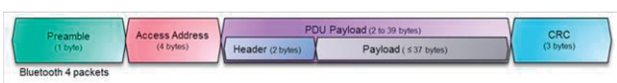
運用更智慧的方式進行 BLE 傳輸器測試

您可透過可靠、經濟的頻譜分析儀R&S®FPC1000採用智慧方式驗證和解碼低功耗藍牙 (Bluetooth Low Energy, BLE) 傳輸訊號。

您的任務

BLE 使用 40 個頻道，搭配 3 個廣告封包 (頻道 37-39) 和 37 個資料封包 (頻道 1-36)。連結層封包結構包含 4 個規定欄位，前置訊號、存取地址、PDU 承載量與循環冗餘檢查 (CRC)。



BLE 傳輸器設計期間和設計後，進行測試確保傳輸的資訊是否正確，是件很重要的事。驗證測試封包結構、輸出功率、調變特徵和載波頻率誤差等測試都是必要的。

R&S量測解決方案

BLE 產品成本一般不貴，因此裝在價格生態系統的分析儀是不可或缺的。跟同級產品相比，初階的 R&S®FPC1000 在頻率範圍方面擁有卓越的 RF 效能，最佳的價格與彈性，是測試 BLE 傳輸器的實用選擇。

Specifications in brief		
Frequency range	R&S®FPC1000	5 kHz to 1 GHz
	with R&S®FPC-B2 option	5 kHz to 2 GHz
	with R&S®FPC-B3 option	5 kHz to 3 GHz
Frequency resolution		1 Hz
Resolution bandwidth		1 Hz to 3 MHz in 1/3 sequence
Displayed average noise level	0 dB RF attenuation, 50 Ω termination, RBW = 100 Hz, VBW = 10 Hz, sample detector, log scaling, normalized to 1 Hz	± 1.5% of full scale
	frequency	R&S®FPC1000 preamplifier = off
	1 MHz to 10 MHz	< –127 dBm, –135 dBm (typ.)
	10 MHz to 1 GHz	< –142 dBm, –150 dBm (typ.)
	1 GHz to 3 GHz	< –138 dBm, –147 dBm (typ.)
	frequency	R&S®FPC1000 preamplifier = on
	1 MHz to 10 MHz	< –147 dBm, –157 dBm (typ.)
	10 MHz to 2 GHz	< –158 dBm, –165 dBm (typ.)
	2 GHz to 3 GHz	< –155 dBm, –163 dBm (typ.)
Third-order intercept (IP3)	intermodulation-free dynamic range, signal level of 2 × –20 dBm, RF attenuation = 0 dB, RF preamplifier = off	+7 dBm (meas.)
Level measurement uncertainty		
Absolute frequency uncertainty at 100 MHz	+20 °C to +30 °C	< 0.3 dB
Frequency response (+20 °C to +30 °C)	100 kHz ≤ f < 10 MHz	< 1.5 dB (nom.)
	10 MHz ≤ f ≤ 3 GHz	< 1 dB

應用案例

測試 BLE 待測物前，請將天線或待測物連接 R&S®FPC1000 的 RF 輸入接口 (圖 1)，進入下列安裝區域並進行設定 (表 1)。

圖1 R&S®FPC1000 和 BLE 安裝

Setup at R&S®FPC1000		
PRESET		
Mode	Digital Demodulation	
Frequency	2402 MHz	
Ampt	Reference Level	→ -20 dBm
Sweep	Trigger	→ IQ Power → -30 dBm
Meas	FSK	→ Standard → Bluetooth LE
Ampt	Deviation per Division	→ 100 kHz
Meas	Demod Parameters	→ Burst Processing
	Number of Symbols	→ 400

表1 R&S®FPC1000 安裝配置

ROHDE&SCHWARZ

檢驗資料結構
從符號顯示來看，可辨別不同封包的資料結構。圖 3 顯示前置訊號有 8 個位元、存取地址有 32 個位元，表頭有 16 個位元，CRC 是最後的 24 個位元，表頭跟 CRC 之間的位元則屬於承載量。已傳輸符號應與設計相符。

已調變訊號
調變偏移模式可在頻譜檢視畫面顯示已調變的 BLE 訊號。承載量頻率偏移量、承載量電力、承載量頻率漂移以及調變誤差均顯示在訊號上方。請確認這些數值，以確保檢查結果會在設計規格中。

評估 BLE 訊號品質
透過眼圖可快速藉由目視檢查確認設計的訊號完整性，協助輕鬆找出設計問題。圖 2 所顯示為簡易的眼圖，圖 5 則為由 BLE DUT 測量的眼圖。

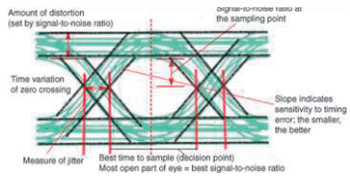


圖2 眼圖說明[1]

總結

您可透過具備調變分析(R&S®FPC-K7)功能的R&S®FPC1000，輕鬆地評估已傳輸的 BLE 訊號測試。R&S®FPC-K7 選項亦支援其他 AM、FM、ASK 或 FSK 調變分析。

[1]資料來源 *http://www.testandmeasurementtips.com/basics-eye-diagrams/*

使用 R&S®FPC1000 測量 BLE 資訊

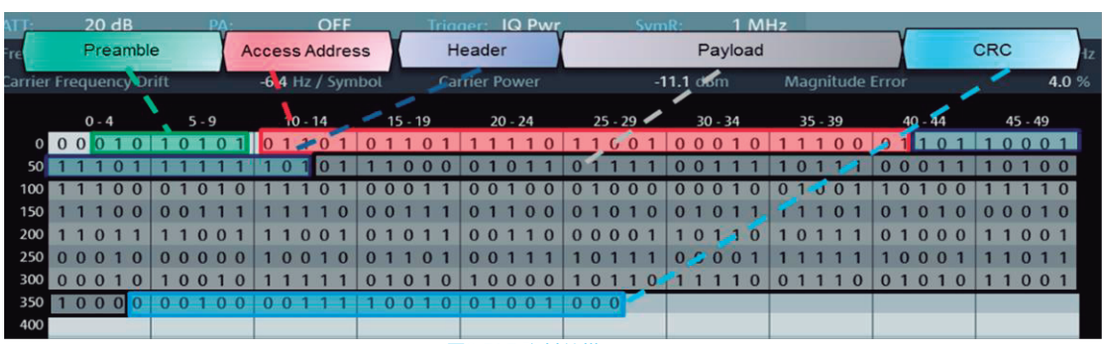


圖3 BLE 資料結構

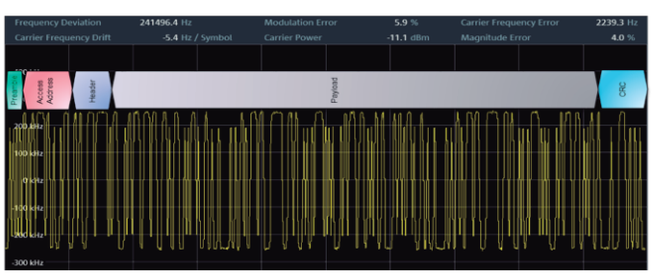


圖4 已調變 BLE 訊號

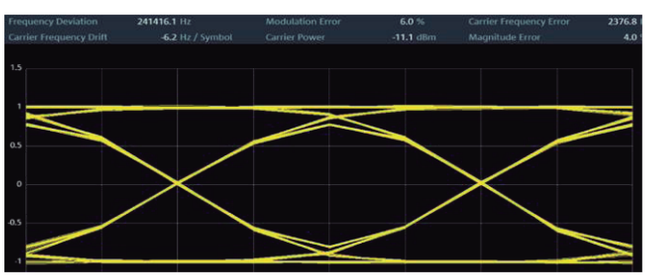


圖5 BLE 眼圖

訂購資訊		
R&S®FPC1000 頻譜分析儀，5 kHz 至 1 GHz	R&S®FPC1000	1328.6660.02
頻譜分析儀頻率升級，1 GHz 至 2 GHz	R&S®FPC-B2	1328.6677.02
頻譜分析儀頻率升級，2 GHz 至 3 GHz	R&S®FPC-B3	1328.6683.02
頻譜分析儀前置放大器	R&S®FPC-B22	1328.6690.02
Wi-Fi 連線支援	R&S®FPC-B200	1328.6990.02
調變分析	R&S®FPC-K7	1328.6748.02
接收器模式	R&S®FPC-K43	1328.6754.02
進階測量	R&S®FPC-K55	1328.6760.02