

FCC Measurement/Technical Report on

Industrial WLAN Access Point / Client

SCALANCE W700 / MSAX

MSAX-W1-RJ-E2

FCC ID: LYHMSAXV1
IC: 267AA-MSAXV1

Test Report Reference: MDE_SIEM_2207_FCC_06

Test Laboratory:

7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany



Deutsche
Akkreditierungsstelle
D-PL-12140-01-01
D-PL-12140-01-02
D-PL-12140-01-03

Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization

Certification for an Intentional Radiator (Digital Device / Spread Spectrum).

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (10-1-21 Edition) and 15 (10-1-21 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

Part 15, Subpart E – Unlicensed National Information Infrastructure Devices

§ 15.403 Definitions

§ 15.407 General technical requirements

Note:

The DFS tests were selected and performed with reference to KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02, 2016-04-08 "COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVICES OPERATING IN THE 5250-5350 MHz AND 5470-5725 MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION".

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for UNII / LE-LAN (e.g. WLAN 5 GHz) equipment from FCC and IC

UNII equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 5: 8.8
Occupied bandwidth	§ 15.403 (26 dB) / § 15.407 (e) (6 dB)	RSS-247 Issue 2: 6.2.1.1, 6.2.2.1, 6.2.3.1 (99%) RSS-247 Issue 2: 6.2.4.1 (6 dB)
Maximum conducted output power	§ 15.407 (a) (1) to (8), (11)	RSS-247 Issue 2: 6.2.1.1, 6.2.2.1, 6.2.3.1, 6.2.4.1
Maximum power spectral density	§ 15.407 (a) (1) to (8), (12)	RSS-247 Issue 2: 6.2.1.1, 6.2.2.1, 6.2.3.1, 6.2.4.1
Transmitter undesirable emissions; General Field Strength Limits, Restricted Bands	§ 15.407 (b) § 15.209 (a)	RSS-Gen Issue 5: 6.13/8.9/8.10; RSS-247 Issue 2: 3.3/6.2 6.2.1.2, 6.2.2.2, 6.2.3.2, 6.2.4.2
Frequency stability	§ 15.407 (g)	RSS-Gen Issue 5: 6.11/8.11
Transmit Power Control (TPC) and Dynamic Frequency Selection (DFS)	§ 15.407 (h)	RSS-247 Issue 2: 6.2.2.1, 6.2.3.1, 6.3
Antenna requirement	§ 15.203 / 15.204 § 15.407 (a) (9)	RSS-Gen Issue 5: 8.3
Receiver spurious emissions	-	-

1.3 MEASUREMENT SUMMARY

47 CFR CHAPTER I FCC PART 15 FCC §15.31, §15.407 (h)
Subpart E §15.407

Dynamic Frequency Selection - U-NII Detection Bandwidth
 The measurement was performed according to KDB 905462

Final Result

OP-Mode	Setup	Date	FCC	IC
Radio Technology				
WLAN a Diversity	S01_AC04	2023-02-15	Passed	Passed
WLAN ax 40 MHz	S01_AC04	2023-02-15	Passed	Passed

47 CFR CHAPTER I FCC PART 15 FCC §15.31, §15.407 (h)
Subpart E §15.407

Dynamic Frequency Selection - Channel Availability Check Time
 The measurement was performed according to KDB 905462

Final Result

OP-Mode	Setup	Date	FCC	IC
Radio Technology				
WLAN ax 20 MHz	S01_AC04	2023-02-15	Passed	Passed

47 CFR CHAPTER I FCC PART 15 FCC §15.31, §15.407 (h)
Subpart E §15.407

Dynamic Frequency Selection - In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period
 The measurement was performed according to KDB 905462

Final Result

OP-Mode	Setup	Date	FCC	IC
Radio Technology				
WLAN ax 40 MHz	S01_AC04	2023-02-16 2023-03-30	Passed	Passed

47 CFR CHAPTER I FCC PART 15 FCC §15.31, §15.407 (h)
Subpart E §15.407

Dynamic Frequency Selection - Statistical Performance Check
 The measurement was performed according to KDB 905462

Final Result

OP-Mode	Setup	Date	FCC	IC
Radio Technology				
WLAN ax 20 MHz MIMO	S01_AC04	2023-02-15	Passed	Passed
WLAN ax 40 MHz MIMO	S01_AC04	2023-02-15	Passed	Passed

N/A: Not applicable
 N/P: Not performed

2 REVISION HISTORY / SIGNATURES

Report version control			
Version	Release date	Change Description	Version validity
initial	2023-07-31	--	valid
--	--	--	--

COMMENT: According to the applicant there exists a second variant of the EUT with type MSAX-W1-RJ-E2-NO without the DI/DO port. Tested for this report is the MSAX-W1-RJ-E2 variant since it is the fully equipped variant and thus assumed worst case. This report is a DFS report only. The other applicable tests are not part of this report.



(responsible for accreditation scope)
Dipl.-Ing. Marco Kullik



(responsible for testing and report)
Dipl.-Ing. Daniel Gall



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3 ADMINISTRATIVE DATA

3.1 TESTING LABORATORY

Company Name: 7layers GmbH
Address: Borsigstr. 11
40880 Ratingen
Germany

The test facility is accredited by the following accreditation organisation:

Laboratory accreditation no: DAKKS D-PL-12140-01-01 | -02 | -03
FCC Designation Number: DE0015
FCC Test Firm Registration: 929146
ISED CAB Identifier DE0007; ISED#: 3699A

Responsible for accreditation scope: Dipl.-Ing. Marco Kullik

Report Template Version: 2022-05-25

3.2 PROJECT DATA

Responsible for testing and report: Dipl.-Ing. Daniel Gall
Employees who performed the tests: documented internally at 7Layers
Date of Report: 2023-07-31
Testing Period: 2023-02-15 to 2023-03-30

3.3 APPLICANT DATA

Company Name: SIEMENS AG
Address: Östliche Rheinbrückenstr. 50
76187 Karlsruhe
Germany
Contact Person: Malgorzata Janson

3.4 MANUFACTURER DATA

Company Name: SIEMENS AG
Address: 76181 Karlsruhe
Germany
Contact Person: Kilian Löser

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Industrial WLAN Access Point / Client
Product name	SCALANCE W700 / MSAX
Type	MSAX-W1-RJ-E2
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	24 V
Tested Modulation Type	OFDM
Specific product description	<p>The MSAX-W1-RJ-E2 device is a wireless LAN access point / client for industrial applications supporting following WLAN modes and frequency bands:</p> <ul style="list-style-type: none"> • 802.11 ax/ac/a/h/n Mode: 5.15 - 5.35 GHz and 5.47 - 5.85 GHz • 802.11 ax/b/g/n Mode: 2400 - 2483.5 MHz <p>2 reverse SMA connectors are available for usage with external antennas. 2x2 MIMO operation is possible in both bands. Simultaneous operation of the device in both frequency bands is supported. Module may be used either as Master or as Client WLAN device.</p> <p>The device supports 10/100/1000 Mbit/s Ethernet on 4 RJ45 ports. Additionally, the device features one digital input and one digital output signalling line, a configuration/licensing plug and a sleep timer. Supply power is 24Vdc.</p> <p>OFDMA for ax mode is not supported in the current firmware.</p> <p>In the relevant DFS bands 5250 -5350 and 5470 -5725 MHz 20 and 40 MHz Bandwidth are supported. 80 MHz bandwidth is additionally supported outside of the DFS bands.</p>
Ports of the device	<ul style="list-style-type: none"> • Enclosure • DC port: cable length appr. 1.0m • Digital I/O port: cable length 2.0m (terminated with DIDO box), only for radiated tests • LAN port: cable length (shielded), appr. 3.0m, only for radiated tests • USB C service port: cable length, appr. 2.0m, only for conducted tests <p>2 Antenna ports, Reverse SMA-connector, appr. 1.0 m & antenna</p>
Antenna Type	EUT has two permanent 50 Ohm antenna connectors. External antenna(s)
Antenna Gain	Assumed minimum gain for testing: 0 dBi
Number of Transmit Chains	2

Number of Receive Chains	2
Type of TX / RX Chains	symmetrical
Nominal Bandwidth	20 MHz, 40 MHz, 80 MHz (not supported in the DFS bands)
Max. Data Rates	WLAN a: up to 54 Mbit/s WLAN n: up to 300 Mbit/s WLAN ac: up to 866.7 Mbit/s WLAN ax: up to 1201 Mbit/s
Special software used for testing	The test modes were set by command line commands provided by the applicant.
Transmit Power Control	Supported
Power level of the EUT (E.I.R.P.)	30 dBm, 17 dBm/MHz
User Access Restriction	The manufacturer confirms that information regarding the parameters of the detected waveforms is not accessible to the end user.
Channel Loading System Type	IP based system

Declared data by the laboratory	
Used antenna ports during testing	Both antenna ports were connected to the test setup.
Antenna Assembly gain used for DFS Threshold Level	0 dBi
Used threshold level	-64 dBm (EIRP > 200 mW and power spectral density > 10 dBm/MHz)
Channel loading	Video Streaming from laptop connected to EUT to Laptop connected to Client device.
Pulse Type Generation	Pulses were randomly generated using Rohde & Schwarz K6 Pulse sequencer.

4.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
EUT ac04	DE1039038ac04	
Sample Parameter	Value	
Serial No.	VPP7205251	
HW Version	02	
SW Version	V03.00.00	
Comment	Used as DFS Master	

Sample Name	Sample Code	Description
EUT ad04	DE1039038ad04	
Sample Parameter	Value	
Serial No.	VPP7205248	
HW Version	02	
SW Version	V03.00.00	
Comment	Used as Client without radar detection	

NOTE: The short description is used to simplify the identification of the EUT in this test report.

4.3 ANCILLARY EQUIPMENT

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Device	Details (Manufacturer, Type Model, OUT Code)	Description
-	-	-

4.4 AUXILIARY EQUIPMENT

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

Device	Details (Manufacturer, Type Model, HW, SW, S/N)	Description
AUX1	Fujitsu, Lifebook U758, 2018-06, Win10 Pro Engl., DSAL006396	Laptop Computer
AUX2	Fujitsu, Lifebook E series E781, 2012-03, Win10 Pro Engl., DSCK013809	Laptop Computer
AUX301	Siemens, -, -, -, -	DI/DO Test box with cable

4.5 EUT SETUPS

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

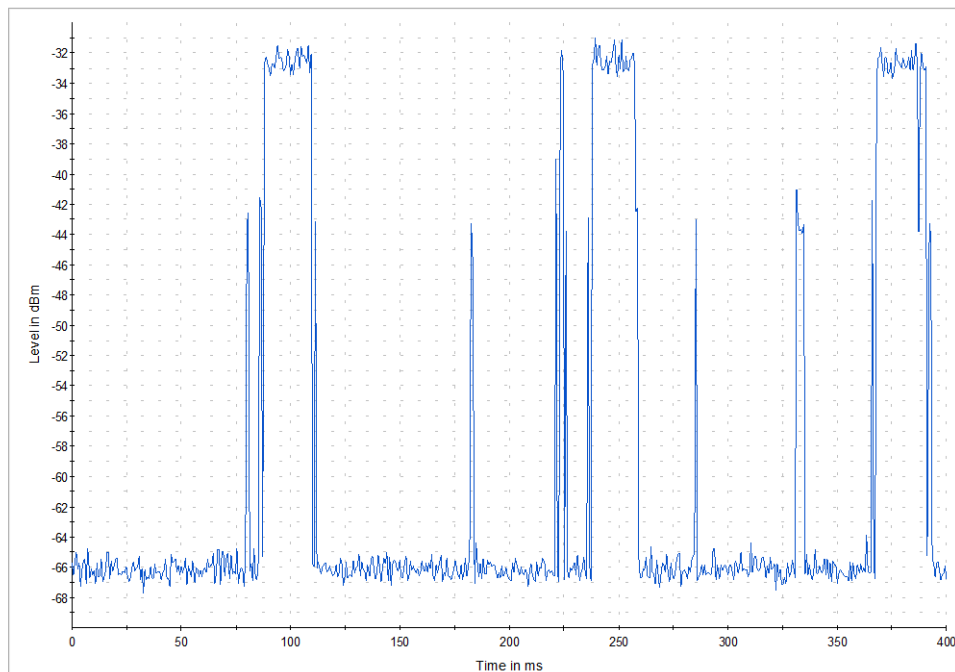
Setup	Combination of EUTs	Description and Rationale
S01_AC04	EUT ac04, EUT ad04, AUX1, AUX2, AUX301	Conducted DFS Setup

4.6 OPERATING MODES / TEST CHANNELS

This chapter describes the operating modes of the EUTs used for testing.

U-NII-Subband 2A 5250 - 5350 MHz			U-NII-Subband 2C 5470 - 5725 MHz			Nom. BW
low	mid	high	low	mid	high	20 MHz
-	-	-	100	-	-	Ch.-No.
-	-	-	5500	-	-	MHz
low	mid	high	low	mid	high	40 MHz
-	-	-	102	-	-	Ch.-No.
-	-	-	5510	-	-	MHz

Channel Loading Duty Cycle



123 of 601 sweep points > -54 dBm results in 20.2 % DC

4.7 PRODUCT LABELLING

4.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

4.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

5 TEST RESULTS

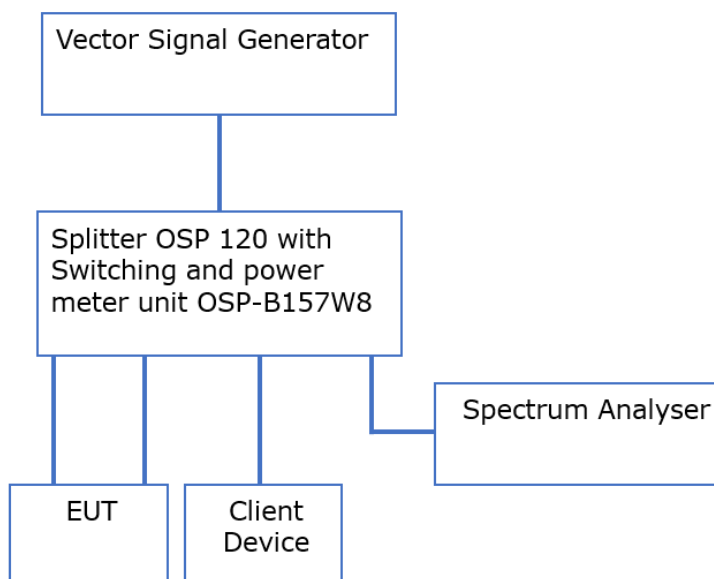
5.1 DYNAMIC FREQUENCY SELECTION - U-NII DETECTION BANDWIDTH

Standard **FCC Part 15 Subpart E**

The test was performed according to:
KDB 905462

5.1.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room for the DFS measurements.



Since the DFS Master shall be tested stand alone, the DFS Client was connected but not activated.

After activating the EUT, a radar pulse of type 0 was send on mid channel frequency from the radar signal generator and the response was noted. This was repeated 9 further times.

If at least 9 of the 10 pulses were recognized by the device, the radar pulse frequency was increased or decreased by 5 MHz and the test was repeated. If the detection rate falls below 9 pulses, the step size is reduced to 1 MHz from the previous 5 MHz step until detection rate falls below 9 again. The result is compared to the 99 % Bandwidth.

5.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart E, §15.407 (h) (2)

The device must sense for radar signals at 100 percent of its emission bandwidth.

The minimum DFS detection threshold for devices with a maximum e.i.r.p. of 200 mW to 1 W is -64 dBm. 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.

The detection threshold is the received power averaged over 1 microsecond referenced to a 0 dBi antenna.

5.1.3 TEST PROTOCOL

Ambient temperature: 25 °C
 Air Pressure: 1014 hPa
 Humidity: 40 %

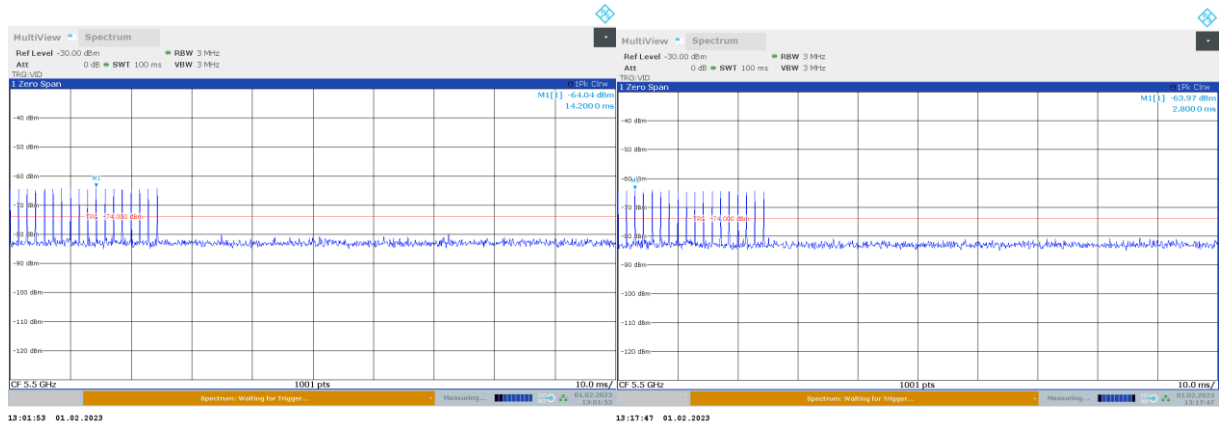
Radio Technology	TX Frequency [MHz]	Channel BW [MHz]	Radar Test Signal #	FL [MHz]	FH [MHz]	Detection BW [MHz]	Max. 99 % BW [MHz]
WLAN a Diversity	5500	20	Radar Type 0	5490	5510	20	19.0
WLAN ax 40 MHz	5510	40	Radar Type 0	5490	5530	40	37.8

Remark: Detection of radar pulses is monitored by console interface.
 No plots are recorded.

5.1.4 MEASUREMENT RESULT

MHz from Centre	TX Centre Frequency [MHz]	Channel BW [MHz]	Detected	TX Centre Frequency [MHz]	Channel BW [MHz]	Detected
-20				5510	40	10
-19				5510	40	
-18				5510	40	
-17				5510	40	
-16				5510	40	
-15				5510	40	10
-10	5500	20	10	5510	40	10
-9	5500	20		5510	40	
-8	5500	20		5510	40	
-7	5500	20		5510	40	
-6	5500	20		5510	40	
-5	5500	20	10	5510	40	10
0	5500	20	10	5510	40	10
5	5500	20	10	5510	40	10
6	5500	20		5510	40	
7	5500	20		5510	40	
8	5500	20		5510	40	
9	5500	20		5510	40	
10	5500	20	10	5510	40	10
15				5510	40	10
16				5510	40	
17				5510	40	
18				5510	40	
19				5510	40	
20				5510	40	10

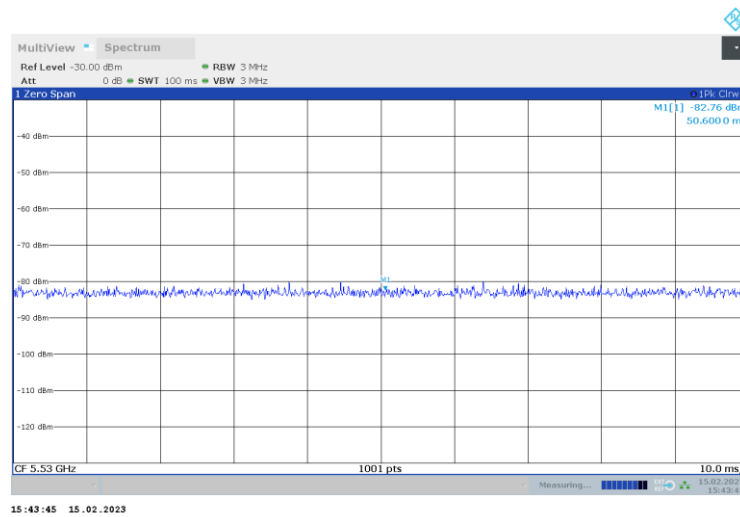
Radar Pulse Level Calibration



Antenna Port 1

Antenna Port 2

Radar Pulse level



Noise Level

5.1.5 TEST EQUIPMENT USED

- R&S TS8997

5.2 DYNAMIC FREQUENCY SELECTION - CHANNEL AVAILABILITY CHECK TIME

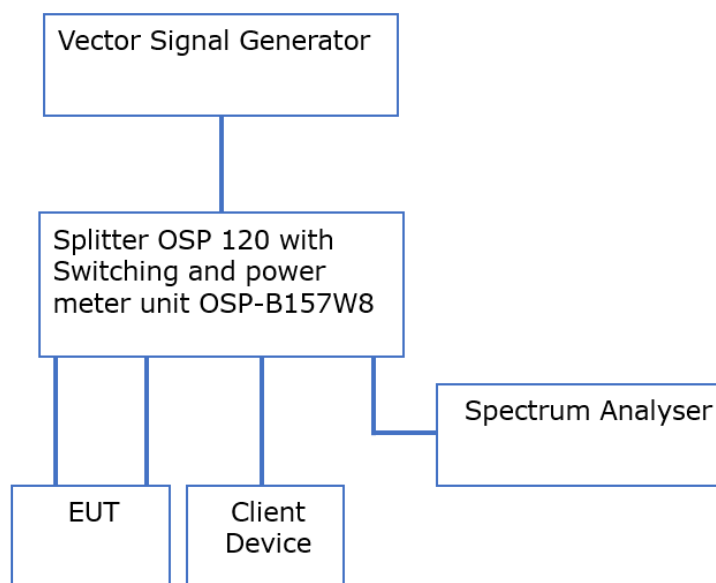
Standard **FCC Part 15 Subpart E**

The test was performed according to:

KDB 905462

5.2.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room for the DFS measurements.



The blocked channel list is reset and the EUT restarted by software commands.

When the console interface indicates the restart, the measurement sweep on the spectrum analyser is started.

Analyser settings:

- Resolution Bandwidth (RBW): 3 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Clear/Write
- Sweeps: Single Sweep
- Sweeptime: 150 s
- Detector: Peak

5.2.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart E, §15.407 (h) (2) (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.

FCC Part 15, Subpart E, §15.407 (h) (2)

The minimum DFS detection threshold for devices with a maximum e.i.r.p. of 200 mW to 1 W is -64 dBm. 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. The detection threshold is the received power averaged over 1 microsecond referenced to a 0 dBi antenna.

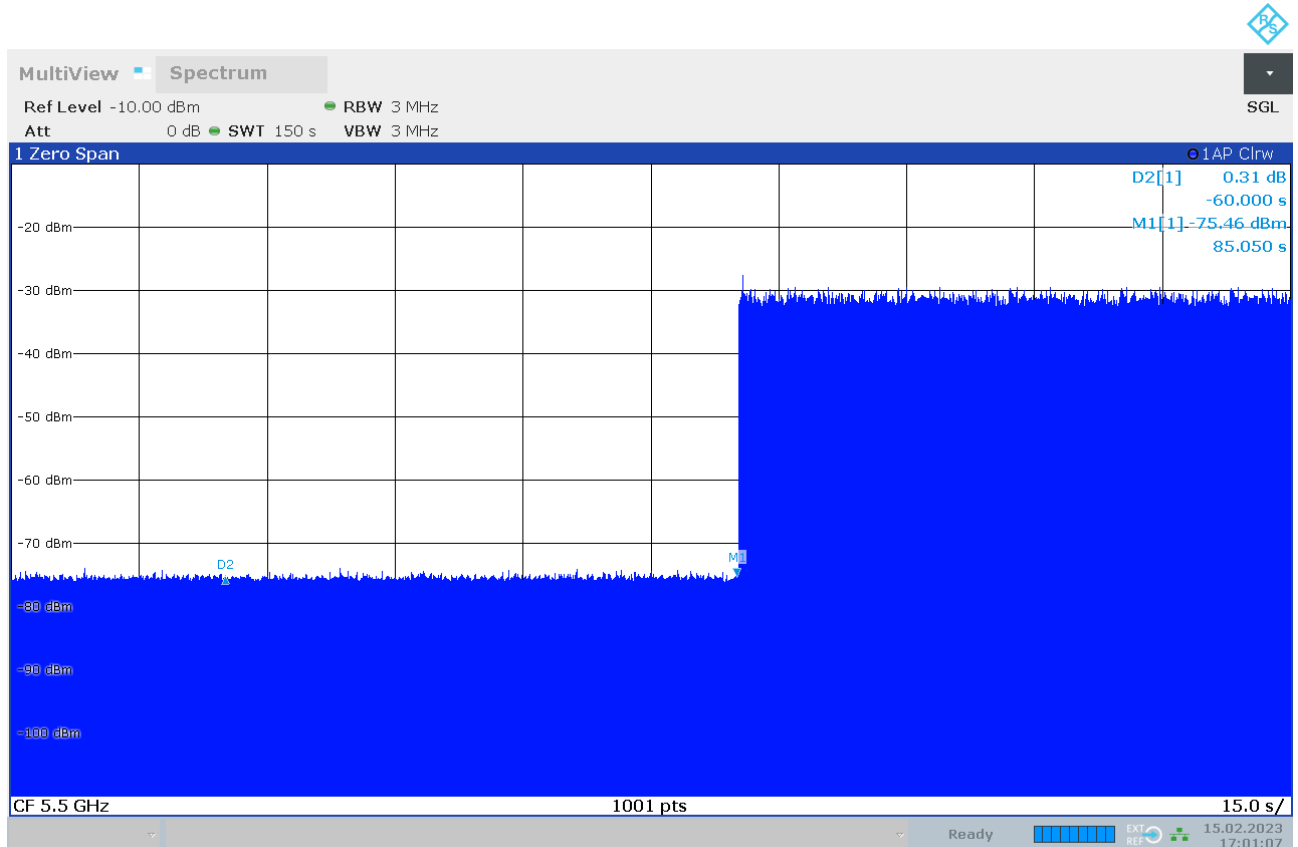
5.2.3 TEST PROTOCOL

Ambient temperature: 25 °C
 Air Pressure: 1014 hPa
 Humidity: 40 %

Radio Technology	TX Frequency [MHz]	Radar Test Signal #	Detected?	Transmissions within 150 s?
WLAN ax 20 MHz	5500	Type 0 @ 0 to 6 s	Yes	No
WLAN ax 20 MHz	5500	Type 0 @ 54 to 60 s	Yes	No

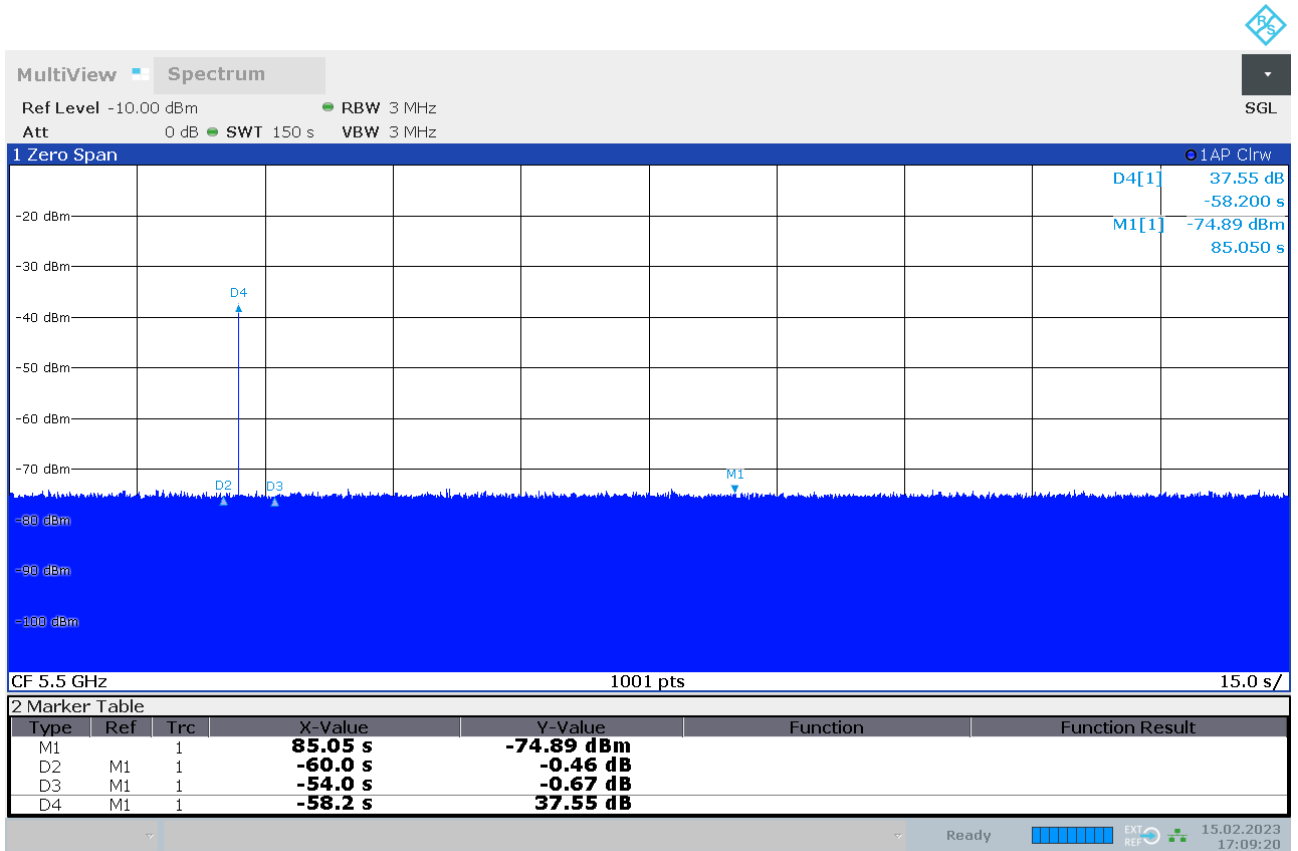
Remark: Please see next sub-clause for the measurement plot.

5.2.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)



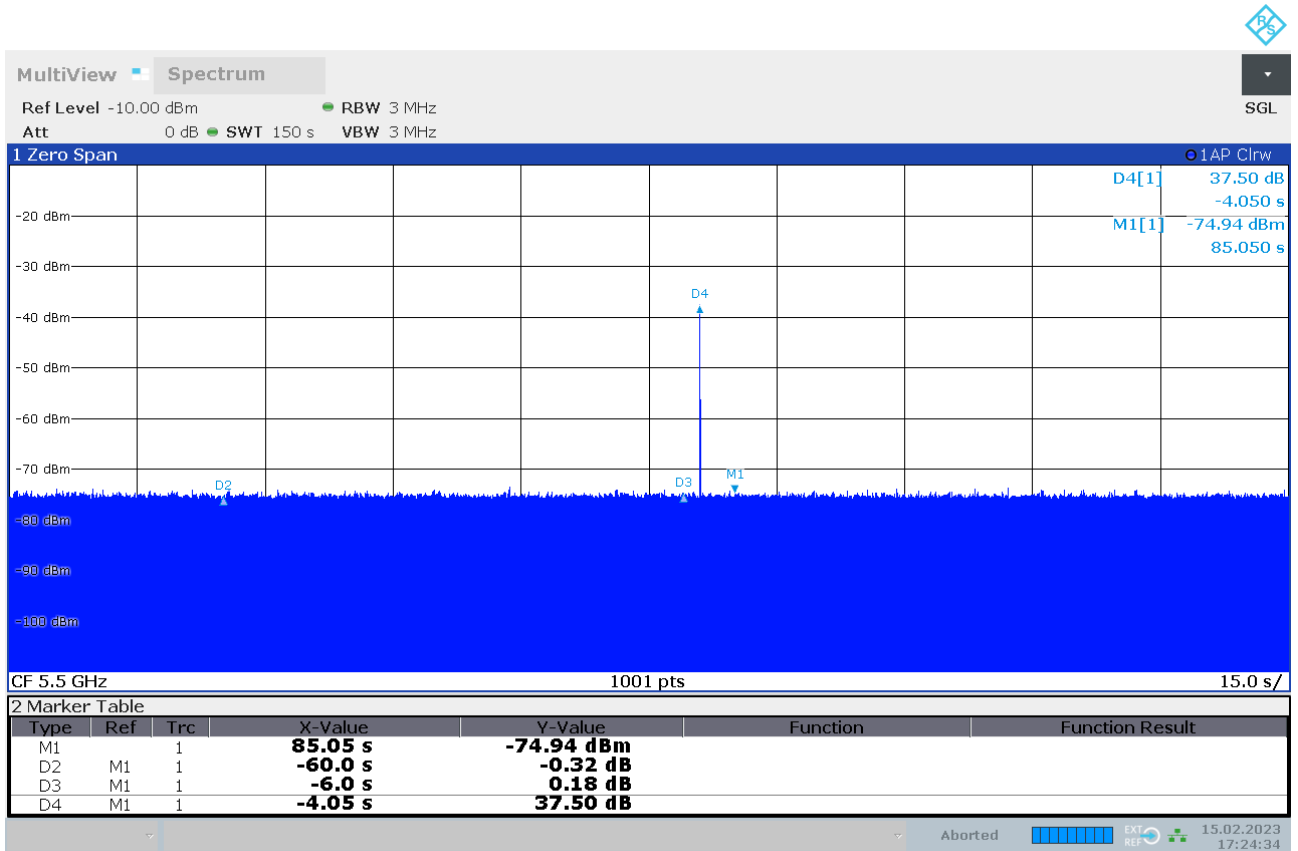
17:01:07 15.02.2023

Determination of startup time (no radar pulse send)
Resulting start up time: 85.05 s (Marker 1) – 60 s = 25.05 s (Marker D2)



17:09:20 15.02.2023

Radar Pulse at beginning of CAC period.
Emission of radar pulse at 1.8s after calculated startup (Marker D4)



17:24:34 15.02.2023

Radar Pulse at end of CAC period.
Emission of radar pulse at 55.95s after calculated startup (Marker D4)

5.2.5 TEST EQUIPMENT USED

- R&S TS8997

5.3 DYNAMIC FREQUENCY SELECTION - IN-SERVICE MONITORING FOR CHANNEL MOVE TIME, CHANNEL CLOSING TRANSMISSION TIME AND NON-OCCUPANCY PERIOD

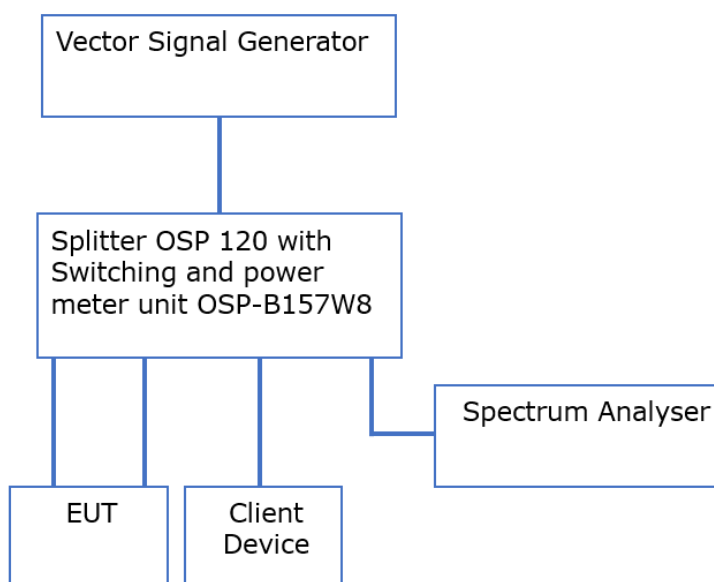
Standard **FCC Part 15 Subpart E**

The test was performed according to:

KDB 905462

5.3.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room for the DFS measurements.



The Master and Client EUT were powered together with the laptops for traffic generation. Afterwards the master and client were configured for connection on a DFS channel using the maximum supported bandwidth. Once the Channel Availability Check was completed and connection was established, the video streaming was started.

With established connection, a radar pulse of type 0 was send from the radar pulse generator. At the same time the spectrum analyser is triggered by the radar signal generator and a trace is recorded:

Analyzer settings:

- Resolution Bandwidth (RBW): 3 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Clear/Write
- Sweeps: Single Sweep
- Sweeptime: 20 s
- Detector: Peak
- Trigger: External

In addition to the plot also the trace data is recorded to calculate the Channel Closing Time.

Afterwards the test is repeated with a sweep time of 32 minutes to monitor the Non-occupancy period.

5.3.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart E, §15.407 (h) (2) (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.

FCC Part 15, Subpart E, §15.407 (h) (2) (iii)
 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.

Limits according KDB 905462 D02 UNII DFS Compliance Procedures New Rules

Parameter	Value
<i>Non-occupancy period</i>	Minimum 30 minutes
<i>Channel Availability Check Time</i>	60 seconds
<i>Channel Move Time</i>	10 seconds See Note 1.
<i>Channel Closing Transmission Time</i>	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
Note 1: <i>Channel Move Time</i> and the <i>Channel Closing Transmission Time</i> should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst. Note 2: The <i>Channel Closing Transmission Time</i> is comprised of 200 milliseconds starting at the beginning of the <i>Channel Move Time</i> plus any additional intermittent control signals required to facilitate a <i>Channel</i> move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.	

5.3.3 TEST PROTOCOL

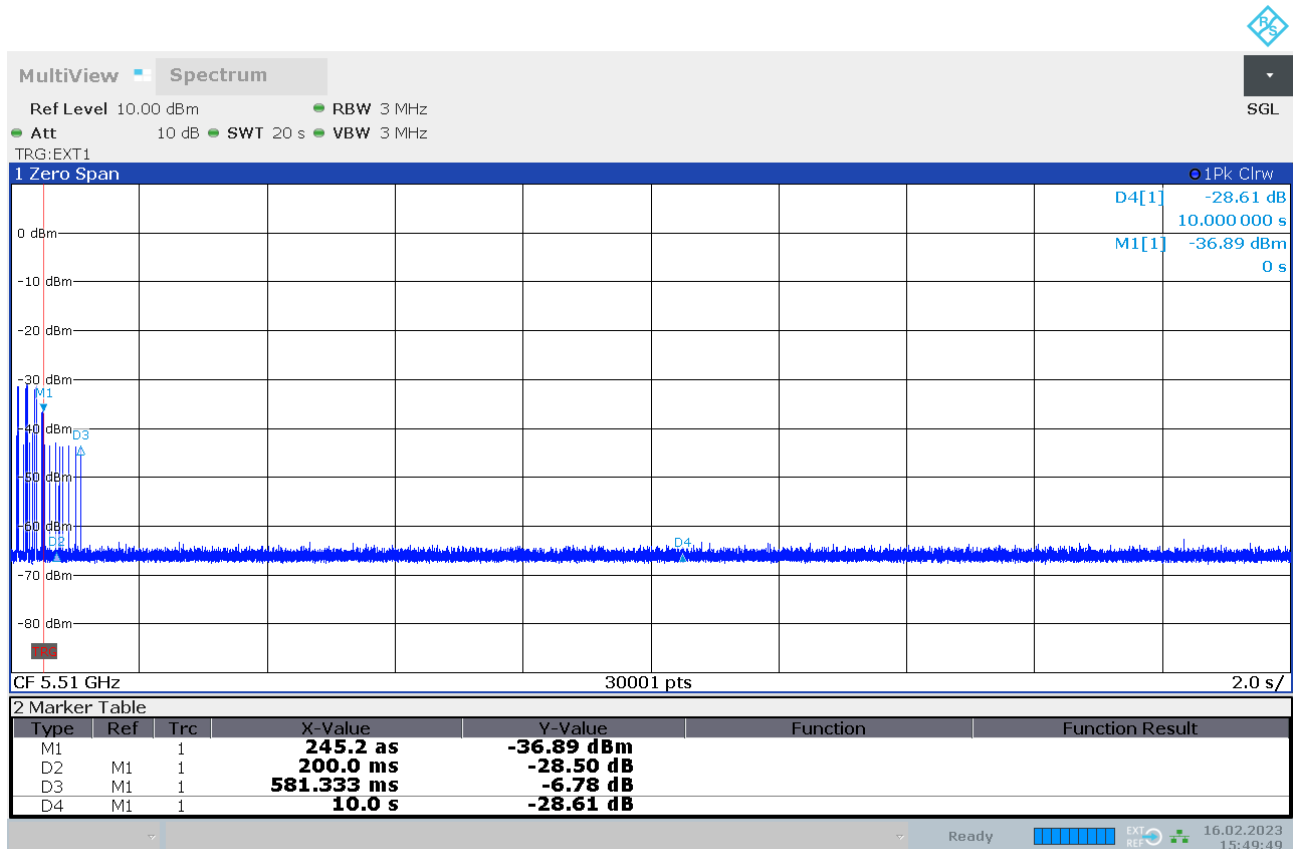
Ambient temperature: 25 °C
 Air Pressure: 1014 hPa
 Humidity: 40 %

Operational Mode	Radio Technology	TX Frequency [MHz]	Radar Test Signal #	Channel Closing Transmission Time following the first 200 ms [ms]	Limit [ms]	Channel Move Time [s]	Limit [s]	Transmissions in Non Occupancy Period?
Master	WLAN ax 40 MHz	5510	Type 0	5.3	60	0.581	10	None
Client without Radar Detection	WLAN ax 40 MHz	5510	Type 0	4.8	60	0.572	10	N/P

Remark: Please see next sub-clause for the measurement plot.

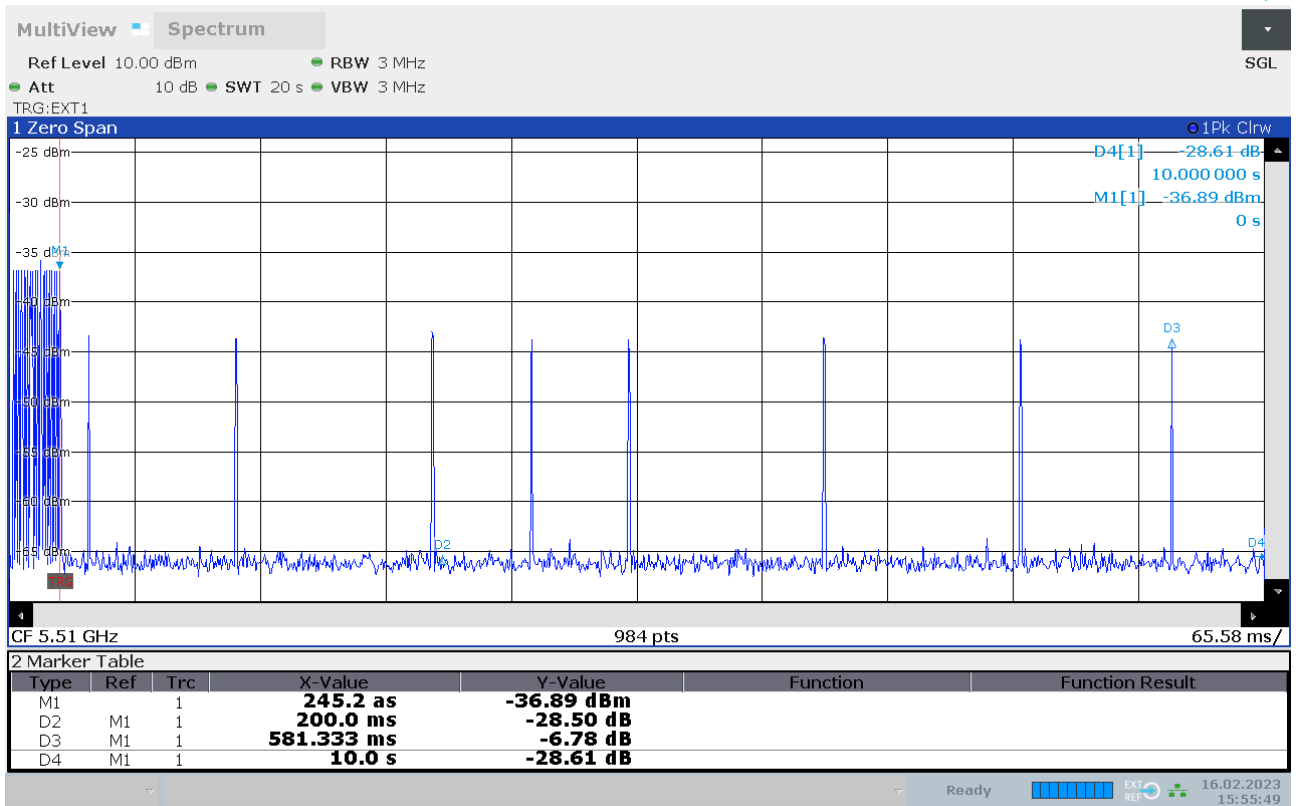
5.3.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

DFS Master



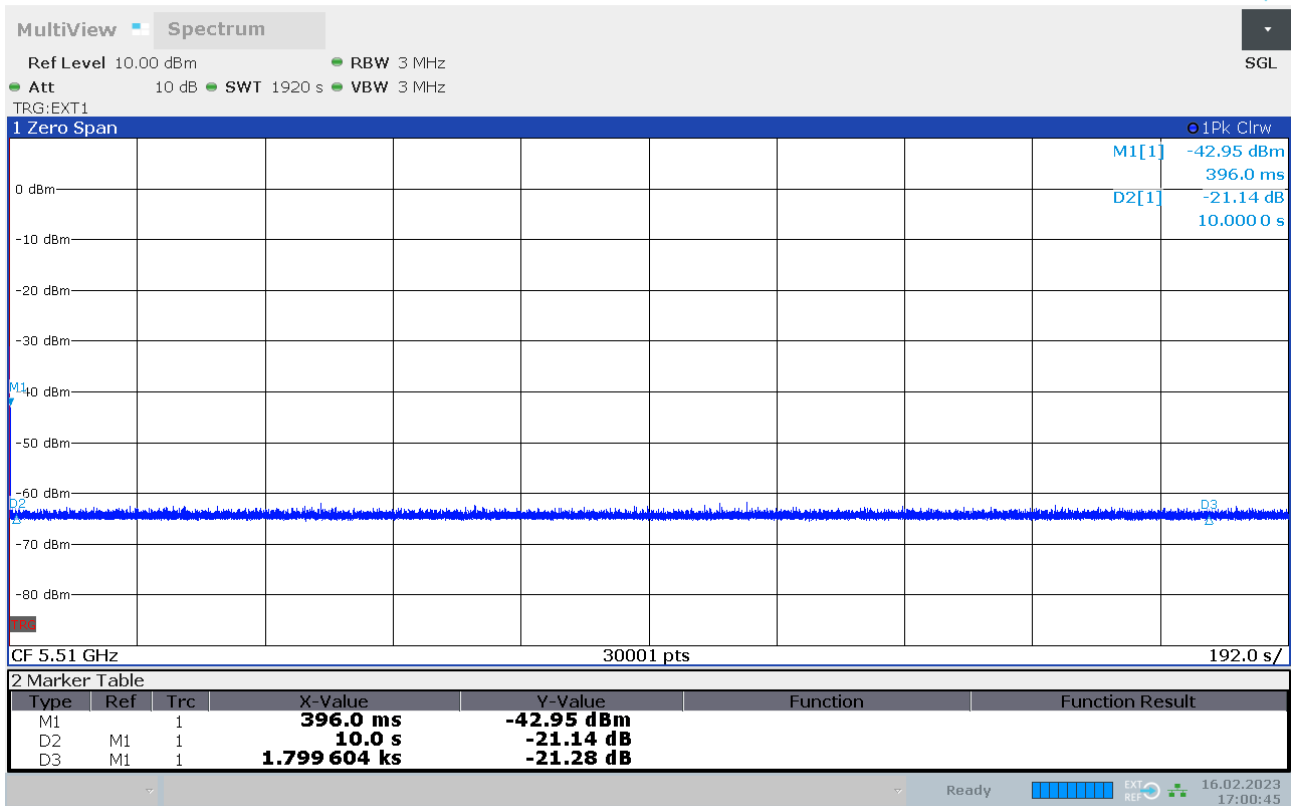
15:49:49 16.02.2023

M1 = Radar Pulse, D2 = 200 ms after Radar Pulse end, D3 = Last Transmission end



15:55:50 16.02.2023

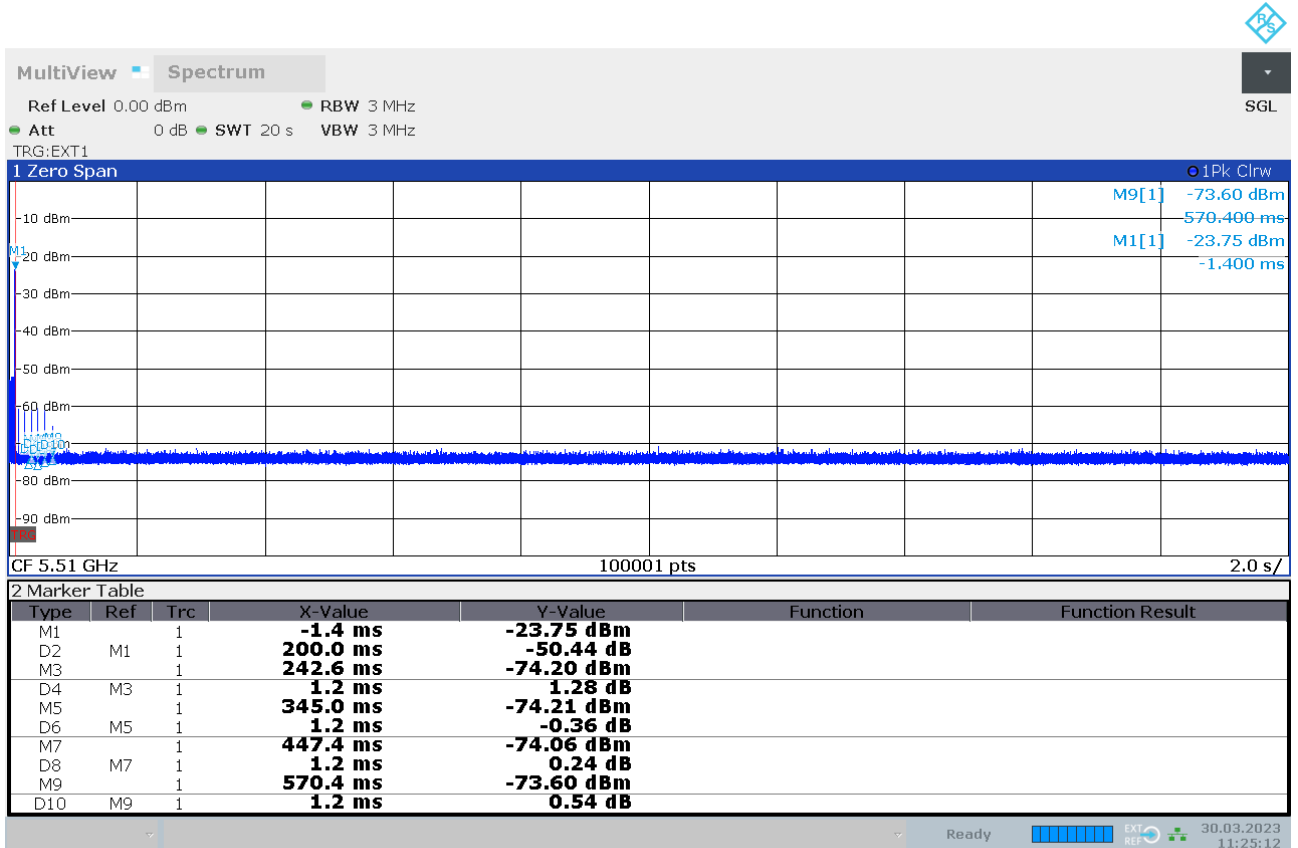
Zoomed into trace data of channel move and channel closing time plot.



17:00:45 16.02.2023

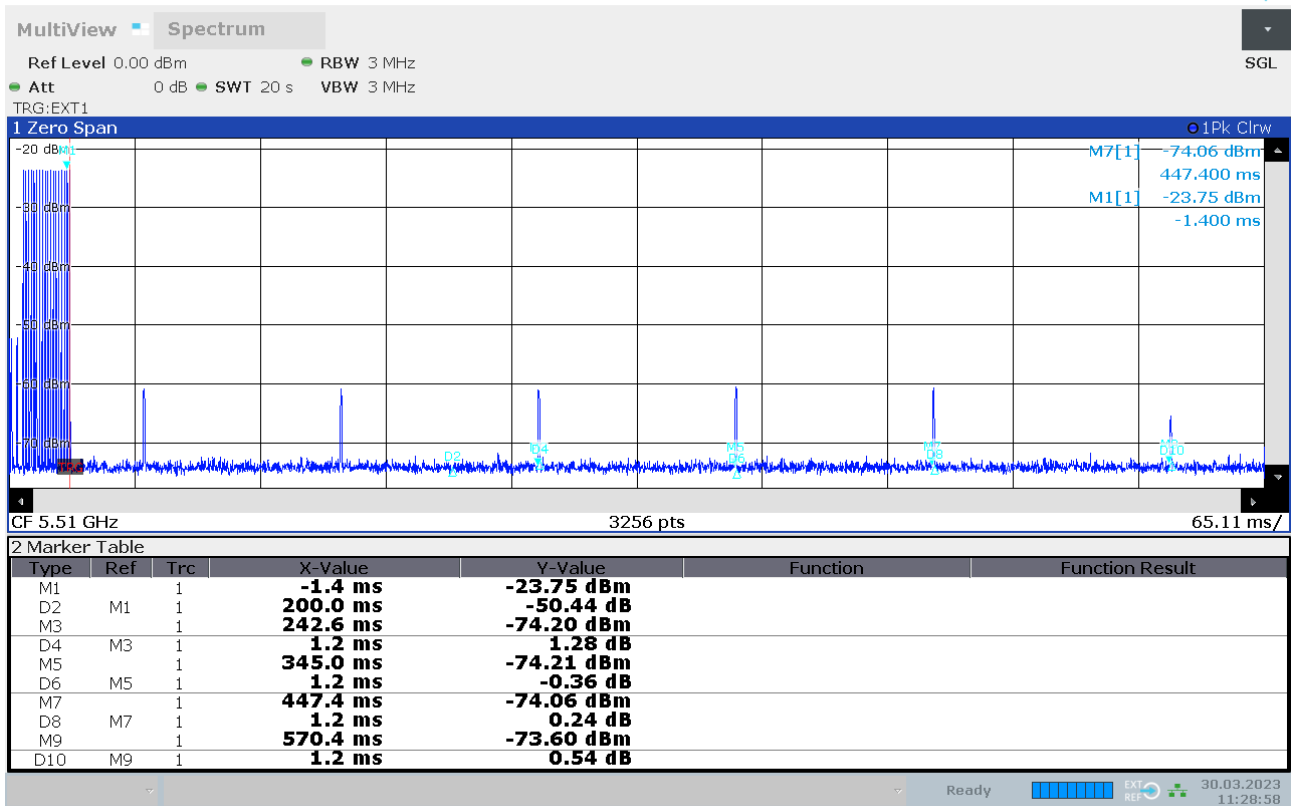
Non Occupancy Period

DFS Client



11:25:13 30.03.2023

M1 = Radar Pulse, D2 = 200 ms after Radar Pulse end, D10 = Last Transmission end



11:28:59 30.03.2023

Zoomed into trace data of channel move and channel closing time plot.

5.3.5 TEST EQUIPMENT USED

- R&S TS8997

5.4 DYNAMIC FREQUENCY SELECTION - STATISTICAL PERFORMANCE CHECK

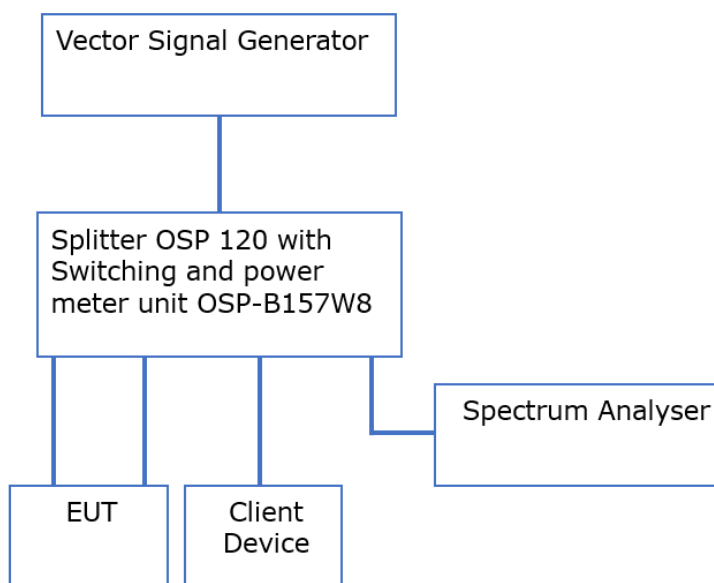
Standard **FCC Part 15 Subpart E**

The test was performed according to:

KDB 905462

5.4.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room for the DFS measurements.



The Master and Client EUT were powered together with the laptops for traffic generation. Afterwards the master and client were configured for connection on a DFS channel. Once the Channel Availability Check was completed and connection was established, the video streaming was started.

Using command line commands provided by the customer, the device's channel change functionality was deactivated and non-occupancy period reduced to 1 s to reduce testing time.

Detection of radar pulse is monitored by console interface.

30 unique pulses of radar type 1 to 6 are send while for each type 10 pulses are send at the lower end of the 99 % detection BW, 10 pulses at the higher end of the detection BW and 10 are send mid channel.

For each send pulse detection is recorded.

Testing is repeated for all supported channel bandwidths.

5.4.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart E, §15.407 (h) (2)

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. Operators shall only use equipment with a DFS mechanism that is turned on when operating in these bands. The device must sense for radar signals at 100 percent of its emission bandwidth. The minimum DFS detection threshold for devices with a maximum e.i.r.p. of 200 mW to 1 W is -64 dBm. 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. The detection threshold is the received power averaged over 1 microsecond referenced to a 0 dBi antenna.

Limits according KDB 905462 D02 UNII DFS Compliance Procedures New Rules

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	Roundup $\left\{ \begin{array}{l} \left(\frac{1}{360} \right) \cdot \\ \left(\frac{19 \cdot 10^6}{PRI_{\mu sec}} \right) \end{array} \right\}$	60%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 µsec, with a minimum increment of 1 µsec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

Table 6 – Long Pulse Radar Test Waveform

Radar Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Number of Pulses per Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 7 – Frequency Hopping Radar Test Waveform

Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

5.4.3 TEST PROTOCOL

Ambient temperature: 25 °C
 Air Pressure: 1014 hPa
 Humidity: 40 %

Radio Technology	TX Frequency [MHz]	Radar Test Signal #	Number of send pulses	Number of detected pulses	Successful Detection Percentage [%]	Limit [%]	Margin to Limit [%]
WLAN ax 20 MHz MIMO	5500	Type 1	30	28	93.3	60	33.3
WLAN ax 20 MHz MIMO	5500	Type 2	30	27	90	60	30
WLAN ax 20 MHz MIMO	5500	Type 3	30	22	73.3	60	13.3
WLAN ax 20 MHz MIMO	5500	Type 4	30	27	90	60	30
WLAN ax 20 MHz MIMO	5500	Aggregate 1-4	120	104	86.7	80	6.7
WLAN ax 20 MHz MIMO	5500	Type 5	30	30	100	80	20
WLAN ax 20 MHz MIMO	5500	Type 6	30	30	100	70	30
WLAN ax 40 MHz MIMO	5510	Type 1	30	26	86.7	60	26.7
WLAN ax 40 MHz MIMO	5510	Type 2	30	28	93.3	60	33.3
WLAN ax 40 MHz MIMO	5510	Type 3	30	27	90	60	30
WLAN ax 40 MHz MIMO	5510	Type 4	30	26	86.7	60	26.7
WLAN ax 40 MHz MIMO	5510	Aggregate 1-4	120	107	89.2	80	9.2
WLAN ax 40 MHz MIMO	5510	Type 5	30	29	96.7	80	16.7
WLAN ax 40 MHz MIMO	5510	Type 6	30	30	100	70	30

Remark: Please see next sub-clause for the measurement plot.

5.4.4 MEASUREMENT RESULT

20 MHz Bandwidth Pulse Types 1 to 4 and 6

RADAR TYPE 1 Table Random					RADAR TYPE 1 5a				
Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)	Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)
1	59	1	899	yes	1	102	1	518	yes
2	21	1	2586	yes	2	99	1	538	yes
3	51	1	1042	yes	3	95	1	558	yes
4	21	1	2564	yes	4	92	1	578	yes
5	18	1	2990	yes	5	89	1	598	yes
6	23	1	2343	yes	6	86	1	618	yes
7	54	1	979	yes	7	83	1	638	yes
8	20	1	2761	no	8	81	1	658	yes
9	70	1	760	yes	9	78	1	678	yes
10	22	1	2435	yes	10	76	1	698	no
11	26	1	2050	yes	11	74	1	718	yes
12	77	1	692	yes	12	72	1	738	yes
13	23	1	2316	yes	13	70	1	758	yes
14	29	1	1847	yes	14	68	1	778	yes
15	25	1	2131	yes	15	67	1	798	yes
RADAR TYPE 2					RADAR TYPE 3				
Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)	Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)
1	28	2.6	174	yes	1	16	10	367	yes
2	27	1.2	227	yes	2	18	6.9	369	yes
3	29	1.7	212	yes	3	18	8.8	320	yes
4	28	3.5	212	yes	4	17	8.4	384	yes
5	24	4.6	181	yes	5	18	6.7	261	yes
6	26	2.3	225	yes	6	16	8.7	357	yes
7	27	4.6	188	no	7	17	6	251	yes
8	28	4.7	219	yes	8	18	7.7	270	yes
9	23	4.3	152	yes	9	17	9.2	296	yes
10	27	4.6	222	yes	10	17	6.5	441	yes
11	26	4.4	185	yes	11	17	9.8	403	yes
12	27	4.5	206	no	12	17	9	411	yes
13	28	2.2	195	yes	13	18	8.3	346	yes
14	27	3	210	no	14	16	8.4	319	yes
15	24	1.6	175	yes	15	18	8.9	375	no
16	25	3.1	172	yes	16	17	6.3	230	no
17	25	3.8	226	yes	17	17	9.3	456	yes
18	28	3.5	211	yes	18	16	8.4	424	yes
19	28	2.9	170	yes	19	17	6.4	218	yes
20	27	3.9	211	yes	20	18	6.8	255	yes
21	28	4.1	162	yes	21	17	6.3	255	yes
22	28	1.9	178	yes	22	16	7.8	400	yes
23	29	1.7	176	yes	23	17	8.7	487	yes
24	23	4.2	164	yes	24	16	8.2	333	yes
25	27	3.3	187	yes	25	17	6.3	442	yes
26	23	2.5	189	yes	26	16	7.9	450	yes
27	26	1.9	226	yes	27	17	6.5	446	yes
28	23	3.8	176	yes	28	17	6.3	493	yes
29	29	3	186	yes	29	17	8.7	388	no
30	28	4.3	189	yes	30	17	9	353	yes

RADAR TYPE 4					RADAR TYPE 6				
Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)	Trial #	Number of Pulses per Hop	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)
1	13	14	407	yes	1	9	1	333	yes
2	14	14.6	348	yes	2	9	1	333	yes
3	13	13.6	398	yes	3	9	1	333	yes
4	13	19.7	416	yes	4	9	1	333	yes
5	14	15.2	363	yes	5	9	1	333	yes
6	12	17.2	487	yes	6	9	1	333	yes
7	14	15.2	310	yes	7	9	1	333	yes
8	14	13.2	265	no	8	9	1	333	yes
9	16	18.2	246	yes	9	9	1	333	yes
10	14	20	385	yes	10	9	1	333	yes
11	14	14.8	266	no	11	9	1	333	yes
12	15	13.5	235	yes	12	9	1	333	yes
13	14	15.5	484	no	13	9	1	333	yes
14	12	17.3	439	yes	14	9	1	333	yes
15	14	17.5	434	yes	15	9	1	333	yes
16	14	17.1	469	no	16	9	1	333	yes
17	15	11	452	yes	17	9	1	333	yes
18	15	15.5	340	yes	18	9	1	333	yes
19	13	16	355	yes	19	9	1	333	yes
20	14	11.9	457	yes	20	9	1	333	yes
21	14	16.5	292	yes	21	9	1	333	yes
22	13	13.8	401	yes	22	9	1	333	yes
23	15	14	324	yes	23	9	1	333	yes
24	15	18.2	312	no	24	9	1	333	yes
25	15	13.5	394	yes	25	9	1	333	yes
26	13	14.5	375	yes	26	9	1	333	yes
27	14	15.6	301	yes	27	9	1	333	yes
28	14	16.6	423	yes	28	9	1	333	yes
29	14	14.8	267	yes	29	9	1	333	yes
30	12	18.8	279	yes	30	9	1	333	yes

40 MHz Bandwidth Pulse Types 1 to 4 and 6

RADAR TYPE 1 Table 5a					RADAR TYPE 1				
Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)	Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)
1	102	1	518	yes	1	59	1	899	yes
2	99	1	538	yes	2	21	1	2586	yes
3	95	1	558	yes	3	51	1	1042	yes
4	92	1	578	yes	4	21	1	2564	yes
5	89	1	598	yes	5	18	1	2990	yes
6	86	1	618	yes	6	23	1	2343	no
7	83	1	638	yes	7	54	1	979	yes
8	81	1	658	yes	8	20	1	2761	yes
9	78	1	678	yes	9	70	1	760	yes
10	76	1	698	yes	10	22	1	2435	yes
11	74	1	718	no	11	26	1	2050	yes
12	72	1	738	yes	12	77	1	692	no
13	70	1	758	yes	13	23	1	2316	no
14	68	1	778	yes	14	29	1	1847	yes
15	67	1	798	yes	15	25	1	2131	yes
RADAR TYPE 2					RADAR TYPE 3				
Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)	Trial #	Number of Pulses per Burst	Pulse Width (µsec)	PRI (µs)	Detection (yes/no)
1	28	2.6	174	yes	1	16	10	367	yes
2	27	1.2	227	yes	2	18	6.9	369	no
3	29	1.7	212	no	3	18	8.8	320	no
4	28	3.5	212	yes	4	17	8.4	384	yes
5	24	4.6	181	yes	5	18	6.7	261	yes
6	26	2.3	225	yes	6	16	8.7	357	yes
7	27	4.6	188	yes	7	17	6	251	no
8	28	4.7	219	yes	8	18	7.7	270	no
9	23	4.3	152	yes	9	17	9.2	296	yes
10	27	4.6	222	yes	10	17	6.5	441	yes
11	26	4.4	185	yes	11	17	9.8	403	yes
12	27	4.5	206	yes	12	17	9	411	yes
13	28	2.2	195	yes	13	18	8.3	346	no
14	27	3	210	yes	14	16	8.4	319	no
15	24	1.6	175	yes	15	18	8.9	375	yes
16	25	3.1	172	yes	16	17	6.3	230	yes
17	25	3.8	226	yes	17	17	9.3	456	yes
18	28	3.5	211	yes	18	16	8.4	424	yes
19	28	2.9	170	yes	19	17	6.4	218	yes
20	27	3.9	211	yes	20	18	6.8	255	no
21	28	4.1	162	yes	21	17	6.3	255	no
22	28	1.9	178	no	22	16	7.8	400	yes
23	29	1.7	176	yes	23	17	8.7	487	yes
24	23	4.2	164	yes	24	16	8.2	333	yes
25	27	3.3	187	yes	25	17	6.3	442	yes
26	23	2.5	189	yes	26	16	7.9	450	yes
27	26	1.9	226	yes	27	17	6.5	446	yes
28	23	3.8	176	yes	28	17	6.3	493	yes
29	29	3	186	yes	29	17	8.7	388	yes
30	28	4.3	189	yes	30	17	9	353	yes

RADAR TYPE 4					RARAR TYPE 6				
Trial #	Number of Pulses per Burst	Pulse Width (μsec)	PRI (μs)	Detection (yes/no)	Trial #	Number of Pulses per Hop	Pulse Width (μsec)	PRI (μs)	Detection (yes/no)
1	13	14	407	yes	1	9	1	333	yes
2	14	14.6	348	yes	2	9	1	333	yes
3	13	13.6	398	yes	3	9	1	333	yes
4	13	19.7	416	yes	4	9	1	333	yes
5	14	15.2	363	yes	5	9	1	333	yes
6	12	17.2	487	yes	6	9	1	333	yes
7	14	15.2	310	yes	7	9	1	333	yes
8	14	13.2	265	yes	8	9	1	333	yes
9	16	18.2	246	yes	9	9	1	333	yes
10	14	20	385	yes	10	9	1	333	yes
11	14	14.8	266	no	11	9	1	333	yes
12	15	13.5	235	yes	12	9	1	333	yes
13	14	15.5	484	yes	13	9	1	333	yes
14	12	17.3	439	yes	14	9	1	333	yes
15	14	17.5	434	yes	15	9	1	333	yes
16	14	17.1	469	yes	16	9	1	333	yes
17	15	11	452	yes	17	9	1	333	yes
18	15	15.5	340	yes	18	9	1	333	yes
19	13	16	355	yes	19	9	1	333	yes
20	14	11.9	457	yes	20	9	1	333	yes
21	14	16.5	292	yes	21	9	1	333	yes
22	13	13.8	401	yes	22	9	1	333	yes
23	15	14	324	yes	23	9	1	333	yes
24	15	18.2	312	yes	24	9	1	333	yes
25	15	13.5	394	no	25	9	1	333	yes
26	13	14.5	375	yes	26	9	1	333	yes
27	14	15.6	301	no	27	9	1	333	yes
28	14	16.6	423	yes	28	9	1	333	yes
29	14	14.8	267	yes	29	9	1	333	yes
30	12	18.8	279	yes	30	9	1	333	yes

Pulse Type 5

TYPE 5 20 MHz			TYPE 5 40 MHz		
Trial #	Detection (yes/no)	Radar Pulse Freq. [MHz]	Trial #	Detection (yes/no)	Radar Pulse Freq. [MHz]
1	yes	5500	1	yes	5510
2	yes	5500	2	no	5510
3	yes	5500	3	yes	5510
4	yes	5500	4	yes	5510
5	yes	5500	5	yes	5510
6	yes	5500	6	yes	5510
7	yes	5500	7	yes	5510
8	yes	5500	8	yes	5510
9	yes	5500	9	yes	5510
10	yes	5500	10	yes	5510
11	yes	5497.7	11	yes	5498.3
12	yes	5494.5	12	yes	5495.1
13	yes	5494.1	13	yes	5494.7
14	yes	5496.5	14	yes	5497.1
15	yes	5497.7	15	yes	5498.3
16	yes	5493.3	16	yes	5493.9
17	yes	5495.3	17	yes	5495.9
18	yes	5498.1	18	yes	5498.7
19	yes	5496.9	19	yes	5497.5
20	yes	5496.9	20	yes	5497.5
21	yes	5503.5	21	yes	5522.9
22	yes	5501.5	22	yes	5520.9
23	yes	5503.1	23	yes	5522.5
24	yes	5506.3	24	yes	5525.7
25	yes	5506.7	25	yes	5526.1
26	yes	5504.3	26	yes	5523.7
27	yes	5503.9	27	yes	5523.3
28	yes	5503.9	28	yes	5523.3
29	yes	5506.7	29	yes	5526.1
30	yes	5501.9	30	yes	5521.3

Trial Number : 1						
Bursts in Trial: 8						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	3	59.6	14	1871	1615	1294
2	1	95.5	14			971
3	2	85.3	14	1913		1294
4	1	72.3	14			67
5	3	53.2	14	1145	1560	1461
6	2	54.4	14	1237		471
7	1	63.9	14			869
8	2	75.7	14	1412		548
Trial Number : 2						
Bursts in Trial: 9						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	78.6	20	1262		350
2	1	82.4	20			280
3	1	84.9	20			388
4	1	64.8	20			302
5	1	86.8	20			628
6	2	83.2	20	1270		589
7	2	77.3	20	1907		731
8	2	77.4	20	1168		1240
9	1	71.5	20			240
Trial Number : 3						
Bursts in Trial: 10						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	3	98.1	17	1524	1176	855
2	2	66.4	17	1811		373
3	3	52.2	17	1377	1791	494
4	2	90	17	1368		707
5	3	85.2	17	1183	1462	1033
6	2	97.2	17	1122		883
7	1	66.9	17			269
8	3	96.5	17	1648	1685	1186
9	1	57.4	17			856
10	3	73.6	17	1868	1696	994

Trial Number : 4						
Bursts in Trial: 11						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	79.1	19	1092		484
2	2	81.9	19	1309		421
3	1	68.1	19			260
4	1	96.4	19			96
5	3	54.3	19	1237	1097	863
6	2	81.4	19	1849		607
7	2	61.8	19	1320		365
8	2	74	19	1199		320
9	2	81.6	19	1536		964
10	1	61.3	19			920
11	3	60.6	19	946	1935	163
Trial Number : 5						
Bursts in Trial: 12						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	50.2	18	1490		867
2	1	54.6	18			569
3	3	58.5	18	947	1076	823
4	1	60.9	18			294
5	2	57.4	18	1221		908
6	2	84	18	1499		224
7	1	74.8	18			40
8	1	62.3	18			251
9	2	92.3	18	1339		406
10	3	96.6	18	1505	907	143
11	2	56.3	18	1288		564
12	3	56.4	18	1666	1008	441
Trial Number : 6						
Bursts in Trial: 13						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	50.6	10	1129		159
2	1	77.4	10			713
3	3	83.6	10	1589	934	339
4	1	72.8	10			80
5	1	50.4	10			264
6	2	52.6	10	1480		503
7	1	50.7	10			416
8	2	91.6	10	1763		304
9	2	64.6	10	1033		237
10	2	73.8	10	1288		86
11	2	69.8	10	1547		186
12	2	79.7	10	1398		430
13	1	81.8	10			603

Trial Number : 7						
Bursts in Trial: 14						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	86.4	12	1356		408
2	1	57	12			57
3	2	72.8	12	968		46
4	1	85.8	12			431
5	3	92.3	12	1235	1276	39
6	2	61.1	12	1014		746
7	2	56	12	1503		637
8	2	74.1	12	1420		270
9	1	68.7	12			650
10	1	66.6	12			660
11	1	66.4	12			413
12	1	50.4	12			294
13	1	50.4	12			496
14	3	63.8	12	978	1932	721
Trial Number : 8						
Bursts in Trial: 15						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	1	63.8	15			594
2	2	79.7	15	1554		778
3	2	62.7	15	1550		637
4	2	97.1	15	1242		101
5	2	98	15	1030		198
6	2	84.9	15	1804		27
7	2	88.7	15	1382		785
8	2	55.5	15	980		769
9	1	71.3	15			496
10	1	54.8	15			601
11	1	98.5	15			510
12	2	76.9	15	1513		399
13	2	85.8	15	1878		554
14	1	55.4	15			724
15	1	77.2	15			686
Trial Number : 9						
Bursts in Trial: 16						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	3	85.8	17	1061	1648	732
2	2	72.3	17	1557		665
3	2	69.2	17	1394		375
4	2	53.8	17	1568		330
5	3	91.9	17	1248	1747	621
6	2	68.5	17	1404		213
7	1	67.6	17			59
8	3	50.7	17	1636	1054	714
9	1	65.4	17			482
10	1	50.3	17			701
11	3	73.8	17	1876	1355	564
12	3	88.5	17	1085	1361	711
13	2	88.3	17	1801		327
14	3	65.9	17	969	1805	387
15	1	73.6	17			220
16	2	51.7	17	1185		403

Trial Number : 10						
Bursts in Trial: 17						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	55.5	20	1407		191
2	1	58.7	20			490
3	2	88.3	20	978		655
4	3	81.4	20	1611	1366	71
5	2	56.6	20	1482		379
6	1	73.9	20			208
7	2	87.4	20	1803		110
8	2	71.1	20	1659		176
9	2	63.8	20	1634		51
10	2	89	20	1420		527
11	2	96.8	20	1687		381
12	3	51.5	20	1913	981	598
13	2	52.3	20	1682		25
14	2	83.1	20	1262		432
15	1	71.3	20			169
16	2	70.8	20	1154		310
17	3	81.8	20	1233	1230	622
Trial Number : 11						
Bursts in Trial: 18						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	1	58.7	18			497
2	2	91	18	1490		103
3	3	73.9	18	1404	976	383
4	2	96.4	18	1555		439
5	2	90.7	18	1849		493
6	3	58.9	18	1135	1342	641
7	2	61.7	18	984		33
8	2	88	18	1683		113
9	3	80.2	18	1079	1761	187
10	2	54.4	18	1498		328
11	2	98.6	18	1453		118
12	2	84	18	1320		506
13	2	97.2	18	1319		134
14	1	87.2	18			230
15	3	83.3	18	1255	925	448
16	2	61.7	18	1804		324
17	2	92.8	18	977		468
18	1	84.1	18			528

Trial Number : 12						
Bursts in Trial: 19						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	66.5	10	1005		612
2	2	77.1	10	1387		24
3	1	71.4	10			596
4	2	76.1	10	1775		60
5	3	52.8	10	1707	1300	45
6	3	88.6	10	1025	1531	77
7	2	69.7	10	1273		457
8	2	93.4	10	1105		378
9	2	57.4	10	1626		153
10	2	80.3	10	970		282
11	2	87.9	10	1769		48
12	1	55.6	10			484
13	2	93.8	10	1224		88
14	2	65.3	10	1677		616
15	3	52	10	1834	1548	106
16	2	77.2	10	1573		256
17	2	80.3	10	1480		90
18	2	86.3	10	1877		54
19	2	62.8	10	1277		90
Trial Number : 13						
Bursts in Trial: 20						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	1	85.8	9			495
2	2	84.3	9	1766		169
3	2	71.9	9	1878		36
4	2	98	9	1532		147
5	2	72.7	9	991		225
6	2	99.5	9	1640		115
7	2	91.7	9	1348		122
8	3	73.6	9	1474	998	413
9	1	84.9	9			152
10	1	79.9	9			166
11	1	84.3	9			43
12	1	95.4	9			501
13	1	69.4	9			480
14	3	81.1	9	1792	1810	446
15	1	78.3	9			554
16	1	86.3	9			124
17	2	81.4	9	1612		300
18	1	99.5	9			428
19	2	100	9	1756		423
20	3	68.1	9	936	1204	189

Trial Number : 14						
Bursts in Trial: 8						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	1	50.4	15			1265
2	2	89.2	15	1354		512
3	2	79.6	15	1222		1328
4	1	80.3	15			1402
5	3	93.8	15	1410	1065	1315
6	3	62.3	15	1592	1091	479
7	2	87.9	15	1775		602
8	2	76.3	15	1735		1124
Trial Number : 15						
Bursts in Trial: 9						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	3	62.9	18	1777	1448	81
2	2	65.1	18	1167		221
3	2	95.7	18	1644		150
4	3	55.2	18	967	1635	1104
5	1	59.6	18			503
6	1	91	18			49
7	2	58.7	18	1197		1228
8	2	79.6	18	1197		125
9	3	55	18	1111	1194	387
Trial Number : 16						
Bursts in Trial: 10						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	3	91.8	7	1510	1120	178
2	2	68.2	7	1897		1014
3	2	91.9	7	1437		1023
4	1	53.5	7			209
5	3	56.4	7	1643	1411	984
6	2	73	7	1648		583
7	3	66.3	7	1294	1513	663
8	1	53.7	7			1170
9	2	71.2	7	1183		977
10	2	81.9	7	948		259

Trial Number : 17						
Bursts in Trial: 11						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	97	12	1484		331
2	2	61.9	12	1878		423
3	1	57.9	12			464
4	2	98.8	12	1730		784
5	2	85	12	1137		770
6	1	90	12			995
7	1	86.3	12			758
8	2	56.4	12	1333		214
9	1	52	12			217
10	2	58.8	12	1661		127
11	3	76.4	12	1419	1621	294
Trial Number : 18						
Bursts in Trial: 12						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	3	56.5	19	1663	1799	190
2	2	58.8	19	1460		211
3	3	93	19	1452	937	471
4	2	95.8	19	1735		609
5	1	58.2	19			277
6	1	85.5	19			751
7	2	50.2	19	1757		6
8	3	70.5	19	1333	1446	862
9	1	94.7	19			247
10	1	75.9	19			804
11	3	83.5	19	1419	1821	990
12	2	62.1	19	1647		304
Trial Number : 19						
Bursts in Trial: 13						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	3	67.2	16	1497	1639	901
2	3	88.5	16	1864	1330	406
3	3	75.3	16	1293	1022	863
4	2	98.5	16	1504		879
5	2	62.5	16	1613		685
6	2	81.2	16	1072		783
7	3	85.1	16	1027	1773	559
8	2	95.6	16	1008		588
9	3	55.2	16	1022	1203	41
10	2	65.4	16	1311		278
11	3	88.2	16	1789	1163	86
12	2	82.4	16	1872		66
13	1	53.1	16			704

Trial Number : 20						
Bursts in Trial: 14						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	1	64.1	16			735
2	3	86	16	1389	1618	177
3	2	80.1	16	1480		412
4	3	84.2	16	1153	1353	705
5	2	96.5	16	991		768
6	2	78.5	16	1273		232
7	1	75.8	16			240
8	2	72.7	16	1366		628
9	2	99.3	16	1870		727
10	2	57.2	16	1237		814
11	3	62.7	16	1147	1836	44
12	3	68.9	16	1825	1164	214
13	3	65.9	16	1791	1484	798
14	3	58.7	16	1351	1084	532
Trial Number : 21						
Bursts in Trial: 15						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	56	15	1304		660
2	2	52.2	15	977		557
3	3	88.7	15	1261	1716	330
4	2	80.5	15	1676		372
5	3	68.2	15	1248	1364	516
6	2	73.1	15	1565		455
7	1	82.4	15			424
8	2	53.1	15	1165		272
9	3	50.4	15	1022	1671	65
10	3	64.1	15	1756	1843	134
11	3	81.6	15	1778	1865	305
12	2	66.6	15	1309		188
13	3	66.6	15	1181	982	566
14	2	91.1	15	1604		705
15	2	74.2	15	1308		230
Trial Number : 22						
Bursts in Trial: 16						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	53	20	1204		624
2	2	55.3	20	1345		254
3	2	90.2	20	1491		102
4	1	85.8	20			153
5	1	69.8	20			737
6	3	54.5	20	1363	1029	80
7	3	89.4	20	1372	1188	427
8	2	87.9	20	1251		496
9	2	71.9	20	1324		214
10	1	69	20			137
11	2	57.7	20	1262		539
12	2	82.6	20	1860		378
13	2	51.7	20	1132		714
14	3	99.6	20	1600	1805	298
15	2	57.4	20	1308		28
16	2	59.8	20	1437		448

Trial Number : 23						
Bursts in Trial: 17						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	79	16	1296		240
2	1	59.4	16			447
3	2	53.7	16	1140		451
4	3	86.1	16	1759	1382	556
5	2	96.1	16	1605		93
6	2	61	16	1082		59
7	2	86.1	16	984		163
8	2	83.1	16	1655		645
9	3	82.9	16	1508	918	315
10	3	74.6	16	1554	1022	336
11	2	88.7	16	1290		623
12	2	66.1	16	1438		232
13	2	68.6	16	955		544
14	2	79.7	16	1908		271
15	2	76.3	16	969		553
16	3	77.4	16	1791	1708	69
17	2	60.8	16	1435		266
Trial Number : 24						
Bursts in Trial: 18						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	1	57	8			294
2	1	67.5	8			409
3	2	55.8	8	1160		201
4	3	69.7	8	1282	934	410
5	3	77.5	8	1743	1060	349
6	2	94.2	8	1120		88
7	3	91.2	8	1512	1646	576
8	2	60.1	8	980		174
9	2	62.3	8	1881		448
10	1	72.8	8			64
11	3	60.2	8	1180	1750	443
12	2	91.2	8	1306		158
13	2	64.6	8	1506		580
14	1	67.7	8			73
15	2	81.2	8	1782		282
16	2	86.9	8	1497		532
17	2	60.3	8	1288		256
18	1	51.8	8			500

Trial Number : 25						
Bursts in Trial: 19						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	1	92	7			316
2	2	77.1	7	1863		536
3	1	55.1	7			406
4	2	80.1	7	1413		338
5	3	81.4	7	1068	1061	99
6	3	51.7	7	1928	948	100
7	2	81.9	7	1749		447
8	1	87.2	7			461
9	3	89	7	1049	1347	261
10	1	98.8	7			368
11	2	84.5	7	1479		19
12	1	82.4	7			477
13	3	89	7	1137	1509	402
14	2	88.7	7	1058		573
15	2	97.5	7	1819		227
16	2	72.2	7	1282		509
17	2	65.9	7	1720		115
18	2	81	7	946		409
19	3	60.4	7	1239	1311	541
Trial Number : 26						
Bursts in Trial: 20						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	60	13	1621		9
2	2	80.3	13	1015		102
3	3	51.7	13	1683	1669	292
4	2	83.2	13	1400		539
5	2	55.8	13	1010		552
6	3	84.9	13	1481	1341	170
7	2	95.3	13	1659		124
8	2	63.8	13	1019		304
9	3	70.4	13	1043	929	349
10	1	64.2	13			190
11	2	76.8	13	1557		522
12	1	87.9	13			189
13	3	83.5	13	1142	1344	400
14	2	69.4	13	1682		210
15	2	79.5	13	1353		542
16	1	69.2	13			547
17	2	94.1	13	1710		60
18	2	52.4	13	1435		77
19	1	75.5	13			19
20	1	93.8	13			301

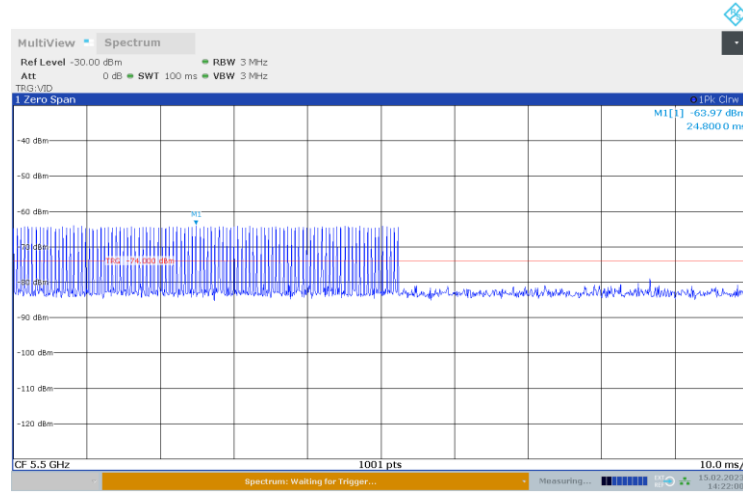
Trial Number : 27						
Bursts in Trial: 12						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	85.3	14	1168		964
2	2	57.7	14	1852		611
3	3	78.6	14	1041	1523	705
4	2	87.8	14	1659		943
5	3	73	14	1898	1157	187
6	3	95	14	1030	1043	133
7	3	89.6	14	1464	1472	86
8	2	62.6	14	1356		756
9	2	51.5	14	1933		804
10	2	97.4	14	1659		397
11	2	88.3	14	1196		61
12	3	51.3	14	1038	1183	974
Trial Number : 28						
Bursts in Trial: 13						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	1	57	14			567
2	3	66.1	14	1142	1531	60
3	2	99.2	14	1733		383
4	2	71.8	14	1332		871
5	1	87.5	14			867
6	1	91.7	14			179
7	2	62.1	14	1199		52
8	3	62.4	14	1236	961	346
9	2	58.8	14	964		65
10	1	64.2	14			583
11	3	77.1	14	1676	1550	15
12	2	57.9	14	1657		252
13	2	65.3	14	1139		31
Trial Number : 29						
Bursts in Trial: 14						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	79.2	7	1617		161
2	3	84.4	7	1335	1097	268
3	3	58.2	7	1178	1402	90
4	3	90.6	7	1685	1224	95
5	1	99	7			811
6	2	74.2	7	1161		418
7	3	80.7	7	1376	931	211
8	2	84.8	7	1754		309
9	2	86	7	1178		259
10	2	75.1	7	998		432
11	1	86.6	7			758
12	3	99.1	7	1235	1333	255
13	2	79.7	7	1314		468
14	2	90.7	7	1536		333

Trial Number : 30						
Bursts in Trial: 15						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 Spacing (µsec)	Pulse 2-to-3 Spacing (µsec)	Start Location Within Interval (msec)
1	2	72.3	19	1354		711
2	2	60.9	19	1460		465
3	3	81.2	19	1054	1916	229
4	1	52.1	19			396
5	1	87.8	19			480
6	3	58.7	19	1356	1344	479
7	1	78.3	19			360
8	3	90.4	19	1035	1213	118
9	3	50.1	19	1664	1065	341
10	1	93.1	19			713
11	2	76.4	19	1533		500
12	2	72.7	19	1210		340
13	3	78	19	1236	990	561
14	2	63.3	19	1177		166
15	2	86	19	1422		551

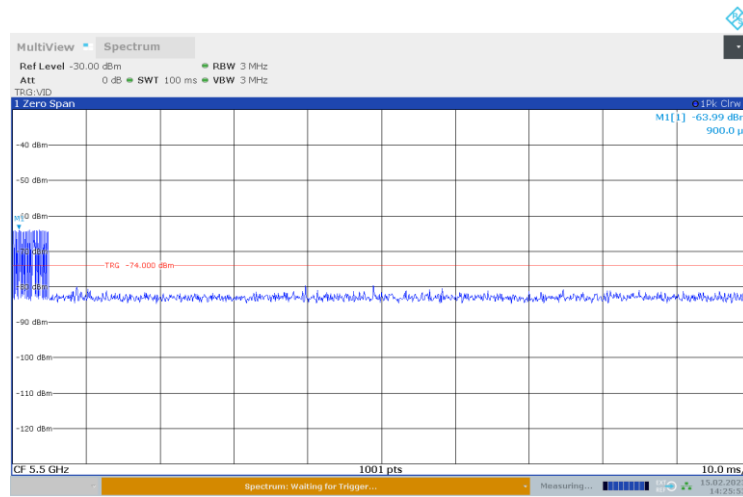
Pulse Type 6

Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

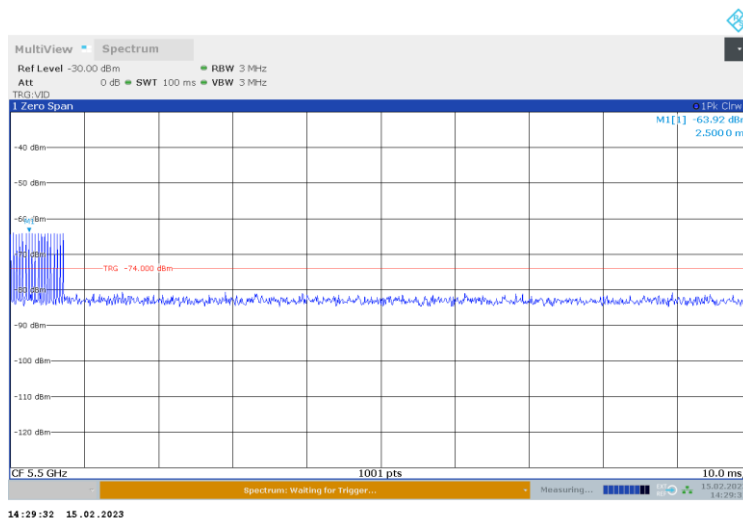
Radar Pulse Calibrations



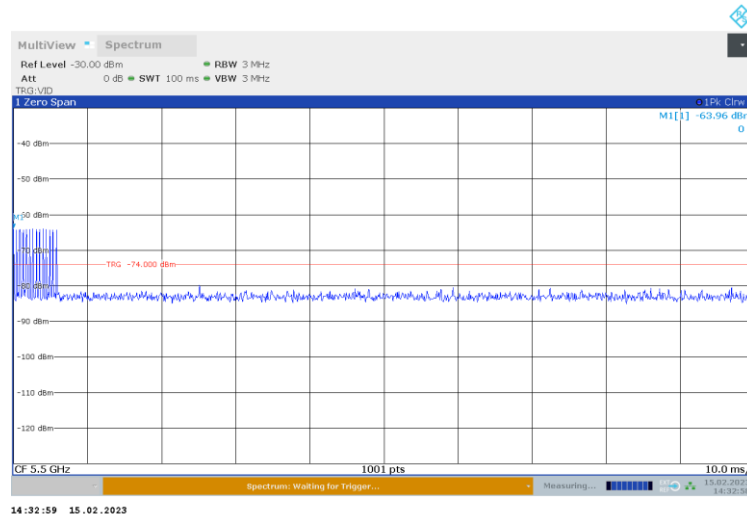
Pulse Type 1



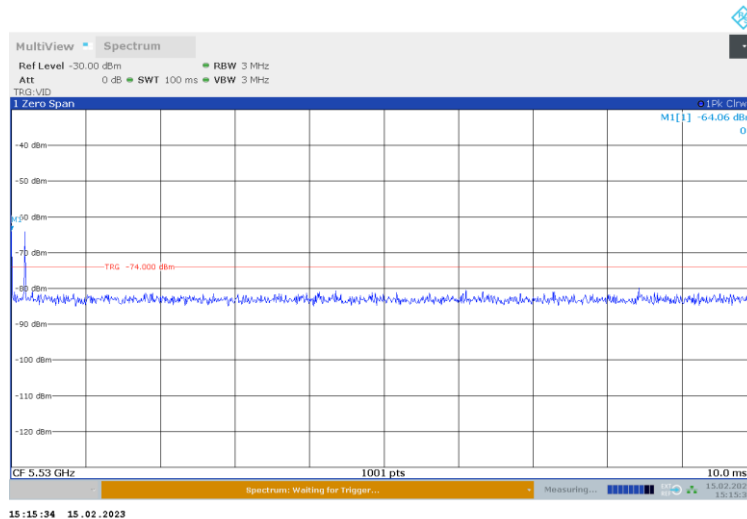
Pulse Type 2



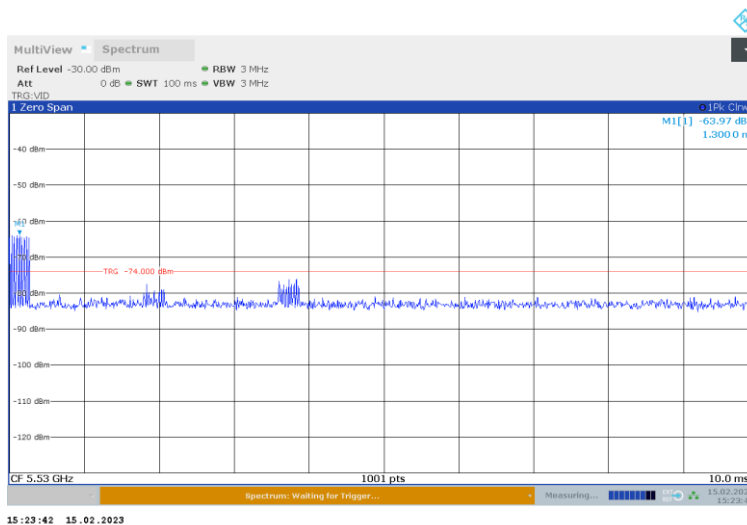
Pulse Type 3



Pulse Type 4



Pulse Type 5



Pulse Type 6

5.4.5 TEST EQUIPMENT USED

- R&S TS8997

6 TEST EQUIPMENT

6.1 TEST EQUIPMENT HARDWARE

- 1 R&S TS8997
2.4 and 5 GHz Bands Conducted Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2021-10	2023-10
1.2	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2021-06	2024-06
1.3	EX520	Digital Multimeter 12	Extech Instruments Corp	05157876	2022-06	2024-06
1.4	NGSM 32/10	Power Supply	Rohde & Schwarz GmbH & Co. KG	3456	2022-01	2024-01
1.5	Temperature Chamber KWP 120/70	Temperature Chamber Weiss 01	Weiss	59226012190010	2022-05	2024-05
1.6	Temperature Chamber VT 4002	Temperature Chamber Vötsch 03	Vötsch	58566002150010	2022-05	2024-05
1.7	FSW43	Signal Analyser	Rohde & Schwarz GmbH & Co. KG	102013	2021-06	2023-06
1.8	Opus10 THI (8152.00)	T/H Logger 14	Lufft Mess- und Regeltechnik GmbH	13993	2021-08	2023-08
1.9	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2023-01	2026-01
1.10	OSP120	Contains Power Meter and Switching Unit OSP-B157W8 PLUS	Rohde & Schwarz	101158	2021-08	2024-08
1.11	CS-RUB6	Rubidium Frequency Standard	Rohde & Schwarz GmbH & Co. KG	100321	2022-10	2023-10

The calibration interval is the time interval between "Last Calibration" and "Calibration Due"

7 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

7.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

Frequency MHz	Corr. dB	LISN insertion loss ESH3- Z5 dB	cable loss (incl. 10 dB atten- uator) dB
0.15	10.1	0.1	10.0
5	10.3	0.1	10.2
7	10.5	0.2	10.3
10	10.5	0.2	10.3
12	10.7	0.3	10.4
14	10.7	0.3	10.4
16	10.8	0.4	10.4
18	10.9	0.4	10.5
20	10.9	0.4	10.5
22	11.1	0.5	10.6
24	11.1	0.5	10.6
26	11.2	0.5	10.7
28	11.2	0.5	10.7
30	11.3	0.5	10.8

Sample calculation

$$U_{\text{LISN}} \text{ (dB } \mu\text{V)} = U \text{ (dB } \mu\text{V)} + \text{Corr. (dB)}$$

U = Receiver reading

LISN Insertion loss = Voltage Division Factor of LISN

Corr. = sum of single correction factors of used LISN, cables, switch units (if used)

Linear interpolation will be used for frequencies in between the values in the table.

7.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

Frequency MHz	AF HFH-Z2) dB (1/m)	Corr. dB	cable loss 1 (inside chamber) dB	cable loss 2 (outside chamber) dB	cable loss 3 (switch unit) dB	cable loss 4 (to receiver) dB	distance corr. (-40 dB/ decade) dB	d _{Limit} (meas. distance (limit) m	d _{used} (meas. distance (used) m
0.009	20.50	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.01	20.45	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.015	20.37	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.02	20.36	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.025	20.38	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.03	20.32	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.05	20.35	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.08	20.30	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.1	20.20	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.2	20.17	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.3	20.14	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.49	20.12	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.490001	20.12	-39.6	0.1	0.1	0.1	0.1	-40	30	3
0.5	20.11	-39.6	0.1	0.1	0.1	0.1	-40	30	3
0.8	20.10	-39.6	0.1	0.1	0.1	0.1	-40	30	3
1	20.09	-39.6	0.1	0.1	0.1	0.1	-40	30	3
2	20.08	-39.6	0.1	0.1	0.1	0.1	-40	30	3
3	20.06	-39.6	0.1	0.1	0.1	0.1	-40	30	3
4	20.05	-39.5	0.2	0.1	0.1	0.1	-40	30	3
5	20.05	-39.5	0.2	0.1	0.1	0.1	-40	30	3
6	20.02	-39.5	0.2	0.1	0.1	0.1	-40	30	3
8	19.95	-39.5	0.2	0.1	0.1	0.1	-40	30	3
10	19.83	-39.4	0.2	0.1	0.2	0.1	-40	30	3
12	19.71	-39.4	0.2	0.1	0.2	0.1	-40	30	3
14	19.54	-39.4	0.2	0.1	0.2	0.1	-40	30	3
16	19.53	-39.3	0.3	0.1	0.2	0.1	-40	30	3
18	19.50	-39.3	0.3	0.1	0.2	0.1	-40	30	3
20	19.57	-39.3	0.3	0.1	0.2	0.1	-40	30	3
22	19.61	-39.3	0.3	0.1	0.2	0.1	-40	30	3
24	19.61	-39.3	0.3	0.1	0.2	0.1	-40	30	3
26	19.54	-39.3	0.3	0.1	0.2	0.1	-40	30	3
28	19.46	-39.2	0.3	0.1	0.3	0.1	-40	30	3
30	19.73	-39.1	0.4	0.1	0.3	0.1	-40	30	3

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

distance correction = $-40 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values

7.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

($d_{Limit} = 3\text{ m}$)

Frequency	AF R&S HL562	Corr.
MHz	dB (1/m)	dB
30	18.6	0.6
50	6.0	0.9
100	9.7	1.2
150	7.9	1.6
200	7.6	1.9
250	9.5	2.1
300	11.0	2.3
350	12.4	2.6
400	13.6	2.9
450	14.7	3.1
500	15.6	3.2
550	16.3	3.5
600	17.2	3.5
650	18.1	3.6
700	18.5	3.6
750	19.1	4.1
800	19.6	4.1
850	20.1	4.4
900	20.8	4.7
950	21.1	4.8
1000	21.6	4.9

cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/decade)	d_{Limit} (meas. distance (limit))	d_{used} (meas. distance (used))
dB	dB	dB	dB	dB	m	m
0.29	0.04	0.23	0.02	0.0	3	3
0.39	0.09	0.32	0.08	0.0	3	3
0.56	0.14	0.47	0.08	0.0	3	3
0.73	0.20	0.59	0.12	0.0	3	3
0.84	0.21	0.70	0.11	0.0	3	3
0.98	0.24	0.80	0.13	0.0	3	3
1.04	0.26	0.89	0.15	0.0	3	3
1.18	0.31	0.96	0.13	0.0	3	3
1.28	0.35	1.03	0.19	0.0	3	3
1.39	0.38	1.11	0.22	0.0	3	3
1.44	0.39	1.20	0.19	0.0	3	3
1.55	0.46	1.24	0.23	0.0	3	3
1.59	0.43	1.29	0.23	0.0	3	3
1.67	0.34	1.35	0.22	0.0	3	3
1.67	0.42	1.41	0.15	0.0	3	3
1.87	0.54	1.46	0.25	0.0	3	3
1.90	0.46	1.51	0.25	0.0	3	3
1.99	0.60	1.56	0.27	0.0	3	3
2.14	0.60	1.63	0.29	0.0	3	3
2.22	0.60	1.66	0.33	0.0	3	3
2.23	0.61	1.71	0.30	0.0	3	3

($d_{Limit} = 10\text{ m}$)

30	18.6	-9.9
50	6.0	-9.6
100	9.7	-9.2
150	7.9	-8.8
200	7.6	-8.6
250	9.5	-8.3
300	11.0	-8.1
350	12.4	-7.9
400	13.6	-7.6
450	14.7	-7.4
500	15.6	-7.2
550	16.3	-7.0
600	17.2	-6.9
650	18.1	-6.9
700	18.5	-6.8
750	19.1	-6.3
800	19.6	-6.3
850	20.1	-6.0
900	20.8	-5.8
950	21.1	-5.6
1000	21.6	-5.6

0.29	0.04	0.23	0.02	-10.5	10	3
0.39	0.09	0.32	0.08	-10.5	10	3
0.56	0.14	0.47	0.08	-10.5	10	3
0.73	0.20	0.59	0.12	-10.5	10	3
0.84	0.21	0.70	0.11	-10.5	10	3
0.98	0.24	0.80	0.13	-10.5	10	3
1.04	0.26	0.89	0.15	-10.5	10	3
1.18	0.31	0.96	0.13	-10.5	10	3
1.28	0.35	1.03	0.19	-10.5	10	3
1.39	0.38	1.11	0.22	-10.5	10	3
1.44	0.39	1.20	0.19	-10.5	10	3
1.55	0.46	1.24	0.23	-10.5	10	3
1.59	0.43	1.29	0.23	-10.5	10	3
1.67	0.34	1.35	0.22	-10.5	10	3
1.67	0.42	1.41	0.15	-10.5	10	3
1.87	0.54	1.46	0.25	-10.5	10	3
1.90	0.46	1.51	0.25	-10.5	10	3
1.99	0.60	1.56	0.27	-10.5	10	3
2.14	0.60	1.63	0.29	-10.5	10	3
2.22	0.60	1.66	0.33	-10.5	10	3
2.23	0.61	1.71	0.30	-10.5	10	3

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

distance correction = $-20 * \text{LOG} (d_{Limit} / d_{used})$

Linear interpolation will be used for frequencies in between the values in the table.

Tables show an extract of values.

7.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

Frequency	AF R&S HF907	Corr.
MHz	dB (1/m)	dB
1000	24.4	-19.4
2000	28.5	-17.4
3000	31.0	-16.1
4000	33.1	-14.7
5000	34.4	-13.7
6000	34.7	-12.7
7000	35.6	-11.0

cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, attenuator & pre-amp)	cable loss 4 (to receiver)
dB	dB	dB	dB
0.99	0.31	-21.51	0.79
1.44	0.44	-20.63	1.38
1.87	0.53	-19.85	1.33
2.41	0.67	-19.13	1.31
2.78	0.86	-18.71	1.40
2.74	0.90	-17.83	1.47
2.82	0.86	-16.19	1.46

Frequency	AF R&S HF907	Corr.
MHz	dB (1/m)	dB
3000	31.0	-23.4
4000	33.1	-23.3
5000	34.4	-21.7
6000	34.7	-21.2
7000	35.6	-19.8

cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, attenuator & pre-amp)	cable loss 5 (to receiver)	used for FCC
dB	dB	dB	dB	dB	15.247
0.47	1.87	0.53	-27.58	1.33	
0.56	2.41	0.67	-28.23	1.31	
0.61	2.78	0.86	-27.35	1.40	
0.58	2.74	0.90	-26.89	1.47	
0.66	2.82	0.86	-25.58	1.46	

Frequency	AF R&S HF907	Corr.
MHz	dB (1/m)	dB
7000	35.6	-57.3
8000	36.3	-56.3
9000	37.1	-55.3
10000	37.5	-56.2
11000	37.5	-55.3
12000	37.6	-53.7
13000	38.2	-53.5
14000	39.9	-56.3
15000	40.9	-54.1
16000	41.3	-54.1
17000	42.8	-54.4
18000	44.2	-54.7

cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
dB	dB	dB	dB	dB	dB
0.56	1.28	-62.72	2.66	0.94	1.46
0.69	0.71	-61.49	2.84	1.00	1.53
0.68	0.65	-60.80	3.06	1.09	1.60
0.70	0.54	-61.91	3.28	1.20	1.67
0.80	0.61	-61.40	3.43	1.27	1.70
0.84	0.42	-59.70	3.53	1.26	1.73
0.83	0.44	-59.81	3.75	1.32	1.83
0.91	0.53	-63.03	3.91	1.40	1.77
0.98	0.54	-61.05	4.02	1.44	1.83
1.23	0.49	-61.51	4.17	1.51	1.85
1.36	0.76	-62.36	4.34	1.53	2.00
1.70	0.53	-62.88	4.41	1.55	1.91

Sample calculation

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$
 U = Receiver reading
 AF = Antenna factor
 Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
 Linear interpolation will be used for frequencies in between the values in the table.
 Tables show an extract of values.

7.5 ANTENNA EMCO 3160-09 (18 GHZ – 26.5 GHZ)

Frequency MHz	AF EMCO 3160-09 dB (1/m)	Corr. dB
18000	40.2	-23.5
18500	40.2	-23.2
19000	40.2	-22.0
19500	40.3	-21.3
20000	40.3	-20.3
20500	40.3	-19.9
21000	40.3	-19.1
21500	40.3	-19.1
22000	40.3	-18.7
22500	40.4	-19.0
23000	40.4	-19.5
23500	40.4	-19.3
24000	40.4	-19.8
24500	40.4	-19.5
25000	40.4	-19.3
25500	40.5	-20.4
26000	40.5	-21.3
26500	40.5	-21.1

cable loss 1 (inside chamber) dB	cable loss 2 (pre- amp) dB	cable loss 3 (inside chamber) dB	cable loss 4 (switch unit) dB	cable loss 5 (to receiver) dB
0.72	-35.85	6.20	2.81	2.65
0.69	-35.71	6.46	2.76	2.59
0.76	-35.44	6.69	3.15	2.79
0.74	-35.07	7.04	3.11	2.91
0.72	-34.49	7.30	3.07	3.05
0.78	-34.46	7.48	3.12	3.15
0.87	-34.07	7.61	3.20	3.33
0.90	-33.96	7.47	3.28	3.19
0.89	-33.57	7.34	3.35	3.28
0.87	-33.66	7.06	3.75	2.94
0.88	-33.75	6.92	3.77	2.70
0.90	-33.35	6.99	3.52	2.66
0.88	-33.99	6.88	3.88	2.58
0.91	-33.89	7.01	3.93	2.51
0.88	-33.00	6.72	3.96	2.14
0.89	-34.07	6.90	3.66	2.22
0.86	-35.11	7.02	3.69	2.28
0.90	-35.20	7.15	3.91	2.36

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

7.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

Frequency GHz	AF EMCO 3160-10 dB (1/m)	Corr. dB	cable loss 1 (inside chamber) dB	cable loss 2 (outside chamber) dB	cable loss 3 (switch unit) dB	cable loss 4 (to receiver) dB	distance corr. (-20 dB/ decade) dB	d _{Limit} (meas. distance (limit) m	d _{used} (meas. distance (used) m
26.5	43.4	-11.2	4.4				-9.5	3	1.0
27.0	43.4	-11.2	4.4				-9.5	3	1.0
28.0	43.4	-11.1	4.5				-9.5	3	1.0
29.0	43.5	-11.0	4.6				-9.5	3	1.0
30.0	43.5	-10.9	4.7				-9.5	3	1.0
31.0	43.5	-10.8	4.7				-9.5	3	1.0
32.0	43.5	-10.7	4.8				-9.5	3	1.0
33.0	43.6	-10.7	4.9				-9.5	3	1.0
34.0	43.6	-10.6	5.0				-9.5	3	1.0
35.0	43.6	-10.5	5.1				-9.5	3	1.0
36.0	43.6	-10.4	5.1				-9.5	3	1.0
37.0	43.7	-10.3	5.2				-9.5	3	1.0
38.0	43.7	-10.2	5.3				-9.5	3	1.0
39.0	43.7	-10.2	5.4				-9.5	3	1.0
40.0	43.8	-10.1	5.5				-9.5	3	1.0

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

Linear interpolation will be used for frequencies in between the values in the table.

$$\text{distance correction} = -20 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$$

Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

8 MEASUREMENT UNCERTAINTIES

Test Case	Parameter	Uncertainty
AC Power Line	Power	± 3.4 dB
Field Strength of spurious radiation	Power	± 5.5 dB
6 dB / 26 dB / 99% Bandwidth	Power Frequency	± 2.9 dB ± 11.2 kHz
Conducted Output Power	Power	± 2.2 dB
Band Edge Compliance	Power Frequency	± 2.2 dB ± 11.2 kHz
Frequency Stability	Frequency	± 25 Hz
Power Spectral Density	Power	± 2.2 dB

9 PHOTO REPORT

Please see separate photo report.