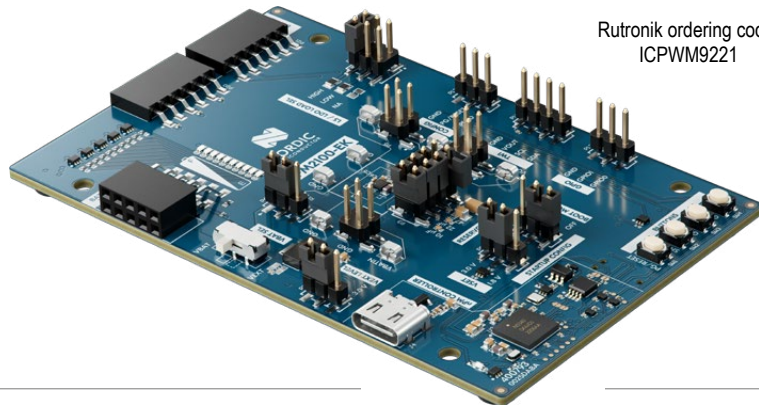
The nPM2100 PMIC enables longer run-time on every battery by implementing toolbox of power saving capabilities for primary cell batteries. It features one boost converter that can provide voltages of 1.8 to 3.3 V output, from input voltages of 0.7 to 3.4 V. Examples of supported batteries are one or two AA/AAA batteries (in series), or one 3V CR2032 coin-cell. Single- or dual-cell silver oxide and zinc-air coin-cell batteries are also supported, or any other battery that operates within the PMICs input voltage range.

Key Features

- Ultra-efficient boost regulator
 - 1.8 to 3.3 V output
 - 150 mA max
- LDO/Load switch supplied by the boost regulator
 - 0.8 to 3.0 V in LDO-mode
 - 50 mA max
- 35 nA Ship Mode with multiple wakeup options
- 175 nA Hibernate mode with wakeup timer
- Fuel gauge for primary cell batteries
- 0.7 to 3.4 V supply voltage
- Multiple package options
 - 1.9 x 1.9 mm WLCSP
 - 4 x 4 mm QFN16
- Seamless configuration through nPM PowerUP desktop software

Applications

- Computer peripherals / HID
- Remote controls
- Smart home sensors
- Bluetooth asset tracking
- Fitness accessories
- Personal medical devices



Rutronik ordering code:
ICPWM9221

nPM1304 Evaluation Kit

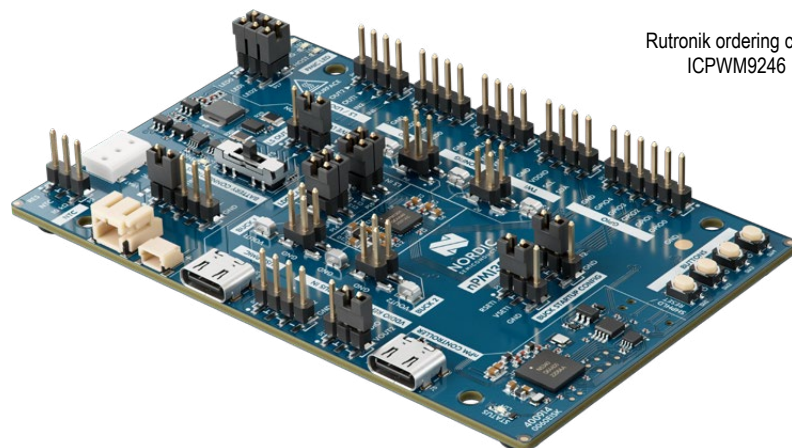
nPM1304 is a power management IC (PMIC) that simplifies system design by integrating essential functions required for embedded Bluetooth Low Energy designs and any other applications requiring small size batteries. It features a hard reset functionality for one or two buttons, precision battery fuel gauging, system-level watchdog, power loss warning, and recovery from failed boot. These functions are typically implemented as discrete components in embedded designs, but the nPM1304 integrates them into a single, compact package, simplifying system design and reducing the number of required components. The nPM1304 is ideal for compact and advanced IoT products with small battery sizes such as smart rings, sports performance trackers and personal health care monitoring devices.

Key Features

- Highly efficient PMIC with built-in system management features
 - Supports model-based precision fuel gauge running on host
 - Watchdog and boot timer
 - Power loss warning
 - One- or two-button hard reset
- 4 - 100 mA battery charger
 - Supports Li-ion, Li-poly and LiFePO4 batteries
- Four individually controllable power rails
 - Two highly efficient buck regulators with 200 mA current limit
 - Two 100 mA load switches or 50 mA LDOs
- Input regulator with USB support
 - USB-C compatible
- Ship- and hibernate modes
- Five GPIOs and three LED drivers
- -40°C to 85°C operating temperature

Applications

- Computer peripherals / HID
- Remote controls
- Smart home sensors
- Bluetooth asset tracking
- Fitness accessories
- Personal medical devices



Rutronik ordering code:
ICPWM9246

Power Management

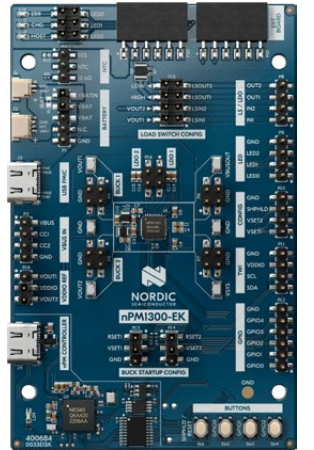
Related Development Tools

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: ICPWM9215

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: ICPWM9164

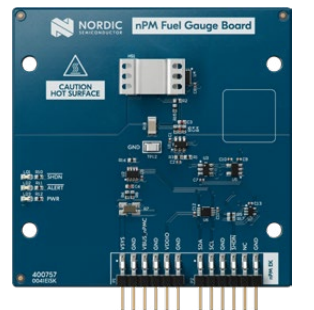
Key Features

- 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.



nRF70 Series Overview



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

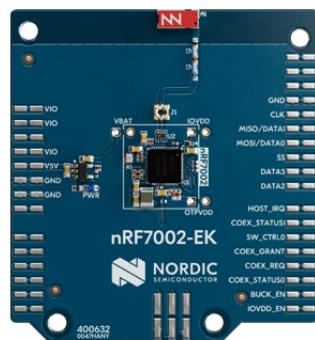
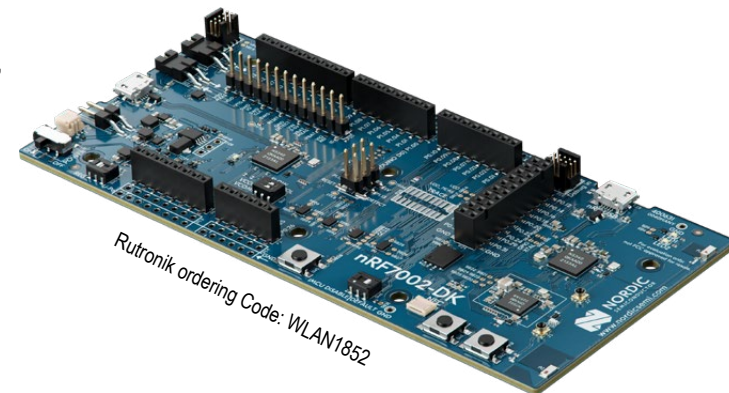
nRF70 Series Related Development Tools

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.

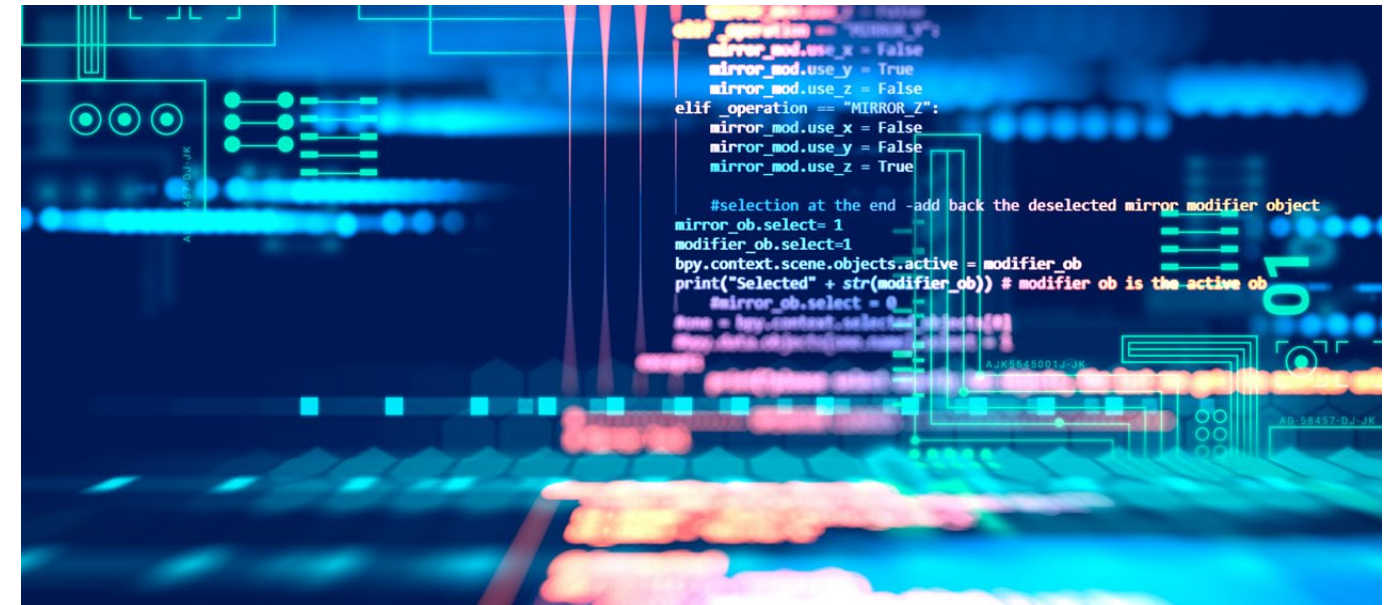
Key Features

- 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

Development Tools Power Profiler Kit



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



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 an 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 8KB 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.

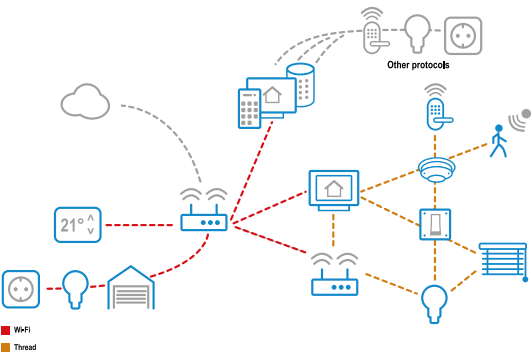
Bare Metal option

The nRF Connect SDK Bare Metal option is a new, alternative development path within the nRF Connect SDK environment that enables single-threaded bare metal Bluetooth LE application development on the nRF54L Series. It is designed for developers creating simple Bluetooth LE applications, such as straightforward data exchange applications requiring connectivity (in applications like medical devices, sports wearables, trackers, or beacons), that do not benefit from an RTOS or advanced features.

The Bare Metal option is integrated into the nRF Connect for VS Code environment, and once installed, you may choose on a per-project basis whether the bare metal or Zephyr RTOS-based development option is used for each project. This makes it easy for you to select the proper foundation for each project without having to switch contexts and environments - everything happens within the same editor and the same set of tools.

The following features and samples are available at launch for the Bare Metal option:

- Bluetooth LE development on nRF54L Series on bare metal
- SoftDevice S115
- Shared tooling within nRF Connect for VS Code
- Clear migration path from nRF5 SDK to nRF Connect SDK environment with provided guidance
- Upgrade path from Bare Metal option to Zephyr RTOS, which comes with the full capabilities of nRF Connect SDK



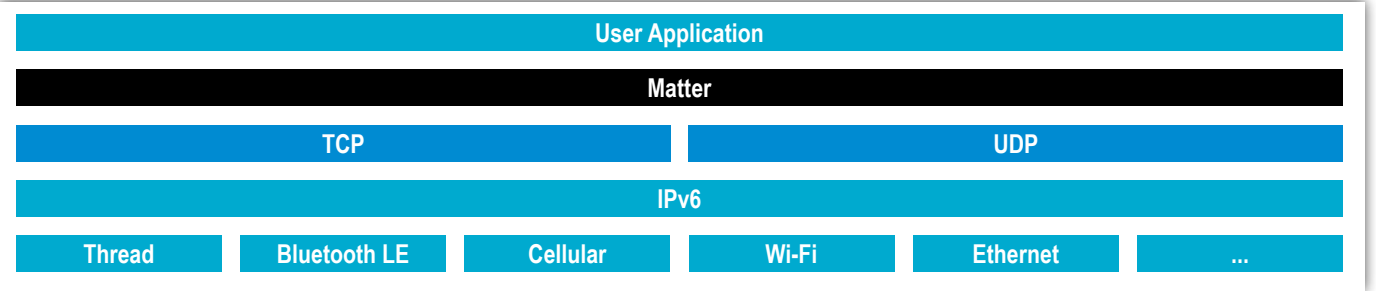
Matter

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: ■ Air Purifiers ■ Air Quality Sensors ■ Dishwashers ■ Fans ■ Laundry Washers ■ Refrigerators ■ Robotic Vacuums ■ Room Air Conditioners ■ Smoke & Carbon Monoxide Alarms	■ 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)
1.4	November 2024	Added Categories: ■ Solar systems ■ Batteries ■ head pumps ■ water heaters	■ Improvements for Thread networks ■ Extended energy management ■ Parallel use of multiple Matter systems
1.4.1	May 2025		■ Enhanced Setup Flow (ESF) allows manufacturers' terms of service to be displayed and accepted directly within Matter-compatible apps ■ Multi-Device Setup QR Code enables compatible apps to use a single QR code to onboard multiple devices at once ■ Onboarding Info in NFC Tag feature extends the previous QR and numeric codes to include Near-Field Communication (NFC)
1.4.2	June 2025		■ crypto and security improvements ■ Platform support for Zephyr ■ improving reliability and fixing minor bugs ■ supports commissioning using concatenated QR codes and discriminators



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.

Memfault Overview

Memfault is the first embedded observability platform that empowers teams to build more robust devices with software at scale.

It gives you real-time visibility into the performance and reliability of deployed devices so you can fix problems before customers even notice. Reduce returns, eliminate site visits, and ship updates with confidence.



Built for low-power, real-world devices

Memfault's technology is optimized for low-power, intermittently connected devices — from ocean buoys to battery-powered sensors with 10+ year lifespans. Data is buffered and sent when connectivity is available, and developers can fine-tune data volume to suit bandwidth constraints.

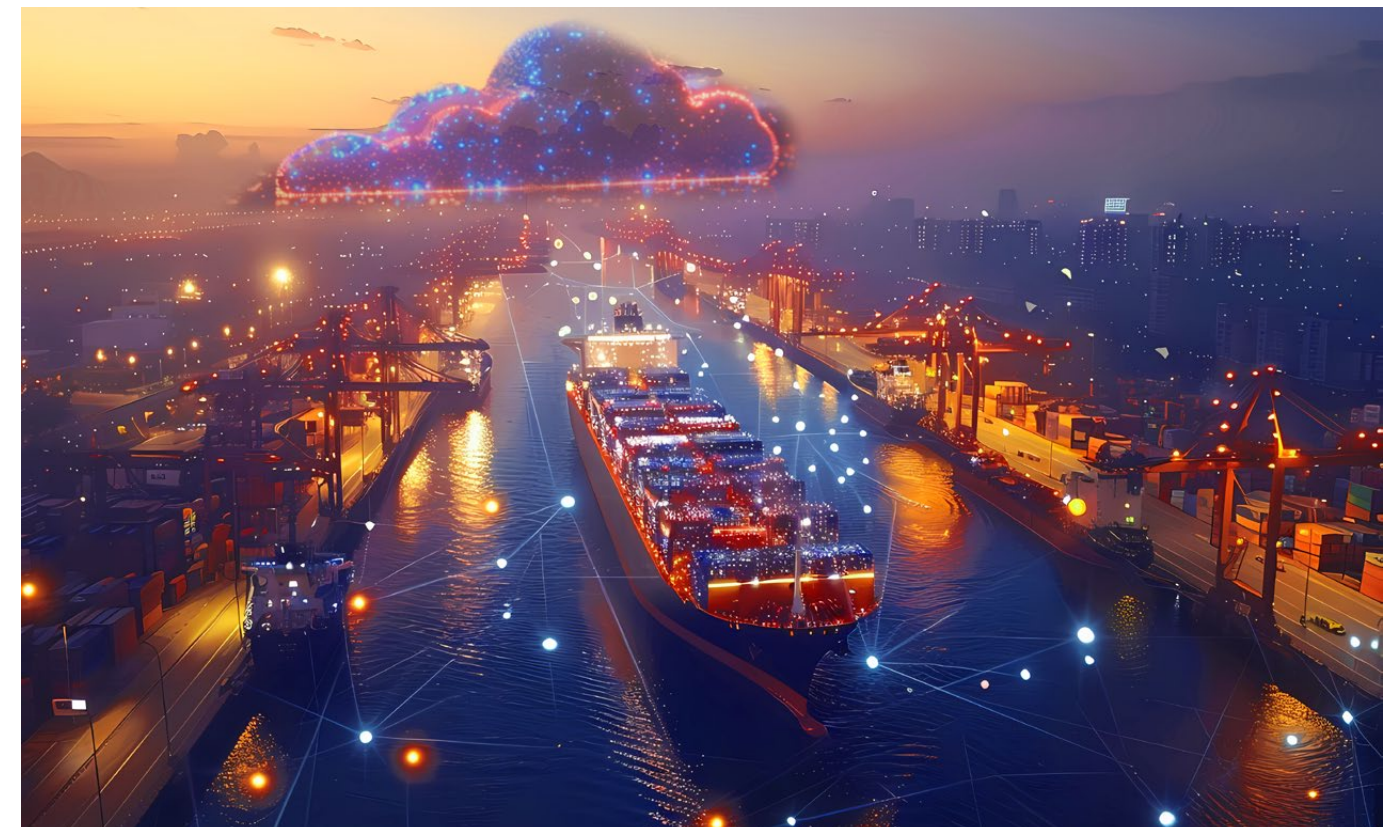
Fast start, seamless software integration, and scalable pricing

Integration and out-of-the-box functionality have been significantly enhanced for the nRF Connect SDK, including the newly launched Bare Metal option. Developers can now connect devices to the cloud, begin monitoring data, and deploy remote updates within minutes—streamlining development and accelerating time to market. Nordic customers can get started for free with up to 10 devices, and scale from just \$0.10/device/month. The integration with nRF Connect SDK and mobile apps makes setup fast and intuitive, enabling remote monitoring and updates in minutes.

Proven results

The combination of Memfault's device observability and nRF Cloud's device management enables development teams to monitor real-world device behavior, prioritize fixes based on data insights, and deploy updates reliably—even on low-power, intermittently connected devices. This enhanced visibility and control shortens debug cycles, improves product quality in production, and strengthens device security throughout the product lifecycle.

Memfault's observability has already helped Nordic resolve critical issues ahead of product launches, including memory leaks and modem bugs in the Thingy:91 X.





Nordic takes security to the next level

Security is becoming increasingly important within the IoT and wireless connectivity for several reasons. Given these risks, it is important to prioritize and define security requirements early in the design process. Nordic offers security enablers that ensure a successful implementation of the security level needed for your specific IoT device.

The industry is coming together to create streamlined best practices, frameworks, and certifications. Nordic aligns with PSA Certified™ to provide a standardized approach to security that guides customers through their individual security journey. Below we have highlighted a few simplified steps, guiding you towards a successful result:

Analyze

Threat models & security analysis



Understand the critical assets that need to be protected in your product, and what threats that have the potential to compromise it, to identify the most effective security measures.

Architect

Hardware & firmware specifications



Once the analysis is concluded it needs to be translated into technical specifications.

Implement

Firmware Source code



The required features must be implemented in the firmware, based on high-level APIs that interface to the hardware root of trust.

Certify

Independently tested



The final step to confirm that all requirements have been satisfied and to establish the reliability of your product is an independent security assessment of your device.

Security Goals and Objectives

Nordic has a clear goal when it comes to security. Enable everyone to design and deploy secure products, by:

1. **Making the right choices from the start.**
2. **Understanding the threats and value of security**
3. **Protecting critical assets against common threats**

IoT product security can be divided into a few simple objectives every product should meet. Product security can be divided into a few simple objectives every product should meet.



Secure boot and secure update with anti-rollback

Security starts at boot time to ensure that only authorized software can be executed and updated on a device. Reinstating previous software versions should be prevented to ensure that fixed security issues don't become exposed.



Isolation between secure and non-secure environments

There must be separation between trusted and un-trusted services to avoid compromising the entire device. Un-trusted services should interact with trusted services through APIs that ensure functionality while keeping confidentiality of critical data and resources.



Secure storage

Critical assets must be uniquely bound to each device and protected from any intrusion, to ensure confidentiality and integrity.



Attestation and unique identification

Every device should be uniquely identifiable and attestable so that a trusted interaction can be established. See the nRF Cloud Security Services for more information.



Security Lifecycle

Device security must be defined through different product lifecycle phases, from initial assembly to decommissioning and every step in between. The nRF Cloud Security Services can simplify some of the lifecycle phases.



Cryptographic services

A secure product sits on top of a set of trusted cryptographic services to enable the implementation of all required security features.

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 (dB)	Efficiency (%)	VSWR	Antenna Size (mm)	Mea- sured 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	400-2700MHz	1.6dBi @ 698-960 MHz 3.1dBi @ 1710-2400 MHz 1.7dBi @ 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	698-3800MHz	2.6dBi @ 698-960 MHz 4.4dBi @ 1710-2200 MHz 3.4dBi @ 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	1.7dBi	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	3.45dBi @ 2.4 GHz / 3dBi @ 2.4 / 5 GHz	68% @ 2.4 GHz / 65% @ 2.4GHz, 50% @5GHz	< 2.5:1 / 2.1:1 @2.4GHz, 7:1@5GHz	1.00 x 0.55 x 0.40	13x2.35 / 16x2.4	-55 to 125	UWB possible
	9005868	BLE	SMD-Chip	2.4 GHz	4 dBi	0,72	1.2:1	1.0 x 0.58 x 0.35	10x6.64	-55 to 125	Corner Placement
	9002418L0-L16L	NTN / L-Band	SMD	1575MHz / 1620MHz	1.7 dBi @ 1540 MHz 1.6 dBi @ 1640 MHz	54% @ 1540 MHz 47% @ 1640 MHz	1.5:1	37.5 x 37.5 x 17.98 (h)	-	-40 to +85	Space saving (components could be placed underneath) / Light weight
	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 Performance 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	5dBi@2.3GHz-2.7GHz	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	617-960/1430-6000MHz	1-7 dBi	40%-45%	0-2.5dBi	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
	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 Performance High Temperature
	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

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 @2.4GHz	~76	~1.2:1 @2.4GHz	39.6 x 8.4 x 0.1	Custo-mazable	-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	Custo-mazable	-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	Custo-mazable	-40 to +85	
	2JF0924P	LTE	FPC	700 - 2700 MHz	~4.5	~58.8	~2.5:1	120 x 8.9 x 0.15	Custo-mazable	-40 to +85	
KYOCERA AVX	W3 Family	BLE + Wi-Fi	FPC/PCB	2.4 / 5 GHz	2.3dBi @2.4GHz	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
	W7 Family	BLE	FPC/PCB	2.4 / 5 / 6 GHz	2 dBi @2.4GHz	70% @2.4 GHz	1.7:1	35.2 x 8.5 x 0.4	100	-40 to +85	
	W1 Family	BLE + Wi-Fi	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@617-960MHz 4.65 dBi @ 1415-2690 MHz	35% @617-960MHz 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	2.9dBi @698-960 MHz 4.3dBi @ 1710-260- 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 @2.4GHz	<2.0:1	4.3 x 15.3 x 0.1	100 - 290	-40 to +85	Small form factor
	W3918xxx	BLE + Wi-Fi	FPC	2.4 / 4.9-7.125 GHz	Max. 4	60 @2.4GHz	<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	2-3dBi	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	4.14dBi	52%-82%	4:1 max	90 x 20 x 0.55	100	-40 to +85	Small size, broadband
	ANTX200P001B24003	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
	ANTX100P01B24553	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	
	ANTX100P001BWPEN3	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

Nordic & Rutronik

Nordic DevZone & Support

The Nordic DevZone is an open forum that gives users access to Nordic tech support, interaction with other engineers worldwide and a technical blog. More than 25,000 developers come there to ask, share and discuss. devzone.nordicsemi.com

Nordic Dev Academy

Interactive online learning platform to equip developers with the technical information and know-how to build wireless products. academy.nordicsemi.com

Nordic TechDocs

Find more information about technical documentations. docs.nordicsemi.com

Rutronik Support

Check availability, pricing, useful companion products and clarify any other open question regarding your wireless idea: wireless@rutronik.com

Nordic Infocenter

The Infocenter is a comprehensive library containing technical documentation. infocenter.nordicsemi.com

Get Connected Blog

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

Get Started

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

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



		 nRF91 Series	 nRF70 Series	 nRF54L Series	 nRF53 Series	 nRF52 Series
IC TYPE		Wireless SiP	Wi-Fi Companion IC	Wireless SoC	Wireless SoC	Wireless SoC
ICs		nRF9161, nRF9160, nRF9151, nRF9131	nRF7002, nRF7001, nRF7000	nRF54L15, nRF54L10, nRF54L05, nRF54LM20A	nRF5340	nRF52840, nRF52833, nRF52832, nRF52820, nRF52811, nRF52810, nRF52805
WIRELESS	LTE-M, NB-IoT, NON-TERRESTRIAL NETWORKS (NTN), DECT NR+, GNSS	Yes				
	DUAL-BAND Wi-Fi 6		Yes (with host)	Yes (with nRF70 Series)	Yes (with nRF70 Series)	Yes (with nRF70 Series)
	Wi-Fi LOCATIONING	Yes (with nRF70 Series)	Yes (with host)	Yes (with nRF70 Series)	Yes (with nRF70 Series)	Yes (with nRF70 Series)
	BLUETOOTH LOW ENERGY 6.0			Yes	Yes	Yes
	BLUETOOTH CHANNEL SOUNDING			Yes		
	BLUETOOTH LE AUDIO				Yes	
MCU FUNCTIONALITY	BLUETOOTH MESH, ZIGBEE, THREAD, MATTER, AMAZON SIDEWALK, NFC			Yes	Yes	Yes
	ESB AND 2.4 GHz PROPRIETARY PROTOCOLS			Yes up to 4 Mbps	Yes up to 2 Mbps	Yes up to 2 Mbps
	PROCESSOR	64 MHz Arm Cortex-M33		128 MHz Arm Cortex-M33	2× Arm Cortex-M33, up to 128 MHz	64 MHz Arm Cortex-M4
	RISC-V COPROCESSOR			128 MHz FLPR		
	NVM	1 MB		Up to 1.5 MB	1 MB + 256 KB	Up to 1 MB
	RAM	256 KB		Up to 256 KB	512 KB + 64 KB	Up to 256 KB
SECURITY	STANDARD PERIPHERALS AND INTERFACES	Yes	High-speed SPI/QSPI	Yes	Yes	Yes
	HIGHLIGHTED DIGITAL INTERFACES				12 Mbps USB	12 Mbps USB
	ISOLATION	TrustZone		TrustZone	TrustZone	TrustZone
SECURITY	CRYPTOGRAPHIC ACCELERATOR	Yes		Yes with side-channel leakage protection	Yes	Yes
	TAMPER DETECTORS			Yes		
GPIOs		32		Up to 32	48	Up to 48
PACKAGE TYPES		LGA	QFN, WLCSP	QFN, WLCSP	aQFN, WLCSP	aQFN, QFN, WLCSP
MINIMUM PACKAGE SIZE		11×7×1 mm	3.8×3.4 mm	2.4×2.2 mm	3.5×3.6 mm	2.5×2.5 mm
COMPATIBLE PMICs		nPMI300, nPM6001	nPM6001	nPMI300, nPMI100, nPM6001	nPMI300, nPMI100, nPM6001	nPMI300, nPMI100, nPM6001
nRF Cloud SERVICES		Yes	Yes			



		nPM6001	nPM2100	nPMI304	nPMI300	nPMI100
TYPE	PMIC	●	●	●	●	●
	BUCK REGULATOR	4		2	2	1
FEATURES	BOOST REGULATOR		1			
	BATTERY CHARGER			●	●	●
	LDO		1	2	2	
	LOAD SWITCH		1	2	2	
CHARGER	TERMINATION VOLTAGE			3.5 to 4.65 V	3.5 to 4.45 V	4.1 to 4.2 V or 4.25 to 4.35 V
	MAX CHARGING CURRENT			100 mA	800 mA	400 mA
	POWER PATH MANAGEMENT				●	●
	THERMAL PROTECTION				●	●
	BATTERY COMPATIBILITY		LiMnO ₂ , AA/AAA 1S or 2S, Silver Oxide LiFePO ₄ , Li-ion, LiPo	LiFePO ₄ , Li-ion, LiPo	LiFePO ₄ , Li-ion, LiPo	Li-ion, LiPo
POWER RAILS	INPUT VOLTAGE	3 to 5.5 V	0.7 to 3.4 V	4 to 5.5 V	4 to 5.5 V	4.1 to 6.7 V
	USB COMPLIANCE			Type-C	Type-C	●
	REGULATED OUTPUT VOLTAGE	0.5 to 3.3 V	1.8 to 3.3 V	V I to 3.3 V	1 to 3.3 V	1.8 to 3 V
	MAX CURRENT PER BUCK	550 mA, 200 mA, 150 mA, 150 mA	150 mA	200 mA, 200 mA	200 mA, 200 mA	150 mA
SYSTEM MANAGEMENT	SYSTEM MONITORING		Battery-voltage and -temp (derived from die temp)	System-, input bus- and battery-voltage; battery-current and -temp; die temp	System-, input bus- and battery-voltage; battery-current and -temp; die temp	
	FUEL GAUGE		●	●	●	
	HARD SYSTEM RESET		●	●	●	
	TIMED WAKE-UP		●	●	●	
	WATCHDOG TIMER	●	●	●	●	
	SHIP MODE / HIBERNATE	●	●	●	●	●
	BROWN-OUT DETECTOR	●	●	●	●	●
	LED DRIVERS, GPIOs	0, 3	0, 2	3, 5	3, 5	2, 0
	CONTROL INTERFACE	I2C	I2C	I2C	I2C	Pin-configurable
	REGULATORY COMPLIANCE	CE, RoHS	CE, RoHS	CE, JEITA, RoHS	CE, JEITA, RoHS	CE, JEITA, RoHS
OPERATING TEMPERATURE		-40 to 85°C	-40 to 85°C	-40 to 85°C	-40 to 85°C	-40 to 85°C
EVALUATION KITS		nPM6001 EK	nPM2100 EK	nPM6001 EK	nPMI300 EK	nPMI100 EK
PACKAGE OPTIONS		2.2×3.6 mm WLCSP	4×4 mm QFN16, 1.9×1.9 mm WLCSP	5.5 mm QFN32, 3.1×2.4 mm WLCSP	5×5 mm QFN32, 3.1×2.4 mm WLCSP	4×4 mm QFN24, 2.1×2.1 mm WLCSP



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Rutronik Elektronische Bauelemente GmbH
Industriestraße 2 | 75228 Ispringen | Germany