QUECTEL

Build a smarter world

Smart homes and smart buildings white paper

Short-range technologies and improved interoperability drive smart home and smart building growth

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INTRODUCTION

Wireless connectivity in homes and buildings has introduced a smart revolution in which cost-effective, easy-to-set-up wireless technologies enable automation of previously manual processes.

Across smart locks, energy monitoring, gateways for connected devices, and building automation, short-range wireless technologies are creating the connectivity framework for an integrated web of devices that improve users' quality of life, eliminate energy wastage and help residents and building operators optimize their homes and buildings.

Technologies such as Wi-Fi, Bluetooth, Thread and Zigbee are well-understood and widely adopted with leading brands bringing products to market that enable multiple protocol communications. Global home furnishings brand IKEA is just one example of a company that is combining Thread and Zigbee capabilities in its smart home products while Wi-Fi in all of its variants and Bluetooth have become familiar standards for all types of users. Standardization efforts such as Matter are further simplifying smart home deployments, enabling products from different vendors to integrate with each other so users can create comprehensive smart home environments rather than simply deploy a complex portfolio of point solutions.

Importantly, this doesn't need to be the same as the VHS vs BetaMax battle from the dawn of home video in which one technology fought to eventually dominate. Multi-protocol solutions are helping to avoid this scenario, supported by the current generation of smart home components, which enable versatility across short-range wireless technologies.

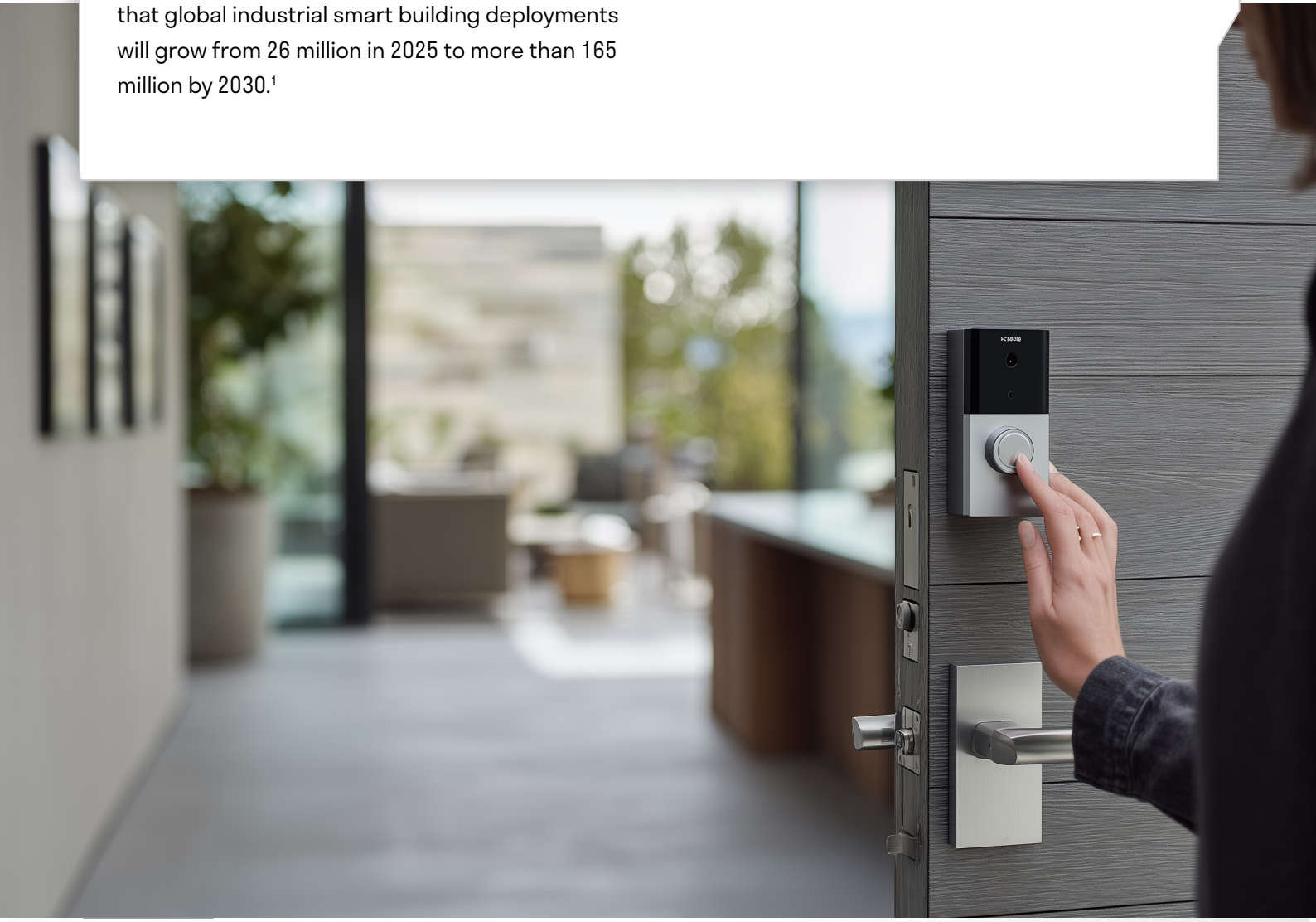
GROWTH DEMANDS INTEROPERABILITY

Smart buildings increasingly rely on sensors to manage HVAC, energy consumption, security and occupant comfort. Operations such as lighting, predictive maintenance and space utilization analytics are all performed to maximize building performance, improve experiences for users and minimize downtime when functions are out of service. Short-range wireless connectivity enables not only discrete smart building systems to communicate but also opens up the opportunity for systems to interact with each other to deliver new value and enhanced optimization.

The simplification of connectivity alongside more cost-effective sensor-based devices is stimulating market growth. Juniper Research has projected that global industrial smart building deployments will grow from 26 million in 2025 to more than 165 million by 2030.[1]

Systems that reduced energy wastage and bespoke vertical solutions are set to drive the 525% surge in deployments by 2030, the firm says. By then there will be a total of 487.6 million smart building deployments, 14.7 billion smart building sensor deployments and total smart building revenue will hit US$170.6 billion.

Smart homes similarly demand interoperability so users can execute on the vision of a set of devices and sensors that can interact with each other to provide consolidated control of a smart home. The connectivity fabric unlocks this potential by enabling multi-protocol connectivity across short-range technologies such as Wi-Fi, Bluetooth, Thread and Zigbee.



1 https://www.juniperresearch.com/press/industrial-smart-buildings-energy-wastage-bespoke-vertical-solutions/

HEADROOM FOR PENETRATION GROWTH

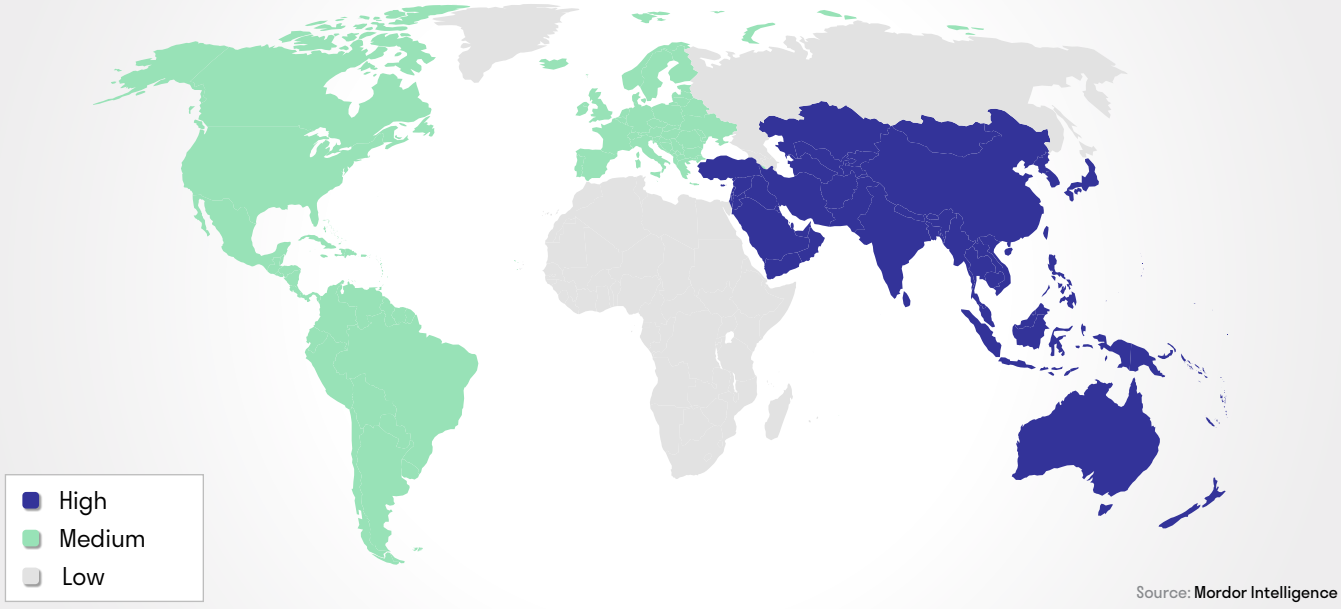
Analyst firm Berg Insight predicts that by 2029 about 90.9 million homes in North America will be smart, equal to about 59% of all homes in the region.[2] The European market is still behind the North American in terms of market penetration with the number of smart homes in the region forecast to reach about 102.8 million at the end of 2029, representing a market penetration of approximately 42%.

The firm says the most popular smart home products include smart thermostats, smart light bulbs, smart security cameras, smart door locks and smart speakers. The market for whole-home systems is served mainly by traditional home automation specialists, home security providers, telecom operators and DIY solution providers.

Mordor Intelligence also sees substantial growth coming. The firm valued the smart home market size at US$140.42 billion in 2025 and the value will grow from US$164.13 billion in 2026 to reach US$311.22 billion by 2031, at a CAGR of 13.65% during the forecast period of 2026-2031. The smart homes market is following a mainstream curve as Matter-enabled interoperability breaks down historic vendor lock-in, while tax incentives in the United States and Europe lower the ownership costs for connected HVAC, battery storage and EV chargers, the firm says.

Uptake is accelerating among first-time buyers who treat automation as standard infrastructure rather than a luxury. This view is being reinforced by visible savings being achieved from utility demand-response payouts. Hardware roadmaps now emphasize perimeter security, in-home health and energy dashboards, with each area benefiting from rapid gains in low-power semiconductors that extend battery life and shrink form factors, the firm adds.

FIGURE 1 Small cell networks market



Source: **Mordor Intelligence**

2 https://www.berginsight.com/more-than-190-million-european-and-north-american-homes-will-be-smart-in-2029

CONNECTIVITY IN A MULTI-PROTOCOL HOME OR BUILDING

Traditionally smart buildings and smart homes would have relied on Wi-Fi and Bluetooth exclusively to enable connectivity of wireless devices but there are now other technologies to consider that support necessary functionality at an optimal price or at a low-power consumption rate that supports battery-operated devices.

These protocols help strengthen the business case for new smart home and building applications by making hardware available and affordable to more customers.

The key protocols being relied upon in the smart home and smart building markets include:

Wi-Fi, which provides high-speed, high-power connectivity for devices that need to make large data transfers, such as video doorbells or safety cameras. Higher end Wi-Fi variants, such as Wi-Fi 7 and Wi-Fi HaLow, have a growing number of applications in smart campuses and across large smart buildings. Wi-Fi is also utilized in smart home and smart building hubs. Wi-Fi, in addition to being used for higher-data-rate communication, is the primary means for connecting sensor networks to the home router, either for direct remote control or for interaction with the cloud. Typical use cases include transferring data to the cloud for storage and for firmware upgrades.

Bluetooth is widely understood by users as an enabling technology for connecting products such as smart speakers. The Bluetooth Low Energy (BLE) variant is mostly utilized to support provisioning or pairing of devices and is typically used for short-range tasks because of its low-power usage. BLE applications include setup of devices and connecting wearables. In addition, Bluetooth 6.0 supports channel sounding, a high-accuracy, secure distance measuring technology that offers approximately 0.3 m accuracy within 5 m. The technology is ideal for smart locks, building access and pet tracking, among other smart home use cases.

Zigbee is a mature low-power mesh network technology that is popularly used for sensors and lighting. Highly energy efficient, Zigbee requires a hub and is used to connect dense sensor networks with its mesh network footprint. Typically, Zigbee operates in the 2.4 GHz frequency band, transmitting data at 250 kbps while the latest Zigbee 4.0 specification, Suzi, supports sub-G frequencies. An alternative is Z-Wave which operates sub-1GHz with a transmission rate of around 100 kbps.

Thread provides a secure, low-power, IP-based mesh network and, in contrast to Zigbee, does not require a central hub. It only needs a Thread border router which is now built into many new smart speakers and hubs enabling devices to connect directly to the internet. This makes the protocol well-suited to connecting sensors, lighting and other smart home devices.

Matter-over-Thread utilizes the increasingly widely adopted Matter application layer, essentially the language that devices speak with Thread-based networking. This allows devices from different manufacturers to work together without needing a manufacturer-specific hub. Matter-over-Thread provides faster response times than Wi-Fi while consuming less energy, so it's ideal for battery-operated devices. It does require a Thread border router to connect the low-power Thread network to a main home Wi-Fi network.

Ultra-wideband (UWB) is an emerging short-range, high bandwidth wireless communication protocol that enables secure, real-time tracking and precise positioning. Unlike Wi-Fi or Bluetooth, UWB uses time-of-flight measurements of radio signals to determine distances between devices with centimeter-level accuracy.

CHANGING PRIORITIES

Wi-Fi continues to dominate. Mordor Intelligence has reported that Wi-Fi connectivity accounted for 60.12% of revenue in the smart homes market in 2025.[3] The firm says that Wi-Fi powered more than 60% of connected homes in 2025 thanks to ubiquitous routers and bandwidth capable of streaming multiple 2K or 4K camera feeds simultaneously.

The firm predicts that Zigbee and Z-Wave will face displacement as Matter elevates Thread. Apple's HomePod Mini and Google's Nest Hub Max, in addition to the IKEA products mentioned earlier, now function as Thread border routers, establishing foundational mesh coverage without the need for dedicated gateways. Bluetooth Low Energy retains a niche solution for proximity-based locks and health wearables, where rapid pairing overrides range limitations.

3 https://www.mordorintelligence.com/industry-reports/global-smart-homes-market-industry

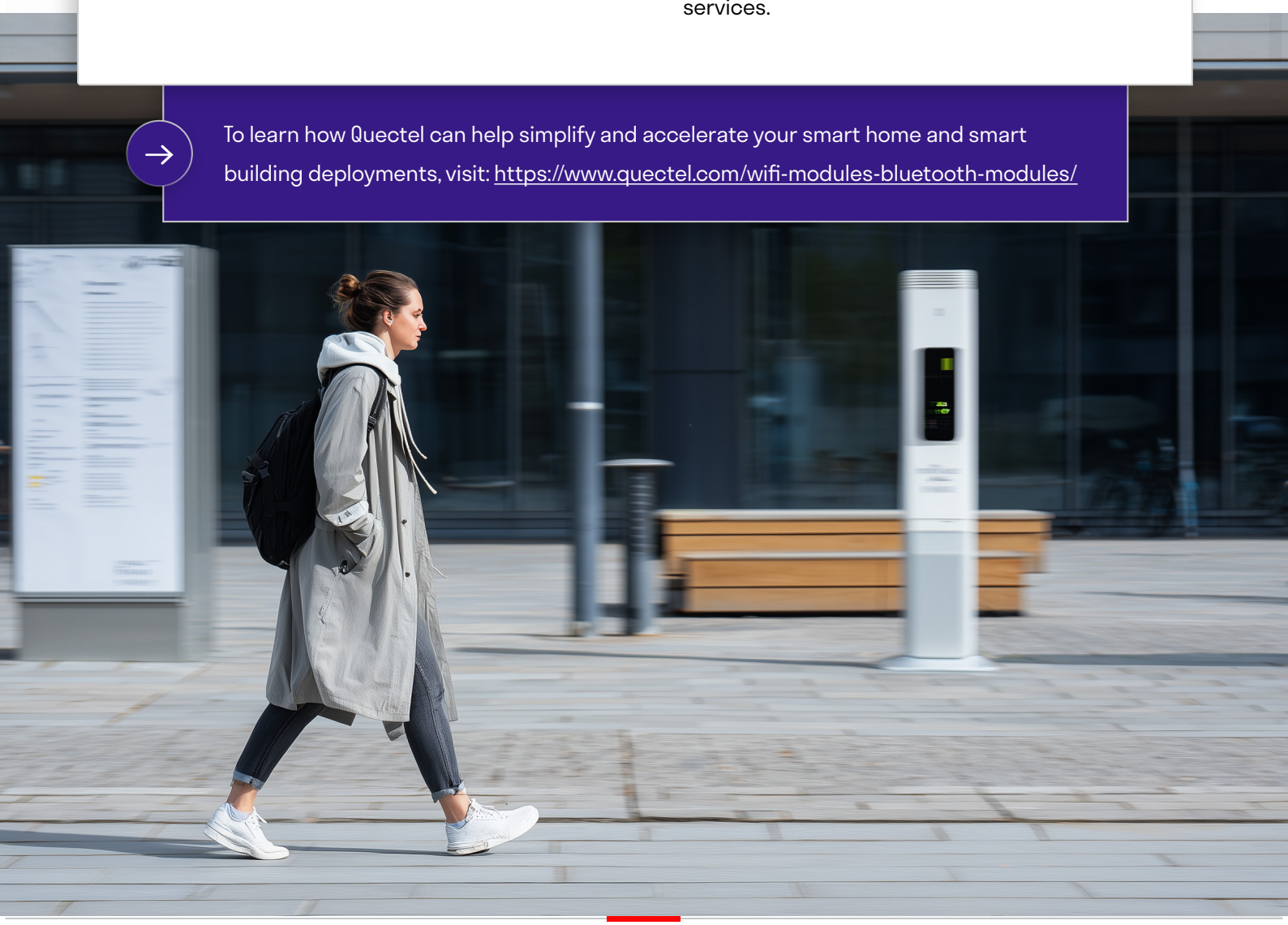
CHOOSE THE RIGHT TECHNOLOGY FOR YOUR USE CASE

The fundamental choice of which connectivity technology to select is determined by the use case and the limitations of the device in terms of power, form factor and cost. Matter-over-Thread is increasingly utilized for smart door locks thanks to the interoperability and low-power consumption it offers but we also see many battery-powered and low-power Wi-Fi devices being utilized to support sensors and smart lighting and electrical controls.

Quectel, with its comprehensive portfolio of short-range modules, just a few of which are detailed in Appendix I, supports the selection of the optimal technology for your smart home or smart building use case. Encompassing hardware, software and services the Quectel portfolio also includes sub-brands to support specific sectors and strategic partners in adjacent disciplines. The company, which was established in 2010 and now has more than 8,000 customers, continues to focus on innovation with eight R&D centers across the globe including centers in Belgrade, Delhi, Penang and Vancouver. These facilities total 8,000 m² of lab space.

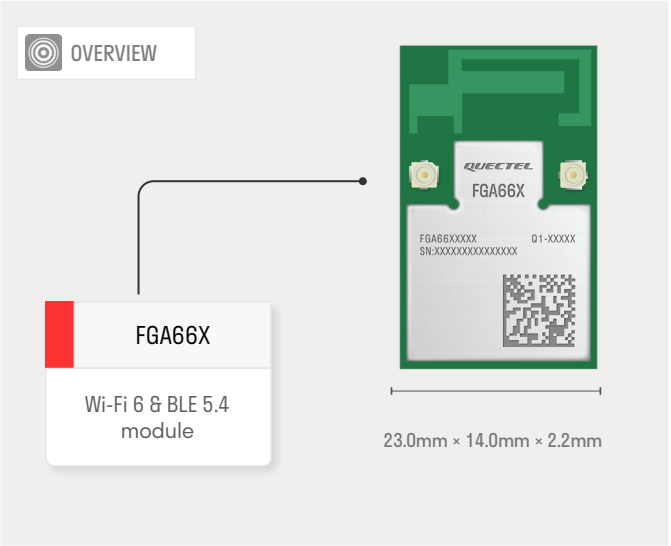
In addition to modules, Quectel antennas also enable resilient connectivity for millions of devices and Quectel's software and services capabilities encompass low code development, antenna services, ODM services and certification, testing and security services.

To learn how Quectel can help simplify and accelerate your smart home and smart building deployments, visit: https://www.quectel.com/wifi-modules-bluetooth-modules/

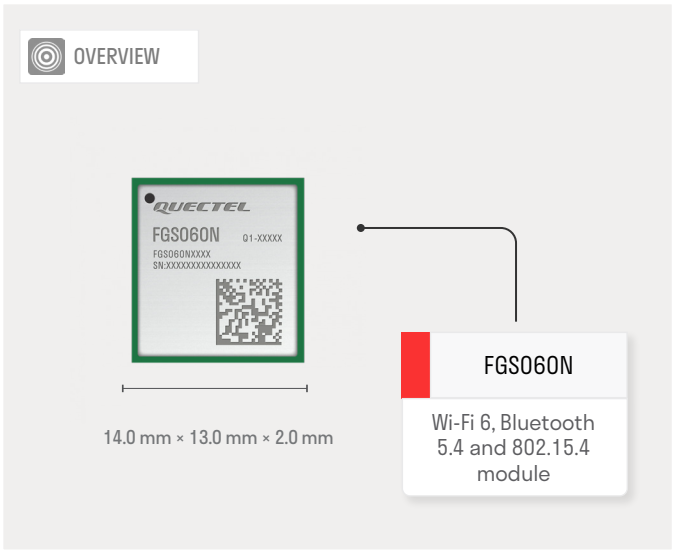


APPENDIX I: THE MODULES

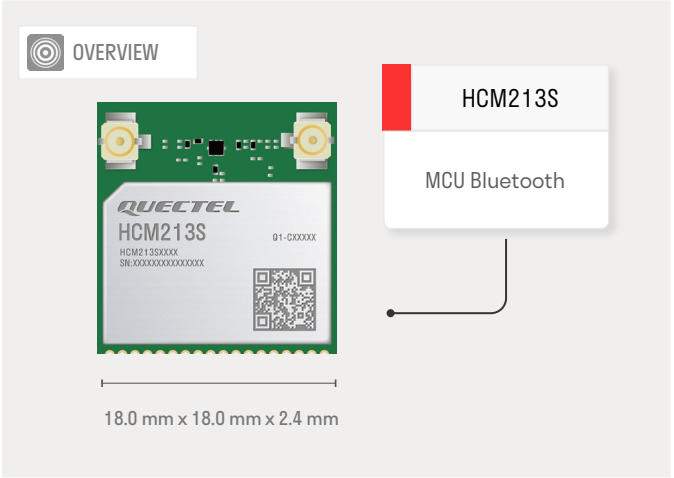
The Quectel FGA66X is a high-performance Wi-Fi 6, Bluetooth Low Energy (BLE) and Thread and Zigbee module. With an ultra-compact size of 23.0 mm × 14.0 mm × 2.2 mm, the FGA66X has been designed to optimize the cost for end products and meet the demands of size-sensitive use cases. Utilization of surface mount technology (SMT) makes the module an ideal solution for durable and rugged designs and with its wide operating temperature of -40°C to +85°C, the FGA66X is suitable for a wide variety of smart home and smart building applications.

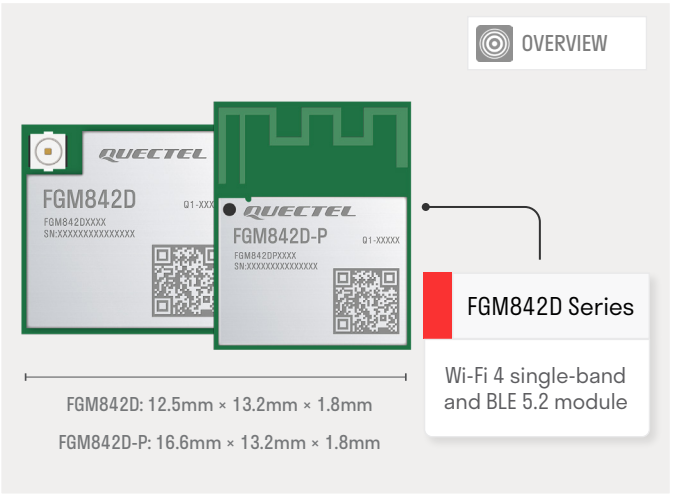


The Quectel FGS060N is a Wi-Fi 6, Bluetooth 5.2 and 802.15.4 (Thread, Zigbee) module with an ultra-compact size of 14.0 mm × 13.0 mm × 2.0 mm and an operating temperature range of -40°C to +85°C. Offering a maximum data rate of 600.4 Mbps, the module is ideal for IoT gateways. Surface mount technology (SMT), combined with a weight of just 0.7 g, makes the FGS060N well-suited for durable and rugged designs for a variety of smart home applications. The Quectel FCM365X is a Wi-Fi 6, Bluetooth Low Energy 5.4 and IEEE 802.15.4 module that boasts a high-performance ARM Cortex M33 processor. The module features 1.2 MB of SRAM and 8 MB of flash memory and complies with WPA-PSK, WPA2-PSK and WPA3-SAE security standards. With an ultra-compact package size of 25.5 mm x 18.0 mm x 3.16 mm, the FCM365X supports GPIO, SDIO, UART, USB, SPI and JTAG interfaces by default and I2C, I2S, ADC, LCD and PWM interfaces in the QuecOpen solution. With a wide range of connection interfaces and large PSRAM, it's a great fit for gateways, bridges and Thread OTBR devices. It also supports Matter for seamless smart home integration.



The Quectel HCM213S is a BLE 6.0 module, featuring an ARM Cortex M33 processor, that supports BLE 6.0 and BLE Mesh. The module features built-in 256 KB SRAM and 1MB or 2MB of flash memory. With dimensions of 18.0 mm × 18.0 mm × 2.4 mm, the module operates in the -40 °C to +105 °C temperature range. It supports low-power features for battery powered devices such as door locks, smart plugs, lighting and remote controls. In addition, thanks to BLE 6.0 channel sounding, it is a good fit for smart locks and secure positioning.

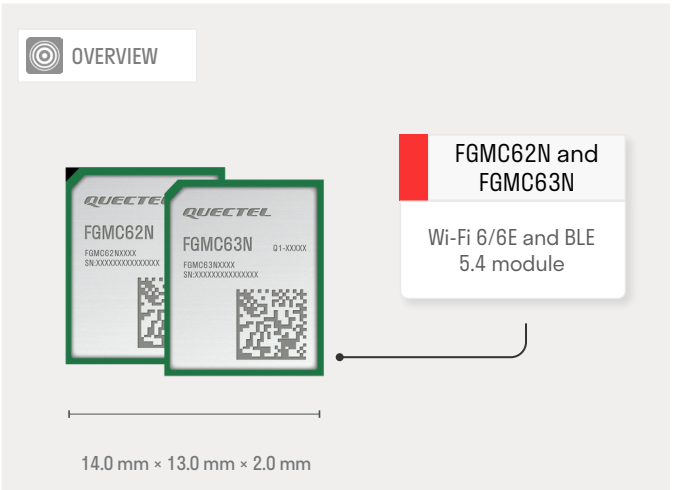


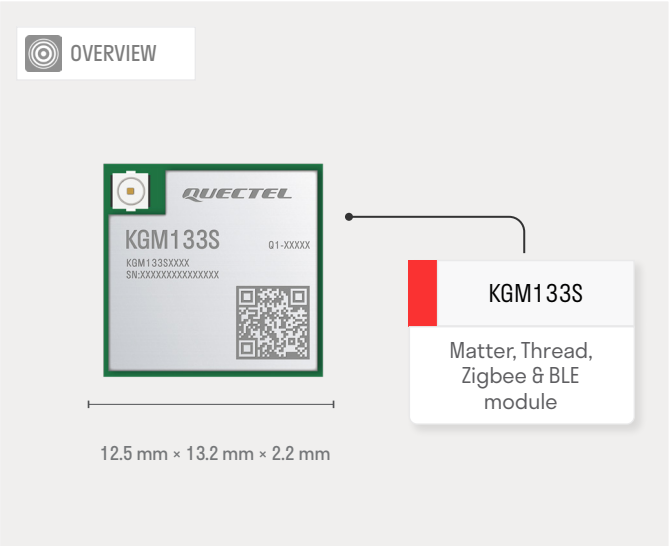


The Quectel FLM263D is a 2.4GHz Wi-Fi 6 Bluetooth and BLE 5.2 module that features a built-in 32-bit RISC-V processor and 512 KB SRAM and 4 MB flash memory. It complies with WPA-PSK, WPA2-PSK and WPA3-SAE security standards and supports the secure boot security start-up mechanism. The Quectel FLM263D has dimensions of 17.3 mm x 15.0 mm x 2.8 mm and weighs just 0.9 g. It also integrates the ACK SDK for the Matter solution which enables terminal products to quickly access the Amazon Alexa platform and other smart devices that support the Matter protocol. The module is widely used for smart lighting solutions.

The Quectel FGM842D series supports Wi-Fi 4 and BLE 5.2, featuring built-in 288 KB RAM and 2 MB flash memory. The series offers compact dimensions across all variants with typical module weights of 1.05-1.14g. The module operates in the -40 to +105 temperature range and supports UART and GPIO interfaces by default and SPI I2C, ADC and PWM function via QuecOpen. In addition, the module features low-power consumption modes and keep alive mechanisms which make it versatile and flexible for applications including smart lighting, switches, sockets and similar electrical devices in smart homes and buildings.

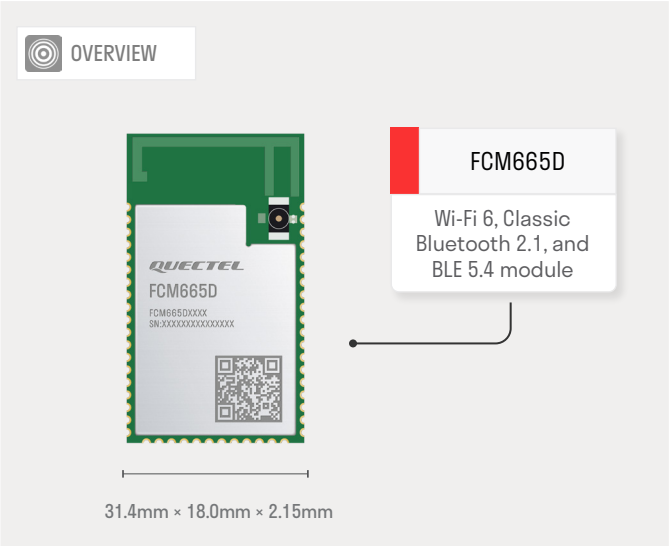
The Quectel FGMC62N and FGMC63N low-power Wi-Fi 6/6E and BLE 5.4 modules feature an ARM Cortex M33 processor, built-in 768 KB of SRAM, 2 MB ROM and 4 MB flash memory. In addition, they comply with WPA, WPA2 and WPA3 security standards. With a compact package size of 16.0 mm × 13.0 mm × 1.7 mm, the size and cost for end products is optimized and the models support up to 48 GPIOs in the open solution. The modules are ideal for use cases including battery powered devices such as doorbells and cameras. In addition, they can also support Matter over Wi-Fi.





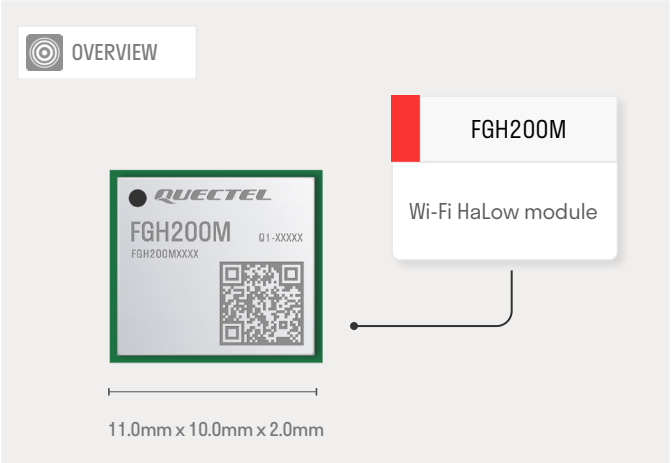
The Quectel KGM133S is a Thread, Zigbee and BLE module that features an ARM Cortex M33 processor and supports Matter, Thread, Zigbee, BLE 6.0 and BLE mesh. The KGM133S can be used as an IoT gateway because of its support for Thread, BLE, Zigbee and Matter. The module features 256KB SDRAM and flash memory options of 1536KB, 2.5MB or 3.5MB. Operating in the -40°C to +105 temperature range, the module has dimensions of 12.5 mm x 13.2 mm x 2.2 mm and can support up to 21 GPIOs in the case of multiplexing. Importantly, this module offers excellent interoperability for Matter-over-Thread use cases, enabling many-to-many communications for smart lighting, smart building and smart home wireless buildings.

The Quectel FCM665D is a powerful MCU-based Wi-Fi 6 and Bluetooth (including BLE 5.4) module designed for smart home applications such as lighting, doorbells and central control systems, with support for edge computing. It offers two SDK options to suit different use cases: AI Development Kit (AIDK) for applications such as voice processing (AEC, ANS, VAD, KWS) and image recognition, and Audio & Video Development Kit (AVDK) for multimedia applications including audio/video processing, display and cloud integration. This flexibility allows a single hardware platform to support both edge computing and audio/video-centric designs. The module features a compact size of 31.4 mm × 18.0 mm × 2.15 mm and operates within a temperature range of –40 °C to +85 °C, making it suitable for a wide range of IoT deployments.



The Quectel FGH100M is a Wi-Fi HaLow module that operates in the 850-950 MHz frequency range with a channel width of 1,2,4 or 8 MHz. The module offers a maximum physical data rate of 32.5 Mbps and its maximum output power is a theoretical 21 dBm. The FGH100M has low-power design and supports large capacity access, enabling simultaneous access for up to 8,191 devices to the same access point. With compact dimensions of 13.0 mm × 13.0 mm × 2.2 mm, the module optimizes and effectively reduces end product size and cost.

The Quectel FGH200M is another Quectel Wi-Fi HaLow module that operates in the 850-950 frequency bands and supports channel width of 1,2,4 or 8 Mbps. The module has a maximum output power of 26dBm and a theoretical maximum physical data rate of 43.3 Mbps. Also supporting up to 8,191 devices from a single access point, the FGH200M supports USB 2.0, SDIO and SPI interfaces. Its compact dimensions of 11.0 mm × 10.0 mm × 2.0 mm make the module ideal for compact end products.



SYSTEM ON MODULES

The Quectel SRG091X series features NXP Semiconductors' i.mx91 IoT processor as its core. This chip integrates a high-performance Arm Cortex-A55 CPU with a maximum operating frequency of up to 1.4 GHz. The system-on-module (SoM) supports flexible memory configurations, with LPDDR4 and e MMC capacity adjustable based on different application requirements. It also supports optional wireless connectivity, including Wi-Fi 6, Bluetooth 5.4, and IEEE 802.15.4 (Thread/Zigbee). With its capability to handle higher data rates and multimedia processing, the module is well-suited for applications such as HMI, gateways and smart control systems. The module measures 46.0 mm × 41.5 mm × 3.0 mm and operates within an industrial temperature range of –40 °C to +85 °C.

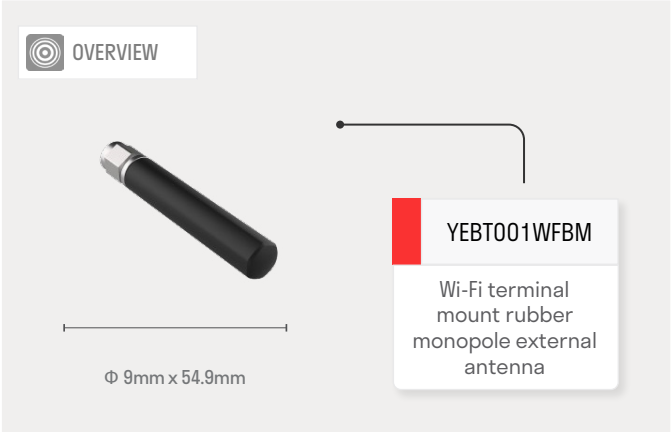
The Quectel SRG093X series is powered by NXP Semiconductors' i.mx93 IoT processor. It integrates a dual-core Arm Cortex-A55 CPU with a maximum operating frequency of up to 1.7 GHz, delivering enhanced performance for more demanding applications. The SoM provides flexible LPDDR4/ LPDDR4X and e MMC configurations, allowing memory size to be tailored according to specific use cases. It also supports optional connectivity, including Wi-Fi 6, Bluetooth 5.4 and IEEE 802.15.4 (Thread/Zigbee). Designed for high-performance and multimedia-rich applications, the module is ideal for use cases such as machine vision, smart home hubs, and industrial control systems. It shares the same compact form factor of 46.0 mm × 41.5 mm × 3.0 mm and supports an operating temperature range of –40 °C to +85 °C.

APPENDIX II: THE ANTENNAS

Quectel offers a range of optimized antennas designed to support smart home and smart building devices. These antennas offer robust wireless connectivity and reliable signal performance in diverse deployment scenarios and have been developed to match the modules' frequency bands and application needs, helping OEMs reduce integration complexity and accelerate time-to-market.

EXTERNAL ANTENNAS

The Quectel YEBT001WFBM and YEBT001WFAM external antennas offer small size and good performance in 2.4 GHz and 5 GHz Wi-Fi 7. The antennas are easy to mount and test. The antennas are terminal mount, rubber monopole external antennas and are both RoHS and REACH compliant. The YEBT001WFBM has a diameter of 9 mm and height of 54.9 mm, is IP65 rated and offers peak gain of 4.3 dBi. The YEBT001WFAM is IP54 rated and offers peak gain of 2.2 dBi. Both antennas operate in the -40 °C to +85 °C temperature range and, in common with Wi-Fi antenna connectors for the global market offer RP SMA male connectors.



A further option is the Quectel YEBT001W1AM, another Wi-Fi terminal mount rubber monopole external antenna that is RoHS and REACH compliant. This is ideal for outdoor scenarios with an IP67 rating and dimensions of 135 mm x 15.6 mm x 13 mm. The Quectel YEBT002W1AM, which can meet low-cost requirements, offers similar performance but is only RoHS compliant and does not have the IP67 rating.

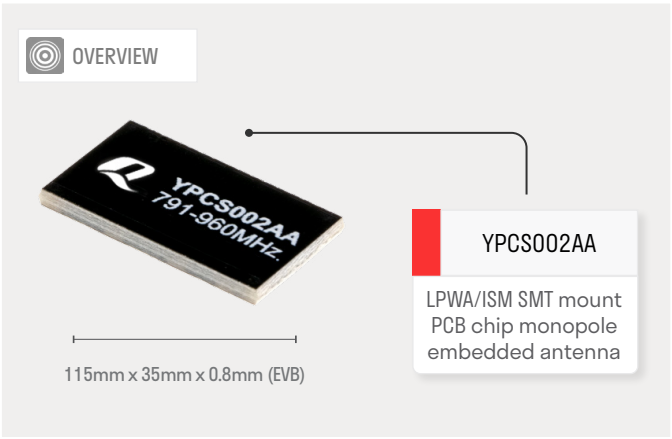
For use cases that need Wi-Fi coverage across three bands, the Quectel YEBA000J1AM with low profile is an attractive solution. This RoHS and REACH compliant adhesive mount, dipole external antenna has dimensions of 60 mm x 16 mm x 6.3 mm and offers peak gain of 2.1 dBi. Operating in the 2400-2500 MHz, 5150-5850 MHz and 5925-7125 MHz frequency ranges the antenna works across -40 °C to +85 °C temperature ranges.

For vending machines in particular, the Quectel YEBA001L1AH and YEBM001L1AH are good options offering adhesive or magnetic mounts respectively. Both antennas are RoHS and REACH compliant, IP67-rated and offer a tri-band Wi-Fi solution with peak gain of 4.7 dBi. Operating in the -40 °C to +85 °C temperature range, the antennas feature 1000 mm cable lengths. The Quectel YENT002W1AM is an LPWA/ISM terminal mount rubber dipole external antenna operating in the 850-950 MHz frequency range. The antenna offers efficiency of 41-57% and peak gain of 1.5 dBi. With an omni-directional radiation pattern and linear polarization the antenna is a good fit with Quectel's FGH100M and FGH200M Wi-Fi HaLow modules. The YENT002W1AM has dimensions of 135 mm x 15.6 mm x 13 mm, has an RP SMA male connector type and operates in the 40 °C to +85 °C temperature range. The antenna is RoHS compliant.

EMBEDDED WI-FI ANTENNAS

The Quectel YXU00A0AA and YFBC001WWA are Wi-Fi SMT embedded antennas that are RoHS and REACH compliant. Operating in the 2400-2500 MHz and 5150-7125 MHz frequency ranges, the YXU00A0AA PCB antenna, offers peak gain of 3.6dBi and has dimensions of 8 mm x 6.6 mm x 1.6 mm. The YFBC001WWA ceramic chip loop antenna operates in the 2400-2500 MHz, 5150-5850 MHz and 5925-7125 MHz frequency ranges, offering peak gain of 2.3dBi. It has dimensions of 1.6 mm x 0.8 mm x 0.4 mm. Both antennas operate in the −40 °C to +85 °C temperature range.

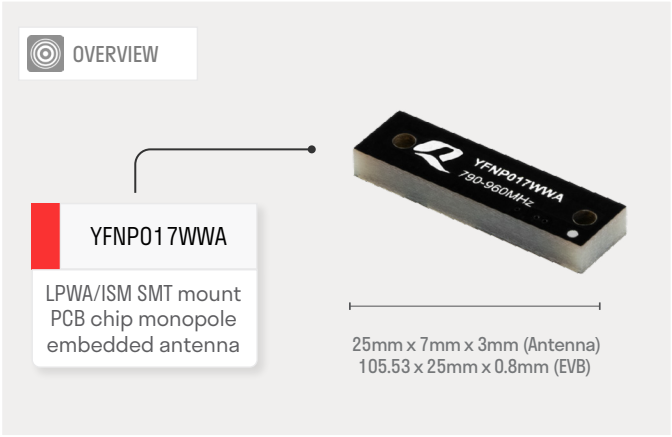
The Quectel YPCS002AA is an LPWA/ISM SMT mount PCB chip monopole embedded antenna that operates in the 791-960 MHz frequency range. The antenna offers 20%-35% efficiency and peak gain of 1.2dBi. With an omni-directional radiation pattern and linear polarization the antenna operates in the 40 °C to +85 °C temperature range. The antenna has dimensions of 20 mm x 11 mm x1.6 mm and is RoHS and REACH compliant. It can be accompanied with an evaluation board, Quectel's **YPCS002AAEVB**.



The Quectel YFNP017WWA is an LPWA/ISM SMT mount PCB chip monopole embedded antenna that operates in the 790-960MHz frequency range. With efficiency of 40-60% and peak gain of 0.5dBi the antenna has an omni-directional radiation pattern and linear polarization. The antenna has dimensions of 25 mm x 7 mm x 3 mm and operates in the 40 °C to +85 °C temperature range. It is both REACH and RoHS compliant. This module also can be accompanied by an evaluation board, Quectel's YFNP017WWAEVB.

EMBEDDED FPC WI-FI TRI-BAND ANTENNAS

The Quectel YF0026LA and YF0027AA are Wi-Fi adhesive mount PFC and cable PIFA embedded antennas that are RoHS and REACH compliant. Operating in the −40 °C to +85 °C temperature range, the antennas feature 100 mm cable lengths. The YF0026LA has dimensions of 28.9 mm x 11 mm and offers peak gain of 5.2dBi. The YF0027AA has dimensions of 38 mm x 7 mm and peak gain of 6.4dBi.



Finally, regarding the external and internal antennas mentioned earlier, Quectel can adjust and optimize their operating frequency bands according to the actual usage scenarios of customers to ensure optimal performance. In addition, we support customization of cable length and connectors in terms of product structure.

To find out more about any of our products or services, please contact:

↗ sales@quectel.com

↗ support@quectel.com

QUECTEL

Build a smarter world