

Wireless Technologies



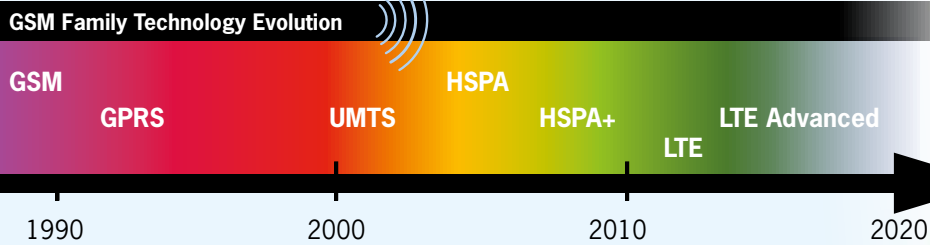
V6.1



Cellular, GNSS, RFID,
Short- & Long Range Wireless Solutions

GSM Family Technology Evolution

Which mobile communication technologies evolved over time in the GSM family?



What does GSM mean?

GSM (Global System for Mobile Communications) is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second generation (2G) digital cellular networks used by mobile phones. It is actually a global standard for mobile communications with over 90% market share, while being available in over 230 countries. GSM is a trademark owned by the GSM Association (GSMA). The GSMA is an association of mobile operators and related companies devoted to support the standardization, the deployment and the promotion of the GSM mobile telephone system.

How does the GSM mobile communications standard work?

The structure of radio signals and the process of data exchange in the GSM network were standardized worldwide. The adherence to this standard ensures that network technology and mobile phones match smoothly in any part of the world. Thus, today a customer of a German network provider can easily make phone calls from abroad to Germany with his own mobile phone. Like all mobile networks of the 2nd and 3rd generation, also GSM networks use a digital transmission method for the transmission of data.

Data Transmission Methods in the GSM Network

The signals resulting from the digital conversion are “packed” into a high-frequency electromagnetic wave which is used as a transport medium from one antenna to the other antenna. This process is also called “modulation”. The first two methods for transmitting data in a GSM network are CSD (Circuit Switched Data), a circuit-switched data transmission method, and SMS (Short Message Service) which is a packet-switched connectionless short message service and limited to 160 characters per message. CSD has already been offered with the beginning of GSM. The user data rate was limited to 9.6 kbit/s. In GSM phase 2 the speed of data transmission was increased to 14.4 kbit/s by dispensing with the error correction of data. As a consequence, the quality of the connection has dropped. Within the GSM Phase 2+, the bundling of multiple channels became possible. The data service HSCSD (High Speed Circuit Switched Data) leads to a higher data rate. Since both techniques are circuit-switched transmission techniques, invoicing is based on the connection time. For the classical application of Internet access that is far from optimal. Therefore, GPRS (General Packet Radio Service) established quickly, which builds only a virtual connection and invoiced on the amount of data transferred. This was the beginning of the existence of a new technology in the GSM family. The data packets are sent 217-times per second within fixed time intervals. However, the sequence of the transmission of data packets varies with mobile phones and mobile base stations.

High Speed Packet Access (HSPA)

HSPA is an amalgamation of two mobile telephony protocols, High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA), that extends and improves the performance of existing 3rd

generation mobile telecommunication networks utilizing the WCDMA protocols. A further improved 3GPP standard, Evolved HSPA (also known as HSPA+), was released late in 2008 with subsequent worldwide adoption beginning in 2010. The newer standard allows bit-rates to reach as high as 337 Mbit/s in the downlink and 34 Mbit/s in the uplink.

LTE

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

5G

5G is the current cellular communication system generation. With IoT-enabled devices in mind, 5G connects a higher density of devices at higher speeds and makes things lag nearly non-existent. As a result, 5G creates an excellent user experience irrespective of what application, device or service you touch. As adoption grows, they will evolve and use public and private networks to stream virtual and augmented reality and 3D video (which requires high bandwidth). Moreover, 5G applications will be used for critical communications like factory automation, uncrewed aerial vehicles (UAVs) and more.5G IoT will improve everyday life from personal applications to changing how we work and live.With 5G IoT, facilities will continue improving to send critical upgrades to networks without freezing functionality or overloading servers. 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.

Technology	Description	Performance Data
GPRS General Packet Radio Service	<ul style="list-style-type: none">Enable a faster data transfer in the GSM networkConnectionless, packet-oriented transmission techniqueThe entire bandwidth can be used in a mobile radio cell by all participants	<ul style="list-style-type: none">Theoretically up to 171.2 kbit/s per user possibleSimultaneous transmission of voice and dataUser pays for the bandwidth used or amount of data transferred rather than the connection timePermanent connect. to the GPRS network possible
EDGE Enhanced Data Rated for GSM Evolution	<ul style="list-style-type: none">Not an independent transmission technology but an extension for the acceleration of GPRS.With EDGE, there are the variants Enhanced GPRS (EGPRS) and Enhanced CSD (ECSD)EGPRS has the same transmission rates than GPRS with fewer channels	<ul style="list-style-type: none">Compared to each other, the transmission rates of GPRS and EDGE (EGPRS) are the following:<ul style="list-style-type: none">- GPRS: 1-2 kByte/s (Send), 3-5 kByte/s (Receive)- EGPRS: 10-12 kByte/s (Send), 15-22 kByte/s (Receive)
UMTS Universal Mobile Telecommunication System	<ul style="list-style-type: none">Third-generation (3G) broadband, packet -based transmission of text, digitized voice, video and multimediaComputer and phone users are constantly attached to the Internet when travelling because of roaming servicesHSDPA (High-Speed Downlink Packet Access) was the packet-based mobile telephony protocol used in 3G UMTS networks to increase the data capacity and speed up transfer rates	<ul style="list-style-type: none">Data rates up to 2 MbpsHSDPA specifies data transfer speeds of up to 14.4 Mbps for downloads and 2 Mbps for uploads- download speeds to at least five times faster than earlier versions of UMTS
HSPA High Speed Packet Access	<ul style="list-style-type: none">HSPA (High Speed Packet Access) is a 3rd generation (3G) mobile broadband communications technology. The term HSPA actually refers to two specific protocols used in tandem:HSDPA and HSUPA (High Speed Uplink Packet Access) HSPA+, however, offers significantly slower speeds than the predominant 4G standard, which is LTE	<ul style="list-style-type: none">HSPA networks offer a maximum of 14.4 Mbps. An improved version of high speed packet access technology, known as HSPA+, offers 42 Mbps
LTE & LTE-Advanced Long Term Evolution & Long Term Evolution-Advanced	<ul style="list-style-type: none">Long Term Evolution (LTE) is a 4G wireless broadband technologyTechnology was named "Long Term Evolution" because it represents the next step (4G) in a progression from GSM, a 2G standard, to UMTS, the 3G technologies based upon GSMLTE-Advanced (Long Term Evolution-Advanced) is a cellular networking standard that offers higher throughput than its predecessor	<ul style="list-style-type: none">LTE provides significantly increased peak data rates: 100 Mbps downstream and 30 Mbps upstream, reduced latency, scalable bandwidth capacity, and backwards compatibility with existing GSM and UMTS technology.LTE Advanced can deliver up to 1 GB per second of data, which has to be compared to a maximum of 300 MB per second over LTE networks.LTE-Advanced networks use multiple-input, multiple-output (MIMO) technology
LTE Cat 1 LTE Cat M1 LTE NB1 / NB-IoT	<ul style="list-style-type: none">IoT Focused, Lower Cost, Smaller Size, Reduced Power, Lower Data SpeedsLTE Lower Categories are Low Power Wide Area Networks (LPWANs) radio technology standards developed to enable a wide range of devices and services to be connected using cellular telecommunications band	<ul style="list-style-type: none">LTE Cat 1 provides a downlink peak rate of 10 Mbps and 5 Mbps upstreamLTE Cat M1 provides a downlink and upstream peak rate of 1 MbpsLTE NB1 provides 250 Kbps as downlink peak rate up 20-250 Kbps as uplink peak rate
5G	<ul style="list-style-type: none">5G is the fifth generation of wireless technologypromises to offer faster speeds, lower latency and more reliable connections than its predecessorhuge variety of advanced technologies like millimeter wave-frequencies, massive MIMO and beamforming	<ul style="list-style-type: none">Faster speed with a peak download speed of up to 20GbpsLower latencyImproved reliability: 5G uses advanced technologies like beamforming and massive MIMO to improve the reliability

Change easily between technologies due to...

GSM | GPRS

GSM | GPRS | GNSS

UMTS | HSPA

UMTS | HSPA+

CDMA | 1xRTT

CDMA | 1xEV-DO Rev A

LTE | DC-HSPA+

LE910

Telit

xE910

Form Factor

GE910

GE910-

UE910

HE910

CE910

DE910

LE910

ME910

NE910

GSM | GPRS

GSM | GPRS | GNSS

UMTS | HSPA

UMTS | HSPA+

CDMA | 1xRTT

CDMA | 1xEV-DO Rev A

LTE | DC-HSPA+

xE310

Telit

xE310

Form Factor

GE910

GE910-

UE910

HE910

CE910

DE910

LE910

ME910

NE910

Cellular Modules



xE910 Family – Unified Form Factor (UFF) and Family Concept

- Key Benefits

The Telit xE910 Unified Form Factor Family is comprised of 2G, 3G and 4G high category as well as LTE low category (Cat. M1 / NB-IoT) products.

All products share a common LGA form factor of 28.2 x 28.2 x 2.2 mm and have same electrical and programing interfaces which allows developers to implement a "design once, use anywhere" strategy.

Product Group	Description	Cellular Techn.	Bands	Typical Applications	GNSS
ME910G1	<div>The ME910G1 is the Category M1/NB2 evolution of the Telit xE910 family</div> <div>Specified in the approved Release 14 of the 3GPP standard</div> <div>The ME910G1 offers maximum downlink and uplink data rates of 1 Mbps</div> <div>Supports the Power Saving Mode (PSM) and the extended Discontinuous Reception (eDRX), for longer battery operation</div> <div>Enhanced coverage, with up to +15dB/+20dB in maximum coupling loss (MCL) compared to the other cellular technologies</div>	4G (LTE Cat M1 / NB2) 2G (for EU & WW Version)	Over 10 different variants are available (North America, Europe, Australia, Japan & World Wide)	<div>Cat M1/NB2 devices are specifically tailored for IoT applications, offering optimized power consumption and enhanced coverage</div> <div>The ME910G1 helps increase the addressable market for LTE technology to include a broad range of new applications and use cases best served with lower maximum data rate, ultra-low power, reduced complexity and cost</div> <div>Smart meters, industrial sensors, healthcare monitors, home automation, asset tracker and many more low data rate IoT devices</div>	Optional available with embedded GPS, Glonass, BEIDOU + Galileo (for all variants)
NE910C1	<div>The NE910C1 is the LTE Category NB1 evolution of the Telit xE910 family</div> <div>Specified in the approved Release 13 of the 3GPP standard</div> <div>The NE910C1 delivers maximum downlink and uplink data rates of 250kbps</div> <div>Supports the Power Saving Mode (PSM) and the extended Discontinuous Reception (eDRX), longer battery operation</div>	4G (LTE Cat NB1 / NB-IoT)	LTE 800/900	<div>Cat NB1 devices are specifically tailored for IoT applications, offering optimized power consumption, enhanced coverage and low cost</div> <div>Smart meters, smart parking, smart agricul-ture, waste collection, industrial sensors, healthcare monitors, home automation, and many more low data rate IoT devices</div>	Optional embedded GNSS
LE910(C1)	<div>The LE910 series of Cat. 1 modules are optimized for LTE low category networks</div> <div>Modules are available in single mode and 3G/2G fallback options</div> <div>In addition to VoLTE support, the LE910 Cat.1 series are swappable with other modules in the xE910 family</div> <div>LE910 Cat. 1 delivers data rates of 10 Mbps downlink and 5 Mbps uplink</div>	4G (LTE Category 1)	Over 12 different variants are available (North America, Europe & APAC)	<div>Ideal platform for IoT applications, mobile data and computing devices</div> <div>Applications requiring lower data rates</div>	Optional GPS, Glonass, BEIDOU, Galileo + QZSS (LE910C1-NA / -AP / -NS)
LE910(C4)	<div>The LE910 series of Cat. 4 modules are optimized for LTE low category networks</div> <div>Modules are available in single mode and 3G/2G fallback options</div> <div>In addition to VoLTE support, the LE910 Cat.4 series are swappable with other modules in the xE910 family</div> <div>LE910 Cat. 4 delivers data rates of 10 Mbps downlink and 5 Mbps uplink</div>	4G (LTE Category 4)	Over 12 different variants are available (North America, Europe & APAC)	<div>Ideal platform for IoT applications, mobile data and computing devices</div> <div>Applications requiring lower data rates</div>	Optional GPS, Glonass, BEIDOU, Galileo + QZSS (LE910C1-NA/-AP/-NS)
LE910S1	<div>The LE910S1-EA is an industrial-grade, cost-optimized LTE Cat 1 module</div> <div>Ideal for IoT applications that need data and voice transmission, including devices requiring full mobility throughout the extended European region</div> <div>LE910S1-EA supports 2G fallback and connecting devices in remote areas where LTE networks have not rolled out yet and voice use cases in the absence of Voice over LTE (VoLTE).</div>	LTE Category 1)	Over 3 different variants are available (EMEA, APAC, LATAM)	<div>The optional embedded GNSS receiver makes the LE910S1-EA ideal for all-in-one tracking use cases in which more precise, faster-refreshing, satellitebased positioning and navigation must complement cellular-based positioning</div>	Optional GPS L1, GLONASS L1, Galileo E1, BeiDou B1

Cellular Modules



xE310 Family – Ultra Small Formfactor for Telit LTE-M & NB-IoT Solutions

The Telit x310 is a family of form factor modules that are designed for use in a wide range of IoT applications. The x310 modules offer a wide range of connectivity options, including cellular, Wi-Fi, Bluetooth, GNSS, and NFC. This makes them ideal for IoT applications that require reliable, high-speed connectivity. Those modules have a small form factor, which makes them easy to integrate into a wide range of devices. This also means that they can be used in applications where space is at a premium. They are designed to be highly energy efficient, which means that they can be used in battery-powered devices without draining the battery too quickly.

The x310 modules are designed to be robust and reliable, with a wide operating temperature range and the ability to withstand shocks and vibrations and they are also designed to be easy to integrate into existing devices and systems, with a range of software tools and development kits available to help developers get started quickly. The x310 modules come with a range of security features, including secure boot, secure firmware updates, and encrypted communication protocols. This helps to protect sensitive data and prevent unauthorized access to IoT devices and networks.

In summary, the Telit x310 family of form factor modules offers a range of connectivity options, a small form factor, low power consumption, robust design, easy integration, and security features. These features make them ideal for a wide range of IoT applications, including smart homes, industrial automation, and asset tracking.

- Key Benefits

LTE-M & NB-IoT solutions in a form factor of only 14.3 x 13.1mm

3GPP Release 14 LTE Cat M1 & NB2 ready for 5G

2G variant helps migration to LTE Mobile IoT for markets like Europe and Latin America

Control via AT commands according to 3GPP TS27.005, 27.007 and customized Telit AT commands

VoLTE (planned)

Optional embedded GNSS

OMA Lightweight M2M (LWM2M)

Variant	Market	Bands	Voice
ME310G1-W1	Worldwide	B1 – B5, B8, B12, B13, B14, B17, B18, B19, B20, B25 – B28, B66, B85	No
ME310G1-WW	Worldwide	B1 – B5, B8, B12, B13, B14, B17, B18, B19, B20, B25 – B28, B66, B85 B2, B3, B5, B8	No
ME310G1-WWV	Worldwide	B1, B2, B3, B4, B5,B8, B8_US**, B12, B13, B18, B19, B20, B25, B26, B27, B28, B66, B71, B85, B103**	Yes VoLTE and 2G Voice
ME310G1-W1	Worldwide	B1, B2, B3, B4, B5, B8, B8_US**, B12, B13, B18, B19, B20, B25, B26, B27, B28, B66, B71, B85, B103**	No
ME310G1-W2	EMEA, LATAM	B1, B3, B8, B20 B28, B31, B72, B87, B88	No
ME310G1-W3	Worldwide	B1, B2, B3, B4, B5, B8, B8_US, B12, B13, B14, B18,B19, B20, B25, B26, B27, B28, B66, B85	No
NE310L2-W1	Worldwide	B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B25, B26, B28, B66, B85	No
NE310L2-W2	Worldwide	B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B25, B26, B28, B66, B85	No

Cellular Data Cards



LM960A18 LTE Cat 18 Mini PCIe Data Cards

The LM960A18 Mini PCIe data card delivers high speed data rates via Advanced LTE and offers a cellular connection for products in network appliance environments. This data card is well-suited for products that demand high throughput such as routers, mobile gateways and access points, to provide the most advanced 4G LTE connectivity, ensuring a rich and seamless user experience. Based on LTE Category 18, the LM960A18 mPCIe data card achieves download rates up to 1.2 Gbps. It supports 4x4 MIMO, 5x downlink carrier aggregation and 2x uplink carrier aggregation. The product supports multiple RF frequency bands and band combinations to accommodate global deployments.

Key Benefits

- Standard Mini PCIe Data-card form factor
- LTE Cat 18: high-speed with data rates of up to 1.2 Gbps download and 150 Mbps upload
- Full GNSS support: GPS, GLONASS, Galileo, Beidou
- Data only card

Application Fields

- Routers
- Mobile gateways
- Access points

Features & Specifications

- Form factor: PCI Express Mini Card type (mPCIe)
- Dimension: 50.95 x 30 x 2.8 mm
- Chipset: Qualcomm SDX20
- Global SKU
- 4x4 MIMO
- 5x DL Carrier Aggregation
- 2x UL Carrier Aggregation
- Support for CBRS band
- LAA up to 60MHz
- Support for Firstnet B14

- Full GNSS support - GPS, GLONASS, Galileo, Beidou
- RF bands:
 - LTE FDD: B1, B25(B2), B3, B66(B4), B26(B5), B7, B8, B12(17), B13, B14, B20, B28, B29(DL), B30, B32(DL), B71
 - LTE TDD: B38, B39, B40, B41, B42, B46(DL), B48
 - WCDMA: B1, B2, B4, B5, B8
- Temperature range: -40 to +85 °C
- Operating voltage: 3.1 V – 3.6 V
- Interfaces: Standard mPCIe interface, USB 2.0/3.0, Dual SIM, GPIOs
- Approvals: FCC/IC, PTCRB, CE/GCF, AU



Cellular Data Cards



LN920 Cat 6 / Cat 12

The LN920 M.2 data card is part of the family of Telit highspeed data cards. Designed in M.2 (NGFF) form factor, it is the natural evolution toward 5G technology. The LN920 is available as LTE Category (Cat) 12 (600 Mbps peak data rate DL, 150 Mbps UL) and Cat 6 (300 Mbps peak data rate DL, 50 Mbps UL). This data card supports a broad set of LTE frequency bands and carrier combinations and includes 3G/HSPA+ legacy technology and a GNSS receiver, making it ideal for worldwide deployments. Compatible with 3GPP Release (Rel) 12, it is certified for global deployments across EMEA, the Americas and APAC, including specific MNO certifications in regions requiring them like APAC and NA.

Key Benefits

- Standard M.2 (NGFF) form factor
- Same form factor and pinout available as 4G Cat 12 and Cat 6
- 3G/HSPA+ Rel 8 for fallback to legacy networks
- Broad frequency band support, ideal for worldwide deployments and private LTE networks
- Certified with leading MNOs
- Single-side printed circuit board for optimal heat dissipation
- High-speed USB 3.0 port
- Support of up to 3xCA DL (Cat 12)

- Up to three independent firmware images onboard selectable at boot to support various network operator requirements
- State-of-the-art GNSS receiver with separate RF connector
- Internal GNSS L1 LNA, allowing the use of less expensive passive antennas and lowering the total cost of ownership
- Advanced security features: SELinux, secure boot
- Full industrial operating temperature range
- Drivers support: Windows 10, Linux
- 2 x 2 MIMO

5G Solutions



FN990 5G Module

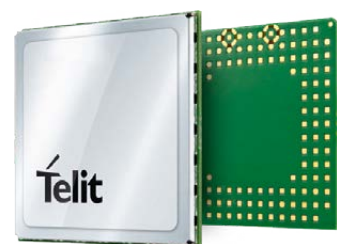
The Telit FN990 is a 5G module designed for use in high-speed data applications such as enterprise routers, gateways, and fixed wireless access. This product offers high-speed, low-latency 5G connectivity with advanced security features, making it a suitable solution for a wide range of IoT applications that require fast and reliable connectivity. The Telit FN990Axx is capable of delivering high-speed data transfer rates with its support for 5G NR Sub-6GHz and mmWave frequencies, as well as 4G LTE-Advanced Pro. The advances technology allows for low-latency connectivity, making it an ideal solution for applications that require real-time data transfer, such as industrial automation or virtual reality. It is designed to support future 5G features and capabilities, ensuring that devices using this module will remain relevant and functional for years to come.

Key Benefits

- High-speed data transfer
- Low latency: The Telit FN990's advanced 5G technology allows for low-latency connectivity, making it an ideal solution for applications that require real-time data transfer, such as industrial automation or virtual reality.
- Compact size -small form factor
- Advanced security features
- Future-proof design: The Telit FN990 is designed to support future 5G features and capabilities, ensuring that devices using this module will remain relevant and functional for years to come



Telit is the global leader in IoT enablement. Our enterprise-grade hardware, connectivity, and platforms transform business through the power of IoT. With over one thousand of the world's leading IoT experts, we share a relentless commitment to delivering the future of digital business for our customers.



Telit IoT Modules

We offer the largest portfolio of specialty IoT communications modules. Designed to the most stringent standards, our single and multimode modules use a common footprint so that products can be easily adapted to multiple markets and technologies.

IoT SIM Cards & Custom Data Plans

Get reliable service & coverage from an established leader in IoT

Telit IoT connectivity solutions address the challenges of managing multi-site deployments across two or more different wireless network operators with varying pricing rules and agreement terms. Our SIM cards and flexible data plans are designed for IoT applications including asset tracking, telematics, remote monitoring, security and surveillance, digital signage, PERs, utilities and more.



2G, 3G, & 4G LTE

Custom plans for data, SMS & voice on tier-one networks



Simple Terms

One agreement. Predictable pricing. No hidden fees or roaming charges.



24/7 Support

Dedicated IoT experts & account team



Secure

Multi-layer security & VPN connections

Telit IoT Portal

Our cloud-based IoT subscription service powered by deviceWISE is the industry's most comprehensive set of tools and resources for any end-to-end IoT deployment.

- Connect. Manage. Integrate. With our comprehensive platform functions.
- Connect any thing to any app. With web-based and mobile apps and enterprise systems across all wireless networks
- Pay-as-you-grow. With our adaptable subscription services – from free trials to full commercial deployment
- No upfront investment. Reduced cost, risk, complexity and time-to-market versus developing your own solution



IoT Terminals



Telic LT910-WW IoT Terminal

The LT910-WW is a compact and robust IoT terminal designed for the use in the LTE network with fallback to the UMTS / GSM network. The device is based on the Telit LE910C1-WWX module and supports a large number of LTE frequency bands and therefore can ideally be used in applications with a global footprint. The terminal provides industrial standard interfaces and guarantees safe, fast and reliable data transfer. The integrated power-saving mode supports the use in applications where low power consumption is required. The LT910-WW terminal is the quickest way to integrate wireless connectivity in your global IoT application.

Key Features & Benefits

- Based on Telit LTE Cat. 1 module LE910C1-WWX with UMTS/GSM fallback
- 16 LTE frequency bands for global use across EMEA/North America/APAC/LATAM
- Interfaces: Power supply; SIM card holder lockable; FME antenna connector; RS232 (V.24/V.28) on Sub-D; USB
- Supply Voltage: 5-32V DCOperation temperature: -30°C - +80°C
- Support of low-power mode
- Robust & compact housing for industrial use
- Housing is mechanically compatible with GT910-G, HT910-E (G), LT910-E
- Firmware Over-The-Air (FOTA) UpdateOptional variants on request: e.g. USB poweredExtensive range of accessories

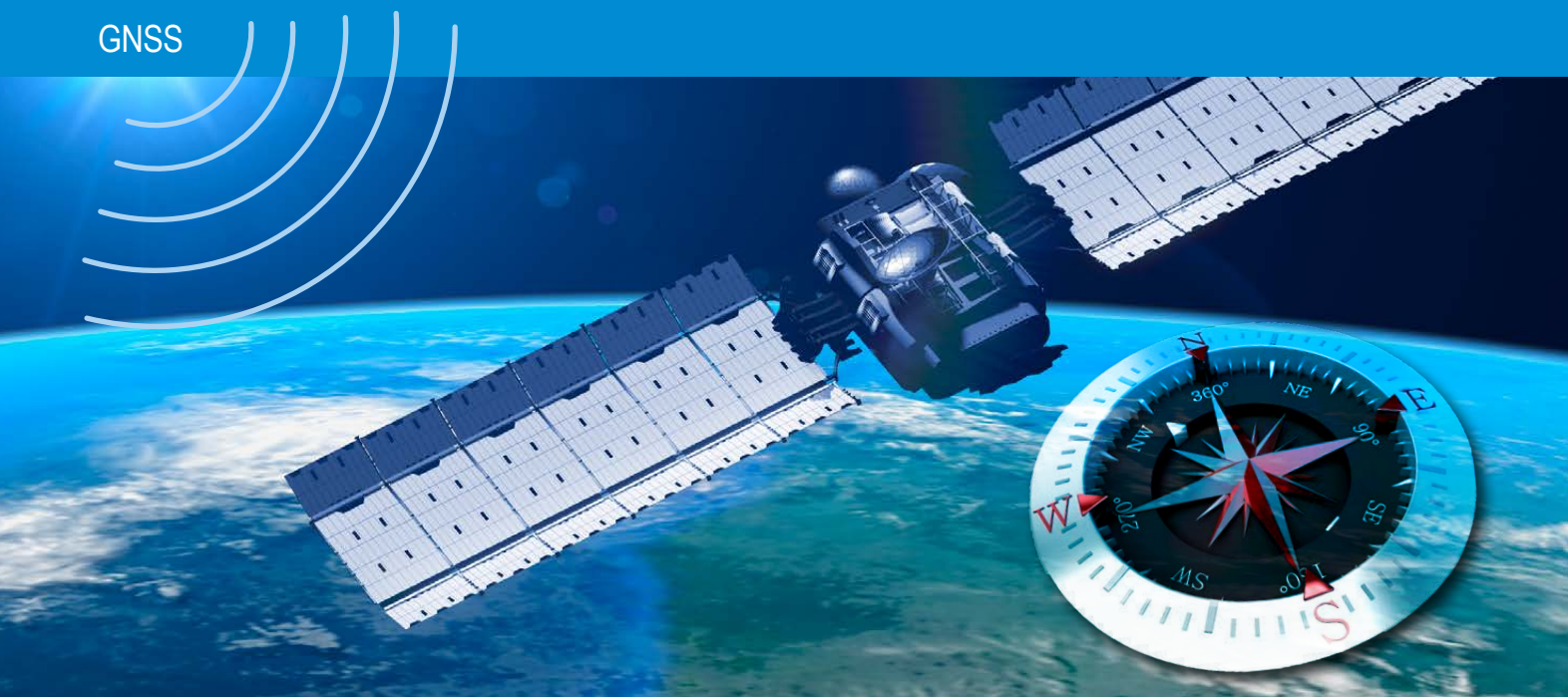
Key Applications

- Monitoring of vending machines
- Monitoring of data from industrial plants
- Intelligent control and monitoring of power grids
- Transmission of meter readings from electricity, gas and water meters
- Live transmission of video images
- Monitoring of heating, ventilation and air conditioning

Functionality	Interfaces	Software	Approvals
Built in UDP/TCP/FTP/SMTP stack	Power connector 6P6C modular jack	Telit application development environment: AppZoneC	CE
IPv4/IPv6 stack	RS-232 interface DSUB 9-pin female		WEEE, RoHS and REACH compliant
Control via AT commands according to 3GPP TS 27.005, 27.007 and Telit custom AT commands	USB 2.0, connector mini USB		
SIM application Tool Kit 3GPP TS 51.014	Antennaconnector FME (male)		
OMA-DM Telit Software Management	SIM card holder (Mini) - 1.8 V and 3.0V		
	SIM chip option; 3 Status LEDs		

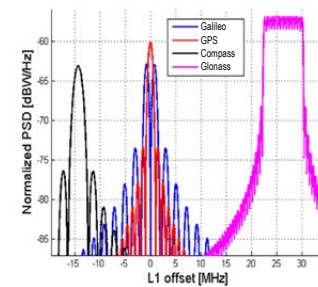
Cellular Devices – Selection Guide

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Global Navigation Satellite Systems (GNSS)

A Global Navigation Satellite System (GNSS) is a system of satellites providing autonomous geospatial positioning with global coverage. It allows small electronic receivers to determine their locations to a high precision by using time signals transmitted along a line of sight by radio from satellites.



GNSS Wireless Modules – GPS/BDS/GLONASS/Galileo/QZSS







Operational Navigation Constellations

- GPS (24-satellite constellation + 6 backup SVs)
- Glonass (24-satellite constellation + 6 backup SVs)

Navigation Constellations in Development

- Galileo (currently 18 SVs launched)
- Beidou (currently 19 SVs launched)

USA	RUSSIA	EUROPE	CHINA
 <ul style="list-style-type: none"> ■ CDMA ■ 24+6 orbiting SV ■ 6 orbital planes with 4 SV each ■ Frequencies (MHz): 1575.42 (L1), 1227.6 (L2), 1176.45 (L5) ■ Each SV is identified by its own ID 	 <ul style="list-style-type: none"> ■ FDMA ■ 24+6 orbiting SV ■ 3 orbital planes with 8 SV each ■ Frequencies (MHz): 1602 (L1) + k1, 1246 (L2) + k2, where: k1=(-7 to +13) * 562.5 KHz k2=(-7 to +13) * 437.5 KHz ■ Each SV is identified by its own frequency 	 <ul style="list-style-type: none"> ■ CDMA ■ 24+6 orbiting SV ■ Frequencies (MHz): 1575.42 (E1), 1227.6 (L2), 1176.45 (E5A), 1207.14 (E5B), 1278.75 (E6) ■ Each SV is identified by its own ID 	 <ul style="list-style-type: none"> ■ CDMA ■ 5 Geostationary SV + 27+5 orbiting SV ■ Frequencies (MHz): 1561.098 (B1), 1207.14 (B2), 1268.52 (L5) ■ Interface control document (ICD) "test version" published in October 2011 ■ Each SV is identified by its own ID

GNSS Technologies

System	USA	Russia	EU	China	Japan
Type	Global	Global	Global	Global	Regional
Date Deployed	1995	1995/2011	2016 / 2018	2015/2020	Future (ex. 2020?)
Frequency	L1=1575.42 MHz	L1=1602 MHz	E1=1575.42 MHz	B1=1561.098 MHz	L1-SAIF=1575.42 MHz
Num. of Satellites	24-32	~ 30	27-30	30-35	4

UM980 – All-constellation Multi-frequency High Precision RTK Positioning Module

UM980 is Unicore's new-generation proprietary high-precision RTK positioning module. By combining advanced hardware design and exclusive algorithms, UM980 supports BDS B1I/B2I/B3I/B1C/B2a/B2b*, GPS L1/L2/L5, GLONASS L1/L2, Galileo E1/E5a/E5b, QZSS L1/L2/L5, and SBAS. The built-in multi-frequency anti-jamming technology realizes enhanced RTK engine calculation working on multiple modes and frequencies, which significantly improves RTK initialization speed, measurement accuracy and reliability in complex environments such as city blocks and tree shades. Relying on the excellent performance, UM980 is well suited for high precision navigation and positioning applications such as UAV, lawn mower, precision agriculture, surveying and mapping and intelligent driving.

Key Features

- Based on the new generation GNSS SoC - NebulasIV, which integrates RF, baseband, and high precision algorithm 17.0 x 22.0 x 2.6 mm SMD
- Supports on-chip RTK positioning calculation on all systems and multiple frequencies
- Supports BDS B1I/B2I/B3I/B1C/B2a/B2b + GPS L1/L2/L5 + GLONASS L1/L2 + Galileo
- E1/E5a/E5b + QZSS L1/L2/L5 + SBAS
- All-system multi-frequency RTK engine and advanced RTK technology
- Independent tracking of each frequency and 60dB narrowband anti-jamming technology

About Unicore

Technical Side

- More than 10 years of experiences in positioning
- Customized functions available for key accounts

Product Side

- Varies accuracy options from centimeter to meter level
- Solid success stories with world famous brands and partners
- High reliability with large shipments each and every month
- Whole solution available from hardware to software

Support

- Efficient technical support
- Designated Sales and FAE





GNSS Wireless Modules



SE873K5 – Multi-Constellation Smart Antenna GNSS

The SE873K5 is the latest addition to Telit SE873 family and is the natural migration path from SE873 and SE873Q5. The SE873K5 is a multi-constellation receiver in 7x7x2.25 mm QFN-like package including embedded SQI flash, RTC, TCXO.

The SE873K5, thanks to its small package, the latest generation chipset, and the advanced power modes is the ideal solution for wearable, light portable devices and battery powered solutions.

Key Benefits

- Latest generation chipset
- Complete GNSS module, including TCXO, RTC, and flash memory
- Full GNSS compliance: GPS, Glonass, Galileo and BeiDou
- Flexible power management modes allow improvement to the battery life
- Supports both local and server-based A-GNSS for improved TTFFs
- Satellite Based Augmentation System (SBAS) corrections increase positioning accuracy
- Battery-friendly 1.8 V GPIO

Key Features

- Frequency Bands: GPS L1, GLONASS L1, Galileo E1, BeiDou B1, QZSS L1
- Standards: NMEA
- SBAS (EGNOS, WAAS, GAGAN and MSAS) or QZSS L1S capability
- RTC for efficient power management
- Jammer rejection
- Local and server-based A-GNSS

Application Fields

- Fleet management systems
- European GPS-assisted road tolling systems
- Cellular base stations
- In-car navigation systems
- Automotive telematics
- GPS-based personal sports training monitors



GNSS Wireless Modules



The SL871 Low-power GPS Receiver Module

The SL871 is a compact and low-power GPS receiver module developed by Telit, designed to provide high-accuracy positioning and timing for a wide range of industrial and consumer applications. It uses 22 tracking and 66 acquisition channels to provide accurate positioning data. The module supports various satellite positioning systems, including GPS, QZSS, GLONASS, and SBAS. The SL871 also has a small form factor of 10.1 x 9.7 x 2.5 mm and operates on a low power supply of 1.8 to 3.6 V. Overall, the Telit SL871 is a high-performance GPS receiver module that provides accurate positioning and timing with low power consumption, making it a suitable solution for various industrial and consumer applications.

Key Benefits

- Accurate positioning: The SL871 provides accurate positioning data with a horizontal accuracy of up to 2.5 meters, making it suitable for various applications that require precise location information.
- Low power consumption: The module has a low power consumption of less than 50 mW, making it suitable for battery-powered devices that require long operating times.
- Fast time to first fix (TTFF): The module has a fast TTFF of less than 1 second, ensuring quick and reliable positioning data acquisition.
- Reliable performance: The module is designed to operate in harsh environments and can withstand high levels of shock and vibration, ensuring reliable performance in various applications.
- Easy integration: The SL871 comes with a simple and easy-to-use interface, making it easy to integrate into various devices.

Key Features

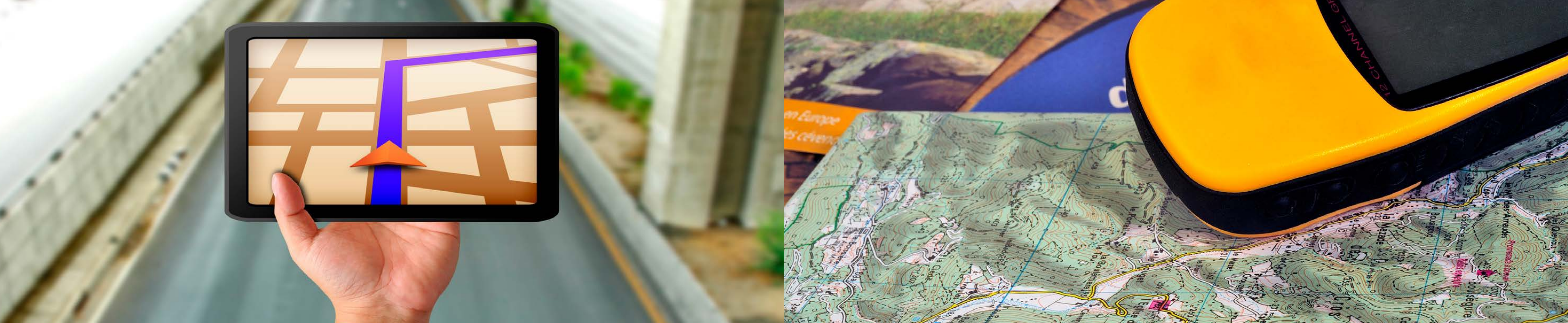
- Support for multiple satellite positioning systems
- Small form factor and low power consumption
- High accuracy and reliability
- Fast TTFF and easy integration

Application Fields

The SL871 is suitable for a wide range of industrial and consumer applications that require accurate positioning and timing.

- Telematics
- Fleet management
- Navigation systems
- Wearables
- Asset tracking





Smart Modules



SE250B4 – Smart Modules with Android

The SE250B4 Series modules are designed to provide reliable and secure connectivity for industrial and commercial IoT applications. The SE250B4 Series provides a reliable and secure cellular connectivity solution for a wide range of IoT applications, with global coverage, low power consumption, and secure firmware capabilities.

Key Benefits

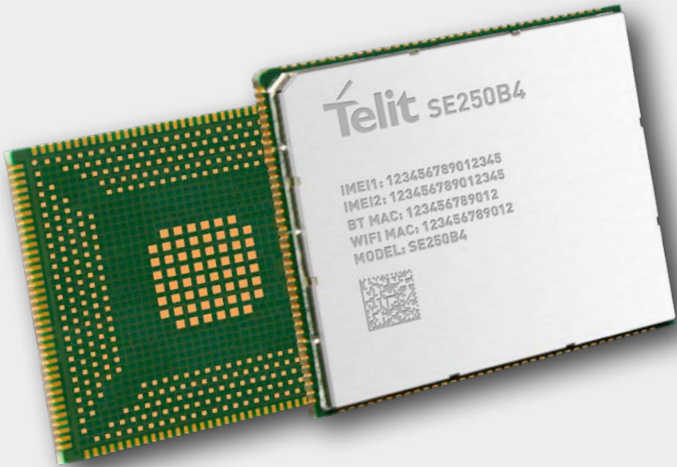
- Enables reliable and secure connectivity for IoT devices
- Simplifies development and integration of IoT solutions
- Provides global coverage for IoT applications with cellular connectivity
- Low power consumption for optimized battery life and reduced maintenance
- Extended temperature range for use in a variety of environments

Key Features

- Global coverage with multiple radio access technologies (2G, 3G, 4G LTE)
- Integrated GNSS (Global Navigation Satellite System) positioning
- Low power consumption for extended battery life
- Compact size for easy integration into devices
- Extended temperature range for use in harsh environments
- Secure boot and secure firmware update capabilities

Key Applications

- Smart energy and utilities
- Industrial automation and control
- Smart cities and infrastructure
- Asset tracking and management
- Healthcare and medical devices
- Environmental monitoring
- Smart agriculture
- Retail and payment systems



Smart Antenna GNSS Modules



SE868K3-A/AL Family – Industry's Smallest GNSS Patch Antenna Module

The tiny and mighty SE868K3-A/AL is the industry's smallest multi-constellation GNSS patch antenna module. Designed with an additional Low Noise Amplifier (LNA) and Surface Acoustic Wave (SAW) Filter, these modules deliver best-in-class performance. The combination of advanced features and a low-profile design significantly simplifies integration for space constrained applications by eliminating the need for external components. The SE868K3-A/AL includes a 9 x 9 mm patch antenna.

SE868K3-A/AL Variants

- Standard antenna (SE868K3-A)
- Low profile antenna (SE868K3-AL)

Key Benefits

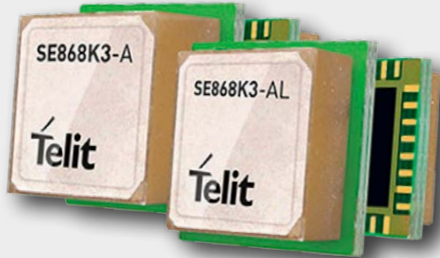
- Standard variant with integrated 9 x 9 x 4mm SMT antenna
- Low profile variant with 9 x 9 x 2mm antenna
- Additional LNA and SAW filter
- SMT mounting - no holes on host PCB
- Supports GPS, QZSS and GLONASS and ready for Galileo
- Backward compatible with SE868-A
- Pin-to-pin compatible with GPS-only variant SE868K7-A / AL and SE868-AS
- Supports ephemeris file injection (A-GPS)
- Satellite Based Augmentation System (SBAS) compliant

Key Features

- Multi-constellation GNSS core
- Frequency Bands: GPS L1, GLONASS L1, QZSS L1, Galileo E1
- Standards: NMEA
- Flash memory
- Ultra-compact 11 x 11mm 32-pad QFN package with embedded SMT antenna
- Real Time Clock (RTC) and Temperature Compensated Crystal Oscillator (TCXO)
- Jamming rejection
- Pin-to-pin compatibility with other modules in the series

Application Fields

- Wearables
- Tracking
- Telematics
- Security



Model	Constellations	Interfaces	Add. LNA	Flash	Size in mm
SE868K3-A	GPS, QZSS, Glonass, Galileo	UART, I ² C, SPI	Yes	Yes	11 x 11 x 6.1
SE868K3-AL	GPS, QZSS, Glonass, Galileo	UART, I ² C, SPI	Yes	Yes	11 x 11 x 4.1
SE868K7-A	GPS, QZSS	2 x UART	Yes	No	11 x 11 x 6.1
SE868K7-AL	GPS, QZSS	2 x UART	Yes	No	11 x 11 x 4.1
SL871L-S	GPS, QZSS	UART	Yes	No	10.1 x 9.7 x 2.4
SE868SY-D	GPS, Glonass, Galileo, BeiDou, IRNSS	UART, I ² C, SPI	Embedded	No	11 x 11 x 2.8
SE868K3-A	GPS, QZSS, Glonass, Galileo	UART, I ² C, SPI	Yes	Yes	11 x 11 x 6.1
SE868K3-AL	GPS, QZSS, Glonass, Galileo	UART, I ² C, SPI	Yes	Yes	11 x 11 x 6.1

GNSS Modules – Selection Guide



Manufacturer	Part Name	Chipset	Sensitivity (in dBm)			Power (in mW)		Power (in µW)	Interface				Features										Time to First Fix (90%@ -130 dBm)		Antenna Typ		Dimensions (mm)	Pack-age	Evaluation Kit / Development Kit
			Aqisi-tion	Naviga-tion	Tracking	Acquisi-tion	Tra-cking		NMEA Out-put	DGPS/ RTCM Input	MEMS Port	Others	1 PPS (ns RMS)	PPS output	GPS	Glo-nass	Gali-leo	Bei-dou	NAVIC	SBAS	QZSS	LNA	Hot start	Cold start	GPS Patch anten-na	GPS Chip anten-na			
Telit	JF2-ROM	SirFstarIV	-148 dBm	-160 dBm	-163 dBm	83	67	25	x		x	UART, I2C, SPI, GPIO	x	x	x					x	x		1s	< 35s			11 x 11 x 2.4	LGA	EVK-JF2
	JF2-FLASH	SirFstarIV	-148 dBm	-160 dBm	-163 dBm	83	67	25	x		x	UART, I2C, SPI, GPIO	x	x	x					x	x		1s	< 35s			11 x 11 x 2.4	LGA	EVK-JF2
	JN3-ROM	SirFstarIV	-148 dBm	-160 dBm	-163 dBm	135	106	132	x		x	UART, I2C	x	x	x					x	x		1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-JN3
	JN3-FLASH	SirFstarIV	-148 dBm	-160 dBm	-163 dBm	135	106	132	x		x	UART, I2C	x	x	x					x	x		1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-JN3
	SE868-V3	SirFStarV	-148 dBm	-163 dBm	-165 dBm	76	70	69	x		x	UART, I2C, SPI, GPIO	x	x	x	x	x	x		x	x		1s	< 35s			11 x 11 x 2.6	QFN	EVK-SE868-V3
	SL869-FLASH	ST Teseo 2	-146 dBm	-158 dBm	-162 dBm	221	139	241	x	x	x	UART, USB, I2C, GPIO	x	x	x	x	x			x	x		1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-SL869
	SL869-T	ST Teseo 2	-146 dBm	-158 dBm	-162 dBm	221	139	241	x		x	UART, I2C, GPIO	x	x	x	x	x			x	x		1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-SL869-T
	SL869T2-I	tbd.	-146 dBm	-162 dBm	-163 dBm				x	x		UART, I2C	x	x	x				x	x		x	1s	< 34s			16 x 12.2 x 2.4	LCC	tbd.
	SL869-V2	MT3333	-145 dBm	-158 dBm	-161 dBm	103	81	21	x	x		UART	x	x	x	x	x	x		x	x		1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-SL869 V2
	SL869L-V2	MT3333	- 148 dBm	-160 dBm	- 162 dBm	86	76	23	x			UART, I2C	x	x	x	x	x	x		x	x	x	1s	< 28s			16 x 12.2 x 2.4	LCC	EVK-SL869L-V2S
	SL869-V2S	MT3337	-144 dBm	-158 dBm	-160 dBm	74	64	21	x			UART	x	x	x					x	x		1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-SL869-V2S
	SL869L-V2S	MT3337	- 148 dBm	-161 dBm	- 162 dBm	64	54	21	x			UART	x	x	x					x	x	x	1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-SL869L-V2S
	SL869-V3	ST Teseo 3	- 147 dBm	-158 dBm	- 162 dBm	171	147	251	x	x		UART, I2C	x	x	x	x	x	x		x	x	x	1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-SL869-V3
	SL869-ADR	ST Teseo 3	-147 dBm	-158 dBm	-162 dBm	188	158	221	x	x	x	UART, I2C, GPIO	x	x	x	x	x	x		x	x	x	1s	< 35s			16 x 12.2 x 2.4	LCC	EVK-SL869-ADR
	SL871	MT3333	-145 dBm	-159 dBm	-162 dBm	76	66	21	x	x		UART, I2C, GPIO	x	x	x	x	x	x		x	x		1s	< 35s			10.1 x 9.7 x 2.4	LCC	EVK-SL871
	SL871-S	MT3337	-144 dBm	-159 dBm	-163 dBm	51	45	21	x			UART	x	x	x					x	x		1s	< 35s			10.1 x 9.7 x 2.4	LCC	EVK-SL871-S
	SL871L	MT3333	-147 dBm	-160 dBm	-163 dBm	86	76	21	x			UART			x	x	x	x		x	x	x	1s	< 31s			10.1 x 9.7 x 2.4	LCC	EVK-SL871L
	SL871L-S	MT3337	-147 dBm	-161 dBm	-164 dBm	64	54	21	x			UART			x					x	x	x	1s	< 31s			10.1 x 9.7 x 2.4	LCC	EVK-SL871L-S
	SC872-A	MT3333	-148 dBm	-163 dBm	-164 dBm	99	86	56	x			UART	x	x	x	x	x	x		x	x	x	1s	< 35s	x		21 x 22 x 6.8	BtoB	EVK-SC872-A
	SE868K3-A	MT3333	-148 dBm	-161 dBm	-164 dBm	111	99	59	x			UART, I2C, SPI, GPIO	x	x	x	x	x			x	x	x	1s	< 35s	x		11 x 11 x 6.1	QFN	EVK-SE868K3-A
	SE868K3-AL	MT3333	-146 dBm	-157 dBm	-157 dBm	111	99	59	x			UART, I2C, SPI, GPIO	x	x	x	x	x			x	x	x	1s	< 35s	x		11 x 11 x 4.1	QFN	EVK-SE868K3-AL
	SE878K7-A	tbd.	-148 dBm	-163 dBm	-165 dBm	93	34		x			UART, I2C, SPI	x	x	x	x	x	x		x	x	x	1s	< 35s	x		18 x 18 x 6.1	QFN	EVK-SE878K3-A
	SE868K7-A	MT3337	-148 dBm	-163 dBm	-164 dBm	85	71	21	x			UART, GPIO	x	x	x					x	x	x	1s	< 35s	x		11 x 11 x 6.1	QFN	EVK-SE868K7-A
	SE868K7-AL	MT3337	-148 dBm	-159 dBm	-160 dBm	85	71	21	x			UART, GPIO	x	x	x					x	x	x	1s	< 35s	x		11 x 11 x 4.1	QFN	EVK-SE868K7-AL
	SE878K7-A	tbd.	-148 dBm	-163 dBm	-165 dBm	61	54	9	x			UART	x	x	x						x	x	1s	< 35s	x		18 x 18 x 6.1	QFN	EVK-SE878K7-A
	SE868-AS	MT3333	-148 dBm	-163 dBm	-165 dBm	84	72	21	x	x		UART	x	x	x					x	x		1s	< 35s	x		11 x 11 x 6.1	QFN	EVK-SE868-AS
	SL876Q5-A	SirFStarV	-148 dBm	-161 dBm	-165 dBm	84	70	68	x		x	UART, I2C, SPI, GPIO	x	x	x	x	x	x		x	x	x	1s	< 27s		x	11 x 11.9 x 2.15	LCC	EVK-SL876Q5-A
	SE873Q5	SirFstarV	-146 dBm	-161 dBm	-167 dBm	101	77	62	x		x	UART; I2C, SPI	x	x	x	x	x	x		x	x	x	1s	< 35s			7 x 7 x 1.85	QFN	EVK-SE873Q5
GNS Technologies	TC6000GN	TI CC4000	-147 dBm	-162 dBm	-162 dBm				x			UART	x	x	x					x	x		1s	< 34s			10 x 9.3 x 2.3	LGA	TC6000GN Starter Kit
	TC6000GTIM	TI CC4000	-146 dBm	-162 dBm	-162 dBm				x			UART	x	x	x					x	x	x	1s	< 34s			10 x 9.3 x 2.3	LGA	TC6000GTIM Starter Kit
	GNS2301	SirFStarV	-146 dBm	-160 dBm	-165 dBm				x	x		UART, I2C, SPI	x	x	x	x	x	x		x	x	x	1s	< 35s			10 x 9.3 x 2.1	SMD	GNS2301 GPS/GLONASS Starter Kit
	GNS802	SirFStarV	-146 dBm	-160 dBm	-165 dBm				x	x		UART, I2C, SPI	x	x	x	x	x			x	x	x	1s	< 35s		x	16 x 10 x 2.1	SMD	GNS802 GPS/GLONASS Starter Kit
	GNS3301	MT3333	-148 dBm	-165 dBm	-165 dBm				x	x		UART	x	x	x		x			x	x		1s	< 34s			10 x 9.3 x 2	SMD	GNS3301 GPS/GLONASS Starter Kit
	GNS3301B	MT3333	-148 dBm	-165 dBm	-165 dBm				x	x		UART	x	x	x			x		x	x		1s	< 34s			10 x 9.3 x 2	SMD	GNS3301B GPS Starter Kit
	GNS902	MT3333	-148 dBm	-165 dBm	-165 dBm				x	x		UART	x	x	x	x				x	x	x	1s	< 35s		x	16 x 10 x 2.1	SMD	GNS902 GPS/GLONASS Starter Kit
	GNS902B	MT3333	-148 dBm	-165 dBm	-165 dBm				x	x		UART	x	x	x	x		x		x	x	x	1s	< 35s		x	16 x 10 x 2.1	SMD	GNS902B GPS Starter Kit
	GNS2201	MT3337	-148 dBm	-165 dBm	-165 dBm				x	x		UART	x	x	x					x	x	x	1s	< 34s			10 x 9.3 x 2	SMD	GNS2201 GPS Starter Kit
	GNS202	MT3337	-148 dBm	-165 dBm	-165 dBm				x	x		UART	x	x	x					x	x	x	1s	< 34s		x	16 x 10 x 2.1	SMD	GNS202 GPS Starter Kit
	GNS502	TI CC4000	-145 dBm	-161 dBm	-161 dBm				x	x		UART	x	x	x					x	x	x	1s	< 34s		x	16 x 10 x 2.1	SMD	GNS502 GPS Starter Kit
	GNS601uLP	MT3339	-148 dBm	-165 dBm	-165 dBm				x	x		UART	x	x	x					x	x	x	1s	< 35s	x		16 x 16 x 6	SMD	GNS 601uLP Starter Kit
	GNS302uLP	MT3339	-148 dBm	-165 dBm	-165 dBm				x	x		UART	x	x	x					x	x	x	1s	< 35s		x	10 x 15.7 x 2	SMD	GNS 302uLP Starter Kit

GNSS Cards – Selection Guide



Manufacturer	Part Name	Chipset	Sensitivity (in dBm)		Power (in mA)		Interface			Features										Time to First Fix (90%@ -130 dBm)		Antenna Typ		Dimensions (mm)	Package
			Acquisi-tion	Tracking	Acquisi-tion	Tracking	NMEA Output	DGPS/ RTCM Input	Others	Acquisi-tion channels	1 PPS (ns RMS)	PPS output	GPS	Glo-nass	Galileo	Beidou	SBAS	QZSS	Deep sleep	Hot start	Cold start	GPS Patch Anten-na	GPS Chip Antenna		
Advantech	EWM-G110H01E Half-size Mini-PCIe card	u-blox NEO-M8U	-160 dBm	-167dBm						72	30 ns		x	x	x	x	x	x		1.5s	26s	UFL Connector		30 x 26.8 x 2.4	SMD
Advantech	AIW-210 XU-001 M.2 2242 card	u-blox NEO-M9N	-160 dBm	-167dBm						92	30 ns		x	x	x	x	x	x		2s	24s	UFL Connector		31 x 26.8 x 2.4	SMD



What is the difference between Wireless LAN and WiFi?

WLAN is a type of Local Area Network (LAN) that uses high frequency radio waves rather than wires to communicate and transmit data. As wired networks connect devices to the internet by using cables, WLAN is a flexible data communication system implemented as an extension or an alternative to wired LANs. WLAN usually provides a connection through an access point to the wider internet. This gives users the ability to move around within a local coverage area and still be connected to the network.

The term "WiFi" refers on one hand to a company consortium of 300 companies, which certifies devices with wireless interface. On the other hand, WiFi is also the associated brand name, as products which are certified according to the guidelines of the WiFi-alliance are labeled with its logo.

Which WLAN Network Standards exist?

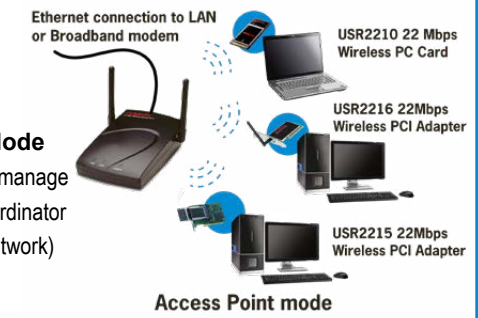
802.11 refers to a family of specifications developed by the IEEE (Institute of Electrical and Electronics Engineers) for WLAN technology. 802.11 specifies an over-the-air interface between a wireless client and a base station or between two wireless clients.

There are several specifications in the 802.11 family

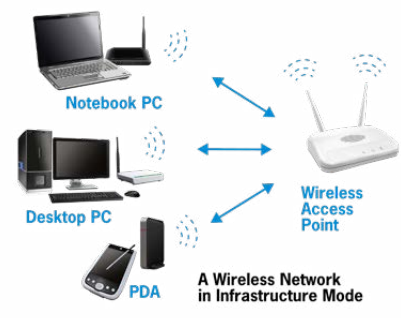
Standard	Released	Modulation	Frequency	Bandwidth	Highest Data-rate
802.11 (Legacy)	1997	DSSS	2.4GHz	20MHz	2Mbps
802.11b	1999	CCK	2.4GHz	20MHz	11Mbps
802.11a	1999	OFDM	5GHz	20MHz	54Mbps
802.11g	2003	OFDM	2.4GHz	20MHz	54Mbps
802.11h	2006	OFDM	5GHz	20MHz	54Mbps
802.11n	2009	OFDM, MIMO	2.4GHz/5GHz	20MHz, 40MHz	1x1: 150Mbps 2x2: 300Mbps 3x3: 450Mbps
802.11p	2010	OFDM	5GHz	10MHz	27Mbps
802.11ac	2013	OFDM, MIMO, MU-MIMO	5GHZ	20MHz, 40MHz, 80MHz & 160MHz (Opt)	1x1 (80MHz): 433Mbps 2x2 (80MHz): 866Mbps 3x3 (80MHz): 1300Mbps 4x4 (80MHz): 1733Mbps
802.11 ad	2012	SC-OFDM	60 GHz	2 GHz	6930 Mbps
802.11 ah	2016	OFDM	900 MHz	2 MHz	150 Kbps
802.11 ax	2019	OFDMA	2.4/5GHz	160MHz	1201 Mbps

The 802.11 standard defines different operating modes:

- **Access Point Mode**
The module should manage a network itself (coordinator and router in one network)

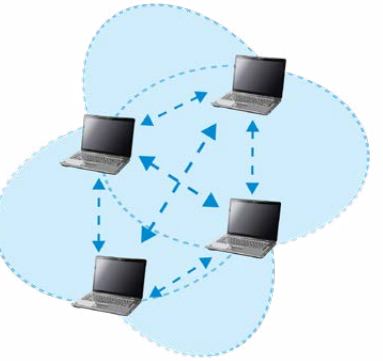


- **Infrastructure Mode**
The module has to connect to an existing access point to join a network



- **Ad hoc Mode**

Module can be connected to one or more other devices without having a coordinator (an access point is not involved here). The ad hoc network is a decentralized type of network as it does not rely on a pre-existing infrastructure such as routers or access points. Here each wireless node forwards data to other nodes until the receiver is reached



- **WiFi-Direct**
This standard enables devices to connect quickly with each other without requiring a wireless access point or a router (e.g. camera and printer)

Which Wireless Safety Standards are applicable?

Wi-Fi Protected Access (WPA) and Wi-Fi Protected Access II (WPA2) are two security protocols and security certification programs developed by the Wi-Fi Alliance to secure wireless computer networks. WPA (sometimes referred to as the draft IEEE 802.11i standard) became available in 2003. The Wi-Fi Alliance intended it as an intermediate measure in anticipation of the more secure and complex WPA2.

WPA superseded the previous security specification Wired Equivalent Privacy (WEP), which had shown to have security vulnerabilities. WPA implemented a subset of a draft of 802.11i. WPA2 has replaced it in 2004 and is therefore called IEEE 802.11i-2004 or 802.11i. WPA2, which requires testing and certification by the Wi-Fi Alliance, implements the mandatory elements of IEEE 802.11i. In particular, it introduces CCMP, a new AES-based encryption mode with strong security. Certification began in September, 2004; from March 13, 2006, WPA2 certification is mandatory for all new devices to bear the Wi-Fi trademark.

What are Wireless Operation Modes?

There are several kinds of hardware that may be used to implement a WiFi wireless network:

- Wireless adapters or network interface controllers (NICs) are network cards with the 802.11 standard which let a machine connect to a wireless network.
- Access points (AP, sometimes called hotspots) can let nearby WiFi-equipped stations access a wired network to which the access wpoint is directly connected.

(Please see graphics on the top)



WiFi 6E Modules

Dual Band Wi-Fi IC: Nordic's first Wi-Fi Product



nRF7002 an Ultra-Low Power, Dual-Band Wi-Fi 6 Companion IC

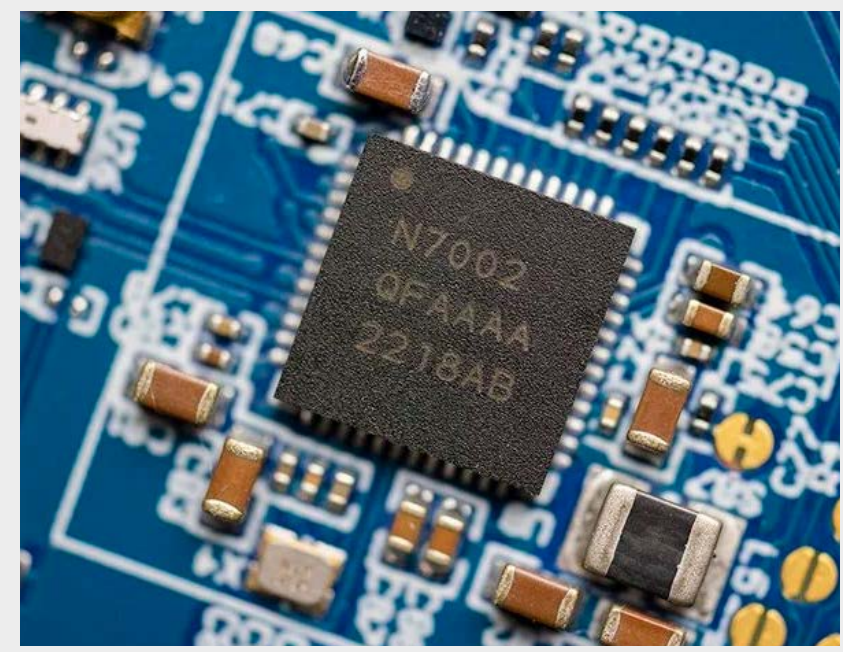
The potential synergy between Nordic Semiconductor's low-power wireless heritage and Wi-Fi's latest low-power evolution now enables battery-powered IoT devices. Nordic want to use the decades of wireless ultra-low-power expertise and maximize Wi-Fi's low-power potential in applications such as sensor networks, smart speakers, security cameras, home appliances, robot vacuums, and more. The product range of Nordic now covers Bluetooth, cellular IoT and Wi-Fi. With the nRF7002, Nordic Semiconductor brings decades of ultra-low-power wireless IoT and silicon design expertise to Wi-Fi 6, a standard which features efficiency gains that support long-life, battery-powered wireless IoT operation. 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, is supplied in a 6 x 6mm QFN package.

Key Benefits

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

Application Fields

- White goods
- Home automation
- Fitness equipment
- Lighting control
- Printer
- Smart meters
- Media player
- POS terminal
- Patient monitors



SX-PCEAX – Industry's First Tri-band Wi-Fi 6E 2x2 PCIe Module

The SX-PCEAX, based on Qualcomm's QCA2066, is one of the first Wi-Fi 6E modules. To increase the overall capacity and performance, the SX-PCEAX has been equipped with the 6 GHz band (Wi-Fi 6E) in addition to the 2.4 and 5 GHz bands plus Bluetooth 5.2 BR/EDR/LE.

WiFi6e works with the same standard as WiFi6 but with an extended spectrum of additional up to 1.2GHz. Access to the 6GHz frequency brings more bandwidth, faster speeds and lower latency, as well as is ideal for future-proof devices. Silex' Wifi6e module family is certified for Europe, North America, Japan and Canada and is available in several sizes and form factors to meet a wide range of requirements. The SX-PCEAX is used in medical applications, especially in the field of imaging diagnostics, storage/logistics applications such as self-propelled trucks or intelligent production lines, as well as in industrial environments.



Silex Technology's Wi-Fi 6E Embedded Modules



Applications

- Medical
- Smart Factory
- Transportation & Logistics
- Industrial PC's

Key Features

- IEEE802.11 a/b/g/n/ac/ax (2x2) (Wi-Fi 6E)
- 2.4 / 5 / 6 GHz Frequency band
- Bluetooth 5.2 (BR/EDR/HS/LE Compliant)
- Orthogonal Frequency Division Multiple Access (OFDMA)
- Dual Band Simultaneous (DBS)
- Target Wake Time (TWT)
- 2x MHF4 connectors
- Temperature range: -20 – +65 °C
- Linux, Kernel 5.10 (Other versions on request)
 - Station
 - Access Point (Support for up to 32 Clients)
 - WPA3
 - IEEE802.1X (TLS, TTLS, PEAP)
- Size
 - SX-PCEAX-SMT: 14.0 mm x 18.0 mm x 1.9 mm
 - SX-PCEAX-HMC: 29.85 mm x 26.65 mm x 2.9 mm
 - SX-PCEAX-M2: 22.0 mm x 30.0 mm x 2.7 mm



Single Band Wi-Fi Modules



WE310F5

The WE310F5 is a fully integrated, single-band Wi-Fi (802.11 b/g/n) and Bluetooth Low Energy (BLE5) combination module that provides a low-cost and high-speed wireless connection to an embedded microcontroller over UART, SPI and SDIO interfaces. The comprehensive software features exposed through AT commands enable faster time to market, even with limited wireless expertise.

IoT devices integrating WE310F5 are secured with WPA3 protocol, the nextgeneration, cutting-edge Wi-Fi security specification. Out-of-the-box support for Firmware Over-the-Air (FOTA) upgrades significantly reduces integration time. WE310F5 also offers multiple provisioning schemes, helping configure the device securely from a smartphone or a laptop.

Key Features

- Fully integrated, single-band Wi-Fi (11n) and BLE5 combination IoT module
- Low-cost, high-speed, serial-to-wireless connection to an MCU over UART, SPI and SDIO interface
- Comprehensive software features
- Low power consumption Advanced security features (including WPA3)
- Industrial-grade temperature range (-40 °C to +85 °C)
- Variants with (WE310F5-I) and without (WE310F5-P) antennas

IoT Applications

- Industrial automation
- Sensor gateways
- Condition-based monitoring
- Security panel
- Energy management
- Inspection camera
- Data logger
- Building automation
- Smart Home
- Thermostat
- Air purifier
- Air conditioner
- Security/monitoring camera
- Pet food dispenser



Single and Dual Band Wi-Fi Modules



Type 1YN

The Murata Type 1YN single band WiFi IEEE 802.11 b/g/n and Bluetooth BR/EDR/ LE 5.2 combo module comes with a very small form factor of only 6.95 x 5.15 x 1.1 mm. It is based on Infineons CYW43439 chipset.

Key Benefits

- 2.4 GHz WiFi + Bluetooth module
- Based on Infineon CYW43439
- IEEE 802.11 b/g/n
- Bluetooth BR/EDR/LE 5.2
- FCC/IC certified, EN compliant by Reference Antenna design
- Package: LGA (46 pads)
- Support for CubeMX, i.MX

Key Features

- Host interfaces: SDIO / UART, PCM
- External Antenna
- 6.95 x 5.15 x 1.1 mm
- Operating Temperature: -30°C to +70°C
- WiFi Transmit Power: +19 dBm max
- Bluetooth Transmit Power: +14dBm max (Class 1)



Type 2AE

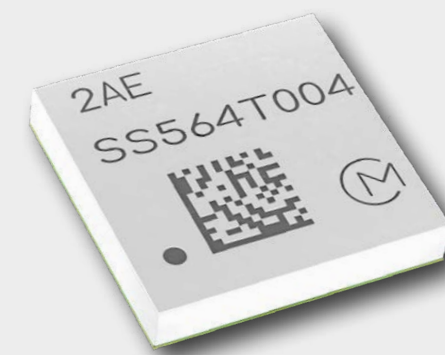
The Type 2AE is based on Infineon's CYW4373E and supports WiFi 802.11 a/b/g/n/ac and Bluetooth 5.2 BR/EDR/LE. Data rates on WiFi are up to 433 Mbps and 3Mbps PHY data rate on Bluetooth. The small form factor of only 8.0 x 7.8 x 1.15 mm makes the module a perfect solution for size-sensitive applications, but also for IoT, smart home and gateways.

Key Benefits

- 2.4 + 5 GHz WiFi + Bluetooth module
- Based on Infineon CYW4373E
- IEEE 802.11 a/b/g/n/ac
- Bluetooth BR/EDR/LE 5.2
- FCC/IC certified
- Support for Linux, Modus, i.MX Yocto

Key Features

- Host interfaces: SDIO / UART, USB
- External Antenna
- Operating Temperature: -40°C to +85°C
- WiFi Transmit Power: +19.5 dBm
- Bluetooth Transmit Power: +14 dBm





Dual Band Wi-Fi Modules

Panasonic

PAN9028 – Wi-Fi 5 (2.4 GHz & 5 GHz) & Bluetooth 5.2 (BR/EDR/LE) based on NXP's 88W8987

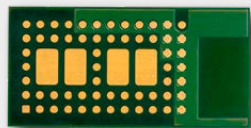
The PAN9028 is a 2.4 GHz and 5 GHz ISM band Wi-Fi and Bluetooth radio module, which includes a wireless radio and a power management IC for easy integration of Wi-Fi and Bluetooth connectivity into various electronic devices.

Key Benefits

- Included PMIC for simple HW design & reduction of BOM costs
- Possibility to switch between Chip Antenna & Bottom Pad
- Power Tables stored on OTP to fulfill regional regulatory requirements
- Certified External antenna for radio unfriendly enclosure

MPU & MCU Host Supported

- Linux based
- NXP i.MX series for Linux/Android & i.MX RT series

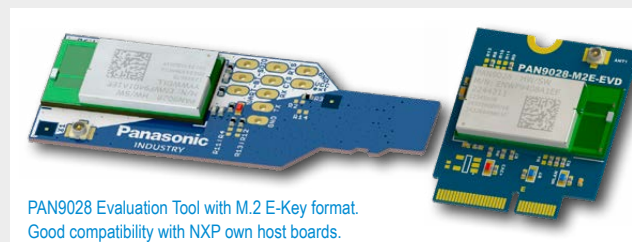


Key Features

Surface Mount Type (SMT)	24 x 12 x 2.8 [mm]
Wide temperature range of	-30 to +85 °C
TX Power	+17 dBm @ 802.11b
RX Sensitivity	typical -98 dBm @ 802.11b DSSS 1 Mbps
Current consumpt	Wi-Fi 390 mA @ TX and 60 mA @ RX

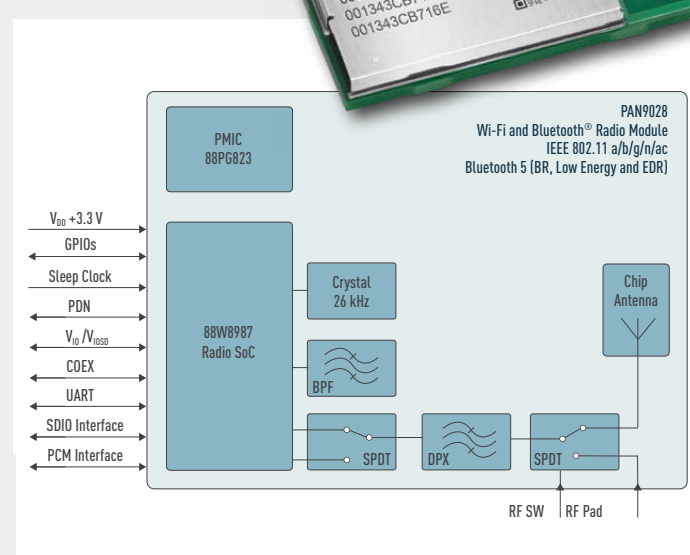
Flexible Evaluation Tool for Quick Start

- Compact micro SD form factor
- External antenna U.FL connector
- UART interface pin header
- External power supply pin header



PAN9028 Evaluation Tool with M.2 E-Key format.
Good compatibility with NXP own host boards.

Block Diagram



Infrastructure

- EV Charging
- Professional Equipment

Medical

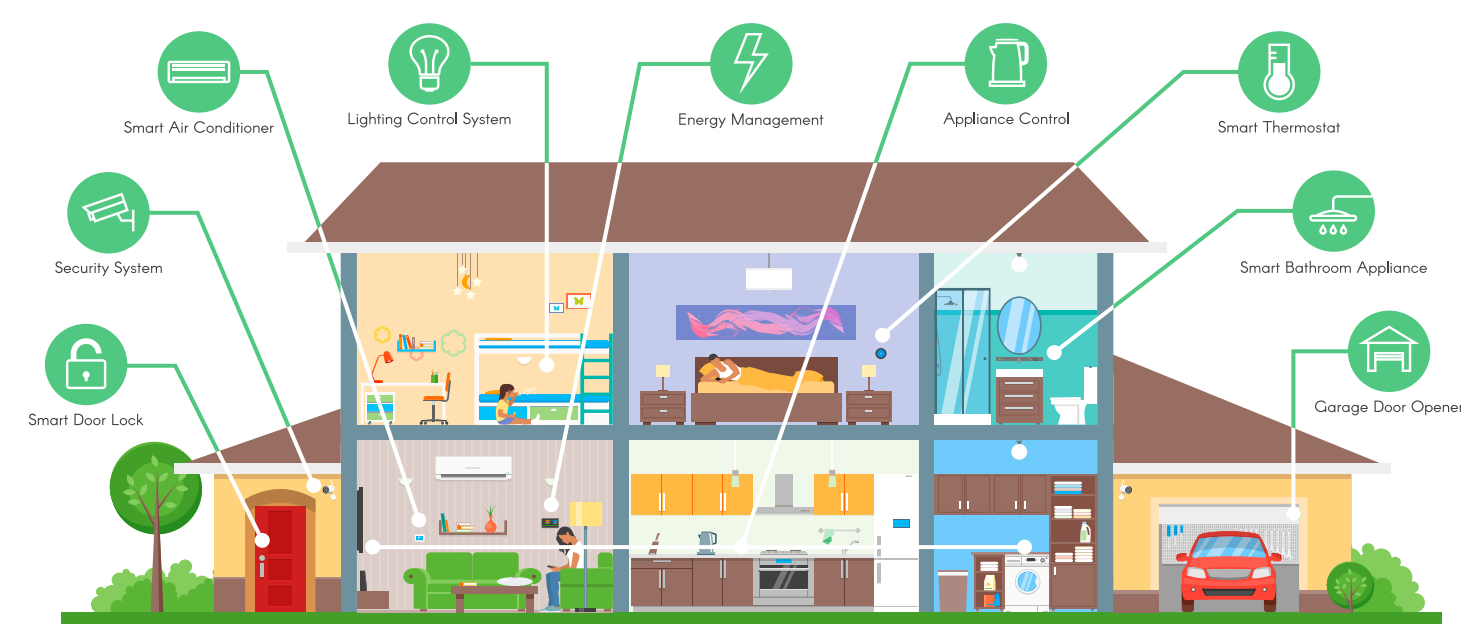
- Equipment
- Diagnostic
- Patient Monitoring

Smart Home / Building

- Home Appliance
- HVAC
- Gateways

Production Line Panasonic

100% end-of-line tested	European development & production
0 ppm failure rate	Produced according to IATF 16949
Certified for CE RED, FCC, ISCED	



Dual Band Wi-Fi Modules

Telit
Cinterion

WE866 Wi-Fi Family

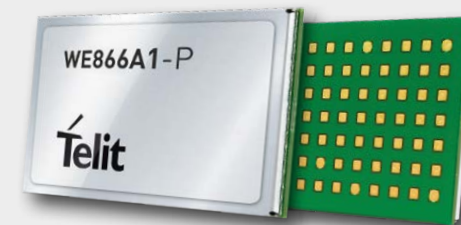
Integrating Wi-Fi™ to your IoT solution is simplified with the use of Telit's pre-certified Wi-Fi modules. This new & upcoming WE866 variants offer a rich feature set while packed in a small footprint. See what low energy Wi-Fi and Wi-Fi + Bluetooth combo solutions can do by integrating Telit's line of fully certified modules.

Key Features

- Dual band (2.4GHz/5GHz) Wi-Fi modules for high bandwidth IoT applications
- International regulatory certifications
- Industrial grade temperature range
- Proprietary technology delivers power consumption savings of up to 97% when compared to the IEEE standard and competitors

Applications

- Connected home
- Wearables
- Healthcare
- Automobiles
- Audio/video
- Smart Home / Smart Energy
- Industrial controls, monitoring



Specifications	WE866C6-P	WE866C3 (LE910 Companion Solution)
Frequency	2.4 & 5 GHz	2.4 & 5 GHz
IEEE 802.11	802.11 a/b/g/n/ac	802.11 ac
Bluetooth	BT/BLE5	Bluetooth v4.2 + HS
IEEE 802.15.4	-	-
ANT	-	ANT+
TCP/IP	Yes	-
Drivers	Linux	Linux, Android OS
MCU	Cortex M4-F	-
Internal Flash	4MB	-
Operating Temp.	-40°C to +85°C	-40°C to +85°C
Operating Voltage	3.3 V	3.3 V
Peripherals	SDIO 3.0, UART, PCM	SDIO 3.0, UART, PCM
Antenna options	External (RF Pad)	External (RF Pad)
Certifications	FCC, IC, CE, TELEC, ANATEL, WPC-ETA, KC, SRRC, RCM	FCC, IC, CE
Dimensions	13 x 15 x 2.2 mm	13 x 13 mm

WE866C6-P – Application Fields

Transportation / Mobility

- Aftermarket/OEM telematics
- Fleet management
- Asset tracking
- Intelligent transportation
- Car phone
- OBD (onboard diagnostics)

Industrial / Infrastructure

- Condition-based monitoring
- Agriculture
- Video surveillance
- Healthcare equipment monitoring

Commercial / Enterprise

- Commercial building automation
- Patient monitoring
- Home security and automation
- Kiosks, vending, POS



intel

intel

Dual Band Wi-Fi Modules and Cards

Intel Wireless M.2 cards with Bluetooth offer the industry's most advanced connectivity technologies, including highly integrated system platforms, power-saving functionality and advanced WiFi features that optimize any WiFi environment.

Intel Dual Band IEEE 802.11 ac M.2 Cards

Devices with Intel® Wireless-AC technology inside (IEEE 802.11 ac) offer up to three times higher data rates, a better network coverage and the possibility to connect more devices to one network, compared to previous WiFi standards.

Type	Intel Dual Band Wireless	Intel Dual Band Wireless	Intel Dual Band Wireless	Intel Dual Band Wireless
	AC 9560*	AC 9260	AC 9462*	AC 9461*
Code Name	Jefferson Peak 2	Thunder Peak 2	Jefferson Peak 1	Jefferson Peak 1
Estimated SW support until	Q4 2024	Q4 2024	Q4 2024	Q4 2024
TX/RX Streams	2x2	2x2	1x1 diversity	1x1
Bands	2.4 GHz, 5 GHz	2.4 GHz, 5 GHz	2.4 GHz, 5 GHz	2.4 GHz, 5 GHz
Max Speed	1.73 Gbps	1.73 Gbps	433 Mbps	433 Mbps
Integrated Bluetooth	V5.1	V5.1	V5.1	V5.1
From Factor	M.2 2230 M.2 1216 (SMD)	M.2 2230	M.2 2230 M.2 1216 (SMD)	M.2 2230 M.2 1216 (SMD)
Supported Operating Systems	Microsoft Windows 10, Linux, Chrome			
System Interface Type	CNVio, GPIO	PCIe, USB	CNVio, GPIO	CNVio, GPIO

*CRF (Companion RF) modules

Intel Dual Band IEEE 802.11 ax M.2 Cards

Compared to the WiFi 5 solutions (IEEE 802.11 ac), WiFi 6 solutions (IEEE 802.11 ax) provide higher data rates, lower latency and longer battery lifetime.

Type	Intel Wi-Fi 6 AX200	Intel Wi-Fi 6 AX201*	Intel Wi-Fi 6E AX210 (E = extended/enhanced)	Intel Wi-Fi 6E AX211*	Intel Wi-Fi 6E AX411 (802.11abgn+acR2+axR2 (Pre-Standard)
Code Name	Cyclone Peak 2	Harrison Peak 2	Typhoon Peak 2	Garfield Peak 2	Garfield Peak 4
Estimated SW support until	Q4 2025	Q4 2025			
TX/RX Streams	2x2				
Bands	2.4 GHz, 5 GHz		2.4 GHz, 5 GHz, 6 GHz		
Max Speed	2.4 Gbps	2.4 Gbps	2.4 Gbps	2.4 Gbps	3 Gbps
Integrated Bluetooth	V5.2				
From Factor	M.2 2230 M.2 1216 (SMD)	M.2 2230 M.2 1216 (SMD)	M.2 2230 M.2 1216 (SMD)	M.2 2230 M.2 1216	M.2 2230 M.2 1625
Supported Operating Systems	Windows 10, 64-bit, Google Chrome OS, Linux				Windows 10, Linux
System Interface Type	PCIe (WiFi), USB (BT)	CNVio2	PCIe (WiFi), USB (BT)	CNVio2	CNVio28

*CRF (Companion RF) modules

Applications

- Consumer
- Transportation / Surveillance
- Medical devices
- POS / Kiosk
- Logistics
- Digital Signage

Intel Dual Band Wireless-AC 9260

The Intel Dual Band Wireless-AC 9260 supports the WLAN standard IEEE 802.11 ac and is the first WLAN module providing Gigabit WiFi speeds with 1.73 Gbps when using 160 MHz channels. Fast downloads and longer battery life times are therefore possible. The Bluetooth v5 functionality offers 4x the range of Bluetooth v4.2 at the same power consumption, 2x speed and better broadcasting functionality.

Improved Gigabit download speed is provided in combination with Intel Core processors. Simultaneous data transmission from one access point to multiple clients and 3x better downlink network capacity are possible due to downlink MU-MIMO.

Intel WiFi 6 AX200

The Intel WiFi 6 AX200 supports the WLAN standard IEEE 802.11 ax. With the new features UL and DL OFDMA and 1024QAM, Target Wake Time and spatial reuse, the AX200 enables smooth streaming of high-resolution videos, stable and faster connections farther away from the router and in dense environments. Fast up- and downloads, lower latency and longer battery life compared to previous WiFi standards are supported as well.

Bluetooth 5.2 provides 4x range over Bluetooth 4.2, doubles data rates and adds new enhanced data broadcasting, enabling seamless location-based services and simpler pairing for Bluetooth devices.

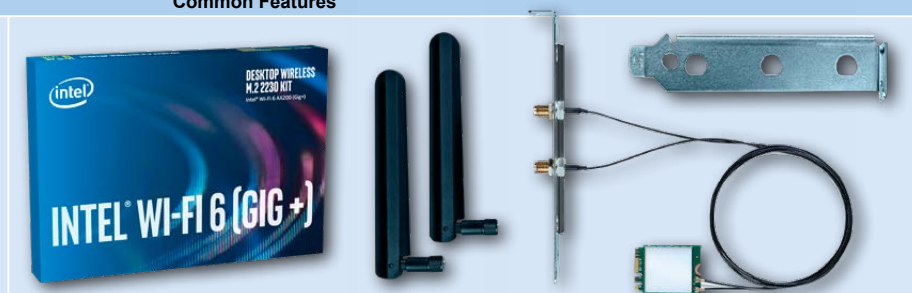
Intel WiFi 6E AX210

The Intel WiFi 6E AX210 supports dual-stream WiFi in the 2.4 GHz, 5 GHz and 6GHz bands as well as Bluetooth 5.2 and WiFi 6 R2 features with UL MU-MIMO. By implementing WiFi 6E technology supporting the 6 GHz band that includes 1200 MHz of new contiguous spectrum (>2x compared to 5 GHz) with more Gigabit WiFi options and exclusivity to WiFi 6 products.

Intel WiFi 6E AX210 module maximizes WiFi 6 and Gigabit WiFi benefits enabling greater network flexibility, faster downloads, sharing and backups as well as reduced latency and improved reliability.

Kit Options

Intel Dual Band Wireless-AC 9260 Embedded IoT Kit	Intel Dual Band Wireless-AC 9260 Industrial Kit	Intel WiFi 6 (Gig+) Desktop Kit, AX200
9260.NGWGIE.NVK	9260.NGWGII.NVK	AX210.NGWG.DTK
0°C to +70°C	-40°C to +85°C	0°C to +70°C
Intel WiFi 5 AC-9260 Embedded module	Intel WiFi 5 AC-9260 Industrial ET module	Intel WiFi 6 AX200 module
Common Features		
<ul style="list-style-type: none">Optimized external antenna (2 pcs.)Standard size mounting bracket with RF cables installedLow profile mounting bracketQuick Start GuideSafety and Regulatory informationRequires motherboard with available M.2 connector key E for wireless		





WLAN Modules – Selection Guide

Manufacturer	Name	Frequency			WLAN Protocol						Other Proto- cols		WLAN Software on Module					WLAN Security							Antenna		Chipset	Certifications	Interfaces					Ope- rating Temp. (°C)	Size (mm)	Package	Evaluation Kit / Development Kit	Drivers	Comments			
		2.4GHz	2.4GHz / 5GHz	60 GHz	802.11a	802.11b	802.11g	802.11n	802.11ac	802.11ad	802.11ah	802.11ax	Bluetooth	ZigBee	TCP/IP	Access Point	WiFi-Direct	Web Server	WEP	WPA	WPA2	WPA2-Enterprise	WPA3	WPS	WPS2	WAPI			SSL/TLS	Integrated Antenna	Antenna Con- nector	SDIO	SPI							UART	USB	Other
Silx	SX-PCEAC		x		x		3T/3R	3T/3R																			uFL	Atheros AR9280	FCC/IC/ETSI/TELEC					PCIe	0 to 60	30x27x4.5	Mini PCIe			Speed up to 1.3Gbps		
	SX-PCEAX		x	x	x	x	x	x			2T/ 2R	5.2				x	x	w				x					2x uFL	Qualcomm QCA2066	FCC, CE, IC, TELEC				x	WiFi: PCIe BT: USB	-20 - +65	14.0x18.0x1.9 29.85x26.65x2.9 22.0x30.0x2.7	M.2 LGA Type 1418 half-size mini PCIe Card M.2 2230 Card					
	SX-PCEAC2		x		x	x	x	x	2T/2R			5.0					x										2x uFL	Qualcomm QCA6174A-5	FCC, IC, CE, TELEC				x	WiFi: PCIe BT: USB	-20 - +70	12.0x16.0x1.44 30.0x26.8x2.54 16.5x30.0x2.34	SMT M.2 LGA Type 1216 Half-size mini PCIe Card M.2 1630 Card	SX-PCEAC2-EVK	Linux, ath10k, Windows			
	SX-PCEAC-DB R2		x		x	x	x	3T/3R	3T/3R																x		uFL	Qualcomm Atheros QCA9880	FCC, IC, ETSI, TELEC, MIC					PCIe	0 to 60	29.9x50.8x4.0	Mini PCIe			Speed up to 1.3Gbps		
	SX-PCEAN2c SX-PCEAN2i		x		x	x	x	2T/2R											x	x	x		x				uFL	Atheros AR9582 Atheros AR9592	FCC / TELEC					PCIe	0 - +60 -40 - +85	29.85x26.80x3.45	Half-size Mini PCIe		Linux			
	SX-SDMAC(+) SX-SDPAC		x		x	x	x	x	1T/1R			5.0				x	x		x	x	x	x		x			x	uFL or onboard	QCA9377-3	FCC, IC, CE, TELEC	x		x			-20 to 85/ -40 to 85	24x24x3.4	Surface Mount	SX-6K3-EVK-SB AR6003 WLAN Radio Evaluation Kit (Includes SX-SDMGN-2830C	Linux, Windows 10, Windows 10 IoT, Windows Embedded Compact 7 and 2013, FreeRTOS	Link Rate upto 433 Mbps	
	SX-USBAC		x		x	x	x	x	1T/1R			5.0				x	x			x	x	x	x	x			uFL or onboard	QCA9377-7	FCC, IC, CE, TELEC				x		-40 - +85	22 x 21 x 2.95 (SMT)	Surface Mount		Linux, ath10k, Windows			
	SX-ULPGN-BTZ		x		x	x	x	1T/1R				5.0		x	x												x		QCA4020	FCC, IC, CE, TELEC						-20 to 80	33.5x28.6x3.2	Surface Mount	SX-ULPGN-BTZ -EVK			
	SX-SDMGN-2830C	x				x	x	1T/1R											x	x	x						x	uFL	Atheros AR6103	FCC, CE	72 Mbps					-20 to 85	24x24x3.4	Surface Mount	SX-6K3-EVK-SB AR6003 WLAN Radio Evaluation Kit (Includes SX-SDMGN-2830C	Reference Driver: Linux, Android, WinCE	Speed up to 72.2Mbps	
	SX-ULPGN	x				x	x	1T/1R							x	x	x				x								QCA4010	FCC, IC, CE						0 - +70	30x16x2.6	Surface Mount				
	SX-59HLS		x			x	x	x	1T/1R						x			x				x							QCA4012-2	FCC, IC, CE, TELEC				x		0 - +70	43x20x2.5	Surface Mount	SX-59HLS-EVK			
	SX-590		x			x	x	x	x	1T/1R					x				x	x	x			x				PCB	uFL	NXP i.Mx6ULL ARM Cortex-A7, 528MHz	FCC, IC, CE, TELEC		10			-40 to 85	55x30x 9.25	Surface Mount		Linux		
	SX-23BT											5.0			x													x	uFL		FCC, IC, CE, TELEC						-40 - +85	16x10x2.7	Surface Mount	SX-23BT-EVK		
	SX-NEWAH										1T/ 1R																		uFL	Newracom NRC 7292	FCC		x				-40 - +85	20.5x27.0x3.1	Surface Mount	SX-NEWAH-EVK-US		

WLAN Modules – Selection Guide

Manufacturer	Name	Frequency			WLAN Protocol							Other Proto- cols		WLAN Software on Module					WLAN Security							Antenna		Chipset	Certifications	Interfaces					Ope- rating Temp. (°C)	Size (mm)	Package	Evaluation Kit / Development Kit	Drivers	Comments	
		2.4GHz	2.4GHz / 5GHz	60 GHz	802.11a	802.11b	802.11g	802.11n	802.11ac	802.11ad	802.11ah	802.11ax	Bluetooth	ZigBee	TCP/IP	Access Point	WiFi-Direct	Web Server	WEP	WPA	WPA2	WPA2-Enterprise	WPA3	WPS	WPS2	WAPI	SSL/TLS			Integrated Antenna	Antenna Con- nector	SDIO	SPI	UART							USB
Intel	Wireless-AC 9260	x			x	x	x	2T/2R	2T/2R				5.0			x	x		x	x	x		x			x	uFL	Thunder Peak 2	FCC/IC/CE				x	PCIe	0 to 80 -40 +85	22x30x2.4	M.2 2230 card	Embedded Kit: 9260. NGWGIE.NVK Industrial Kit: 9260.NGW- GII.NVK	Microsoft Windows 10, Linux (limited feature support), Chrome	1.73 Gbps	
	Wireless-AC 9560	x			x	x	x	2T/2R	2T/2R				5.0			x	x		x	x	x		x			x	uFL	Jefferson Peak 2	FCC/IC/CE				x	CNVi	0 to 80	22x30x2.4 12x16x1.57	M.2 2230 M.2 1216 card	Microsoft Windows 10, Linux (limited feature support), Chrome	CRF (Companion RF) module; 1.73 Gbps		
	Wireless-AC 9461	x			x	x	x	1T/1R	1T/1R				5.0			x	x		x	x	x		x			x	uFL	Jefferson Peak 1	FCC/IC/CE				x	CNVi	0 to 80	22x30x2.4 12x16x1.57	M.2 2230 card M.2 1216 card	Microsoft Windows 10, Linux (limited feature support), Chrome	433 Mbps		
	Wireless-AC 9462	x			x	x	x	1T/1R	1T/1R				5.0			x	x		x	x	x		x			x	uFL	Jefferson Peak 1	FCC/IC/CE				x	CNVi	0 to 80	22x30x2.4 12x16x1.57	M.2 2230 card M.2 1216 card	Microsoft Windows 10, Linux (limited feature support), Chrome	CRF (Companion RF) module; 433 Mbps		
	Wireless AX200	x	x		x	x	x	x	x			2T/2R	5.0		x				x	x	x	x	x				uFL	Cyclone Peak 2					WiFi: PCIe BT: USB	0 to 80	22x30x2.4 12x16x1.65	M.2 2230 M.2 1216		Windows 10, 64-bit, Google Chrome OS, Linux			
	Wireless AX201	x			x	x	x	x	x			2T/2R	5.2						x	x	x	x				x	uFL	Harrison Peak 2					CNVio2	0 to 80	22x30x2.4 12x16x1.65	M.2 2230 M.2 1216		Windows 11, 64-bit*, Windows 10, 64-bit*, Linux*, Chrome OS*	CRF (Companion RF) module		
	Wireless AX210	x	x		x	x	x	x	x			2T/2R	5.2						x	x	x	x				x	uFL	Typhoon Peak 2					WiFi: PCIe BT: USB	0 to 80 -40 to 85	22x30x2.4 12x16x1.65	M.2 2230 M.2 1216	Embedded Kit: AX210. NGWGE.NVK Industrial Kit: AX210. NGWGI.NVK	Windows 11, 64-bit*, Windows 10, 64-bit*, Linux*			
	Wireless AX211	x	x		x	x	x	x	x			2T/2R	5.2				x		x	x	x	x				x	uFL							CNVio2	0 to 80	22x30x2.4 12x16x1.65	M.2 2230 M.2 1216		Windows 11, 64-bit*, Windows 10, 64-bit*, Linux*, Chrome OS*	CRF (Companion RF) module	
	Wireless AX411	x	x		x	x	x	x	x			2T/2R	5.2						x	x	x	x					uFL	Garfield Peak 4							CNVio2	0 to 80	22x30x2.4 16x25x1.65	M.2 2230 M.2 1625		Windows 11, 64-bit*, Windows 10, 64-bit*, Linux*	CRF (Companion RF) module
Panasonic	PAN9520	x				x	x	x							x	x				x	x	x				x		Espressif ESP32-S2	EU CE RED / FCC / IC under preparation		x	x		"QSPI, I²C, I²S, GPIO"	-40°C +85°C	24 x 13 x 3.1	Surface Mount	PAN9520 Eval Board / ENW49D01AZKF	Fully embedded		
	PAN9026		x			x	x	x	1T/1R			4.2	x		8 clients				x	x	x				x		x		Marvell® 88W8977	CE/FCC/IC	x		x			-30 to 85	17.5 x 10.0 x 2.6	Surface Mount	PAN9026 EVALKIT / ENWF9201AYEF	Linux / Android Driver	
	PAN9028		x			x	x	x	x			5.0	x						x	x	x				x		x		Marvell® 88W8977		x		x			-30 to 85	17.5 x 10.0 x 2.6	Surface Mount		Linux / Android Driver	Scheduled for autumn 2019
Telit	GS2200M	x				x	x	x						x	16 clients				x	x	x	x	x			x	Chip	uFL		CE/FCC/IC/Telec	x	x	x		I²C, I²S, GPIO, ADC, PWM, JTAG	-40 to 70	13.5 x 17.85 x 2.1	Surface Mount			
	GS2101M	x				x	x	x						x	16 clients				x	x	x	x	x			x	PCB	uFL		CE/FCC/IC/Telec	x	x	x		I²C, I²S, GPIO, ADC, JTAG	-40 to 85	18 x 25 x 2.7	Surface Mount			
	WE866A1-P	x				x	x	x						x	4 clients	x	x				x	x			x		Pin		CE/FCC/IC		x	x			SPI, UART	-40 to 85	15 x 19	Surface Mount		Companion WiFi module for Telit's LE910 cellular solution	
	WL8654E4-P		x			x	x	x	x				5		x	x	x		x	x	x	x			x		RF PAD		CE/FCC/IC/Telec	x	x	x	x		I²C, I²S, GPIO, ADC, PWM, JTAG	-40 to 85	24.4 x 24.4	Surface Mount			
	WE866C3		x			x	x	x	x				4.1	ANT+		10 clients										x	RF PAD		CE/FCC/IC	x		x			PCM	-40 to 85	13 x 13	Surface Mount		Linux / Android Driver	

WLAN Modules – Selection Guide

Manufacturer	Name	Frequency			WLAN Protocol						Other Proto- cols		WLAN Software on Module				WLAN Security						Antenna		Chipset	Certifications	Interfaces					Ope- rating Temp. (°C)	Size (mm)	Package	Evaluation Kit / Development Kit	Drivers	Comments							
		2.4GHz	2.4GHz / 5GHz	60 GHz	802.11a	802.11b	802.11g	802.11n	802.11ac	802.11ad	802.11ah	802.11ax	Bluetooth	ZigBee	TCP/IP	Access Point	WiFi-Direct	Web Server	WEP	WPA	WPA2	WPA2-Enterprise	WPA3	WPS			WPS2	WAPI	SSL/TLS	Intergrated Antenna	Antenna Con- nector							SDIO	SPI	UART	USB	Other		
Avantech	EWM-W142F01E	x				x	x	2T/2R											x	x	x							uFL	Atheros AR9287	CE, FCC, China...etc.					1 PCIe	0 to 60	51x30x2.3	Mini PCIe		Windows XP/ Vista/ 7 (32 and 64 bit)	1 300 Mbps			
	EWM-W158F01E	x	x		x	x	x	2T/2R											x	x	x							uFL	Atheros AR9592-AR1B	FCC, CE					PCIe	-40 to 85	51x30x2.8	Mini PCIe		Windows XP / Vista / 7 / 8 / 8.1 and Linux	300 Mbps			
	EWM-W159M201E		x		x	x	x	2T/2R	x				5.0						x	x	x				x			2x MHF4	Realtek RTL-8822CE-CG	FCE, CE, NCC, Mexico, Telec				x	PCIe	0 to 70	22x30x2,2	M.2 2230 A-E Key card		Windows 10				
	EWM-W157M201E		x		x	x	x	x	x				4.2						x										Realtek RTL-8821CE-CG	FCC, IC, Telec					x	PCIe	0 to 70	22x30x2,2	M.2 2230 A-E Key card		Windows 7/8.x/10			
	EWM-W172H01E		x		x	x	x	2T/2R	x				4.2						x	x	x							2x MHF4	Realtek RTL-8822BU-CG	FCC, CE, IC, Telec					x	PCIe	-20 to 70	26,65x29,85x3,25	Half-size Mini PCIe		Windows 7/8.1/10 / Linux / Android			
	EWM-W173H01E		x		x	x	x	2T/2R	x			x	5.0						x	x	x		x					2x MHF4	Broadcomm AP6275P						x	PCIe	-40 to 85	29,85x26,65x2,5	Half-size Mini PCIe		Linux / Android			
	EWM-W193H01E		x		x	x	x	x	x				5.0						x	x	x				x			2x MHF4	Realtek RTL-8822CE-CG						X	PCIe	0 to 70	30x26,8x2,5	Half-size Mini PCIe		Windows 10, / Linux (Kernel v4.0 and above)			
	EWM-W194M201E		x		x	x	x	2T/2R	x				5.0						x	x	x		x		x			2x MHF4	NXP 88W8997			x					-30 to 85	22x30x2,85	M.2 2230 card		Linux (Kernel v4.0 and above)			
	EWM-W306S01E		x			x	x	x	2T/2R	x			5.1						x	x	x		x			x			2x MHF4	Marvell 88W8997			x				PCIe	-30 to 85	12x16x1,85	M.2 1216 LGA		Linux OS		
	EWM-W310S01E		x			x	x	x	2T/2R	x			5.0						x	x	x					x			2x MHF4	Realtek RTL-8822CE-CG							x	PCIe	0 to 70	12x16x1,7	M.2 1216 LGA		Windows10	
	AIW-154BN		x			x	x	x	2T/2R	x			5.0						x	x	x		x			x			2x MHF4	NXP 88W8997					x		PCIe	-30 to 85	30x22x2,85	M.2 2230 card		Linux (Kernel v4.0 and above)		
	AIW-163BR		x			x	x	x	2T/2R	x				x	5.2				x	x	x		x						2x MHF4	Realtek RTL 8852BE							x	PCIe	0 to 70	30x22x2,2	M.2 2230 A-E Key card		Windows 10	
	AIW-164SN		x			x	x	x	x	x				x	5.3												x			NXP 88W9098			x					PCIe	-40 to 85	20x18x2,8	LGA		Linux	
	AIW-165BN			x		x	x	x	x	x				x	5.3								x				x			NXP 88W9098				x				PCIe	-40 to 85	28x30x3,95	M.2 2830 E Key card		Linux	
iVativ	MIST	x				x	x	x					x					x	x	x				x		x			Qualcomm QCA4010	FCC, IC, CE						Standard: 0° to 85 Storage: -40° to 85	16 x 20 x 2.1	LGA						
	AVIC	x				x	x	x										x	x	x				x		x			Qualcomm QCA4010 and CSR8811	FCC, IC, CE						Standard: 0° to 85 Storage: -40° to 85	16 x 20 x 2.1	LGA						
	RILA	x				x	x	x					x					x	x	x				x		x			Qualcomm QCA4010	FCC, IC, CE						Standard: 0° to 85 Storage: -40° to 85	16 x 20 x 2.1	LGA						
	BALI		x						x											x	x								Qualcomm QCA9377	FCC, IC, CE, BT SIG	x				x	PCIe	-40C to 85C	11.8 x 12 x 1.6 LGA	M.2 1630 M.2 2230 Half-size Mini PCIe					
	EVIA		x							x										x	x								Qualcomm QCA9377	FCC, IC, CE		x				x	PCIe	-40C to +85C	11.8 x 12 x 1.6 12 x 16 x 1.9	Surface Mount M.2 1630, M.2 2230 Half-Size Mini PCIe / Mini PCIe			Supported Ecosystem: WICED, i.MX	
Murata	Type 1FX	x				x	x	x																					Infineon CYW43364	FCC/IC, EN compliant by Reference Antenna design	x						-40 to +85	6.95 x 5.15 x 1.1	LGA (46 pads)	LBEE5KL1DX-TEMP-EVB		Supported Ecosystem: WICED, CubeMX, i.MX, STM32M		
	Type 1DX	x				x	x	x				5.1																	Infineon CYW4343W		x			x		PCM	-30 to +70	6.95 x 5.15 x 1.1	LGA (46 pads)	LBEE5KL1DX-TEMP-EVB		Supported Ecosystem: i.MX, STM32M		
	Type 1MW		x		x	x	x	x	x				5.0 + BR/ DER															Infineon CYW43455	x				x		PCM, I²S	-30 to +85	7.9 x 7.3 x 1.1	LGA (72 pads)		Supported Ecosystem: Modus, CubeMX, i.MX, STM32M				
	Type 1LV		x		x	x	x	x					5.0 + BR/ DER																Infineon CYW43012		x			x		PCM, I²S	-20 to +70	10.0 x 7.2 x 1.4	LGA (106 pads)	CY8CKIT-062S2-43012 (Infineon)		Supported Ecosystem: CubeMX, i.MX		
	Type 1YN	x				x	x	x					5.2 + BR/ DER																Infineon CYW43439		x			x		PCM	-30 to +70	6.95 x 5.15 x 1.1	LGA (46 pads)		Supported Ecosystem: CubeMX, i.MX			
	Type 2AE		x		x	x	x	x	x					5.2 + BR/ DER															Infineon CYW4373E			x		x	x	PCIe, PCM	-40 to +85	8.0 x 7.8 x 1.25	LGA (72 pads)		Supported Ecosystem: WICED			
	Type 1GC		x		x	x	x	x																					Infineon CYW43907					x	x	x	GPIO, I²S, MII, RMII, IC	-30 to +85	10.0 x 10.0 x 1.2	LGA (136 pads)	CYW943907AEVAL1F		Supported Ecosystem: WICED	
	Type 1LD	x				x	x	x					5.2 + BR/ DER																Infineon CYW43438 + STM32F412 Cortex M4	FCC/IC/TELEC, EN compliant by Reference Design				x	x		I²C, GPIO, JTAG	-40 to +85	8.9 x 7.8 x 1.2	LGA (70 pads)	LBEE5PA1LD-TEMP-A		Supported Ecosystem: i.MX RT, i.MX	
	Type 1ZM		x		x	x	x	x	x					5.1 + BR/ DER															NXP 88W8987	FCC/IC, EN compliant by Reference Antenna design	x				x			-20 to +75	10.2 x 9.3 x 1.55	LGA (94 pads)		Supported Ecosystem: i.MX		
	Type 1YM		x		x	x	x	x	x					5.2 + BR/ DER															NXP 88W8997	FCC/IC, EN compliant wuth Flex PCB Antenna	x				x	x	PCIe	-30 to +85	11.8 x 8.4 x 1.3	LGA (120 pads)		Supported Ecosystem: i.MX RT, i.MX		
	Type 1XK		x		x	x	x	x						5.2 + BR/ DER															NXP IW416	FCC/IC, EN compliant by Reference Antenna design	x				x			-40 to +85	9.1 x 8.3 x 1.3	LGA (81 pads)		Supported Ecosystem: i.MX RT		
	Type 2DS	x				x	x	x																			x		NXP 88M8801	FCC/IC, CE compliant	x					x		-40 to +85	25 x 14 x 2.32	LGA (88 terminations)				



What is Bluetooth®?



Bluetooth is a wireless technology standard implemented for exchanging data over usually short distances from fixed and mobile devices, building Personal Area Networks (PANs). Here, short-wavelength microwaves in the ISM band from 2.4 to 2.485 GHz are used.

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which today has more than 30,000 member companies in the area of telecommunication, computing, networking, and consumer electronics. The term “Bluetooth” covers a number of different versions which evolved over the last years. Today, classic Bluetooth is differentiated from the latest Bluetooth standards 4.0-5.3, which are known as Bluetooth Low Energy / Bluetooth Dual Mode. Actually, Bluetooth Low Energy and Classic Bluetooth have to be seen independently from each other (an exception are Dual Mode modules or chips, where both standards, Classic Bluetooth

and Bluetooth Low Energy can be used). While the overall difference between the diverse versions of Classic Bluetooth consists of an improved enhancement of the transferred data rate, the most recent Bluetooth Low Energy standard is rather classified as an individual standard which was designed to create low data rate networks using a minimum amount of power.

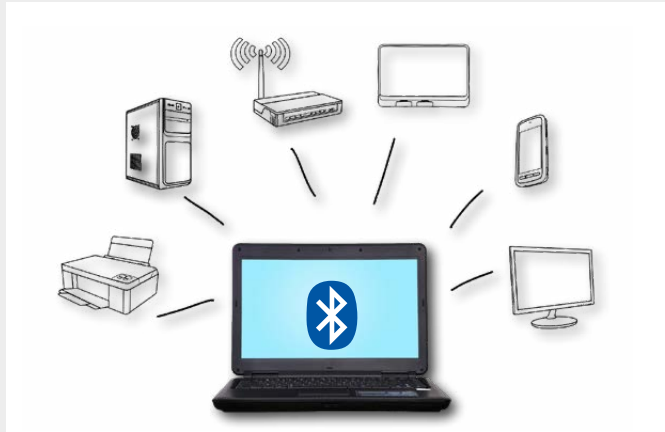
Furthermore, it does not only enable point-to-point connection but also mesh topology for establishing many-to-many device communications.

Common Bluetooth Versions and Their Characteristics

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

What are Bluetooth® Profiles?

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



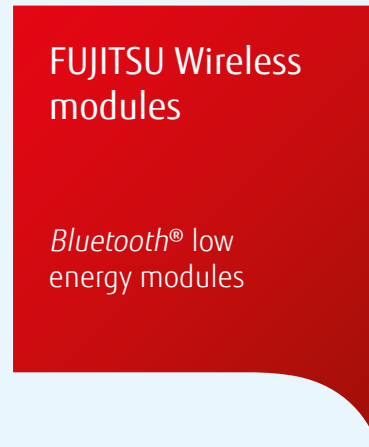
New Security Regulations

Security standards are a major topic at Bluetooth SIG. To keep this standard high, safe and always available, several standards for producing Bluetooth applications have to be maintained: Lately the new EN ETSI and RED (Radio Equipment Directive – 2014/53/EU) decree were released which implicate duties for manufacturers.

Especially for body-close applications you need to do SAR measurements and a special Bluetooth declaration process is required.

Bluetooth Profiles

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



Bluetooth® Low Energy

Panasonic

Bluetooth® Low Energy



PAN178x – Bluetooth® Low Energy 5.1

The PAN1781 Series RF Module is a high technology device featuring the Nordic nRF52820 Single-Chip Controller and is ideal for IoT Wireless Connectivity applications.

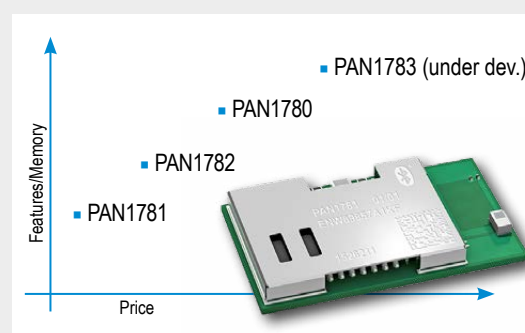
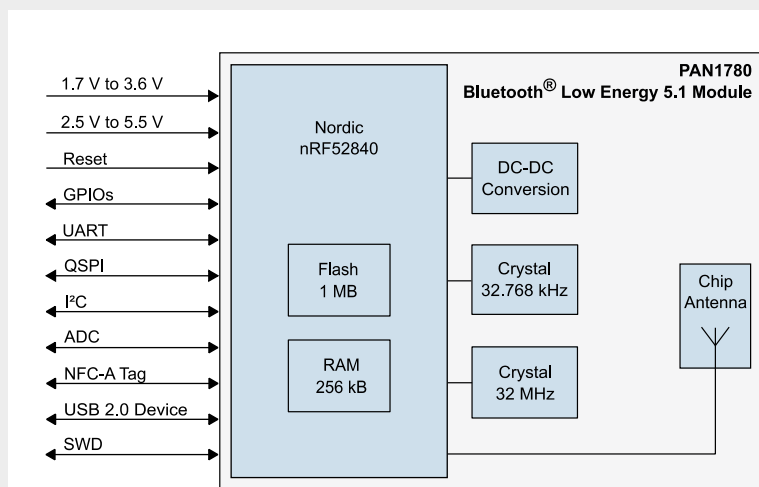
PAN1780 – the Flagship based on nRF52840

- Bluetooth 5 & 802.15.4
- Support of Matter, BLE Mesh, ZigBee, Thread and Wireless
- All 48 GPIOs available
- Extended certifications
- U.FL connector and AT Command Set variants
- Separate 32 kHz Crystal Oscillator
- Small size of 15.6 x 8.7 x 2 [mm]

Broad portfolio based on

- From low- to high-end feature chipsets
- Integrated antenna and u.FL connector versions
- With or without AT Command stack variants

Block Diagram



Infrastructure

- EV Charging
- Professional Equipment
- Smart Lighting

Medical

- Equipment
- Diagnostic
- Patient Monitoring

Smart Home / Building

- Home Appliance
- HVAC
- Gateways

Production Line Panasonic

100% end-of-line tested	European development & production
0 ppm failure rate	Produced according to IATF 16949
Certified for CE RED, FCC, ISCED, MIC, KCC, RCM, SRRC	

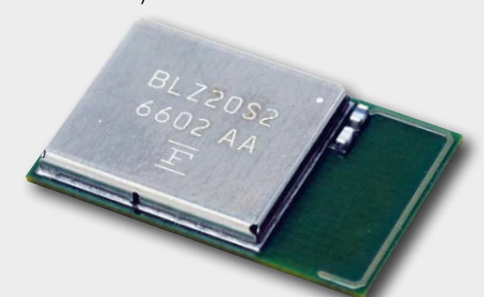
PAN1780	PAN1780AT	PAN1770	PAN1781	PAN1782	PAN1783
Bluetooth Low Energy 5.1			Bluetooth Low Energy 5.1		Bluetooth Low Energy 5.x
nRF52840			nRF52820		nRF5340
ARM® Cortex® -M4F			ARM® Cortex® -M4		ARM® Cortex® -M33
1MB Flash, 256kB RAM	AT Command Set	1MB Flash, 256kB RAM	256kB Flash, 32kB RAM	512kB Flash, 128kB RAM	1 MB Flash & 512 KB RAM256 KB Flash & 64 KB RAM
Chip Antenna		u.FL connector	Chip Antenna	Chip Antenna	tbd
15.6 x 8.7 x 2 [mm]					

Fujitsu's BLE Series (MBH7BLZ & FWM7BLZ)

Key Features

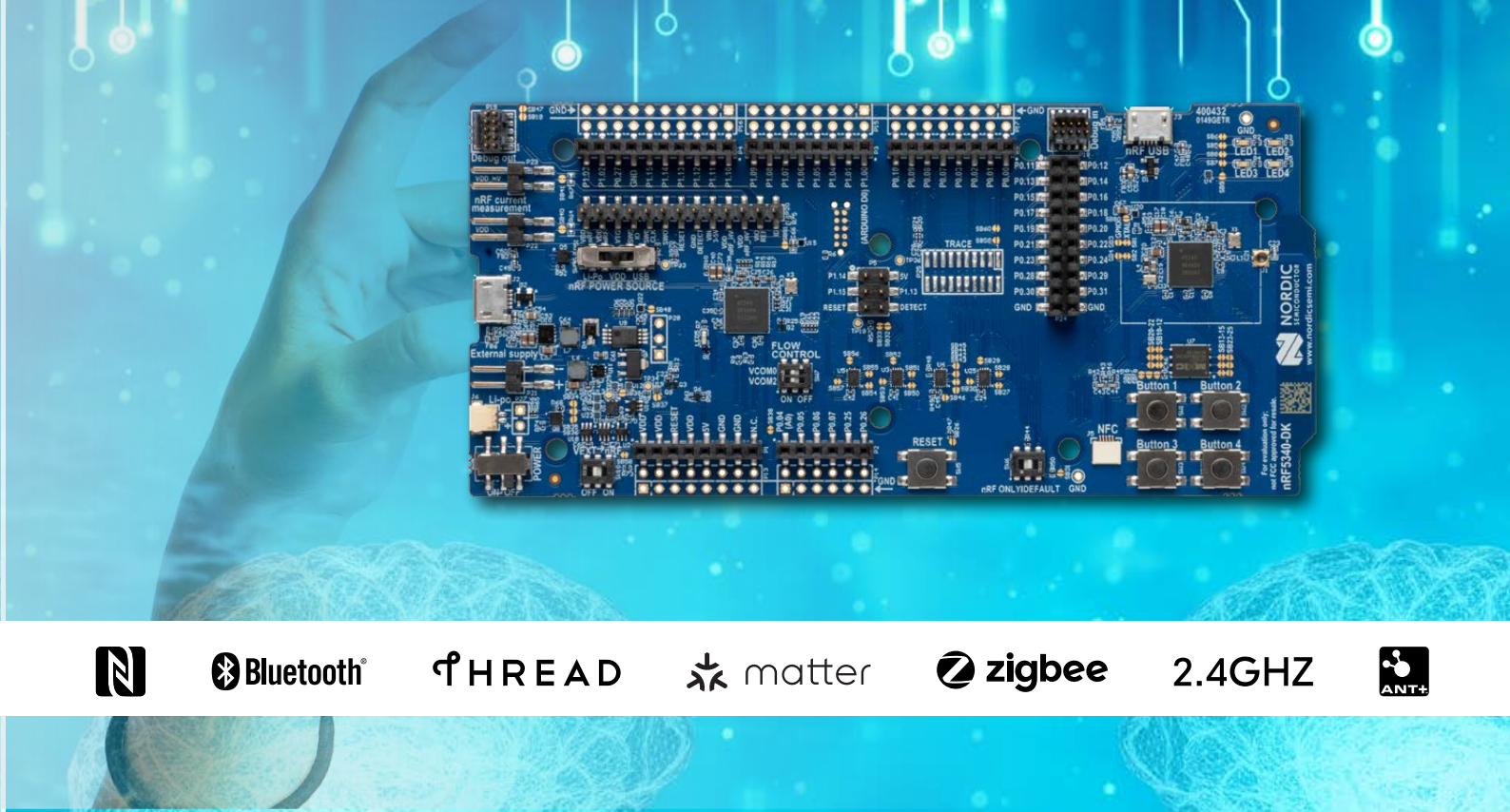
- Bluetooth specification version 4.1, 4.2 and 5 compliant
- Nordic Semiconductor nRF5x series based
- Full set of GPIO pins available. Per series (MBH7BLZ07 - 22 pins, MBH7BLZ01/02 - 31 pins and FWM7BLZ20 - 30 pins) are assigned to this module (Possible to use them as I2C, NFC, SPI, TWI, UART and ADC)
- Available with FUJITSU's unique data communication profile or with the complete SoftDevice provided by Nordic Semiconductor
- Power supply: 1.7~3.6V
- RoHS and RED compliant
- Surface mount type
- Small footprints (BLZ07: 11.5 mm x 7.9 mm, BLZ02/20 15.7 x 9.8 mm)

- Built-in crystal oscillators (32 MHz and in the FWM7BLZ20 also the 32.768 kHz)
- Integrated antenna
- NFC function by the connection of an external antenna (FWM7BLZ20 series)



Bluetooth Low Energy Overview

Features	MBH7BLZ01-1090xx, MBH7BLZ01A-1090xx, MBH7BLZ02-109058, MBH7BLZ02A-109059, MBH7BLZ07-109060	MBH7BLZ01-109029, MBH7BLZ01A-109008, MBH7BLZ02-109031, MBH7BLZ02A-109009, MBH7BLZ07-109033	FWM7BLZ20-109068	FWM7BLZ20-109062
Used IC	Nordic Semiconductor nRF51822 rev. 3 MBH7BLZ01/02(A): QFN rev. 3 MBH7BLZ07: CSP	Nordic Semiconductor nRF51822 256kB Flash MBH7BLZ01/02(A): QFN rev. 3 MBH7BLZ07: CSP	Nordic Semiconductor nRF52832 QFN	Nordic Semiconductor nRF52832 512kB Flash QFN
RAM Size	n/a	MBH7BLZ01/02: 16kB MBH7BLZ01A/02A: 32 kB MBH7BLZ07: 16kB	n/a	64 KB
Type	Version 4.1 (single mode) Fujitsu unique data transmission profile embedded	Version 4.1 (single mode) GATT, GAP, ATT, SM and L2CAP embedded with SoftDevice	Version 4.2 (single mode) Fujitsu unique data transmission profile embedded	Version 4.2 (single mode) GATT, GAP, ATT, SM and L2CAP embedded with SoftDevice
Size	BLZ01(A): 10.5 x 9.2 x 1.6 mm BLZ02(A): 15.7 x 9.8 x 2.0 mm BLZ07: 11.5 x 7.9 x 1.7 mm	BLZ01(A): 10.5 x 9.2 x 1.6 mm BLZ02(A): 15.7 x 9.8 x 2.0 mm BLZ07: 11.5 x 7.9 x 1.7 mm	15.7 x 9.8 x 1.7 mm	15.7 x 9.8 x 1.7 mm
Operating Temp.	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C
Attachment	SMD	SMD	SMD	SMD
Host Interface	UART	UART	UART	UART
I/O Pins	TBD	BLZ01: 31 BLZ02: 31 BLZ07: 22	TBD	30
Antenna	BLZ01: No BLZ02/07: Yes	BLZ01: No BLZ02/07: Yes	Yes	Yes
Qualification	QDID: 59305 (BLZ01/02), 63976 (BLZ07) FCC/IC/CE/Radio Act (Japan): BLZ02/07	QDID: 59305 (BLZ01/02), 63976 (BLZ07) FCC/IC/CE/Radio Act (Japan): BLZ02/07	QDID: 89374 FCC/IC/CE/Radio Act	QDID: 89374 FCC/IC/CE/Radio Act



Bluetooth® Low Energy

nRF5340 – New Dual-core Flagship SoC

nRF5340 – Dual-Core Bluetooth 5.3 SoC supporting Bluetooth LE, Bluetooth mesh, NFC, Matter, Thread and Zigbee

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

Key Features

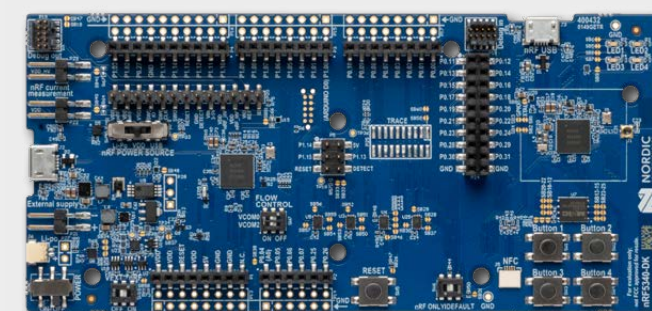
- **High-performance application processor**
 - 128/64 MHz Arm Cortex-M33 with FPU & DSP instructions
 - 1 MB Flash + 512 kB low leakage RAM
 - 8 kB 2-way set associative cache
- **Fully-programmable network processor**
 - 64 MHz Arm Cortex-M33 with 2 kB instruction cache
 - 256 kB Flash + 64 kB RAM
 - Ultra-low power
- **Next level security**
 - Trusted execution with Arm TrustZone
 - Hardware accelerated cryptography with Arm CryptoCell-312
 - Secure Key Storage
 - Secure bootloader with root-of-trust and DFU
- **Bluetooth Low Energy**
 - Bluetooth 5.3
 - LE Audio
 - Direction Finding
 - 2 Mbps, Advertising Extensions and Long Range
- **Bluetooth mesh**
 - Thread, Zigbee and 802.15.4
- **NFC**
 - Full range of digital interfaces with EasyDMA
 - Full-speed USB
 - 96 MHz encrypted QSPI
 - 32 MHz high-speed SPI
- **105 °C extended operating temperature**
- **1.7-5.5 V supply voltage range**



Start your Development today!

nRF5340 DK

The nRF5340 DK is the development kit for the nRF5340 System-on-Chip (SoC), containing everything needed to get started with development, on a single board.



nRF5340 Audio DK

The nRF5340 Audio DK is a development kit for Bluetooth LE Audio applications. It contains everything needed to get started with development.



Nordic Thingy:53

The Thingy:53 is Nordic's rapid prototyping platform, based on the nRF5340 System-on-Chip (SoC), the current flagship dualcore wireless SoC. With integrated sensors for motion, sound, light and environmental factors, it is the perfect platform for building proof-of-concepts and developing new prototypes in a very short time.





Bluetooth   

Bluetooth® Low Energy

Fast-Track Your IoT Deployment with Insight SiP Solutions

The InsightSiP "Ready-to-go" RF modules offer you the fast, low risk way to deploy your IoT infrastructure, with fully CE, FCC, IC, Telec and Bluetooth SiG certified solutions. All modules are based on Nordic Semiconductor's SoCs.



- ISP2053-AX**
 - High end dual core architecture
 - Power optimized
 - Advanced security features
 - BLE audio support
 - Advanced real time capability
 - Trust Zone
- SP1807-LR / ISP1907-HT**
 - High-capacity Flash/RAM
 - Advanced Bluetooth features
 - Long range
 - Angle of arrival
 - Mesh
 - Rich I/O set
- ISP1907-LL**
 - Connectivity node
 - Simple applications
 - Cost effective solution
 - Simple angle of arrival tag
- ISP1907-LL**
 - All purpose device
 - Core Bluetooth feature set
 - Large application capacity
 - Balanced price/performance trade off

Part Number	ISP1507-AX	ISP1807-LR	ISP1907-LL	ISP1907-HT	ISP2053-AX
Bluetooth	5.0	5.0	5.1	5.1	5.2
BT Features	Bluetooth LE	Bluetooth LE Long Range	Bluetooth LE Long Range Dir. Finding	Bluetooth LE Long Range Dir. Finding	Bluetooth LE Long Range Dir. Finding - Audio
Other protocol	BT Mesh - ANT	BT Mesh - ANT Thread - Zigbee	BT Mesh - ANT	BT Mesh - ANT Thread - Zigbee	BT Mesh - ANT Thread - Zigbee
Tx Power	+ 4 dBm	+ 8 dBm	+ 4 dBm	+ 8 dBm	+ 3 dBm
Chip	nRF52832	nRF52840	nRF52811	nRF52833	nRF5340
Processor	Cortex M4F	Cortex M4F	Cortex M4	Cortex M4F	2 x Cortex M33
Flash	512 kB	1 MB	192 kB	512 kB	1 MB + 512 kB
RAM	64 kB	256 kB	24 kB	128 kB	256 kB + 64 kB
Security	-	Cryptocell	-	-	TrustZone - Cryptocell
GPIOs (ADCs)	30 (8)	46 (8)	13 (3)	30 (8)	46 (8)
Interfaces	(High Speed) SPI, TWI, UART, PWM, PDM (Applicable for all)				
NFC tag	Yes	Yes	-	Yes	Yes
USB	-	Yes	-	Yes	Yes
Temperature	85°C	85°C	85°C	105°C	105°C
Dimensions	8 mm x 8 mm x 1 mm (Applicable for all)				

Bluetooth® Low Energy



BT v5.0 Module – WSM-BL241-ADA-008

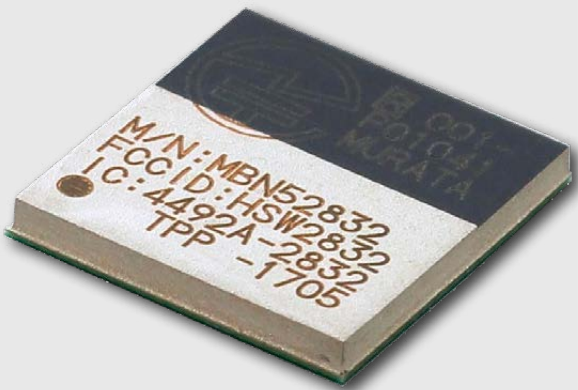
The latest MBN52832 device consists of Nordic Semiconductor's nRF52832 IC, a 32 MHz crystal for timing, and an on-board antenna. Additionally, it contains pins for an off-board omni-directional antenna and a NFC antenna. The module provides a Serial Port Interface (SPI) and UART interface to Nordic's nRF52832 ARM Cortex M4 processor.

The WSM-BL241-ADA-008 module provides BLE connectivity between tablets, cell phones, cloud services, and other proprietary functions. Further, Nordic Semiconductor's software developer's kit enables developers to create and run edge device applications that can monitor and capture diagnostic information for preventive maintenance.

These features can be combined in apps for both iOS and Android devices that run BT v5.0. With this functionality and small footprint, it is ideally suited for OEMs wanting to develop Internet of Things (IoT) devices. Target markets include Industrial IoT, energy, and home and office automation applications.

Specific end products include asset tracking devices, medical insulin pumps, white goods, and other consumer goods that require connectivity.

- Features**
- Bluetooth® v5
 - Higher throughput
 - Increased broadcast capacity
 - Improved channel co-existence algorithm (SCA)
 - ANT, NFC Tag
 - Nordic nRF52832 Bluetooth Smart®
 - Built-in ARM Cortex M4 core with 64 KB RAM and 512 KB flash
 - Dimension 7.4 x 7.0 x 0.9 mm
 - Packaging: LGA
 - Bluetooth/ANT Antenna Configuration:
 - On-board PCB antenna
 - Supports external antenna from pin pad
 - Maximum transmit power: +4dBm @ antenna port (LDO Mode)
 - Receive sensitivity: -93 dBm@ 1Mbps(LDO Mode)
 - Power consumption
 - TX: 7 mA @ 3.5 dBm (DCDC Mode)
 - RX: 6 mA (DCDC Mode)
 - Host interface: UART, SPI
 - Other interfaces: 20 GPIO, 5 ADC, UART,SPI (master and slave), I2C, PW M and Debug SWD
 - Operating temperature range: -40 °C to 85 °C
 - RoHS compliant
 - MSL Level 3in accordance with JEDEC J-STD-020
 - Regulatory certificates: FCC, IC, ETSI (plan)





AIROC™ Bluetooth® and Bluetooth® Low Energy Solutions

Infineon's AIROC™ Bluetooth® Low Energy-only and dual-mode Bluetooth® solutions deliver the most reliable and highest performing connectivity for your applications. These SoC's are supported in ModusToolbox™ Software and Tools with copious Bluetooth® code examples as well as in-house AIROC™ globally certified modules for rapid time to market.

AIROC™ Bluetooth® Low Energy portfolio consists of the CYW20736, CYW20835 and their respective modules, as well as the PSoC™ 4 Bluetooth® LE and PSoC™ 6 Bluetooth® LE System-on-Chip (SoC) devices and fully certified modules.

Product	SDK	CPU	Flash (KB)	RAM (KB)	GPIOs	Bluetooth LE Max Tx Power	RX Sensitivity
AIROC™ CYW20736	ModusToolbox™	24 MHz Arm® Cortex®-M3	External	60	14	4 dBm	-93 dBm
AIROC™ CYW20835	ModusToolbox™	96 MHz Arm® Cortex®-M4	External	384	24	12 dBm	-94.5 dBm
PSoC™ 4 MCU w/ Bluetooth® LE	PSoC™ Creator	48 MHz Arm® Cortex®-M0	Up to 256KB	Up to 32	36	3 dBm	-91 dBm
PSoC™ 63 MCU w/ Bluetooth® LE	ModusToolbox™	150 MHz Arm® Cortex®-M4 & 100 MHz Arm® Cortex®-M0	Up to 1MB	Up to 288	Up to 84	4 dBm	-95 dBm

AIROC™ CYW20835 Bluetooth® LE SoC

is designed to support the entire spectrum of Bluetooth® Low Energy IoT device use cases like home automation, sensors, lighting, Bluetooth® Mesh, and wireless input devices.



PSoC™ 63 MCU with AIROC™ Bluetooth® LE

is a dual core, highly optimized, flexible and ultra low power, machine learning ready microcontroller with Bluetooth® Low Energy for IoT applications.



The dual-mode Bluetooth® portfolio includes Bluetooth® SIG -compliant, devices and modules that integrate Bluetooth® standard profiles and protocols for embedded applications.

Product	CPU	Flash (KB)	RAM (KB)	GPIOs	Basic rate Max Tx Power	EDR 2Mbps Max Tx Power	EDR 2Mbps Rx Sensitivity	LE Max Tx Power	LE RX Sensitivity
AIROC™ CYW20706	48 MHz Arm® Cortex®-M3	External	352	24	12 dBm	9 dBm	-95.5 dBm	9 dBm	-96.5 dBm
AIROC™ CYW20719	96 MHz Arm® Cortex®-M4	1 MB	512	Up to 40	5 dBm	0 dBm	-94 dBm	5.5 dBm	-95.5 dBm
AIROC™ CYW20721	96 MHz Arm® Cortex®-M4	1 MB	512	Up to 40	5 dBm	0 dBm	-94 dBm	5.5 dBm	-95.5 dBm
AIROC™ CYW20819	96 MHz Arm® Cortex®-M4	256	176	22	5 dBm	0 dBm	-94.5 dBm	4.5 dBm	-95 dBm
AIROC™ CYW20820	96 MHz Arm® Cortex®-M4	256	176	22	11.5 dBm	2.5 dBm	-94 dBm	11.5 dBm	-94.5 dBm

AIROC™ CYW20820 Bluetooth® & Bluetooth® LE SoC

Bluetooth® and Bluetooth® LE connectivity that is 5.2 core spec compliant. An integrated Arm® Cortex®-M4 processor with a floating point, enables high performance compute capabilities.



AIROC™ CYW20819 Bluetooth® & Bluetooth® LE SoC

The CYW20819 is a Bluetooth® 5.2 core spec compliant device for IoT applications. The CYW20819 employs high levels of integration to minimize external components, reducing the device footprint and the costs associated with implementing Bluetooth® solutions.



AIROC™ Bluetooth® Modules

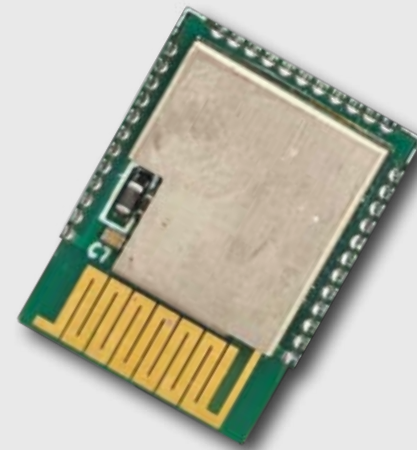
All of the AIROC™ Bluetooth® modules are fully integrated, globally certified, programmable modules designed to help you build your products faster and easier. Visit [MODULES](#) for a full list of modules for the AIROC™ Bluetooth® and Bluetooth® LE devices.

Product	Size (mm)	Base Chip	FLASH	RAM	GPIO	LE Range (meters, LoS)	Bluetooth core spec.	Bluetooth LE	Bluetooth Classic	Operating Temp.	Evaluation Kit
CYBT-343026-01	12 x 15.5 x 1.95	AIROC™ CYW20706	512KB SFLASH	352 KB	11	250	5	Yes	Yes	-30~85°C	CYBT-343026-EVAL
CYBT-413055-02	12.0 x 16.3 x 1.70	AIROC™ CYW20719	1 MB	512 KB	17	75	5	Yes	Yes	-30~85°C	CYBT-413055-EVAL
CYBT-483056-02	12.75 x 18.59 x 1.80	AIROC™ CYW20719	1 MB	512 KB	15	1 km	5	Yes	Yes	-30~85°C	CYBT-483056-EVAL
CYBT-483062-02	12.75 x 18.59 x 1.80	AIROC™ CYW20721	1 MB	512 KB	15	1 km	5	Yes	Yes	-30~85°C	N/A
CYBLE-343072-02	13.3 x 21.89 x 1.95	AIROC™ CYW20835	512KB SFLASH	352 KB	24	225	5.2	Yes	No	-30~85°C	CYBLE-343072-EVAL-M2B
CYBT-243053-02	12x16.61x1.7	AIROC™ CYW20820	256KB	176 KB	22	200	5	Yes	Yes	-30~85°C	CYBT-243053-EVAL
CYBT-213043-02	12.0 x 16.6 x 1.70	AIROC™ CYW20819	256 KB	176 KB	22	75	5	Yes	Yes	-30~85°C	CYBT-213043-EVAL

AIROC™ CYW20820 Bluetooth® LE Modules

These modules like the CYBT-243053-02 are highly integrated modules.

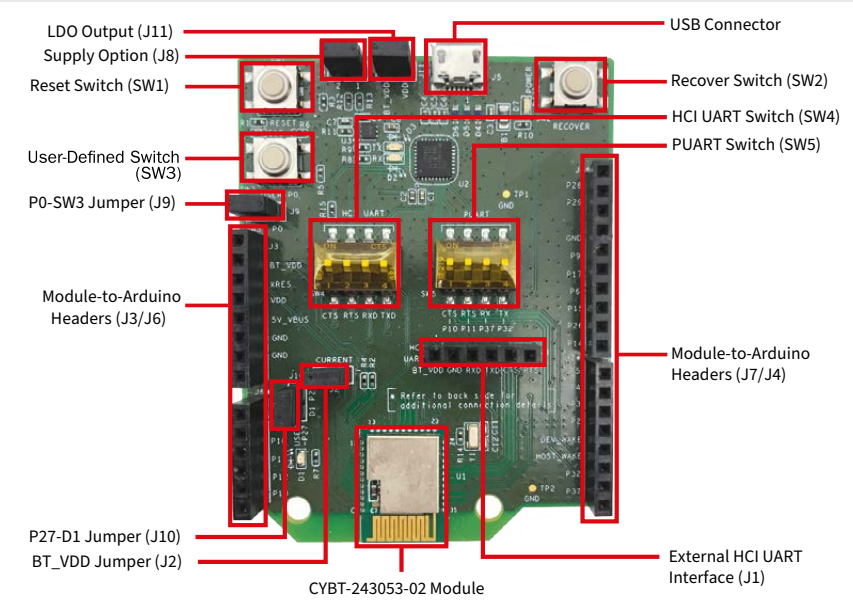
Globally certified to support fast time-to-market and supported by the AIROC™ Bluetooth® SDK in ModusToolbox™ software.

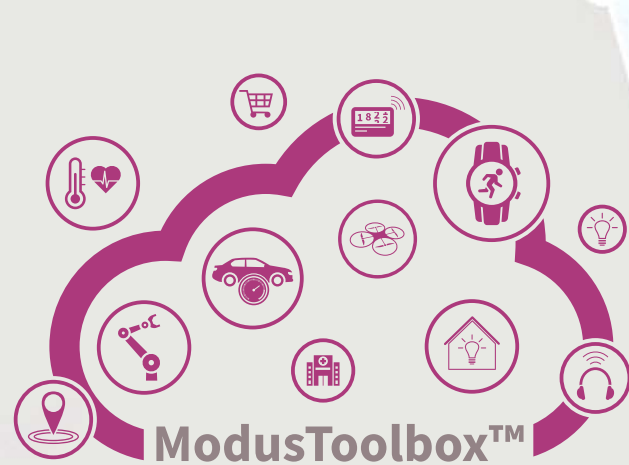


AIROC™ CYBT-243053-02 Module

AIROC™ CYW20820 Bluetooth® LE Module Evaluation Kit

The Infineon AIROC™ CYW20820 Bluetooth® LE Module Evaluation Kit (CYBT-243053-EVAL) enables you to evaluate and develop single-chip AIROC™ Bluetooth® applications using the CYBT-243053-02 module.





Bluetooth® SDK along with the ModusToolbox™ Software

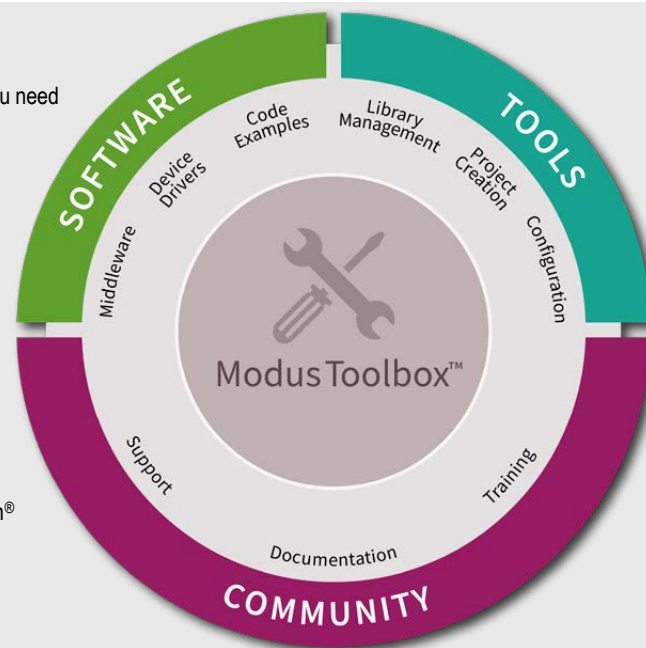


Building your product has never been easier or faster

The Bluetooth® SDK, embedded within ModusToolbox™, contains everything you need to build applications following dual-mode (BR + EDR + Bluetooth® LE).

The Bluetooth® SDK integrated within the ModusToolbox™ software and tools and Bluetooth® configurator tools form a powerful but easy-to-use toolset that helps you create amazing Bluetooth®-enabled IoT solutions such as beacons, trackers, smart watches, audio devices, HID device (remotes, mice, and keyboards) medical devices, and home automation platforms.

ModusToolbox™ was built to make the developers life easy. It is a collection of easy-to-use software and tools enabling rapid development of Infineon MCUs, covering applications from embedded sense and control to wireless and cloud-connected systems using AIROC™ Wi-Fi, AIROC™ Bluetooth® and AIROC™ Wi-Fi and combo devices.



Bluetooth® Mesh



NORDIC
SEMICONDUCTOR

Nordic Semiconductor's Software Development Kit for Bluetooth mesh solutions using nRF52 and nRF53 series

Bluetooth mesh is a mesh networking technology that extends the capabilities of Bluetooth Low Energy by enabling the creation of large-scale device networks. It is possible to have a powerful concurrent multicast (many-to-many) communication in networks with hundreds or thousands of nodes. This functionality is essential for applications in lighting, sensor networking, predictive maintenance, asset tracking and positioning. Bluetooth mesh messages are encapsulated in either Bluetooth LE advertisements or GATT packets, referred to as advertising bearer or GATT bearer (connections). Normal nodes typically use the advertising bearer but when a smartphone connects into the network it typically uses the GATT bearer. The smartphone connects to one node and that node relays the message into the network.

Complete Solution

Nordic offers a broad portfolio of SoCs (nRF53 and nRF52 Series) with different memory sizes and capabilities supporting Bluetooth mesh. Completing SoCs, Nordic has the development hardware, software and tools in its portfolio for easily building a product.

Products

- nRF5340
- nRF52840
- nRF52833
- nRF52832
- nRF52820

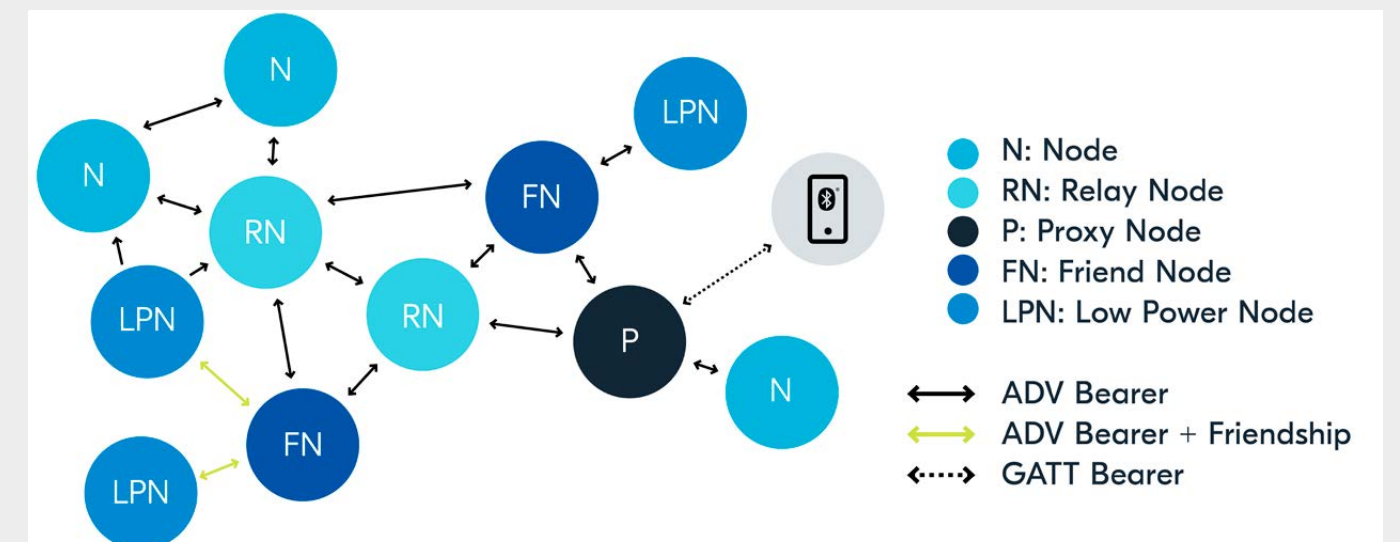
Development Software

the nRF Connect SDK is a complete software development kit for developing Bluetooth mesh applications, including the scalable Zephyr RTOS, Bluetooth mesh and Bluetooth LE stacks, a variety of samples, hardware drivers and much more.

Development Tools

Nordic provides tools for developing code, testing it, debugging, and much more. The nRF Mesh app enables to provision, configure and control Bluetooth mesh networks, to demonstrate a subset of the capabilities of the nRF Mesh open source libraries.

Bluetooth Mesh Network Topology to be created by the nRF Connect SDK for Mesh





Bluetooth® CHiPs – Selection Guide

Manuf- acturer	Name	Bluetooth specification	Software/Profile											BLE Max. Trans- mit Power TX (dBm)	BT EDR 2Mbps Max. Transmit Power (dBm)	Supply Voltage Range (V)	BT EDR 2 Mbps Sensiti- vity RX (dBm)	BLE Sensitivity RX (dBm)	MCU		Memory					Interfaces								Operating Temp. (°C)	Size (mm)	Package	Evaluation Kit / Development Kit	Balun	Crystal	
			SPP	HCI	HID	HSP	ATT	GAP	GATT	L2CAP	LL	SM	ANT						Gazell	NFC	Yes	No	Flash	RAM	ROM	SRAM	No	GPIO	PCM	SPI	UART	JTAG	ADC							I²C
Bluetooth Low Energy																																								
Nordic Semiconductor	nRF5340-QKAA	5.3	x	x		x	x	x	x	x	x	x	x		+3	1.7 - 5.5	-98	2 x Cortex M33		1 MB 256kB	512kB 64kB				48		x	x		x	x		x	-40 to +105°C	7 x 7	QFN94	nRF5340 DK, nRF5340 Audio DK, Thingy:53	On-chip balun	XTAL_2016 XTAL_2012	
	nRF5340-CLAA	5.3	x	x		x	x	x	x	x	x	x	x		+3	1.7 - 5.5	-98	2 x Cortex M33		1 MB 256kB	512kB 64kB				48		x	x		x	x		x	-40 to +105°C	4.4 x 4.0	WLCSP95	nRF5340 DK, nRF5340 Audio DK, Thingy:53	On-chip balun	XTAL_2016 XTAL_2012	
	nRF52840-QIAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+8	1.7 - 5.5	-95 to -103	Cortex M4F		1 MB	256 kB				48		x	x		x	x	x	x	-40 to +85°C	7 x 7	aQFN73	nRF52840 DK / nRF52840 Dongle	On-chip balun	XTAL_2016 XTAL_3215	
	nRF52840-QFAA	5.3	x	x		x	x	x		x	x	x	x	x	+8	1.7 - 5.5	-95 to -103	Cortex M4F		1 MB	256 kB				30		x	x		x	x		x	-40 to +85°C	6 x 6	QFN48	nRF52840 DK / nRF52840 Dongle	On-chip balun	XTAL_2016 XTAL_2012	
	nRF52840-CKAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+8	1.7 - 5.5	-95 to -103	Cortex M4F		1 MB	256 kB				48		x	x		x	x	x	x	-40 to +85°C	3.5 x 3.6	WLCSP94	nRF52840 DK / nRF52840 Dongle	On-chip balun	XTAL_2016 XTAL_2012	
	nRF52833-QIAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+8	1.7 - 5.5	-89 to -103	Cortex-M4		512 kB	128 kB				42		x	x		x	x		x	-40 to +105°C	7 x 7	aQFN73	nRF52833 DK	On-chip balun	XTAL_2016 XTAL_3215	
	nRF52833-QDAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+8	1.7 - 5.5	-89 to -103	Cortex-M4		512 kB	128 kB				18		x	x		x	x		x	-40 to +105°C	5 x 5	QFN40	nRF52833 DK	On-chip balun	XTAL_1612 XTAL_2012	
	nRF52833-CIAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+8	1.7 - 5.5	-89 to -103	Cortex-M4		512 kB	128 kB				42		x	x		x	x		x	-40 to +105°C	3.2 x 3.2	WLCSP95	nRF52833 DK	On-chip balun	XTAL_1612 XTAL_2012	
	nRF52832-QFAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 - 3.6	-89 to -96	Cortex-M4		512 kB	64 kB				32		x	x		x	x	x		-40 to +85°C	6 x 6	aQFN48	nRF52 DK / Nordic Thingy:52	On-chip balun	XTAL_2016 XTAL_3215	
	nRF52832-QFAB	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 -3.6	-89 to -96	Cortex-M4		256 kB	32 kB				32		x	x		x	x	x		-40 to +85°C	6 x 6	aQFN48	nRF52 DK / Nordic Thingy:52	On-chip balun	XTAL_2016 XTAL_3215	
	nRF52832-CIAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 -3.6	-89 to -96	Cortex-M4		512 kB	64 kB				32		x	x		x	x	x		-40 to +85°C	3.0 x 3.2	WLCSP50	nRF52 DK / Nordic Thingy:52	On-chip balun	XTAL_2016 XTAL_2012	
	nRF52820-QDAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+8	1.7 - 5.5	-89 to -103	Cortex-M4		256 kB	32 kB				18		x	x				x		-40 to +105°C	5 x 5	QFN40	nRF52833 DK	On-chip balun	XTAL_1612 XTAL_2012	
	nRF52820-CFAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+8	1.7 - 5.5	-89 to -103	Cortex-M4		256 kB	32 kB				18		x	x				x		-40 to +105°C	2.5 x 2.5	WLCSP	nRF52833 DK	On-chip balun	XTAL_1612 XTAL_1610	
	nRF52811-QFAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 - 3.6	-94 to -104	Cortex M4		192 kB	24 kB				32		x	x		x		x		-40 to +85°C	6 x 6	QFN48	nRF52840 DK	On-chip balun	XTAL_2016 XTAL_3215	
	nRF52811-QCAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 - 3.6	-94 to -104	Cortex M4		192 kB	24 kB				17		x	x		x		x		-40 to +85°C	5 x 5	QFN32	nRF52840 DK	On-chip balun	XTAL_2016 XTAL_3215	
	nRF52811-CAAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 - 3.6	-94 to -104	Cortex M4		192 kB	24 kB				15		x	x		x		x		-40 to +85°C	2.48 x 2.46	WLCSP	nRF52840 DK	On-chip balun	XTAL_2016 XTAL_2012	
	nRF52810-QFAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 -3.6	-96	Cortex M4		192 kB	24 kB				32		x	x		x		x		-40 to +85°C	6 x 6	QFN48	nRF52 DK	On-chip balun	XTAL_2016 XTAL_3215	
	nRF52810-QCAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 -3.6	-96	Cortex M4		192 kB	24 kB				16		x	x		x		x		-40 to +85°C	5 x 5	QFN32	nRF52 DK	On-chip balun	XTAL_2016 XTAL_3215	
	nRF52810-CAAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 -3.6	-96	Cortex M4		192 kB	24 kB				15		x	x		x		x		-40 to +85°C	2.48 x 2.46	WLCSP33	nRF52 DK	On-chip balun	XTAL_2016 XTAL_2012	
	nRF52805-CAAA	5.3	x	x		x	x	x	x	x	x	x	x	x	+4	1.7 -3.6	-97	Cortex-M4		192 kB	24 kB				10		x	x						-40 to +85°C	2.48 x 2.46	WLCSP28	nRF52 DK	On-chip balun	XTAL_2016 XTAL_2012	
Infineon	AIROC™ CYW20706	5.2	x	x	x	x	x	x	x	x	x			+9	+9	1.62 - 3.6 (VBAT) 2.25 - 2.94 (VDDPA)	-95.5	-96.5	Arm® Cortex®-M3		352 kB	848 kB			24	x	x	x	x	x	x	x		-30°C - +85°C	4.5 x 4.0	49-pin FBGA	AIROC™ CYW920706WCDEVAL	On-chip balun		
	AIROC™ CYW20719	5.1	x	x	x		x	x	x	x	x		x	+5.5	0	1.76 - 3.63	-94	-95.5	Arm® Cortex®-M4		1 MB	512 kB	2 MB			40	x	x	x	x	x	x	x		-30°C - +85°C	5 x 5 (QFN) 3.2 x 3.1 (WLCSP)	40-QFN WLCSP	AIROC™ CYW920719B2Q40EVB-01	On-chip balun	
	AIROC™ CYW20721	5.1	x	x	x	x	x	x	x	x	x		x	+5.5	0	1.76 - 3.63	-94	-95.5	Arm® Cortex®-M4		1 MB	512 kB	2 MB			40	x	x	x	x	x	x	x		-30°C - +85°C	5 x 5 (QFN) 3.2 x 3.1 (WLCSP)	40-QFN WLCSP	AIROC™ CYW920721M2EVK-01 AIROC™ CYW920721M2EVK-02 AIROC™ CYW920721M2EVB-03	On-chip balun	
	AIROC™ CYW20736	5.2		x			x	x	x	x	x			+4	N/A	1.62 - 3.63	N/A	-93	Arm® Cortex®-M3			60 kB	320 kB			14		x	x	x	x	x	x		-30°C - +85°C	5 x 5	32-QFN	AIROC™ CYW920736M2EVB-01	On-chip balun	
	AIROC™ CYW20819	5.2	x	x	x		x	x	x	x	x			+4.5	0	1.71 - 3.3	-95	-95	Arm® Cortex®-M4		256 kB	176 kB	1 MB			22	x	x	x	x	x	x	x		-30°C - +85°C	4.5 x 4.5	62-pin FPBGA	AIROC™ CYW920819M2EVB-01	On-chip balun	
	AIROC™ CYW20835	5.2		x	x		x	x	x	x	x			+12	N/A	1.625 - 3.63	N/A	-94.5	Arm® Cortex®-M4			384 kB	2 MB			24	x	x	x	x	x	x	x		-30°C - +85°C	7 x 7	QFN (60-pin)	AIROC™ CYW920835M2EVB-01	On-chip balun	
	AIROC™ CYW20820	5.2	x	x	x		x	x	x	x	x			+11.5	2.5	1.71 - 3.3 2.375 - 2.625 (PAVDD)	-94	-94.5	Arm® Cortex®-M4		256 kB	176 kB	1 MB			22	x	x	x	x	x	x	x		-30°C - +85°C	4.5 x 4.5	62-pin FPBGA	AIROC™ CYW920820M2EVB-01	On-chip balun	

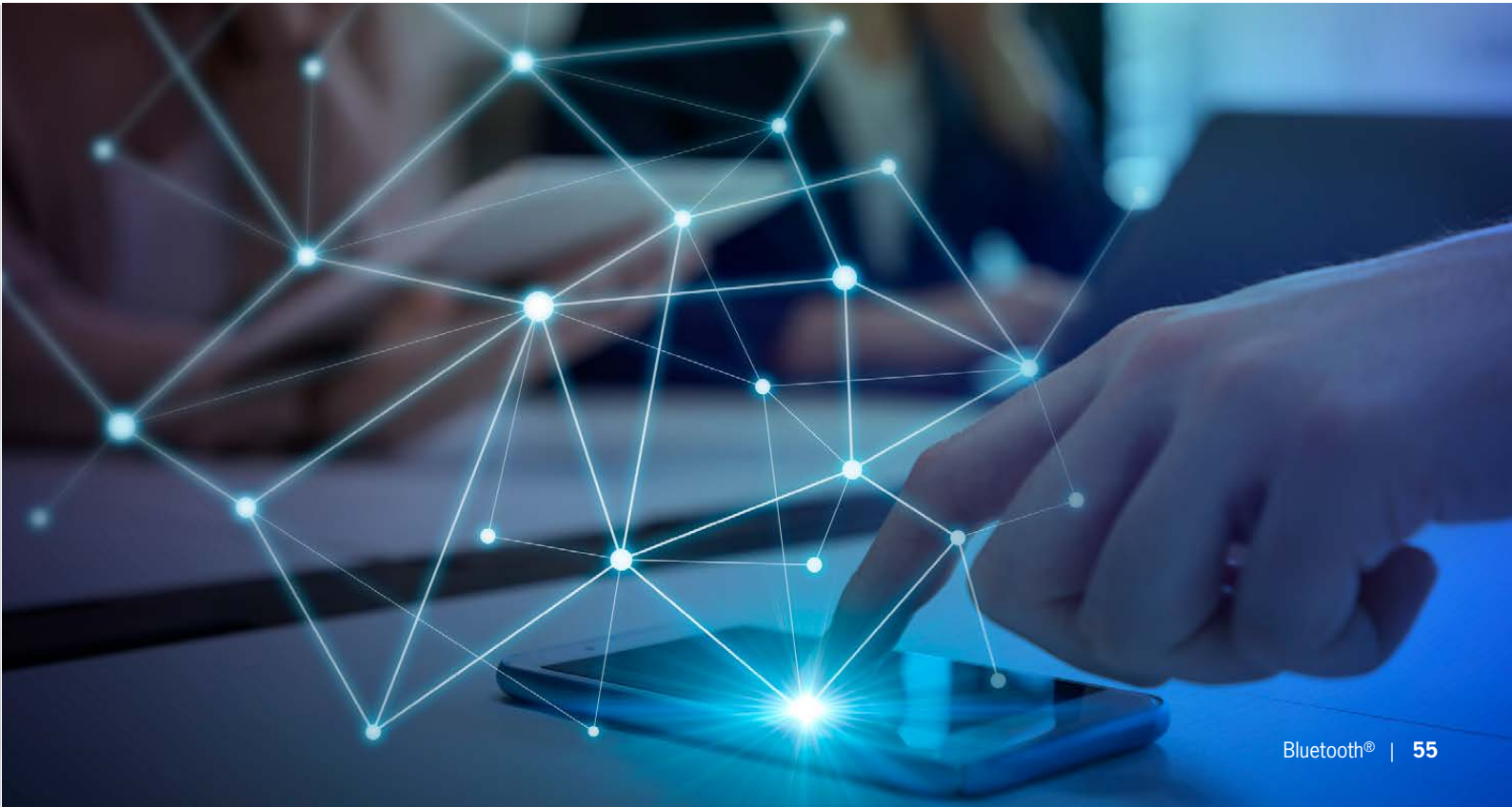
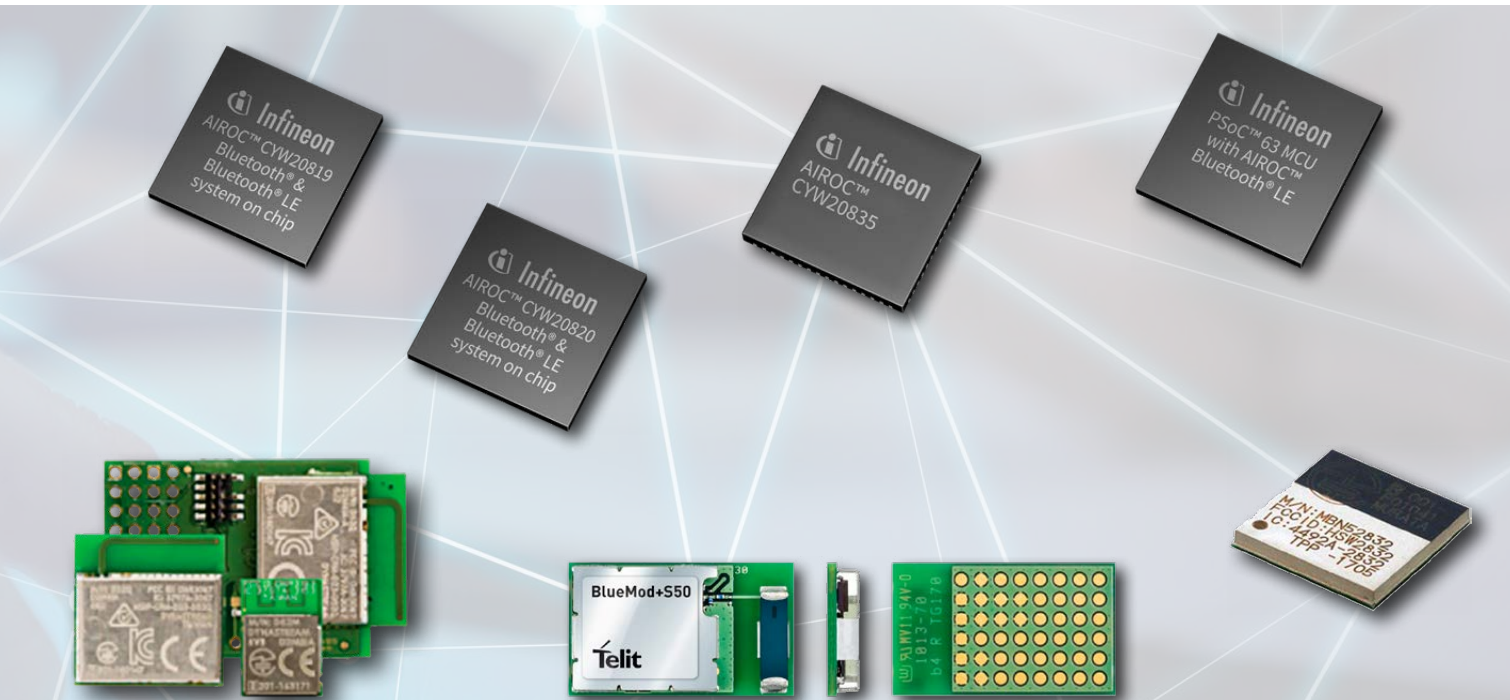
*continuously updated | **CSA2, Long Reach, Codec phy, High Speed up to 2 Mbps, enhanced broadcasting

Bluetooth® Modules – Selection Guide

Manufacturer	Name	Bluetooth specification	Bluetooth class	Stack/Profile																		Max.Trans-mit Power TX (dBm)	Supply Voltage Range (V)	Input Sensitivity RX (dBm)	Used Ics	Interfaces										Antenna		Operating Temp. (°C)	Size (mm)	Package	Evaluation Kit / Development Kit				
				SPP	HCI	HDP	ATT	GAP	GATT	L2CAP	HID	HSP	HFP	DUN	RFCOMM	SDP	A2DP	AVRCP	IAP	SDAP	SMP					LL	SM	Gazell	TI	Other	GPIO	PCM	SPI	UART	JTAG	ADC	I²C					USB	RS-232	other	Intergrated Antenna
Bluetooth Classic																																													
Panasonic	PAN13x5B	2.1	1	x																						+10	1.8 - 4.8	-93	CC2560B	x	x		x						Chip	x	-40 to 85	9.0 x 6.5 x 1.8 (w/o antenna) 9.0 x 9.5 x 1.8 (w/ antenna)	SMD		
Bluetooth Low Energy																																													
Garmin	N550M8/M4CC	4.1	2				x	x																	ANT	+4	1.8 - 3.6	-93	nrf51422 16KB RAM	x		x	x			x			PCB		-25 to 75	14.0 x 9.8 x 2.0 (M8)	LGA	N5DK1	
	N5150M8/M4/M5CD	4.1	2				x	x																	ANT	+4	1.8 - 3.6	-93	nrf51422 32KB RAM	x		x	x			x			PCB		-25 to 75	14.0 x 9.8 x 2.0 (M8)	LGA	N5DK1	
	D52QD2M4IA D52QPMM4IA D52QGM4IA	4.2	2				x	x	x	x											x				ANT ANT BLAZE G.FIT	+4	1.7 - 3.6	-96 (BLE) -93 (ANT)	nRF52832 64kB RAM	x		x	x			x			x		-40 to 85	20 x 20	LGA	D52QSKM6IA-A	
	D52QD2M4IA-A D52QPMM4IA-A D52QGM4IA-A	4.2	2				x	x	x	x											x				ANT ANT BLAZE G.FIT	+4	1.71 - 3.6	-96 (BLE) -93 (ANT)	nRF52832 64kB RAM	x		x	x			x			x		-40 to 85	20 x 20	LGA	D52QSKM6IA-A	
	D52MD2M8IA D52MPMM8IA D52MGFM8IA	4.2	2				x	x	x	x											x				ANT ANT BLAZE G.FIT	+4	1.7 - 3.6	-96 (BLE) -93 (ANT)	nRF52832 64kB RAM	x		x	x			x			x		-40 to 85	14.0 x 9.8 x 2.0	LGA	D52QSKM6IA-A	
EnOcean	STM 550B																								Energy harvesting Sensor	+4	Energy Harvesting										PCB		-25 to 65	40.0x40.0x13mm	Switch module				
	PTM 215B	4.2	2																						Energy harvesting light switch	+0.4	Energy Harvesting										PCB		-25 to 65	40.0x40.0x11.2mm	Switch module				
	PTM 215ZE																								ZigBee	+7	Energy Harvesting										PCB		-25 to 65	40.0x40.0x11.2mm	Switch module				
Fujitsu	FWM7BLZ20	4.2	2				x	x	x	x										x	x				FDC	+4	1.7 - 3.6	-96	nRF52832 QFN					x			NFC-A	PCB		40 to 85	15.7 x 9.8 x 1.7	SMD	FWM7BLZ20-EVB2-EF2		
	FWM7BLZ20-109049	4.2	2				x	x	x	x										x	x				BLANK: s132_ nrf52_3.0.0_softdevice	+4	1.7 - 3.6	-96	nRF52832 QFN	x (30)		x	x		x	x		NFC-A	PCB		40 to 85	15.7 x 9.8 x 1.7	SMD	FWM7BLZ20-EVB2-EB2	
	FWM7BLZ20-109062	4.2	2				x	x	x	x										x	x				BLANK: s132_ nrf52_3.1.0_softdevice	+4	1.7 - 3.6	-96	nRF52832 QFN	x (30)		x	x		x	x		NFC-A	PCB		40 to 85	15.7 x 9.8 x 1.7	SMD	FWM7BLZ20-EVB2-EB2	
	FWM7BLZ20B	5.0	2				x	x	x	x										x	x				FDC	+4	1.7 - 3.6	-96	nRF52832 QFN	x (30)		x	x		x	x		NFC-A	PCB		40 to 85	15.7 x 9.8 x 1.7	SMD	FWM7BLZ20-EVB2-EB2	
	FWM7BLZ20B-109077	5.0	2				x	x	x	x										x	x				BLANK: s132_ nrf52_6.1.1_softdevice	+4	1.7 - 3.6	-96	nRF52832 QFN	x (30)		x	x		x	x		NFC-A	PCB		40 to 85	15.7 x 9.8 x 1.7	SMD	FWM7BLZ20-EVB2-EB2	
	FWM7BLZ22 (As of now, this is not a Blue-tooth qualified product yet.)*	-																									+8	1.7 - 3.6	-96	nRF52833	x (20)			x		x				x		40 to 85	7.5 x 7.9 x 1.7	SMD	TBA
InsightSIP	ISP1507-AX	5.0	2				x	x	x	x										x	x	x					+4	1.7 - 3.6	-96	nRF52832	x	x	x	x		x	x		NFC-A	x		-40 to 85	8 x 8 x 1	LGA	ISP1507-AX-EB ISP1507-AX-TB
	ISP1807-LR	5.3	1				x	x	x	x										x	x	x					+8	1.7 - 5.5	-103	nRF52840	x	x	x	x		x	x	x	NFC-A	x		-40 to 85	8 x 8 x 1	LGA	ISP1807-LR-EB
	ISP1907-LL	5.3	2				x	x	x	x										x	x	x					+4	1.7 - 3.6	-94 / -104	nRF52811	x	x	x	x		x	x		PDM	x		-40 to 85	8 x 8 x 1	LGA	"ISP1907-LL-EB ISP1907-LL-TB"
	ISP1907-HT	5.3	1				x	x	x	x										x	x	x					+8	1.7 - 3.6	-94 / -104	nRF52833	x		x	x		x	x	x	PDM	x		-40 to 105	8 x 8 x 1	LGA	"ISP1907-HT-EB ISP1907-HT-TB"
	ISP2053-AX	5.3	2				x	x	x	x										x	x	x					+3	1.7 - 5.5	-98 / -104	nRF5340	x		x	x			x		QSPI, I²S, PDM, PWM	x		-40 to 105	8 x 8 x 1	LGA	ISP2053-AX-EB
Panasonic	PAN1740	4.0	2						x																		+0	2.35 - 3.3	-93	DA14580	x		x	x		x	x			Chip		40 to 85	9.0 x 9.5 x 1.8	SMD	PAN1740-EMK, PAN1740-KIT
	PAN1740A	5.0	2																																										
	PAN1780(AT) PAN1770	5.1	2																								+8	1.7 - 5.5	-95	nRF52840	x		x	x		x	x	x	PWM, QDEC, NFC, COMP	x	x	40 to 85	15.6 x 8.7 x 2	SMD	ENW89854AUKF (PAN1780) ENW89854AVKF (PAN1780AT) ENW89854CXKF / ENW89854CZKF
	PAN1781	5.1	2																								+8	1.7 - 5.5	-95	nRF52820	x		x	x			x	x	QDEC	x		40 + 85	15.6 x 8.7 x 2	SMD	ENW89857AXKF
	PAN1782	5.1	2																								+8	1.7 - 5.5	-95	nRF52833	x		x	x		x	x	x	PWM, QDEC, NFC, COMP	x		40 to 85	15.6 x 8.7 x 2	SMD	ENW89858AXKF
	PAN1783	5.x	2																								+3	1.7 - 5.5	-98	nRF5340	x		x	x		x	x	x	PWM, QDEC, NFC	x	x	40 to 85	15.6 x 8.7 x 2	SMD	tbd
	PAN4620	4.2	2																					IEEE802.15.4	+3	1.8 - 4.2	-98	NXP® Kinetis® KW41Z	x		x	x		x	x		TSI, DAC	Chip		40 + 85	15.6 x 8.7 x 1.9	SMD			
Murata	WSM-BL241-ADA-008	5.0	2				x	x	x													x		LL, SM	+4	1.7 - 3.6	-93	nRF52832	x		x	x		x	x			PCB		-40 to 85	7.4 x 7.0 x 0.9	LGA	WSM-BL241-ADA-008DK		
TDK	SESUB-PAN-T2541	4.0	2																					TI	+0	-0.3 - 3.9	-70	TI CC2541	x				x	x					x	-20 to 70	4.6 x 5.6 x 1.0	SESUB LGA	SESUB-PAN-T2541EVK		
	SESUB-PAN-D14580	4.1	2					x																			+0	-0.1 - 3.6	-94	DA14580	x		x	x		x	x				x	-20 to 70	3.5 x 3.5 x 1.0	SESUB BGA	SESUB-PAN-D14580EVK
Teitit	BlueMod+S	4.1	2					x																	Terminal I/O GATT central role Automation I/O	+4	1.8 - 3.6		nRF51822	x		x	x		x	x			x		20 + 75	17 x 10 x 2.6	LGA, 49 pins	BueEva+S, BlueDev+S	
	BlueMod+S42	4.2	2					x																	Terminal I/O LUA	+5	1.7 - 3.6	-93	nRF52832	x		x	x		x	x			x		40 + 85	17 x 10 x 2.6	LGA, 49 pins	BlueEva+S42, BlueDev+S42	
	BlueMod+S42M	4.2	2					x																	Terminal I/O	+0	1.7 - 3.6	-94		x		x	x		x	x			x		0 + 70	17 x 10 x 2.6	LGA, 49 pins		

Bluetooth® Modules – Selection Guide

Manufacturer	Name	Bluetooth specification	Bluetooth class	Stack/Profile																		Max. Trans- mit Power TX (dBm)	Supply Voltage Range (V)	Input Sensitivity RX (dBm)	Used Ics	Interfaces								Antenna		Operating Temp. (°C)	Size (mm)	Package	Evaluation Kit / Development Kit				
				SPP	HCI	HDP	ATT	GAP	GATT	L2CAP	HID	HSP	HFP	DUN	RFCOMM	SDP	A2DP	AVRCP	IAP	SDAP	SMP					LL	SM	Gazell	T1	Other	GPIO	PCM	SPI	UART	JTAG					ADC	I²C	USB	RS-232
... Bluetooth Low Energy																																											
Infineon	CYBLE-333074-02	5.2	1	x		x	x	x	x	x				x				x	x	x					+12	2.5 - 3.6	-94.5	AIROC™ CYW20835	x	x	x	x	x	x	x			x		-30 to 85	13.3 x 21.89 x 1.95	43-pad SMT	CYBLE-333074-EVAL-M2B
	CYBLE-343072-02	5.2	1	x		x	x	x	x	x	x			x				x	x	x					+12	2.5 - 3.6	-94.5	AIROC™ CYW20835	x	x	x	x	x	x	x			x		-30 to 85	13.3. x 21.89 x 1.95	43-pad SMT	CYBLE-343072-EVAL-M2B
	CYBLE-416045-02	5.0	2	x		x	x	x	x	x								x	x	x					+4	1.71 - 3.6	-20	PSoC™ 63-BLE	x	x	x	x	x	x	x	x		x		-40 to 85	14 x 18.5 x 2.0	43-pad SMT	CYBLE-416045-EVAL
	CYBLE-012011-00	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4 w/ BLE	x		x	x		x	x			x		-40 to 85	14 x 19 x 2.0	31-pad SMT	CYBLE-012011-EVAL
	CYBLE-212020-01	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4-BLE	x		x	x		x	x			x		-40 to 85	14 x 19 x 2.0	31-pad SMT	CYBLE-212020-EVAL
	CYBLE-022001-00	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4-BLE	x		x	x		x	x			x		-40 to 85	10 x 10 x 1.8	21-pad SMT	CYBLE-022001-EVAL
	CYBLE-222014-01	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4-BLE	x		x	x		x	x			x		-40 to 85	10 x 10 x 1.8	22-pad SMT	CYBLE-222014-EVAL
	CYBLE-014008-00	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4-BLE	x		x	x			x			x		-40 to 85	11 x 11 x 1.8	32-pad SMT	CYBLE-014008-EVAL
	CYBLE-214015-01	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4-BLE	x		x	x		x	x			x		-40 to 85	11 x 11 x 1.8	32-pad SMT	CYBLE-214015-EVAL
	CYBLE212006-01	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4-BLE	x		x	x		x	x			x		-40 to 85	15 x 23 x 2.0	30-pad SMT	CYBLE-212006-EVAL
	CYBLE-202007-01	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4-BLE	x		x	x		x	x				x	-40 to 85	15 x 23 x 2.0	30-pad SMT	CYBLE-202007-EVAL
	CYBLE-202013-11	5.1	2	x		x	x	x	x	x				x				x	x	x					+3	1.71 - 5.5	-87	PSoC™ 4-BLE	x		x	x		x	x				x	-40 to 85	15 x 23 x 2.0	30-pad SMT	CYBLE-202013-EVAL
CYBLE-224110-01	5.1	1	x		x	x	x	x	x				x				x	x	x					+9.5	2 - 3.6	-95	PSoC™ 4-BLE	x		x	x		x	x			x		-40 to 105	9.5 x 15 x 1.8	32-pad SMT	CYBLE-224116-EVAL	
Bluetooth Dual Mode																																											
Panasonic	PAN1316B PAN1326B	4.1/2.1	1	x					x																+10	1.8 - 4.8	-93	CC2564B	x	x		x			x			Chip	x	-40 to 85	9.0 x 6.5 x 1.8 9.0 x 9.5 x 1.8	SMD	PAN1326B-DB / ENW89819AZKF
	PAN1316C PAN1326C	4.2	1	x																					+11.5	1.7 - 4.8	-93	CC2564C	x	x		x			x			Chip	x	-40 to 85	9.0 x 6.5 x 1.8 9.0 x 9.5 x 1.8	SMD	PAN1326C EVALKIT / ENW89819AYKF
Telit	BlueMod+SR	4.0	1	x					x		x														+8	2.5 - 3.6			x		x	x		x	x			x	x	-30 to 85	17 x 10 x 2.6	SMD	BlueEva+SR
	BL871	4.2	1	x					x																+12	2.2 - 4.8	-95		x	x						Chip		-40 to 85	9.7 x 10.1 x 2.5	SMD / LCC	BL871E2-HI Evaluation Kit		
Fujitsu	FWM7BTZ61	5,2		x			x	x	x	x				x	x			x		x	x	x			+4	1.71 - 3.3	-93		x (10)			x			x	Chip		-30 to 85	17.6 x 10.6 x 1.9	SMD			
Infineon	CYBT-213043-02	5.0	2	x	x		x	x	x	x				x	x			x		x	x	x			+4	1.71 - 3.3	-95	AIROC™ CYW20819	x	x	x	x	x	x	x			x		-30 to 85	12.0 x 16.6 x 1.7	35-pad SMT	CYBT-213043-EVAL
	CYBT-243043-01	5.0	1	x	x		x	x	x	x				x	x			x		x	x	x			+10.5	2.6 - 3.3	-94.5	AIROC™ CYW20820	x	x	x	x	x	x	x			x		-30 to 85	12.0 x 16.6 x 1.7	35-pad SMT	CYBT-243043-EVAL
	CYBT-343026-01	5.0	1	x	x		x	x	x	x	x		x		x	x	x	x	x		x	x	x		+9	2.3 - 3.6	-96.5	AIROC™ CYW20706	x	x	x	x	x	x	x			x		-30 to 85	12.0 x 15.5 x 1.95	24-pad SMT	CYBT-343026-EVAL
	CYBT-333032-02	5.0	1	x	x		x	x	x	x	x			x	x	x	x	x	x		x	x	x		+9	2.3 - 3.6	-96.5	AIROC™ CYW20706	x	x	x	x	x	x	x				x	-30 to 85	12.0 x 13.5 x 1.95	24-pad SMT	CYBT-333047-EVAL
	CYBT-333047-02	5.0	1	x	x		x	x	x	x	x		x		x	x	x	x	x		x	x	x		+9	2.3 - 3.6	-96.5	AIROC™ CYW20706	x	x	x	x	x	x	x				x	-30 to 85	12.0 x 13.5 x 1.95	24-pad SMT	CYBT-333047-EVAL
	CYBT-353027-02	5.0	1	x	x		x	x	x	x	x		x		x	x	x	x	x		x	x	x		+9	2.3 - 3.6	-96.5	AIROC™ CYW20707	x	x	x	x	x	x	x			x		-30 to 85	9.0 x 9.0 x 1.75	19-pad SMT	CYBT-353027-EVAL
	CYBT-423055-02	5.0	1	x	x		x	x	x	x	x		x		x	x		x	x	x					+4	1.76 - 3.63	-95.0	AIROC™ CYW20719	x	x	x	x	x	x	x			x		-30 to 85	12.0 x 16.3 x 1.70	30-pad SMT	CYBT-413055-EVAL
	CYBT-423054-02	5.0	1	x	x		x	x	x	x	x		x		x	x		x	x	x					+4	1.76 - 3.63	-95.5	AIROC™ CYW20719	x	x	x	x	x	x	x			x		-30 to 85	11.0 x 11.0 x 1.70	28-pad SMT	CYBT-423054-EVAL
	CYBT-483056-02	5.0	1	x	x		x	x	x	x	x		x		x	x		x	x	x					+20	1.76 - 3.63	-95.0	AIROC™ CYW20719	x	x	x	x	x	x	x			x		-30 to 85	12.75 x 18.59 x 1.8	34-pad SMT	CYBT-483056-EVAL
	CYBT-413061-02	5.0	1	x	x		x	x	x	x	x		x		x	x		x	x	x					+4	1.76 - 3.63	-95.0	AIROC™ CYW20721	x	x	x	x	x	x	x			x		-30 to 85	12.0 x 16.3 x 1.70	30-pad SMT	N/A
	CYBT-423060-02	5.0	1	x	x		x	x	x	x	x		x		x	x		x	x	x					+4	1.76 - 3.63	-95.0	AIROC™ CYW20721	x	x	x	x	x	x	x			x		-30 to 85	11.0 x 11.0 x 1.70	28-pad SMT	N/A
	CYBT-483062-02	5.0	1	x	x		x	x	x	x	x		x		x	x		x	x	x					+20	1.76 - 3.63	-95.0	AIROC™ CYW20721	x	x	x	x	x	x	x			x		-30 to 85	12.75 x 18.59 x 1.8	34-pad SMT	N/A





What is ISM?

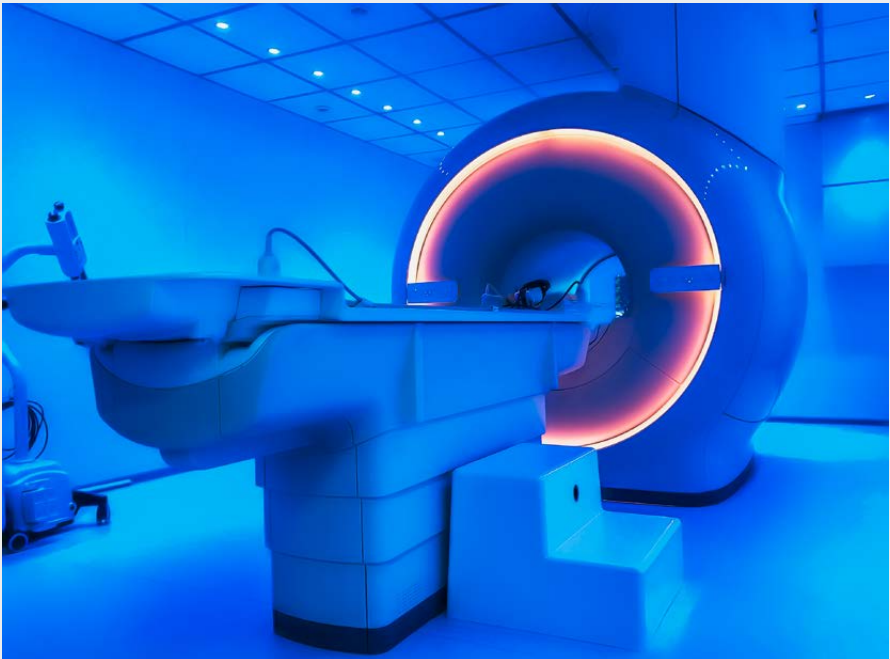
The industrial, scientific and medical (ISM) radio bands are radio bands that are internationally reserved for the use of radio frequency (RF) energy for industrial, scientific and medical purposes. ISM covers frequency bands from 125 kHz to 50 GHz.

That means that not only the worldwide operating 2.4 GHz band is supported by ISM, but also the European (169 MHz, 433 MHz, 868 MHz) as well as the US-American (315 MHz, 915 MHz) SubGHz bands. Consequently, ISM covers those frequency bands which cover short range radio technology applications.

SubGHz ISM radio frequency solutions as well as 2.4 GHz ISM radio frequency solutions are presented in this chapter. Still, ISM has to be differentiated from other wireless technologies which use the same frequency bands.

At Rutronik, the classification group ISM covers all solutions which do not belong to WiFi, Bluetooth, ZigBee, RFID, GSM or GPS.

These technologies are presented in the previous or the now following chapters.



Wireless Control Receiver ICs



The Wireless Control Receiver series from Infineon is made up by a group of very low power consumption single chip ASK and ASK/FSK Superheterodyne Receivers (SHR) for the sub 1 GHz frequency bands. The ICs offer a high level of integration and need only a few external components.

TDA5240, TDA5235 & TDA5225 – High sensitivity, low-power receiver family SmartLEWIS RX+

Features:

- Multi-band (300-320, 425-450, 863-870, 902-928 MHz) for worldwide operation coverage
- 10.5 Hz high resolution Sigma-Delta Fractional-N PLL
- One crystal frequency for all supported frequency bands
- Integrated IF-filter but also optional external CER filter possible
- Low supply current: 0,8 µA in Power down, 12 mA for Run mode
- Datarate up to 112 kchip/s
- ESD protection +/-2kV on all pins
- Digital RSSI peak detectors
- On-chip temperature sensor
- Voltage supply range 3.3 / 5.0 V
- Temperature range -40 to +105 °C
- Automotive Qualified
- Higher sensitivity due to improved noise figure and reducible noise bandwidth
- Programmable on-chip channel bandpass filter
- Improved channel selectivity due to dual conversion architecture
- Improved blocking performance against co-channel interference
- Full finest resolution sigma-delta PLL
- Both 3.3V and 5V-compatible I/O interface to microcontroller
- Configurable AGC and AFC for improved dynamic range and handling of freq.offsets

Additional Features for TDA5240 & TDA5235

- Highest sensitivity receiver:
Typ. -118 dBm for FSK, Typ. -116 dBm for ASK
- Autonomous receive mode leads to reduced noise of host processor, improved sensitivity and reduced power consumption of the system
- Up to 4 (TDA5240) / 2 (TDA5235) parallel parameter sets and up to 12 different frequency channels (TDA5240 only)
- Several embedded encodings and modulation schemes
- Support for additional encodings biphas and NRZ
- Ultrafast Fallback Wake-up criterion reduces receiver's active time (and average current consumption), when no data available
- More configuration options for autonomous polling schemes

Applications

- Remote keyless entry systems
- Remote start applications
- Tire pressure monitoring
- Remote control units
- Cordless alarm systems
- Remote metering

SubGHz Chips Selection Guide

Manufacturer	Name	Mode			Modulation Scheme								Max. Transmit Power TX (dBm)	Supply Voltage Range (V)	Frequency Range (Hz)						Temperature Range (°C)	Max. Input Sensitivity RX (dBm)	Multi-Channel		MCU		Memory				Interface								Package (Size in mm)	Evaluation Kit/ Development Kit
		TRX	RX	TX	ASK	2-/FSK	GFSK	MSK	GMSK	OOK	BPSK	O-QPSK			CSS	169M	315M	345M	433M	868M			915M	960M	Yes	No	Yes	No	Flash	RAM	EEPROM	No	GPIO	GPO	UART	SPI	JTAG	I²C		
Receiver																																								
Infineon	TDA5240		x		x	x								3.0-3.6 / 4.5-5.5	x	x	x	x	x	x		-40 to 105	FSK: 102 / ASK: 116	x			x					x						TSSOP-28	Evaluation Board TDA5240 434MHz Evaluation Board TDA5240 868MHz	
	TDA5225		x		x	x								3.0-3.6 / 4.5-5.5	x	x	x	x	x	x		-40 to 105	FSK: 118/ ASK: 116	x			x					x						TSSOP-28	Evaluation Board TDA5225 868MHz	
	TDA5240		x		x	x								3.0-3.6 / 4.5-5.5	x	x	x	x	x	x		-40 to 105	FSK: 102 / ASK: 116	x			x					x						TSSOP-28	Evaluation Board TDA5235 315MHz Evaluation Board TDA5235 434MHz Evaluation Board TDA5235 868MHz Evaluation Board TDA5235 915MHz	

SubGHz Modules Selection Guide

Manufacturer	Name	Mode			Modulation Scheme							Max. Transmit Power TX (dBm)	Supply Voltage Range (V)	Frequency Range (Hz)								Temperature Range (°C)	Input Sensitivity RX (dBm)	Multi-Channel		MCU		Memory				Interfaces										Package (Size in mm)	Evaluation Kit / Development Kit				
		TRX	RX	TX	ASK	(2-/FSK)	GFSK	MSK	GMSK	OOK	BPSK			O-QPSK	CSS	169M	315M	345M	433M	868M	902M			928M	915M	960M	Yes	No	Yes	No	Flash	RAM	EEPROM	No	GPIO	GPO	UART	SPI	JTAG	I²C	ADC			DAC	PWM	USB	CAN
EnOcean	TCM 300	X			X								+3	2.6 to 4.5					X					-25 to 85	-96		X	X		32kB	2kB			X		X	X		X	X	X				22 x 19 x 3	EDK 350	
	TCM 300U	X				X							+1	2.6 to 4.5						X				-25 to 85	-98		X	X		32kB	2kB			X		X	X		X	X	X				22 x 19 x 3	EDK 350U	
	TCM 310	X			X								+3	2.6 to 4.5					X					-25 to 85	-96		X		X					X										22 x 19 x 3	EDK 350		
	TCM 310U	X				X							+1	2.6 to 4.5						X				-25 to 85	-98		X		X					X										22 x 19 x 3	EDK 350U		
	TCM 320	X			X								+3	2.6 to 3.3					X					-25 to 85	-96		X	X		32kB	2kB			X		X	X		X	X	X				36.5 x 18 x 5.5	EDK 350	
	TCM 320U	X				X							+1	2.6 to 3.3						X				-25 to 85	-98		X	X		32kB	2kB			X		X	X		X	X	X				36.5 x 18 x 5.5	EDK 350U	
	TCM 330	X			X								+5	3.0 to 3.3					X					-25 to 85	-96		X	X		32kB	2kB			X		X	X		X	X	X				22 x 19 x 3		
	TCM 330U	X				X							+1	3.0 to 3.3						X				-25 to 85	-98		X	X		32kB	2kB			X		X	X		X	X	X				22 x 19 x 3		
	TCM 410J	X				X							+0	2.6 to 5.0								X		-25 to 85	-95		X	X		64kB	4kB	8kB		X		X	X		X	X	X				22 x 19 x 3		
	TCM 515	X			X								+10	2.0 to 3.6					X					-40 to 85	-92		X		X					X											19 x 14.7 x 3		
	TCM 515U	X				X							+1	2.0 to 3.6						X				-40 to 85	-98		X		X						X										19 x 14.7 x 3		
	PTM 210			X	X								+5	el. dyn. power generator					X					-25 to 65			X		X																	40 x 40 x 11.2	
	PTM 210U			X		X							+5	el. dyn. power generator						X				-25 to 65			X		X																	40 x 40 x 11.2	EDK 350U
	PTM 210J			X		X							+0	el. dyn. power generator								X		-25 to 65			X		X																	40 x 40 x 11.2	EDK 400J
	PTM 215			X	X								+5	el. dyn. power generator					X					-25 to 65			X		X																	40 x 40 x 11.2	EDK 350
	PTM 535			X	X								+5	ECO 260 / energy impulse					X					-25 to 65			X		X																	26.2 x 21.15 x 3.5	
	PTM 535J			X		X							+0	ECO 260 / energy impulse							X			-25 to 65			X		X																	26.2 x 21.15 x 3.5	
	STM 300	X			X								+3	2.1 to 4.5					X					-25 to 85	-96		X	X		32kB	2kB			X		X	X		X	X	X				22 x 19 x 3.1	EDK 350	
	STM 300U	X				X							+1	2.1 to 4.5						X				-25 to 85	-98		X	X		32kB	2kB			X		X	X		X	X	X				22 x 19 x 3.1	EDK 350U	
	STM 320			X	X								+5	solar cell					X					-20 to 60			X	X		32kB	2kB														43 x 16 x 6		
	STM 320U			X		X							+99	solar cell						X				-20 to 60			X	X		32kB	2kB														43 x 16 x 6		
	STM 329			X	X								+5	solar cell					X					-20 to 60			X	X		32kB	2kB														43 x 16 x 6		
	STM 330			X	X								+6.4	solar cell					X					-20 to 60			X	X		32kB	2kB														43 x 16 x 8	EDK 350	
	STM 331			X	X								+5	solar cell					X					-20 to 60			X	X		32kB	2kB														43 x 16 x 8	EDK 350	
	STM 331U			X		X							+99	solar cell							X			-20 to 60			X	X		32kB	2kB														43 x 16 x 8	EDK 350U	
	STM 332U			X		X							+102	solar cell						X				-20 to 60			X	X		32kB	2kB														43 x 16 x 8	EDK 350U	
	STM 333U			X		X							+99	solar cell							X			-20 to 60			X	X		32kB	2kB														43 x 16 x 8	EDK 350	
	STM 350			X	X								+5	solar cell					X					-20 to 60			X	X		32kB	2kB														50 x 16 x 10		
	STM 350U			X		X							+99	solar cell							X			-20 to 60			X	X		32kB	2kB														50 x 16 x 10		
	STM 400J	X				X							+0	2.1 to 5.0								X		-25 to 85	-95		X	X		64kB	4kB	8kB		X		X			X	X	X				22 x 19 x 3	EDK 400J	
	STM 429J			X		X							+0	solar cell								X		-25 to 60			X	X		64kB	4kB	8kB													43 x 16 x 6		
	STM 431J			X		X							+0	solar cell								X		-25 to 60			X	X		64kB	4kB	8kB													43 x 16 x 8	EDK 400J	
	STM 550												+5 dBm	solar cell					X	X	X			-5°C to +45°C																					40 x 40 x 13 mm		
	USB 300/500U/400J	X											+3	USB					X	X	X			0 to 50	-96																	Type A			70 x 23 x 9		



What is LPWAN?

Low Power Network (LPN) or Low Power Wide Area Network (LPWAN) is a new technology where a high network coverage and low power consumption are the key criteria in the operation of such a wireless network.

There are currently numerous technologies from which IoT decision makers can choose. From a technology point-of-view, they differentiate broadly into 2 major categories:

1. LPWAN technologies operate in unlicensed bands, typically in the Sub 1 GHz area. All technology contenders belonging to this category can be considered proprietary, i.e. all Intellectual Property Rights (IPRs) are either owned by one or by a limited number of companies.
2. The second category covers those technologies which operate in licensed bands, which are accessible only to mobile network operators which have purchased appropriate licenses from local regulatory authorities.

SigFox and LoRa, among others, belong to this category. As the name suggests, networks operating in unlicensed band can be deployed by virtually anyone.

This category of LPWAN technologies is standardized by the 3GPP (3rd Generation Partnership Project), an international standards organization which has also produced the standards for the GSM, UMTS and LTE mobile network technologies.

The technologies known as NB-IoT and LTE Cat-M1 are the key LPWAN options which have been standardized by the 3GPP.

Feature	Cat M1	Cat NB1 / NB-IoT	LoRa	SigFox
Radio Spectrum	Licensed	Licensed	Unlicensed	Unlicensed
Guaranteed QoS	Yes	Yes	No	No
Latency	Milliseconds – Seconds	Seconds	Seconds – Minutes	Seconds – Minutes
Roaming	Global	Global	Local	Single network
Peak Data Rate	375 kbps (DL/UL)	27.2 / 62.5 kbps (DL/UL)	5.5 – 50 kbps	100 / 500 bps (UL/DL)
Range	Basement	Underground	Underground	Underground
Mobility	Vehicular (full handover)	Nomadic (no handover)	No	No
Voice support	Yes	No	No	No
Battery life	5-10 years	10 years +	10 years +	10 years +
Module cost	Low	Low	Low	Low
SIM Card	Yes	Yes	No	No

Dual Radio Devices with Integrated Antennas
Bluetooth LE / ANT+ / NFC / UWB / LoRa Mixed Solutions



The InsightSIP “Ready-to-go” RF modules offer you the fast, low risk way to deploy your IoT infrastructure, with fully CE, FCC, IC, Telec and Bluetooth SiG certified solutions. All modules are based on Nordic Semiconductor’s SoCs.



ISP4520 – LPWAN LoRa / BLE Module

Worldwide LoRa band coverage through EU (EMEA), US (Americas) and AS (Asia) versions.

For large spectrum of IoT applications:

- Smart cities / Smart retail
- Big data / Data science
- Industrial Internet
- Energy engagement / Smart grids

Part Number	ISP4520-EU	ISP4520-US	ISP4520-AS
Main protocol	LoRa		
BT Features	Bluetooth LE 5.0		
Other protocol	BT Mesh - ANT		
LoRa Tx Power	+14 dBm	+22 dBm	+14 dBm
BT Tx Power	+4 dBm		
LoRa Chip	SX1261	SX1262	SX1261
BT Chip	nRF52832		
Processor	Cortex M4F		
Flash	512 kB		
RAM	64 kB		
GPIOs (ADCs)	23 (8)		
Interfaces	(High Speed) SPI, TWI, UART, PWM, PDM		
NFC tag	Yes		
Temperature	85°C		
Dimensions	9.8 mm x 17.2 mm x 1.7 mm		



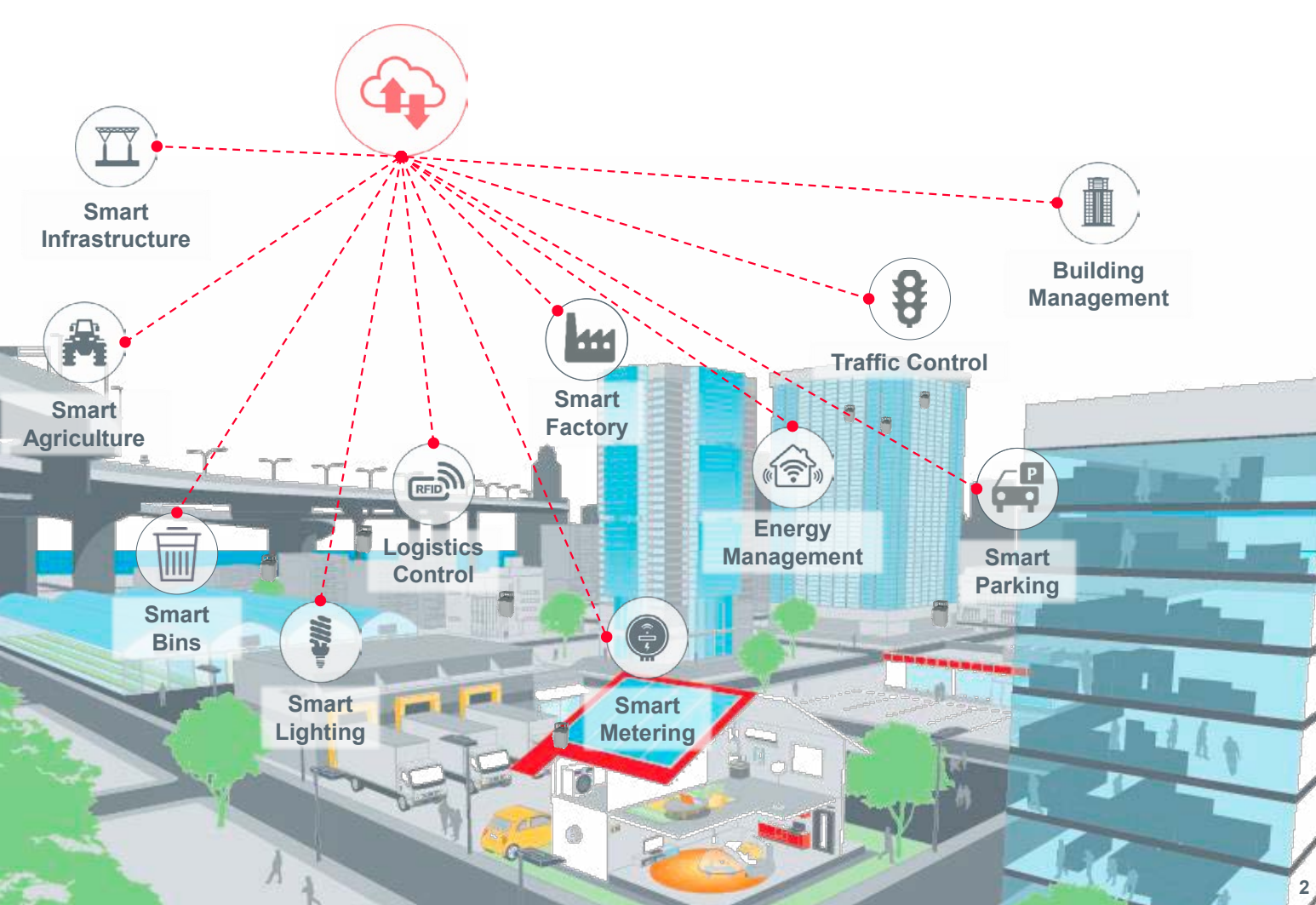
ISP3080 – Positioning UWB / BLE Module

With integrated BLE and dual Band (5 and 9) UWB antennas offering global coverage with a single device.

Including main applications

- RTLS (Precision real time location systems)
- Access control
- Security bubble
- Indoor positioning

Part Number	ISP3080-UX
Main protocol	UWB
BT Features	Bluetooth LE 5.1
Other protocol	BT Mesh – Thread – Zigbee
UWB Tx Power	- 41.3 dBm / MHz
BT Tx Power	+ 8 dBm
UWB Chip	QM33110
BLE Chip	nRF52833
Processor	Cortex M4F
Flash	512 kB
RAM	128 kB
GPIOs (ADCs)	23 (4)
Interfaces	(High Speed) SPI, TWI, UART, PWM, PDM
NFC tag	Yes
Temperature	85°C
Dimensions	10 mm x 12 mm x 1 mm



Unlicensed Modules – LoRa

muRata
INNOVATOR IN ELECTRONICS

LBAA0QB1SJ Module

The Type 1SJ is Murata's new LoRaWAN module and with a size of only 10 x 8.0 x 1.6 mm it is one of the smallest on the market. It is based on the Semtech SX1262 and the STM32L with a Cortex M0+ processor for stack and application is integrated. The module has a lower power consumption and higher output than previous products.

Key Features

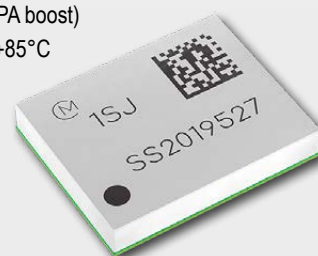
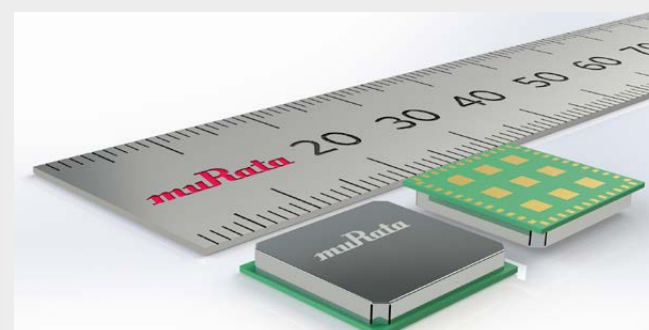
- Radio Chip: Semtech SX1262
- MCU STM32L Cortex M0+ (192 kBytes Flash)
- Open MCU for Application
- External Antenna
- Host interfaces: UART, SPI, I²C
- Other interfaces: GPIO/ADC
- LGA (56 pads)
- RF Tx Power: +14 dBm (+21.5 dBm with PA boost)
- Operating Temperature Range: -40°C to +85°C
- Resin Mould package
- Low current consumption Rx mode
- Vcc: 2.0 V to 3.6 V

Key Applications

- Asset/Animal Tracking
- Smart Parking
- Smart Agriculture
- Fuel/Water Management
- Smart Waste
- Smart Home

Industry's Smallest Size and Lightweight Design

In the development of IoT devices, there are many situations where compact, lightweight, and well-designed modules such as wearables are required. Murata's LPWA module is the smallest module available in the industry, making it ideal for use in hardware designs.



Licensed Modules – LTE Cat. M1 & NB-IoT

Telit
Cinterion

ME310G1 Series – LTE Cat M1/NB2 Modules

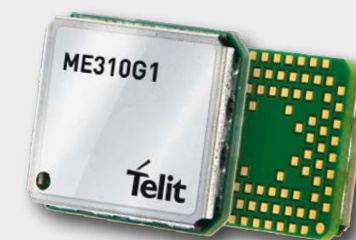
Enabling a new generation of massive low-cost IoT device deployments numbering in the hundreds of thousands or millions, the ME310G1 is the Category M1/NB2 evolution of the brand new Telit xE310 product family. Exceeding market demands for optimized power consumption and enhanced quality of coverage, Cat M1/NB2 devices are specifically tailored for low data throughput IoT applications. The ME310G1 creates brand-new IoT-enabled business models by addressing connectivity and battery life concerns for the growing number of OEMs, integrators and device designers looking to dramatically increase the number of data points they can collect from their operations and customers via IoT devices. IoT is now possible at a scale and cost point that makes many previously unviable deployments ROI positive.

Key Features

- LTE UE Category M1(1.4 MHz) / NB2 (200 KHz)
- Single Rx, single antenna
- 3GPP Rel. 12 Power Saving Mode (PSM)
- 3GPP Rel. 13 Extended Discontinuous Reception (eDRX)
- 3GPP Rel. 13 Extended coverage
- Control via AT commands according to 3GPP TS27.005, 27.007 and customized Telit AT commands
- VoLTE (planned)
- SMS over NAS
- IPv4/IPv6 stack with TCP and UDP protocol
- TLS / DTLS
- Optional embedded GNSS (GPS, GLONASS, Beidou, Galileo)
- Over-the-Air firmware update
- Extended temp. range: -40 °C to +85 °C
- Dimensions: 13.1 x 14.3 x 2.6mm
- Supply voltage: Nominal: 3.8 VDC

Key Benefits

- Small size and low power consumption
- Optimized for ease-of-design, high yield and low-cost manufacturing
- Compliant to 3GPP Release 14 Cat M1/NB2, tailored for IoT devices
- Module sizes ranging from 300 down to below 200 mm² on a fixed 94-pad LGA footprint enable a "design once, use anywhere" IoT device strategy.



Application Fields

- Medical devices, fitness trackers, industrial sensors, smart meters
- Mass-production and mass-deployment applications

Model	ME310G1-W1	ME310G1-WW
M1/NB2	M1 & NB2	M1 & NB2
Market	Worldwide	Worldwide
4G	B1, B2, B3, B4, B5, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B27, B28, B66, B85	B1, B2, B3, B4, B5, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B27, B28, B66, B85
2G	–	B2, B3, B5, B8
Output power	LTE: 20 dBm (Power Class 5)	LTE: 23 dBm (Power Class 3) GSM/GPRS 33 dBm (Power Class 4)
Approvals (planned)	FCC/IC, RED, GCF, PTCRB, AT&T, Verizon	



Licensed Modules – LTE Cat. M1 & NB-IoT



ML865C1/G1 Series – LTE Cat. M1 & NB-IoT Combo Modules

The ML865G1 is the Category M1/NB2 evolution in the widely deployed Telit xL865 product family. It's specifically tailored for IoT applications, offering optimized power consumption and enhanced coverage. In addition, with its square 24.4 x 24.4 mm VQFN footprint, the ML865G1 is designed for size sensitive applications. This next generation of products supports the new features specified by 3GPP to boost IoT applications, such as the Power Saving Mode (PSM) and the extended Discontinuous Reception (eDRX), which allow the devices to wake up periodically to deliver only very small amounts of data to the network and then go back to sleep for most of the time, thus allowing longer battery operation.

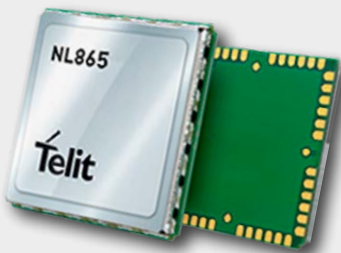
Key Features

- LTE UE Category M1/NB2
- 3GPP release 14 compliant
- Half Duplex FDD
- Single Rx, single antenna
- 3GPP Rel. 12 Power Saving Mode (PSM)
- 3GPP Rel. 13 Extended Discontinuous Reception (eDRX)
- 3GPP Rel. 13 Extended coverage
- Control via AT commands according to 3GPP TS27.005, 27.007 and customized AT commands
- SMS
- IPv4/IPv6 stack with TCP and UDP protocol
- OMA Lightweight M2M (LWM2M)
- Over-the-Air firmware update

- Telit Application Development Environment: AppZone C
- TLS 1.2
- Optional embedded GNSS (GPS, GLONASS, Beidou, Galileo)
- Dimensions 24.4 x 24.4 x 2.6 mm
- Temperature range: -40 °C to +85 °C
- Interfaces: USB 2.0 HS, UART, SPI, I²C, GPIO, ADC

Application Fields

- Smart meters
- Industrial sensors
- Healthcare monitors
- Home automation
- Asset tracker



Model	ML865C1-EA	ML865C1-NA	ML865G1-WW	ML865G1-W1
M1/NB2	M1 & NB2	M1	M1 & NB2	M1 & NB2
Market	Europe, APAC, Latin America	North America	World wide	World wide
4G	B1, B3, B5, B8, B18, B19, B20, B26, B28	B2, B4, B12, B13	Yes	Yes
2G	B2, B3, B5, B8	-	Yes	-
Approvals	RED, GCF	FCC/IC, GCF, PTCRB, Verizon, AT&T	tbd	tbd

Licensed Modules – LTE Cat. M1 & NB-IoT



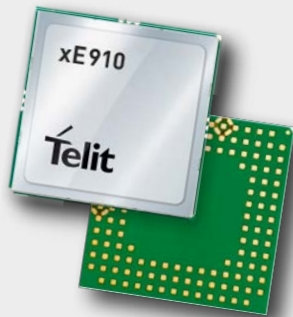
ME910C1/G1 Series – LTE Cat. M1 & NB-IoT Combo Modules

The ME910G1 is the Category M1/NB2 evolution of the Telit LE910 Series of LTE modules with maximum downlink and uplink data rate in the range of 300kbps. This next generation of products supports the new features specified by 3GPP to boost IoT applications, such as the Power Saving Mode (PSM) and the extended Discontinuous Reception (eDRX), which allow the devices to wake up periodically to deliver only very small amounts of data to the network and then go back to sleep for most of the time, thus allowing longer battery operation. The ME910G1 Cat M1/NB2 devices are specifically tailored for IoT applications, offering optimized power consumption and enhanced coverage. This model further enriches the widely deployed Telit xE910 family of 28 x 28mm LGA modules.

Key Features

- LTE UE Category M1/NB2
- 3GPP release 14 compliant
- 3GPP Rel. 12 Power Saving Mode (PSM)
- 3GPP Rel. 13 Extended Discontinuous Reception
- 3GPP Rel. 13 Extended coverage
- Control via AT commands
- SIM application Tool Kit 3GPP TS 51.01
- IPv4/IPv6 stack with TCP and UDP protocol
- Over-the-Air firmware update (for future release)
- Dimensions 28.2 x 28.2 x 2.2 mm
- Temperature range: -40 °C to +85 °C
- Interfaces: USB 2.0 HS, UART, SPI, I²C, GPIO

- Telit Application Development Environment: AppZone C (for future release)
- SSL
- Optional embedded GNSS (GPS, GLONASS, Beidou, Galileo)
- Data LTE Cat. M1:
 - Uplink up to 375 kbps
 - Downlink up to 300 kbps
- Data LTE NB-IoT:
 - Uplink up to 20 kbps (single-tone), 250 kbps (multi-tone)
 - Downlink up to 250 kbps



Model	ME910C1-WW	ME910G1-WW	ME910G1-W1	ME910C1-P1	ME910C1-P2
M1/NB2	M1 & NB2	M1 & NB2		M1 & NB2	
Market	Worldwide	Worldwide		Worldwide / simWISE Ready	
4G	B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B26, B27, B28, B66, B71, B85	B1, B2, B3, B4, B5, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B27, B28, B66, B71, B85		B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B26, B28	
2G	B2, B3, B5, B8	B2, B3, B5, B8		B2, B3, B5, B8	
Approvals	PTCRB, GCF, RED, FCC/IC, RCM*, Jate, Telec, CCC, AT&T, Verizon	FCC/IC*, RED*, GCF*, PTCRB*, AT&T*, Verizon*		PTCRB*, GCF*, RED*, FCC/IC*	

*planned



A secure, prepackaged management software suite embedded within data efficient cellular IoT modules

Shorten Your Path to IoT Monetization

OneEdge is an innovative module-embedded software suite enabling solutions for a new generation of Telit's cellular LPWA IoT modules.

Harness the LPWA Revolution

With LTE-M and NB-IoT quickly becoming ubiquitous comes the need for cost effective ways to start and scale massive IoT deployments. OneEdge tools accelerate your enterprise digitalization journey – reducing time-to-market, total cost of ownership, and risk.

Telit OneEdge will support you:

- From Prototype to Production
- From Development to Deployment
- From Mock-up to Mature Solution



With integrated, secure, easy-to-use tools, OneEdge dramatically simplifies design, deployment and management of IoT products and solutions, enabling a leap ahead into the new 5G super-connected world.



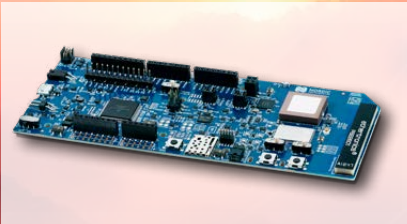
Telit's preconnected OneEdge modules are fully tested and network certified, so they're ready to connect to the cloud as soon as they're activated. From a single dashboard, you can manage all your devices, connectivity and application data—there's no need to integrate other devices or management platforms.

To learn more about Telit OneEdge, visit telit.com/oneedge

Software Development Kits

nRF91 DK

The nRF9160 DK is an affordable, 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 for example can be used to build a Bluetooth Low Energy gateway.



Nordic Thingy:91

The Thingy:91 is an easy-to-use battery-operated prototyping platform for cellular IoT using LTE-M, NB-IoT and GNSS. It is ideal for creating Proof-of-Concept (PoC), demos and initial prototypes in your IoT development phase.



Low Power SiP with Integrated LTE-M, NB-IoT and GNSS Wireless Modem



nRF9160 – Cellular IoT System-in-Package

The nRF9160 is a compact, highly integrated System-in-Package (SiP) that makes the latest low power LTE technology and advanced processing and security accessible, and easy to use, for a wide range of single device low power cellular IoT designs. Targeting asset tracking applications, the nRF9160 SiP has built-in assisted GPS. It combines location data from the cellular network with GPS satellite trilateration to allow remote monitoring of the device position.

Key Features

- Fully integrated SiP for cellular IoT
- Dedicated application processor and memory
- Multimode LTE-M/NB-IoT modem with integrated RFFE
- GPS
- Designed for true low power cIoT
- 10x16x1.04 mm LGA package
- Single variant certified for global operation:
 - Verizon
 - GCF, PTCRB
 - FCC (USA), CE (EUR), ISED (CAN), ACMA RCM (AUS), NCC (TWN), IMDA (SGP), MIC (JPN), MSIP (KOR)
- Single variant certified for global operation: nordicsemi.com/9160cert

Applications

- Logistics and asset tracking
- Smart city
- Smart agriculture
- Predictive maintenance & industrial
- Wearables & medical



Feature	nRF9160-SIAA	nRF9160-SIBA	nRF9160-SICA
Wireless Protocol	LTE-M only product	NB-IoT only product	LTE-M/NB-IoT/GPS product
Type	System in Package		
CPU	64 MHz Arm Cortex-M33		
FPU	x		
DSP Instruction Set	x		
Cache	x		
Memory	1 MB Flash/256 kB RAM		
Clocks	64 MHz / 32 kHz		
Arm Trustzone	x		
Arm CryptoCell	310		
Root-of-trust	x		
Secure key storage	x		
AES encryption	x		
LTE-M/NB-IOT/GPS Modem	x		
LTE band support in hardware	Cat-M1: B1, B2, B3, B4, B5, B8, B12, B13, B14, B18, B19, B20, B25, B26, B28, B66 Cat-NB1/NB2: B1, B2, B3, B4, B5, B8, B12, B13, B17, B19, B20, B25, B26, B28, B66		
Frequencies	700-2200 MHz		
Maximum TX Power	23 dBm		
RX Sensitivity	-108 dBm (LTE-M), -114 dBm (NB-IoT), -155 dBm (GPS)		
Antenna interface	50 Ω single-ended		
TWI, SPI, UART	4xTWI/SPI/UART		
PWM	4		
PDM	x		
I2S	x		
ADC, Comparator	ADC		
Timer, RTC	3, 2		
Temperature Sensor	x		
Applications	Sensor networks, Smart energy, Smart agriculture, Logistic and asset tracking, Industrial Systems, Smart Buildings, Retail and monitor devices, Medical devices, Wearables		
Certifications	nordicsemi.com/9160cert		
Operating Temp.	-40 to 85 °C		
Supply Voltage Range	3.0 V to 5.5 V		
Development Kits	nRF9160 DK, Nordic Thingy:91		
Packages	10x16x1.04 mm LGA		

LPWAN Chips & Modules – Selection Guide

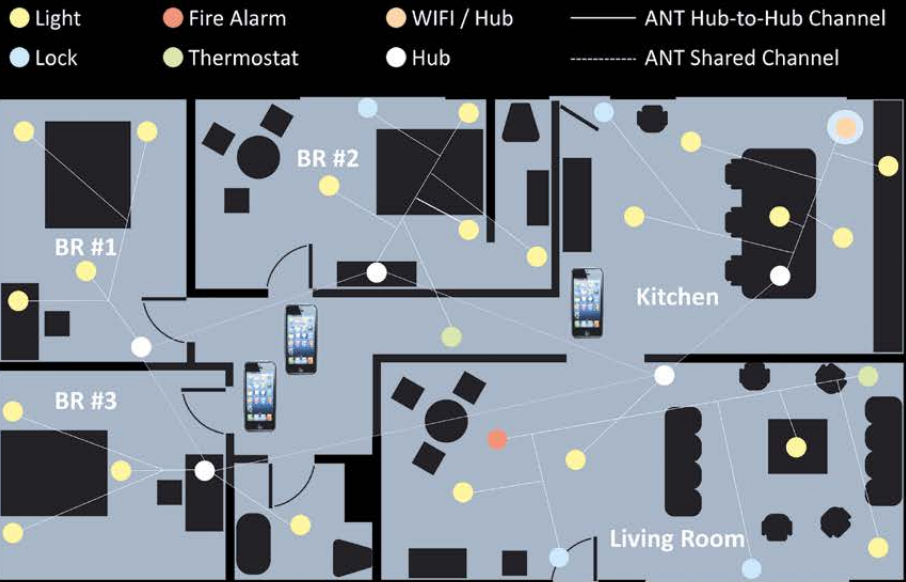
LPWAN / SubGHz Modules

Manuf- acterer	Name	Technology / Protocol				Unlicensed Bands		Licensed Bands						Fall-back	Modulation				Radio Data Rate	Max. Transmit Power TX (dBm)	Max. Input Sensitivity RX (dBm)	Supply Voltage Range (V)	Temperature Range (°C)	MCU		Memory			Interface							Package (Size in mm)	Evaluation Kit/ Development Kit														
		LoRa	SigFox	LTE Cat. M1	LTE NB-IoT	Other	433M	868M	915M	920M	2.4G	600M	700M		800M	850M	900M	1700						1800	1900	2100	2G	GFSK	FSK	BPSK	CSS	OFDM	Yes	No	Flash			RAM	EEPROM	No	GPIO	UART	SPI	PC	USB	ADC	RS232, TTL	PWM			
Insight SiP	ISP4520-EU	x				BLE 5.3	x			x													LoRa Radio in 868Mhz band	+4	1.8 - 3.6	-96	1.7 - 3.6	-30 to 85	x		512/256 KB	64/32KB			x	x	x	x		x			9.8 x 17.2 x 1.7	ISP4520-EU-DK							
	ISP4520-US	x				BLE 5.3			x		x												LoRa Radio in 923Mhz band	+4	1.8 - 3.6	-96	1.7 - 3.6	-30 to 85	x		512/256 KB	64/32KB			x	x	x	x		x			9.8 x 17.2 x 1.7	ISP4520-US-DK							
	ISP4520-AS	x				BLE 5.3				x	x												LoRa Radio in 923Mhz band	+4	1.8 - 3.6	-96	1.7 - 3.6	-30 to 85	x		512/256 KB	64/32KB			x	x	x	x		x			9.8 x 17.2 x 1.7	ISP4520-AS-DK							
	ISP3080-UX	x				BLE 5.3	x	x	x	x														FiRa Compatible UWB Radio	+8	2.8 - 3.6	-94 / -104	1.7 - 5.5	-30 to 85	x		512 KB	128 KB			x	x	x	x		x			12 x 10 x 1.0 mm	ISP3080-DK						
Murata	CMWX1ZZABZ	x	x										x	x							x				up to 300 Kbps	+18.5	- 135.5	2.2 - 3.6	-40 to 85	x		192KB	20KB	6KB			x	x	x	x					12.5 x 11.6 x 1.76	ST - B-L072Z-LRWAN1					
Telit	RE866A1	x				BLE 4.2, NFC, Terminal I/O	x														x		x		250-5470 bps (LoRa) 1 Mbps (BLE)	+19	- 138	1.8 - 3.6	-40 to 85	x		512kB	64kB			x		x	x		x		x	LGA (19 x 15 x 2.2)	RE866A1-EU Interface Board (+EVK 2) RE866A1-EU TLB Interface Board (+EVB)						
	ME910C1-NV			x		Optional GNSS						x				x							x	UL 375 Kbps DL 300 Kbps	+23	- 106	3.4 - 4.2	-40 to 85			x				x	x	x	x	x	x					LGA (28.2 x 28.2 x 2.2)	ME910C1-NV Interface Board					
	ME910C1-NA			x		Optional GNSS						x				x		x					x										x	x	x	x	x	x						ME910C1-NA Interface Board							
	ME910C1-N1			x		Optional GNSS						x				x		x					x										x	x	x	x	x	x						ME910C1-N1 Interface Board							
	ME910C1-E1			x	x	Optional GNSS							x		x		x		x				x										x	x	x	x	x	x						ME910C1-E1 Interface Board							
	ME910C1-E2			x	x	Optional GNSS							x	x	x		x	x	x		x		x										x	x	x	x	x	x						ME910C1-E2 Interface Board							
	ME910C1-AU			x	x	Optional GNSS						x		x	x		x						x										x	x	x	x	x	x						ME910C1-AU Interface Board							
	ME910C1-J1			x	x	Optional GNSS							x	x	x		x		x				x										x	x	x	x	x	x						ME910C1-J1 Interface Board							
	ME910C1-WW			x	x	Optional GNSS							x	x	x	x	x	x	x	x	x		x										x	x	x	x	x	x						ME910C1-WW Interface Board							
	NE910C1-E1				x	Optional GNSS							x		x								x											x			x	x	x	x							NE910C1-E1 Interface Board				
	ML865C1-EA			x	x	Optional GNSS							x	x	x	x		x	x	x	x													x														ML865C1-EA Interface Board			
	ML865C1-NA			x		Optional GNSS							x				x		x																x														VQFN (24.4 x 24.4 x 2.6)	ML865C1-NA Interface Board	
	ME310G1-W1			x	x	Optional GNSS							x	x	x	x	x	x	x	x															x															LGA (13.1 x 14.3 x 2.6)	tbd
	ME310G1-WW			x	x	Optional GNSS							x	x	x	x	x	x	x	x	x														x																
	ME910G1-W1			x	x	Optional GNSS							x	x	x	x	x	x	x	x	x														x																
	ME910G1-WW			x	x	Optional GNSS							x	x	x	x	x	x	x	x	x														x																
	ME910C1-P1			x	x	Optional GNSS								x	x	x	x	x	x	x	x														x																
ME910C1-P2			x	x	Optional GNSS								x	x	x	x	x	x	x	x										x																					
Nordic	nRF9160-SIAA			x								B13/ B28*	B20	*	B8*	B4*	B3*	*	B1*				x		UL 300 DL 375	-108	3.0 - 5.5	40 to 85	x		1 MB	256 kB			x	x	x	x		x		x			10 x 16 x 1.2	nRF9160 DK, Thingy:91					
	nRF9160-SIBA				x							B28	B20	*	B8*		B3*					x		UL 30 DL 60	-114				x		1 MB	256 kB			x	x	x	x		x		x			nRF9160 DK, Thingy:91						
	nRF9160-SICA			x	x	GPS						B13/ B28*	B20	*	B8*	B4*	B3*	*	B1*				x		UL 300 (M1) DL 375 (M1) UL 30 (NB1) DL 60 (NB1)	-108 (LTE-M) -114 (NB-IoT)				x		1 MB	256 kB			x	x	x	x		x		x			nRF9160 DK, Thingy:91					

*more certifications coming



Product Examples



Product Examples



What is ANT™ ?



ANT™ is a practical wireless sensor network protocol. It offers an 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.

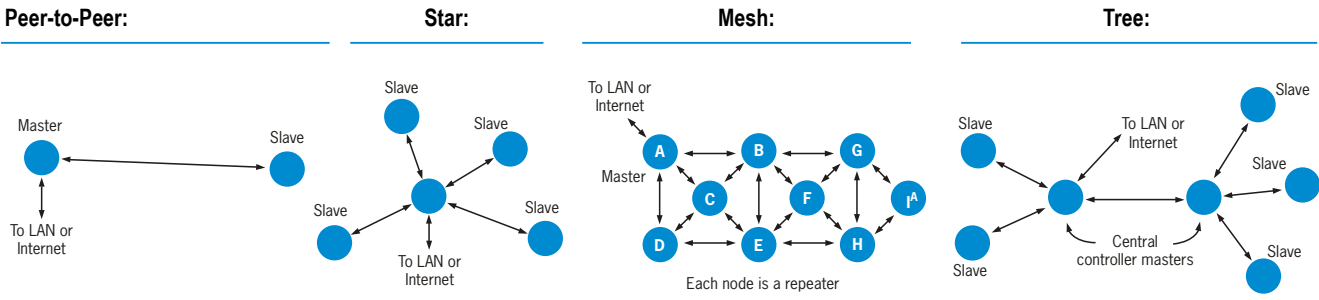
ANT provides reliable data communication, flexible and adaptive network operation and co-existence immunity. The ANT protocol stack is extremely compact, requiring minimal microcontroller resources and considerably reduces system costs.

ANT can be easily and quickly 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 first created for applications in sport, fitness and 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. With recent additions of a System on Chip (SoC) IC the customer can choose between an integrated or not-integrated MCU.

ANT+ is an interoperability application definition that can be added to the base ANT protocol. It standardizes communication and facilitates interoperability between a wide array of personal sports, wellness and lifestyle monitoring devices. ANT+ defines device profiles that specify access use cases, data formats and channel parameters.

ANT can also be used for communication with smartphones. While e.g. Sony, Sharp and Samsung have already ANT integrated, there is also an ANT adapter for iPhones available.

Rutronik offers ANT to USB adapters which can be individually brand labeled for computers and laptop connections.



ANT BLAZE™ & ANT IGNITE™
for High Node Count IoT Applications



ANT BLAZE is a connectionless mesh network technology for control and sensing applications that require high throughput with no special router nodes. ANT IGNITE is a protocol that connects hundreds of low power sensors to a hub. Combine it with ANT BLAZE for a complete control or sensor mesh solution.

- Features**
- Robust ANT BLAZE networks of up to 500 nodes are self-forming and self-healing, providing ease of installation and maintenance when run either with or without a cloud connection.
 - Reliable and enterprise-ready, ANT BLAZE acts as its own independent communications 'backbone', coexisting cleanly with on-premises IT infrastructures or operate on its own independent network alongside existing infrastructure.
 - Add ANT IGNITE nodes to your ANT BLAZE backbone via a star topology for nodes that need to be ultra low power.
 - Developers can deploy ANT BLAZE networks that can be concurrently commissioned and accessed from tablets and phones using Bluetooth.
 - ANT BLAZE and IGNITE run on Dual-Protocol D52 and D524 ANT SoC Premium Modules.

- Additional Features**
- Connect multiple nodes in a noisy environment to a gateway
 - Embedded libraries available for end nodes and gateways
 - High throughput (>50 bytes/s)
 - Supports node mobility
 - >99% message success rate in both high & low node density environm.
 - Robustness and concurrent operation in WiFi and BLE environments

Garmin Canada Starter Kit and Extender Kit

The updated D52 ANT SoC Module Starter Kit (D52DK2) contains everything needed to begin developing with ANT, ANT+, ANT BLAZE, ANT IGNITE, G.FIT and Bluetooth low energy technology. The Extender Kit (D52EXT1) includes four battery powered nodes to enable ANT BLAZE & IGNITE IoT application development.





TOP BRANDS COMPATIBLE DEVICES.

The new ANT+ Product Directory guides you to all the interoperable and certified ANT+ products available today.



ANT SoC Module Series



nRF52840 Based Module

Key Features

Based on Nordic Semiconductor's nRF52840 SoC (with 256 kB RAM; 1 MB Flash; 32-bit ARM Cortex M4F CPU), the D524 ANT SoC Module supports ANT, Bluetooth® low energy and extended features such as Thread, Zigbee and NFC. A standard feature of the module is Garmin Canada's pre-loaded S340 low energy SoftDevice, which enables concurrent usage of both ANT and Bluetooth. The Bluetooth 5.0 capabilities provide both extended range and enhanced power, resulting in a heightened experience for edge computing. It is also enabled to run both ANT BLAZE and IGNITE, enhancing its capabilities to create low-power meshed solutions. In addition, the D524 module has completed the Bluetooth Qualification Process and received its certification of compliance with regulation standards in major markets, including North America, Europe, Australia/New Zealand, Japan, and Korea.

Key Benefits

- Comes pre-loaded with the S340-concurrent ANT and Bluetooth low energy SoftDevice from Garmin Canada
- Integrated printed antennaw
- Operating temperature: Industrial (-40 °C to +85 °C)
- Up to 48 GPIOs
- Programmable output/channel from -20 dBm to 8 dBm
- Excellent receiver sensitivity
 - 93 dBm ANT mode
 - 96 dBm BLE mode
- SPI, I²C and UART interface
- Onboard USB controller
- Size: 14 x 9.8 x 2.0 mm module

Application Fields

- Personal area networks
- Logistics & tracking
- Sports & fitness sensors & monitor devices
- Beacons
- Home & industrial monitoring
- Mobile phone accessories
- Health sensors & monitoring devices

nRF52832 Based Modules

Key Features

- The D52 series of ANT SoC Modules, based on Nordic Semiconductor's nRF52832 SoC (with 64 kB RAM and 512 kB Flash and a 32-bit ARM Cortex M4F CPU) supporting ANT, Bluetooth® low energy and extended features such as NFC
- The D52 series can be flashed with all available Soft Devices from Nordic Semiconductor
 - S121-ANT only SoftDevice from Garmin Canada (preloaded)
 - S332-concurrent ANT and Bluetooth low energy SoftDevice from Garmin Canada
 - S132-Bluetooth low energy only SoftDevice from Nordic Semiconductor
- Qualification by the Bluetooth SIG, Certification of compliance with regulation standards in major markets including North America, Europe, Australia / New Zealand, Japan and Korea
- Drop-in compatibility with Garmin Canada C7, AP2 and N5 M4 modules (in certain configurations)
- ANT BLAZE and ANT IGNITE run on D52 ANT SoC Premium modules (D52QPMM4IA, D52QPMM4IA-A, D52MPMM8IA)

Key Benefits

- Integrated printed antenna
- Operating temperature: Industrial (-40 °C to +85 °C)
- Up to 30 GPIOs (D52QD2M4IA, D52QPMM4IA)
- Up to 24 GPIOs (D52QD2M4IA-A, D52MD2M8IA, D52QPMM4IA-A, D52MPMM8IA)
- Programmable output/channel from -20 dBm to 4 dBm
- Excellent receiver sensitivity
 - 93 dBm ANT mode
 - 96 dBm BLE mode
- SPI, I²C and UART interface
- Size
 - 20 x 20 mm module (D52QD2M4IA, D52QD2M4IA-A, D52QPMM4IA, D52QPMM4IA-A)
 - 14 x 9.8 x 2.0 mm module (D52MD2M8IA, D52MPMM8IA)
- Onboard 3-axis MEMS accelerometer (D52QD2M4IA-A, D52QPMM4IA-A)

ANT Transceiver Modules



Name of Module	ANT Chip Used	MCU (Yes)	MCU (No)	Memory (Flash)	Memory (RAM)	Channel	GPIO	UART	SPI	I2C	ADC	PDM	PWM	USB	NFC	Serial Interf.	Integr. Ant.	Eval. Kit/ Developm. Kit
D524D2M8IA	nRF52840	Cortex M4F		1MB	256kB	15	48	X	X	X	X	X	X	X	X	X	X	TBD
ANTUSBm	nRF24LU1+		X	500B		8								X		X	X	
D52QD2M4IA	nRF52832	Cortex M4F		512kB	64kB	15	30	X	X	X		X	X		X	X	X	D52DK2
D52QD2M4IA-A	nRF52832	Cortex M4F		512kB	64kB	15	24	X	X	X		X	X		X	X	X	D52DK2
D52QSKM6IA-A	nRF52832	Cortex M4F		512kB	64kB	15	24	X	X	X		X	X		X	X	X	D52DK2
D52QD2M8IA	nRF52832	Cortex M4F		512kB	64kB	15	24	X	X	X		X	X		X	X	X	D52DK2
D52QPMM4IA	nRF52832	Cortex M4F		512kB	64kB	15	30	X	X	X		X	X		X	X	X	D52DK2/ EXT1
D52QPMM4IA-A	nRF52832	Cortex M4F		512kB	64kB	15	24	X	X	X		X	X		X	X	X	D52DK2/ EXT1
D52QPMM8IA	nRF52832	Cortex M4F		512kB	64kB	15	24	X	X	X		X	X		X	X	X	D52DK2/ EXT1
D52QGFMAIA	nRF52832	Cortex M4F		512kB	64kB	15	30	X	X	X		X	X		X	X	X	D52DK2
D52QGFMAIA-A	nRF52832	Cortex M4F		512kB	64kB	15	24	X	X	X		X	X		X	X	X	D52DK2
D52MGM8IA	nRF52832	Cortex M4F		512kB	64kB	15	24	X	X	X		X	X		X	X	X	D52DK2
N550M8CC	nRF51422 v3	Cortex M0		256kB	16kB	15	24	X	X	X				X		X	X	ANTN5DK1
N5150M4CC	nRF51422 v3	Cortex M0		256kB	16kB	15	13	X	X	X				X		X	X	ANTN5DK1
N5150M8CD	nRF51422 v3	Cortex M0		256kB	32kB	15	24	X	X	X				X		X	X	ANTN5DK1
N5150M4CD	nRF51422 v3	Cortex M0		256kB	32kB	15	13	X	X	X				X		X	X	ANTN5DK1
N5150M5CD	nRF51422 v3	Cortex M0		256kB	32kB	15	13	X	X	X				X		X	X	ANTN5DK1
ANTUSB2	nRF24LU1+		X	500B		8								X		X	X	

G.FIT



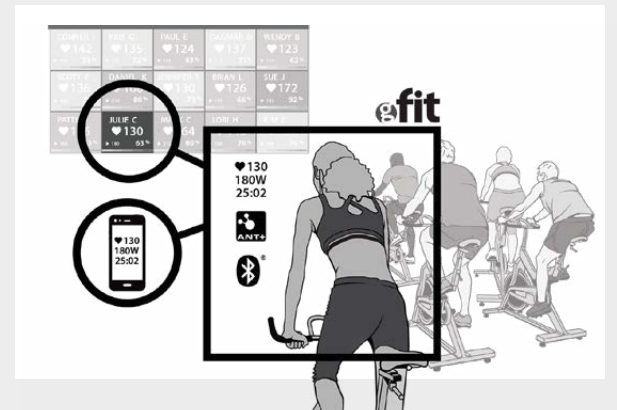
G.FIT is a turnkey dual-protocol solution for wireless fitness equipment and smart bike trainers. It connects fitness equipment in large group settings with support for over 50 concurrent devices. It runs on G.FIT specific SKUs based on the D52 ANT SoC modules.

Implementation Options

- Use G.FIT in network processor mode with your existing fitness equipment console controller (MCU)
- Build custom G.FIT firmware, including your console application, using G.FIT libraries to create a single-MCU solution

Features & Benefits

- Handles high coexistence (optimized for group and classroom training applications)
- Bluetooth® qualified, ANT+ certified
- Dual-protocol heart rate, workout data broadcast (FE-C/FTMS) and trainer control
- RSSI and list-based sensor pairing





What Does RFID Mean?

RFID stands for Radio Frequency Identification and is a special kind of wireless communication to identify or count an object contactless. On one side there is a RFID-reader, like a terminal or handheld device. On the other side there is a transponder, like a tag or a label. Within a smartphone there is both a transponder and a reader.

In a passive RFID system, the reader sends out a field of energy and data. The transponder uses the energy and data to read out his memory and sends back the content to the reader. In an active RFID system the transponder has its own battery, which allows much bigger memory sizes, a wider range and a faster communication.

Technologies

Parameter	Low Frequency	High Frequency	Ultra High Frequency
Frequency	125 kHz	13.56 MHz	868 – 915 MHz
Reading Distance (typical)	1 m	5 cm	10 m
Reading Rate	slow	depending on ISO-standards	fast
Humidity	No influence	No influence	Negative influence
Metal	Negative influence	Negative influence	No influence
ISO Standards	11784/85, 14223 and 18000-2	14443, 15693 and 18000-3	14443, 15693 and 18000-6
Applications	Admission control, going away barrier, gas reading	Asset management, ticketing, tracking & tracing, group collection	Pallet collection, container tracking

It is also possible to make own active RFID systems by using components of 868 MHz or 2.4 GHz, which can be found in other chapters of this catalogue.

What is the difference between RFID and NFC?

NFC means Near-Field-Communication and is based on the RFID-technology. However, NFC can be seen as an “extension” or “specialisation” of the RFID-technology. NFC transfers low data rates on a short distance (max. 10cm) and stands out for a safe way of data transfer. It also provides standardized application data packets.

While data transfer based on RFID-technology has to take place between an active and a passive party, with NFC it is also possible peer-to-peer (between two active parties, e.g. a checkout counter in a supermarket and a NFC-mobile). The frequency band reserved for NFC-technology is standardized on an individual wave-band (135kHz; 13,56MHz, ISO 18000-2, -3; 22536).



Transponder Applications Examples

ISO and Hybrid Cards
Available 125 kHz, 13.56 MHz and UHF IC technologies. Cards can be customized with different personalization and encoding options.

Smartlabels and Tickets
Adhesive labels, Windshield Labels, Multi-Purpose Labels, Logistic Single Labels

Special Tags
On-Metal Tags, High Temperature Tags, Laundry Tags, Heavy Duty Tags, etc.

Keyfobs and Wristbands
All keyfobs and wristbands are waterproof and can be printed and personalized.

Disctags
These tags are all available with different diameters, with printing and with/without centre hole.

RFID Modules, Readers & Passive Transponders



RFID Stick Reader Evo

The RFID Stick Reader EVO is a compact RFID reader and writer with adjustable performance. Its practical USB interface is used for the fast transfer of data as well as the power supply. Thanks to the IP40 protection class, it can withstand dust and other foreign objects up to 1 mm.



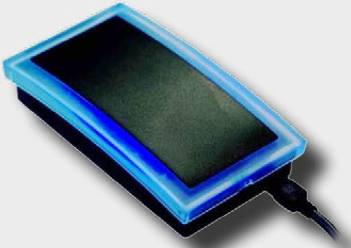
- Product Features**
- Dimensions: 83.5 x 36 x 11.2 mm
 - Housing-Material: ABS
 - Power Supply: 5V DC, via USB
 - Operating Systems: Windows XP, Vista, 7, 8, 8.1, 10
 - Antenna: integrated
 - Interface: USB VCP, HID

The RFID Stick Reader EVO is Available in the Following Versions

Freq.-Range	Frequency	Standard
UHF	868 – 916 MHz	Standard ISO 18000-6C incl. Class 1 Gen 2
HF	13.56 MHz	ISO 14443 A/B, ISO 15693 MIFARE Family

Desktop Reader EVO

iDTRONIC's Desktop Reader EVO is an easy-to-use RFID Reader/Writer which uses the USB 2.0 interface for high-speed data transfer. A Multi-LED illuminated frame is included, turning on during reading process. It comes with a full SDK and a MS Windows based application SW. Additionally, Keyboard Emulation (KEMU) is optional for all Versions.



- Product Features**
- Dimensions: 125 x 70 x 26 mm
 - Housing-Material: ABS
 - Power Supply: 5 VDC , via USB
 - Operating Systems: Windows XP/7, Linux
 - Antenna: Integrated
 - Interface: USB 2.0, cable length 1.2 m

The Desktop Reader EVO is Available in the Following Versions

Freq.-Range	Supported Standards / Card Types
UHF	ISO 18000-6C incl. Class1 Gen2
HF	MIFARE® Classic 1K, 4K; MIFARE Ultralight®; MIFARE Pro; AT88RF020; 66CL160S; SR176; SRIX4K (TYPE-B); I-Code2; TI RFid Tag-it HF-I; EM4135; EM4034 Read only UID of all other ISO 14443A/B, ISO 15693 cards
LF	ISO 11784, ISO 11785
LEGIC	ISO 14443A/B; ISO 15693; LEGIC Prime/Advant
TEMIC	TEMIC 55x7

BLUEBOX Professional RFID

BLUEBOX professional RFID is a family of highly sophisticated RFID controllers, readers, antennas and solutions allowing easy system integration.

- BLUEBOX Unique Advantages**
- Ruggedized product design and enclosures (All components minimum IP67 or IP54)
 - Available for
 - UHF 860–960 MHz (ISO18000-6C, EPC Class1 Gen2),
 - HF 13.56 MHz (ISO15693, ISO14443A/B, ISO 18000-3)
 - LF 125 kHz (ISO18000-2, ISO11784/11785)
 - Solutions for Near Field, Short-, Mid- and Long-Range appl.
 - Contr. with integr. antenna or for running 1, 2 and 4 antennas
 - Extended range of application specific antennas
 - Outstanding read / write performance and reading distances
 - Possibility of using diff. RFID standards in parallel in one application
 - Multiple Interface Options (USB, CANbus, RS232/485, Ethernet, Profibus, Profinet, etc.)
 - Integrated Webserver for remote access to Controller
 - Suitable for Stand-Alone operation
 - Integrated I/O ports
 - Micro SD slot for memory extension
 - Diagnostic interface
 - Several Standard Read Modes like Buffered Read Mode, Scan Mode, Notification Mode, RSSI Mode
 - Unique SDK for all BLUEBOX products
 - BLUEBOX SHOW applications software
 - M12 connections for trouble-free and secure connection and installation (optional RJ45 for UHF CX Controller)

Passive RFID Transponders – Overview

With its large portfolio of chips iDTRONIC covers the total frequency bandwidth of LF, HF and UHF RFID transponders.

Freq.	IC Version	ISO-Standard	Memory Cap.
UHF	NXP NTAG203	ISO/IEC 14443A	168 Byte
	Alien UHF Higgs 3 Gen2	ISO/IEC 18000-6C	64 Byte
	UHF U-Code Gen2	ISO 18000-6C	16 Byte
HF	NXP Mifare Ultralight (UL)	ISO 14443 A	64 Byte
	NXP Mifare Ultralight (UL) C	ISO 14443 A	192 Byte
	NXP Mifare Classic Mini	ISO 14443 A (1-3)	320 Byte
	NXP Mifare Classic 1K	ISO 14443 A	1024 Byte
	NXP Mifare Classic 4K	ISO 14443 A	4096 Byte
	NXP Mifare MF1S20 (mini)	ISO 14443	A 320 Byte
	NXP Mifare MF1S50 (1K)	ISO 14443 A	1024 Byte
	NXP Mifare MF1S70 (4K)	ISO 14443 A	4096 Byte
	NXP Mifare DESFire EV1 (2K)	ISO 14443 A (1-3)	2048 Bytes
	NXP Mifare DESFire EV1 (4K)	ISO 14443 A (1-3)	4096 Byte
	NXP Mifare DESFire EV1 (8K)	ISO 14443 A (1-3)	8192 Byte
	NXP Mifare Plus S 2K	ISO 14443 A	1 kB
	NXP Mifare Plus S 4K	ISO 14443 A	4 kB
	NXP Mifare Plus X 2K	ISO 14443 A	1 kB
	NXP Mifare Plus X 4K	ISO 14443 A	4 kB
	NXP I-Code SLI	ISO 15693	128 Byte
	NXP I-Code SLI-S (2K)	ISO 15693	256 Byte
	LEGIC MIM256	ISO 14443 A	256 Byte
	LEGIC MIM1024	ISO 14443 A	1024 Byte
	TI Tag-it HF-I	ISO 15693	256 Byte
LF	LEGIC Advant 1024	ISO 14443 / 15693	128 Byte
	LEGIC Advant 2048	ISO 14443 / 15693	256 Byte
	STM SRI512	ISO 14443 B	64 Byte
	STM LRI2K	ISO 15693	256 Byte
	STM SRI4K	ISO 14443 B	512 Byte
	Contactl. EM4100/4200	Read Only	8 Byte
	Contactl. Card EM4450/4550	ISO 11784/85	125 Byte
	Atmel Temic 5567	ISO 11784/88	363 Byte
	NXP Hitag 1	ISO 11784/88	256 Byte
	NXP Hitag 2	ISO 11784/88	32 Byte
	NXP Hitag S256	ISO 11784/88	256 Byte
	NXP Hitag S2048	ISO 11784/88	2 kB

Freq.-Range	Desktop Reader	Various Controller with integrated Antenna	Various Controller with up to 4 ports for external Antenna	M30 Cylindrical Reader (metal)	Various M18/M30 Cylindrical Antennas	Various other Short Range, Mid Range and Long Range Antennas
UHF Reading Distance	Up to 30 cm	Up to 3 m	Up to 10 m	up to 50 cm*	Up to 20 cm	
HF Reading Distance	Up to 15 cm	Up to 15 cm	Up to 15 cm	Up to 8 cm	Up to 6 cm	Up to 80 cm
LF Reading Distance	Up to 10 cm	Up to 15 cm	Up to 30 cm	Up to 6 cm	Up to 8 cm	Up to 13 cm

*IP67

Transponder Chips – Selection Guide

Parameters	Manufacturer	Transponder Chip	Frequency (Hz)			Standard						Storage Type		Package						
			LF	HF	UHF	ISO 15693	ISO 14443	ISO 14443-2	ISO 14443-3	ISO 14443-4	JISX 6319-4 (FelCa)	Other	EEPROM	FeRAM	SO8	TSSOP8	UFDFPN8	Wafer	16-pin QFN	24-pin QFN
Dual Interface RFID	Infineon	NAC1080		13.56				Type A				60 kB								
	Giantec	GT23SC4479		13.56				x				x					x			
		GT23SC4489		13.56				x				x					x			
		GT23SC8899-1/2/3/4		13.56				x			NFC Forum Type2	x					x			
		GT23SC8899C-1/3/4		13.56				x			NFC Forum Type2	x							XDFN4	
		GT23SC6699-1/2		13.56				x			NFC Forum Type2	x			x	x				
		GT23SC4419-1/2/3		13.56		x					NFC Forum Type5	x					x			
	Fujitsu	MB97R8110			x						ISO 18600-6 Type C, EPCglobal C1G2 Ver.1.2.0		8kB				x			
MB89R118C			13.56		x	x				ISO 18000-3		2kB					x			
Single Interface RFID	Fujitsu	MB97R8050			x						ISO 18600-6 Type C, EPCglobal C1G2 Ver.1.2.0		256Byte				x			
	Fujitsu	MB97R8120			x						ISO 18600-6 Type C, EPCglobal C1G2 Ver.1.2.0		8kB				x			
	Fujitsu	MB89R119B		13.56		x	x					256 Byte					x			
	Fujitsu	MB89R112A		13.56		x	x				ISO 18000-3		9kB				x		x	

Active RFID Tags – Selection Guide

Manufacturer	Part Name	RFID RX Frequency			ISM TRX Frequency (MHz)				Temp. Range (°C)	MCU		Memory		Dimension
		LF	HF	UHF	315	433	868	915		Yes	No	Flash	EEPROM	
Murata	LXMS33HCNG-134		x						-40 to 85	x		896 bits	64 bits	3.2 x 3.2 mm
	LXMS33HCNK-171		x						-40 to 85	x		384 bits	64 bits	3.2 x 3.2 mm
	LXMSJZNCMD-217			x			x	x	-40 to 85					1.2 x 1.2 x 0.55 mm
	LXMSJZNCMF-210			x			x	x	-40 to 85					1.2 x 1.2 x 0.55 mm
	LXMS21ACMF-218			x			x	x	-40 to 85					2.0 x 1.2 x 0.5 mm
	LXMS21ACMD-220			x			x	x	-40 to 85					2.0 x 1.2 x 0.5 mm
	LXTBKZMCMG-010			x			x	x	-40 to 85					6 x 2.0 x 2.3 mm



Reader Modules – Selection Guide

Parameters	Manu- facturer	Description	Order Code	Reader Type		Frequency (Hz)			Supported Standard												Supported Tags	Power Supply	Interface							Antenna	Dimensions (mm)		
				Module	Stick	LF	HF	UHF	ISO 11784	ISO 11785	ISO 15693	ISO 14443 A	ISO 14443 B	ISO 14443-2 B	ISO 14443-3 B	ISO 18000-6C	ISO 18092	ISO 18000-3	ISO 7816	ISO 19092			JISX 6319-4 (FeliCa)	USB	I/O	TTL	TCP/IP	SAM slot	RS232			RS485	
Embedded HF Modules with integrated antenna	iDTRONIC	HF NFC Embedded Reader R835 - TTL HF NFC Embedded Reader R835 - USB HF NFC Embedded Reader R835 - HID HF NFC Embedded Reader R835 - PC/SC	OEM-DES-R835-TTL OEM-DES-R835-USB OEM-DES-R835-HID OEM-DES-R835-PCSC	x			13.56M														see supported Standard	5 V	USB, HID, PCSC		x					integrated	58.4 × 35 × 4.7		
Embedded HF / NFC Modules with external antenna	iDTRONIC	OEM HF NFC Embedded Module M890 - TTL OEM HF NFC Embedded Module M890 - USB OEM HF NFC Embedded Module M890 - HID OEM HF NFC Embedded Module M890 - RS232 OEM HF NFC Embedded Module M890 - PC/SC	OEM-DES-M890-TTL OEM-DES-M890-USB OEM-DES-M890-HID OEM-DES-M890-RS232 OEM-DES-M890-PCSC	x			13.56M				EM4135, EM4043, EM4x33, EM4x35, I-Code SLI/SLIX/DNA, M24LR16/64, TI Tagit HF-I, SRF55Vxx (my-d vicinity)	Read/Write: MIFARE® Classic Mini /1K /4K, MIFARE Ultralight®, MIFARE Ultralight® C, MIFARE Ultralight® Nano, MIFARE® DESFire®EV1, MIFARE® DESFire® Light, MIFARE® Smart MX, MIFARE® Plus S / X, MIFARE® Pro X, NTAG 21x, NTAG 424 Read UID only: Read UID only of all other ISO14443A RFID tags	SRI4K, SR1X4K, AT-88RF020, 66CL160S, SR176							PSAM		see supported Standard	3.3 ~ 5 Vdc	USB VCP, USB HID, PC/SC		x				x	x	external	22 × 42 × 3 mm (TTL) 22 × 53 × 5 mm (USB, RS232)
Embedded HF / NFC Module MULTI ISO with external antenna	iDTRONIC	OEM HF NFC Embedded Module M900 - TTL OEM HF NFC Embedded Module M900 - USB OEM HF NFC Embedded Module M900 - HID OEM HF NFC Embedded Module M900 - PC/SC	OEM-DES-M900-TTL OEM-DES-M900-USB OEM-DES-M900-HID OEM-DES-M900-PCSC	x			13.56M														see supported Standard	3.3 Vdc	x		x					external	25 × 16.5 × 2.8		
Embedded HF Module LEGIC with external antenna	iDTRONIC		OEM-LEG-M800-TTL-FLEX	x			13.56M					x									LEGIC PRIME / Advant	5 V	x		x					external	31 x 26 x 4		
Embedded HF Module LEGIC with integrated antenna	iDTRONIC	OEM HF Module LEGIC with antenna	OEM-LEG-R800-TTL OEM-LEG-R800-232	x			13.56M					x									LEGIC PRIME / Advant	5 V	x		x			x		integrated	82 x 57 x 10		
OEM RFID LF Modules & Readers	iDTRONIC	OEM RFID LF Reader ONLY / TTL	OEM-LF-R810-TTL	x		125k			x	x											R/O chips EM4200	5 V								integrated	30 x 8,5		
	iDTRONIC	OEM RFID LF Stick EVO / USB	OEM-LF-R830-USB			125k			x	x											EM4200 / 4550 NXP Hitag 1,2,S	5 V											
	iDTRONIC	OEM RFID LF Module ISO / TTL OEM RFID LF Module ISO / RS-232 OEM RFID LF Module ISO / RS-485	OEM-LF-M800-TTL OEM-LF-M800-232 OEM-LF-M800-485	x		125k			x	x											EM4200 / 4550 NXP Hitag 1,2,S	5 V 12 V (option)			x			x	x	1 antenna port	30,5 x 25,5 x 9,5		
	iDTRONIC	OEM RFID Reader COMPACT / USB OEM RFID Reader COMPACT / RS232	OEM-LF-R820-USB OEM-LF-R820-232	x		125k			x	x											EM4200 / 4550 NXP Hitag 1,2,S	X V (Version USB) 12 V (Version RS232)	x					x		integrated	69 x 47,5 x 18		
OEM RFID UHF Modules & Readers	iDTRONIC	OEM RFID UHF Stick Reader EVO / USB	OEM-UHF-R830-USB-SR01		x		860-925M										incl. EPC Class 1 Gen 2				ALIEN Higgs3 Gen2 NXP U-Code GSXM / G2XL	20dBm / 100 mW (can be regulated with SW)	x							integrated	80 x 21 x 12		
		OEM RFID UHF Module / TTL	OEM-UHF-M800-TTL / 232	x			860-925M										incl. EPC Class 1 Gen 2				ALIEN Higgs3 Gen2 NXP U-Code GSXM / G2XL	27dBm / 100mW (can be regulated with SW)			x			x		UFL connector for external antenna available	31 × 38 × 6.5		
	iDTRONIC	UHF Module MULTI ISO TTL / USB	OEM-UHF-M900-TTL/USB	x			860-925M										incl. EPC Class 1 Gen 2				ALIEN Higgs3 Gen2 NXP U-Code GSXM / G2XL	27dBm / 100mW (can be regulated with SW)	x		x					UFL connector for external antenna available	25 x 30 x 5		
	iDTRONIC	Embedded UHF RFID Module TTL / USB	OEM-UHF-M950-TTL / 232	x			860-925M										incl. EPC Class 1 Gen 2				ALIEN Higgs3 Gen2 NXP U-Code GSXM / G2XL	27dBm / 100mW (can be regulated with SW)	x		x					UFL connector for external antenna available	66 x 45 x 6.5		

Reader Devices – Selection Guide

Parameters	Manufacturer	Description	Order Code	Frequency (Hz)			ISO 18000-6C	ISO 14443 A	ISO 14443 B	ISO 18000-6C	ISO 18000-3	Supported Tags	Power Supply	Interface USB	Antenna	Dimensions (mm)	Weight (g)
				LF	HF (NFC)	UHF											
USB Readers	iDTRONIC	Stick Reader EVO UHF	R-STICK-EVO-UHF R-STICK-EVO-UHF-HID			865-868M				incl. Class 1 Gen2		Alien Higgs 2/3/4m Impinj Monza, NXP UCODE, etc.	5V	x	internal, linear polarised	83.5 x 36 x 11.2	20
		Desktop Reader EVO UHF	R-DT-EVO-UHF R-DT-EVO-UHF-HID			865-868M				incl. Class 1 Gen 2		Alien Higgs 2/3/4m Impinj Monza, NXP UCODE, etc.	5 V	x	internal, linear polarised	125.5 x 69 x 27	95
		Stick Reader EVO NFC	R-Stick-EVO-NFC		13.56M		EM4135, EM4043, EM4x33, EM4x35, ICode SLI / SLIX, M24LR16/64, TI Tag-it HF-I, SRF55Vxx (my-d vicinity)	Read/write: MIFARE® Classic/1K/4K, MIFARE Ultralight®/C, MIFARE® DESFire®EV1/2, MIFARE® Smart MX, MIFARE® Plus S / X, MIFARE® Pro X, NTAG 21x, Read UID only of all other ISO14443A RFID tags	SRI4K, SRIX4K, AT88RF020, 66CL160S, SR176		I-Code ILT-M		5V	x	internal	75 x 20 x 10	15
		Desktop Reader NEO 2 (HF Version) Desktop Reader NEO 2 (HF Version, preconfigured to HID) Desktop Reader NEO 2 (HF PC/SC Version)	R-DT-NEO2-HF R-DT-NEO2-HF-HID R-DT-NEO2-HF-PC/SC		13.56M								5V	x	internal	115 x 70 x 17	90
		Desktop Reader NEO 2 (Dual Frequency HF + LF Version)	R-DT-NEO2-HF/LF	125K	13.56M								5V	x	nternal	115 x 70 x 17	90
		Desktop Reader NEO 2 (LEGIC Version)	R-DT-NEO2-LEG		13.56M								5V	x	internal	115 x 70 x 17	90
		Desktop Reader NEO 2 (LF Version) Desktop Reader NEO 2 (LF Version, preconfigured to HID)	R-DT-NEO2-LF R-DT-NEO2-LF-HID	125K								EM4200, Hitag1 , Hitag2	5V	x	internal	115 x 70 x 17	90
Cylindrical Readers	iDTRONIC	UHF Cylindrical Reader BLUEBOX - RS232 UHF Cylindrical Reader BLUEBOX - RS485 UHF Cylindrical Reader BLUEBOX - SAE J1939 UHF Cylindrical Reader BLUEBOX - CANopen	R-IN-UHF-5224U R-IN-UHF-5225U R-IN-UHF-5226U R-IN-UHF-5227U			865-868M				incl. Class 1 Gen2		Alien Higgs 2/3/4m Impinj Monza, NXP UCODE, etc.	10-36VDC		internal	M30 x 1.5 x 90.65	115
		HF NFC Cylindrical Reader BLUEBOX - M12 without cable - RS232 HF NFC Cylindrical Reader BLUEBOX - M12 without cable - RS485 HF NFC Cylindrical Reader BLUEBOX - Cable 1.5 m with open ends - RS232 HF NFC Cylindrical Reader BLUEBOX - Cable 1.5 m with open ends - RS485	R-IN-HF-5224H R-IN-HF-5225H R-IN-HF-5227H R-IN-HF-5228H		13.56M		x	x	x			MIFARE Family	10-36VDC		internal	M30 x 1.5x 78	220
Short Range Readers	iDTRONIC	UHF Short Range Reader BLUEBOX - RS232/RS485 UHF Short Range Reader BLUEBOX - USB VCP UHF Short Range Reader BLUEBOX - USB HID UHF Short Range Reader BLUEBOX - SAE J1939 UHF Short Range Reader BLUEBOX - CANopen	R-IN-UHF-5721U R-IN-UHF-5721U-USB R-IN-UHF-5721U-HID On Request (MOQ: 20 Units) On Request (MOQ: 20 Units)			865-868M				incl. Class 1 Gen2		ALIEN Higgs3 Gen2 NXP U-Code GSXM / G2XL	10-36VDC	x	internal	120 x 122 x 37	400
Mid Range Readers	iDTRONIC	UHF Mid Range Reader BLUEBOX - Basic Version ETSI UHF Mid Range Reader BLUEBOX - Real Time Clock ETSI UHF Mid Range Reader BLUEBOX - Wiegand Interface ETSI UHF Mid Range Reader BLUEBOX - CANbus (J1939) UHF Mid Range Reader BLUEBOX - Basic Version FCC UHF Mid Range Reader BLUEBOX - Real Time Clock FCC UHF Mid Range Reader BLUEBOX - Wiegand Interface FCC	R-IN-UHF-5426U-G R-IN-UHF-5426U-RTC-G R-IN-UHF-5427U-G R-IN-UHF-5428U-G R-IN-UHF-5426U-G-FCC R-IN-UHF-5426U-RTC-G-FCC R-IN-UHF-5427U-G-FCC			840-960M				incl. Class 1 Gen2		Alien Higgs 2/3/4, Impinj Monza, NXP UCODE, etc.	10-36VDC		internal	190 x 190 x 80	900
Long Range Readers	iDTRONIC	UHF Long Range Reader BLUEBOX - RJ45 Ethernet + RS232/485 UHF Long Range Reader BLUEBOX - RJ45 Ethernet + RS232/485 + Real Time Clock UHF Long Range Reader BLUEBOX - M12 Ethernet + RS232/485 UHF Long Range Reader BLUEBOX - M12 Ethernet + RS232/485 + Real Time Clock UHF Long Range Reader BLUEBOX - M12 Wiegand UHF Long Range Reader BLUEBOX - M12 CANbus (SAE J1939 or CANopen) + Ethernet	R-IN-UHF-5345U R-IN-UHF-5345U-RTC R-IN-UHF-5346U R-IN-UHF-5346U-RTC R-IN-UHF-5347U R-IN-UHF-5348U			840-960M				incl. Class 1 Gen 2		Alien Higgs 2/3/4, Impinj Monza, NXP UCODE, etc.	10-36VDC		Two external (50 Ω) TNC-female	110 x 140 x 62	700
Panel Readersd	iDTRONIC	HF NFC Panel Reader NEO - USB HF NFC Panel Reader NEO - RS232	R-IN-DES-PAN-USB R-IN-DES-PAN-RS232		13.56M		EM4135, EM4043, EM4x33, EM4x35, ICode SLI / SLIX, M24LR16/64, TI Tag-it HF-I, SRF55Vxx (my-d vicinity)	Read/write: MIFARE® Classic/1K/4K, MIFARE Ultralight®/C, MIFARE® DESFire®EV1/2, MIFARE® Smart MX, MIFARE® Plus S / X, MIFARE® Pro X, NTAG 21x, Read UID only of all other ISO14443A RFID tags	SRI4K, SRIX4K, AT88RF020, 66CL160S, SR176		I-Code ILT-M		5VDC	x	internal	Panel cut-out: ø 22.3 mm Cable Length: 80 cm (other lengths on request)	35
Wall readers	iDTRoonic	HF NFC Access Reader EVO - TCP / IP HF NFC Access Reader EVO - RS485 HF NFC Access Reader EVO - TCP / IP (Read-Only)	R-EA-WR-ET-HF R-EA-WR-485-HF R-EA-WR-ET-HF-RO		13.56M								12 Vdc (±5 % regulated)		internal	110 x 56 x 18	50
		HF NFC Access Reader NEO - RS485	R-EA-WR-ID500-HF-485		13.56M							MIFARE® Classic Mini / 1K / 4K	12 Vdc (±5 % regulated)		internal	110 x 56 x 18	50





Wireless Protocols / Proprietary Protocols

Further technologies are available to build up wireless mesh networks. Some protocols are based on top of the IEEE802.15.4 specification (PHY and MAC layer specification) which is the standard for low data rate, low power networks. The advantage is the possibility to change the transceiver from one supplier to another, so you are more independent than using a single source. The disadvantage is the specification itself. The DSSS modulation, having 5 MHz per channel and only 16 channels available is very often not the perfect choice for an application because it needs more energy and frequency resources than other modulation schemes. Also IEEE802.15.4 solutions are often based on SoCs instead of separated transceiver and microcontroller. In case of using a SoC the advantage of being independent from a single source is not given.

Thread

Thread is based on IEEE 802.15.4. 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.

Part of this security protocol is:

- Interoperability
- Cryptographic protection of the transmitted data
- Access control
- Integrity of data
- Authentication of transmitter (user authentication)
- Encryption
- Authentication of keys
- Administration of keys (key management)
- The Thread Group has some strong market drivers in its board, so we would not wonder if it will be the de facto standard for home applications soon.

ZigBee

Zigbee is based on IEEE 802.15.4. The technology supports large mesh networks and operates globally in 2.4 GHz unlicensed bands. Transport and application layers are defined by the CSA which aims to create IoT standards.

Zigbee is already widely adopted and includes a mature application layer called the Zigbee Cluster Library. Zigbee uses the counter mode (CTR) encryption, which has a 128 bit AES length and the cipher block chaining (CBC) with a 128 bit AES for the generation of the message integrity code (MIC). Within Zigbee a Trust Center (TC) device is determining and approving who wants to join the network. The Trust Center either instructs the router to authenticate the joined device or force it to leave.

There are three types of Zigbee security keys to protect the data: link, network and master/ application keys. All of them are symmetric.

EnOcean delivers under their Dolphin brand energy harvesting solutions also for 2.4 GHz ZigBee systems. The PTM 216Z for examples enables the realization of battery-less wall switches for smart home applications using the ZigBee Green Power standard. The use of ECO 200 plus the transmitter module PTM 535Z allows the design of e.g. remote controls, key card switches or industrial switches.

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.

6LoWPan

6LoWPan is an acronym for IPv6 over low power Wireless Personal Area Networks and is another protocol using IEEE 802.15.4. The working group IETF (Internet Engineering Task Force) created the basis for connecting wireless sensor networks with the internet. The specialty of this protocol is that it is not proprietary and is an open IoT networking protocol. It is able to connect to the internet and thus offers the possibility to allocate an unique IP address to every single device. Furthermore in contrast to other proprietary protocols it is able to communicate with other IEEE 802.15.4 devices and can operate with devices on other IP networks link (e.g. Wi-Fi).

Well suitable applications for 6LoWPan can be found in e.g. building management, transport business and healthcare management.

EnOcean Wireless Standard

The EnOcean radio standard (ISO/IEC 14543-3-1X) operates in license-free 868 MHz (Europe, RED regulations), 902 MHz (North America, FCC/IC specifications) and 928 MHz (Japan, ARIB specification) frequency bands with 1% duty cycle and a reliable radio range of approx. 30m indoors and 300 meters in free field. For sending a signal in the EnOcean standard there is only an extremely small amount of energy necessary: Already 50 µWs are enough for a standard EnOcean energy harvesting wireless module to transmit a signal. Radio telegrams are of extremely short signal duration of maximum one millisecond enabling maintenance free sensor designs. Communication of the EnOcean solutions is possible via Gateways to bus systems like KNX, LON, DALI, BACnet or TCP/IP.

Wirepas


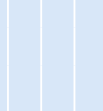
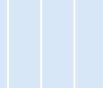


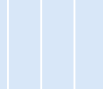
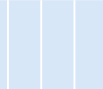

Wirepas connectivity technology is an automated multi-hop, self-configuring, self-healing low power wide-area mesh network. It's an ideal solution for large-scale industrial and infrastructure IoT applications such as smart meters and smart cities.

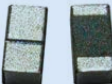







All the Wirepas Connectivity intelligence is in the network. The devices decide the best actions by themselves locally. No central network management is needed. The local decision-making ensures that the devices always operate the similar way, independent of the network size or the devices' locations within the network. Through Wirepas, devices can automatically choose their role according to the situation. This means that every device is a possible routing point for forwarding data. The user does not need to define the roles of the devices, this is done automatically depending on what the optimal topology is at a given time.

Wirepas devices can act synchronously, and co-operatively select the times and channels used for communication. All the available channels in a given band can be used. Whenever two devices want to communicate with each other they know the channel and the exact times to send and receive. This way all unnecessary overhead, such as overhearing, idle listening, and intra-network collisions, are removed. Furthermore Wirepas devices can communicate data over multiple hops. The topology is optimized continuously and adapts to changes in the environment and the network. For each device there are multiple routing options (next hops), and multiple Gateways (backhaul connection) can be used in the same network.






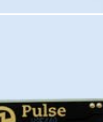



Embedded Antennas









Manufacturer	Part	Picture	Standard								Antenna Type	Frequencies	Peak Gain (dBi)	Efficiency (%)	VSWR	Size (mm)	Polarization	Return loss (dB)	Temperature (C)	Impedance (Ohm)
			RFID	GSM / 2G	UMTS / 3G	LTE / 4G	ISM Standard	Bluetooth	WLAN	GNSS										
Moxel	2065130001						x	x	x		Ceramic	2.4 GHz	~3.6	55	*	3.0 x 3.0 x 4.0	Linear	< -6	-40 to +85	50
	1462350001									x	Helical	1561 MHz	~0.7	>50%	*	5.0 x 3.0 x 4.0	RHCP	< -8	-40 to +85	50
												1575 MHz	~1.1	>55%						
												1602 MHz	~1.1	>50%						
	2066400001									x	Adhesive	1564-1607 MHz	~4.5	*	2.5	25 x 25 x 6.5	RHCP	< -8	-40 to +85	50
Pulse	W3008C						x	x	x		Ceramic	2400-2483.5 MHz	~1.3	68	*	3.2 x 1.6 x 1.1	Linear	-8	-40 to +85	50
	W3008						x	x	x		Ceramic	2400-2483.5 MHz	~1.1	66	*	3.2 x 1.6 x 1.1	Linear	-4	-40 to +85	50
	W3325			x							Ceramic	791-960 MHz	~1.3	>55	*	14 x 7 x 1.5	Vertical	5dB	-40 to +85	50
	W3326			x	x						Ceramic	791 - 960 MHz	~0.6	>50	*	20 x 7 x 1.5	Vertical	5dB	-40 to +85	50
												1710 - 2170 MHz	~2.3	>55						
	W3043						x	x	x	x	Ceramic	1575.42 MHz	~0.35	43	*	3.2 x 1.6 x 1.1	Linear	-15	-40 to +85	50
											2400-2483.5 MHz	~4	70	-12						

Manufacturer	Part	Picture	Standard								Antenna Type	Frequencies	Peak Gain (dBi)	Efficiency (%)	VSWR	Size (mm)	Polarization	Return loss (dB)	Temperature (C)	Impedance (Ohm)	
			RFID	GSM / 2G	UMTS / 3G	LTE / 4G	ISM Standard	Bluetooth	WLAN	GNSS											UWB
Pulse	W3340										x	Ceramic	6-8.5 GHz	>1.5	>65	*	3.2 x 1.6 x 1.1	Linear	9	-40 to +85	50
	W3540										x	Ceramic	2700-8200 MHz	~5.89	81	~2:1	12.5 x 10.6 x 0.8	Vertical	10	-40 to +85	50
	W3015L						x					Ceramic	433 MHz	~2.5	35	*	10 x 3.2 x 4	Linear	*	-40 to +85	50
	W3078						x	x	x			Ceramic	2400 – 2483.5 MHz	~1,7	65	*	3.2 x 1.6 x 1.1	Linear	-10	-40 to +85	50
											4950 – 5850 MHz		~4,3	80	*	-6					
	W3079						x	x	x			Ceramic	2400–2483.5 MHz	~2.4	70	< 1.9	3.2 x 1.56 x 1.1	Linear	*	-40 to +85	50
											5150–5850 MHz		~5.7	77	< 2.5	*					
	W7001		x									Flex Stamp	13.56 MHz	*	*	*	25 x 25 x 0.12	*	*	-40 to +85	50 / 80
W7002		x										13.56 MHz	*	*	*	94.6 x 56.8 x 3.65	*	*	-40 to +85	50 / 80	
W3211						x						Ceramic	902-928 MHz	~1.35	43	*	10 x 3.2 x 5	Linear	-10	-40 to +85	50













Embedded Antennas













Manufacturer	Part	Picture	Standard							Antenna Type	Frequencies	Peak Gain (dBi)	Efficiency (%)	VSWR	Size (mm)	Polarization	Return loss (dB)	Temperature (C)	Impedance (Ohm)
			RFID	GSM / 2G	UMTS / 3G	LTE / 4G	ISM Standard	Bluetooth	WLAN										
Pulse	W3214					x				Ceramic	863-873 MHz	~1	38	*	10 x 3.2 x 5	Linear	-20	-40 to +85	50
	W3012					x				Ceramic	902 – 928 MHz	~2	70	*	10 x 3.2 x 4	Linear	-6	-40 to +85	50
	W3796		x	x	x				Ceramic	698-960 MHz	~1.5	65	~3:1	40 x 7 x 3	Linear	6dB	-40 to +85	50	
										1427.9-1660.5 MHz	~2	55							
										1695-2200 MHz	~5.5	75							
										2300-2700 MHz	~5	70							
	W3544A		x	x					Ceramic	824 - 960 MHz	~1.9	65	*	7.65 x 26 x 3	Linear	-4.1	-40 to +85	50	
										1710 - 1880 MHz	~1.3	74				-4.6			
										1850 - 1990 MHz	~1.3	74				-16.3			
										1920 - 2170 MHz	~1.66	68				-12.3			
W3070		x	x	x					880-960 MHz	~1.2	65	*	10 x 3.2 x 2	Linear	-5.1	-40 to +85			
									1710-1880 MHz	~2.5	60				-5.8				
W3056						x	x	x	Ceramic	1558-1616 MHz	~0.5	45	*	10 x 3.2 x 1.5	Linear	-5	-40 to +85	50	
										2.4-2.5 GHz	~2	65				-7			
W3320					x		x		Ceramic	868/915 MHz	~1	64	*	3.2 x 10 x 2	Vertical	<-7dB	-40 to +85	50	
										2.4 GHz	~3	68				<-5dB			

Manufacturer	Part	Picture	Standard							Antenna Type	Frequencies	Peak Gain (dBi)	Efficiency (%)	VSWR	Size (mm)	Polarization	Return loss (dB)	Temperature (C)	Impedance (Ohm)	
			RFID	GSM / 2G	UMTS / 3G	LTE / 4G	ISM Standard	Bluetooth	WLAN											GNSS
Yageo	ANT3216LL00R2400A						x	x		Ceramic	2.4 GHz	5	*	*	3.2x1.6x1.2	Linear	~10	-40 to +105	50	
	ANT1608LL14R2400A						x	x	x		Ceramic	2.4 GHz	2.0	*	6.0 max	1.6x0.8x0.4	Linear	~8	-40 to +105	50
	ANT1818B00AT1575S									x	Patch	1575 MHz	2	*	1.5 max	18x18x2	RHCP	~10	-40 to +105	50
	ANT8010LL05R1516A									x	Ceramic	1575-1602 MHz	1.69	*	*	8.0x1.0x1.0	Linear	~10	-40 to +105	50
	ANT1818B00BT1516S									x	Patch	1575-1606 MHz	2.59	*	2:1	18x18x4	RHCP	~10	-40 to +105	50
	ANT2525B00DT1516S									x	Patch	1575-1606 MHz	5	*	2	25x25x4	RHCP	~10	-40 to +105	50
	ANT1204LL00R0918A		x								Ceramic	900 MHz	1.6	*	3.0 max	12.0x4.4x1.2	Linear	~10	-40 to +105	50
												1800 MHz	1.08							
ANT3505B002TWPENS		x	x							Ceramic	824-960 MHz	2.9	*	2.8 max	35x5x6	Linear	~7	-40 to +105	50	
											1710 - 2170 MHz			3.5 max						

*Not specified by supplier














Internal Antennas

















Manufacturer	Part	Picture	Standard							Antenna Type	Frequencies	Peak Gain (dBi)	Efficiency (%)	Size (mm)	Polarization	Cable Length (mm)	Connector	Impedance
	GSM / 2G		UMTS / 3G	LTE / 4G	ISM Standard	Bluetooth	WLAN	GNSS	NFC									
2J	2JF0415P					x				FPC / Adhesive	868 MHz	2.7	58	25 x 70 x 0.2	Linear	100	U.FL compatible	50
												915 MHz	3.6					
AVX electronics	1002289		x	x	x					FPC	698-960 MHz	*	7400%	53.6 x 25.1 x 0.2	Linear	25	U.FL / I-PEX	50
												1710-2690 MHz	*					
molex	1052630003		x	x	x					FPC / Adhesive	824-960 MHz	2.2	*	106.7 x 13 x 0.1	Linear	200	U.FL / I-PEX	50
												1710-2690 MHz						
	479501011					x	x	x		FPC / Adhesive	2.4 GHz	3.0	>80	35.9 x 15.9 x 0.1	Linear	150	U.FL / I-PEX	50
												5 GHz	4.8					
	1052620001					x				FPC / Adhesive	868 MHz	0.4	*	79 x 10 x 0.1	Linear	100	U.FL / I-PEX	50
												915 MHz						
	2084820150					x	x	x		FPC / Adhesive	2.4 GHz	3.2	62% (Port1), 72% (Port2)	55.2 x 19.2 x 0.16	Linear	150	U.FL / I-PEX	50
												5 GHz	5.7					
	2065600100								x	FPC / Adhesive	1561 MHz	0.9	>72	40.4 x 15.4 x 0.1	Linear	100	U.FL / I-PEX	50
												1575 MHz	1.0					
	2069950150					x	x	x		FPC / Adhesive	1602 MHz	1.37	>73	20.5 x 20.5 x 3	Linear	150	U.FL / I-PEX	50
												2.4 GHz	2.6					
	1462340100		x	x	x					FPC / Adhesive	698 MHz	1.8	>70	140 x 20 x 0.1	Linear	100	U.FL / I-PEX	50
												1500 MHz						
	2072350100		x	x	x					FPC / Adhesive	2.7 GHz	5.0	>30	40.4 x 15.4 x 0.1	Linear	100	U.FL / I-PEX	50
												824 MHz						
				x	x	x					1710 MHz	4.3	>60					

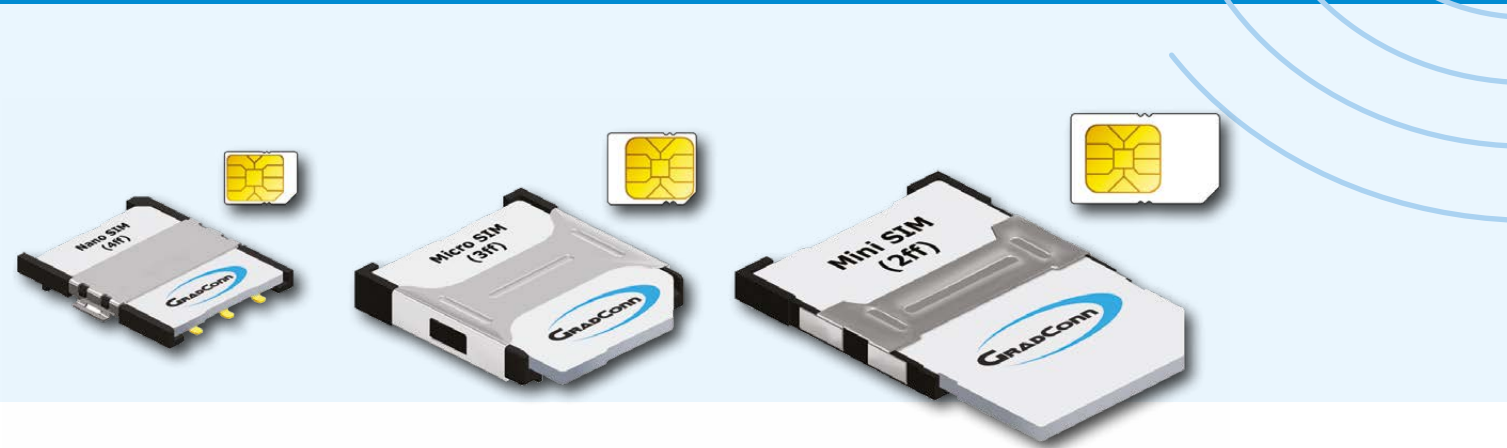
Manufacturer	Part	Picture	Standard							Antenna Type	Frequencies	Peak Gain (dBi)	Efficiency (%)	Size (mm)	Polarization	Cable Length (mm)	Connector	Impedance
	GSM / 2G		UMTS / 3G	LTE / 4G	ISM Standard	Bluetooth	WLAN	GNSS	NFC									
Pulse	W3915		x	x				x		PCB	880-960 MHz	1	50	74 x 19	Linear	100	U.FL compatible	50
											1710-2170 MHz	2	75					
											1565-1605 MHz	0.5	55					
	W3334B0150					x	x	x		Adhesive	2400-2500 MHz	4	50	4.3 x 15.3 x 0.1	Linear	150	U.FL compatible	50
											4900-6000 MHz	5.5	70					
	W3554B0140		x	x	x	x	x	x	x	FPC / Adhesive	698-960 MHz	1.9	45	30 x 120 x 0.2	Linear	143	U.FL compatible	50
											1400-1600 MHz	2.5	53					
											1710-2690 MHz	3.2	66					
									3300-3800 MHz		3.3	57						
									4900-6000 MHz	3.5	37							
W3312XXXXXX					x				FPC / Adhesive	863-928 MHz	0.8	45	75 x 15	Linear	100	U.FL compatible	50	
Yageo	ANTX100P001B24553						x	x		PCB	2400 - 2500 MHz	4.6	81	50 x 10 x 0.95	Linear	100	U.FL / I-PEX	50
											5150 - 5875 MHz	3.9	62					
	ANTX100P001BWPN3		x	x						PCB	850-960 MHz	5.1	68	50 x 10 x 0.95	Linear	100	U.FL / I-PEX	50
											1800-2100 MHz	5.0	76					
iDTRONIC	A910: 20 x 30 mm - M8 U.FL A911: 20 x 30 mm - M8 U.FL								x	PCB	13.56 MHz						U.FL or Molex PicoBlade 53261	50
	A912: 35 x 50 mm - M8 U.FL								x									
	A913: 80 x 80 mm - M8 U.FL								x									
	A914: 60 x 80 mm - M8 U.FL								x									
	A915: 45 x 86 mm - M8 U.FL								x									
	A916: 49 x 55 mm - M8 U.FL								x									

*Not specified by supplier

External Antennas

Manufacturer	Part	Picture	Standard						Antenna Type	Frequencies	Peak Gain (dBi)	Eff. (%)	VSWR	Size (mm)	Polarization	Cable Length (mm)	Connector	Impedance (Ohm)
			GSM / 2G	UMTS / 3G	LTE / 4G	ISM Standard	Bluetooth	WLAN										
2J	2J301M		x	x					Magnetic Mount	824-960 MHz	~1.7	~49	~1.6:1	30.9 x 71.5	Linear	3000	SMA-Male	50
										1710-2170 MHz	~0.3	~28	~1.8:1	30.9 x 71.5	Linear	3000	SMA-Male	50
	2J664B		x	x		x	x	x	Body Mount	824-2400 MHz	~2.2	*	<2.6:1	77.4 x 15.9	Linear	2500	FME-Female	50
	2J620PF		x	x					Adhesive Mount	824-960 MHz	~1.5	~43	~1.6:1	Ø77 x 12	Linear	3000	SMA-Male	50
								x		1710-2170 MHz	~0.5	~32	~2.4:1					
	2J6602B					x	x	x	Screw Mount	2410-2490 GHz	~4.9	~48.7	~1.5:1	Ø77.3 x 15	Linear	3000	RP-SMA-Male	50
										4920-5925 GHz	~4.5	~29.2	~1.5:1					
	2J5115-XXX					x			Adhesive Mount, Flexible	433/ 868/ 915 MHz	3,4	62,4	1,2	122 x 14 x 6	Linear	3000	multiple connectors available	50
	2J0202					x	x	x	Connector Mount	2410-2490 GHz	~4.0	~60	~1.4:1	56 x 9.5	Linear	-	RP-SMA-Male	50
										4920-5925 GHz	~5.2	~83	~1.7:1					
	2J050		x	x			x	x	Connector Mount	824-2400 MHz	~2.2	*	<2.5:1	54 x 6.7-9.65	Vetical	-	SMA-Male	50
	2J6A24BA		x	x	x				Screw Mount	698-960 MHz	~0.8	~35	~2.8:1	Ø77.3 x 65.5	Linear	3000	SMA-Male	50
										1710-2170 MHz	~2.5	~51	~1.7:1	Ø77.3 x 65.6				
										2500-2700 MHz	~3.4	~49	~1.3:1	Ø77.3 x 65.7				
	2J300M		x	x	x				Magnetic Mount	698-960 MHz	~1.0	~47	~1.9:1	Ø31 x 72	Linear	3000	SMA-Male	50
										1710-2170 MHz	~2.4	~39	~1.5:1					
										2500-2700 MHz	~2.1	~36	~1.3:1					
	2J670B		x	x			x	x	Body Mount	824-2170 MHz	2.2 max	*	<2:1	77.3 x 36.5	Horizontal	2500	C1(Mobile): FME-Female; C2 (Navigation): SMA-Male	50
										1575.42 MHz	*	*	<1.2:1		RHCP			
	2J0B15					x			Connector Mount	433/ 868/ 915 MHz	1,2	69,3	1,8	44-48 x 19,1 x 9	Linear	-	SMA-Male-R/A	50
	2J6050PGF		x	x	x	x	x	x	Adhesive Mount	698-960 MHz	~2.9	~55.6	~2.2:1	80 x 76 x 16	Linear	3000	SMA-Male	50
										1710-2170 MHz	~3.2	~56.0	~1.2:1					
										2500-2700 MHz	~2.1	~38.7	~2.2:1					
										2410-2490 MHz	~3.2	~50	~1.3:1				RP-SMA-Male	
										4920-5925 MHz	~4.2	~30	~1.3:1				SMA-Male	
	2J7624B		x	x	x	x	x	x	Screw Mount	698-960 MHz	2.6	56	2.1:1	Ø50 x 50.08	Linear	3000	SMA-Male	50
										1710-2170 MHz	3.2	56	1.8:1					
										2500-2700 MHz	1.4	38	2.5:1					

Manufacturer	Part	Picture	Standard						Antenna Type	Frequencies	Peak Gain (dBi)	Eff. (%)	VSWR	Size (mm)	Polarization	Cable Length (mm)	Connector	Impedance (Ohm)	
			GSM / 2G	UMTS / 3G	LTE / 4G	ISM Standard	Bluetooth	WLAN											GNSS
AVX ethertronics	1002857							x	Helical	1575 MHz	~3.0	27	2.0:1 max	Ø15.0 x 34.93	RHCP	-	SMA-Male	50	
	9000984				x				Screw Mount	790 MHz	~2.2	40	2.0:1	196 x 13	Linear	-	SMA-Male	50	
								868 MHz		~2.2	80								
								915 MHz		~3.4	75								
chinmore	AA-C02MT07FME-397		x						Magnetic Mount	900 MHz	~0.45	75	1.26:1	Ø26.7 x 79	Linear	3000	FME-Female	50	
	AA-C13M05SMA-1107		x						Magnetic Mount	900 MHz	~1.71	60	1.85:1	Ø52.2 x 343.7	Linear	3000	SMA-Male	50	
										1800 MHz	~3.68	63	1.69:1						
	EM-B10.0X106-069						x	x	Connector Mount	2.4 GHz	~3.5	45	1.7:1	Ø67.5 x 108.0	Linear	-	SMA-Male		
	EM-W117G-2ANT-240					x			Connector Mount	868 MHz	0~3	*	2.0:1	Ø37 x 112.6	Vertical	-	SMA-Male	50	
	GS-10D174MCX-198							x	Adhesive Mount	1575.42 MHz	~3.8	*	2.0:1	38.2 x 34.2	RHCP	300	MCX-Male	50	
	CA-C09-1SMAM-094		x						Adhesive Mount	840-960 MHz	~3.06	59	1.72:1	129.5 x 22.8	Linear	3000	SMA-Male (90°)	50	
									1760-1860 MHz	~5.23	88	1.30:1							
	EM-B9.3X33.0-168						x	x	Connector Mount	2.4 GHz	1.3	*	2.0:1	Ø9.4 x 33	Vertical	-	SMA-Male	50	
	EM-9.10X55.8-058		x	x					Connector Mount	824-960 MHz	~2.3	*	2.5:1	Ø6.5 x 56.6	Vertical	-	SMA-Male	50	
									1710-2170 MHz	~2.5									
	EM-W79B-7ANT-108		x	x					Connector Mount	824-2170 MHz	~2.8	*	5.6:1	Ø9.3 x 114	Vertical	-	FME-Female	50	
CA-C09-1FMEF-019		x	x					Adhesive Mount	900-1800 MHz	~1.78	42	1.36:1	129.5 x 22.8	Linear	3000	FME-Female	50		
									~4.77	81	1.45:1								
molex	2068663000				x		x	x	Adhesive Mount	824-1710 MHz	~0.5	21	3 max	Ø77 x 15	Linear, RHCP	3000	FAKRA	50	
Pulse	W5028x					x	x	x	Connector Mount	1575 MHz	~2.7	23							
											2.4 GHz	3.0							27
											2.4-2.5 GHz	1.9	>80						
	W5084x		x	x	x				Connector Mount	698-960 MHz	2	58	3 max	228.84	Vertical	-	TNC-Male/ SMA-Male	50	
											1400-2690 MHz	4	78						3.6 max
											3400-3700 MHz	5	60						3 max
	W5017					x			Connector Mount	868-928 MHz	0.9	70	2.5 max	179	Vertical	-	SMA-Male	50	


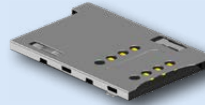


SIM Card Holders




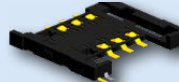
A SIM (Subscriber Identification Module) card is an integrated circuit that stores mobile subscriber identity to authenticate subscribers of mobile phone devices. The standard SIM card (Mini SIM -2FF) has been used since 1996 but with the release of Apple iPhone 4 in 2010 the smaller Micro SIM (3FF) started to become more popular in mobile phones. The Micro SIM has the same thickness and contact arrangement as the standard SIM card. Micro SIM also uses the same size and position of pins as the standard SIM card. The card size for Micro SIM card is 12mm x 15mm x 0.76mm compared with 15 mm x 25 mm x 0.76 mm for standard SIM card. Nano SIM (4FF) was released 2012 and once again it was Apple that first adopted the new standard with the iPhone 5. The Nano SIM use the same contact arrangement but is more thinner compared to Mini SIM and Micro SIM. The measurement for Nano SIM is 8.8 mm x 12.3 mm x 0.67 mm.



Push/Push SIM Card Holder

Type	CH03-DD060-A	
Format	Mini SIM (2FF)	
Number of contacts	6	
Height	1.9 mm	
Durability	5000 cycles	
SIM card detection switch Optional location peg		

Type	CH03-GB060-ABR	
Format	Micro SIM (3FF)	
Number of contacts	6	
Height	1.5 mm	
Durability	1500 cycles	
SIM card detection switch		



Push SIM Card Holder

Type	CH03-AA060-A	
Format	Mini SIM (2FF)	
Number of contacts	6	
Height	2.4 mm	
Durability	10000 cycles	
SIM card detection switch Optional location peg		

Type	CH03-FB060-OBR	
Format	Micro SIM (3FF)	
Number of contacts	6	
Height	2.4 mm	
Durability	5000 cycles	
No SIM card detection switch No location peg		

Type	CH03-KB060-HAR	
Format	Nano SIM (4FF)	
Number of contacts	6	
Height	1.35 mm	
Durability	1500 cycles	
Location peg		

Flip SIM Card Holder

Type	CH03-BH060-A	
Format	Mini SIM (2FF)	
Number of contacts	6	
Height	2.5 mm	
Durability	5000 cycles	
SIM card detection switch Optional location peg		



Timing Devices



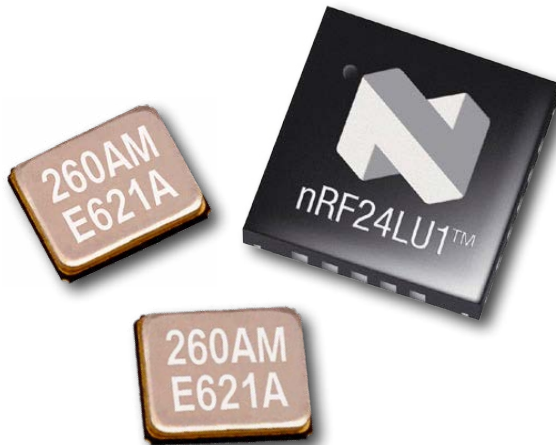
Epson provides many applicable oscillation devices for IC manufactures' products. Rutronik has more detailed information about IC reference designs of many other IC manufacturers. Please contact us for further information. The leading quartz timing devices manufacturer Epson is the only manufacturer of electronic components with in-house competencies for QMEMS Timing Devices and for semiconductors. This combination is the base for outstanding product properties and excellent competitiveness.

Reference Design Information

IC Manufacturer	Product	IC Name	Frequency	ETC P/N
Fujitsu Microelectronics	WiMAX	MB39C316	32.768000 kHz	FC-12M
Fujitsu Microelectronics	WiMAX	MB86K23	48.000000 MHz	FA-128
Intel	MCU (CPU)	Hartsville (Moorestown platform)	32.768000 kHz	FC-135
Intel	Smartphone	Lightning Peak	38.400000 MHz	FA-20H
Intel	WiFi	Crane Peak (-30/85°C)	40.000000 MHz	TSX-3225
Intel	WiFi	Crane Peak (-40/85°C)	40.000000 MHz	TSX-3225
Intel	WiFi	Jackson Peak Marble/Wilkins Peak	40.000000 MHz	FA-20H
Nordic Semiconductor	Bluetooth LE	nRF-24LU1	16.000000 MHz	FA-20H TSX-3225
Nordic Semiconductor	Bluetooth LE	nRF-80xx	16.000000 MHz	FA-20H
Nordic Semiconductor	Bluetooth LE	nRF-80xx	32.000000 MHz	FA-128
Nordic Semiconductor	ISM	nRF-24Axx	16.000000 MHz	FA-20H TSX-3225
Nordic Semiconductor	NFC	nRF51x22	32.000000 MHz	FA-20H
Nordic Semiconductor	sub 1GHz RF	nRF-9E5_05	16.000000 MHz	TSX-3225
Nordic Semiconductor	ZigBee	nRF51x22	16.000000 MHz	FA-20H
Nordic Semiconductor	ZigBee	nRF52xx	32.000000 MHz	FA-20H FA-128
Nordic Semiconductor	ZigBee	nRF52xx (-40/85°C)	32.000000 MHz	FA-128 FC-135
Renesas	WirelessHD	R8J43011A	32.768000 kHz	SG3031CM
Renesas	WLAN	R8J43011A	40.000000 MHz	SG-210STF
Renesas	Zigbee	M16C/6B3,6B4	16.000000 MHz	FA-20H
Renesas	Zigbee	PD78F8058	32.000000 MHz	TSX-3225
Rohm	WiFi	BW9419	40.000000 MHz	SG-211SCE



QUARTZ+MEMS
high accuracy and high stability
Micro Electro Mechanical Systems



Why is Security important?....

Threats resulting from new technologies regularly make the headlines – whether thefts of vehicles with Keyless Go, illicit surveillance scandals, data theft, disclosure of passwords on the Internet, or phishing attacks. However, the greatest damage is in most cases not suffered by the users: Once negative publicity has stuck to a product, or a manufacturer, it becomes a serious threat to the business.

Encryption technologies offer comparatively cost-effective protection. When handling personal data, encryption is required by data protection laws in any case.

Security is Always a System

The issue of security is often neglected in relation to embedded systems especially. The result: Industrial spies can use hacked devices to penetrate the entire corporate network, gain access to the company's intellectual property (IP) and business secrets, and manipulate data.

Users of smart home devices might unintentionally disclose information to potential thieves through their security cameras, or even open doors and windows for them by way of automated control systems.

Automobiles are also subject to virtually infinite vulnerabilities thanks to autonomous driving and over-the-air firmware updates. When such cases become known, customers trust in the device – or even the entire business – is lost.

In view of this, encryption should be top of the priority list for all manufacturers of connected products. In order to understand encryption, it is helpful to consider what its aims are. These are focused on three key areas: authenticity, confidentiality, integrity.

When a user wirelessly connects multiple products in his home, for example, it is important that only authorized products can join the network, and that both the data in the network and the complete system are protected.

That is to say, protection must be in place against unauthorized access to the network (authenticity), data tapping (confidentiality) and manipulation (integrity).

State-of-the-art cryptography covers all three aspects. It is available in two fundamentally different modes: symmetric and asymmetric encryption.

Hardware or Software?

Each encryption method can be implemented by software or hardware. Software-based encryption entails the major disadvantage that the program is not an autonomous self-contained unit, but is always dependent on its environment, such as the operating system. It is susceptible to errors and attacks as a result. And there is another negative: As the micro-controller or processor of an embedded system additionally has to handle the complex encryption and decryption, loss of performance is inevitable.

The opposite case is represented by encryption using specially developed ICs. Their sole function is encryption, so there is no performance loss. Many encryption ICs are additionally protected against physical attacks. The security of those components – and also of the keys – is thus independent of the security of the overall system.

Encryption ICs in different designs meet the requirements of a range of applications: Simple authentication chips, such as the Infineon OPTIGA™ Authenticate S, use asymmetric encryption (ECC163), and are good choice for the authentication of original accessories in consumer electronics for example. The OPTIGA™ Trust M with ECC521 and SH512 assures authentication of medical equipment, in smart homes, in industry, or in cloud computing authentication for license management for example.

Encrypted Smart Home

A simple practical example illustrates the use of encryption ICs: In a smart home, simple authentication chips such as the OPTIGA™ Authenticate S ensure that only authorized devices – such as shutter controls or surveillance cameras installed by the user – are able to log in to the central smart home gateway.

A OPTIGA™ TPM in the central gateway assures key storage, firmware updates, and the transfer of all data to the Cloud. As a result, the e.g. Smart Home owner can be certain that authenticity, confidentiality and integrity are assured.



Selection Guide

Manu-facturer	Part Name	Security Level	Functionality	NVM (Data)	Cryptography	Type of Host System	Inter-face	Package
Infineon	OPTIGA™ TPM SLM 9670	CC EAL 4+	Security Cryptocontroller for Trusted Platform Modules	6.9 kByte	ECC, ECC BN-256, ECC NIST P-256, ECC NIST P-256, RSA1024, RSA2048, HMAC, SHA-1, SHA-256	Embedded Linux / Windows / MCU without OS / proprietary OS	SPI	PG-VQFN-32
	OPTIGA™ TPM SLB 9672	CC EAL 4+	Security Cryptocontroller for Trusted Platform Modules	51 kByte	Up to RSA4096 and ECC NIST P384 HMAC and up to SHA2-384 and AES-256	Windows / Linux	SPI	PG-UQFN-32
	OPTIGA™ TPM SLB 9673 FW26.xx	CC EAL 4+	Security Cryptocontroller for Trusted Platform Modules	51 kByte	Up to RSA4096 and ECC NIST P384 HMAC and up to SHA2-384 and AES-256	Windows / Linux	I2C	UQFN-32
	OPTIGA™ Trust M	CC EAL 6+	Connected device security	Up to 10 kB user memory	ECC: NIST curves up to P-521, Brainpool r1 curve up to 512	MCU without OS / proprietary OS / RTOS, Embedded Linux	I2C with shielded connection	USON-10
	OPTIGA™ Trust M Express	CC EAL 6+	Secure IoT devise deployment to the cloud	Up to 10 kB user memory	ECC: NIST curves up to P-521, Brainpool r1 curve up to 512, RSA with keys up to 2048 bits	MCU without OS / proprietary OS / RTOS, Embedded Linux	I2C with shielded connection	USON-10
	OPTIGA™ Authenticate S	CC EAL 6+	Enhanced device authentication	3 types of lockable NVM sizes (1 K, 2 K, 5 Kbit)	ECC 163-bit	Host code software – with new OS library	GPO, SWI, I2C	PG-TSNP-6-12
	OPTIGA™ Trust Charge	CC EAL 6+	Qi Authentication for inductive wireless charging	10 kByte	ECC: NIST P256/P384, SHA-256, TRNG, DRNG	Wireless Charging MCU, host SW for typical MCUs provided	I2C	PG-USON-10-2,-4
	OPTIGA™ Connect Consumer	CC EAL 6+	eSIM for cellular-connected consumer devices	800 kByte	RSA up to 2048 bit, ECC up to 521 bit, NIST P-256, Brainpool256r1, FRP256V1	Cellular Modem + LPA (Android or Windows)	UART	XFWLB-25-3, VQFN-8-4
	OPTIGA™ Connect IoT	CC EAL 5+	eSIM for cellular-connected IoT devices	350 kByte	SHA, DES, AES, ECC, RSA, COMP128, MILENAGE, TUAK, CAVE	Cellular Modem	UART	PG-VQFN-8-4



OPTIGA™ TPM – Trusted Platform Module

Certified Security high-end controllers for computing, IoT networking and embedded applications



OPTIGA™ TPM (Trusted Platform Module) is a standardized security controller which protects the integrity and authenticity of devices and systems in embedded networks. Built on proven technologies and supporting the latest TPM 2.0 standard, OPTIGA™ TPM highlights include secured storage for keys, certificates and passwords as well as dedicated key management. As the established, trusted market and innovation leader in the Trusted Computing space, we offer a broad portfolio of certified OPTIGA™ TPM security controllers based on the Trusted Computing Group (TCG) standard to suit all needs.

Key Features

- High-end security controller with advanced cryptographic algorithms implemented in hardware (e.g. RSA & ECC256, SHA-256, AES)
- Common Criteria (EAL4+) and FIPS security certification
- Flexible integration with SPI and I2C interface support
- Extended temperature range (-40 to +85 °C) for a variety of applications

Benefits

- Reduced risk based on proven technology
- Fast time to market through concept reuse and standardized approach
- Flexibility thanks to wide range of security functions as well as dedicated key management
- Easy integration into all platform architectures and operating systems

Target Applications

- PC and embedded computing
- Printers
- Network equipment
- Industrial control systems
- Smart Home / Smart City security and automation
- Energy generation and distribution systems
- Automotive electronics



Overview of OPTIGA™ TPM Family

SLB 9645	SLB 9670	SLM 9670	SLI 9670	SLB 9672 FW15.xx	SLB 9672 FW 16.xx	SLB 9673
<ul style="list-style-type: none">TPM 1.2I2C InterfaceBased on EAL 4+ certified hardware and firmwareTSSOP-28 or VQFN-32 packages	<ul style="list-style-type: none">SPI InterfaceEither TPM 1.2 or TPM 2.0 compliantTCG and Common Criteria EAL 4+FIPS 140-2 certifiedVQFN-32 package	<ul style="list-style-type: none">SPI InterfaceTPM 2.0 certifiedTCG and Common Criteria EAL 4+FIPS 140-2 certifiedIndustrial quality gradeVQFN-32 package	<ul style="list-style-type: none">SPI interfaceTPM 2.0 certifiedTCG and Common Criteria EAL 4+FIPS 140-2 certifiedAutomotive qualif. (AEC-Q100)VQFN-32 package	<ul style="list-style-type: none">SPI interfaceOptimized for Computing (laptops desktops /servers)TPM 2.0 CertifiedTCG and Common Criteria EAL 4+UQFN-32 packageFIPS 140-2 certified	<ul style="list-style-type: none">SPI interfaceEnhanced security features for IoT networking and connected devicesTPM 2.0 certifiedTCG and Common Criteria EAL 4+UQFN-32 packageFIPS 140-2 certified	<ul style="list-style-type: none">I2C InterfaceEnhanced security features for IoT networking and connected devicesTPM 2.0 certifiedTCG, Common Criteria and FIPS CertificationsUQFN-32 package

OPTIGA™ TPM – TPM SLM 9670

Standardized and certified TPM 2.0 security solution for industrial & demanding applications



The OPTIGA™ TPM SLM 9670 addresses the requirements of industrial and other demanding applications where an extended temperature range, an extended lifetime and industrial-grade quality are key. Pushing beyond the qualifications processes performed for standard TPMs, the OPTIGA™ TPM SLM 9670 is qualified according to the industrial JEDEC JESD47 standard to enable the requisite performance under demanding environmental conditions.

OPTIGA™ TPM SLM 9670 offers high levels of flexibility to address innovative use cases of Smart Factories and Industry 4.0 that call for robust security:

- Strong digital device ID and device authentication
- Secured communication for data confidentiality and IP protection
- Integrity protection of devices and software incl. software updates

A ready-to-use security building block, SLM 9670 is equipped with a variety of functions to secure industrial devices and systems.

These include:

- Key storage and management
- Identification and authentication
- Signature generation and verification
- Software and firmware integrity attestation
- Secured logging and secured time

Key Features

- SPI Interface
- TPM 2.0 certified
- Common Criteria EAL 4+, FIPS 140-2 level 2 certified
- Industrial quality grade
- VQFN-32 package
- Asymmetric Cryptography: ECC, ECC BN-256, ECC NIST P-256, ECC NIST P-256, RSA1024, RSA2048
- Symmetric Cryptography: HMAC, SHA-1, SHA-256

Benefits

- Standardized security chip compliant with TCG TPM 2.0 standard
- Secured storage for critical data and secrets
- Advanced protection mechanisms against physical and logical attacks
- Support for cryptographic algorithms RSA-1028, RSA-2048, ECC NIST P256, ECC BN256, SHA-1, SHA-256
- Ext. temp. range: -40 to 105 °C
- Ext. lifetime: 20 years
- JEDEC JESD47 industrial qualification
- Security evaluated and certified independently

Target Applications

- Industrial PCs, servers, Programmable Logic Controllers (PLC)
- Network infrastructure devices & equipment like gateways, routers, wireless access points, and switches





OPTIGA™ TPM SLB 9672



Ready-to-use TPM with SPI interface and PQC-protected firmware update mechanism, optimized for PCs and servers

OPTIGA™ TPM SLB 9672 is Infineon’s standardized, ready-to-use Trusted Platform Module with an SPI interface that serves as a robust foundation to identify and authenticate PCs, servers, and connected devices, and to protect data integrity and confidentiality. Feature-rich, ready for current and future security challenges OPTIGA™ TPM SLB 9672 is future-proof – it comes with extended memory and stronger cryptographic algorithms, and is the first TPM in the market that offers a PQC-protected firmware update mechanism. Integrated resiliency features allow the TPM firmware to be recovered in compliance with the NIST SP 800-193 Platform Firmware Resiliency Guidelines. This, combined with improved computational performance, takes system security to the next level.

OPTIGA™ TPM SLB 9672 is available in two versions:

OPTIGA™ TPM SLB 9672 FW15.xx

this standardized and certified security solution is the primary choice for Microsoft Windows environment/ecosystem and connected devices with PC architecture.

Target Applications

- Home & Office devices: Laptops / Desktops / Tablets, Servers, Enterprise Printers

Key Features

- High- end standardized security controller
- PQC-protected firmware update mechanism
- Support for latest specifications of TCG TPM 2.0 standard (rev. 1.59)
- TCG, CC and FIPS certifications
- Windows HLK certification
- Support for various cryptographic algorithms: up to RSA-4096, AES-128, AES-256, ECC NIST P256, ECC BN256, ECC NIST P384, SHA-1, SHA2-256, SHA2-384
- Extended non-volatile memory (51 kB)
- SPI interface
- Thin PG-UQFN-32 package

OPTIGA™ TPM SLB 9672 FW16.xx

Compared with the FW15.xx version, the FW16.xx version offers flexible configuration options, enhanced security features including AES bulk encryption, configuration of the TPM’s unique ID, and configuration of the endorsement primary seed.

Target Applications

- Home & Office devices: Enterprise printers
- Smart Building: Surveillance camera
- Industrial Automation: Factory robots, Programmable Logic Controllers (PLC)
- Network infrastructure: Routers, Switches, Access Point, Gateway, 5G Equipment

Benefits

- Proven, standardized turnkey security solution
- High confidence level based on common criteria and FIPS certification
- faster cryptographic operations (2-4 times faster, depending on the functions)
- Easy integration with Windows and Linux OS Platforms



OPTIGA™ TPM SLB 9673 FW26.xx



Ready-to-use TPM with a PQC-protected firmware update mechanism, optimized for embedded systems with an I2C interface

OPTIGA™ TPM SLB 9673 FW26.xx is the latest addition to the OPTIGA™ TPM family targeted at connected devices that require enhanced security features. This standardized, ready-to-use security solution comes with an I2C interface. It serves as a robust foundation to identify and authenticate network infrastructure and light industrial machines such as factory robots and Programmable Logic Controllers (PLC). In addition, it protects data integrity and confidentiality.

OPTIGA™ TPM SLB 9673 FW26.xx

is future-proof thanks to a PQC-protected firmware update mechanism, extended memory, and strong algorithms. Integrated resiliency features allow the TPM firmware to be recovered in compliance with the NIST SP 800-193 Platform Firmware Resiliency Guidelines.

OPTIGA™ TPM SLB 9673 FW26.xx gives “things” a unique identification number so they can connect to the IoT or the network. This number can be used to track IoT devices and equipment on the networks, and to validate their access rights. To avoid the risk of counterfeit, this number is protected from being modified. A set of configurable commands is available to set the TPM up according to application-specific needs during platform manufacturing.

Its enhanced security features include AES bulk encryption, configuration of the TPM-unique ID, and a configurable endorsement primary seed.

Key Features

- I2C interface up to 1 MHz
- Extended non-volatile memory (51 kB)
- Support for latest cryptographic algorithms: up to RSA-4096, ECC NIST P384, SHA2-384
- TCG TPM2.0 (revision 1.59), CC and FIPS certifications
- PQC-protected firmware upgrade mechanism using XMSS signatures
- Thin UQFN-32 package
- Extended temperature range: (-40°C to 105°C)

Benefits

- Proven, standardized turnkey security solution
- High confidence level based on Common Criteria and FIPS certifications
- Easy integration with Linux OS platforms
- Faster cryptographic operations than previous generation



Target Applications

- Home & Office devices: Enterprise printers
- Industrial Automation: Factory robots, Programmable Logic Controllers (PLC)
- Smart Building: Surveillance Camera
- Health & Lifestyle: Monitoring System
- Renewable Energy: Solar energy farms, Electrical windmills
- Smart Mobility: EV charging
- Network infrastructure: Routers, Switches, Access point, Gateway, 5G Equipment



OPTIGA™ Trust M

Secured cloud service provisioning – the easy way!



Cloud services and AI are driving a wave of innovative applications. The number of devices connected to these applications is growing, presenting great opportunities – but also increased security risks. Responding to a growing focus on embedded systems amongst attackers, Infineon offers the OPTIGA™ Trust M solution, a high-end security controller optimized for connected devices.

It provides extremely flexible, high-performance, secured access to any major cloud provider for industrial and building automation, smart home and consumer applications.

Key Features

- CC EAL6+ (high) certified high-end security controller
- I²C interface with shielded connection
- Hibernate mode for zero power consumption
- USON-10 package (3 x 3 mm)
- Standard and extended temperature ranges: -40 to +105 °C
- Up to 10 kB user memory
- Configurable device security monitor
- Lifetime of 20 years for industrial and infrastructure applications
- Cryptographic ToolBox
- MIT licensed software framework on GitHub

Benefits

- Secured zero-touch provisioning
- Easy integration
- Future-proof security
- Performance
- MIT licensed software

Target Applications

- Industrial and building automation
- Smart home
- Consumer devices
- Drones

OPTIGA™ Trust M Express

The easiest way to securely deploy IoT devices to the cloud at scale



OPTIGA™ Trust M Express offers rock-solid security for IoT devices every step of the way from manufacturing through cloud onboarding to field deployment. The cryptographic identity of OPTIGA™ Trust M Express is provisioned in a certified and secured Infineon fab. It is protected from exposure at all stages during the product lifetime. This off-the-shelf solution removes the need for secured ID injection during IoT device manufacturing. This allows you to enhance the security of your IoT devices and their cloud connectivity while simplifying the production flow, accelerating time-to-market, and increasing cost efficiency. OPTIGA™ Trust M Express is offered in combination with CIRRENT™ Cloud ID – Infineon’s cloud service that automates IoT device certificate registration and device provisioning in the product cloud at scale with zero manual intervention. This saves time and resources, protects against human error, and makes the process highly scalable.

Key Features

- Pre-provisioned with a unique device identity (x.509 certificate) injected in a security certified Infineon facility
- Device certificate tracking
- CIRRENT™ Cloud ID support for automated provisioning of IoT devices in the product cloud
- CC EAL6+ (high) certified high-end security controller
- I²C interface with shielded connection
- Hibernate mode for zero power consumption
- USON-10 package (3 x 3 mm)
- extended temperature range: -40 to + 105 °C
- Up to 10 kB user memory; Protected updates, Usage counters, dynamic object
- Configurable device security monitor
- Lifetime of 20 years for industrial and infrastructure applications
- Cryptographic toolbox commands for SHA-256, ECC and RSA features, AES, HMAC and key derivation

Benefits

- Saves costs, by removing the need for highly secured manufacturing environment and the need to build and maintain a public key infrastructure
- Go to market quickly, by a faster design-in process and removes the need for personalization during manufacturing, as well as ready to connect to Azure and AWS.
- Scales quickly, by automated device onboarding to cloud and a simplified device claiming process
- Robust security

Target Applications

- Smart Home
- Smart Buildings
- Smart Mobility
- Smart Cities
- Industrial IoT
- Healthcare / Lifestyle



OPTIGA™ Authenticate S

Enhanced device authentication to protect against counterfeits



Infineon's anti-counterfeit turnkey solution, combining enhanced device authentication with unprecedented levels of configuration flexibility. OPTIGA™ Authenticate S gives each product a secret key so it can be authenticated at the point of use, and so products can be tracked and traced throughout the supply chain. With its rich set of 16 customization options, it supports even the most complex authentication requirements – all on a single, tiny footprint. OPTIGA™ Authenticate S is suited to an ever-expanding range of applications, from single-use disposables and rechargeable batteries for smartphones, portable devices and e-mobility solutions, to computing and robotic systems in highly complex IoT environments. The turnkey solution comes with full system integration support including embedded software, host software and advanced ecosystem support tools based on the latest PSoC™ 6 MCUs. An NDA is required.

Key Features

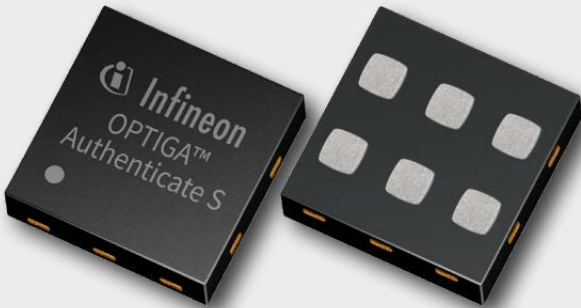
- 4 ECC authentication modes (one-way, mutual, host binding and host support)
- 4 lifecycle counters with independent kill structures
- 3 types of lockable NVM Sizes (1K, 2K, 5Kbit)
- 3 temperature options (-40 to 85°C / -40 to 105°C / -40 to 120°C)
- 2 ECC 163-bit key pairs and 193-bit ODC
- 2 Serial communication options (SWI & I2C + GPO)
- Host code software – with new OS library
- 1.5 x 1.5 x 0.38 mm PG-TSNP-6-12 package
- Infineon proprietary protection against reverse engineering (PRE)
- High-end security controller certified to Common Criteria EAL6+ (high)

Benefits

- Rich customization options
- Effortless implementation – full turnkey solution – full system integration support
- Additional customer services, such as alerts when spare parts need replacing
- Security to rely on – e.g. enhanced HW security with extended key length
- Freedom to design even very small products – tiny package of 1.5 mm²

Target Applications

- Batteries and accessories and battery powered tools, such as portable devices, e-scooters
- Replacement parts (water filters, printer cartridge, purifiers)
- Electronics (power tools, wearable devices, multicopters and drones)



OPTIGA™ Trust Charge

The trusted authentication solution for wireless charging



Infineon's OPTIGA™ Trust Charge is a turnkey solution providing secured device authentication for inductive wireless charging according to the Qi 1.3 wireless charging standard. Secured authentication with OPTIGA™ Trust Charge contributes to device and user safety by protecting against fake chargers. The turnkey setup – with full system integration support and all key and certificate material preprogrammed – minimizes customer effort for design, integration and deployment. OPTIGA™ Trust Charge comes with preprogrammed locked OS, locked application code, and host-side modules to integrate with host microcontroller software. Integration support includes a reference board and documentation for rapid design-in.

Key Features

- WPC Qi 1.3 authentication
- Common Criteria EAL6+ (high) certified hardware
- ECDSA P-256 authentication
- NIST P-256, SHA-2 cryptography
- Up to 10 kB user memory
- Qi certificate format
- PKI
- I²C serial communication
- USON10-2 package (3 x 3 mm)
- Extended temperature range version available
- Full turnkey solution incl. drivers, SW library, preimplemented certificate(s) and key pair(s)

Benefits

- Protection of consumers against fake charging devices
- Turnkey solution with full system integration support including embedded software, host software, a development board, a reference board and documentation
- WPC-specific personalized keys and certificates preloaded at secured Infineon fabs
- Tiny package (3 x 3 mm) optimized for small devices
- Versions for standard and extended temperature ranges

Target Applications

- Mobile phones
- Tablets
- Cameras
- Accessories and other small personal electronic devices with charging according to the Qi standard
- Health tech devices





OPTIGA™ Connect Consumer

eSIM turnkey solution for cellular-connected consumer devices



OPTIGA™ Connect Consumer is a ready-to-connect embedded SIM (eSIM) solution for consumer devices. It is especially suited to extending cellular connectivity to smaller devices like smart watches, fitness trackers and other wearables. OPTIGA™ Connect Consumer represents the next generation of eSIMs implementing GSMA's technical specification for mobile consumer devices. This turnkey solution securely authenticates the device to the subscribed carrier networks of choice. Remote SIM provisioning (RSP) allows the user to change or add carriers over the air provided the device is equipped with a local profile assistant (LPA). Generally speaking, SIM-based cellular connectivity is more resistant to security breaches than typical wireless network connections as it provides end-to-end encryption and secured key exchange.

Key Features

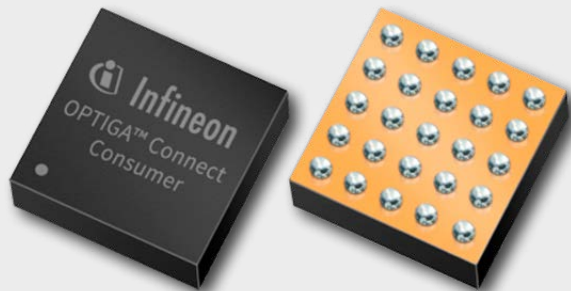
- Compliant with network technologies 2G, 3G, 4G (LTE), 5G
- Network Access Applications SIM, USIM, CSIM, RUIM and ISIM
- Remote SIM Provisioning (RSP) compliant with GSMA SGP.22 v2.2.2
- Compliant with Trusted Connectivity Alliance (TCA) eUICC Profile Package V2.3.
- Interoperable with MNOs offering commercial eSIM services
- Chip-scale (2.9 x 2.5 x 0.4 mm) and ETSI MFF2 (5.0 x 6.0 mm) packages
- Up to 800 kB free memory for MNO profiles, applications, and data (supporting integration of additional applets)
- Certified and tested solution according to GSMA

Benefits

- Increased customer convenience
- More design flexibility by providing an ultra-small package size
- Future-ready device
- Based on a solid security platform
- Interoperable
- Turnkey solution with lower design-in and qualification effort

Target Applications

- Smartphones
- Tablets
- Wearables
- Laptops
- Access Points
- Consumer IoT Devices



OPTIGA™ Connect IoT

Turnkey eSIM solution for cellular-connected IoT devices



OPTIGA™ Connect IoT is a ready-to-connect embedded SIM (eSIM) solution for cellular IoT devices. This turnkey solution allows easy, secured and cost-optimized deployment and management of cellular-enabled IoT devices at scale. It comes with a pre-installed GSMA-compliant operating system and pre-integrated connectivity capabilities. Supported by the partner Tata Communications, this eSIM offers global cellular network coverage with a choice of 640+ networks across 200 countries. End-to-end connectivity management extending from design through manufacture to deployment reduces complexity, offers full visibility into IoT devices and simplifies control. It addresses today's key pain points in connectivity management, namely interoperability across different vendors' GSMA subscription management platforms, local service deployment options, technical support, cost and coverage.

Key Features

- Reprogrammable eSIM
- Compliant with GSMA remote SIM provisioning specification SGP.02 v3.2 Support 2G, 3G, 4G, 5G LTE-M, NB IoT1)
- ETSI TS102 221 and ETSI TS102 671 compliance
- MFF2 (QFN8) package (other packages on request)
- Supported interface: ISO7816- UART
- Voltage classes: A, B, C > Industrial grade (-40 to +105°C)
- Data retention: 10 years
- Common criteria EAL5+ certified hardware
- Free memory available for storage of up to 10 operator profiles
- Bootstrap connectivity with global cellular coverage (640+ networks, 200 countries/ territories)
- Adjustable data plan
- Single secured access point to remote data and connectivity management via partner portal

Benefits

- Ready to connect with onboarded bootstrap
- Global cellular coverage
- Flexible connectivity services for IoT devices
- Free choice of Mobile Network Operator (MNO)
- Cost-effective, pervasive (worldwide) and secured connectivity
- Easy deployment and management of cellular IoT at scale
- Reduced complexity through interoperability and connectivity management Simplified path to market
- Single SKU for all applications and regions
- Open for integration of additional applets
- Low power consumption

Target Applications

- Smart Home (Security Cameras, alarms, air conditioning, access control)
- Smart city (security cameras, lighting, park sensors)
- Smart energy (metering, storage, distribution)
- Industry automation (factory automation, asset tracking)
- Wearables (Health monitoring)





Energy Converters

Energy can be found everywhere – in the movement of doors and windows or machine components, the vibration of motors, changes in temperature or variances in luminance level. These energy sources, which usually remain unused, can be tapped into by means of energy harvesting to power electronic devices and transmit wireless signals. This principle is the basis of energy harvesting wireless technology from EnOcean.

EnOcean
Self-powered IoT

The World of Energy Harvesting Wireless Technology

Sending a wireless signal over the EnOcean standard requires only a small amount of energy. This energy can be generated by so called energy converters, which convert energy from the environment into electric energy. Due to the fact that no further power supply is required, the product can be designed to be maintenance-free. Electric energy can be harvested from temperature differences, light and motion.

The EnOcean Energy Harvesters are intended for powering the international standard ISO/IEC 14543-3-1X (EnOcean standard). This standard is optimized for ultra-low power wireless application and energy harvesting. The EnOcean ISO/IEC standard uses different license-free frequency bands in the SubGHz range to meet the specifics and legal regulations of countries all around the world, for example:

- 868 MHz for Europe and China
- 902 MHz for North America and Canada
- 928 MHz for Japan

EnOcean's energy harvesting solutions can also connect to the Zigbee/IEEE 802.15.4 standard as well as to Bluetooth® networks which both use the worldwide available 2.4 GHz frequency band.

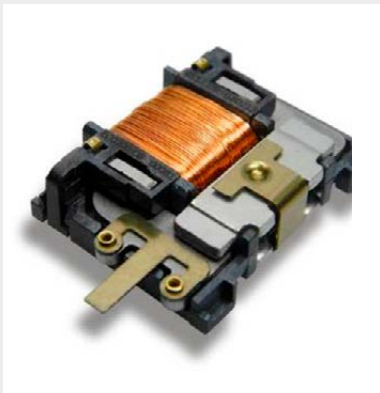
Application Fields

- Building and Home automation: HVAC, lighting, shutter control...
- Ultra-low power devices
- Consumer LED lighting control
- Window contact sensors
- Temperature sensors
- Humidity sensors



ECO 260

Kinetic Energy Harvesting

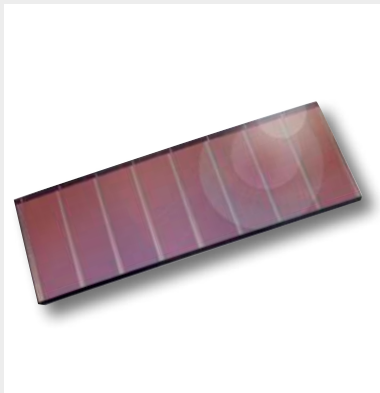


The kinetic converter in combination with a wireless module enables numerous battery-free switch applications. Energy from a switching operation (button pressure):

- Electrodynamic energy converter
- Energy generation from kinetic motion
- Typically more than 1,000,000 switching cycles at 25 °C
- For small and flat switch designs

ECS 300

Solar Cell for Self-Powered Wireless Sensors



Solar cell for energy harvesting wireless sensors ECS 300.

Form Factor: 35.0 × 12.8 × 1.1 mm

- Indoor solar cell
- Designed for use with EnOcean STMicroelectronics sensors
- The small ECS 300 is ideal for unidirectional sensor applications

ECT 310 Perpetuum

Thermo Energy Harvesting



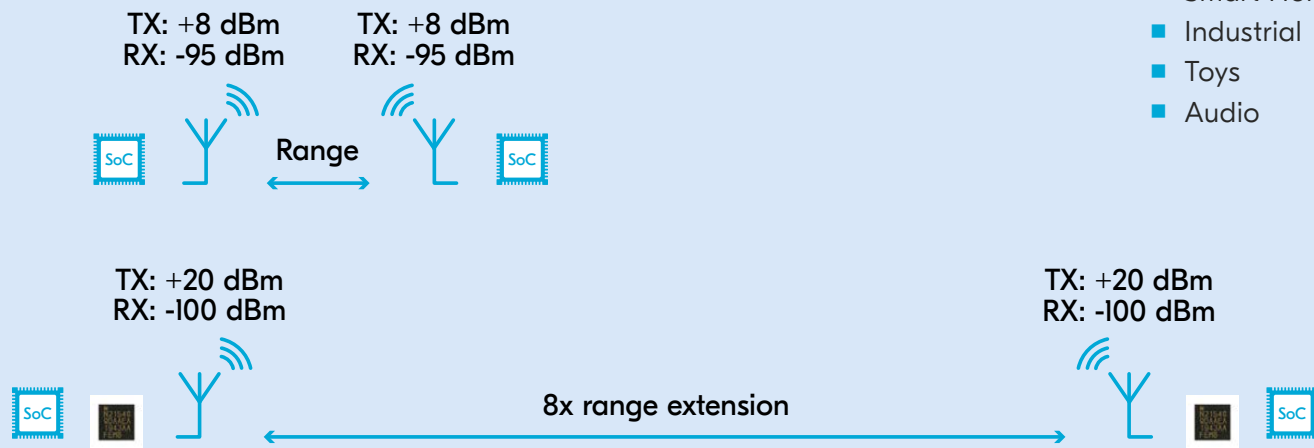
Ultra-low power DC/DC converter for thermal energy harvesters.

Heat dissipation as energy source

- Standard peltier element
- Usage of minimum temperature difference
- Maintenance free, full integration
- Allows energy harvesting actuators



Figure of link budget improvement Overview



Link budget improvement for the nRF21540-DK compared to the nRF52840-DK.

- Professional lighting
- Smart Home
- Industrial
- Toys
- Audio

Introduction to Power Management IC



nPM1100 – Extremely Compact Power Management IC (PMIC) with Power Path and Charging

The nPM1100 is a dedicated power management IC (PMIC) with dual-mode configurable buck regulator and integrated battery charger. It is designed as a complementary component to Nordic's nRF52® Series and nRF53® Series System-on-Chips (SoCs) to ensure reliable power delivery and stable operation, whilst maximizing battery life through high efficiency and low quiescent currents.

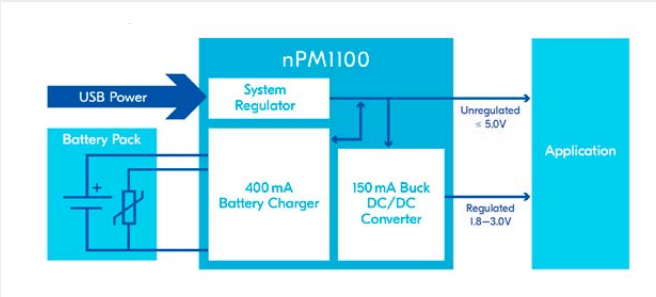
Key Benefits

- Combined USB battery charging and power supply with as little as 23 mm² PCB area including passives
- 100 % pin configurable, no software needed
- Prolongs battery life of any nRF52® or nRF53® Series SoC based application using a rechargeable battery
- Provides ample current for both the SoC and additional circuitry

Key Features

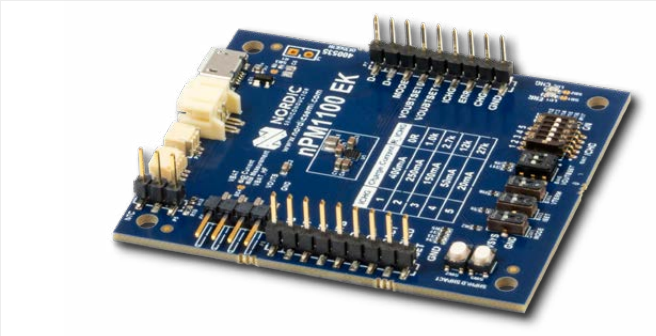
- Ultra-small form factor PMIC
 - 2.075 x 2.075 mm WLCSP package
- 400 mA battery charger
 - Automatic charging mode
 - For Li-ion and Li-Polymer batteries
 - Battery thermal protection
- Highly efficient regulator
 - Up to 92 % power conversion efficiency
 - Hysteretic and PWM mode
 - Selectable output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

Block Diagram



Related Development Tool: 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.



Applications

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



Introduction to Range Extender



nRF21 Series – RF front end module (FEM)

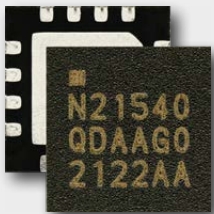
The range and link robustness of Nordic nRF52 and nRF53 Series SoCs fulfill the requirements of most applications and use-cases, but sometimes adding an RF front-end module (FEM) is the correct choice. An RF FEM increases the range at which two wireless devices can communicate, while also enhancing link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

Key Features

- Supports
 - Bluetooth® Low Energy (incl. Bluetooth mesh)
 - Thread and Zigbee (802.15.4)
 - Proprietary 2.4 GHz
- Adjustable output power in small increments up to +21 dBm
- +13 dB receive gain with 2.5 dB noise figure
- Two antenna ports for antenna diversity
- Control interface via GPIOs, SPI, or a combination
- 40°C to +105°C operating temperature range
- 1.7 V to 3.6 V input supply range
- 4 x 4 mm QFN16 package
- When combined with an nRF52 or nRF53 Series SoC:
 - Up to 6.3-10x range increase /
 - 100 dBm RX sensitivity (Bluetooth LE, 1 Mbps)
- Current consumption:
 - TX tuned to +20 dBm: 110 mA / RX: 2.9 mA
- Power down mode: 30 nA

Applications

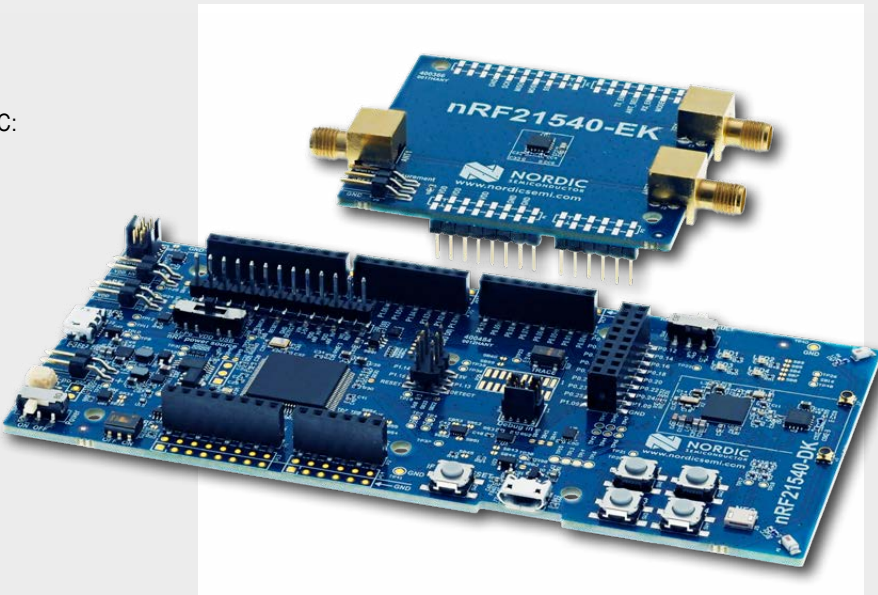
- Asset tracking and RTLS
- Professional lighting
- Smart Home
- Industrial
- Toys



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.



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