BLUETOOTH® LOW ENERGY CHANNEL SOUNDING VALIDATION

The R&S®CMW wideband radio communication tester platform (R&S®CMW500, R&S®CMW270) uses high accuracy distance measurements (HADM) with phase based ranging (PBR) for a comprehensive and fully automated test solution to verify Bluetooth® Low Energy physical layer functionality.

Your task

The Bluetooth Special Interest Group (SIG) plans to extend positioning capabilities with a new channel sounding feature. The feature will be added along with advertising, RSSI-ranging and direction finding (DF) capabilities. Bluetooth® channel sounding (CS) will enable high accuracy distance measurements (HADM) between two Bluetooth® Low Energy devices. CS uses the relative phase shift between received and transmitted radio signals over multiple RF frequencies or the round trip time, based on packets or a combination of both. Typical HADM applications include keyless entry systems, indoor navigation and asset tracking with new use cases continuously being developed for future applications.

Phase based measurement principle

PBR uses the phase shift (Θ) of a radio signal as it travels over distance D at frequency f. When two or more signals with different frequencies are used, the measured phase difference (ΔΘ) between the signals can help accurately estimate a distance. When estimating a distance with channel sounding, one device initiates (initiator) the procedure and a second device reciprocates the radio transmission (reflector) without modifying the phase. For every transmission in the frequency f_i, the phase change ($\Delta\Theta_i$) between the transmitted and the received signal is measured by the initiator. Uncoded narrowband Gaussian minimum shift keying (GFSK) signals can be sent or received using a single antenna for easy implementation in standard Bluetooth® Low Energy radio chips. Alternatively, multiple antennas can be used to improve performance or DF coexistence.

Phase based ranging principle for high accuracy distance measurements
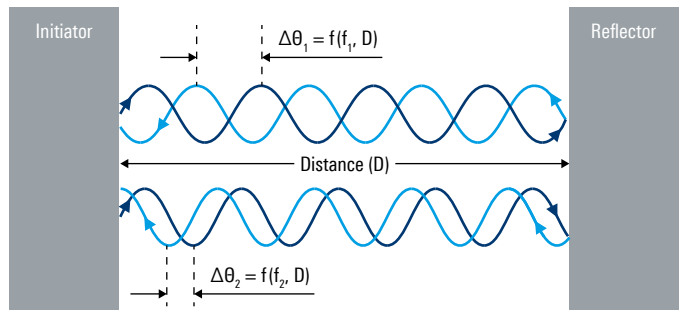
Ensuring best-in-class accuracy

The Bluetooth SIG defined RFPHY test cases (TCs) to verify satisfactory device RF performance when a Bluetooth® DUT acts either as an initiator or reflector. Test solutions must operate both roles. Measurements must show that an initiator can generate the CS packets and tones with the required phase stability, that the reflector transmits signals with the correct phase and that general DUT phase measurements are accurate. The frequency offset also needs to be within a certain limit. When an antenna array is used, the antenna switching function must also be verified.

Rohde & Schwarz solution

R&S®CMW wideband radio communication testers can generate and analyze all required CS packets and tones in a one-box solution. The solution can be used to manually or automatically perform all RFPHY TCs. The DUT is controlled via a UART/USB interface with the HCI protocol in direct test mode (DTM).
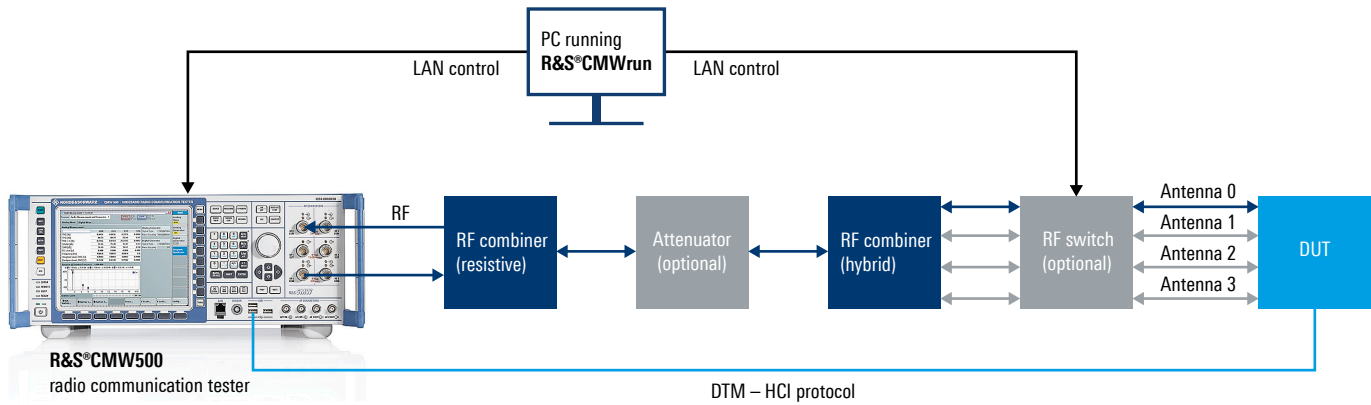
ROHDE & SCHWARZ

Make ideas real

Bluetooth® Low Energy channel sounding physical layer verification setup with R&S®CMW500 and R&S®CMWrun

All transmitter and receiver RFPHY measurements are simple with the intuitive, user-friendly graphical user interface. All HCI reports can be logged for further analysis and debugging. An off-the-shelf test plan with full coverage of all CS preconformance RFPHY TCs is included in the R&S®CMWrun sequencer software tool. Test cases can be run individually or with full preconformance testing and a test report. The R&S®CMWrun sequencer software tool also generates log files after each test run to make regression and verification testing easier than ever.

Application
A fully automated Bluetooth® CS test setup for user equipment with more than one antenna includes the R&S®CMW wideband radio communication tester and the R&S®OSP open switch and control platform. Both are controlled by R&S®CMWrun (installed on a separate controlling PC) via LAN/GPIB connections. The fully automated solution is especially suited for antenna switching integrity (ASI) testing, when multiple RF connections/disconnections are required. R&S®CMWrun sequencer software supports all Bluetooth® CS test cases along with legacy Bluetooth® Low Energy and Bluetooth® Classic testing.

Transmitter testing
▶ Stable phase testing
▶ Companion signal verification
▶ Modulation spectrum
▶ Antenna switching integrity
▶ Modulation characteristics, bandwidth-symbol time product (BT) = 2.0
▶ Signal-to-noise output control

Transmitter-receiver testing
▶ Step mode frequency verification
▶ Antenna switching integrity
▶ Phase measurement accuracy

Summary
The Bluetooth® Low Energy channel sounding test and measurement solution from Rohde & Schwarz uses the R&S®CMW platform to fully cover all R&D verification needs during product design, including functional tests and RF parametric measurements and production requirements. Together with R&S®CMWrun, an off-the-shelf test plan ensures regression and preconformance test efficiency.

See also

Ordering information

Designation	Type	Order No.
Wideband radio communication tester	R&S®CMW500	1201.0002K50
Wireless connectivity tester	R&S®CMW270	1201.0002K75
Bluetooth® Low Energy CS DTM and RX measurements	R&S®CMW-KS725	1211.5588.02
Bluetooth® Low Energy CS TX measurements	R&S®CMW-KM725	1211.5571.02