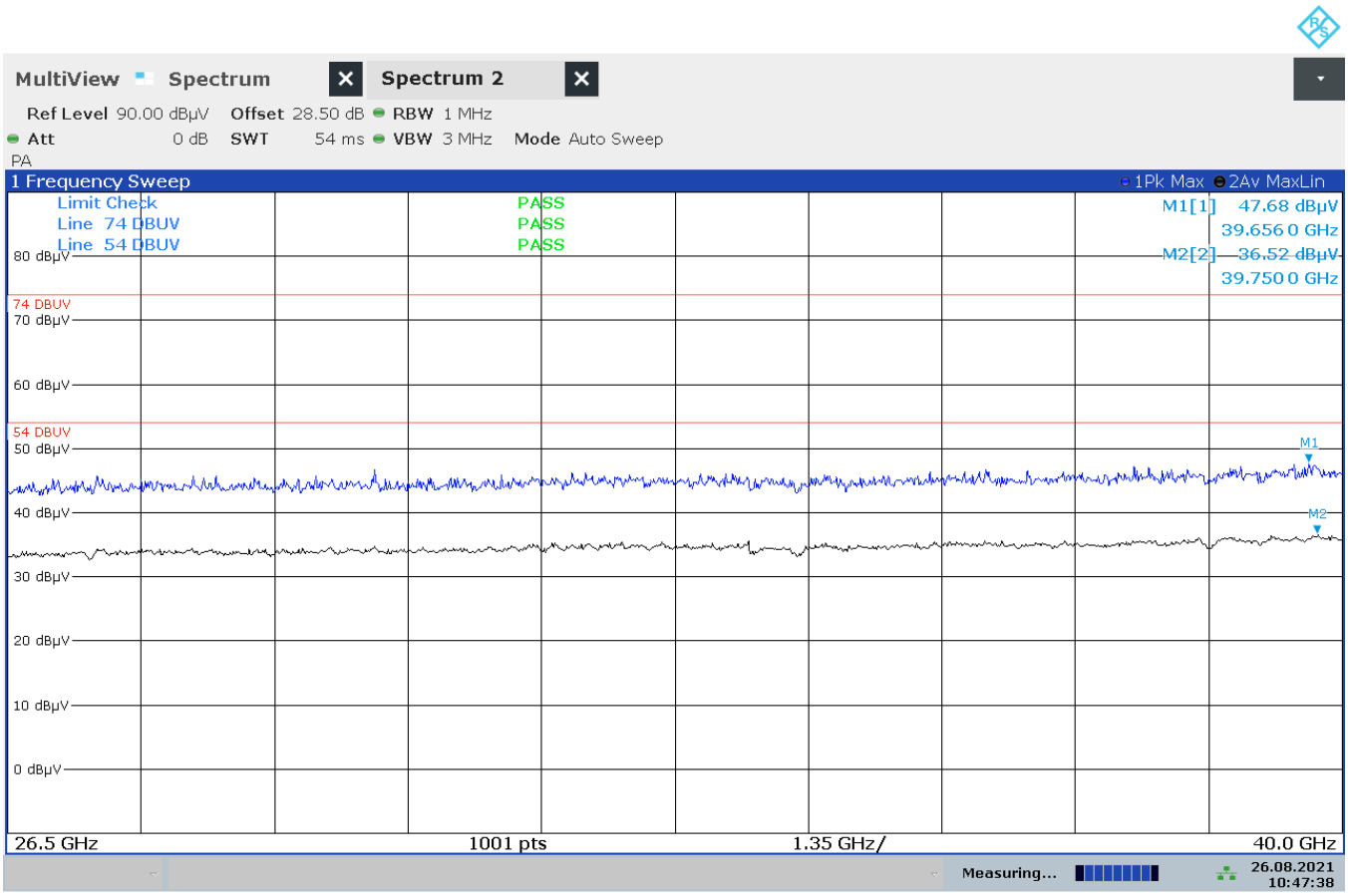
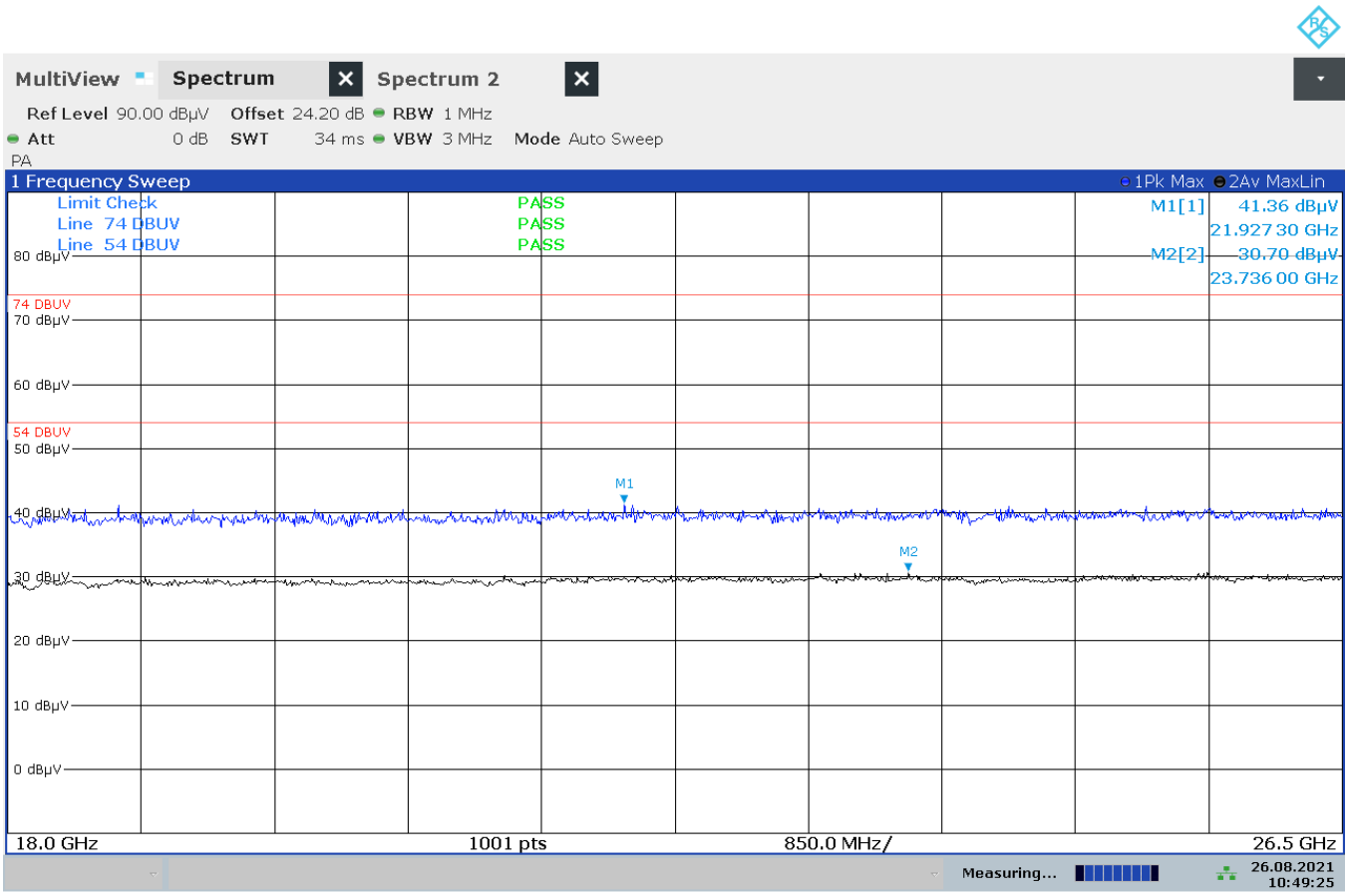
Plot 517: Mode 6, RSE 26.5 GHz – 40 GHz, channel 42, horizontal / vertical polarisation



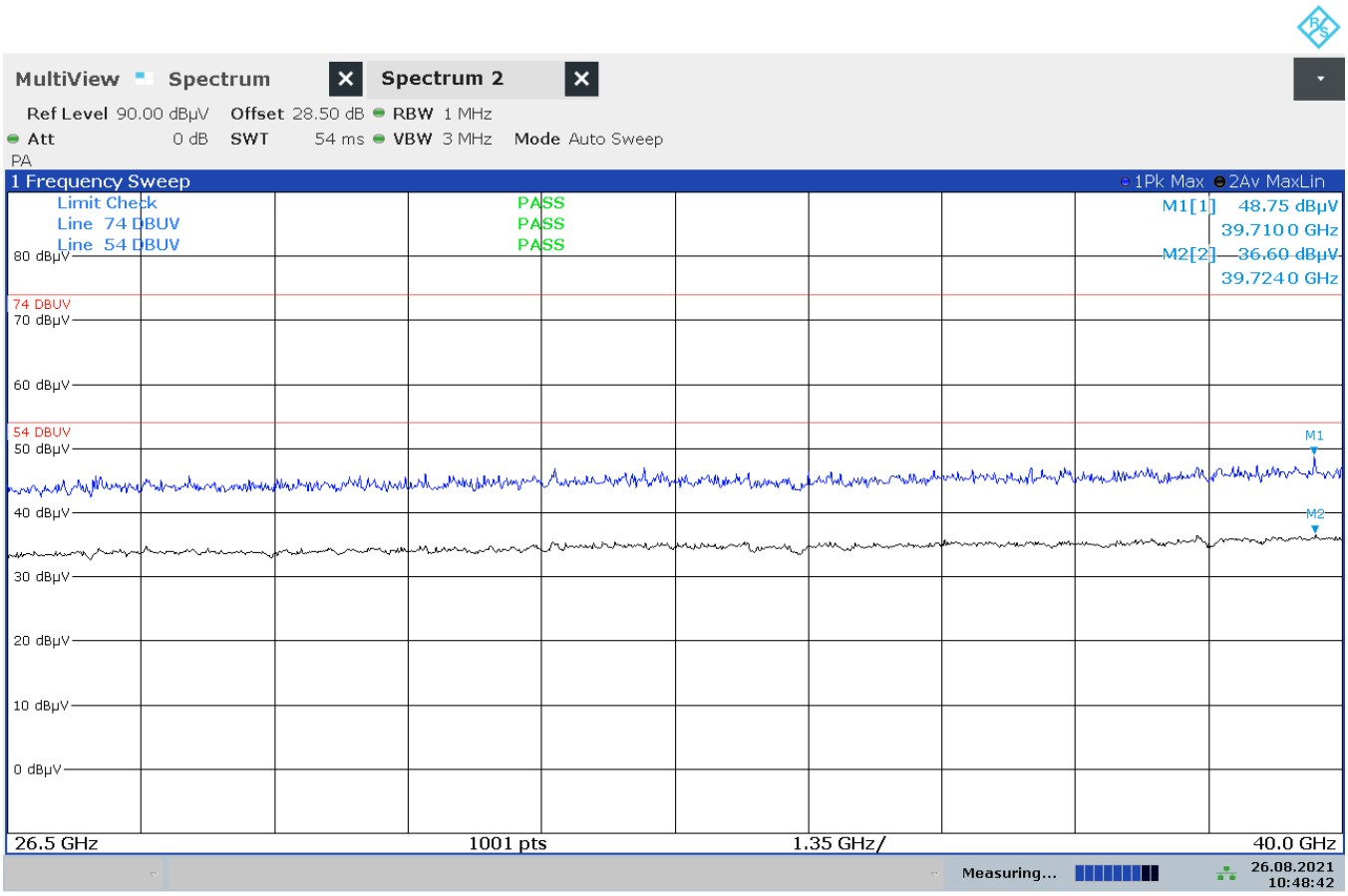
10:47:39 26.08.2021

Plot 518: Mode 6, RSE 18 GHz – 26.5 GHz, channel 58, horizontal / vertical polarisation

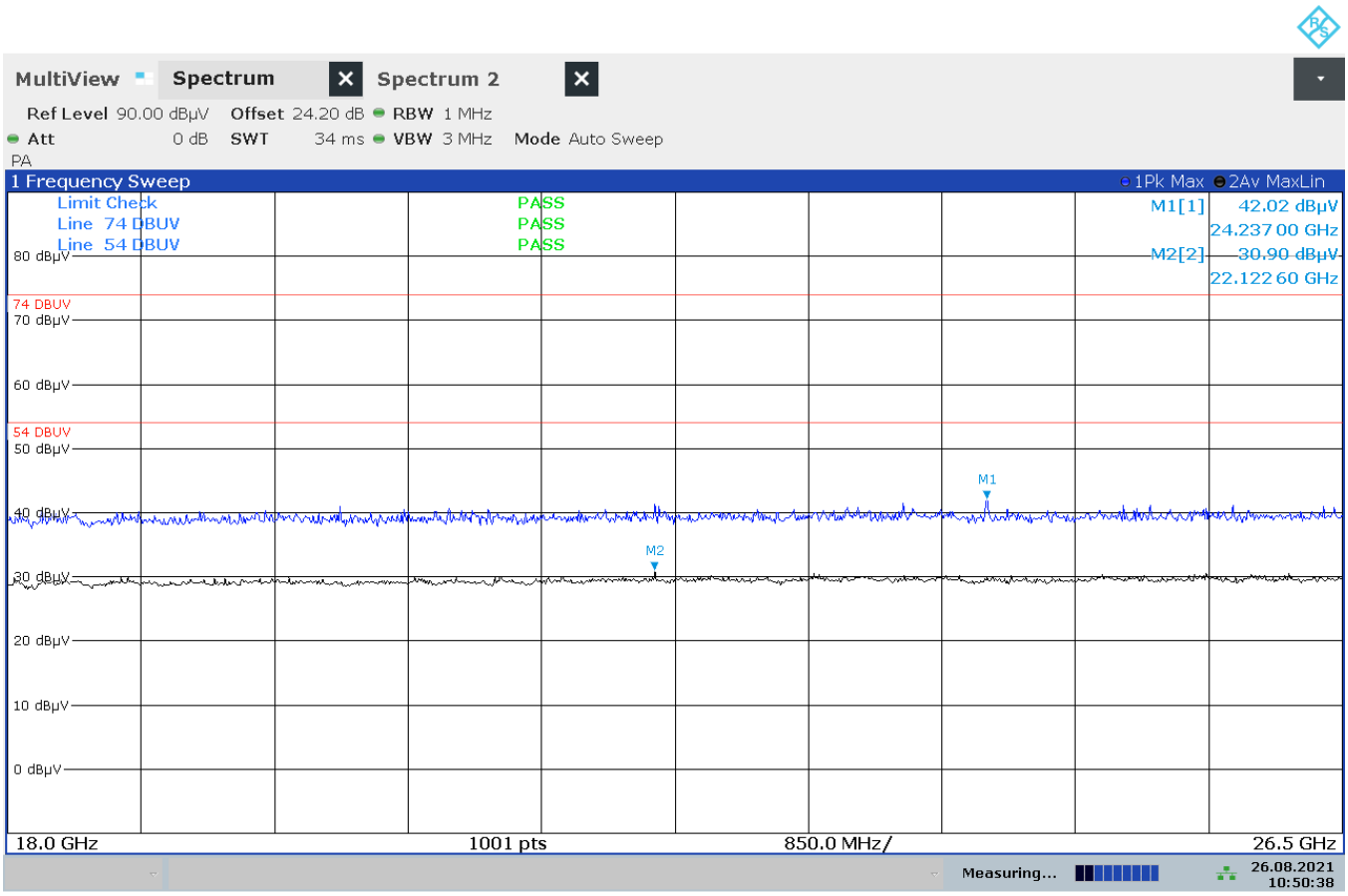


10:49:26 26.08.2021

Plot 519: Mode 6, RSE 26.5 GHz – 40 GHz, channel 58, horizontal / vertical polarisation

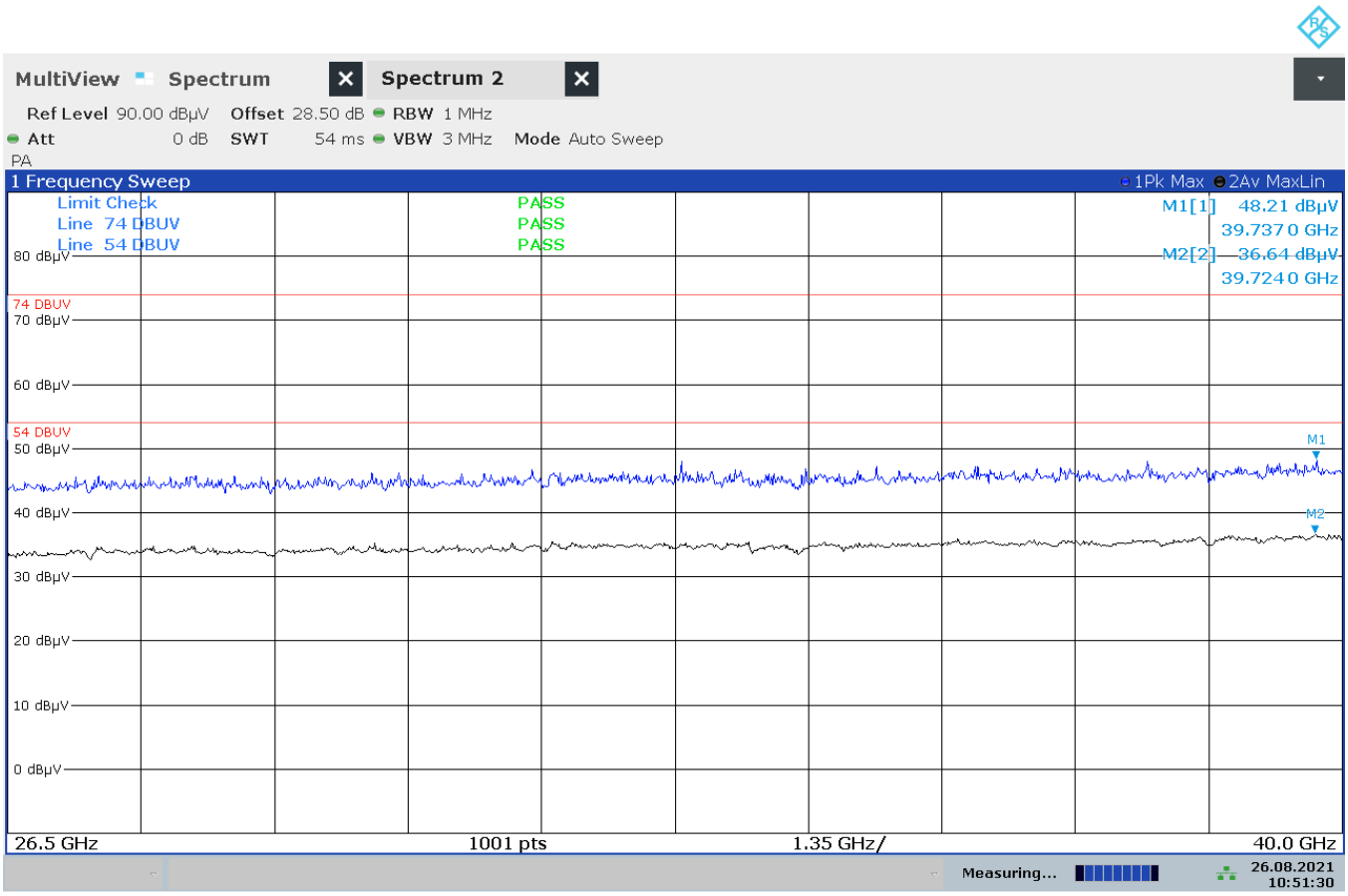


Plot 520: Mode 6, RSE 18 GHz – 26.5 GHz, channel 106, horizontal / vertical polarisation



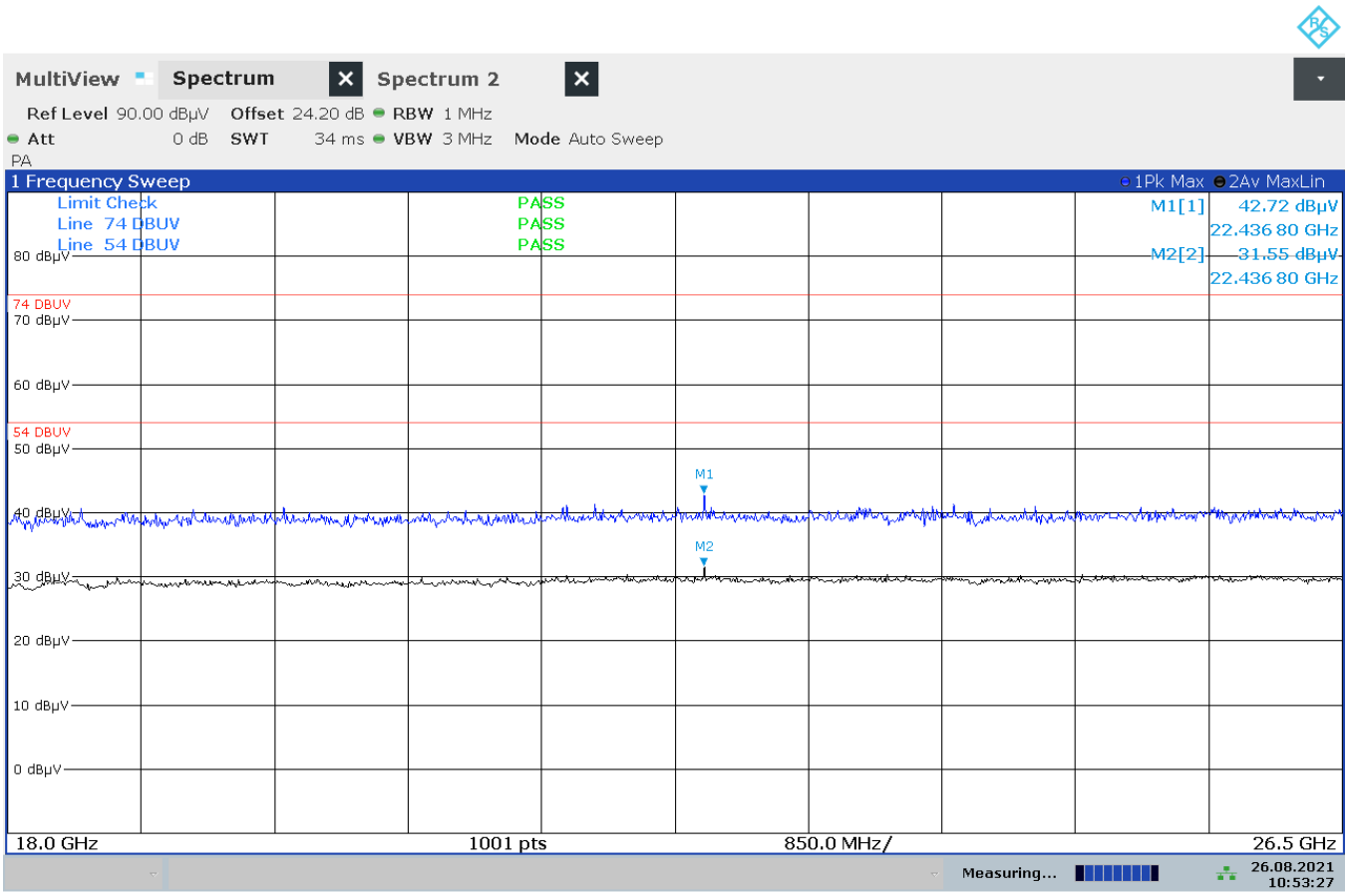
10:50:38 26.08.2021

Plot 521: Mode 6, RSE 26.5 GHz – 40 GHz, channel 106, horizontal / vertical polarisation



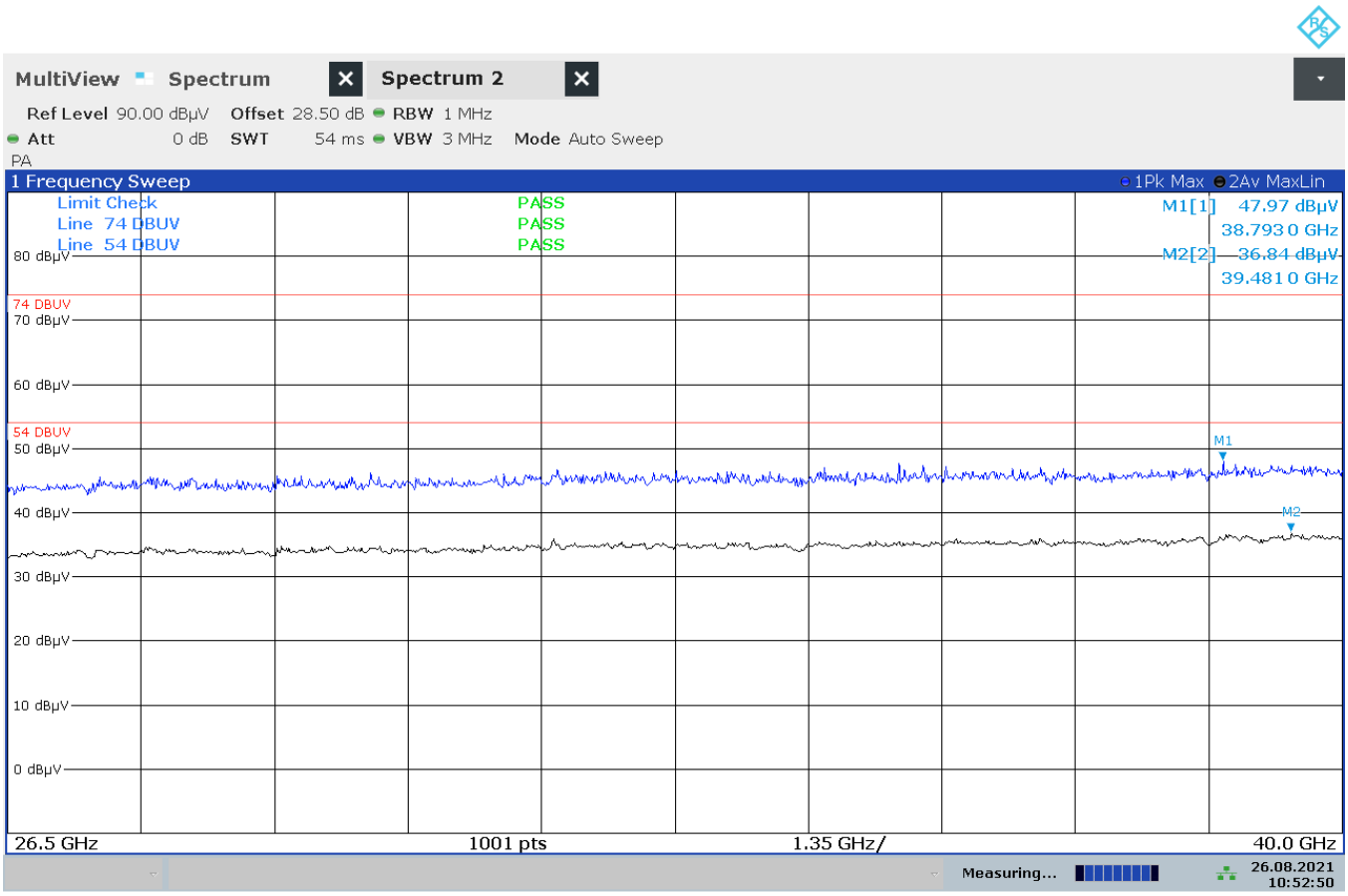
10:51:30 26.08.2021

Plot 522: Mode 6, RSE 18 GHz – 26.5 GHz, channel 122, horizontal / vertical polarisation



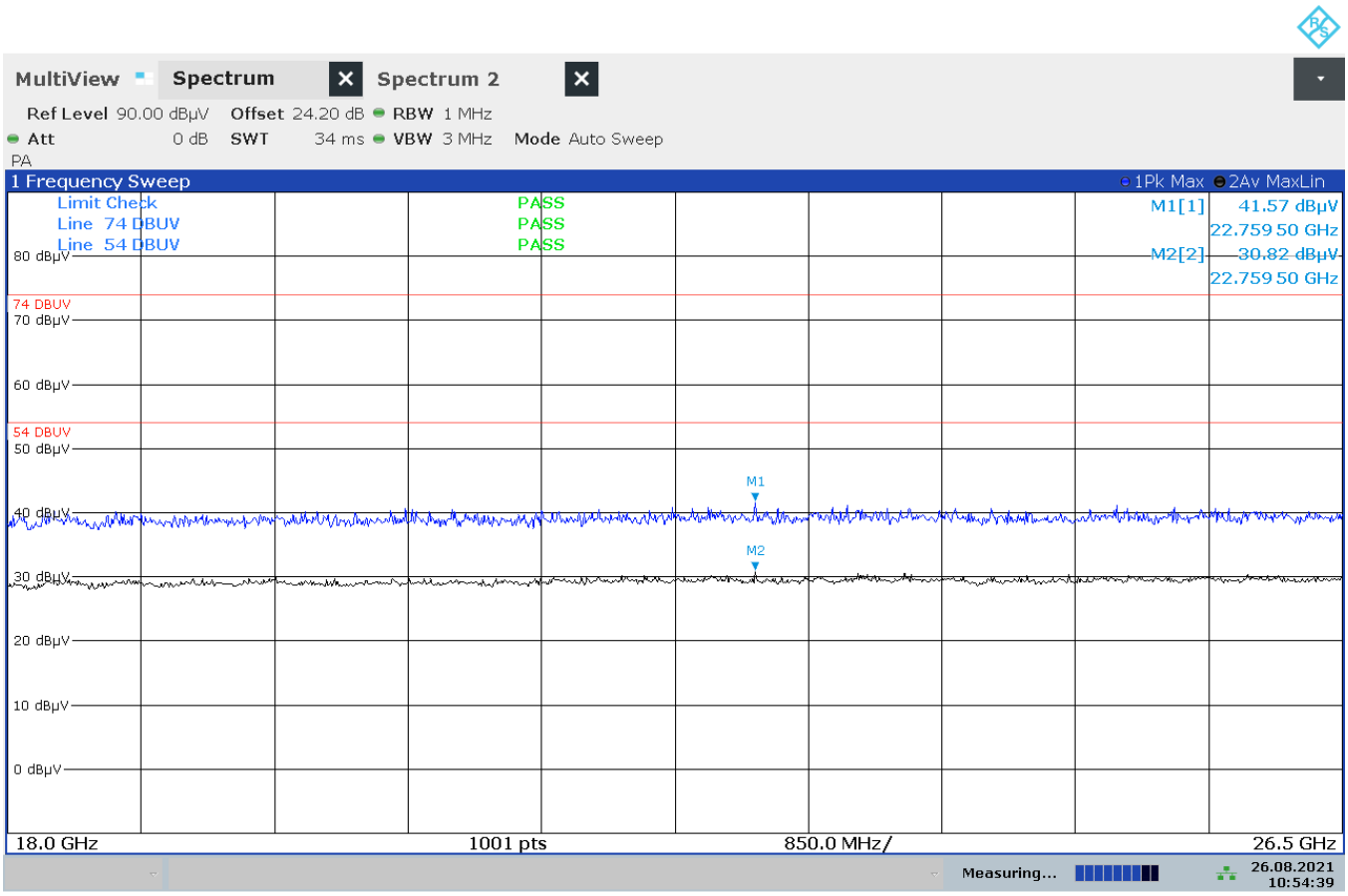
10:53:27 26.08.2021

Plot 523: Mode 6, RSE 26.5 GHz – 40 GHz, channel 122, horizontal / vertical polarisation

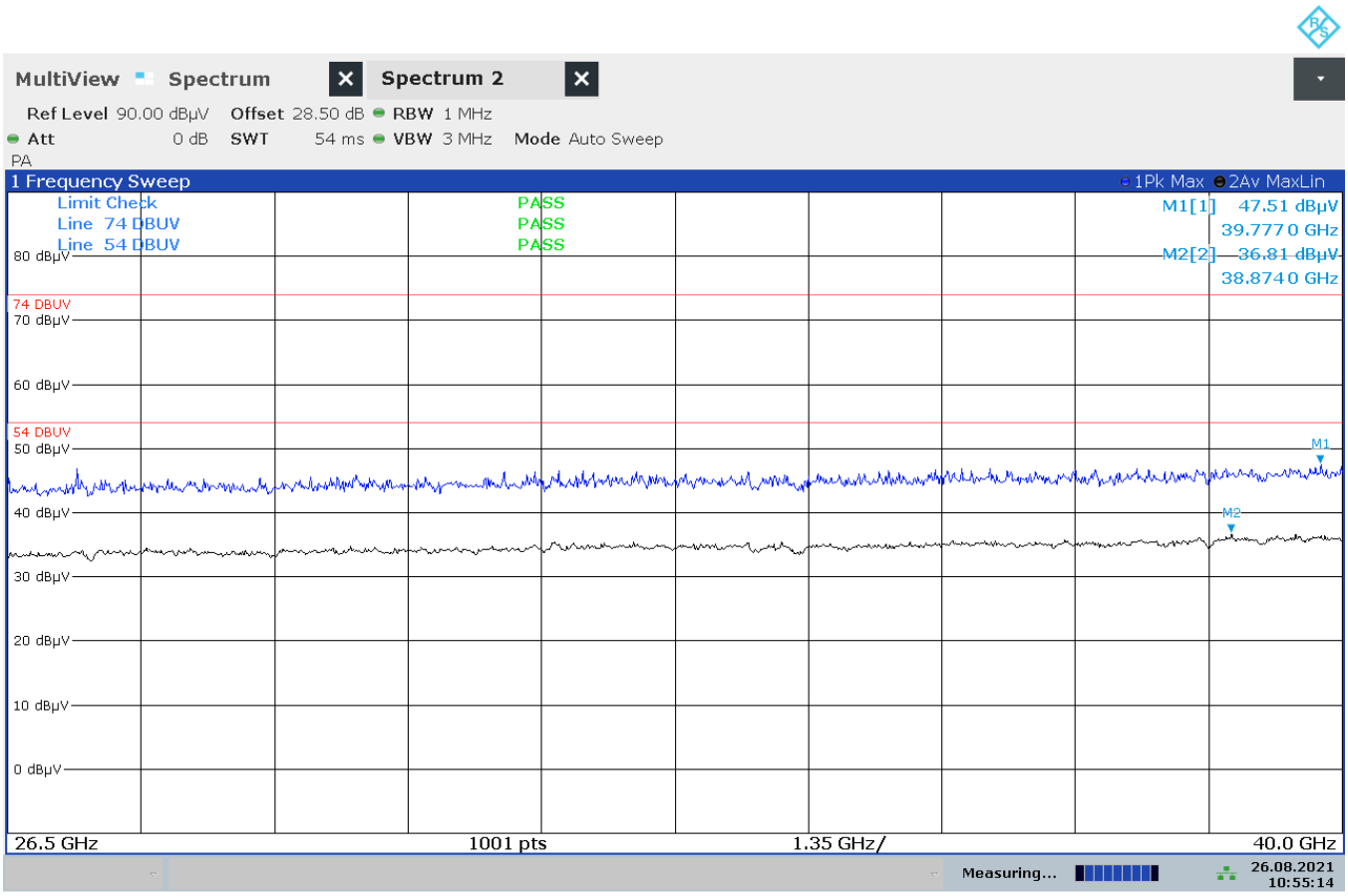


10:52:51 26.08.2021

Plot 524: Mode 6, RSE 18 GHz – 26.5 GHz, channel 138, horizontal / vertical polarisation

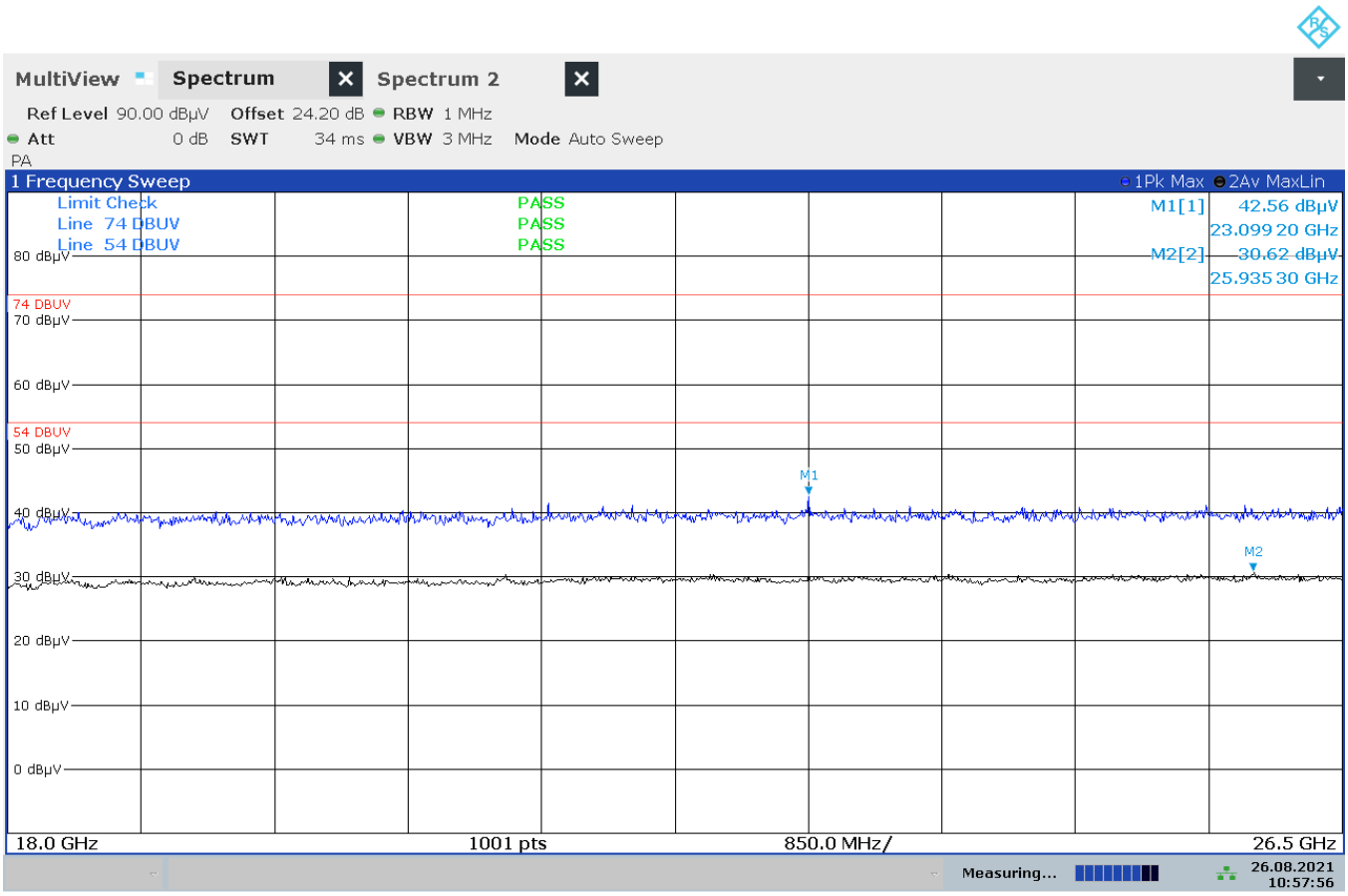


Plot 525: Mode 6, RSE 26.5 GHz – 40 GHz, channel 138, horizontal / vertical polarisation



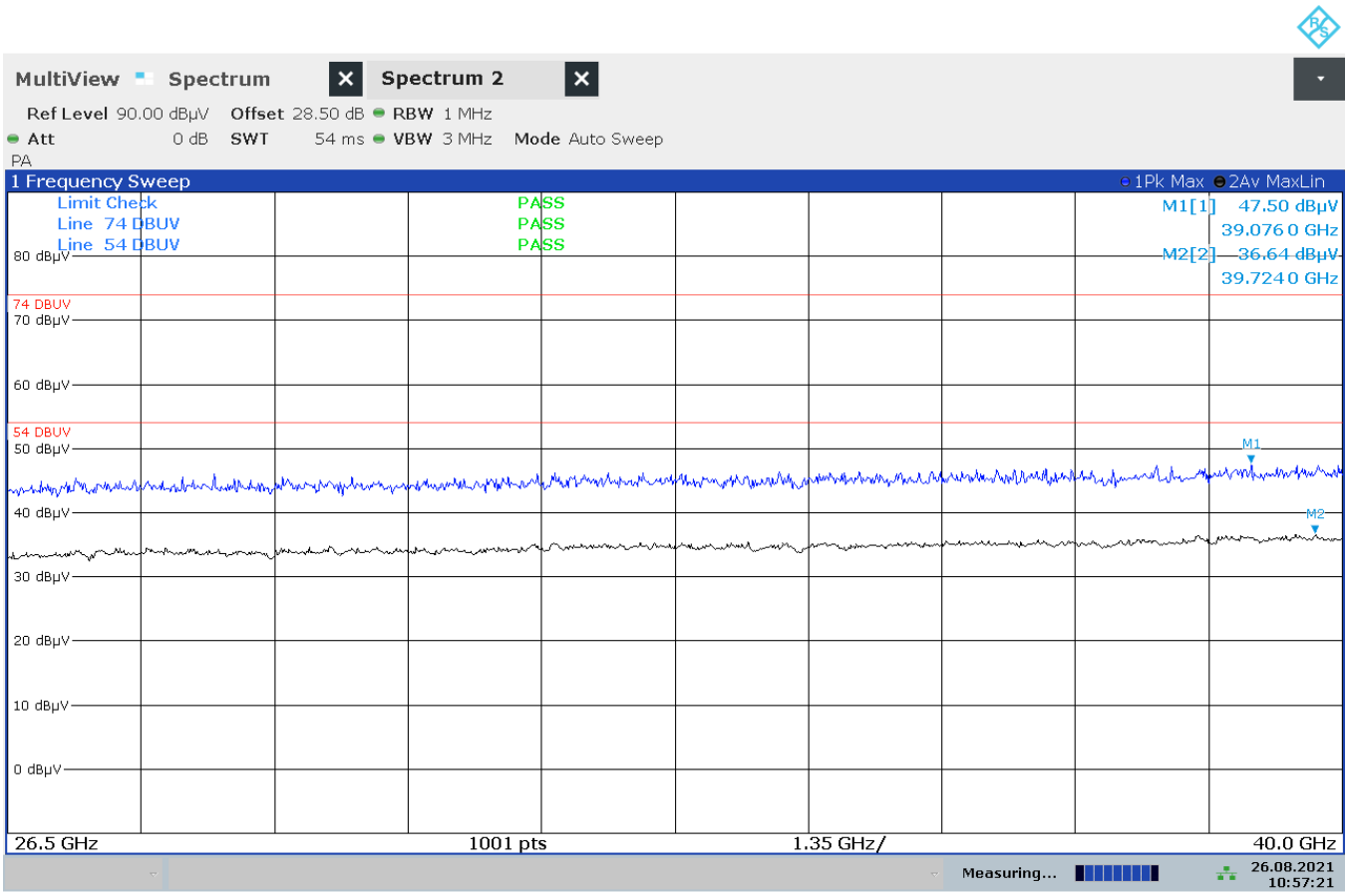
10:55:15 26.08.2021

Plot 526: Mode 6, RSE 18 GHz – 26.5 GHz, channel 155, horizontal / vertical polarisation



10:57:56 26.08.2021

Plot 527: Mode 6, RSE 26.5 GHz – 40 GHz, channel 155, horizontal / vertical polarisation



10:57:22 26.08.2021

7.11 Dynamic Frequency Selection (DFS)

Applicability

This requirement applies to unlicensed National Information Infrastructure (U–NII) devices operating in the 5.15–5.35 GHz, 5.47–5.725 GHz and 5.725–5.85 GHz bands.

Description

Dynamic frequency selection (DFS) is a mechanism that dynamically detects signals from other systems and avoids co-channel operation with those systems, notably radar systems.

Limits

§15.407 (h)

U– NII devices operating with any part of its 26 dB emission bandwidth in the 5.25–5.35 GHz and 5.47–5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems.

For devices that operate with less than 200 mW e.i.r.p. and a power spectral density of less than 10 dBm in a 1 MHz band, the minimum detection threshold is -62 dBm.

(i) Operational Modes. The DFS requirement applies to the following operational modes:

(A) The requirement for channel availability check time applies in the master operational mode.

(B) The requirement for channel move time applies in both the master and slave operational modes.

(ii) Channel Availability Check Time. A U–NII device shall check if there is a radar system already operating on the channel before it can initiate a transmission on a channel and when it has to move to a new channel. The U–NII device may start using the channel if no radar signal with a power level greater than the interference threshold values listed in paragraph (h)(2) of this section, is detected within 60 seconds.

(iii) Channel Move Time. After a radar's presence is detected, all transmissions shall cease on the operating channel within 10 seconds. Transmissions during this period shall consist of normal traffic for a maximum of 200 ms after detection of the radar signal. In addition, intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

(iv) Non-occupancy Period. A channel that has been flagged as containing a radar system, either by a channel availability check or in-service monitoring, is subject to a non-occupancy period of at least 30 minutes. The non-occupancy period starts at the time when the radar system is detected.

RSS 247 section 6.3:

ISED requires the use of either the FCC KDB Procedure 905462 or the DFS test procedure in the ETSI EN 301 893 for demonstrating compliance with the DFS radar detection requirements set out in this section.

Test procedure

KDB 905462 D02

Test setup: 8.4 with conducted test sample (see section 5.2)

Device under test (DUT) items	Device under test (DUT) settings
DFS capability	Yes*
DFS mode	Client (slave) without radar detection*
Startup time (incl. CAC)	120 s
Startup time delay	0 s
Conf. occ. bandwidth for	Nom. Bandwidth ‘20000000’ = 20 MHz
Conf. occ. bandwidth for	Nom. Bandwidth ‘40000000’ = 40 MHz
Conf. occ. bandwidth for	Nom. Bandwidth ‘80000000’ = 80 MHz

* declared by applicant

Test parameters	Declared by the lab		
Test environment	Normal		
Test set-up	☒ Conducted	☐ Radiated	☐ Test Fixture

Test results

Test result: Channel move time (CMT) detailed results					
DUT Frequency (MHz)	**Radar Type No.**	**CMT Tx Time (s)**	**CMT Limit (s)**	**CMT Result**	**CMT Comment**
5300.000000	0	0.491	10.000	- PASS -	Tx Time value is last trailing edge found within sweep. See Note 1 in test protocol.

Test result: Channel closing transmission time (CCTT) detailed results						
DUT Frequency (MHz)	**Radar Type No.**	**CCTT No. of Pulses found**	**CCTT Tx Time (ms)**	**CCTT Tx Time Limit (ms)**	**CCTT Result**	**CCTT comment**
5300.000000	0	69[1)] 3[2)]	20.340 1.368	200.000 60.000	- PASS	See Note 1 in test protocol

1) first 200 ms,
2) remaining 10 second(s) period

Comment:	--

Verdict	**- PASS -**	*see test protocol and plots on next pages*

Protocol / Plot 528: DFS In-Service Monitoring, 5300 MHz

Measurement Summary

DUT Frequency (MHz)	Radar Type No.	Type of Measurement value	Overall Result
5300.000000	0	Channel Move Time	PASS
5300.000000	0	Channel Closing Transmission Time	PASS

Channel Move Time Detailed Results

DUT Frequency (MHz)	Radar Type No.	CMT Tx Time (s)	CMT Limit (s)	CMT Result	CMT Comment
5300.000000	0	0.491	10.000	PASS	Tx Time value is last trailing edge found within sweep. See Note 1.

Channel Closing Transmission Time Detailed Results

DUT Frequency (MHz)	Radar Type No.	CCTT Type of Value	CCTT No. of Pulses found	CCTT Tx Time (ms)
5300.000000	0	first 200 ms	69	20.340
5300.000000	0	remaining 10.0 second(s) period	3	1.368

(continuation of the "Channel Closing Transmission Time Detailed Results" table from above)

DUT Frequency (MHz)	CCTT Tx Time Limit (ms)	CCTT Result	CCTT Comment
5300.000000	200.000	PASS	See Note 1.
5300.000000	60.000	PASS	See Note 1.

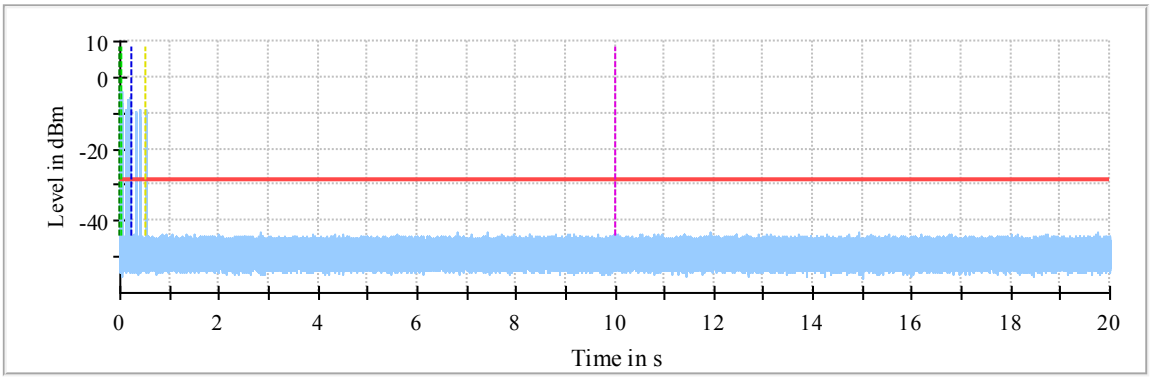
Radar level verification

Description / Formula	Value	Unit
IF(({DFS Mode(0/1/2)}=0)or({DFS Mode(0/1/2)}=1) , IF((dBm2W({Nominal Power[dBm]})>0.2) , -64 , IF(({Configured PSD[dBm]}<10) , -62 , -64))+ {Attenuation Vector Generator to DUT[dB]} , -50+ {Attenuation Vector Generator to COMP[dB]})+ {Radar Signal Level Offset[dB]}	Given setting / formula to calculate Vector Generator level	--
Configured DUT EIRP:	1.26	mW
Configured DUT PSD:	-17.00	dBm/MHz
Requirement of the Detection threshold value for this given values acc. to FCC clause 5.2 / Table 3	-62	dBm
Vector Generator level setting	2.49	dBm
Configured overall pathloss from Vector Generator RF out to DUT connector of 'DUT to OSP'-cable	35.12	dB
Given additional level added to the amplitude of the waveform to account for variations in measurement equipment acc. to FCC clause 5.2 / Table 3 / Note 2	1.00	dB
This results in the following radar signal level at the DUT	-32.62	dBm

Additional Information

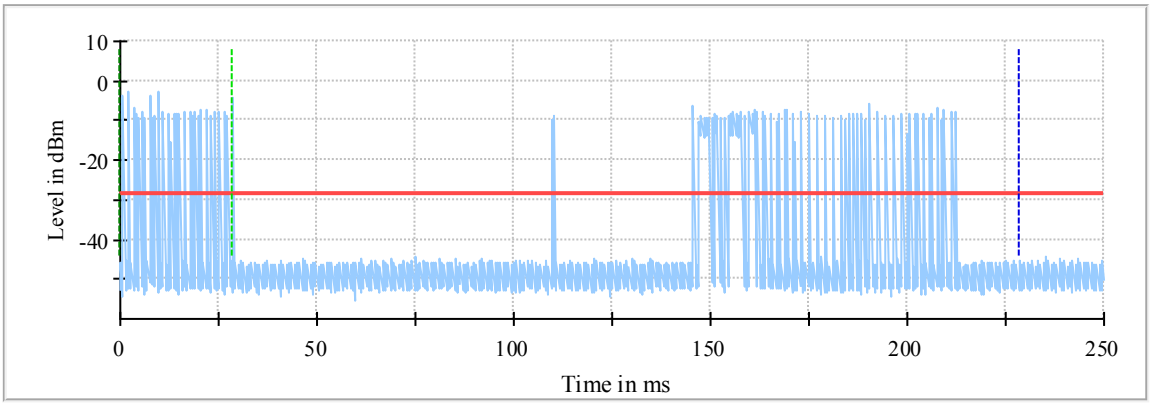
Note	Description
Note 1:	**Because of the radar pulse event at the beginning, the investigation of the trace begins with an offset of 28.7 ms conforming to the end of the Radar burst.**
Note 2:	**Channel move time (CMT) / channel closing transmission time (CCTT) measurement was made with hi resolution video sweep using OSP DAQ channel**
Note 3:	**Because of the substantially higher sampling rate of the video signal the results for CCTT and CMT are more accurate than in the graphics visible. Reached timing accuracy of the video trace: approx 4 µs**
Note 4:	**The Non-Occupancy Period trace starts at the end of the Channel move time trace (20.000 secs.) Labeling of the x-axis (time) is relative to its beginning (0 secs.)**

Channel Move Time



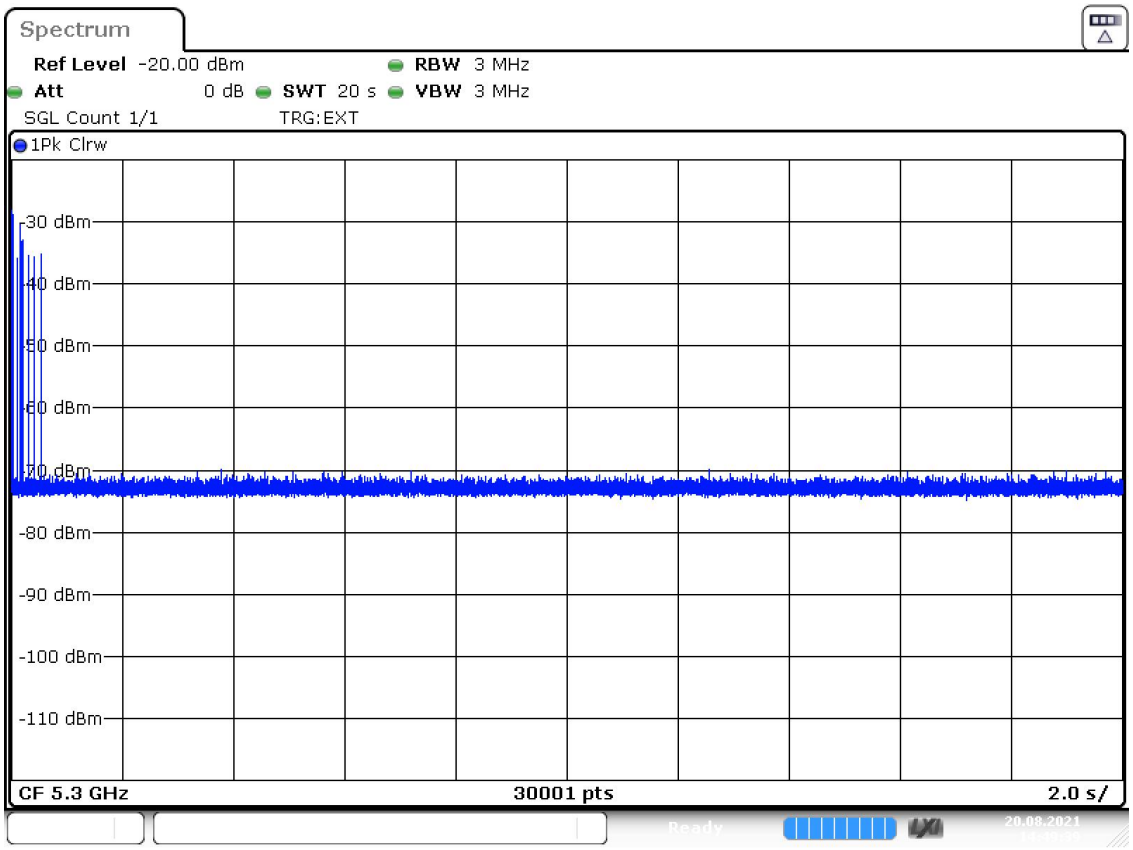
Channel Move Time
Start of Radar
First 200ms of Channel Closing Tx Time
Last measured edge of Channel Closing Tx Time
Threshold
Trigger at end of Radar
10sec Channel Move Time Limit

Channel Move Time first 200ms



Channel Move Time first 200ms
Start of Radar
First 200ms of Channel Closing Tx Time
Threshold
Trigger at end of Radar

Channel Move Time



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Channel Move Time; Channel Closing Transmission Time

Setting	Instrument Value	Target Value
Center Frequency	5.30000 GHz	5.30000 GHz
Span	ZeroSpan	ZeroSpan
RBW	3.000 MHz	>= 3.000 MHz
VBW	3.000 MHz	>= 3.000 MHz
SweepPoints	30001	~ 30001
Sweeptime	20.000 s	20.000 s
Reference Level	-20.000 dBm	-20.000 dBm
Attenuation	0.000 dB	0.000 dB
Detector	MaxPeak	MaxPeak
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Clear Write	Clear Write
Sweeptype	Sweep	AUTO
Preamp	off	off
Trigger	External	External
Trigger Offset	0.000 s	0.000 s

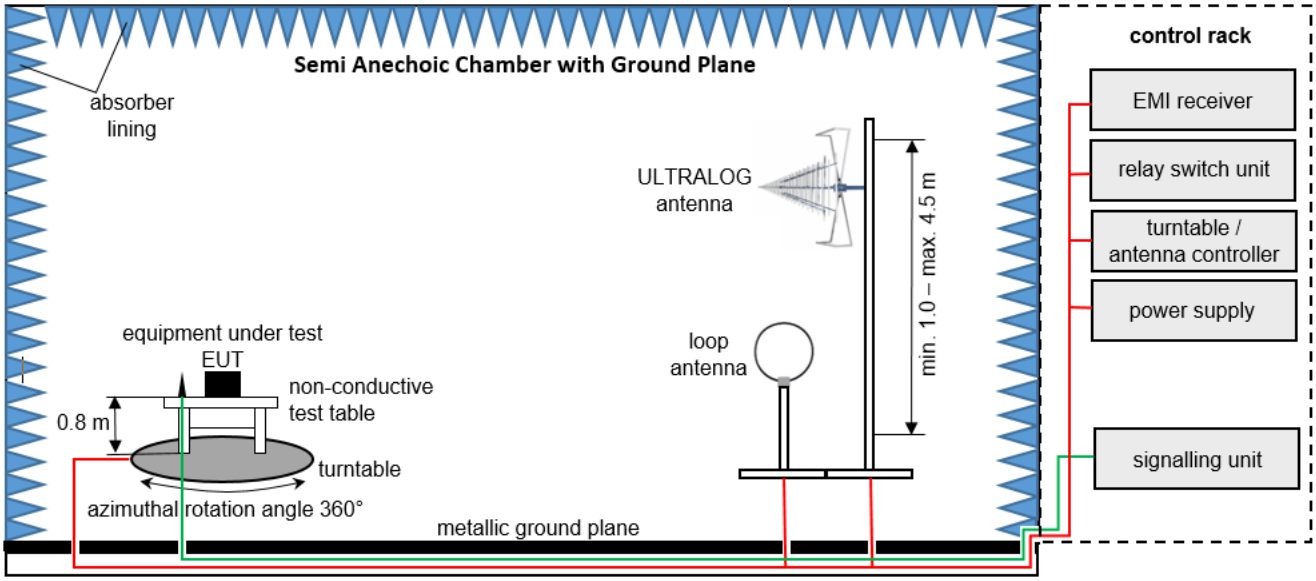
OSP Video Detector

Setting	Instrument Value	Target Value
Measurement Time	20.000 s	20.000 s
Samplerate	2500 kHz	2500 kHz
Tracepoints	50000000	50000000
Time resolution	4.000 µs	4.000 µs
Detector	Peak	Peak

8 TEST SETUP DESCRIPTION

8.1 Semi Anechoic Chamber with Ground Plane

Radiated measurements are performed in vertical and horizontal plane in the frequency range 30 MHz to 1 GHz in a Semi Anechoic Chamber with a metallic ground plane. The EUT is positioned on a non-conductive test table with a height of 0.80 m above the metallic ground plane that covers the whole chamber. The receiving antennas conform to specification ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices. These antennas can be moved over the height range between 1.0 m and 4.5 m in order to search for maximum field strength emitted from the EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by a spectrum analyzer where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: loop antenna 3 m, ULTRALOG antenna 3 m
EMC32 software version: 11.10.00

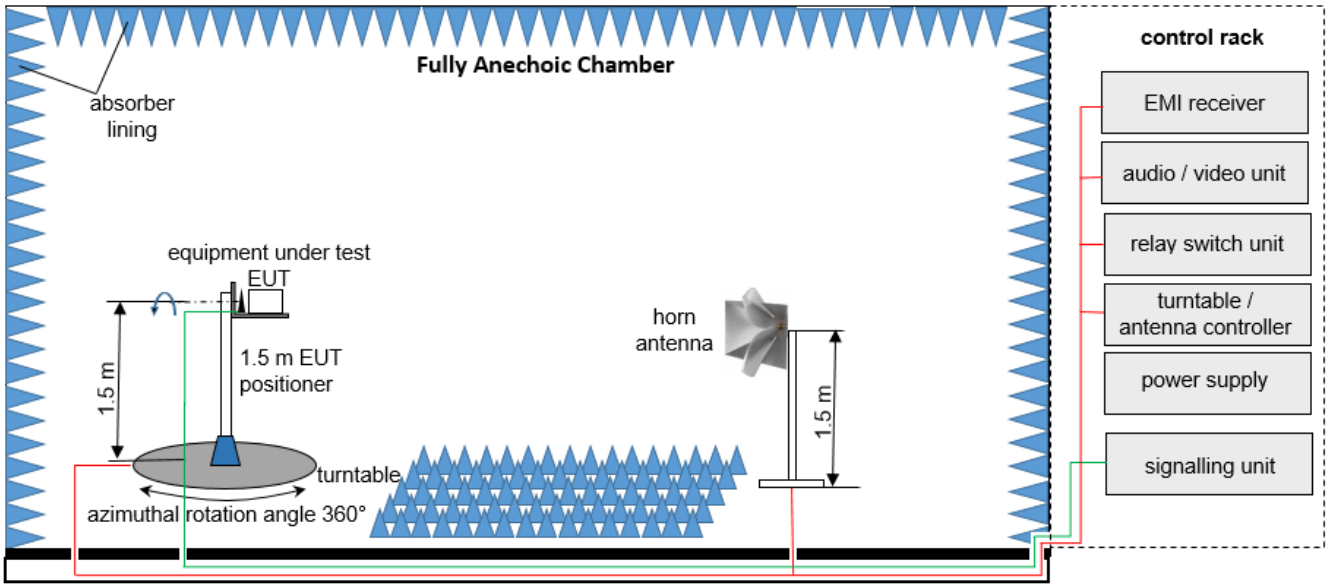
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	INV. No.	Last / Next Calibration
1	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PSI 9080-40 T	2000230001	LAB000313	–
2	Test table	innco systems GmbH	PT1208-080-RH	-	LAB000306	–
3	Power Supply	Chroma	61604	616040005416	LAB000285	–
4	Positioner	maturo GmbH	TD 1.5-10KG		LAB000258	–
5	Compressed Air	Implotex	1-850-30	-	LAB000256	–
6	EMI Test Receiver	Rohde & Schwarz	ESW26	101517	LAB000363	2021-02-05 → 2022-02-05
7	Semi-Anechoic Chamber (SAC)	Albatross Projects GmbH	SAC 5 (Babylon 5)	20168.PRB	LAB000235	2020-08-24 → 2021-08-24
8	Measurement Software	Rohde & Schwarz	EMC32 V11.00.10		LAB000226	–
9	Turntable	maturo GmbH	TT2.0-2t	TT2.0-2t/921	LAB000225	–
10	Antenna Mast	maturo GmbH	CAM4.0-P	CAM4.0-P/316	LAB000224	–
11	Antenna Mast	maturo GmbH	BAM4.5-P	BAM4.5-P/272	LAB000223	–
12	Controller	maturo GmbH	FCU 3.0	10082	LAB000222	–
13	Power Supply	Elektro-Automatik GmbH & Co. KG	PS 2042-10 B	2878350292	LAB000191	–
14	Pre-Amplifier	Schwarzbeck Mess-Elektronik OHG	BBV 9718 C	84	LAB000169	–
15	Open Switch and Control Platform	Rohde & Schwarz	OSP200 Base Unit 2HU	101748	LAB000149	–
16	Antenna	Rohde & Schwarz	HL562E	102001	LAB000123	2020-07-05 → 2023-07-05
17	Antenna	Rohde & Schwarz	HFH2-Z2E - Active Loop Antenna	100954	LAB000108	2020-03-25 → 2023-03-25

8.2 Fully Anechoic Chamber



Measurement distance: horn antenna 3 meter
EMC32 software version: 11.10.00

FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

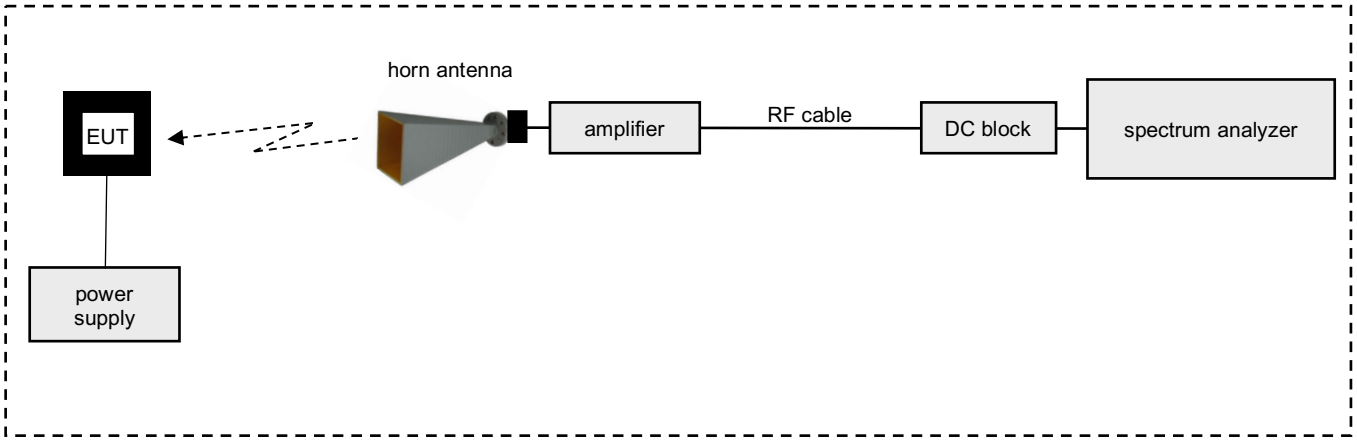
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -65.0 [dBm] + 50 [dB] - 20 [dBi] + 5 [dB] = -30 [dBm] (1 µW)

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	INV. No.	Last / Next Calibration
1	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PSI 9080-40 T	2000230001	LAB000313	–
2	Test table	innco systems GmbH	PT1208-080-RH	-	LAB000306	–
3	Power Supply	Chroma	61604	616040005416	LAB000285	–
4	Positioner	maturo GmbH	TD 1.5-10KG	–	LAB000258	–
5	Compressed Air	Implotex	1-850-30	-	LAB000256	–
6	EMI Test Receiver	Rohde & Schwarz	ESW26	101517	LAB000363	2021-02-05 → 2022-02-05
7	Semi-Anechoic Chamber (SAC)	Albatross Projects GmbH	SAC 5 (Babylon 5)	20168.PRB	LAB000235	2020-08-24 → 2021-08-24
8	Measurement Software	Rohde & Schwarz	EMC32 V11.00.10	–	LAB000226	–
9	Turntable	maturo GmbH	TT2.0-2t	TT2.0-2t/921	LAB000225	–
10	Antenna Mast	maturo GmbH	BAM4.5-P	BAM4.5-P/272	LAB000223	–
11	Controller	maturo GmbH	FCU 3.0	10082	LAB000222	–
12	Power Supply	Elektro-Automatik GmbH & Co. KG	PS 2042-10 B	2878350292	LAB000191	–
13	Pre-Amplifier	Schwarzbeck Mess-Elektronik OHG	BBV 9718 C	84	LAB000169	–
14	Open Switch and Control Platform	Rohde & Schwarz	OSP200 Base Unit 2HU	101748	LAB000149	–
15	Antenna	Rohde & Schwarz	HF907	102898	LAB000124	2020-04-23 → 2023-04-23
16	HP-filter	AtlantRF	–	–	LAB000382	–

8.3 Radiated measurements > 18 GHz

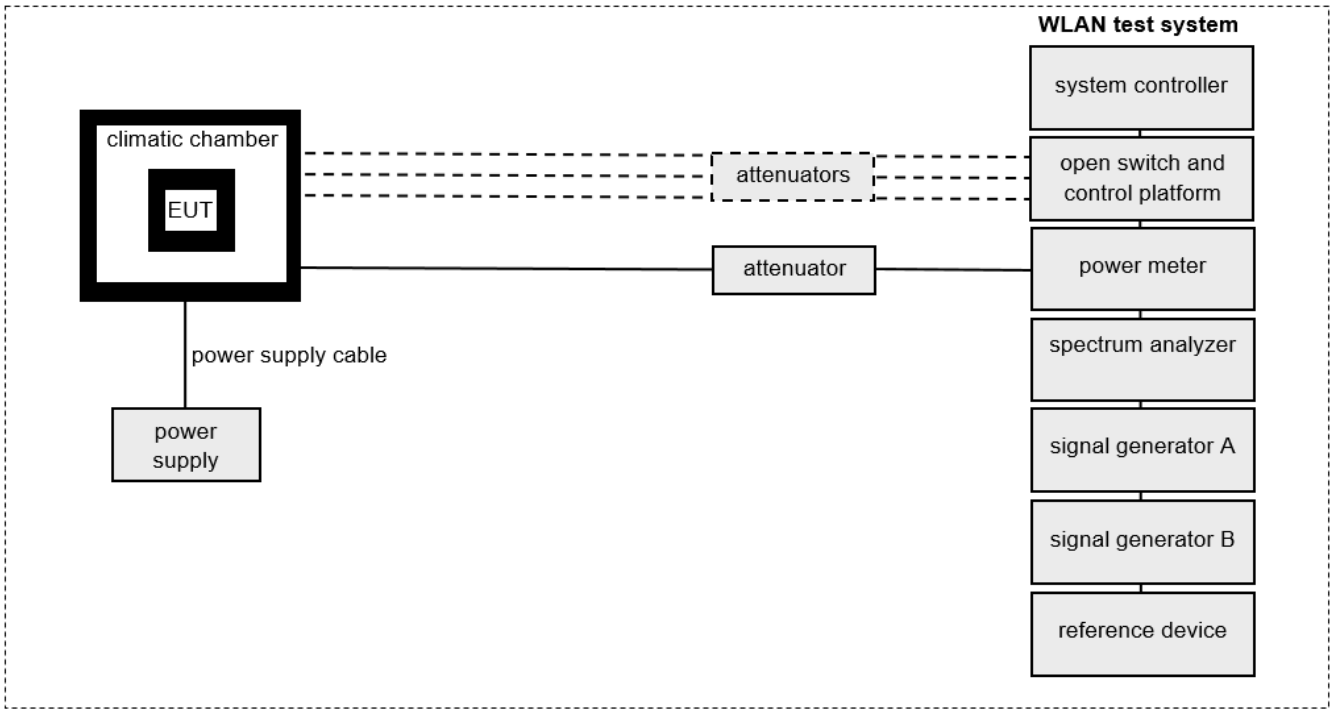


List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	INV. No.	Last / Next Calibration
1	Test table	innco systems GmbH	PT0707-RH light	-	LAB000303	–
2	WG-Coax-Adapter	Flann Microwave Ltd	20093-TF30 UBR220	273374	LAB000181	–
3	Coaxial Cable	Huber & Suhner	SF101/1.5m	503987/1	LAB000165	–
4	Antenna	Flann Microwave Ltd	20240-20	266403	LAB000128	2020-06-29 → 2023-06-29
5	Spectrum Analyser	Rohde & Schwarz	FSW43	101391	LAB000289	2021-07-02 → 2022-07-02

8.4 Conducted measurements WLAN test system R&S TS 8997

The EUT's RF signal is coupled out by the antenna connector which is supplied by the manufacturer. The losses for all signal paths are first checked within a calibration. The measurement readings on the signalling unit/spectrum analyzer are corrected by the specific test set-up loss. The attenuator, power divider, signalling unit and the spectrum analyzer are impedance matched on 50 Ohm.



EMC32/WMS32 software version: 11.00.00

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	INV. No.	Last / Next Calibration
1	TS8997-Rack	Rohde & Schwarz	TS8997-Rack	100829	LAB000322	–
2	Open Switch and Control Platform	Rohde & Schwarz	OSP-B157WX	101247	LAB000280	–
3	Open Switch and Control Platform	Rohde & Schwarz	OSP-B157W8	100982	LAB000279	–
4	Spectrum Analyser	Rohde & Schwarz	FSV40	101403	LAB000278	2021-06-15 → 2022-06-15
5	Signal Generator	Rohde & Schwarz	SMBV100A	258240	LAB000277	2021-06-02 → 2022-06-02
6	Signal Generator	Rohde & Schwarz	SMB100A-20	178175	LAB000276	2021-05-27 → 2022-05-27
7	Radio Communication Tester	Rohde & Schwarz	CMW270	101479	LAB000275	–
8	Controller	Hewlett Packard	ATS-Z230	101379	LAB000274	–
9	Power Supply	EA	PS 2042-10 B	2878350263	LAB000190	–

9 MEASUREMENT UNCERTAINTIES

Radio frequency	≤ ± 1 x 10^{-7}
RF power, conducted	≤ ± 0.75 dB
Power spectral density	≤ ± 3 dB
Maximum frequency deviation	≤ ± 5 %
Deviation limitation Duty Cycle, Tx-sequence, Tx-gap	≤ ± 5 %
Occupied channel bandwidth	≤ ± 5 %
Conducted spurious emission of transmitter	≤ ± 4 dB
Conducted emission of receivers	≤ ± 4 dB
Radiated emission of transmitter	≤ ± 6 dB
Radiated emission of receiver	≤ ± 6 dB
Temperature	≤ ± 2.5 °C
Humidity	≤ ± 10 %

The indicated expanded measurement uncertainty corresponds to the standard measurement uncertainty for the measurement results multiplied by the coverage factor k = 2. It was determined in accordance with EA-4/02 M:2013. The true value is located in the corresponding interval with a probability of 95 %.