Test report

393152-1R1TRFWL

Date of issue: August 26, 2020

Applicant:
Texas Instruments Incorporated

Product:
Intelligent mmWave sensor antenna-on-package (AoP) Evaluation Board

Model:
IWR6843AOPEVM

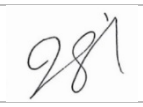
Specifications:

- Draft ETSI EN 305 550 V2.1.0 (2017-10)

Short Range Devices (SRD); Radio equipment to be used in the 40 GHz to 246 GHz frequency range; Harmonised Standard for access to radio spectrum.

Lab and test locations

Company name	Nemko USA Inc.
Address	2210 Faraday Ave, Suite 150
City	Carlsbad
State	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
FCC Site Number	Test Firm Registration Number: 392943 Designation Number: US5058
ISED Test Site	2040B-3

Tested by	Martha Espinoza, Wireless Engineer
Tester signature	
Reviewed by	James Cunningham, Wireless Supervisor
Review date	August 26, 2020
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko USA's ISO/IEC 17025 accreditation.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

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1.2 Test methods

ETSI EN 303 396 V1.1.1 (2016-12)	Short Ranges Devices; Measurement Techniques for Automotive and Surveillance Radar Equipment.

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Test report revision history

Table 1.5-1: Test report revision history

Revision #	Details of changes made to test report
393152-1TRFWL	Original report issued
393152-1R1TRFWL	Correct typo in table 7.3 2: Mean power (EIRP) test results from 300MHZ to 500MHz

Notes:

Section 2 Summary of test results

2.1 Transmitter Conformance Requirements

Table 2.1-1: Transmitter conformance test results

Test description	Verdict
Permitted range of operating frequencies	Pass
Operating frequency range(s) (OFR)	Pass
Mean Power	Pass
Mean Power Spectral Density	Pass
Unwanted emissions in the out-of-band domain	Pass
Unwanted emissions in the spurious domain	Pass

Notes: None

2.2 Receiver Conformance Requirements

Table 2.2-1: Receiver conformance test results

Test description	Verdict
Receiver spurious emissions	Not applicable[1]
Receiver interference signal handling	Pass

Notes: 1. EUT does not operate in receive-only mode

Section 3 Equipment under test (EUT) details

3.1 Applicant

Company name	Texas Instruments Incorporated
Address	12500 TI Boulevard MS K1-20
City	Dallas
Province/State	TX
Postal/Zip code	75243
Country	USA

3.2 Manufacturer

Company name	Texas Instruments Incorporated
Address	12500 TI Boulevard MS K1-20
City	Dallas
Province/State	TX
Postal/Zip code	75243
Country	USA

3.3 Sample information

Receipt date	February 13, 2020
Nemko sample ID number	393152

3.4 EUT information

Product name	Intelligent mmWave sensor antenna-on-package (AoP) Evaluation Board
Model	IWR6843AOPEVM
Model variant	N/A
Serial number	5119910017
Power requirements	5 VDC
Description/theory of operation	The IWR6843 antenna-on-package (AoP) evaluation module (EVM) is an easy-to-use mmWave sensor EVM with integrated, short-range, wide field-of-view (FoV) AoP technology, which enables direct connectivity to the mmWave sensors carrier card platform (MMWAVEICBOOST) and allows for stand-alone use. IWR6843AOPEVM enables access to point-cloud data through a USB interface and raw analog-to-digital converter (ADC) data through a 60-pin high-speed connector. This kit is supported by standard mmWave tools and software, including mmWave studio (MMWAVE-STUDIO) and the mmWave software development kit (MMWAVE-SDK). IWR6843AOPEVM with MMWAVEICBOOST can interface with the TI MCU LaunchPad™ ecosystem.
Operational frequencies	Channel 1: 61-61.5 GHz (500 MHz BW) Channel 2: 57-64 GHz (1.3 GHz BW) Channel 3: 57-64 GHz (4 GHz BW)
Software details	N/A

3.5 EUT setup details

For this test, each channel was established through software provided by client (mmWave) using two USB cables connected between the EUT and a laptop. The signal was monitored with a spectrum analyzer using the adequate settings for each channel. Once the chosen channel is activated, the unit runs in a continuous mode.

Table 3.5-1: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop	Dell	Latitude	N/A	N/A
AC Adapter	Cui Inc.	SWI18-5-N	N/A	N/A

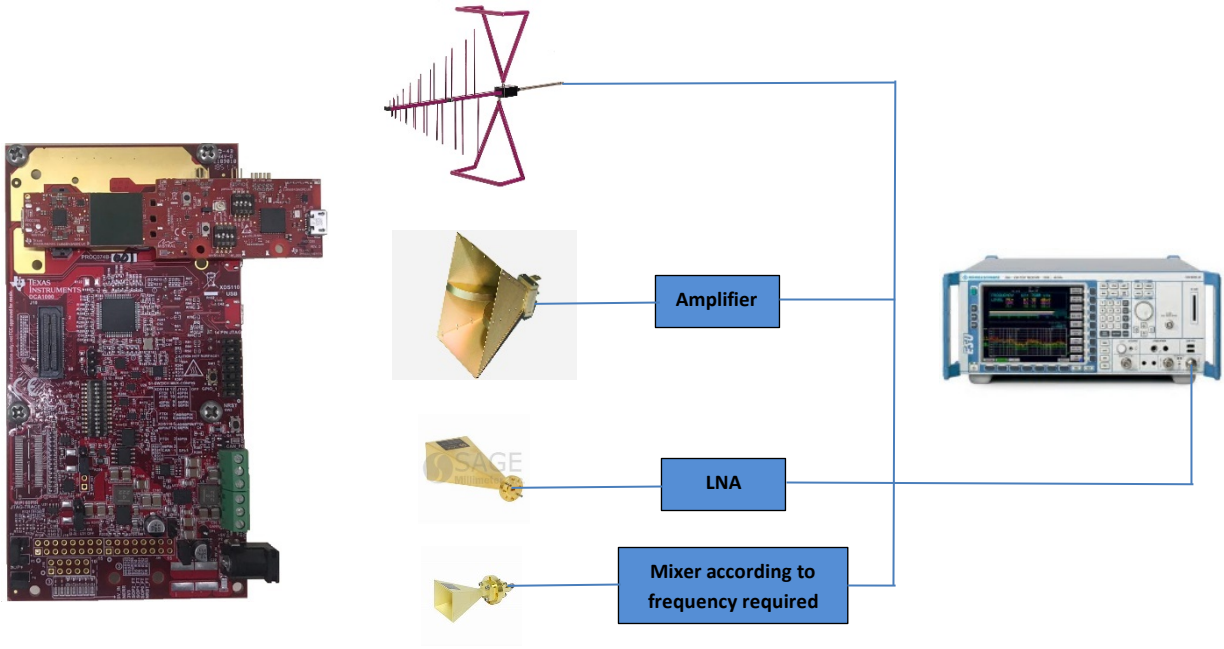


Figure 3.5-1: EUT Test Setup

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

None

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	21.4 °C
Relative humidity	55.7 %
Air pressure	86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Table 6.1-1: Measurement uncertainty.

Test name	Measurement uncertainty, dB
All antenna port measurements/ including OBW	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	1.38
Supply Voltages	0.05%
Time	2.09%

Important note: All testing in this document were done using the maximum radiation side of the antenna for covering the worst case in all the measurements.

Section 7 Testing data

7.1 Permitted range of operating frequencies

7.1.1 References

ETSI EN 305 550 → Section 4.3.1

The operating frequency range is the frequency range over which the EUT is intentionally transmitting. The operating frequency range(s) are determined by the lowest (fL) and highest frequency (fH) as occupied by the power envelope.
The EUT could have more than one operating frequency range. For a single frequency system, the OFR is equal to the occupied bandwidth (OBW) of the EUT. For multi-frequency systems the OFR is described in figure 1.

Table 1: Short Range Devices within the 40 GHz to 246 GHz frequency range

Frequency Bands (Transmit and Receive)	Applications
57 GHz to 64 GHz	Non-specific SRD
61,0 GHz to 61,5 GHz	Non-specific SRD
122 GHz to 123 GHz	Non-specific SRD
244 GHz to 246 GHz	Non-specific SRD

The manufacturer shall declare the permitted range of operating frequencies. The justification/test shall be performed for Operating frequency ranges, see clause 4.3.2.

7.1.2 Test summary

Verdict	Pass		
Test date	March 19, 2020	Temperature	22°C
Test engineer	Martha Espinoza	Air pressure	1005 mbar
Test location	3M semi anechoic chamber	Relative humidity	55 %

7.1.3 Notes

This is a radiated test measurement at 3 m. The mixer conversion loss, antenna correction factors and cable losses were considered in each measurement for getting the correct levels of the test. The complete band was evaluated in each bandwidth for determining if the transmitting signal is operating in the correct band.

7.1.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi anechoic chamber
Measuring distance	3M
Antenna height variation	1.62 m
Turn table position	0°

7.1.4 Setup details continued

Table 7.1-1: Permitted range of operating frequency equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Signal analyzer	Rohde & Schwarz	FSV40	E1120	11-19-2019	11-19-2020
Mixer	Rohde & Schwarz	FS-Z75	E1149	03-07-2019	03-07-2021

Notes: None

7.1.5 Test data

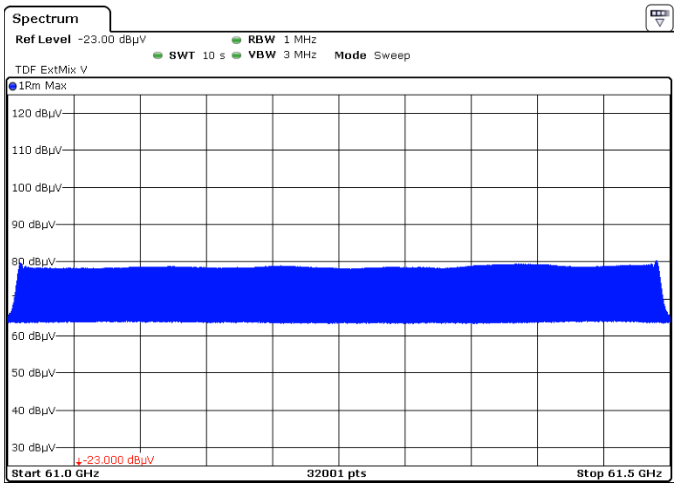


Figure 7.1-1: Permitted range of operating frequency: 500 MHz OBW, 61 GHz to 61.5 GHz band.

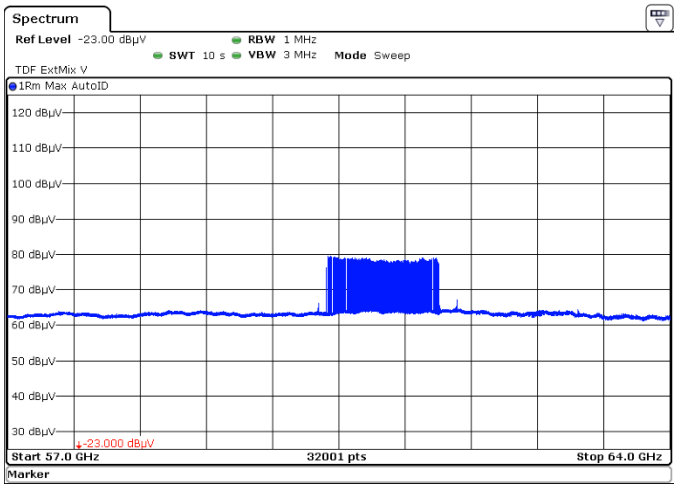


Figure 7.1-2: Permitted range of operating frequency: 1300 MHz OBW, 57 GHz to 64 GHz band.

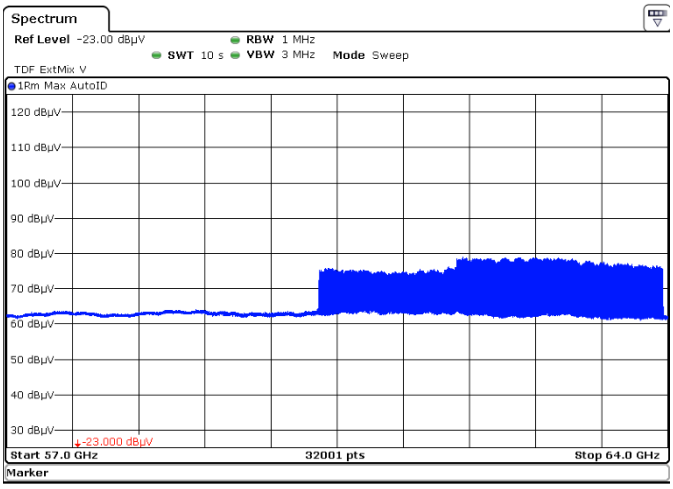


Figure 7.1-3: Permitted range of operating frequency: 4000 MHz OBW, 57 GHz to 64 GHz band.

Note: All the transmitting signal are inside of the band.

7.2 Operating frequency range(s) (OFR)

7.2.1 References

ETSI EN 305 550 → Section 4.3.2 → ETSI EN 303 396→ Clause 6.3.2

The operating frequency range(s) are determined by the lowest (fL) and highest frequency (fH) as occupied by the power envelope. The EUT could have more than one operating frequency range. For a single frequency system, the OFR is equal to the occupied bandwidth (OBW) of the EUT. For multi-frequency systems the OFR is described in figure 1.

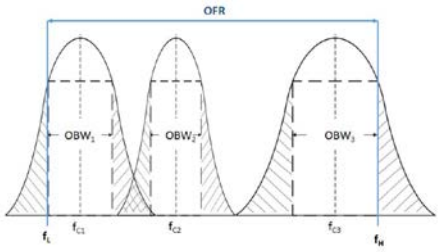


Figure 1: OFR of a multi – frequency system

Limits
The upper (fH) and lower (fL) limits of the operating frequency range shall meet the conditions in table 2.

Table 2: Limits for f_H and f_L [i.9]

	f_L	f_H
57 GHz to 64 GHz	≥ 57 GHz	≤ 64 GHz
61,0 GHz to 61,5 GHz	≥ 61,0 GHz	≤ 61,5 GHz
122 GHz to 123 GHz	≥ 122 GHz	≤ 123 GHz
244 GHz to 246 GHz	≥ 244 GHz	≤ 246 GHz
NOTE: If the device can work in different modes and different frequency ranges these frequencies should be reported for each mode and frequency range.		

7.2.2 Test summary

Verdict	Pass		
Test date	March 19, 2020	Temperature	22°C
Test engineer	Martha Espinoza	Air pressure	1005 mbar
Test location	3M semi anechoic chamber	Relative humidity	55 %

7.2.3 Notes

This is a radiated test done at 3 m. The 99% OBW function is then used to determine the operating frequency range.

FH is determined of the upper maker resulting from the OBW.
FL is determined of the lower maker resulting from the OBW.
FC is the center frequency.

$$fc = \frac{FH + FL}{2}$$

This section is required only in normal test conditions.

7.2.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi anechoic chamber
Measuring distance	3M
Antenna height variation	1.62 m
Turn table position	0°
RBW spectrum	1 MHz
VBW spectrum	≥ 3 MHz
Detector spectrum	RMS
Trace spectrum	Max Hold

Table 7.2-1: Operating frequency range equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Signal analyzer	Rohde & Schwarz	FSV40	E1120	11-19-2019	11-19-2020
Mixer	Rohde & Schwarz	FS-Z75	E1149	03-07-2019	03-07-2021

Notes: None

7.2.5 Test Data

Table 7.2-2: *Operating frequency range results*

OBW	Lower frequency	Higher frequency	Frequency center	99 % OBW
500 MHz	61.0083326 GHz	61.4912518 GHz	61.24979220 GHz	482.919283772 MHz
1300 MHz	60.2976009 GHz	61.5482774 GHz	60.92293915 GHz	1.250676541 GHz
4000 MHz	60.3119650 GHz	63.9274150 GHz	62.11969000 GHz	3.615449517 GHz
Note: None				

7.2.6 Test plots

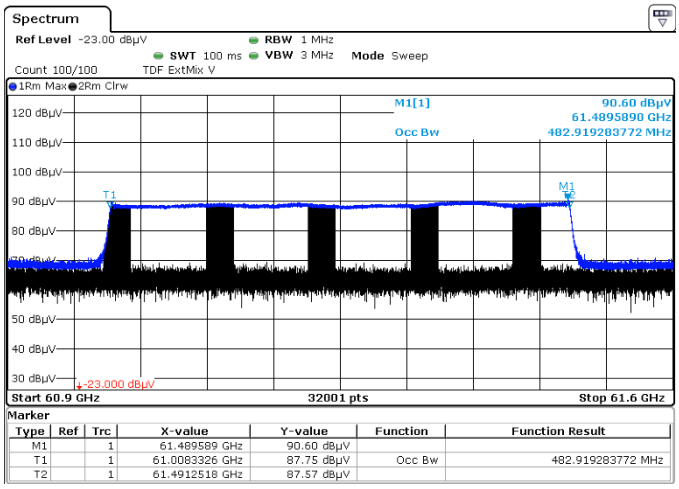


Figure 7.2-1: *Operating frequency range result: 500 MHz OBW*

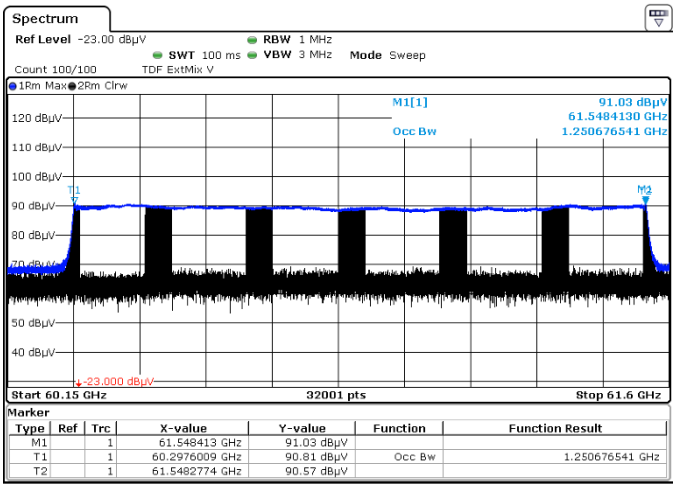


Figure 7.2-2: ***Operating frequency range result: 1300 MHz OBW***

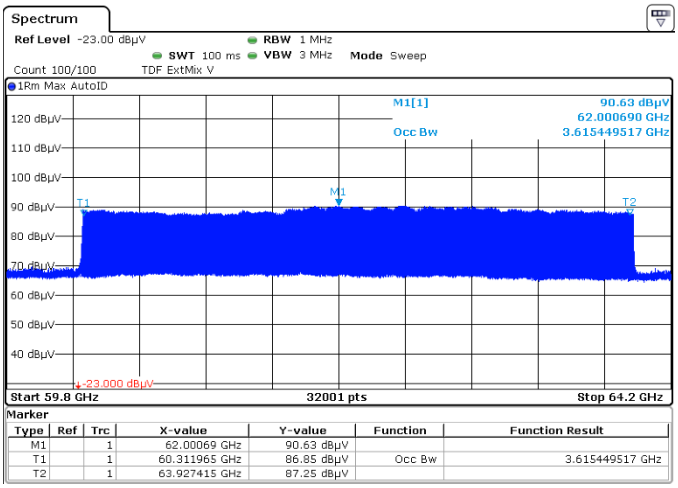


Figure 7.2-3: ***Operating frequency range result: 4000 MHz OBW***

7.3 Mean Power

7.3.1 References

ETSI EN 305 550 → Section 4.3.3 → ETSI EN 303 396→ Clause 6.3.4

The radiated power is the mean Equivalent Isotropic Radiated Power (EIRP) for the equipment during a transmission burst. The mean EIRP refers to the highest power level of the transmitter power control range during the transmission cycle if the transmitter power control is implemented.
The radiated output power is applicable to the system as a whole when operated at the highest stated power level. For a smart antenna system and directional antennas, the limit applies to the configuration which results in the highest EIRP. The radiated output power in normal wideband operation shall be limited by usage as indicated in table 3.

Table 3: RF output power limit [i.1]

Frequency Bands	RF output power	Application	Notes
57 GHz to 64 GHz	100 mW e.i.r.p / 20 dBm e.i.r.p.	Non-specific SRD	Note
61,0 GHz to 61,5 GHz	100 mW e.i.r.p./ 20 dBm e.i.r.p.	Non-specific SRD	
122 GHz to 122,25 GHz	10 dBm e.i.r.p	Non-specific SRD	10 dBm within 250 MHz
122,25 GHz to 123 GHz	100 mW e.i.r.p./ 20 dBm e.i.r.p.	Non-specific SRD	
244 GHz to 246 GHz	100 mW e.i.r.p./ 20 dBm e.i.r.p.	Non-specific SRD	
NOTE: A max transmitter output power of 10 dBm.			

7.3.2 Test summary

Verdict	Pass		
Test date	March 12, 2020	Temperature	20°C
Test engineer	Martha Espinoza	Air pressure	1000 mbar
Test location	3m semi anechoic chamber	Relative humidity	49 %

7.3.3 Notes

This is a radiated test at 3 meters. The equivalent electric field to the limit showed on the table 3 is:

57 to 64 GHz = 20 dBm EIRP = 115.23 dBµV/m @ 3m
61 to 61.5 GHz = 20 dBm EIRP = 115.23 dBµV/m @ 3m

Channel Power function needs to be used to calculate the average power. Boundaries for the calculation needs to be defined. This is typically the operating frequency range.

This section is required only in normal test conditions.

7.3.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi anechoic chamber
Measuring distance	3M
Antenna height variation	1.62 m
Turn table position	0°
RBW spectrum	1 MHz
VBW spectrum	≥ RBW
Detector spectrum	RMS
Trace spectrum	Clear/Write

Table 7.3-1: Mean power equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Signal analyzer	Rohde & Schwarz	FSV40	E1120	11-19-2019	11-19-2020
Mixer	Rohde & Schwarz	FS-Z75	E1149	03-07-2019	03-07-2021

Notes: None

7.3.5 Test data

Table 7.3-2: Mean power (EIRP) test results.

OBW	Mean Power (EIRP)	Limit	Margin
500 MHz	99.54 dBµV/m	115.23 dBµV/m	15.69 dB
1300 MHz	102.46 dBµV/m	115.23 dBµV/m	12.77 dB
4000 MHz	108.36 dBµV/m	115.23 dBµV/m	6.87 dB
Notes: The measurements were performed at a 3m measurement distance			

7.3.6 Test plots

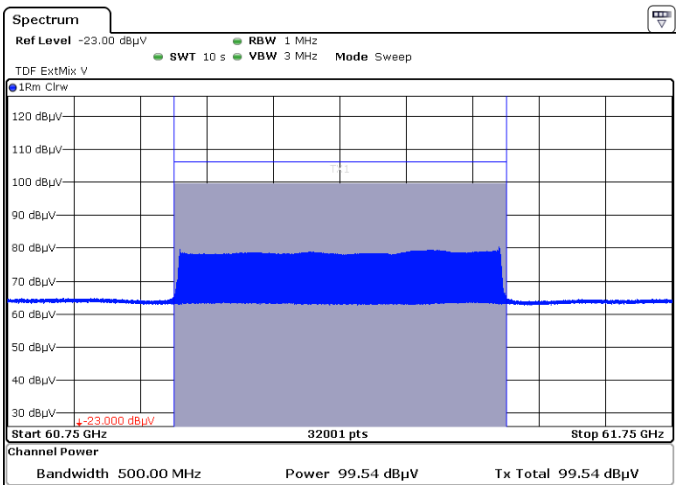


Figure 7.3-1: ***Mean power (EIRP): 500 MHz OBW***

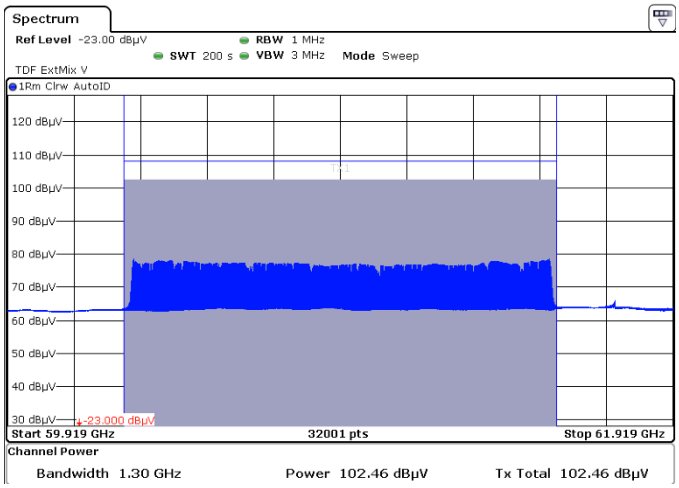


Figure 7.3-2: ***Mean power (EIRP): 1300 MHz OBW***

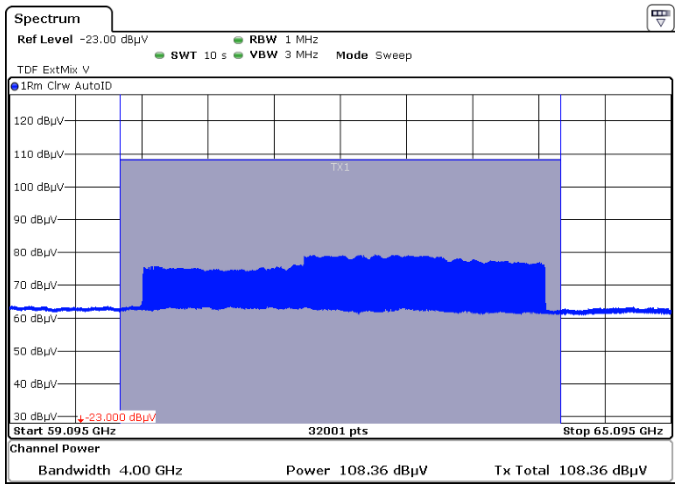


Figure 7.3-3: ***Mean power (EIRP): 4000 MHz OBW***

7.4 Mean Power Spectral Density

7.4.1 References

ETSI EN 305 550 → Section 4.3.4 → ETSI EN 303 396→ Clause 6.3.5

The mean power spectral density (EIRP) is defined as the emitted power spectral density over a defined bandwidth of the transmitter including antenna gain radiated in the direction of the maximum level under the specified conditions of measurement.
The maximum mean power spectral density is applicable to the EUT as a whole when operated at the highest stated power level. The limits are given in table 4.

Table 4: Mean Power Spectral Density Limit (PSD) (e.i.r.p) [i.1]

Frequency Bands	Power Spectral Density	Application	Notes
57 GHz to 64 GHz	13 dBm/MHz e.i.r.p.	Non-specific SRD	
61,0 GHz to 61,5 GHz	No limit defined	Non-specific SRD	
122 GHz to 122,25 GHz	-48 dBm/MHz > 30° elevation	Non-specific SRD	Notes 1, 2 and 3
122,25 GHz to 123 GHz	No limit defined	Non-specific SRD	
244 GHz to 246 GHz	No limit defined	Non-specific SRD	
NOTE 1: These limits should be measured with an rms detector and an averaging time of 1 ms or less. NOTE 2: The limit of -48 dBm/MHz applies for the normal operation mode of handheld and mobile devices and for fixed installation. NOTE 3: See for declaration requirements, clause 5.2.			

7.4.2 Test summary

Verdict	Pass		
Test date	March 12, 2020	Temperature	20°C
Test engineer	Martha Espinoza	Air pressure	1000 mbar
Test location	3m semi anechoic chamber	Relative humidity	49 %

7.4.3 Notes

This is a radiated test at 3 meters. The equivalent electric field to the limit showed on the table 3 is:

57 to 64 GHz = 13 dBm EIRP = 108.23 dBµV/m @ 3m

The mean power spectral density to be considered is the maximum value recorded. This section is required only in normal test conditions.

7.4.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi anechoic chamber
Measuring distance	3m
Antenna height variation	1.62 m
Turn table position	0°
RBW spectrum	1 MHz
VBW spectrum	3 MHz
Detector spectrum	RMS
Trace spectrum	Clear/Write

Table 7.4-1: Mean power spectral density equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Signal analyzer	Rohde & Schwarz	FSV40	E1120	11-19-2019	11-19-2020
Mixer	Rohde & Schwarz	FS-Z75	E1149	03-07-2019	03-07-2021

Notes: None

7.4.5 Test data

Table 7.4-2: Mean power spectral density test results.

OBW	Mean Power (EIRP)	Limit	Margin
500 MHz	80.23 dBµV/m	Not defined	Not defined
1300 MHz	78.51 dBµV /m	108.23 dBµV /m	29.72 dB
4000 MHz	79.13 dBµV /m	108.23 dBµV /m	29.10 dB

Note: These measurements were done at 3 meters

7.4.6 Test plot

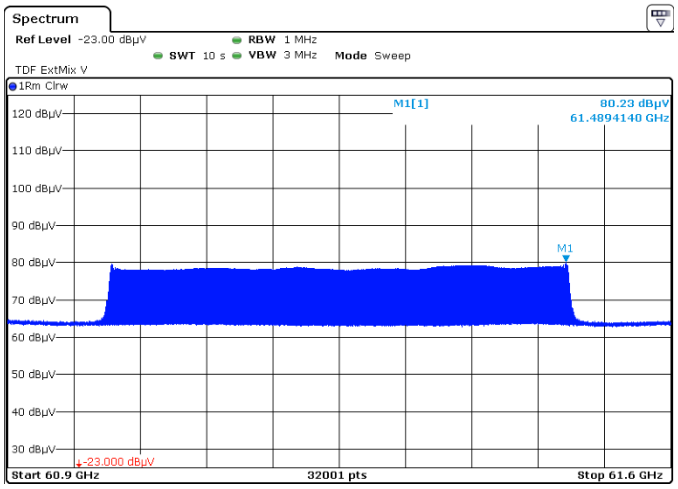


Figure 7.4-1: ***Mean power spectral density (EIRP): 500 MHz OBW***

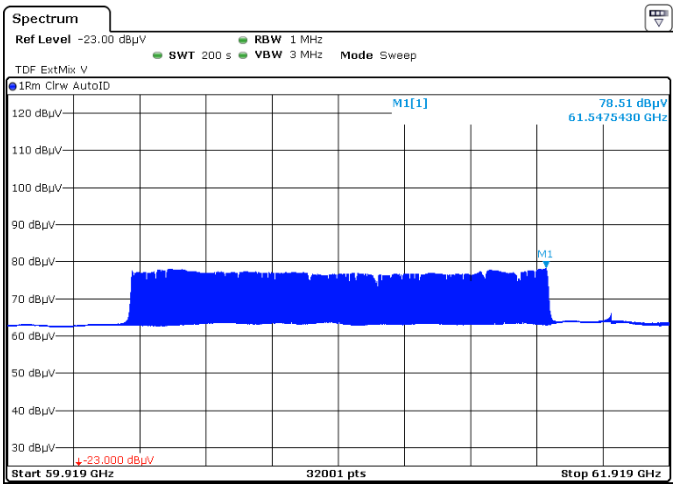


Figure 7.4-2: ***Mean power spectral density (EIRP): 1300 MHz OBW***

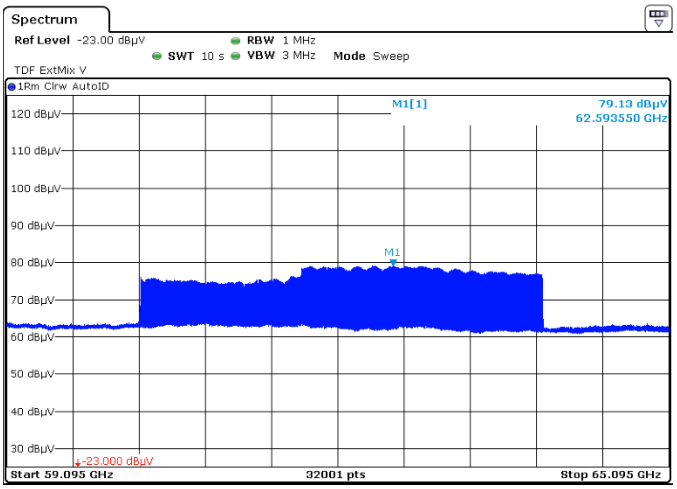


Figure 7.4-3: ***Mean power spectral density (EIRP): 4000 MHz OBW***

7.5 Unwanted emissions in the out-of-band domain

7.5.1 References

ETSI EN 302264 → Section 4.3.5 → ETSI EN 303 396→ Clause 6.2.11 & Clause 6.3.10

The transmitter out-of-band emissions for a single frequency system are to be considered in frequency ranges defined in figure 2.

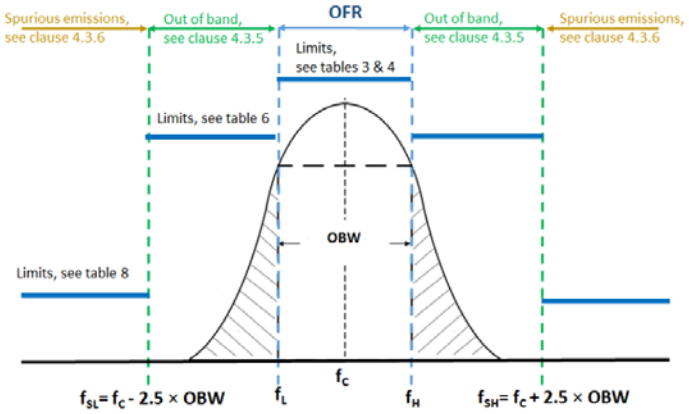


Figure 2: Emissions in the out-of-band and spurious domain

The RMS mean power spectral density radiated in the calculated out-of-band domain (between f_{SL} to f_L and f_H to f_{SH} band) shall not be greater than the values given in table 6. An additional requirement introduced: if the calculated f_{SL}/f_{SH} will be theoretical below or above the frequency which came out of the calculation based on 250 % of the maximum allowed OBW (see table 2). Therefore, the border between OOB / spurious will be fixed at the frequencies in table 5 (normal 250 % rule based on the Centre frequency of the signal).

Table 5: Limits for the max. f_{SL} and f_{SH} frequency, based on the max. theoretical OBW of the EUT

Frequency Bands	Centre frequency	Max OBW	f_{SL}	f_{SH}
57 GHz to 64 GHz	60,5 GHz	7 GHz	43 GHz	78 GHz
61,0 GHz to 61,5 GHz	61,25 GHz	500 MHz	60 GHz	62,5 GHz
122 GHz to 123 GHz	122,5 GHz	1 GHz	120 GHz	125 GHz
244 GHz to 246 GHz	245 GHz	2 GHz	240 GHz	250 GHz

Table 6: Out-of-band domain

Frequency [GHz]	rms power density [dBm/MHz]
$f_{SL} \leq f < f_L$	See table 7
$f_H < f \leq f_{SH}$	See table 7

Table 7: Limits for out-of-band radiation

Frequency Bands	OOB limit [dBm/MHz]
57 GHz to 64 GHz	-20 dBm/MHz
61,0 GHz to 61,5 GHz	-10 dBm/MHz
122 GHz to 123 GHz	-10 dBm/MHz
244 GHz to 246 GHz	-15 dBm/MHz

7.5.2 Test summary

Verdict	Pass		
Test date	March 19, 2020	Temperature	22°C
Test engineer	Martha Espinoza	Air pressure	1005 mbar
Test location	10m semi anechoic chamber	Relative humidity	55 %

7.5.3 Notes

This is a radiated test measured at 3 meters. The limits for this test were calculated according to the information of the section 7.2.5 & 7.5.1.

61 – 61.5 GHz Band

Table 7.5-1: Unwanted emissions in the out of band limits.

61 – 61.5 GHz Band (500 MHz OBW) fc = 61.249 GHz			
FL	60.999 GHz	FH	61.499 GHz
FSL	59.999 GHz	FSH	62.499 GHz
Limit line	-10 dBm/MHz	Limit line	-10 dBm/MHz
Limit line @ 3M	85.23 dBµV/m	Limit line @ 3M	85.23 dBµV/m

57 - 64 GHz Band

Table 7.5-2: Unwanted emissions in the out of band limits.

57 – 64 GHz Band (1300 MHz OBW) fc = 60.922 GHz			
FL	60.272 GHz	FH	61.572 GHz
FSL	57.672 GHz	FSH	64.172 GHz
Limit line	-20 dBm/MHz	Limit line	-20 dBm/MHz
Limit line @ 3M	75.23 dBµV /m	Limit line @ 3M	75.23 dBµV /m

Table 7.5-3: Unwanted emissions in the out of band limits.

57 – 64 GHz Band (4000 MHz OBW) fc = 62.119 GHz			
FL	60.119 GHz	FH	64.119 GHz
FSL	52.119 GHz	FSH	72.119 GHz
Limit line	-20 dBm/MHz	Limit line	-20 dBm/MHz
Limit line @ 3M	75.23 dBµV /m	Limit line @ 3M	75.23 dBµV /m

This section is required only in normal test conditions.

7.5.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi Anechoic Chamber (SAC)
Measuring distance	3 m
Antenna height variation	1.62 M
Turn table position	0
RBW	1 MHz
VBW	≥ 3 MHz
Detector	RMS
Trace	Clear/Write
Sweet Points	Higher than span of the spectrum analyzer divided by the RBW.

Table 7.5-4: Unwanted emissions in the out-of-band domain equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Signal analyzer	Rohde & Schwarz	FSV40	E1120	11-19-2019	11-19-2020
Mixer	Rohde & Schwarz	FS-Z75	E1149	03-07-2019	03-07-2021

Notes: None

7.5.5 Test data and test plots

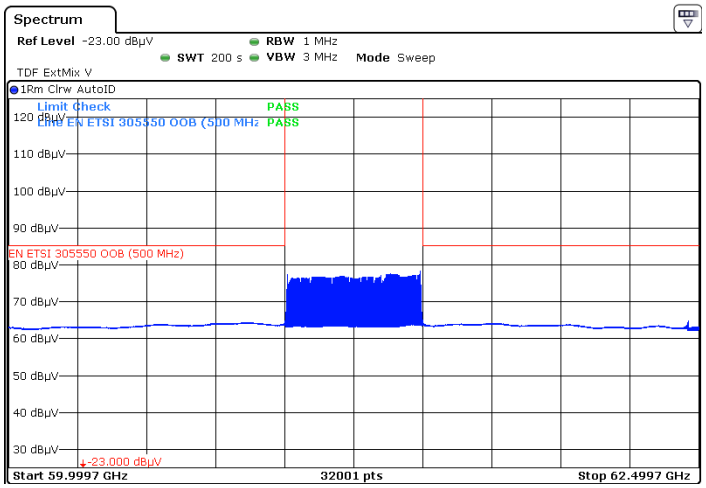


Figure 7.5-1 ***Unwanted emissions in the out of band: 500 MHz OBW***

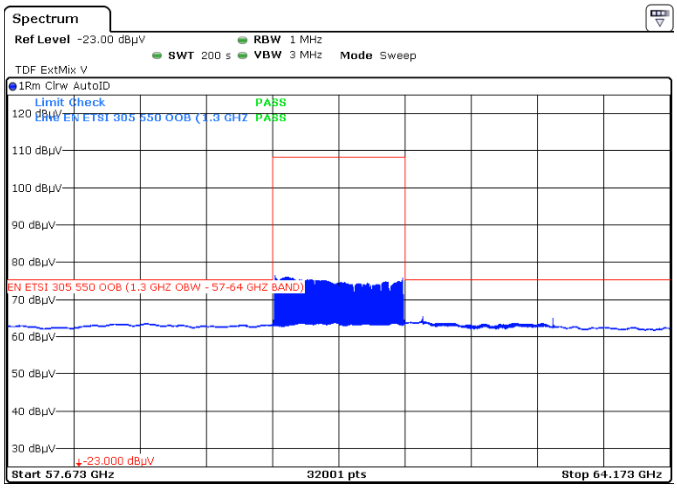


Figure 7.5-2: ***Unwanted emissions in the out of band: 1300 MHz OBW***

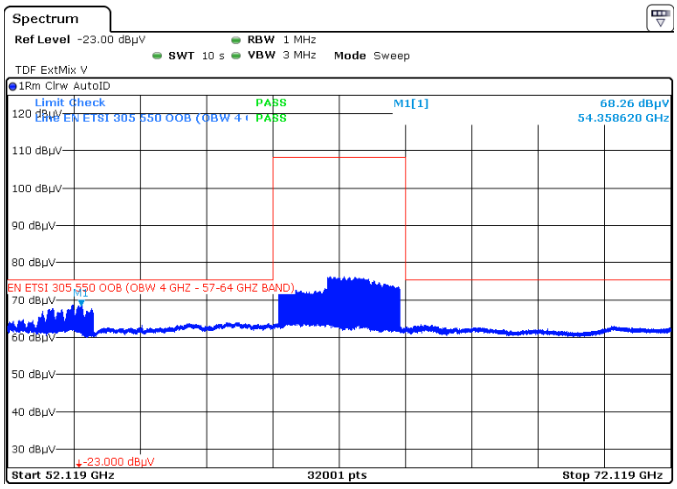


Figure 7.5-3: ***Unwanted emissions in the out of band: 4000 MHz OBW***

7.6 Unwanted emissions in the spurious domain

7.6.1 References

ETSI EN 302264 → Section 4.3.5 → ETSI EN 303 396→ Clause 6.2.11 & Clause 6.3.10

The transmitter spurious emissions for a single frequency system are to be considered in frequency ranges defined in figure 2. The effective radiated power of any radiated spurious emission shall be not greater than the values given in table 8.

Table 8: Limits of radiated spurious emissions [i.3]

Frequency range (MHz)	Limit values for spurious radiation	Detector type
47 to 74	-54 dBm e.r.p.	Quasi-Peak
87,5 to 118	-54 dBm e.r.p.	Quasi-Peak
174 to 230	-54 dBm e.r.p.	Quasi-Peak
470 to 862	-54 dBm e.r.p.	Quasi-Peak
otherwise in band 30 to 1 000	-36 dBm e.r.p.	Quasi-Peak
f > 1 000 to 300 000 (note)	-30 dBm e.i.r.p.	RMS
NOTE: According to CEPT/ERC/REC 74-01 [i.3], spurious emission is measured up to the 2nd harmonic of the fundamental frequency.		

7.6.2 Test summary

Verdict	Pass		
Test date	March 13, 2020; to March 18, 2020	Temperature	20°C - 22°C
Test engineer	Martha Espinoza	Air pressure	1003 - 1006 mbar
Test location	3M semi anechoic chamber	Relative humidity	50% - 53%

Note: None

7.6.3 Notes

This is a radiated test measured at 0.6 meter above 40 GHz (the noise floor increases and for this reason, the limit line is extrapolated at 0.6 m). Below 40 GHz, the measurements were done at 3 meters.

Table 7.6-1: Unwanted emissions spurious domain limits

Frequency range (MHz)	Limit values (dBm)	Limit values (dBµV/m) @ 3 m	Limit values (dBµV/m) @ 0.6 m	Detector
47 to 74	-54 (ERP)	43.38	---	Quasi-Peak
87.5 to 118	-54 (ERP)	43.38	---	Quasi-Peak
174 to 230	-54 (ERP)	43.38	---	Quasi-Peak
470 to 862	-54 (ERP)	43.38	---	Quasi-Peak
Otherwise in band 30 to 1000	-36 (ERP)	61.38	---	Quasi-Peak
F > 1000 to 300 000	-30 (EIRP)	65.23**	79.209	RMS

** Note: The 3 m measurement is extrapolated at 1 m with the equation:

$$Limit\ line\ @\ 1\ m = Emeas + 20 * Log10\ (\frac{dmeas}{dspec\ limit})$$

$$Limit\ line\ @\ 1\ m = 65.23 + 20 * Log10(\frac{3}{0.6})$$

E_{meas} = 65.23 dBµV/m Limit line @ 1 m = 79.209 dBµV/m

d_{meas} = 3 m

d_{spec} limit = 0.6 m

The spurious emissions according to CEPT/ERC/REC 74-01 should be measure up to second harmonic of the fundamental frequency. This section is required only in normal test conditions.

The frequency range from 75 GHz to 110 GHz was break down in two ranges, from 75 to 100 GHz and 100 to 110 GHz according to the requirement: Sweep Points should be higher than the span of the spectrum analyzer divided by the RBW.

7.6.4 Setup details

Setup configuration from 30 MHz to 40 GHz

EUT setup configuration	Tabletop
Test facility	3M Semi Anechoic Chamber (SAC)
Measuring distance	3 m
Antenna height variation	1–4 m
Turn table position	0–360°
Measurement details	A preview measurement was generated with receiver in continuous scan or sweep mode while the EUT was rotated and antenna adjusted to maximize radiated emission. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver/spectrum analyzer settings for frequencies below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	– Peak (Preview measurement) – Quasi-peak (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak preview measurement) – 1000 ms (Quasi-peak final measurement)

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak (Preview measurement) Peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak preview measurement) – 100 ms (Peak and CAverage final measurement)

Setup configuration – Receiver/spectrum analyzer settings for frequencies above 40 GHz

EUT setup configuration	Tabletop
Test facility	3M Semi Anechoic Chamber (SAC)
Measuring distance	0.6 m
Antenna height variation	1.62 M
Turn table position	0°
RBW	1 MHz
VBW	≥ 3 MHz
Detector	RMS
Trace	Clear/Write
Sweet Points	Higher than span of the spectrum analyzer divided by the RBW.

7.6.4 Setup details continued

Table 7.6-1 Unwanted emissions in the spurious domain equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1121	05-25-2018	05-25-2020
Signal Analyzer	Rohde & Schwarz	FSV 40	E1120	11-19-2019	11-19-2020
Signal Generator	Rohde & Schwarz	SMB 100A	E1128	12-23-2019	12-23-2020
Antenna, Bilog	Schaffner-Chase	CBL6111C	1480	04-18-2019	10-18-2020
Antenna, Horn	ETS	3117-PA	E1139	03-21-2019	03-21-2021
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	03-05-2018	06-05-2020
Antenna, Horn	Sage Millimeter	SAR-2309-28-S2	E1148	03-13-2018	06-13-2020
Low Noise Amplifier	Sage Millimeter	SBL-1834034030-KFKF-SI	E1228	NCR	NCR
Antenna, Horn	Sage Millimeter	SAR-2309-19-S2	E1144	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z60	E1138	03-07-2019	03-07-2021
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z75	E1149	03-07-2019	03-07-2021
Antenna, Horn	Sage Millimeter	SAR-2507-10-S2	E1146	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z110	E1154	02-06-2019	02-06-2021
Antenna, Horn	Sage Millimeter	SAR-2507-06-S2	E1182	NCR	NCR
Mixer	Radiometer Physics	HM110-170	E1178	09-27-2018	09-27-2020
Antenna, Horn	Sage Millimeter	SAR-2309-05-S2	E1184	NCR	NCR
Mixer	Radiometer Physics	HM140-220	E1177	09-25-2018	09-25-2020

Notes: None

7.6.5 Test data and test plots

- ***61 – 61.5 GHz: 500 MHz OBW***

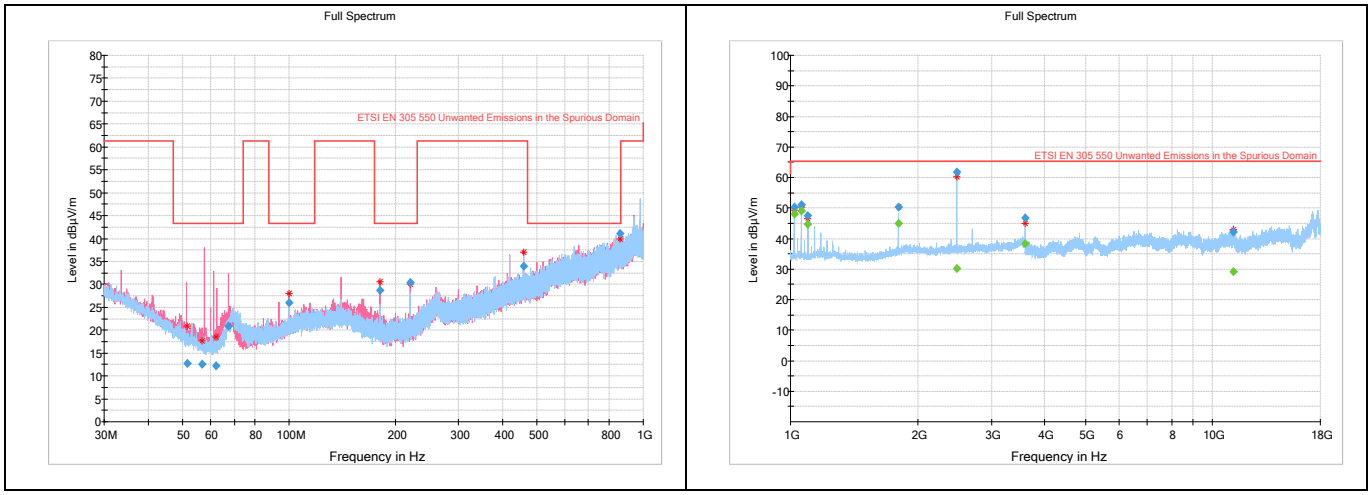


Figure 7.6-1*: Unwanted emissions spurious band plot – Field strength measured from 30 MHz to 18 GHz*

Table 7.6-2*: Unwanted emissions spurious band plot – Field strength measured from 30 to 1000 MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
51.415333	12.77	43.38	30.61	5000.0	120.000	257.5	V	333.0	14.4
56.743333	12.49	43.38	30.89	5000.0	120.000	214.1	V	200.0	12.8
61.966333	12.26	43.38	31.12	5000.0	120.000	187.4	V	0.0	12.5
67.217333	20.91	43.38	22.47	5000.0	120.000	124.2	V	277.0	12.9
100.009333	26.01	43.38	17.37	5000.0	120.000	112.7	V	26.0	17.2
179.994333	28.73	43.38	14.65	5000.0	120.000	183.4	V	154.0	16.6
220.010667	30.48	43.38	12.90	5000.0	120.000	151.3	V	241.0	17.0
459.993333	33.94	61.38	27.44	5000.0	120.000	262.0	H	186.0	26.1
860.009000	41.14	43.38	2.24	5000.0	120.000	147.0	V	305.0	33.7

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4]The spectral plot is a summation of a vertical and horizontal scan.
[5]This measurement was done at 3m

Table 7.6-3: Unwanted emissions spurious band– Field strength measured from 1 to 18 GHz

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1020.033333	---	48.03	65.23	17.20	5000.0	1000.000	112.4	H	340.0	-14.5
1020.033333	50.29	---	65.23	14.94	5000.0	1000.000	112.4	H	340.0	-14.5
1060.100000	---	49.14	65.23	16.09	5000.0	1000.000	112.2	H	329.0	-14.5
1060.100000	51.15	---	65.23	14.08	5000.0	1000.000	112.2	H	329.0	-14.5
1099.933333	47.52	---	65.23	17.71	5000.0	1000.000	110.3	H	320.0	-14.3
1099.933333	---	44.78	65.23	20.45	5000.0	1000.000	110.3	H	320.0	-14.3
1800.166667	50.30	---	65.23	14.93	5000.0	1000.000	100.0	H	343.0	-11.3
1800.166667	---	45.05	65.23	20.18	5000.0	1000.000	100.0	H	343.0	-11.3
2479.933333	---	30.10	65.23	35.13	5000.0	1000.000	118.6	V	17.0	-9.2
2479.933333	61.83	---	65.23	3.40	5000.0	1000.000	118.6	V	17.0	-9.2
3599.900000	---	38.39	65.23	26.84	5000.0	1000.000	211.9	V	24.0	-5.3
3599.900000	46.81	---	65.23	18.42	5000.0	1000.000	211.9	V	24.0	-5.3
11190.166667	---	29.06	65.23	36.17	5000.0	1000.000	249.6	V	0.0	4.0
11190.166667	42.18	---	65.23	23.05	5000.0	1000.000	249.6	V	0.0	4.0

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.
[5] This measurement was done at 3m

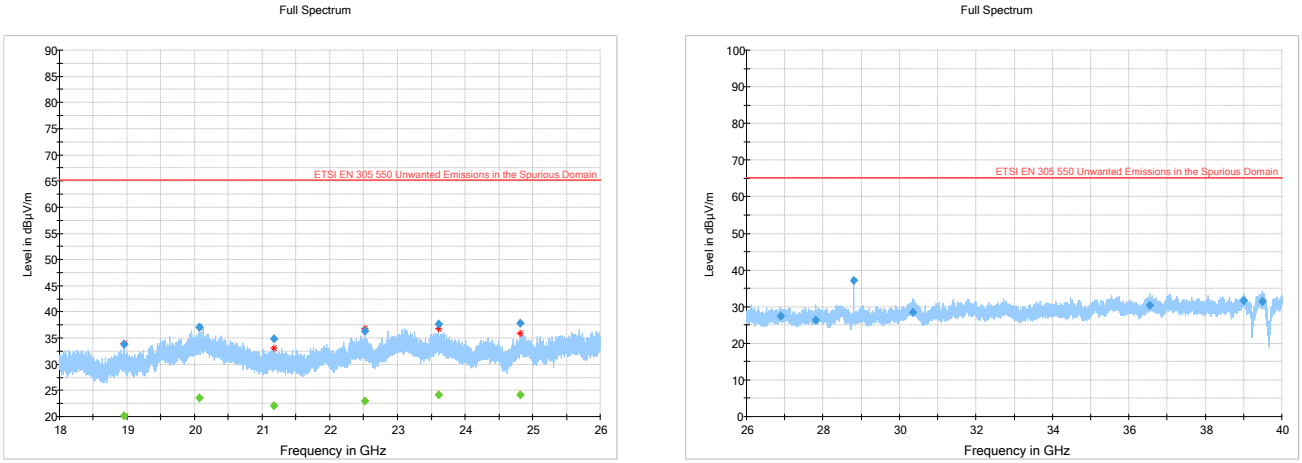


Figure 7.6-2: Unwanted emissions spurious band – Field strength measured from 18 to 40 GHz

Table 7.6-4: Unwanted emissions spurious band– Field strength measured from 18 to 26 GHz

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
18953.433333	---	20.11	65.23	45.12	5000.0	1000.000	110.0	H	141.0	-2.2
18953.433333	33.76	---	65.23	31.47	5000.0	1000.000	110.0	H	141.0	-2.2
20073.900000	---	23.60	65.23	41.63	5000.0	1000.000	110.3	H	241.0	-1.7
20073.900000	37.16	---	65.23	28.07	5000.0	1000.000	110.3	H	241.0	-1.7
21169.633333	34.93	---	65.23	30.30	5000.0	1000.000	175.0	H	345.0	-2.1
21169.633333	---	22.04	65.23	43.19	5000.0	1000.000	175.0	H	345.0	-2.1
22522.033333	---	23.02	65.23	42.21	5000.0	1000.000	141.9	V	74.0	-2.2
22522.033333	36.41	---	65.23	28.82	5000.0	1000.000	141.9	V	74.0	-2.2
23608.966667	37.67	---	65.23	27.56	5000.0	1000.000	112.4	H	309.0	-1.3
23608.966667	---	24.16	65.23	41.07	5000.0	1000.000	112.4	H	309.0	-1.3
24821.100000	---	24.09	65.23	41.14	5000.0	1000.000	125.0	V	162.0	-0.9
24821.100000	37.87	---	65.23	27.36	5000.0	1000.000	125.0	V	162.0	-0.9

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4]The spectral plot is a summation of a vertical and horizontal scan.
[5]This measurement was done at 3m

Table 7.6-5: Unwanted emissions spurious band plot – Field strength measured from 26 to 40 GHz

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
26895.500000	27.42	65.23	37.81	5000.0	1000.000	119.3	V	-20.0	1.9
27813.300000	26.29	65.23	38.94	5000.0	1000.000	175.0	V	-7.0	1.8
28800.300000	37.26	65.23	27.97	5000.0	1000.000	135.7	H	316.0	4.2
30352.766667	28.51	65.23	36.72	5000.0	1000.000	117.6	H	-7.0	4.4
36535.900000	30.43	65.23	34.80	5000.0	1000.000	149.5	H	27.0	8.9
38999.500000	31.66	65.23	33.57	5000.0	1000.000	139.0	H	23.0	10.8
39486.300000	31.52	65.23	33.71	5000.0	1000.000	108.8	V	133.0	11.2

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4]The spectral plot is a summation of a vertical and horizontal scan.
[5]This measurement was done at 3m

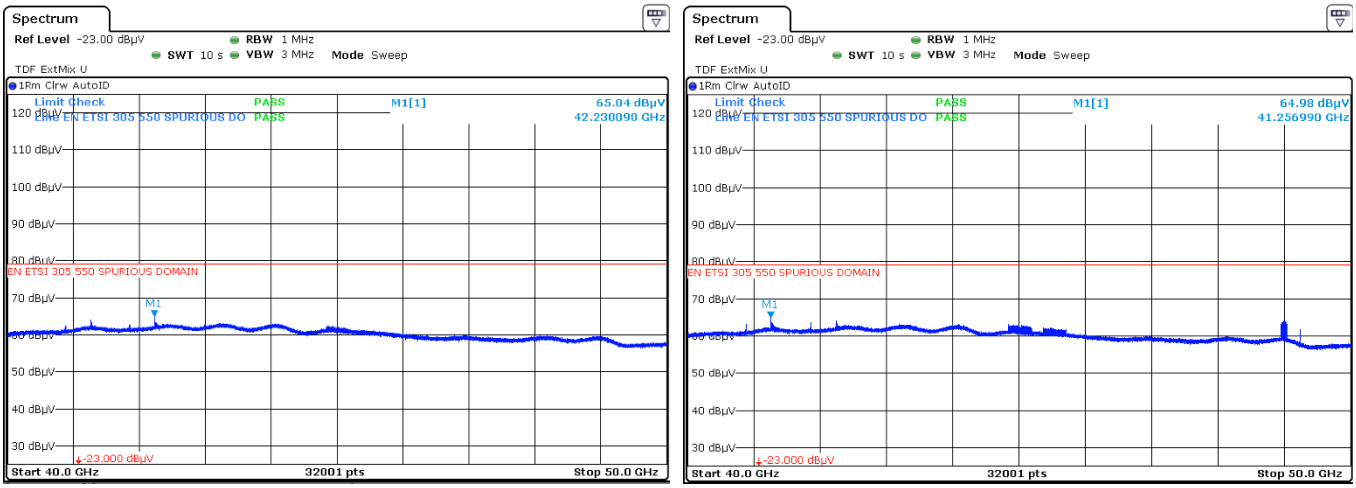


Figure 7.6-3: ***Unwanted emissions spurious band plot – Field strength measured from 40 to 50 GHz, horizontal and vertical polarization respectively.***

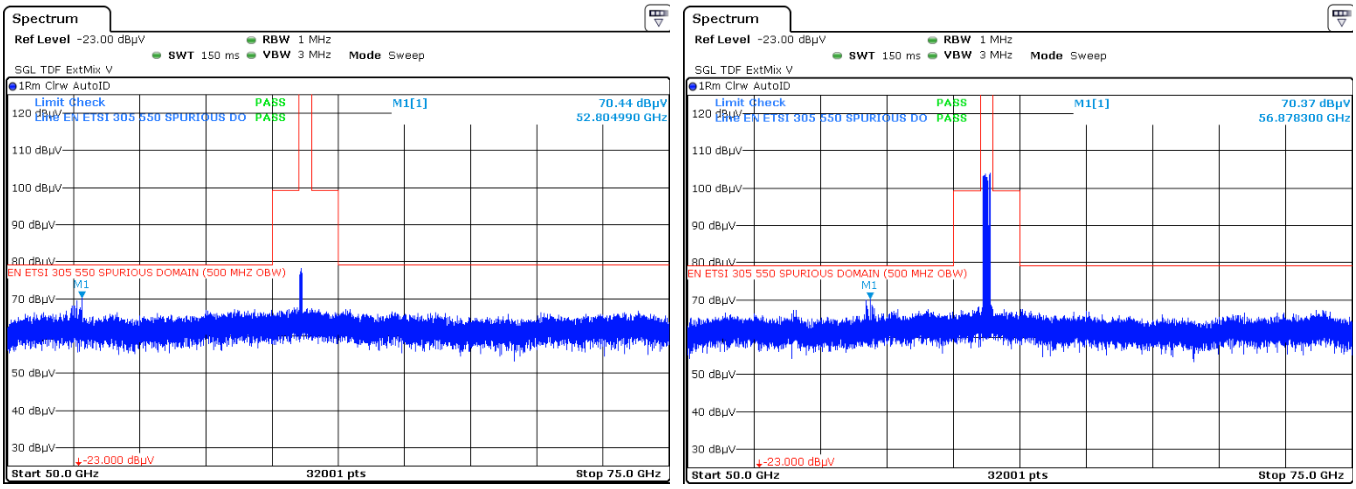


Figure 7.6-4: ***Unwanted emissions spurious band plot – Field strength measured from 50 - 75 GHz, horizontal and vertical polarization respectively.***

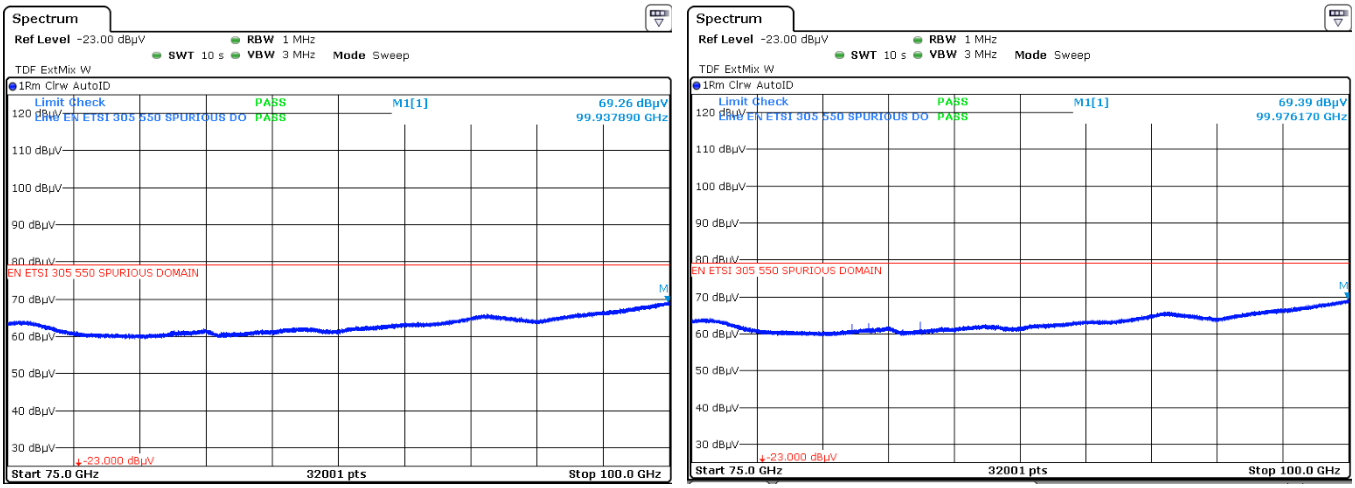


Figure 7.6-5: ***Unwanted emissions spurious band plot – Field strength measured from 75 to 100 GHz, horizontal and vertical polarization respectively.***

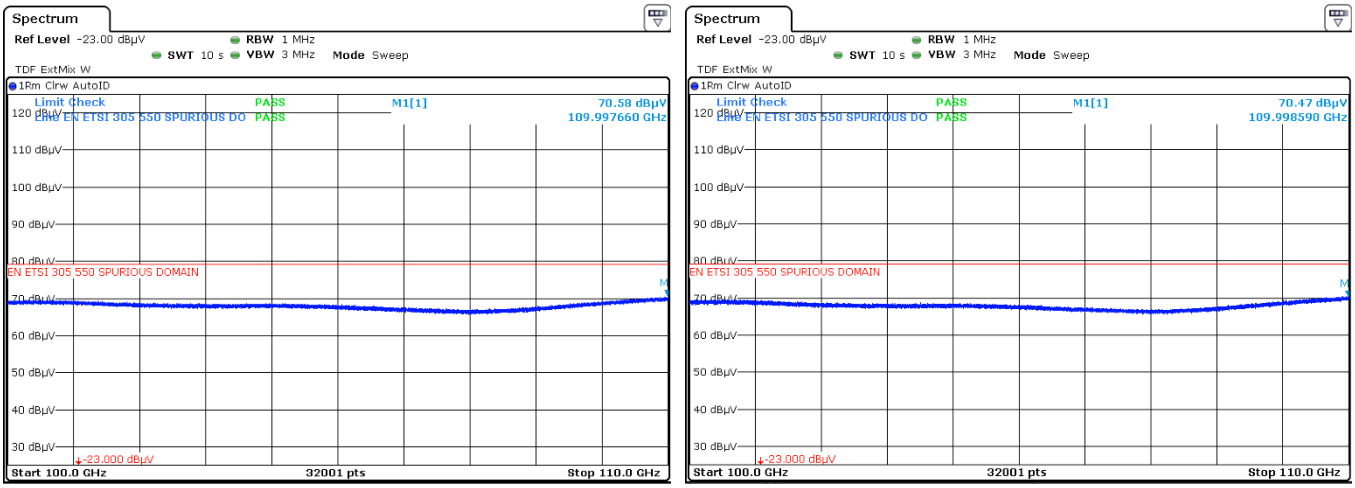


Figure 7.6-6*: Unwanted emissions spurious band plot – Field strength measured from 100 - 110 GHz, horizontal and vertical polarization respectively*

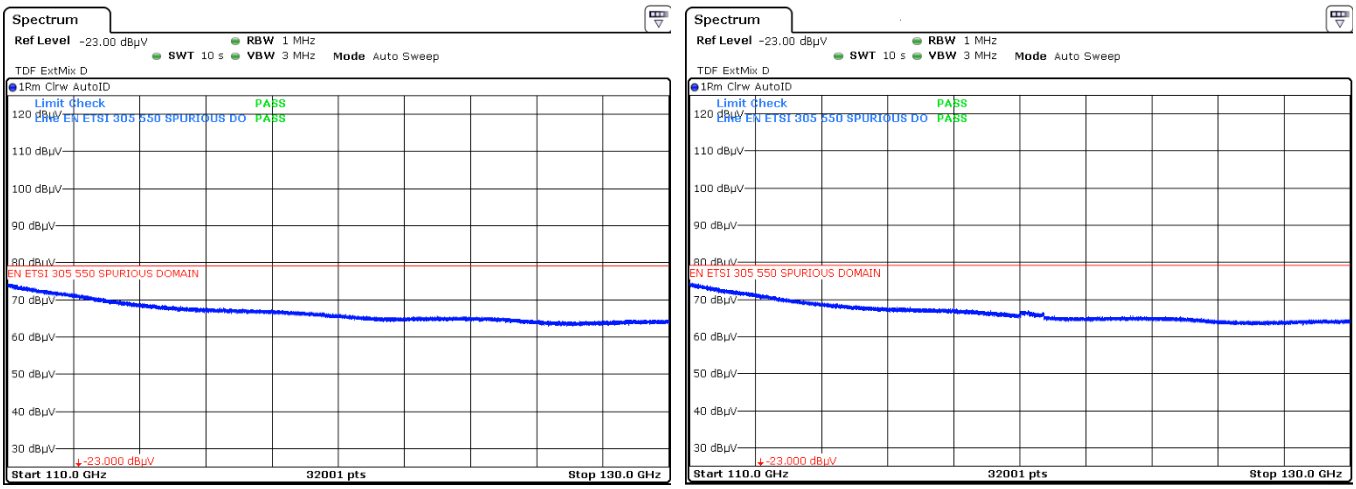


Figure 7.6-7*: Unwanted emissions spurious band plot – Field strength measured from 110 to 130 GHz, horizontal and vertical polarization respectively*

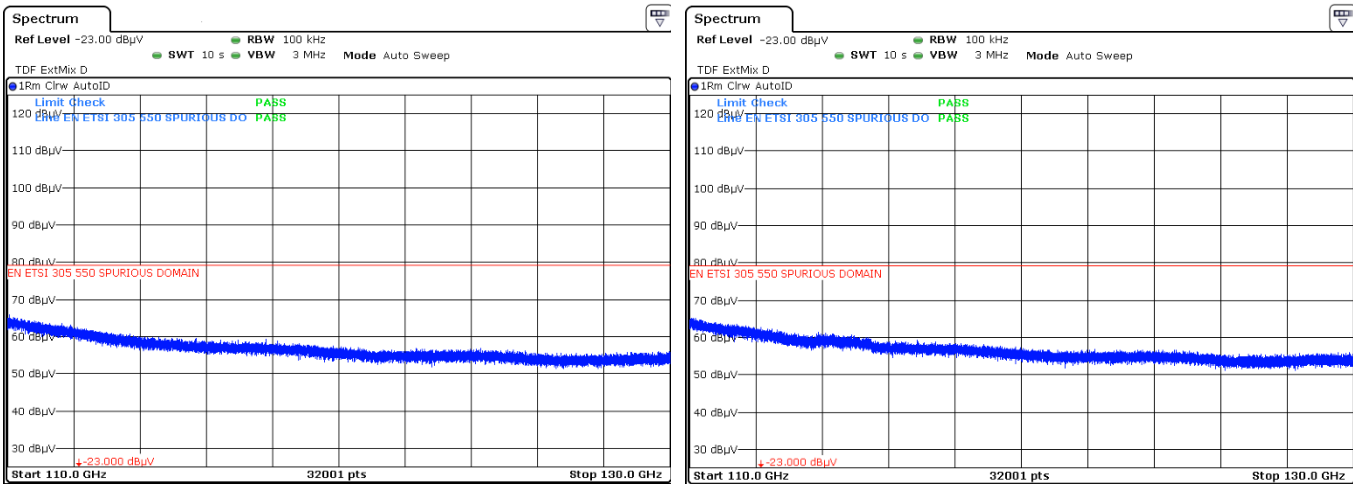


Figure 7.6-8*: Unwanted emissions spurious band plot – Field strength measured from 110 to 130 GHz, horizontal and vertical polarization respectively (100 kHz RBW).*

Note: Above 1 GHz, ETSI EN 305 550 standard specifies a resolution bandwidth of 1 MHz and a video bandwidth of ≥ 3 MHz. However, for this specific case the measurements from 110 to 130 GHz show a high noise floor due to the correction factors applied such as the mixer conversion losses, antenna factors and cable losses. In order to demonstrate there are no spurious emissions, the RBW was changed to 100 kHz in both polarizations.

- ***57 – 64 GHz: 1300 MHz OBW***

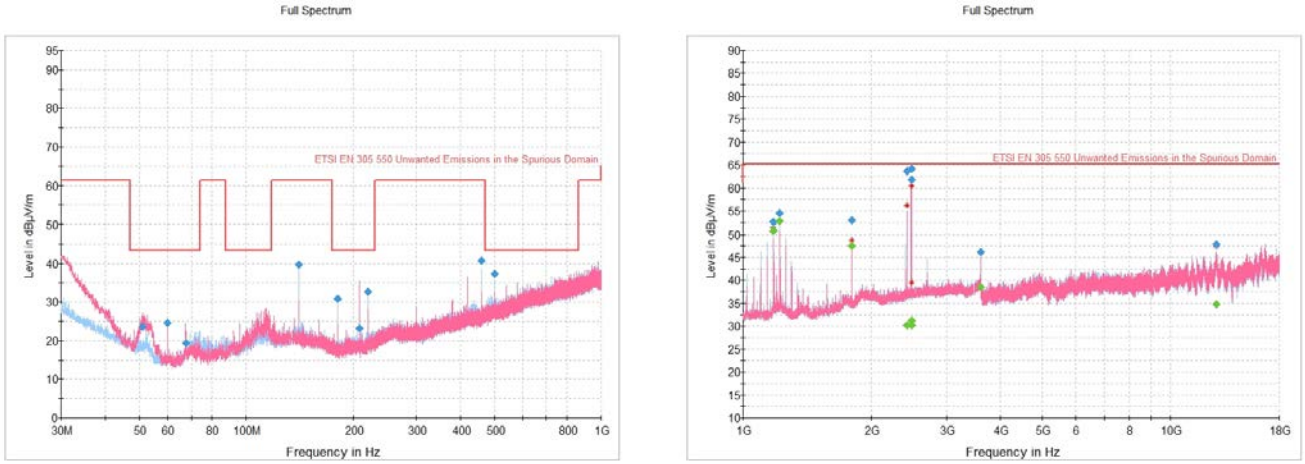


Figure 7.6-9: *Unwanted emissions spurious band plot – Field strength measured from 30 MHz to 18 GHz.*

Table 7.6-6: Unwanted emissions spurious band plot – Field strength measured from 30 to 1000 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
51.081333	23.68	43.38	19.70	1000.0	120.000	150.0	V	209.0	15.3
60.013000	24.60	43.38	18.78	1000.0	120.000	104.0	V	187.0	12.5
67.594333	19.37	43.38	24.01	1000.0	120.000	150.0	V	269.0	13.1
139.998000	39.75	61.38	21.63	1000.0	120.000	123.0	H	106.0	19.4
179.994333	30.91	43.38	12.47	1000.0	120.000	117.0	H	253.0	16.8
208.151667	23.28	43.38	20.10	1000.0	120.000	112.0	V	81.0	17.9
219.990667	32.66	43.38	10.72	1000.0	120.000	106.0	H	211.0	17.8
460.001000	40.73	61.38	20.65	1000.0	120.000	98.0	H	129.0	25.8
500.029667	37.28	43.38	6.10	1000.0	120.000	102.0	H	341.0	26.7

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4]The spectral plot is a summation of a vertical and horizontal scan.
[5]This measurement was done at 3m

Table 7.6-7: Unwanted emissions spurious band plot – Field strength measured from 1 to 18 MHz

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1180.033333	---	50.79	65.23	14.44	5000.0	1000.000	98.0	H	0.0	-14.7
1180.033333	52.58	---	65.23	12.65	5000.0	1000.000	98.0	H	0.0	-14.7
1219.866667	---	52.82	65.23	12.41	5000.0	1000.000	98.0	H	0.0	-14.5
1219.866667	54.53	---	65.23	10.70	5000.0	1000.000	98.0	H	0.0	-14.5
1799.966667	---	47.48	65.23	17.75	5000.0	1000.000	276.0	H	199.0	-12.9
1799.966667	53.05	---	65.23	12.18	5000.0	1000.000	276.0	H	199.0	-12.9
2425.733333	63.69	---	65.23	1.54	5000.0	1000.000	125.0	V	73.0	-10.8
2425.733333	---	30.13	65.23	35.10	5000.0	1000.000	125.0	V	73.0	-10.8
2480.133333	---	31.26	65.23	33.97	5000.0	1000.000	124.0	V	60.0	-10.5
2480.133333	64.11	---	65.23	1.12	5000.0	1000.000	124.0	V	60.0	-10.5
2480.300000	61.75	---	65.23	3.48	5000.0	1000.000	259.0	H	140.0	-10.5
2480.300000	---	30.15	65.23	35.08	5000.0	1000.000	259.0	H	140.0	-10.5
3600.100000	---	38.58	65.23	26.65	5000.0	1000.000	231.0	V	20.0	-6.3
3600.100000	46.20	---	65.23	19.03	5000.0	1000.000	231.0	V	20.0	-6.3
12830.466667	---	34.80	65.23	30.43	5000.0	1000.000	394.0	V	0.0	6.5
12830.466667	47.82	---	65.23	17.41	5000.0	1000.000	394.0	V	0.0	6.5

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4]The spectral plot is a summation of a vertical and horizontal scan.
[5]This measurement was done at 3m

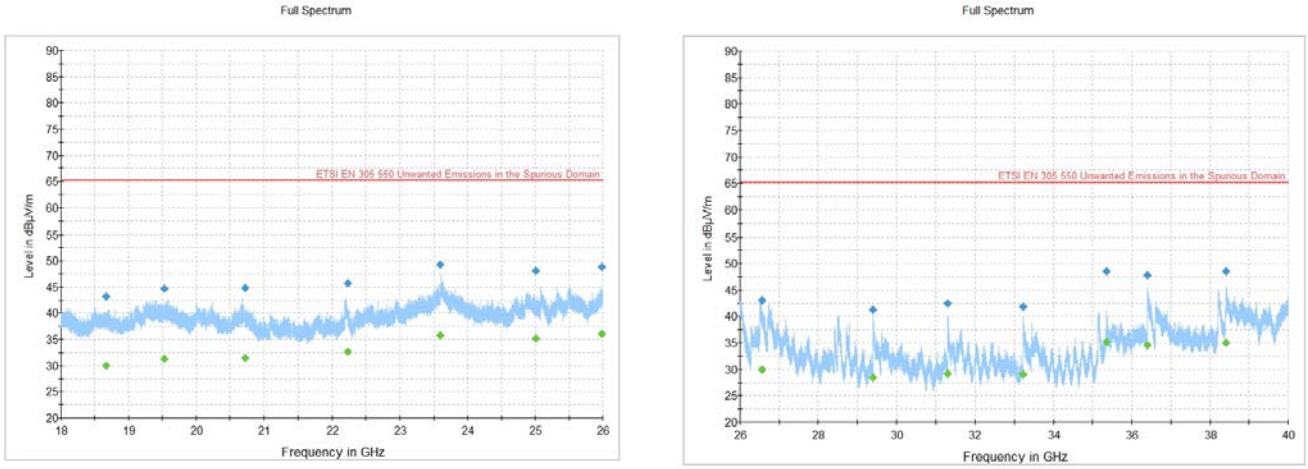


Figure 7.6-10: ***Unwanted emissions spurious band plot – Field strength measured from 18 to 40 GHz***

Table 7.6-8*: Unwanted emissions spurious band plot – Field strength measured from 18-26 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18668.044500	43.17	---	65.23	22.06	5000.0	1000.000	343.0	H	188.0	14.3
18668.044500	---	30.00	65.23	35.23	5000.0	1000.000	343.0	H	188.0	14.3
19531.315167	---	31.36	65.23	33.87	5000.0	1000.000	248.0	V	238.0	14.0
19531.315167	44.66	---	65.23	20.57	5000.0	1000.000	248.0	V	238.0	14.0
20721.595000	44.76	---	65.23	20.47	5000.0	1000.000	219.0	H	127.0	15.9
20721.595000	---	31.45	65.23	33.78	5000.0	1000.000	219.0	H	127.0	15.9
22225.081000	45.66	---	65.23	19.57	5000.0	1000.000	364.0	V	338.0	15.8
22225.081000	---	32.67	65.23	32.56	5000.0	1000.000	364.0	V	338.0	15.8
23601.668500	---	35.73	65.23	29.50	5000.0	1000.000	402.0	H	264.0	20.4
23601.668500	49.30	---	65.23	15.93	5000.0	1000.000	402.0	H	264.0	20.4
25007.743000	---	35.09	65.23	30.14	5000.0	1000.000	281.0	V	163.0	19.0
25007.743000	48.09	---	65.23	17.14	5000.0	1000.000	281.0	V	163.0	19.0
25988.307000	48.88	---	65.23	16.35	5000.0	1000.000	112.0	V	0.0	20.5
25988.307000	---	36.11	65.23	29.12	5000.0	1000.000	112.0	V	0.0	20.5

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.
[5] This measurement was done at 3m

Table 7.6-9*: Unwanted emissions spurious band plot – Field strength measured from 26-40 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Band width (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26553.866667	---	29.89	65.23	35.34	5000.0	1000.	107.0	V	121.0	8.3
26553.866667	43.00	---	65.23	22.23	5000.0	1000.	107.0	V	121.0	8.3
29397.533333	41.23	---	65.23	24.00	5000.0	1000.	103.0	V	1.0	10.1
29397.533333	---	28.52	65.23	36.71	5000.0	1000.	103.0	V	1.0	10.1
31301.733333	42.40	---	65.23	22.84	5000.0	1000.	225.0	V	38.0	12.5
31301.733333	---	29.17	65.23	36.06	5000.0	1000.	225.0	V	38.0	12.5
33221.533333	---	29.08	65.23	36.16	5000.0	1000.	99.0	V	24.0	12.4
33221.533333	41.89	---	65.23	23.34	5000.0	1000.	99.0	V	24.0	12.4
35358.600000	---	35.15	65.23	30.08	5000.0	1000.	218.0	H	177.0	15.7
35358.600000	48.55	---	65.23	16.68	5000.0	1000.	218.0	H	177.0	15.7
36397.733333	---	34.50	65.23	30.74	5000.0	1000.	106.0	V	156.0	16.3
36397.733333	47.74	---	65.23	17.49	5000.0	1000.	106.0	V	156.0	16.3
38411.733333	---	35.01	65.23	30.22	5000.0	1000.	106.0	V	9.0	16.7
38411.733333	48.48	---	65.23	16.75	5000.0	1000.	106.0	V	9.0	16.7

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.
[5] This measurement was done at 3m

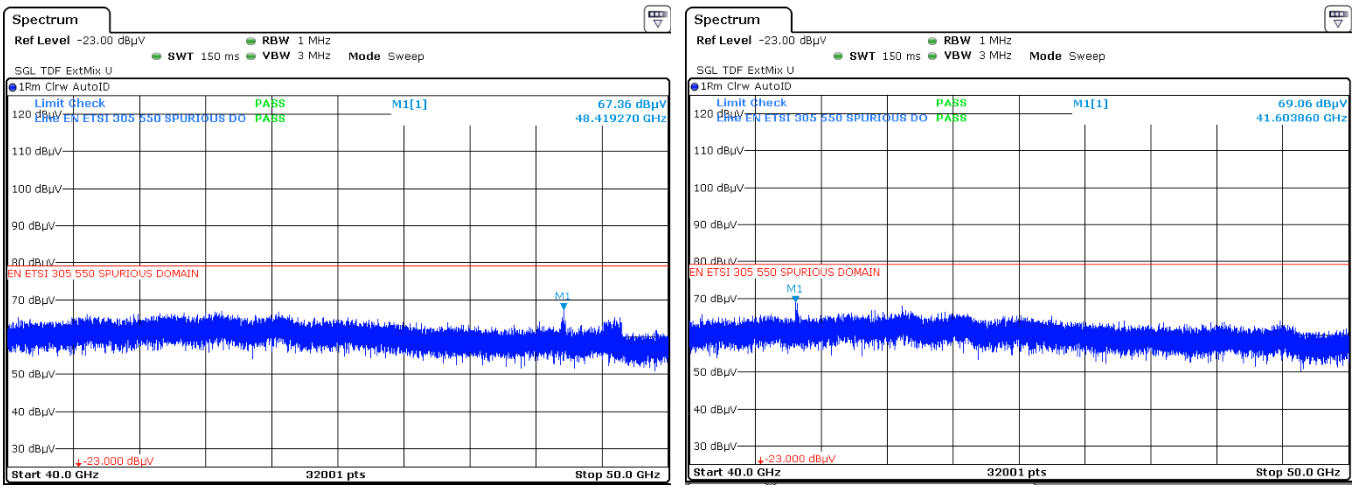


Figure 7.6-11: *Unwanted emissions spurious band plot – Field strength measured from 40 to 50 GHz, horizontal and vertical polarization respectively.*

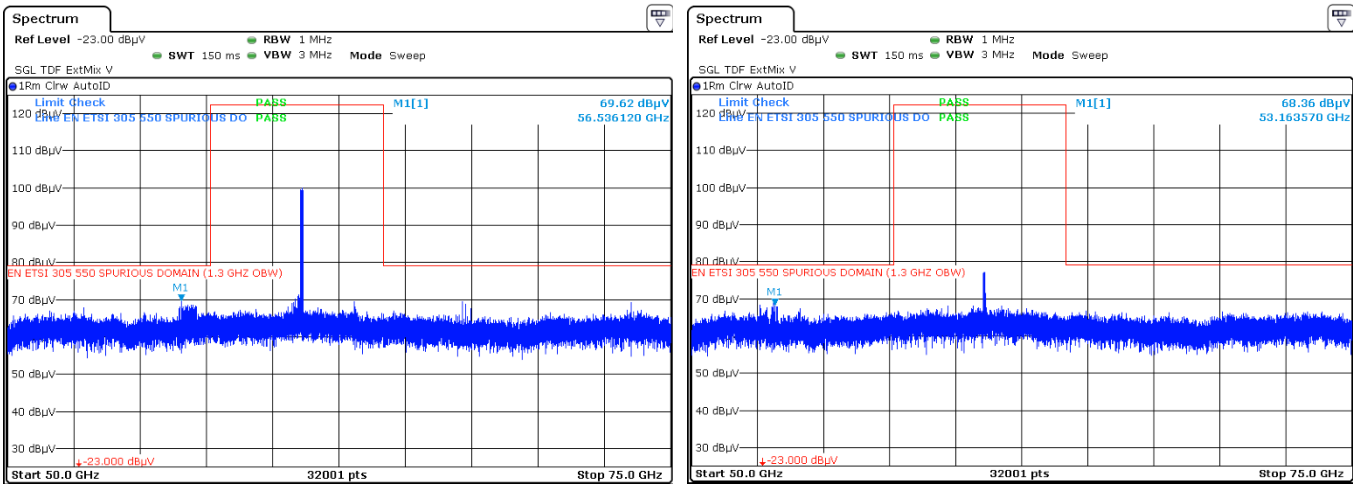


Figure 7.6-12: ***Unwanted emissions spurious band plot – Field strength measured from 50 - 75 GHz, horizontal and vertical polarization respectively.***

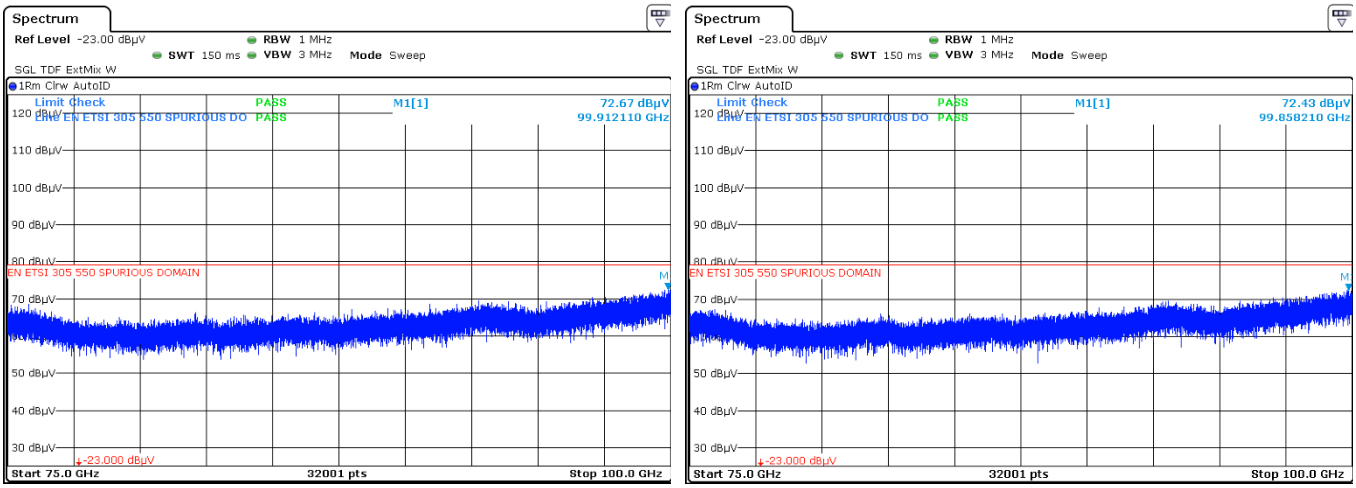


Figure 7.6-13: Unwanted emissions spurious band plot – Field strength measured from 75 to 100 GHz, horizontal and vertical polarization respectively.

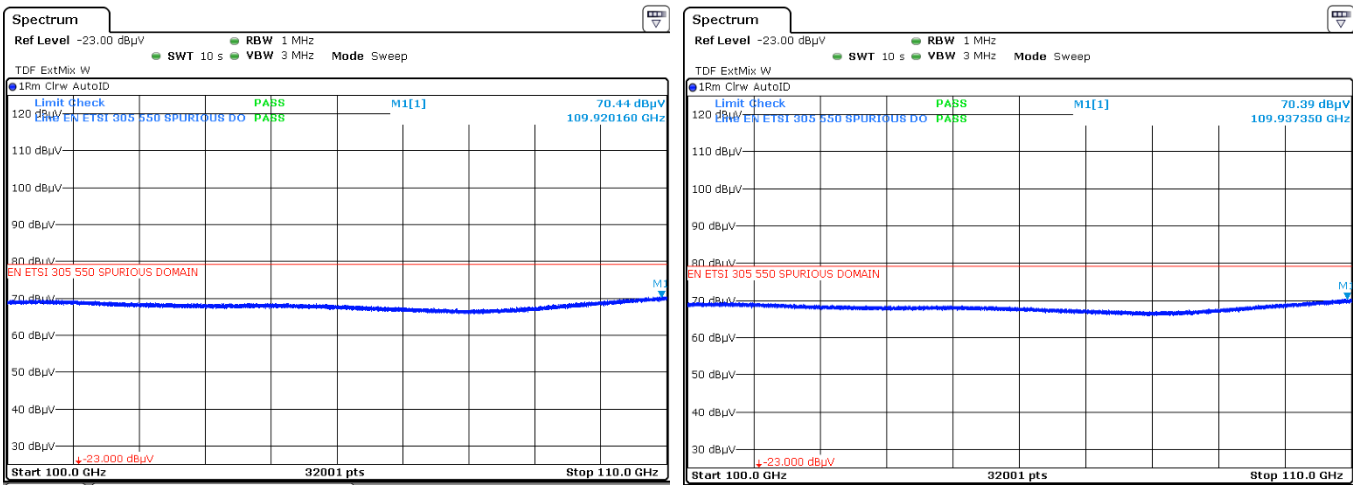


Figure 7.6-14: Unwanted emissions spurious band plot – Field strength measured from 100 - 110 GHz, horizontal and vertical polarization respectively.

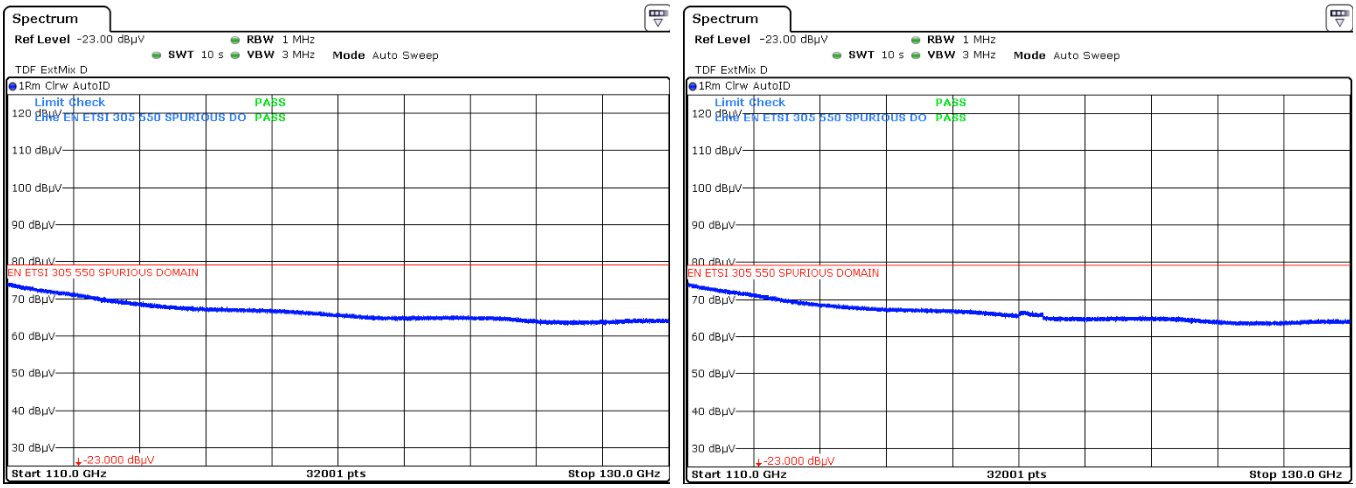


Figure 7.6-15: Unwanted emissions spurious band plot – Field strength measured from 110 to 130 GHz, horizontal and vertical polarization respectively.

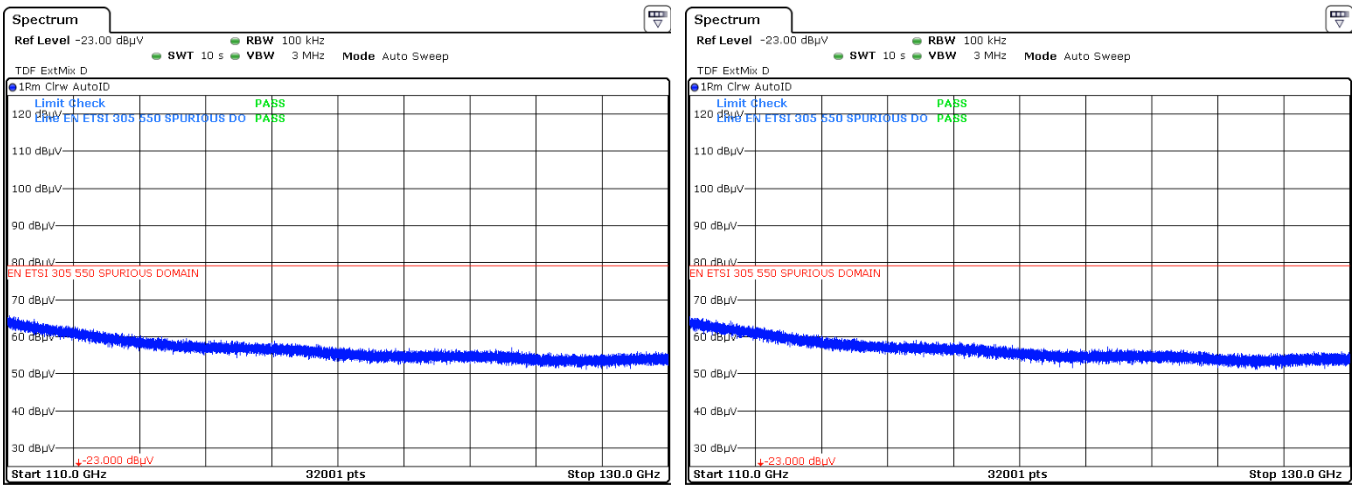


Figure 7.6-16: Unwanted emissions spurious band plot – Field strength measured from 110 to 130 GHz, horizontal and vertical polarization respectively (100 kHz RBW).

Note: Above 1 GHz, ETSI EN 305 550 standard specifies a resolution bandwidth of 1 MHz and a video bandwidth of ≥ 3 MHz. However, for this specific case the measurements from 110 to 130 GHz show a high noise floor due to the correction factors applied such as the mixer conversion losses, antenna factors and cable losses. In order to demonstrate there are no spurious emissions, the RBW was changed to 100 kHz in both polarizations.

- ***57 – 64 GHz: 4000 MHz OBW***

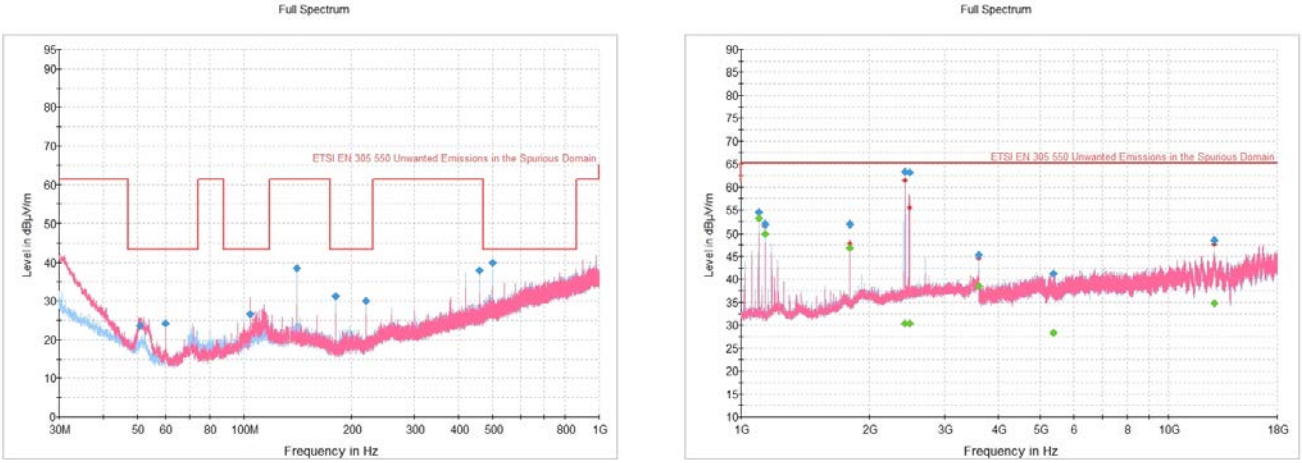


Figure 7.6-17: Unwanted emissions spurious band plot – Field strength measured from 30 MHz to 18 GHz.

Table 7.6-10*: Unwanted emissions spurious band plot – Field strength measured from 30 to 1000 MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
50.803667	23.55	43.38	19.83	1000.0	120.000	102.0	V	130.0	15.5
60.013000	24.16	43.38	19.22	1000.0	120.000	122.0	V	209.0	12.5
104.058667	26.55	43.38	16.83	1000.0	120.000	397.0	V	49.0	18.0
139.998000	38.55	61.38	22.83	1000.0	120.000	126.0	H	257.0	19.4
179.986667	31.34	43.38	12.04	1000.0	120.000	102.0	H	228.0	16.8
219.983000	30.04	43.38	13.34	1000.0	120.000	102.0	H	124.0	17.8
459.993333	37.83	61.38	23.55	1000.0	120.000	106.0	H	172.0	25.8
499.997333	40.02	43.38	3.36	1000.0	120.000	113.0	H	308.0	26.7

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4]The spectral plot is a summation of a vertical and horizontal scan.
[5]This measurement was done at 3m

Table 7.6-11: Unwanted emissions spurious band plot – Field strength measured from 1 to 18 MHz

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1100.133333	---	53.17	65.23	12.06	5000.0	1000.000	103.0	H	315.0	-15.4
1100.133333	54.47	---	65.23	10.76	5000.0	1000.000	103.0	H	315.0	-15.4
1140.200000	51.90	---	65.23	13.33	5000.0	1000.000	101.0	H	344.0	-15.2
1140.200000	---	49.95	65.23	15.28	5000.0	1000.000	101.0	H	344.0	-15.2
1799.966667	52.04	---	65.23	13.19	5000.0	1000.000	314.0	H	194.0	-12.9
1799.966667	---	46.79	65.23	18.44	5000.0	1000.000	314.0	H	194.0	-12.9
2426.300000	63.38	---	65.23	1.85	5000.0	1000.000	117.0	V	20.0	-10.8
2426.300000	---	30.34	65.23	34.89	5000.0	1000.000	117.0	V	20.0	-10.8
2480.366667	---	30.36	65.23	34.87	5000.0	1000.000	184.0	V	16.0	-10.5
2480.366667	63.22	---	65.23	2.01	5000.0	1000.000	184.0	V	16.0	-10.5
3600.100000	45.41	---	65.23	19.82	5000.0	1000.000	236.0	H	12.0	-6.3
3600.100000	---	38.56	65.23	26.67	5000.0	1000.000	236.0	H	12.0	-6.3
5383.900000	41.25	---	65.23	23.98	5000.0	1000.000	402.0	V	32.0	-3.3
5383.900000	---	28.31	65.23	36.92	5000.0	1000.000	402.0	V	32.0	-3.3
12805.100000	48.59	---	65.23	16.64	5000.0	1000.000	293.0	H	178.0	6.5
12805.100000	---	34.74	65.23	30.49	5000.0	1000.000	293.0	H	178.0	6.5

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4]The spectral plot is a summation of a vertical and horizontal scan.
[5]This measurement was done at 3m

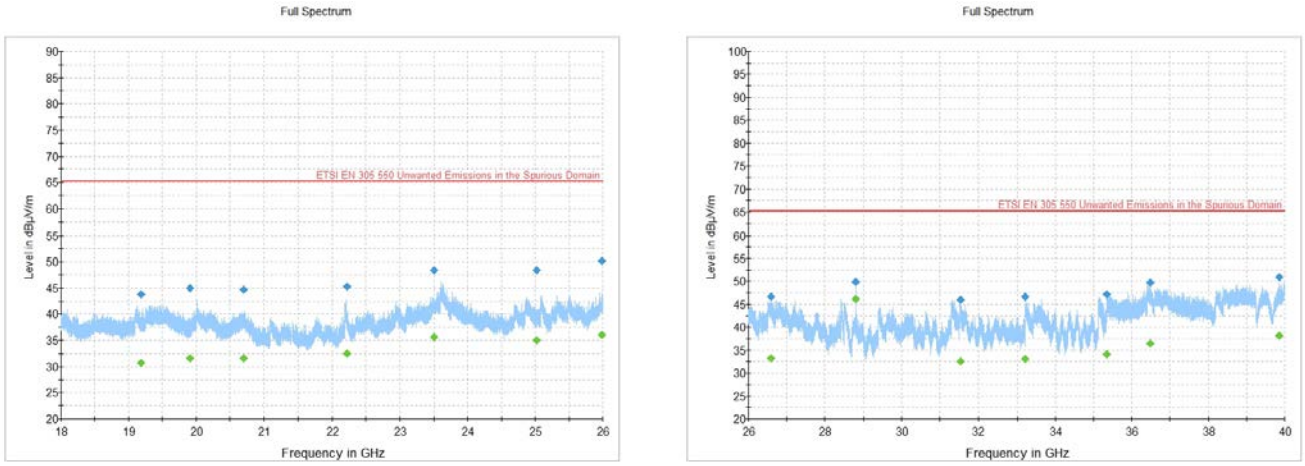


Figure* 7.6-18*: Unwanted emissions spurious band plot – Field strength measured from 18 to 40 GHz

Table 7.6-12*: Unwanted emissions spurious band plot – Field strength measured from 18-26 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19178.324000	43.76	---	65.23	21.47	5000.0	1000.000	274.0	V	20.0	13.8
19178.324000	---	30.63	65.23	34.60	5000.0	1000.000	274.0	V	20.0	13.8
19911.424167	44.97	---	65.23	20.26	5000.0	1000.000	376.0	V	201.0	13.5
19911.424167	---	31.66	65.23	33.57	5000.0	1000.000	376.0	V	201.0	13.5
20700.108667	---	31.59	65.23	33.64	5000.0	1000.000	152.0	H	254.0	15.9
20700.108667	44.63	---	65.23	20.60	5000.0	1000.000	152.0	H	254.0	15.9
22213.849167	45.20	---	65.23	20.03	5000.0	1000.000	209.0	H	0.0	15.9
22213.849167	---	32.55	65.23	32.68	5000.0	1000.000	209.0	H	0.0	15.9
23502.904333	---	35.56	65.23	29.67	5000.0	1000.000	260.0	V	168.0	20.3
23502.904333	48.44	---	65.23	16.79	5000.0	1000.000	260.0	V	168.0	20.3
25025.763667	---	35.06	65.23	30.17	5000.0	1000.000	169.0	V	28.0	19.1
25025.763667	48.36	---	65.23	16.87	5000.0	1000.000	169.0	V	28.0	19.1
25991.166833	50.12	---	65.23	15.11	5000.0	1000.000	328.0	V	78.0	20.5
25991.166833	---	36.09	65.23	29.14	5000.0	1000.000	328.0	V	78.0	20.5

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.
[5] This measurement was done at 3m

Table 7.6-13: *Unwanted emissions spurious band plot – Field strength measured from 26 to 40 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26599.133333	---	33.25	65.23	31.98	5000.0	1000.000	102.0	V	9.0	8.3
26599.133333	46.73	---	65.23	18.50	5000.0	1000.000	102.0	V	9.0	8.3
28800.666667	---	46.15	65.23	19.08	5000.0	1000.000	134.0	V	4.0	9.5
28800.666667	49.96	---	65.23	15.27	5000.0	1000.000	134.0	V	4.0	9.5
31546.066667	---	32.54	65.23	32.69	5000.0	1000.000	98.0	V	339.0	12.9
31546.066667	45.98	---	65.23	19.25	5000.0	1000.000	98.0	V	339.0	12.9
33211.066667	46.70	---	65.23	18.53	5000.0	1000.000	124.0	V	9.0	12.4
33211.066667	---	33.10	65.23	32.13	5000.0	1000.000	124.0	V	9.0	12.4
35349.200000	47.22	---	65.23	18.01	5000.0	1000.000	108.0	V	88.0	15.6
35349.200000	---	34.05	65.23	31.18	5000.0	1000.000	108.0	V	88.0	15.6
36484.933333	---	36.51	65.23	28.72	5000.0	1000.000	106.0	V	192.0	16.3
36484.933333	49.70	---	65.23	15.53	5000.0	1000.000	106.0	V	192.0	16.3
39849.333333	---	38.19	65.23	27.04	5000.0	1000.000	124.0	V	213.0	18.0
39849.333333	50.97	---	65.23	14.26	5000.0	1000.000	124.0	V	213.0	18.0

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.
[5] This measurement was done at 3m

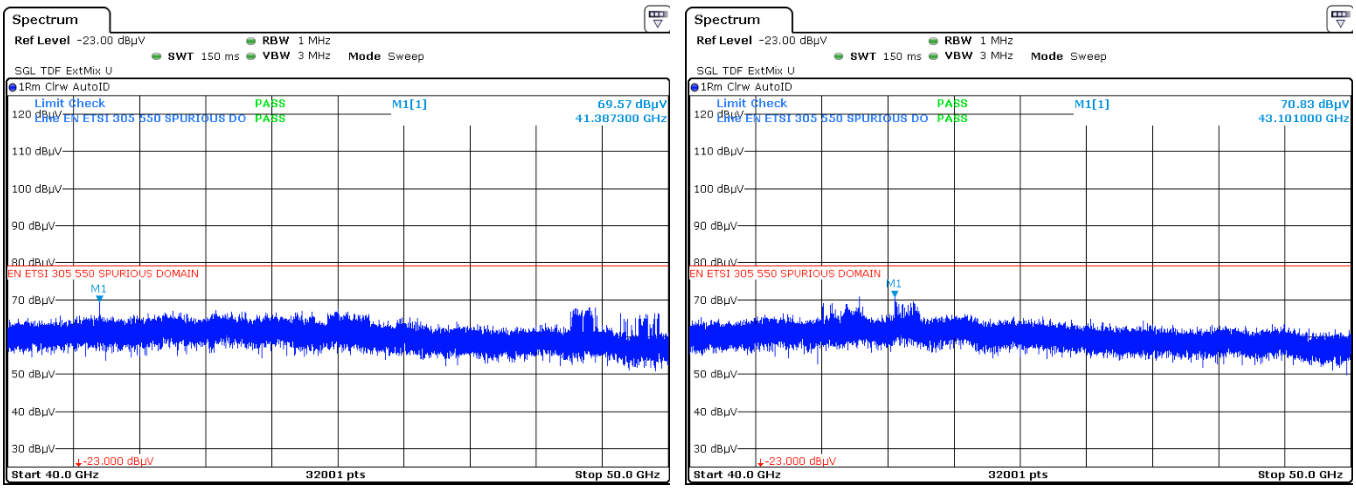


Figure 7.6-19: Unwanted emissions spurious band plot – Field strength measured from 40 to 50 GHz, horizontal and vertical polarization respectively.

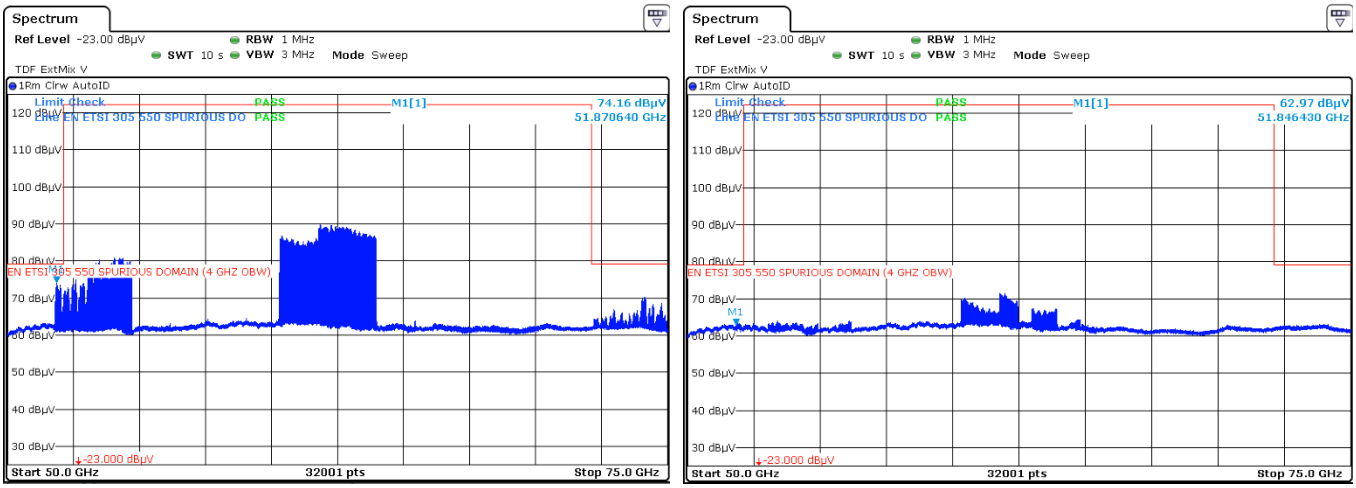


Figure 7.6-20: Unwanted emissions spurious band plot – Field strength measured from 50 - 75 GHz, horizontal and vertical polarization respectively.

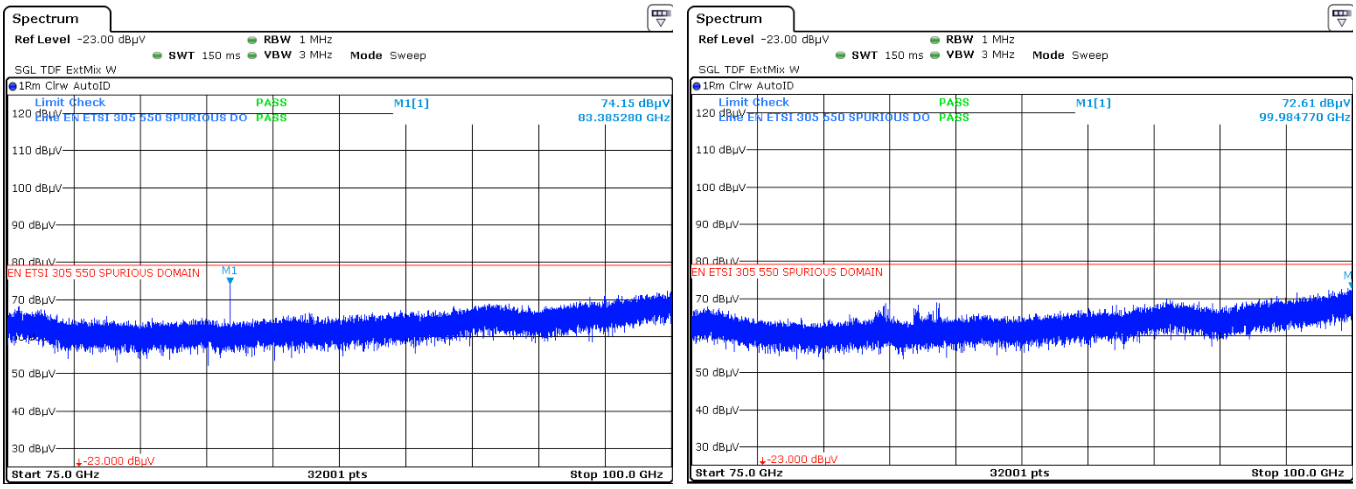


Figure 7.6-21: Unwanted emissions spurious band plot – Field strength measured from 75 to 100 GHz, horizontal and vertical polarization respectively.

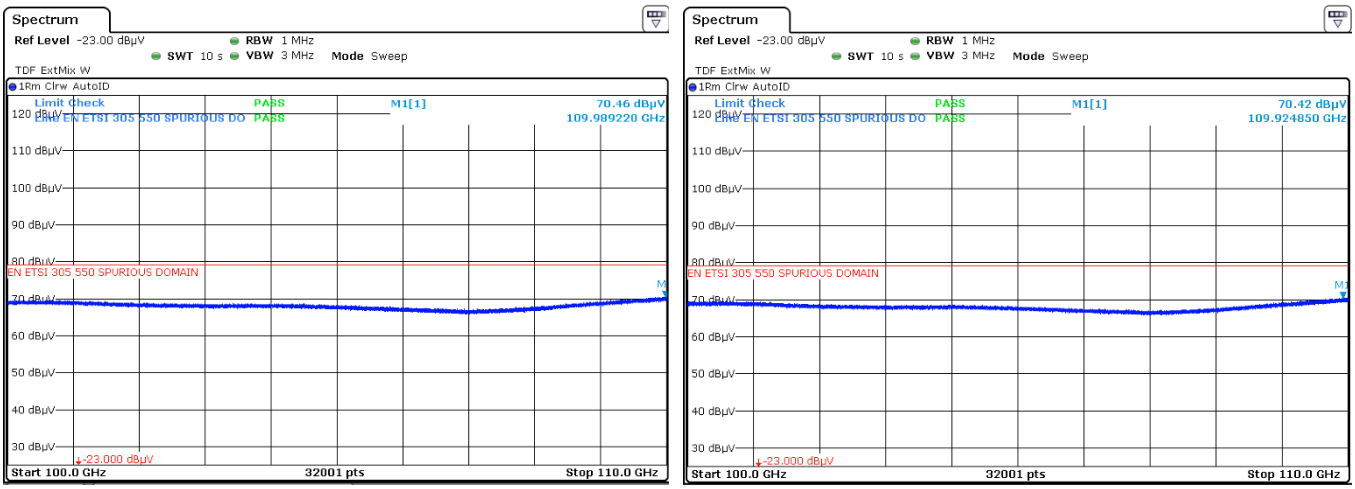


Figure 7.6-22: Unwanted emissions spurious band plot – Field strength measured from 100 - 110 GHz, horizontal and vertical polarization respectively.

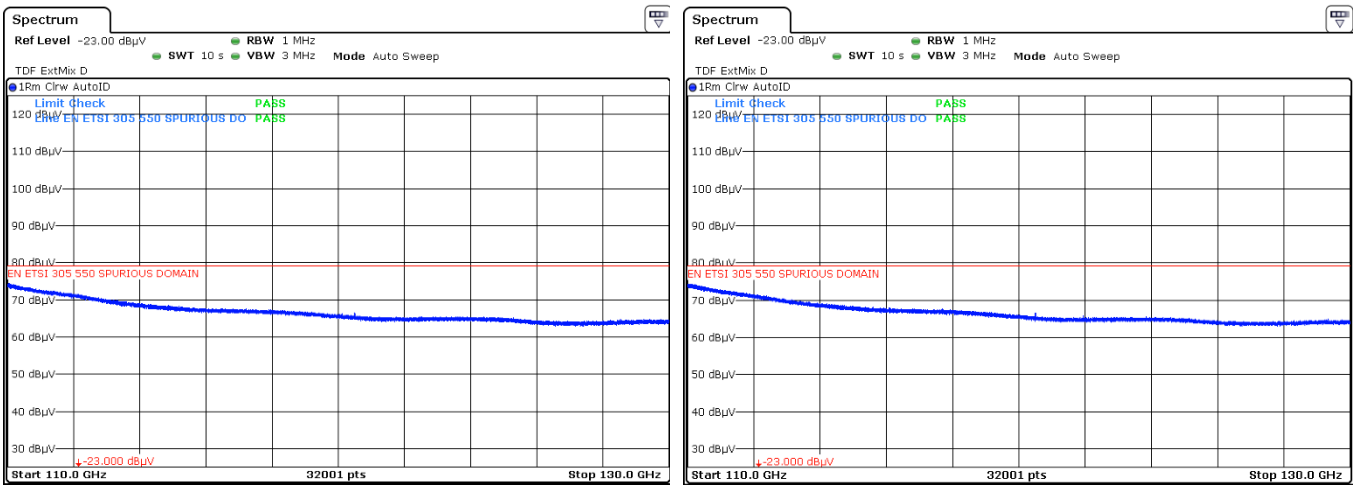


Figure 7.6-23: Unwanted emissions spurious band plot – Field strength measured from 110 to 130 GHz, horizontal and vertical polarization respectively.

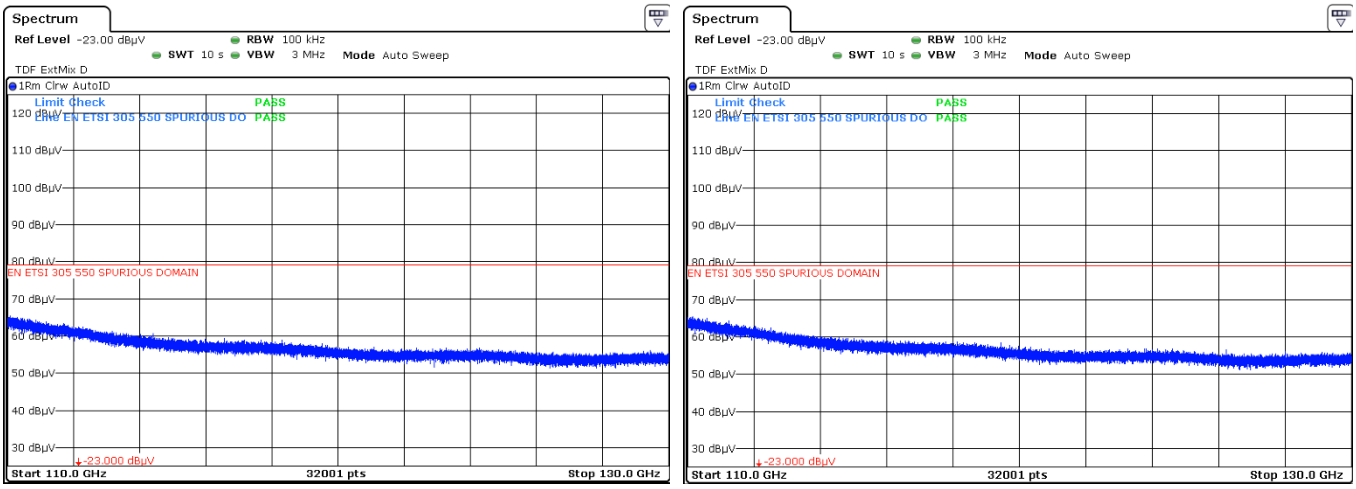


Figure 7.6-24: Unwanted emissions spurious band plot – Field strength measured from 110 to 130 GHz, horizontal and vertical polarization respectively (100 kHz RBW).

Note: Above 1 GHz, ETSI EN 305 550 standard specifies a resolution bandwidth of 1 MHz and a video bandwidth of ≥ 3 MHz. However, for this specific case the measurements from 110 to 130 GHz show a high noise floor due to the correction factors applied such as the mixer conversion losses, antenna factors and cable losses. In order to demonstrate there are no spurious emissions, the RBW was changed to 100 kHz in both polarizations.

7.7 Radiated Emissions Setup photos

Figure **7.7-1: Radiated emissions measured from 30 MHz to 18 GHz. Measurement at 3 m.**

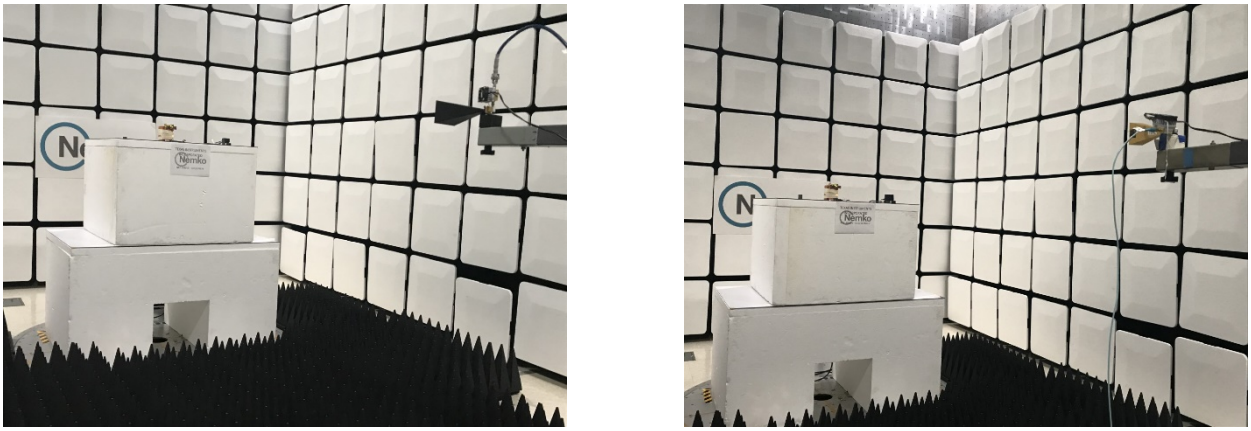


Figure 7.7-2: Radiated emissions measured from 18 GHz to 40 GHz. Measurement at 3 m.

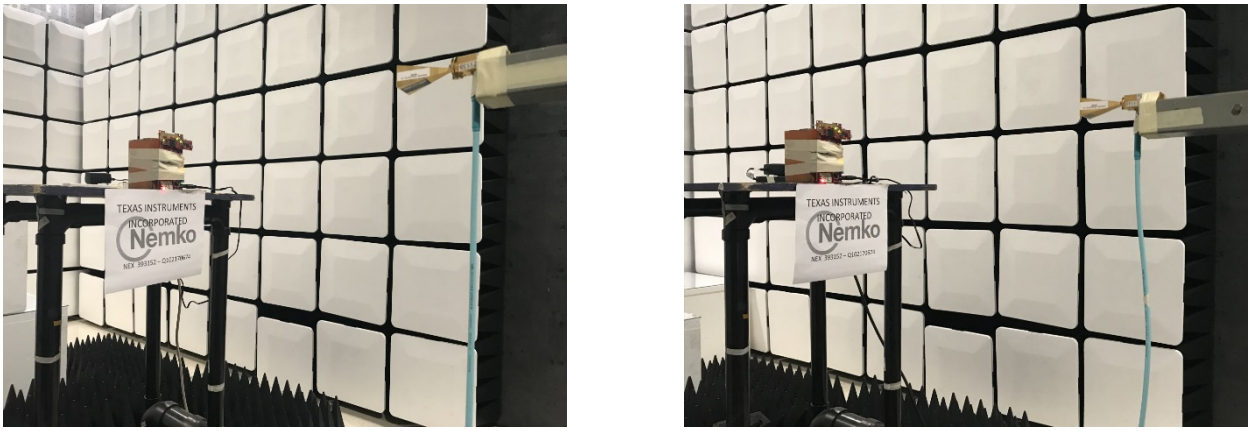


Figure 7.7-3: Radiated emissions measured from 40 GHz to 75 GHz. Measurement at 0.60 m

***Figure* 7.7-4: Radiated emissions measured from 75 GHz to 130 GHz. Measurement at 0.60 m.**

7.8 Receiver interference signal handling

7.8.1 References

ETSI EN 302264 → Section 4.4.3 → ETSI TS 103 361→ Clause 9

Interferer signal handling, defined as the capability of the device to operate as intended in coexistence with interferers, is a receiver parameter for radio applications. The interfering signal transmitter shall transmit continuous wave signals at specific frequencies, as described in table 11 to table 14.

Table 11: For EUT operating within 57 GHz to 64 GHz

	In-band signal	OOB signal	Remote-band signal
Frequency	Centre frequency (f_c) of the EUT modulated signal (see clause 4.3.1)	$f = f_c \pm OBW$	$f = f_c \pm 10 \times OBW$
Signal level field strength at the EUT	55 mV/m	173 mV/m	173 mV/m
Equivalent EIRP at 10 m	10 dBm	20 dBm	20 dBm

Table 12: For EUT operating within 61,0 GHz to 61,5 GHz

	In-band signal	OOB signal	Remote-band signal
Frequency	Centre frequency (f_c) of the EUT modulated signal (see clause 4.3.1)	$f = f_c \pm OBW$	$f = f_c \pm 10 \times OBW$
Signal level field strength at the EUT	55 mV/m	173 mV/m	173 mV/m
Equivalent EIRP at 10 m	10 dBm	20 dBm	20 dBm

7.8.2 Test summary

Verdict	Pass		
Test date	March 27, 2020	Temperature	24°C
Test engineer	Martha Espinoza	Air pressure	998 mbar
Test location	3M semi anechoic chamber	Relative humidity	53%

7.8.3 Notes

This is a radiated test measured at 0.5 meter.

Table 7.8-1: Interference signal injected on EUT.

	OBW	In band signal	OOB Signal	Remote band signal
Frequency	500 MHz	61.2497 GHz	60.7497 GHz; 61.7497 GHz	56.2497 GHz; 66.2497 GHz
Signal level field strength at EUT	----------	94.808 dBµV	104.761 dBµV	104.761 dBµV
Frequency	1300 MHz	60.923 GHz	59.623 GHz; 62.223 GHz	47.923 GHz; 73.923 GHz
Signal level field strength at EUT	----------	94.808 dBµV	104.761 dBµV	104.761 dBµV
Frequency	4000 MHz	62.119 GHz	58.119 GHz; 66.119 GHz	22.119 GHz; 102.119 GHz
Signal level field strength at EUT	----------	94.808 dBµV	104.761 dBµV	104.761 dBµV

The signal level strength given in mv/m was converter in dBµV using the equation:

$$E(dBuV) = \left(20 * Log10\left(E(v/m)\right)\right) + 120$$

This section is required only in normal test conditions.

7.8.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi Anechoic Chamber (SAC)
Measuring distance	0.5 m
Antenna height variation	0.8 M
Turn table position	0
RBW	1 MHz
VBW	≥ 3 MHz
Detector	RMS
Trace	Clear/Write

Table 7.8-2: ***Receiver interference signaling handling equipment list***

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Signal Analyzer	Rohde & Schwarz	FSV 40	E1120	11-19-2019	11-19-2020
Signal Generator	Rohde & Schwarz	SMB 100A	E1128	12-23-2019	12-23-2020
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	03-05-2018	06-05-2020
Antenna, Horn	Sage Millimeter	SAR-2309-28-S2	E1148	03-13-2018	06-13-2020
Low Noise Amplifier	Sage Millimeter	SBL-1834034030-KFKF-SI	E1228	NCR	NCR
Antenna, Horn	Sage Millimeter	SAR-2309-19-S2	E1144	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z60	E1138	03-07-2019	03-07-2021
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z75	E1149	03-07-2019	03-07-2021
Antenna, Horn	Sage Millimeter	SAR-2507-10-S2	E1146	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z110	E1154	02-06-2019	02-06-2021
Antenna, Horn	Sage Millimeter	SAR-2507-06-S2	E1182	NCR	NCR
Mixer	Radiometer Physics	HM110-170	E1178	09-27-2018	09-27-2020
Antenna, Horn	Sage Millimeter	SAR-2309-05-S2	E1184	NCR	NCR
Mixer	Radiometer Physics	HM140-220	E1177	09-25-2018	09-25-2020

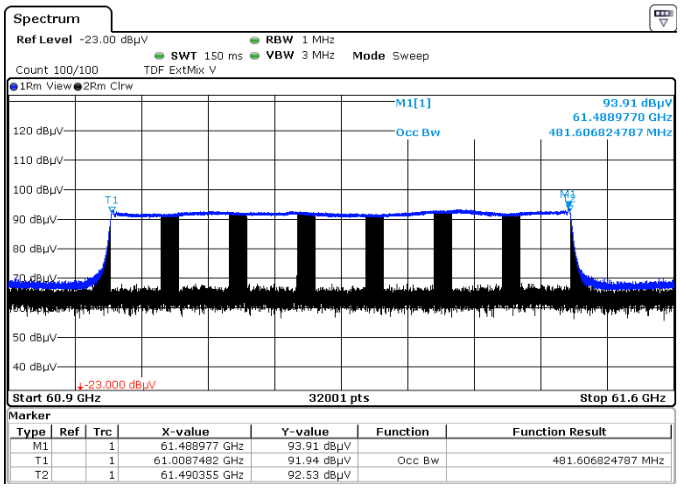
Notes: None

7.8.5 Test data and test plots

- ***61 – 61.5 GHz Band (500 MHz OBW)***

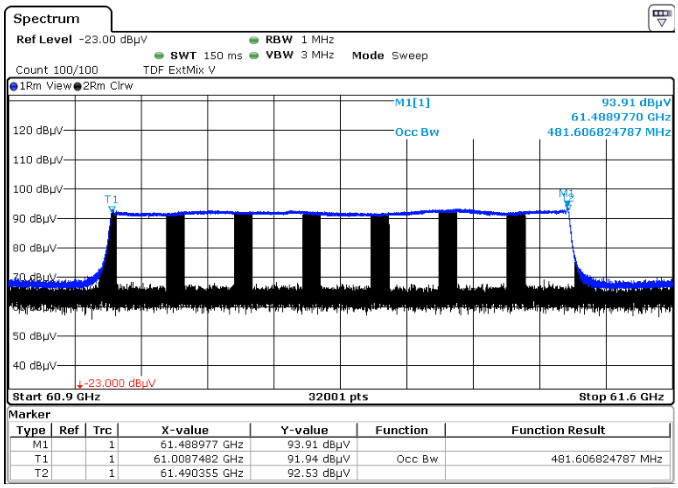
Signal Injected: 56.2497 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is not active for this test.



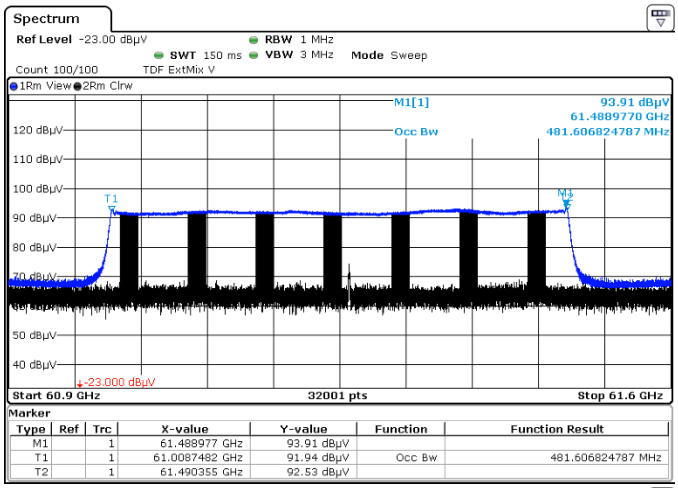
Signal Injected: 60.7497 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is not active for this test



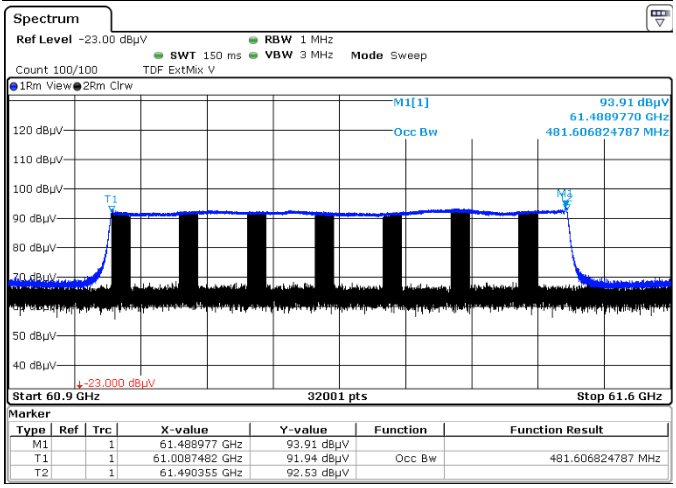
Signal Injected: 61.2497 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 94.808 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is not active for this test



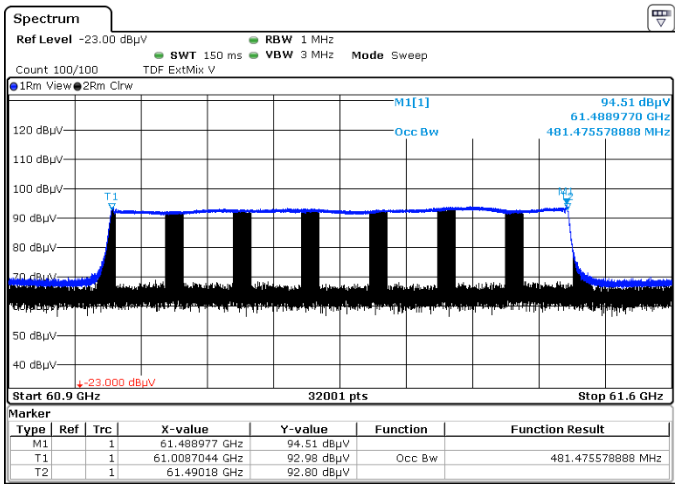
Signal Injected: 61.7497 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is not active for this test



Signal Injected: 66.2497 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

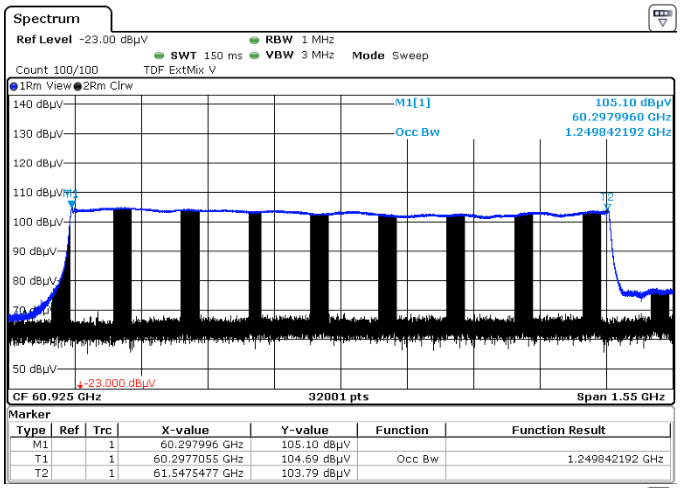
Note: The auto ID is not active for this test



- ***57 - 64 GHz Band (1300 MHz OBW)***

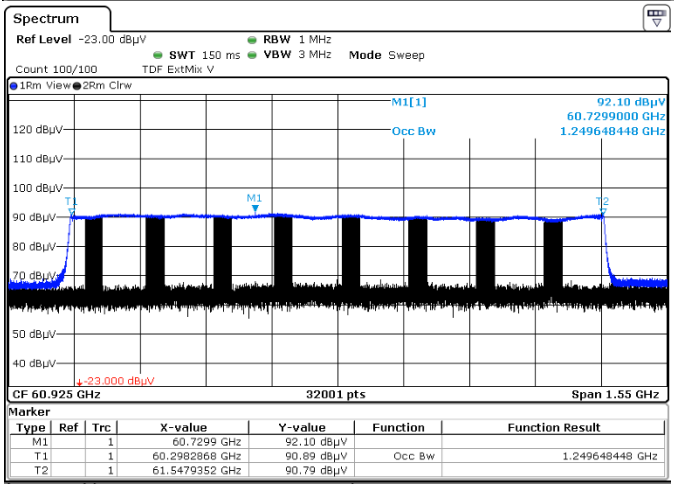
Signal Injected: 47.923 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is not active for this test



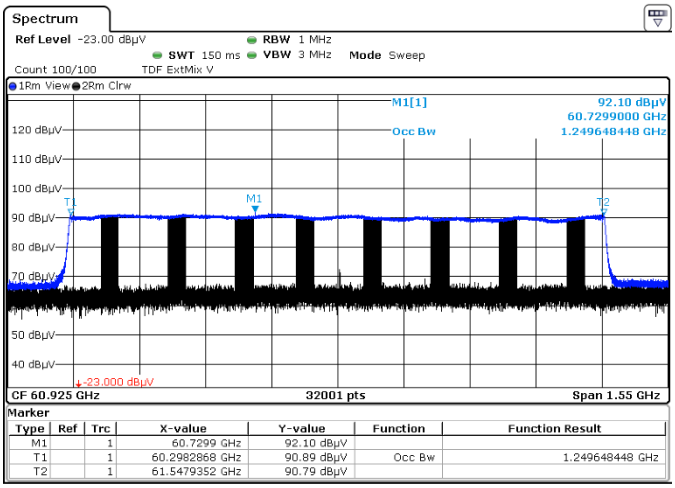
Signal Injected: 59.623 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is not active for this test



Signal Injected: 60.923 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 94.808 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

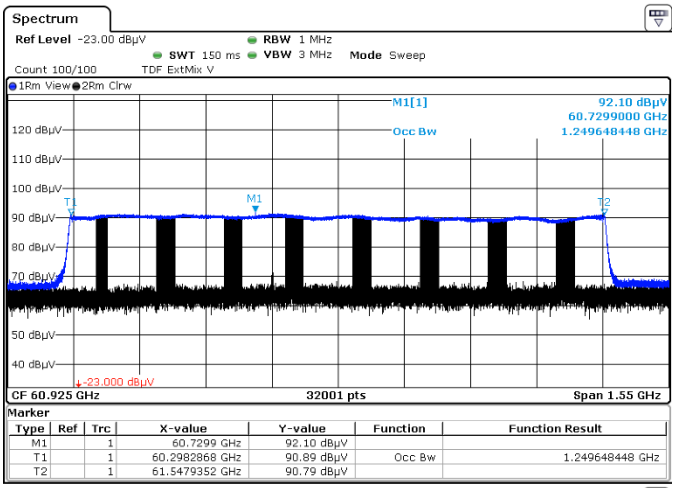
Note: The auto ID is not active for this test



- ***57 - 64 GHz Band (1300 MHz OBW)***

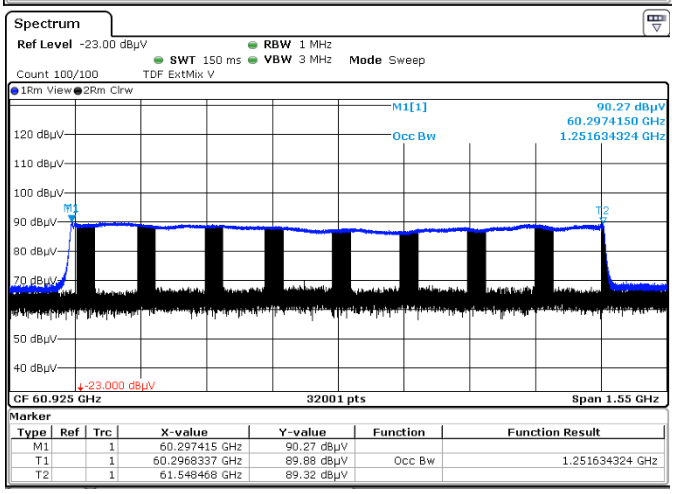
Signal Injected: 62.223 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is not active for this test



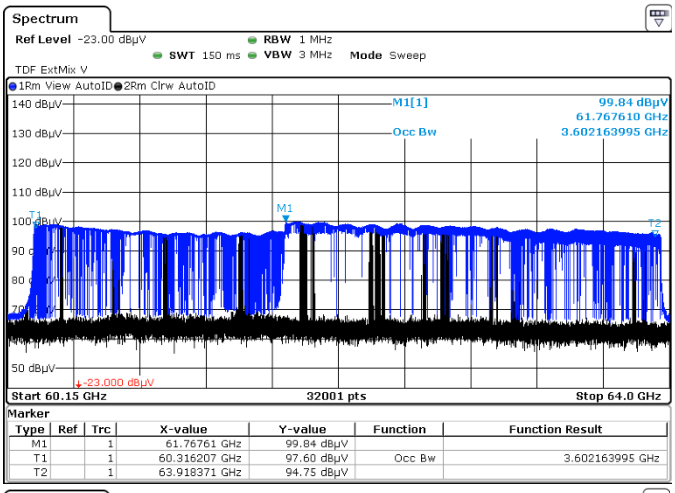
Signal Injected: 73.923 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is not active for this test



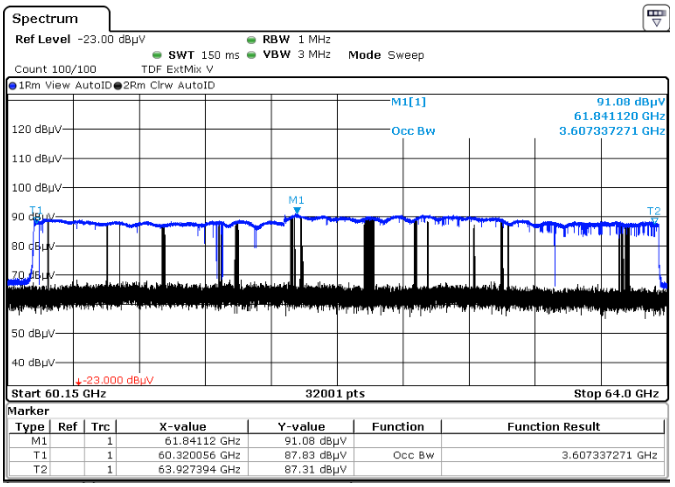
Signal Injected: 22.119 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is active for this test and for that reason the signal does not look so clean as the previous bandwidths where this function was not active.



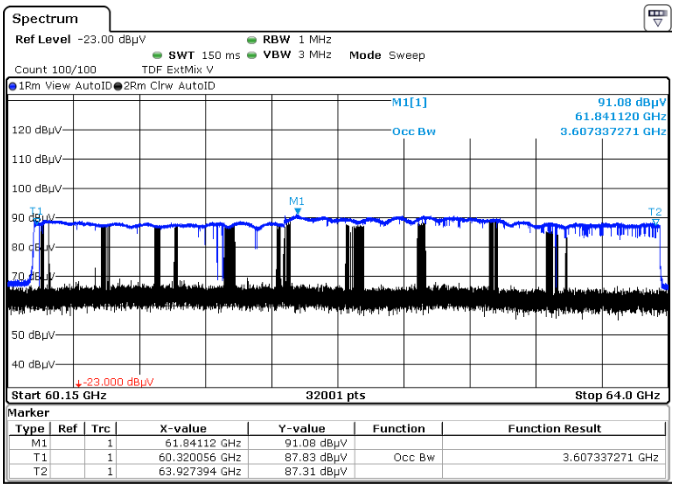
Signal Injected: 58.119 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is active for this test and for that reason the signal does not look so clean as the previous bandwidths where this function was not active.



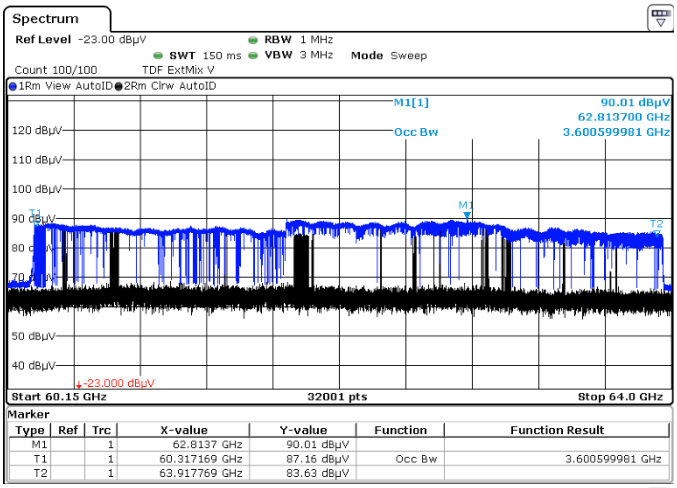
Signal Injected: 62.119 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 94.808 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is active for this test and for that reason the signal does not look so clean as the previous bandwidths where this function was not active.



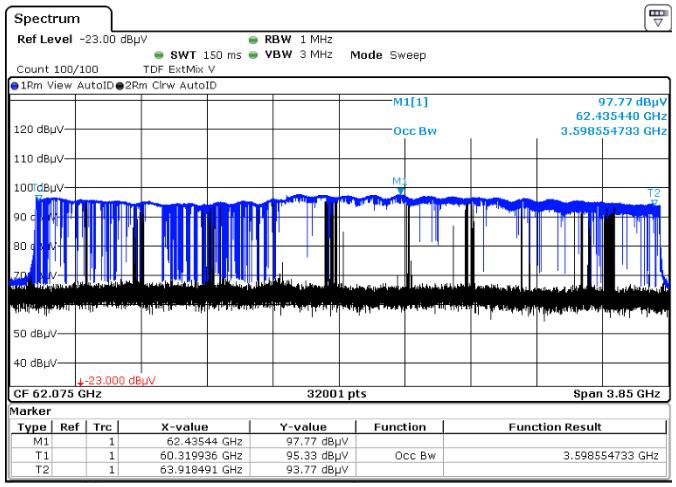
Signal Injected: 66.119 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is active for this test and for that reason the signal does not look so clean as the previous bandwidths where this function was not active.



Signal Injected: 102.119 GHz
Trace 1 (Blue trace): Without signal injected.
Trace 2 (Black trace): With signal injected.
Injected level: 104.761 dBµV
No Issues in the spectrum occupied by the fundamental transmission.

Note: The auto ID is active for this test and for that reason the signal does not look so clean as the previous bandwidths where this function was not active.



7.9 Receiver Interference signal handling Setup photos

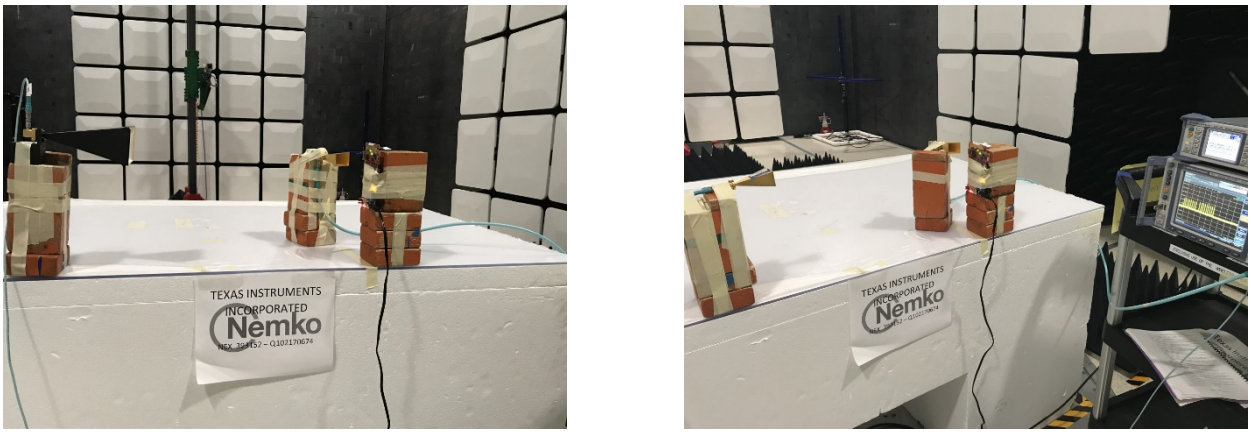


***Figure* 7.9-1: Setup to inject signals.**

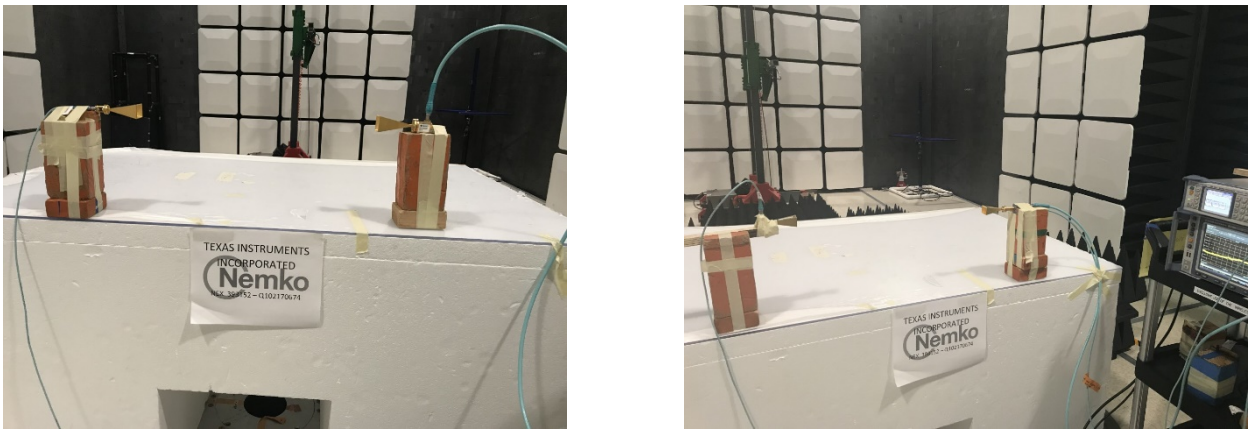


***Figure* 7.9-2: Setup calibration.**