Enabling Global Safety Through BLE

WHITE PAPER

Enabling Global Safety Through BLE

How FORT's new Long Range Bluetooth product line exceeds expectations of traditional bluetooth.

Wireless safety is becoming increasingly important in a world with Autonomous Mobile Robots and Humanoids on the rise in consumer and military applications.

There is a need for reliable wireless communication that can operate anywhere these machines are deployed. While most regions have their own dedicated ISM radio bands, they often differ between places and have different radio requirements. FORT's new implementation of Bluetooth Low Energy offers an option for wireless safety that can be deployed across multiple regions.

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Understanding Bluetooth, Bluetooth Low Energy, and FORT's Long Range Bluetooth.

Bluetooth operates as a frequency-hopping spread spectrum (FHSS) radio technology, transmitting data packets across 79 designated 1 MHz channels within the 2.4 GHz ISM band for short-range wireless data exchange.

Bluetooth Low Energy (BLE) is also operating as a FHSS radio technology, transmitting over the same channels within the same band. The largest difference is that BLE accomplishes this at a lower energy consumption rate. This lower energy consumption means longer battery lives, and longer operation periods. BLE maintains a sleep state unless a connection is initiated. The active connection endures for milliseconds, facilitating the transfer of minimal data, in contrast to the continuously sustained connection characteristic of conventional Bluetooth.

FORT's Long Range Bluetooth product line fully adheres to the standard for BLE 5.2, a newer version of the Bluetooth 4.0 that was released in 2011. Isochronous Channels are utilized for our data streams, primarily leveraging the audio standard due to the analogous nature of FORT's safety data to audio—characterized by small, rapidly transmitted packets.

Isochronous Channels in Bluetooth LE represent a significant advancement for transmitting time-sensitive data between devices. A key attribute of this feature is its ability to ensure synchronized data arrival across all receiving devices, particularly when originating from a singular source. However, a crucial constraint is the finite lifespan of the data; if not transmitted within its designated temporal window, it is discarded. Consequently, receiving devices exclusively process data that remains current and adheres to the stipulated latency parameters.

Comparing Bluetooth, BLE, and FORT Long Range BLE

	Bluetooth Classic	BLE	FORT Long Range BLE (Implementation of BLE 5.2)
Frequency Spectrum	2.4GHz	2.4GHz	2.4GHz
Number of Channels	79 channels with 1MHz width	40 channels with 2MHz width (3 advertising channels/ 37 data channels)	40 channels with 2MHz width (3 advertising channels/ 37 data channels)
Connection Range	10–30m	10–30m (up to 100m in ideal conditions)	150-200m (in ideal conditions)
Typical/Default Tx Power	+4dBm or +8dBm	+4dBm or +8dBm	+17dBm
Topology	Point-to-Point (1:1)	Point-to-Point (1:1)	Point-to-Point (1:1) (2:1 and other topologies coming soon)

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Longer Ranges and Denser Areas of Devices

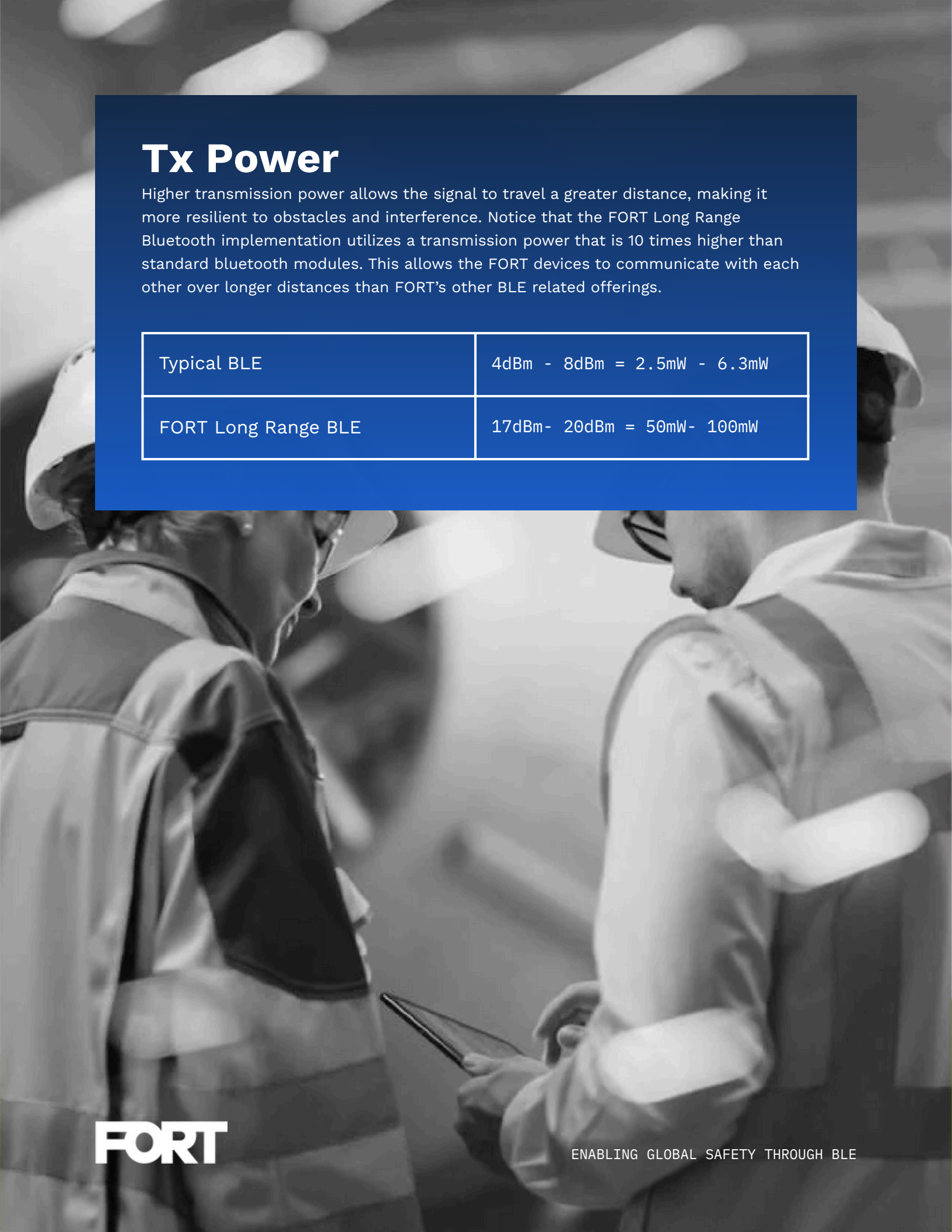
Modern, digital radio communications technologies employ one or more schemes which allow the radio medium to be shared by multiple transmitting devices. These schemes are typically referred to as multiple access methods. The issue being addressed by such schemes is that given a collection of radio devices, all within range of one another, only one may transmit on a particular frequency at a time. If more than one transmission occurs on a particular frequency at the same time, packets are said to collide and data becomes corrupted and must be retransmitted or be lost.

Bluetooth shares the radio medium using Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). FDMA uses 40 distinct 2MHz radio channels, allowing simultaneous communication without collisions. TDMA defines time slots for transmission, called events. This combination enables Bluetooth to support many devices. Bluetooth also employs a channel selection algorithm that monitors channel quality and adapts to environmental conditions, ensuring robust communication in busy radio environments.

FORT's implementation also includes Isochronous Channels, which supports data transmissions that are time-sensitive, as well as synchronized rendering of these data streams across multiple receivers.

These design features allow for better handling of multiple devices in a single area. This means interruptions in communication due to interference on channels are reduced, and end users see more stable performance compared to some ISM radio devices that do not have this. While all high powered radios eventually encounter packet loss, FORT's long range bluetooth implementation standard is capable of a denser number of radios in one area than any other RF product they have offered before. FORT's implementation also incorporates Isochronous Channels, enabling time-sensitive data transmissions and synchronized rendering of these data streams across multiple receivers.

These design features improve the handling of multiple devices in a single area, reducing communication interruptions caused by channel interference. End users experience more stable performance compared to some ISM radio devices lacking these features. While all high-powered radios eventually encounter packet loss, FORT's long-range Bluetooth implementation standard supports a denser concentration of radios in a given area than any other RF product they have previously offered.



Tx Power

Higher transmission power allows the signal to travel a greater distance, making it more resilient to obstacles and interference. Notice that the FORT Long Range Bluetooth implementation utilizes a transmission power that is 10 times higher than standard bluetooth modules. This allows the FORT devices to communicate with each other over longer distances than FORT's other BLE related offerings.

Typical BLE	4dBm - 8dBm = 2.5mW - 6.3mW
FORT Long Range BLE	17dBm- 20dBm = 50mW- 100mW

Worldwide Use and Availability

Bluetooth Low Energy (BLE) has achieved remarkable global availability due to its operation on the unlicensed 2.4 GHz Industrial, Scientific, and Medical (ISM) radio band. This eliminates the need for complex licensing, thereby facilitating its integration into a vast array of devices without regulatory impediments, spanning from smartphones and wearables to smart home appliances and industrial sensors.

This widespread adoption constitutes a significant advantage, fostering an extensive installed base and network of compatible devices, which in turn supports diverse applications. Despite being encrypted, the security posture of BLE devices can be compromised if manufacturers fail to implement adequate encryption and privacy protocols. Interference from other devices operating within the same congested frequency band can also adversely affect performance and reliability.

FORT's Long Range Bluetooth Implementation

FORT is using the BLE audio standard in a special way that is satisfying many different end user needs, enabling mid-range communication distances with high numbers of devices in a single area. There are a few products in the BLE space that also utilize the high power modules with isochronous channels, but typically it is seen in wireless gaming controllers and medical / wearable patient monitoring tech, not the functional safety space.

For more information on FORT's Long Range BLE capabilities, visit fortrobotics.com

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