BLUETOOTH LE UWB

Rohde&Schwarz Korea

" 본 솔루션을 소개하기 위한 PT를 준비 했습니다.
로데슈바르즈의 솔루션을 소개 받고 싶으신 분은
언제든지 요청하여 주시기 바랍니다. "

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90 YEARS
OF ENSURING A SAFER AND CONNECTED WORLD

ROHDE&SCHWARZ
Make ideas real

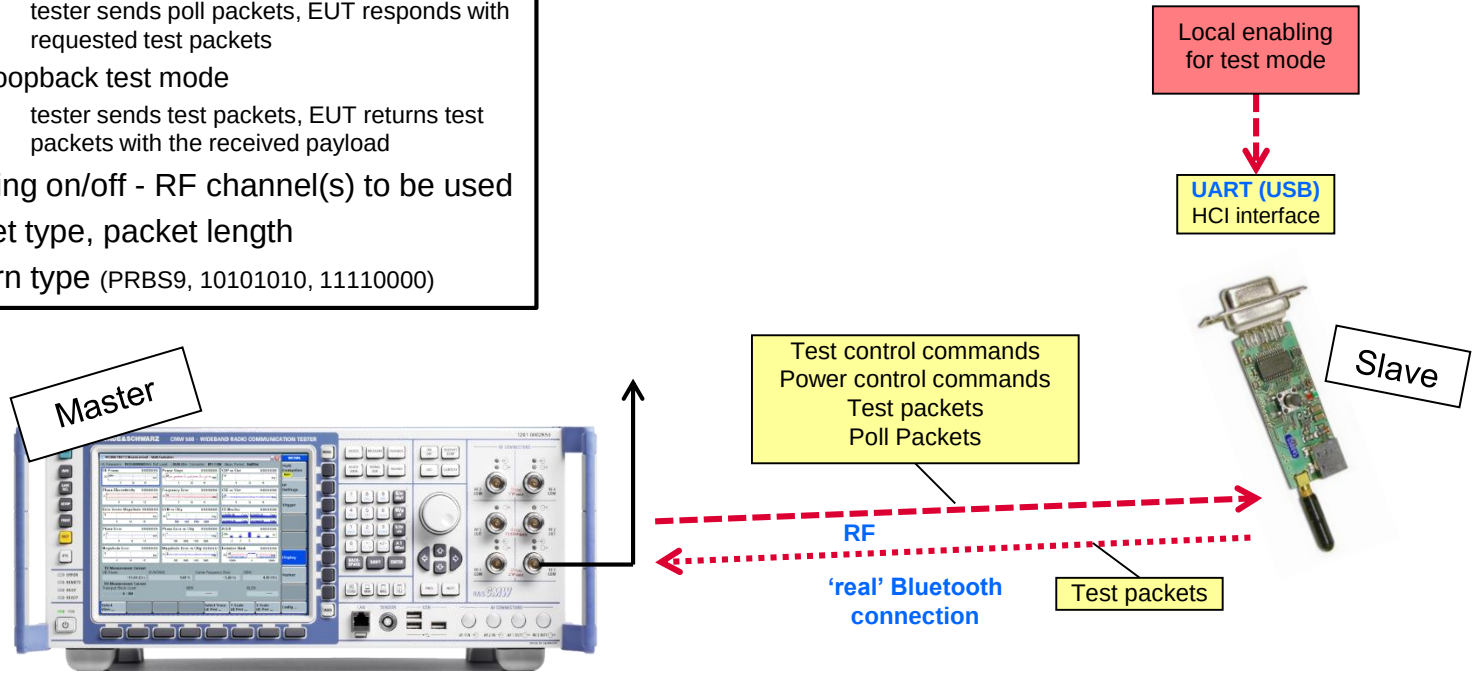
R&S BLUETOOTH SOLUTION

Nov, 2023

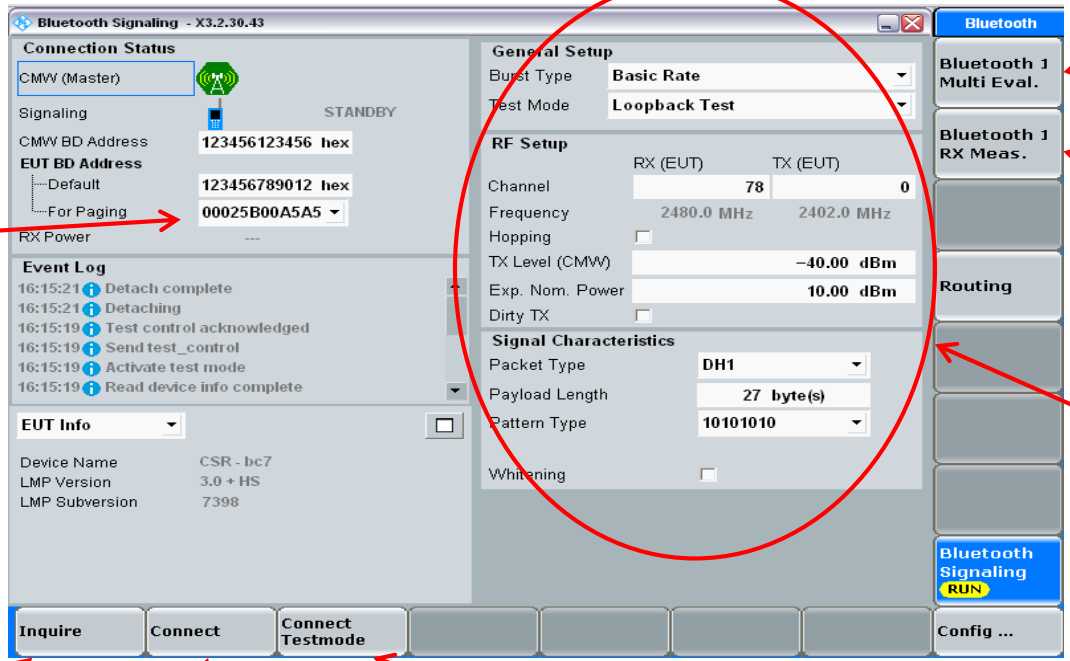
BLUETOOTH BR/EDR TEST MODE (SIGNALING)

Test control commands

- Test mode type
  - TX test mode
    - tester sends poll packets, EUT responds with requested test packets
  - Loopback test mode
    - tester sends test packets, EUT returns test packets with the received payload
- Hopping on/off - RF channel(s) to be used
- Packet type, packet length
- Pattern type (PRBS9, 10101010, 11110000)



BLUETOOTH BR/EDR SIGNALING



select EUT for paging

TX measurements

RX measurements

test mode parameters

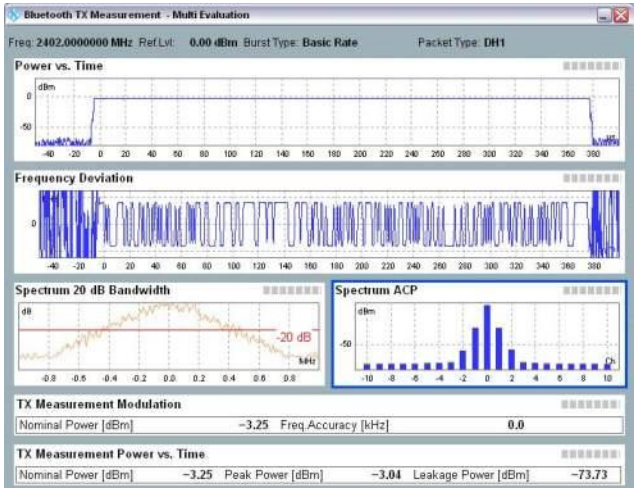
search for EUTs

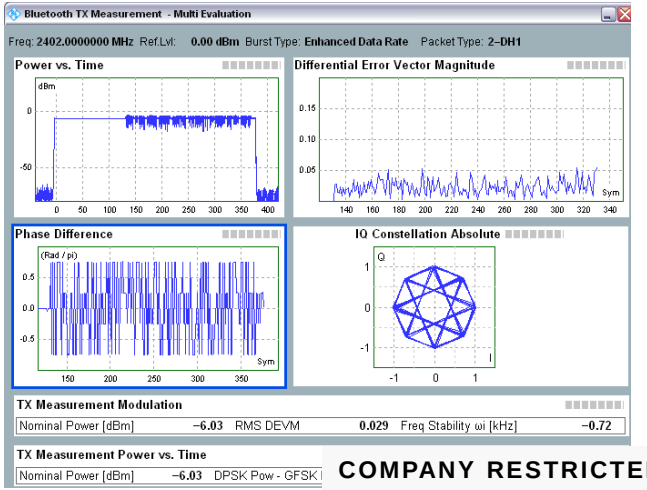
connect to EUT w/o activating testmode (simple go/nogo test)

connect to EUT and activate testmode to perform RF tests

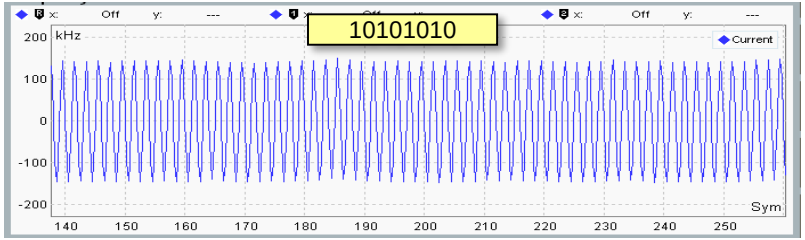
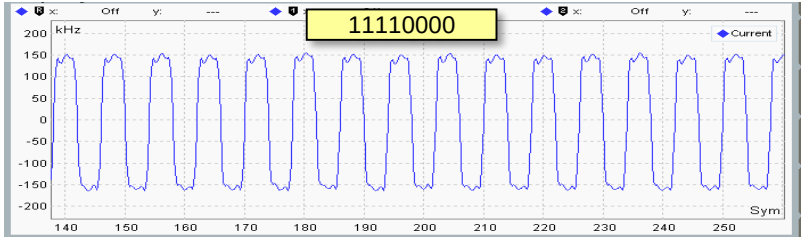
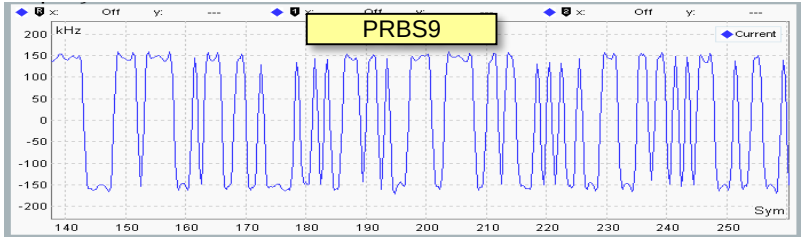
BLUETOOTH BR/EDR TX MEASUREMENTS

- Full set of TX measurements
  - Basic rate:
    - Nominal power
    - Frequency accuracy, frequency drift and max. drift rate
    - Frequency deviation
    - Spectrum - 20 dB bandwidth
    - Spectrum - adjacent channel power (79 channels)
    - Spectrum – frequency range
  - Enhanced data rate
    - Nominal power (GFSK, DPSK)
    - Frequency stability ω_i and $\omega_{0\ max}$ (drift)
    - Differential error vector magnitude
    - Spectrum – in-band emmissions (79 channels)
    - I/Q constellation diagram
    - Phase difference graph
    - Phase Encoding measurement

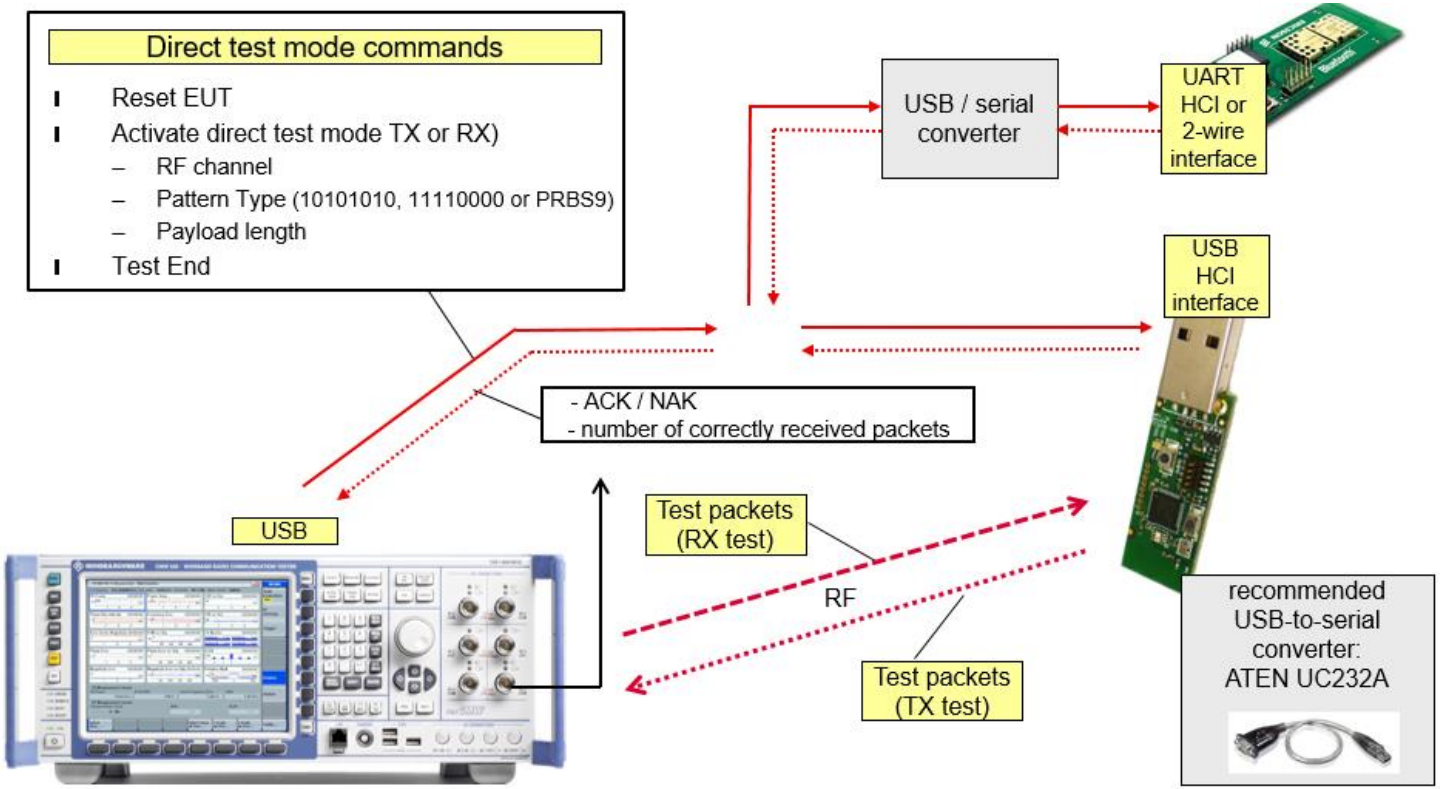




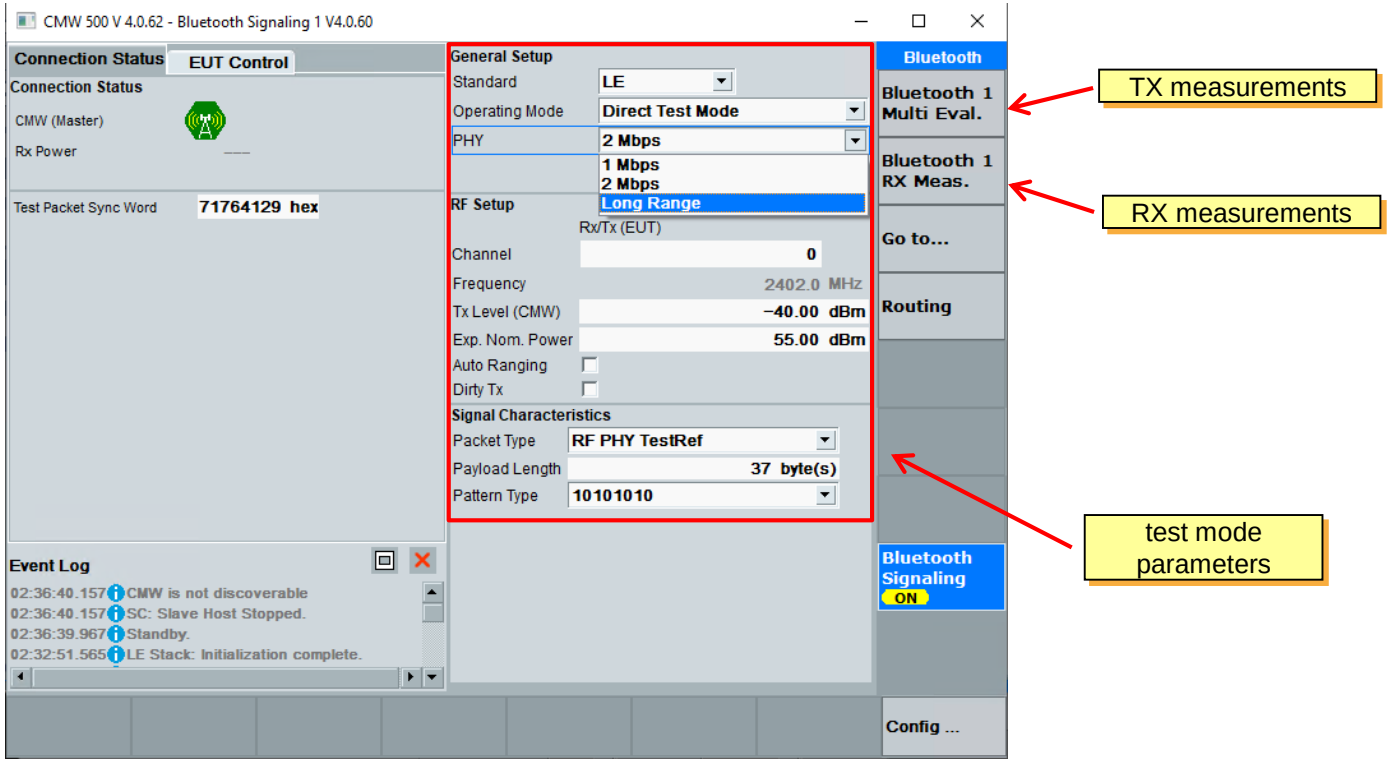
PATTERN TYPES FOR RF MEASUREMENTS

	Measurements acc. to Bluetooth RF Test Specs for **BR and LE**	Measurements acc. to Bluetooth RF Test Spec for **EDR**
	Frequency Drift and Drift Rate Modulation Characteristics (Δf2)	
	Modulation Characteristics (Δf1)	
	Power Initial Carrier Frequency Tolerance Spectrum Sensitivity	Power Initial Carrier Frequency Tolerance Carrier Frequency Stability and Modulation Accuracy Spectrum Sensitivity

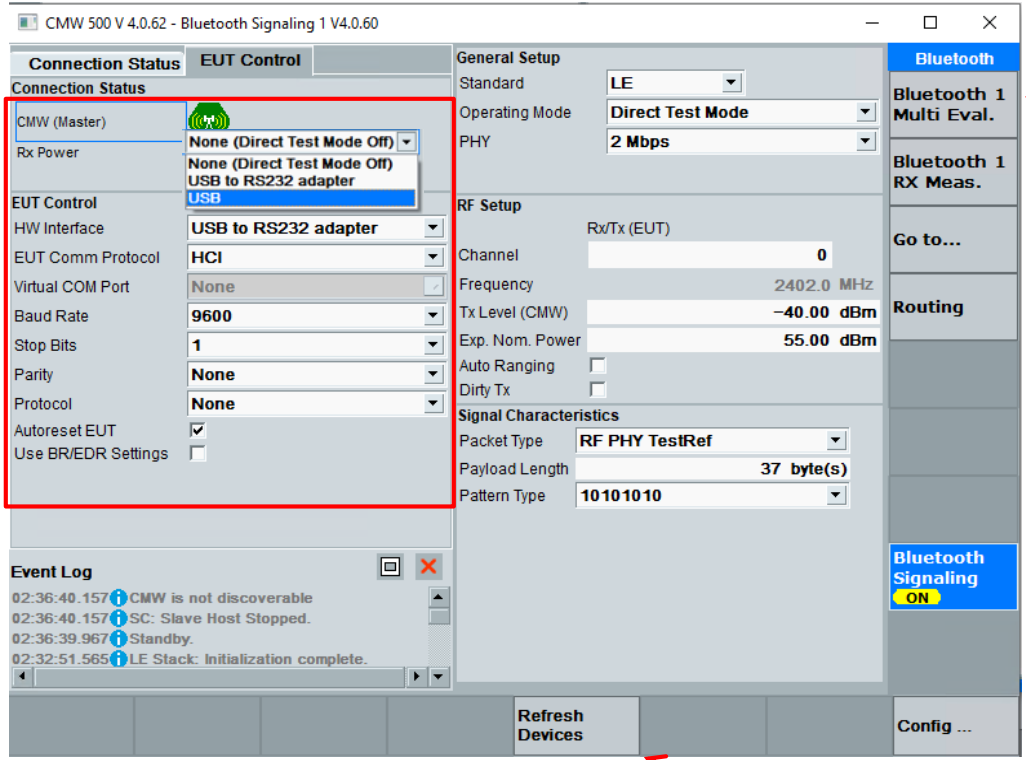
BLUETOOTH LE
DTM MODE- UART / USB



BLUETOOTH LE DTM MODE



BLUETOOTH LE DTM MODE



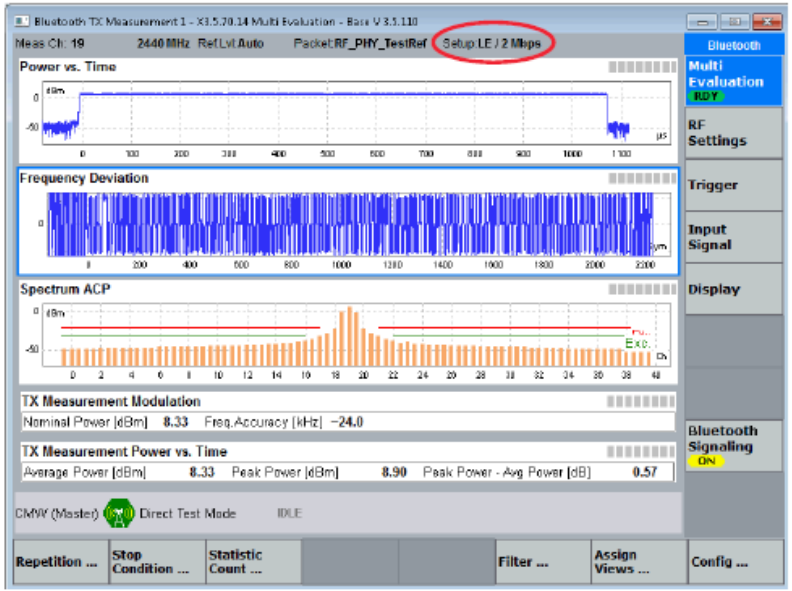
TX measurements

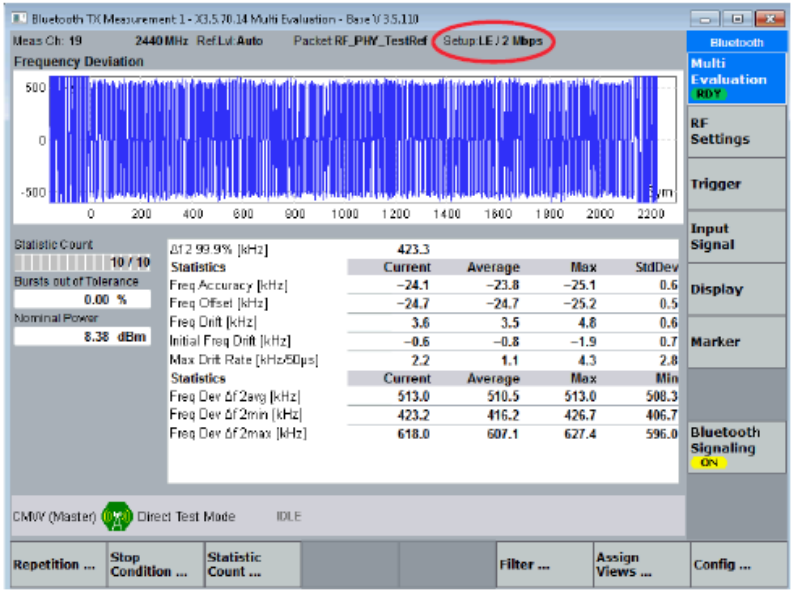
RX measurements

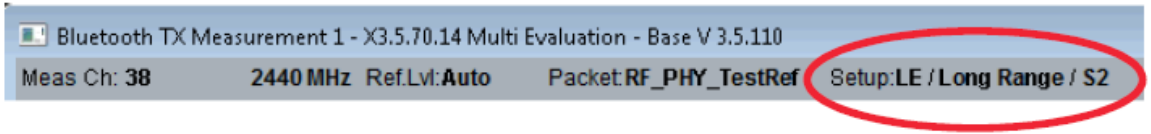
EUT UART settings

search for available COM ports

BLUETOOTH LE TX MEASUREMENT







CMWRUN CMW-KT057: BLUETOOTH TEST AUTOMATION

- Individual Bluetooth RF testing for R&D and verification
- Bluetooth RF pre-qualification testing (test cases)
- Straightforward to use
  - Create your own test sequence or use a pre-defined example sequence
  - Execute the test sequence
    - CMWrun generates a test report
  - Store the test report

CMWRUN KT057
BLUETOOTH RF TEST CASES FOR BR AND EDR

- TRM/CA/01/C (output power)
- TRM/CA/03/C (power control)
- TRM/CA/04/C (TX Output Spectrum - frequency range)
- TRM/CA/05/C (TX Output Spectrum -20dB bandwidth)
- TRM/CA/06/C (TX Output Spectrum -adjacent channel power)
- TRM/CA/07/C (modulation characteristics)
- TRM/CA/08/C (initial carrier frequency tolerance)
- TRM/CA/09/C (carrier frequency drift)

- RCV/CA/01/C (sensitivity – single-slot packets)
- RCV/CA/02/C (sensitivity – multi-slot packets)
- RCV/CA/06/C (maximum input level)

BR

- TRM/CA/10/C (EDR Relative Transmit Power)
- TRM/CA/11/C (EDR Carrier Frequ.Stability and Mod. Accuracy)
- TRM/CA/12/C (EDR Differential Phase Encoding)
- TRM/CA/13/C (EDR In-band Spurious Emissions)
- TRM/CA/14/C (Enhanced power control)

- RCV/CA/07/C (EDR Sensitivity)
- RCV/CA/08/C (EDR BER Floor Performance)
- RCV/CA/10/C (EDR Maximum Input Level)

EDR

These tests require at least a single-channel CMW with Bluetooth options

- TRM/CA/02/C (Power Density)
- RCV/CA/03/C (C/I performance)
- RCV/CA/04/C (Blocking performance)
- RCV/CA/05/C (Intermodulation performance)
- RCV/CA/09/C (EDR C/I Performance)

‚advanced' tests

These test require a dual-channel CMW with ARB generator, spectrum analyzer option and an external CW generator up to 12.75 GHz SGMA (SGS100A)

CMWRUN KT057
BLUETOOTH RF TEST CASES FOR LE

- TRM-LE/CA/01/C (Output power at NOC)
- TRM-LE/CA/02/C (Output power at EOC)
- TRM-LE/CA/03/C (In-band emissions at NOC)
- TRM-LE/CA/04/C (In-band emissions at EOC)
- TRM-LE/CA/05/C (Modulation characteristics)
- TRM-LE/CA/06/C (Carrier frequency offset and drift at NOC)
- TRM-LE/CA/07/C (Carrier frequency offset and drift at EOC)

- RCV-LE/CA/01/C (Receiver sensitivity at NOC)
- RCV-LE/CA/02/C (Receiver sensitivity at EOC)
- RCV-LE/CA/06/C (Maximum input signal level)
- RCV-LE/CA/07/C (PER Report Integrity)

These tests require at least
a single-channel CMW
with Bluetooth options

- RCV-LE/CA/03/C(C/I and receiver selectivity performance)
- RCV-LE/CA/04/C (Blocking performance)
- RCV-LE/CA/05/C (Intermodulation performance)

‚advanced' tests

These test require a dual-channel CMW
with ARB generator and
an external CW generator up to 12.75 GHz
SGMA (SGS100A)

CMWRUN: SETUP FOR RF PRE-QUALIFICATION TESTING

CMW RF Channel 1:
Bluetooth wanted signal
(PRBS9)

CMW RF Channel 2:
Bluetooth modulated signal
(PRBS15)
Spectrum analyzer

internal combiner
(advanced frontend)

SGMA (SGS100A)
static sinewave signal
(CW) 12.75 GHz

external
combiner

See new application note 1MA261

R&S UWB SOLUTION

Nov, 2023

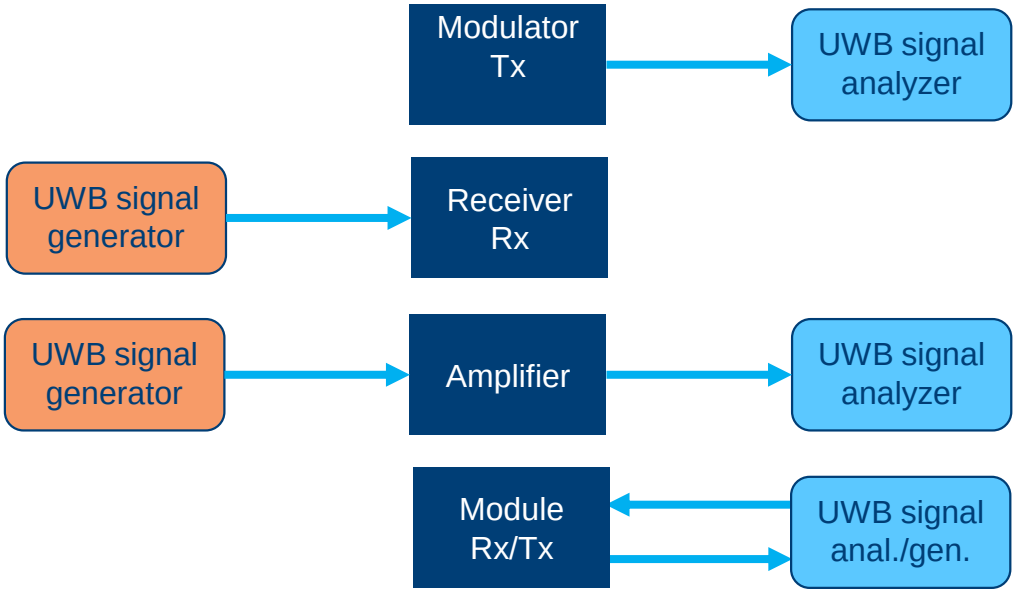
T&M Applications in R&D

R&D of UWB modulators

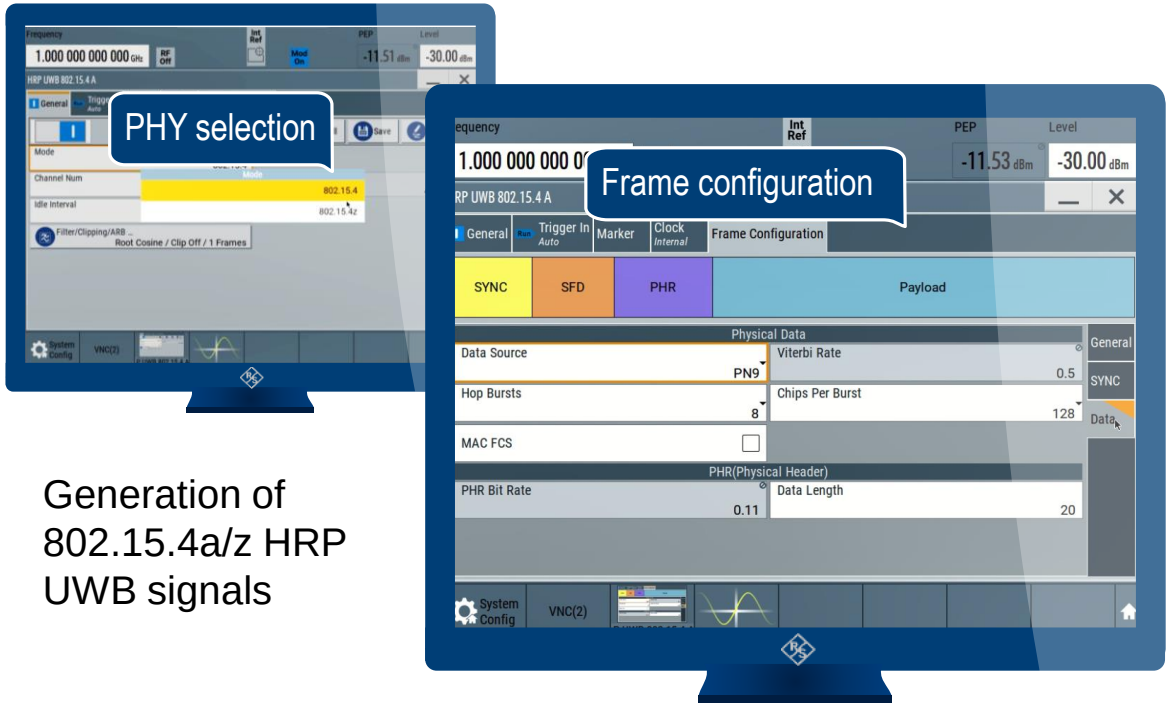
R&D of UWB receivers

R&D of UWB amplifiers

R&D of UWB modules



HRP UWB signal generation in all bands



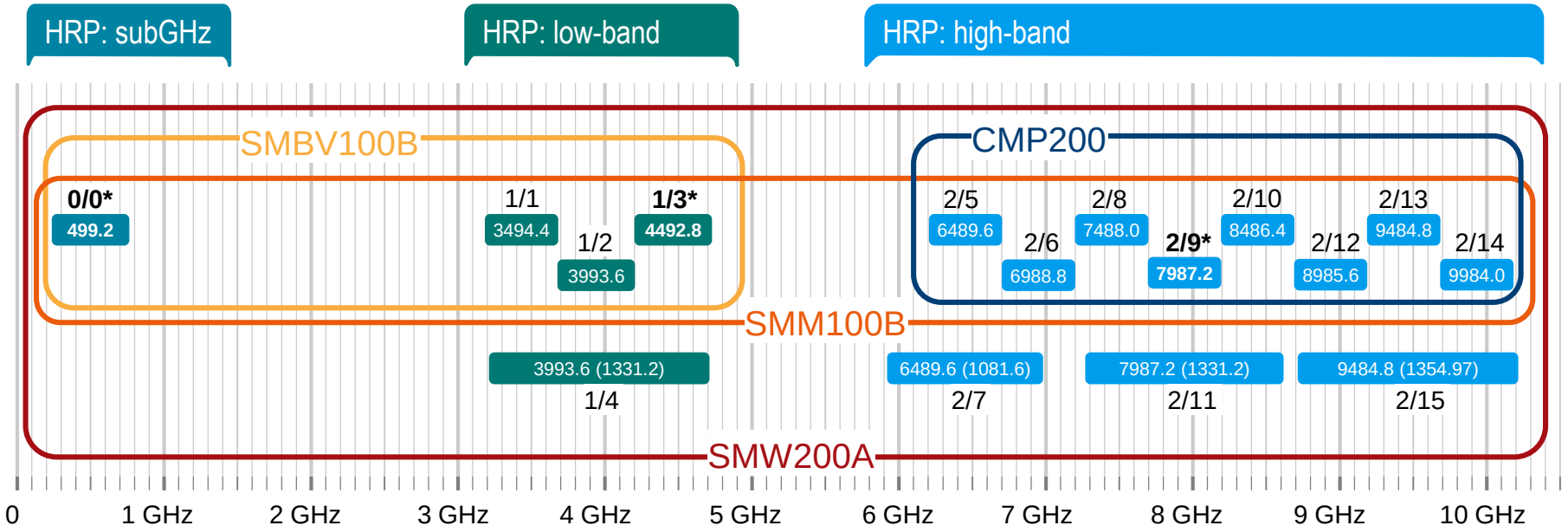
Generation of 802.15.4a/z HRP UWB signals

R&S®SMW200A
[12.75 GHz; 2 GHz BW]

R&S®SMM100A
[12.75 GHz; 1 GHz BW]

R&S®SMBV100B
[6 GHz; 500 MHz BW]

UWB HRP Signal generator options



Support of HRP-RDEV (802.15.4a) and HRP-ERDV BPRF & HPRF (802.15.4z), no LRP support

Options:SMW-K149/449, SMM-K149/449, SMBV-K149/449

Solutions for R&D (Signal analysis)

R&S®FSW26

- with R&S®FSW-B1200 (**1.2 GHz** BW) or
- with R&S®FSW-B2001 (**2.0 GHz** BW)
- optional R&S®FSW-B24 RF preamplifier
- plus new UWB analysis option K149

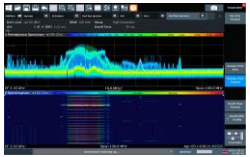
also available: R&S®FSW-B4001/ -B6001/ -B8001

R&S®RTP

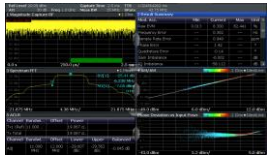
– plus new UWB analysis option (with PC-Software VSE)

HRP UWB signal analysis with R&S®FSW26

- Frequency range from 10 MHz (DC: 2 Hz) to 26.5 GHz to support of all HRP UBW bands
- RF modulation bandwidth up to 2 GHz
  - With **R&S®B1200** support of all mandatory HRP UWB channels
  - With **R&S®B2001** support of all mandatory and optional HRP UWB channels
- Excellent phase noise and DANL characteristic
- Wide range of applications and standards
- HRP UWB measurements with **R&S®FSW-K149**



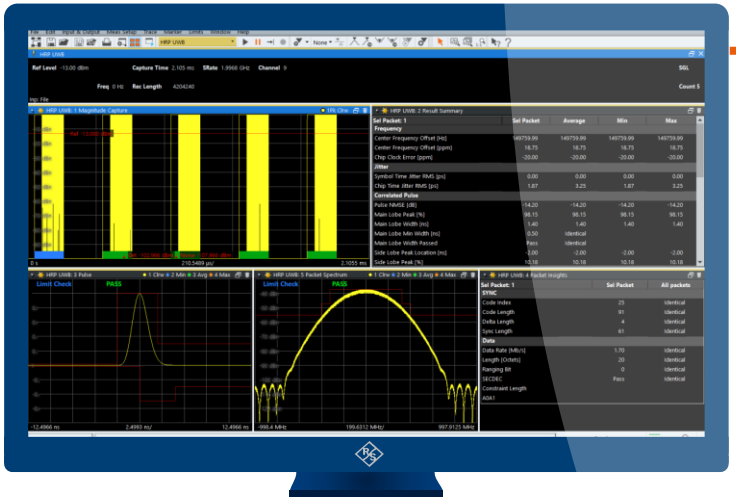
Real-time spectrum analysis up to 800 MHz of bandwidth



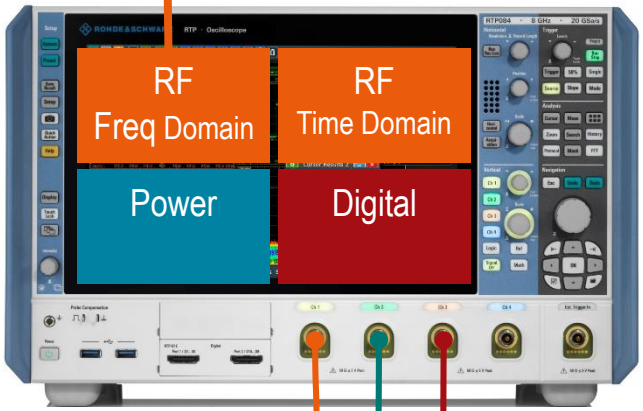
Amplifier measurements

Phase noise measurement

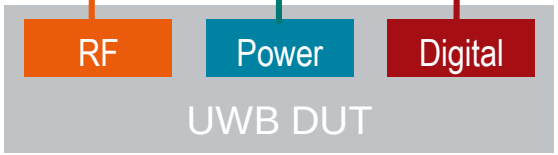
A perfect setup for the multi-domain analysis for all UWB channels incl. FiRa defined measurements



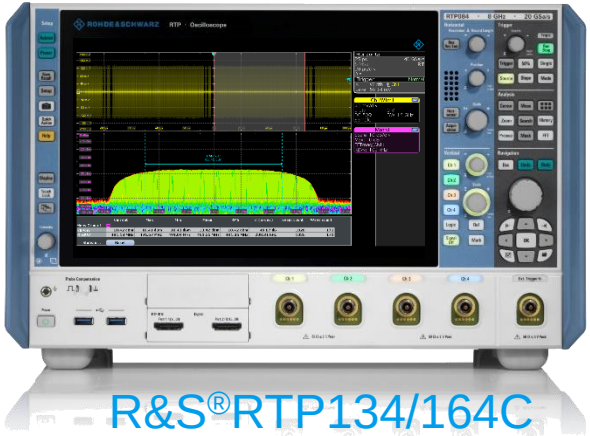
R&S®VSE K-149



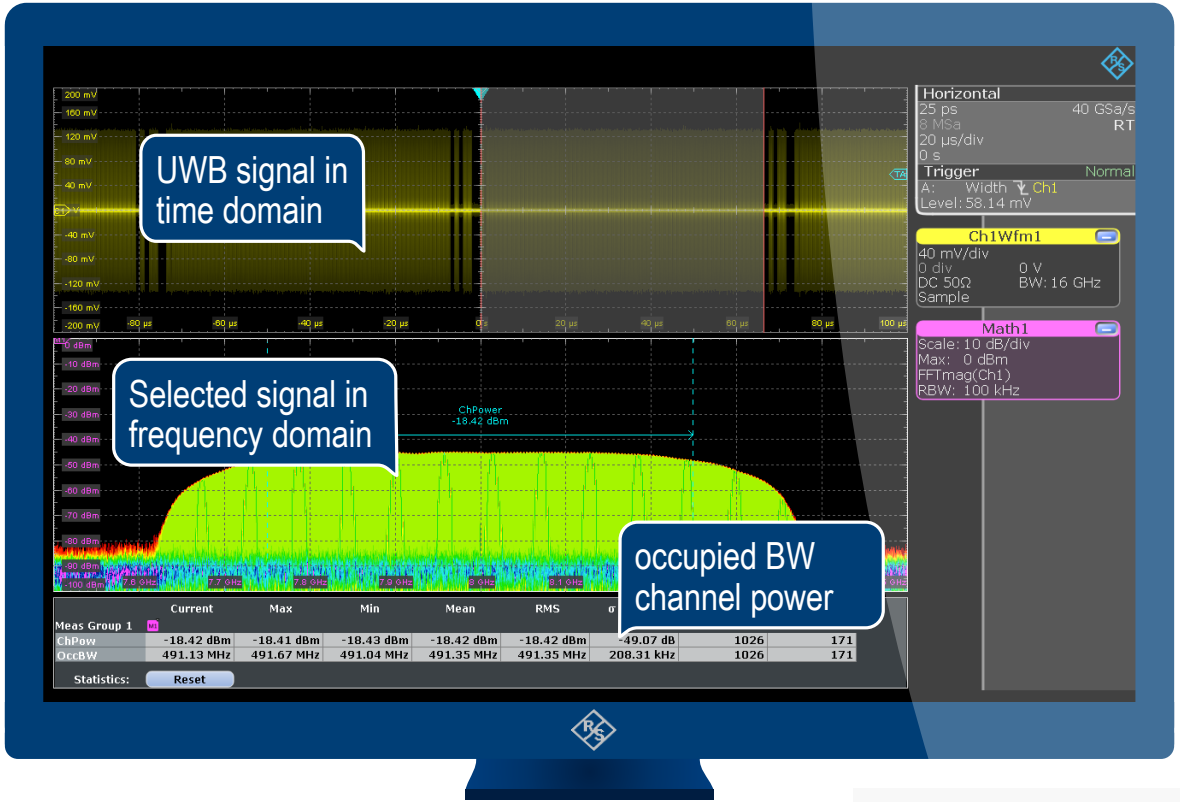
R&S®RTP134/164C



Wideband RF analysis of a IEEE 802.15.4z (UWB) signal using the build in powerful FFT with intuitive settings

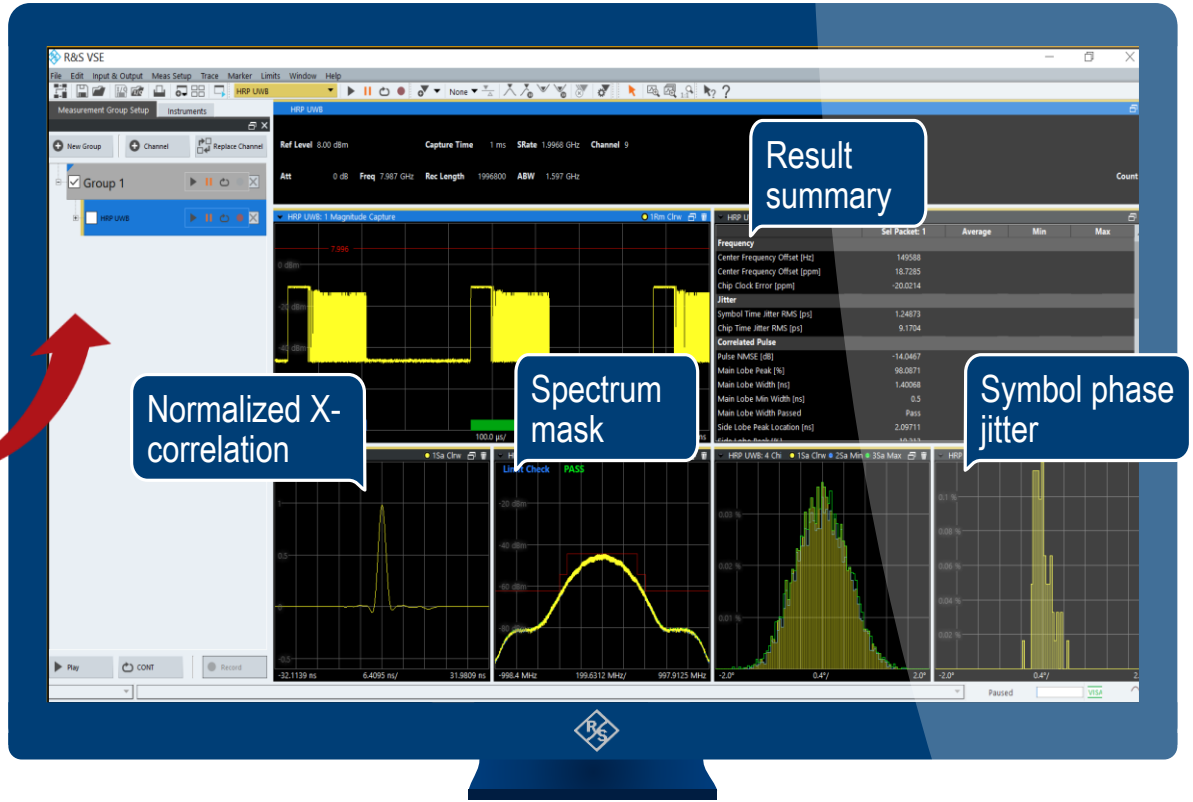


- Example shows an UWB waveform @7.9872 GHz (preamble only)



HRP UWB signal analysis with RTP and VSE

R&S®RTP134/164 serves as a wideband RF frontend and can directly acquire the UWB RF signal that can be analysed by the R&S®VSE with the UWB personality



R&S®CMP200 – Wideband non-signaling test for 5G and more

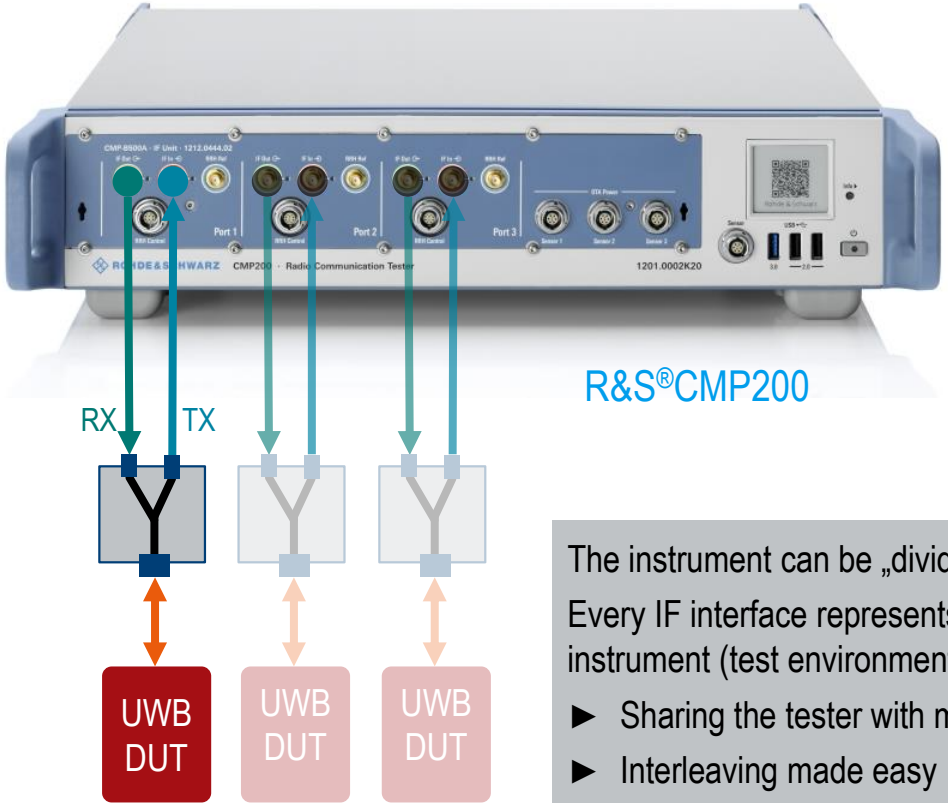
CMP200 features

- One general purpose analyzer
  Frequency range: 4 to 20 GHz
- One ARB generator
  Replay of predefined waveforms (-100 dBm)
  Frequency range: 6 to 20 GHz
- Three switchable ports, 1 GHz bandwidth

Compact UWB non-signaling tester for HRP in high band

- HRP UWB PHY TX measurements (802.15.4)
  Band group 2: 6.5 to 9.5 GHz
- HRP UWB RX measurements by use of customer waveforms or R&S®WinIQSIM2
- Time of flight and angle of arrival measurements

UWB test setup for RF measurements with the R&S®CMP200

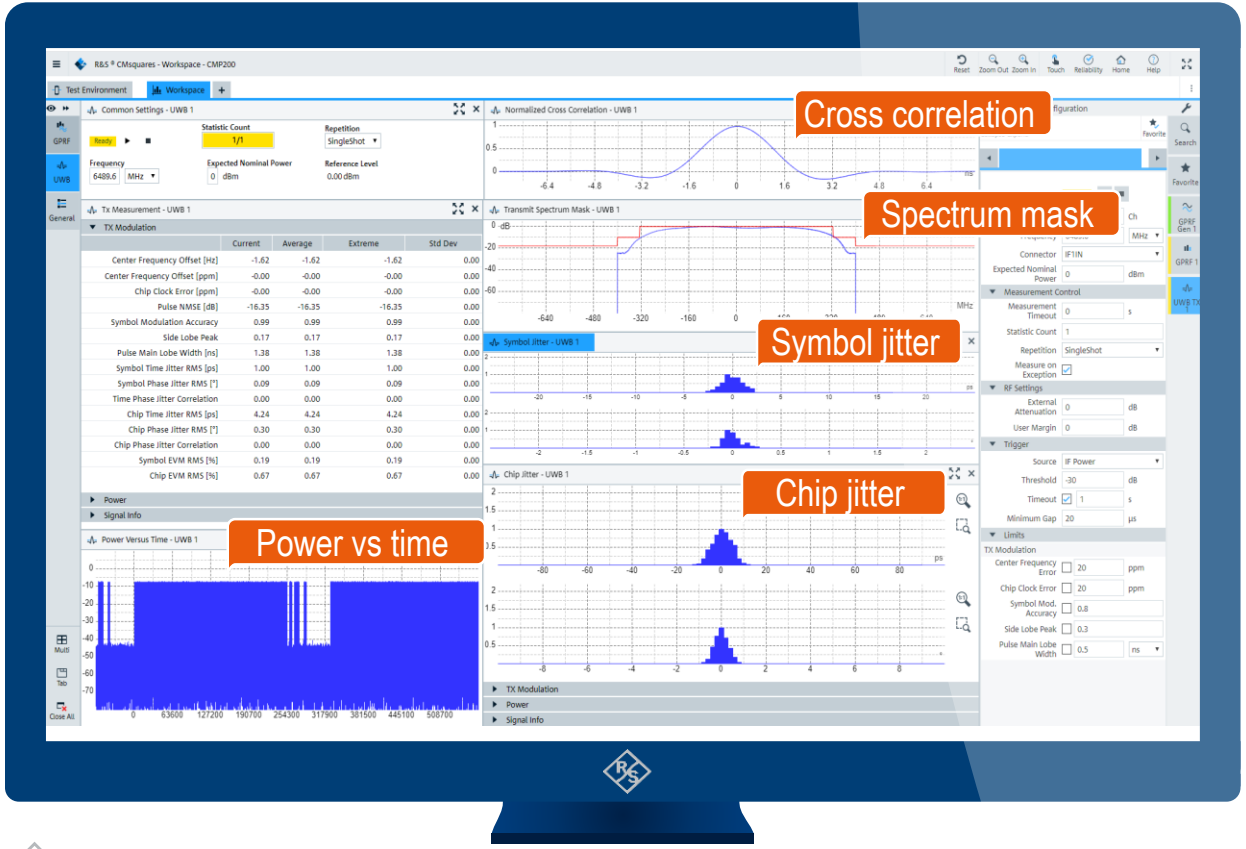


The instrument can be „divided“

Every IF interface represents one sub instrument (test environment):

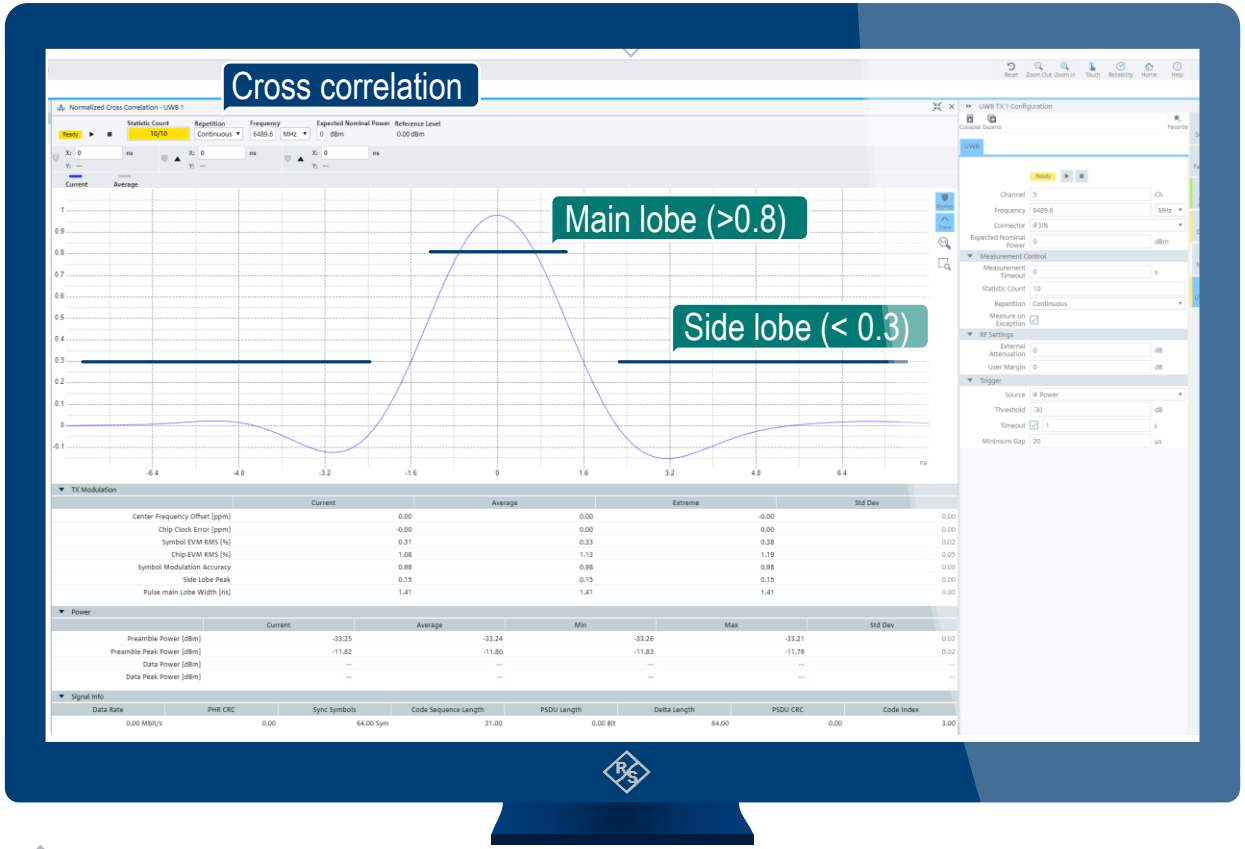
- ► Sharing the tester with multiple DUTs
- ► Interleaving made easy

HRP UWB transmitter measurements with R&S®CMP200

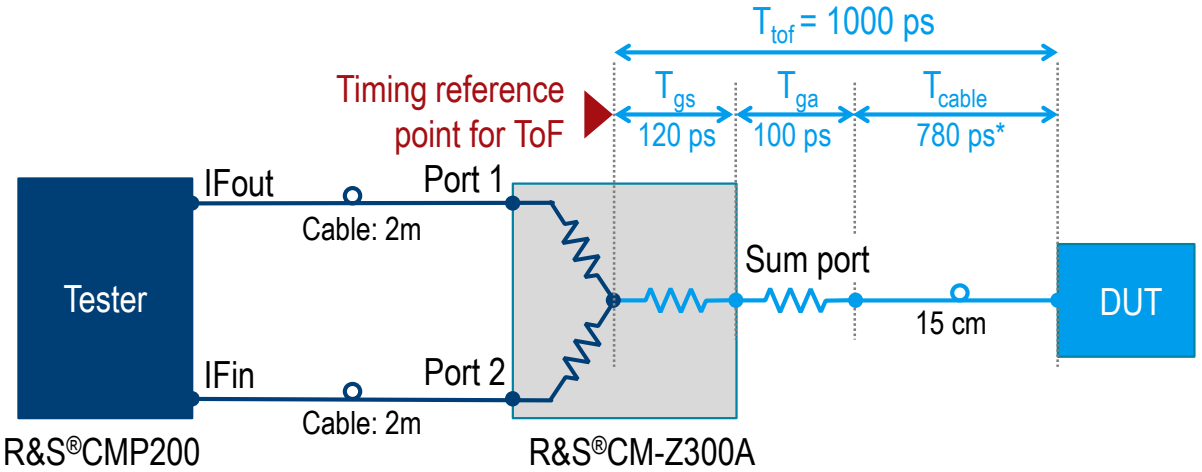


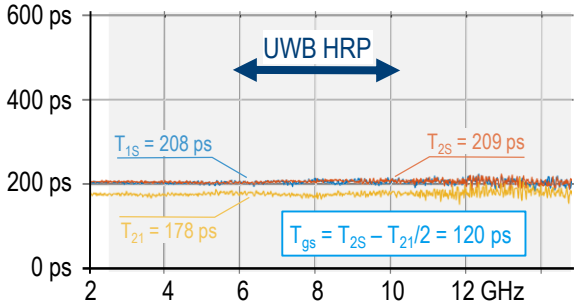
R&S®CMP200

Example: Normalized RRC cross correlation measurements



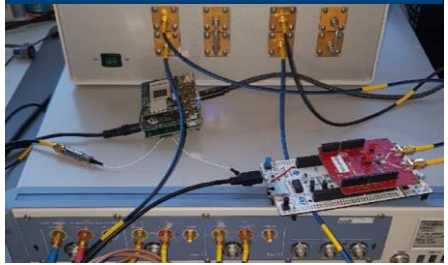
Time of flight KiT reference caculation

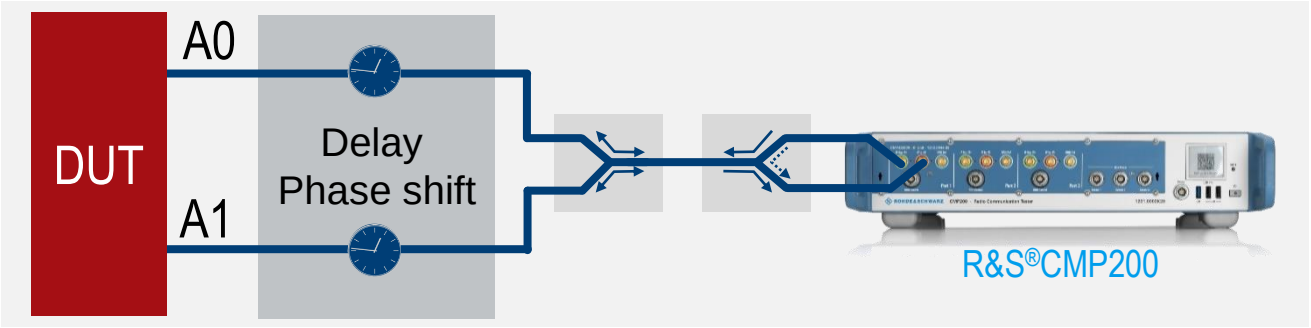




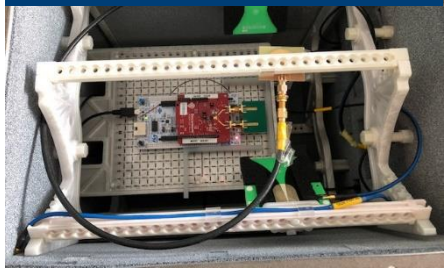
Verification and calibration of Angle of Arrival (AoA)

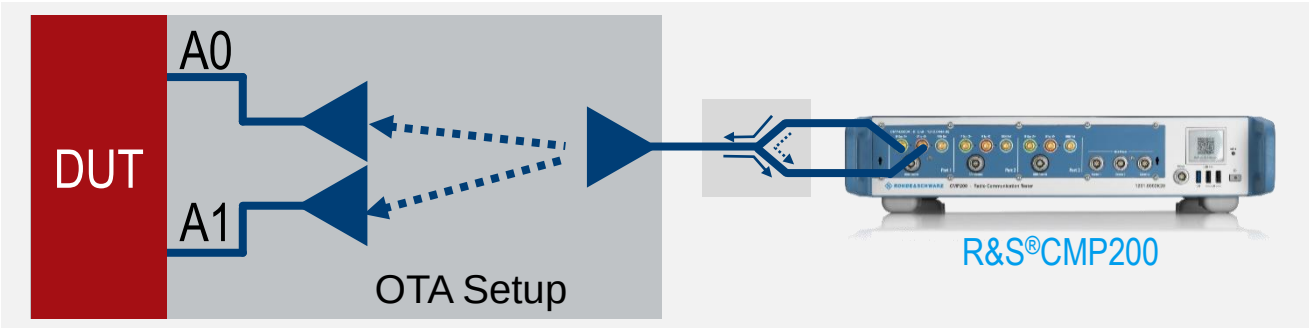
Conducted Mode





Over-the-air Mode





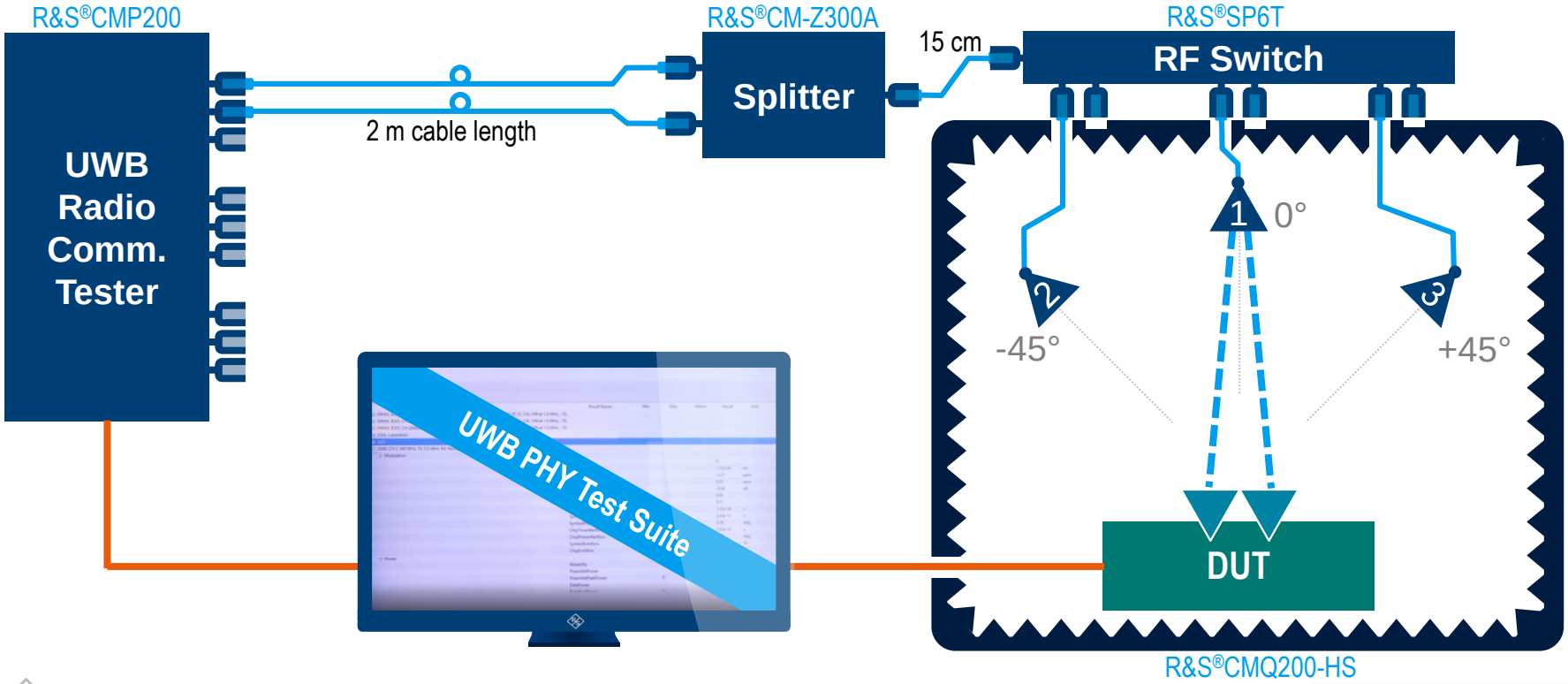
R&S®TS7124

R&S® CMQ500

R&S® CMQ200
w/ CMQ high Extension

UWB RF test solution with R&S chambers

Typical UWB setup for OTA test with multiple antennas (recommended for ToF and AoA measurements)



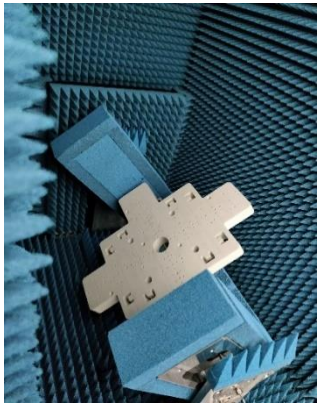
ATS800R
compact CATR test chamber on a rack

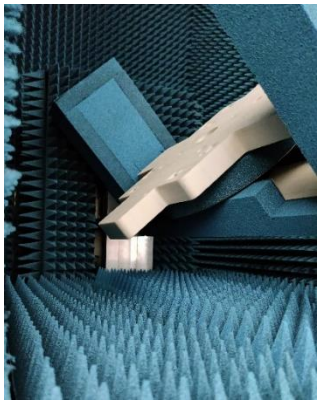
- Key Features & Benefits
  - Ø 20 cm quiet zone in a footprint of 0.7 m^2
  - Easily transportable on wheels
  - High shielding effectiveness
  - 12HU space for instruments in optional rack
  - Flexible in use and setup
    - With rack
    - Benchtop
    - On wheels but without rack
    - As shield box (no reflector/feed but absorber cover)

ATS800R – (optional) 3D Positioner CATR-P3DR

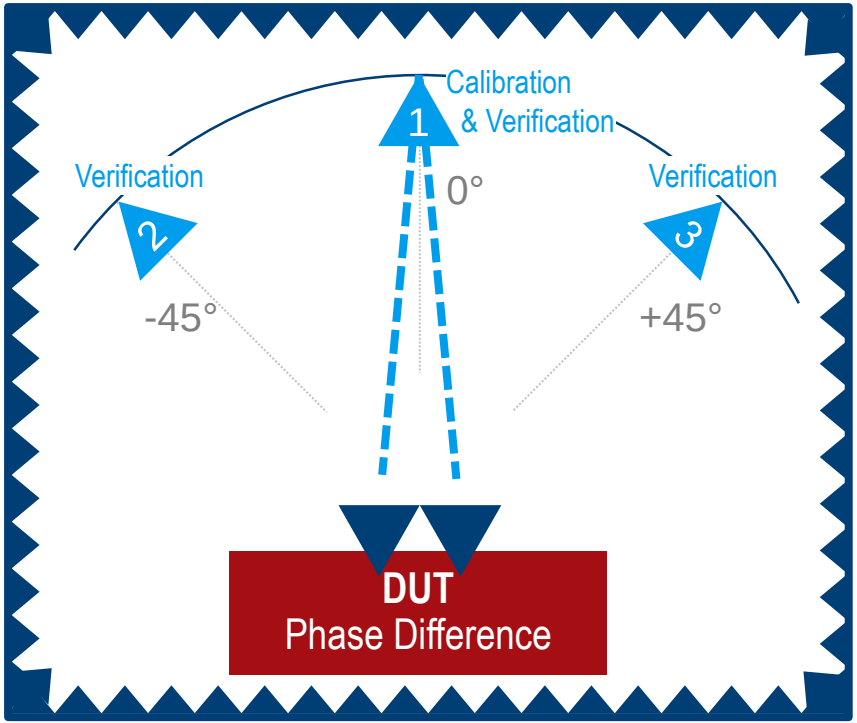
- **Positioner CATR-P3DR var.03**
  - 3D positioner
  - Not combinable with temperature bubble
  - Includes encoders
  - Comes with “snowflake” DUT fixture
  - Upgrade from legacy ATS800R possible (CATR-P3DR)
  - Optional RJs to azimuth and elevation axis **CATR-P3RJ var.03**

Positioner Type	Azimuth over Elevation
DUT Weight	< 2.5kg, centered
DUT size	36cm ⦰
Resolution	0.01 degrees
Elevation accuracy	0.25 degrees @1kg 0.50 degrees @ 2.5kg
Cable management (optional)	2 RF rotary joints 50GHz
Azimuth Range	+/- 180 degrees
Elevation Range	+/- 180 degrees
Rotation speed	< 45 degree/sec

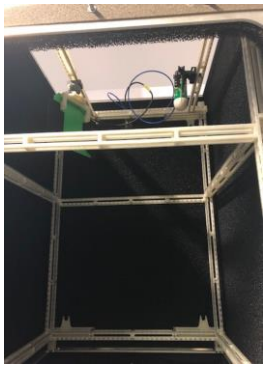




AoA phase difference antenna calibration with CMP200



- Measure the phase difference offset between the antennas at 0º with antenna 1
- Correct the offset vlaue
- Verify the offsets by measuring the phase difference at 0º with antenna 1
- Verify AoA at different angles (antenna 2&3)



감사합니다 !!!