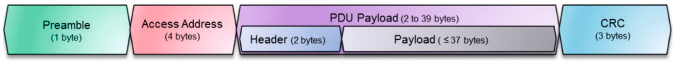
The smarter way to test BLE transmit signals

Smartly verify and decode Bluetooth® Low Energy (BLE) transmit signals with a reliable and cost-efficient spectrum analyzer – the R&S®FPC.

Your task

BLE uses 40 channels, with 3 dedicated channels (37, 38 and 39) for advertising packets and 37 channels (1 to 36) for data packets. The link layer packet structure consists of 4 mandatory fields: preamble, access address, PDU payload, cyclic redundancy check (CRC).



Bluetooth® 4.0 packets.

During and after the design stage of a BLE transmitter, it is important to conduct tests to ensure that the transmitted information is correct. Tests such as verifying the test packet structure, output power, modulation characteristics and carrier frequency error are necessary.

T&M solution

A BLE product is typically inexpensive, which makes it essential that the analyzer also fits in the pricing ecosystem. The R&S®FPC has excellent RF performance compared to its peers, the best price value and the flexibility to extend the frequency range. This makes it the right choice for testing BLE transmitters.

Key specifications	
Frequency range	5 kHz to 1 GHz, with upgrades up to 3 GHz
Max. input power	up to +30 dBm
Low noise floor	down to typ. –165 dBm (with preamplifier)
Connectivity	LAN, USB, Wi-Fi (optional)
Measurement options	modulation analysis, receiver mode, advanced measurements
Tracking generator	5 kHz to 1/2/3 GHz

Application

Before performing any test on a BLE DUT, connect an antenna or the DUT to the R&S®FPC RF input port and configure the test setup using the values in the table below.

BLE setup of the R&S®FPC.

R&S®FPC setup configuration					
PRESET					
Mode	Digital Demodulation				
Frequency	2402 MHz				
Ampt	Reference Level	▷	–20 dBm		
Sweep	Trigger	▷	I/Q Power	▷	–30 dBm
Meas	FSK	▷	Standard	▷	Bluetooth® LE
Ampt	Deviation per Division	▷	100 kHz		
Meas	Demod Parameters	▷	Burst Processing		
	Number of Symbols	▷	400		

Verifying the data structure

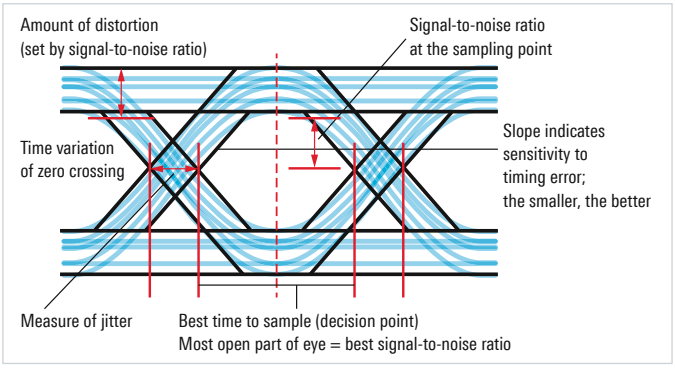
The data structure for different packets can be identified in the symbol display. The BLE beacon advertisements channel in Fig. 1 shows 8 bit for the preamble, 32 bit for the access address and 16 bit for the header. The last 24 bit are for the CRC. Between the header and the CRC is the payload. The transmitted symbols should comply with the design.

Modulated signal

The modulation deviation mode displays a BLE modulated signal in the spectrum view. The carrier frequency deviation, carrier power, carrier frequency drift and modulation error are shown above the signals. Check these values to ensure the results are within the design specification.

Evaluating the quality of the BLE signal

The eye diagram provides a quick visual inspection of the signal integrity. It helps you easily identify design issues.



Interpretation of eye diagram (source: http://www.testandmeasurement-tips.com/basics-eye-diagrams).

Summary

The BLE transmit signal can easily be evaluated using an R&S®FPC with the R&S®FPC-K7 modulation analysis option. R&S®FPC-K7 also supports AM, FM, ASK and FSK modulation analysis.

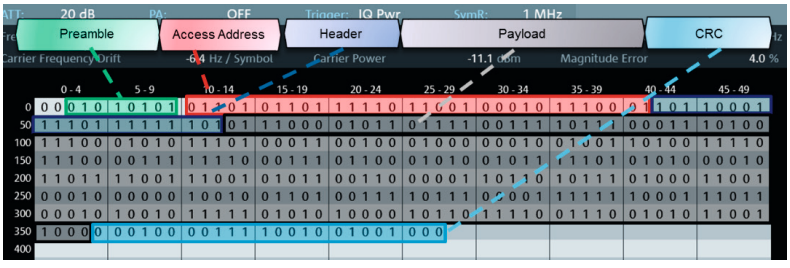


Fig. 1 BLE data structure.

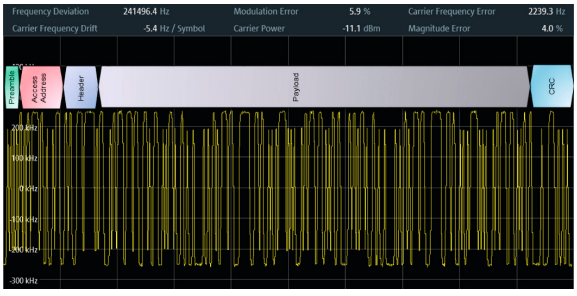


Fig. 2 BLE modulated signal.

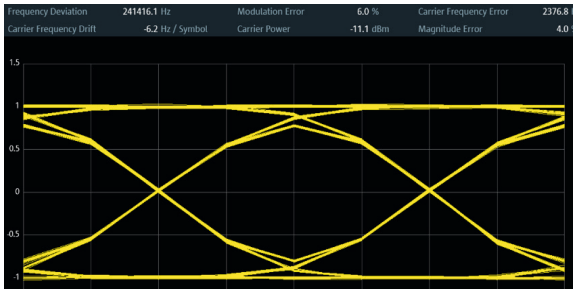


Fig. 3 BLE eye diagram measured at the BLE DUT.

Ordering information

Designation	Typ	Order No.
R&S®FPC1000 Spectrum Analyzer, 5 kHz to 1 GHz	R&S®FPC1000	1328.6660.02
R&S®FPC1500 Spectrum Analyzer, 5 kHz to 1 GHz, with tracking generator	R&S®FPC1500	1328.6660.03
Spectrum Analyzer Frequency Upgrade, 1 GHz to 2 GHz	R&S®FPC-B2	1328.6677.02
Spectrum Analyzer Frequency Upgrade, 2 GHz to 3 GHz	R&S®FPC-B3	1328.6683.02
Spectrum Analyzer Preamplifier	R&S®FPC-B22	1328.6690.02
Wi-Fi Connection Support	R&S®FPC-B200	1328.6990.02
Modulation Analysis	R&S®FPC-K7	1328.6748.02
Vector reflection measurement (for R&S®FPC1500 only)	R&S®FPC-K42	1328.7396.02
Receiver Mode	R&S®FPC-K43	1328.6754.02
Advanced Measurements	R&S®FPC-K55	1328.6760.02

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