Report on the Radio Testing

FOR

Cobham TCS Limited

ON

Phase 4, Agile Mesh Netnode Module D1707
Model No. NETNODEP4

DOCUMENT NO. TRA-026652-03-47-00B

Test Report Number	**:** TRA-026652-03-47-00B
Applicant	**:** Cobham TCS Limited
Apparatus	**:** Phase 4, Agile Mesh Netnode Module D1707
Specification(s)	**:** CFR47 Part 90 and Part 15B
Purpose of Test	**: Certification**
FCCID	**: XRF-NETNODEP4**
Authorised by	: John Charters Digitally signed by John Charters DN: cn=John Charters, o=Element Materials Technology, ou, email=john.charters@element.com, c=GB Date: 2016.03.09 12:08:33 Z
	: Department Manager - Radio
Issue Date	**:9th March 2016**

Authorised Copy Number : *PDF*

Contents

Section 1: Introduction

1.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

Test performed by:	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	[ ]
	Element North West Unit 1 Pendle Place Skemersdale West Lancashire WN8 9PN UK	[X]
Tests performed by:	A Tosif	
Report author:	A Tosif	

1.2 Tests Requested By

This testing in this report was requested by:

Cobham TCS Limited
The Cobham Centre
Fusion 2, 1100 Parkway
Solent Business Park
Whiteley
Hampshire
PO15 7AB

1.3 Manufacturer

As above

1.4 Apparatus Assessed

The following apparatus was assessed between 24th Nov 2015 and 30th Nov 2015:

Phase 4, Agile Mesh Netnode Module D1707
Model No. NETNODEP4

1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	FCC Part	Appendix in Report	Result
RF Power Output	90.205	A1	Pass
Emission Mask	90.210	A2	Pass
Occupied Bandwidth	90.210	A3	Pass
Spurious Emissions at Antenna Terminals	90.210	A4	Pass
Field Strength of Spurious Emissions	90.210	A5	Pass
Frequency Stability	90.213	A6	Pass
Field Strength of Unintentional Spurious Emissions	15.109	A7	Pass
AC Powerline Conducted Emissions	15.107	-	N/A*

*EUT is a battery powered device.

Abbreviations used in the above table:

CFR : Code of Federal Regulations
REFE : Radiated Electric Field Emissions
ANSI : American National Standards Institution
PLCE : Power Line Conducted Emissions

1.6 Standard References

47 CFR 2	Code of Federal Regulations, Title 47, Part 2, “Frequency allocations and Radio Telemetry Matters; General Rules and Regulations”
47 CFR 90	Code of Federal Regulations, Title 47, Part 90,”Land Mobile Radio Service”
47 CFR 15	Code of Federal Regulations, Title 47, Part 15,”Radio Frequency Devices” Subpart B, “Unintentional Radiators”
C63.4-2014	American National Standards Institute (ANSI), “Methods of Measurement of Radio Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range 9 kHz to 40 GHz”

1.7 Notes Relating To Assessment

With regard to this assessment, the following points should be noted:

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.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, “Pass” indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %
Barometric Pressure	: 86 to 106 kPa

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

1.8 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2: Measurement Uncertainty

2.1 Measurement Uncertainty Values

Radio Testing – General Uncertainty Schedule

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence where no required test level exists.

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result (Power Meter) = **1.08dB**
Uncertainty in test result (Spectrum Analyser) = **2.48dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.71dB**

[4] Spurious Emissions

Uncertainty in test result = **4.75dB**

[5] Maximum frequency error

Uncertainty in test result (Power Meter) = **0.113ppm**
Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,
Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[7] Frequency deviation

Uncertainty in test result = **3.2%**

[8] Magnetic Field Emissions

Uncertainty in test result = **2.3dB**

[9] Conducted Spurious

Uncertainty in test result – Up to 8.1GHz = **3.31dB**
Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**
Uncertainty in test result – Up to 26GHz = **3.14dB**

[10] Channel Bandwidth

Uncertainty in test result = **15.5%**

[11] Amplitude and Time Measurement – Oscilloscope

Uncertainty in overall test level = **2.1dB**,
Uncertainty in time measurement = **0.59%,**
Uncertainty in Amplitude measurement = **0.82%**

[12] Power Line Conduction

Uncertainty in test result = **3.4dB**

[13] Spectrum Mask Measurements

Uncertainty in test result = **2.59% (frequency)**
Uncertainty in test result = **1.32dB (amplitude)**

[14] Adjacent Sub Band Selectivity

Uncertainty in test result = **1.24dB**

[15] Receiver Blocking – Listen Mode, Radiated

Uncertainty in test result = **3.42dB**

[16] Receiver Blocking – Talk Mode, Radiated

Uncertainty in test result = **3.36dB**

[17] Receiver Blocking – Talk Mode, Conducted

Uncertainty in test result = **1.24dB**

[18] Receiver Threshold

Uncertainty in test result = **3.23dB**

[19] Transmission Time Measurement

Uncertainty in test result = **7.98%**

Section 3: Modifications

3.1 Modifications Performed During Assessment

No modifications were performed during the assessment

Appendix A: Formal Emission Test Results

Abbreviations used in the tables in this appendix:

Spec	: Specification
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector
CDN	: Coupling & decoupling network

ALSR	: Absorber Lined Screened Room
OATS	: Open Area Test Site
ATS	: Alternative Test Site
Ref	: Reference
Freq	: Frequency
MD	: Measurement Distance
SD	: Spec Distance
Pol	: Polarisation
H	: Horizontal Polarisation
V	: Vertical Polarisation

A1 RF Output Power

Test Details:	
Regulation	Title 47 of the CFR: Part 90.205
Measurement standard	Title 47 of the CFR: Part 2.1046
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	S02
Temperature	22
Humidity	35
EUT set up	Refer to Appendix C

Both the peak and average power levels at maximum power were measured. This was to demonstrate compliance with the maximum allowed power of 5W as defined in 90.205(o). Due to the nature of the carrier (COFDM), the signal has a high peak to average ratio. The manufacturer declares their power as average, thus the power has also been measured as an average to demonstrate compliance with 90.205 (s).

Frequency (MHz)	Peak		RMS Average	
	Carrier power (dBm)	Carrier power (mW)	Carrier power (dBm)	Carrier power (mW)
2452.50	27.9	616.6	15.4	34.6
2466.75	27.8	602.6	15.7	36.7
2481.00	27.9	616.6	15.8	38.1

Limit:

90.205(o)

2450 – 2483.5 MHz	5 W

90.205 (s)

The output power shall not exceed 20% of the manufacturers rated output power (100 mW)	120 mW

A2 Emissions Mask

Test Details:	
Regulation	Title 47 of the CFR: Part 90.210
Measurement standard	Title 47 of the CFR: Part 2.1051
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	S02
EUT set up	Refer to Appendix C

The Spurious limit is as follows:

Test Performed in accordance with FCC Part 2 and 90. In clause 90.210, the frequency band 2450 — 2483.5MHz is not listed in the table. Therefore, "All other bands" mask has been used. In accordance with 90.210 (n), mask B has been used to demonstrate compliance. It was not possible to transmit an unmodulated carrier; therefore the wideband power was measured. Due to the wideband nature of the signal, it was not possible to measure the emission mask using a resolution bandwidth which would show the correct power level. Therefore, the difference between the measurement bandwidth and the occupied bandwidth was established.

10 log (2.316 MHz / 30 kHz) = 18.9 dB

Therefore, an offset of 18.9 dB was added to the spectrum analyzer. The RBW was chosen so the signal shape was not influenced by the RBW filter. The VBW was set to three times the RBW. The detector was set to RMS as the reference power was an RMS measurement.

90.210(b) Mask B

On any frequency removed from the assigned frequency by the following percentage of the authorised bandwidth

(1) ±50%	-	100%	-25	dB
(2) ±100%	-	250 %	-35	dB
(3) > ±250%			43 + 10 Log P	dB

Notes:
(10 log P_{watts}) – (43 + 10 Log (P_{watts} * 1000)) = LIMIT = -13 dBm

Results

The EUT was found to comply with the limits

See plots in Appendix B.

A3 Occupied Bandwidth

Test Details:	
Regulation	Title 47 of the CFR: Part 90.209
Measurement standard	Title 47 of the CFR: Part 2.1049
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	S02
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	FL (MHz)	FH (MHz)	Occupied Bandwidth (MHz)
2452.50	2451.338	2453.654	2.316
2466.75	2465.588	2467.904	2.316
2481.00	2479.838	2482.154	2.316

A4 Spurious Emissions at Antenna Terminals

Test Details:	
Regulation	Title 47 of the CFR: Part 90.210
Measurement standard	Title 47 of the CFR: Part 2.1051
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	S02
EUT set up	Refer to Appendix C

2452.50 MHz

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
No emissions were detected within 20 dB of the limit					

2466.75 MHz

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
No emissions were detected within 20 dB of the limit					

2481.00 MHz

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
No emissions were detected within 20 dB of the limit					

Limit

Limit is determined by the outermost step of the emissions mask and is calculated as follows:

At least 43 + 10 log P dB

$(10\log P_{watts}) - (43+10\log (P_{watts} * 1000)) = \text{Limit} = -13$ dBm

Result

The EUT was found to comply with the limits

A5 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The radiated electric field emission test applies to all spurious and harmonic emissions. The EUT was set to transmit as required.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : [ ] 3m alternative test site : [X]

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details:	
Regulation	Title 47 of the CFR: Part 90.210
Measurement standard	Title 47 of the CFR: Part 2.1053
Frequency range	30 MHz – 25 GHz
EUT sample number	S01
Modification state	0
SE in test environment	S02
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24

2452.50 MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
No emissions were detected within 20 dB of the limit			

2466.75 MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
No emissions were detected within 20 dB of the limit			

2481.00 MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
No emissions were detected within 20 dB of the limit			

Limit

Limit is determined by the outermost step of the emissions mask and is calculated as follows:

At least 43 + 10 log P dB

$(10\log P_{watts}) - (43+10\log (P_{watts} * 1000)) = \text{Limit} = -13$ dBm

Result

The EUT was found to comply with the limit.

Notes:

1. Emissions Checked up to 10 times Fc.

2. The unit was mounted on a turntable and rotated through 360^0 and in 3 orthogonal planes to find the worst case emission.

3. For Frequencies below 1 GHz, RBW = 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

   Peak Detector RBW = 1MHz; VBW = ≥RBW

4. Limit is determined as the outermost step of the emissions mask and is calculated as follows.

   At least 43 + 10 log P dB

   $(10\log P_{watts}) - (43+10\log (P_{watts} * 1000)) =$ LIMIT =-13 dBm

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 2.1057.

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels		✓		
Effect of Position of EUT cables & samples on emission levels	✓			

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

A6 Frequency Stability

Test Details:	
Regulation	Title 47 of the CFR: Part 90.213
Measurement standard	Title 47 of the CFR: Part 2.1055
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	S02
EUT set up	Refer to Appendix C

2452.50 MHz				
Voltage Variation				
Temperature °C	Voltage (Vdc)	Measured Frequency (MHz)	Frequency Difference (Hz)	ppm
+20	12.0	2452.500000	0.00	0.00
+20	10.2	2452.500000	0.00	0.00
+20	13.8	2452.500000	0.00	0.00
Temperature Variation				
Temperature °C	Voltage (Vdc)	Measured Frequency (MHz)	Frequency Difference (Hz)	ppm
+50	12	2452.500000	0.00	0.00
+40	12	2452.500000	0.00	0.00
+30	12	2452.500000	0.00	0.00
+20	12	2452.500000	0.00	0.00
+10	12	2452.500000	0.00	0.00
0	12	2452.495994	-4006.50	-1.63
-10	12	2452.495994	-4006.50	-1.63
-20	12	2452.495994	-4006.50	-1.63
-30	12	2452.500000	0.00	0.00

* Measured f_c at Tnom Vnom used as reference frequency drift calculations of measured f_c at extreme voltage / temperature.

2466.75 MHz				
Voltage Variation				
Temperature °C	Voltage (Vdc)	Measured Frequency (MHz)	Frequency Difference (Hz)	ppm
+20	12.0	2466.750000	0.00	0.00
+20	10.2	2466.750000	0.00	0.00
+20	13.8	2466.750000	0.00	0.00
Temperature Variation				
Temperature °C	Voltage (Vdc)	Measured Frequency (MHz)	Frequency Difference (Hz)	ppm
+50	12	2466.750000	0.00	0.00
+40	12	2466.750000	0.00	0.00
+30	12	2466.750000	0.00	0.00
+20	12	2466.750000	0.00	0.00
+10	12	2466.750000	0.00	0.00
0	12	2466.745994	-4006.50	-1.62
-10	12	2466.745994	-4006.50	-1.62
-20	12	2466.745994	-4006.50	-1.62
-30	12	2466.750000	0.00	0.00

* Measured f_c at Tnom Vnom used as reference frequency drift calculations of measured f_c at extreme voltage / temperature.

2481.00 MHz				
Voltage Variation				
Temperature °C	Voltage (Vdc)	Measured Frequency (MHz)	Frequency Difference (Hz)	ppm
+20	12.0	2482.169872	2481.000000	0.00
+20	10.2	2482.169872	2481.000000	0.00
+20	13.8	2482.169872	2481.000000	0.00
Temperature Variation				
Temperature °C	Voltage (Vdc)	Measured Frequency (MHz)	Frequency Difference (Hz)	ppm
+50	12	2481.000000	0.00	0.00
+40	12	2481.000000	0.00	0.00
+30	12	2481.000000	0.00	0.00
+20	12	2481.000000	0.00	0.00
+10	12	2481.000000	0.00	0.00
0	12	2480.995994	-4006.50	-1.61
-10	12	2480.995994	-4006.50	-1.61
-20	12	2480.995994	-4006.50	-1.61
-30	12	2481.000000	0.00	0.00

* Measured f_c at Tnom Vnom used as reference frequency drift calculations of measured f_c at extreme voltage / temperature.

A7 Unintentional Radiated Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The radiated electric field emission test applies to all spurious emissions on directly related to the transmitter. The maximum permitted field strength is listed in Section 15.109.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : [ ] 3m alternative test site : [X]

Test Details:	
Regulation	Title 47 of the CFR, Part 15 Subpart (c) Clause 15.109
Measurement standard	ANSI C63.10:2013
Frequency range	30 MHz – 25 GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	S02
EUT set up	Refer to Appendix C
Temperature	20

The worst case radiated emission measurements for spurious emissions are listed below:

REF NO.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	34.4	11.7	0.7	15.5	N/A	27.9	24.7	100.0
2.	52.6	18.5	0.9	6.8	N/A	26.2	20.3	100.0

No more emissions were detected within 20 dB of the limit.

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1. For emissions below 30MHz the cable losses are assumed to be negligible.
2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
3 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
4 For Frequencies below 1 GHz, RBW = 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak	RBW=VBW= 1MHz
Average	RBW=VBW= 1MHz

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15: Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits 47 CFR Part 15: Clause 15.109 for all emissions:

Frequency of emission (MHz)	Field strength μV/m	Measurement Distance m	Field strength dBμV/m
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels		✓		
Effect of Position of EUT cables & samples on emission levels	✓			

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

Appendix B: **Supporting Graphical Data**

This appendix contains graphical data obtained during testing.

Notes:

(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A.

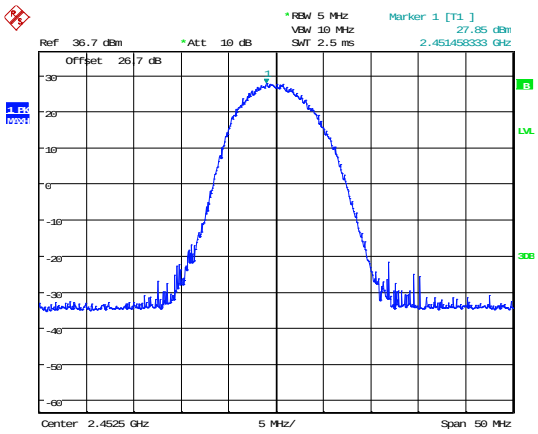
(b) The time and date on the plots do not necessarily equate to the time of the test.

(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

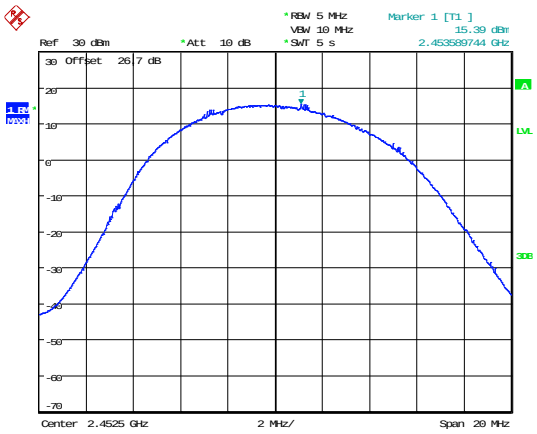
(d) Appendix C details the numbering system used to identify the sample and its modification state.

(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.

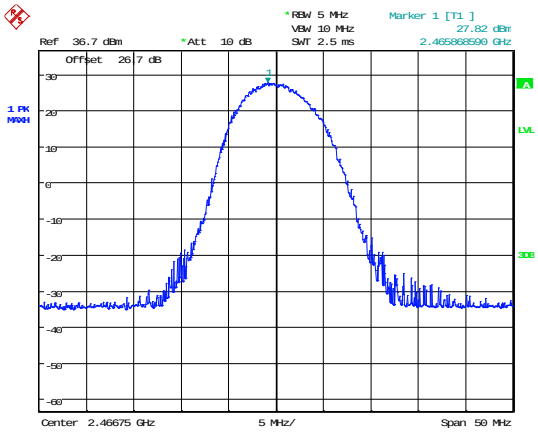
Carrier Power



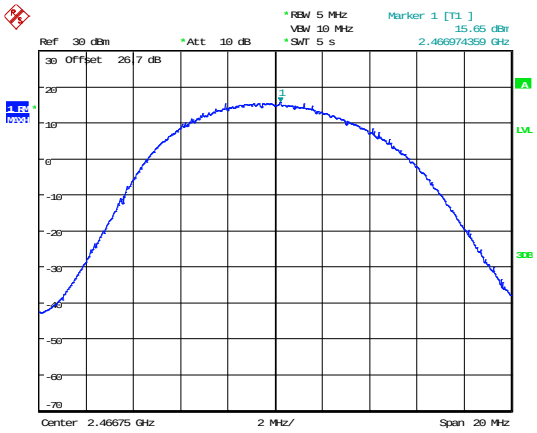
2452.50 MHz peak



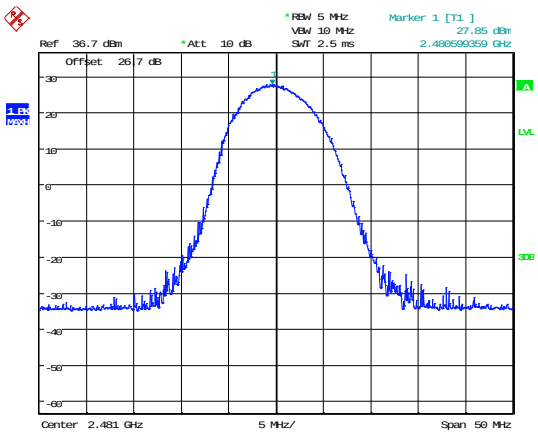
2452.50 MHz rms



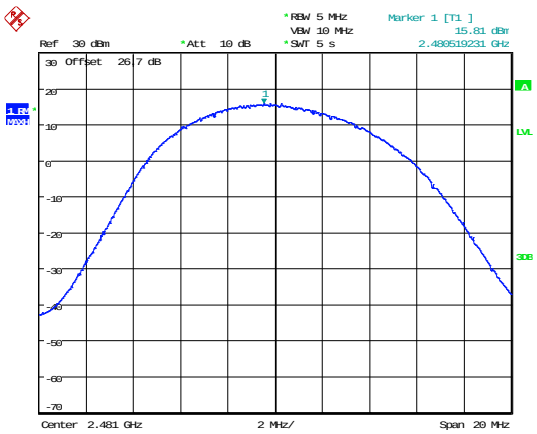
2466.75 MHz peak



2466.75 MHz rms

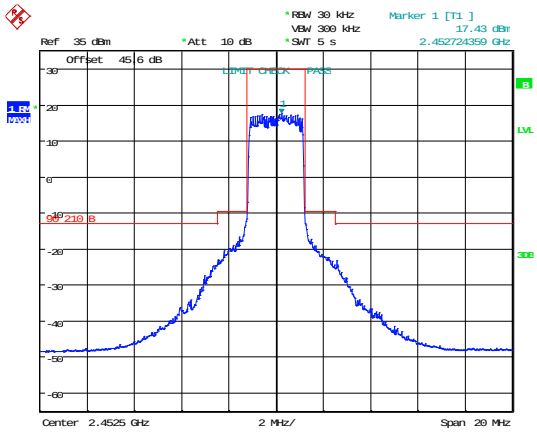


2481.00 MHz Peak



2481.00 MHz rms

Emission Mask



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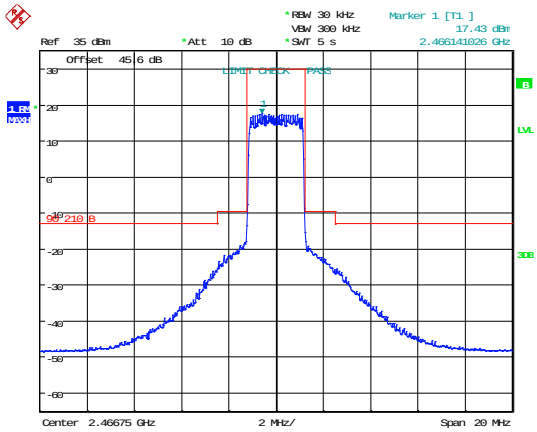
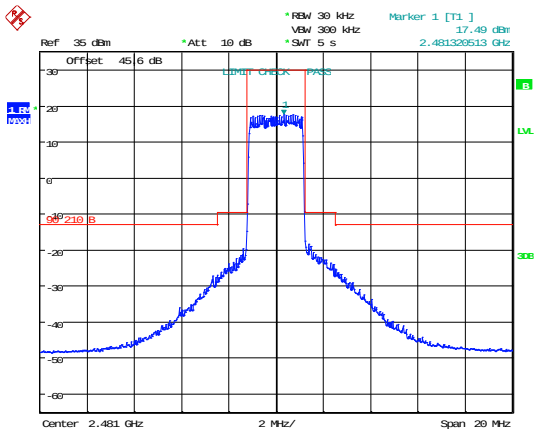
2452.50 MHz



Date: 25.NOV.2015 13:40:29

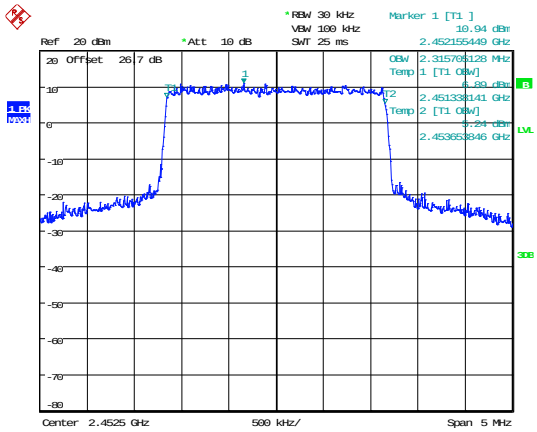
2466.75 MHz



Date: 25.NOV.2015 13:44:29

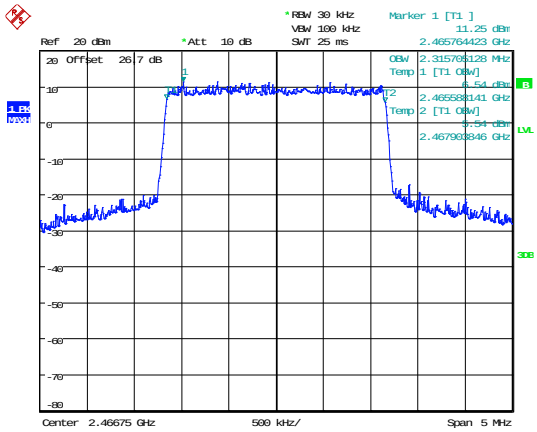
2481.00 MHz

Occupied Bandwidth



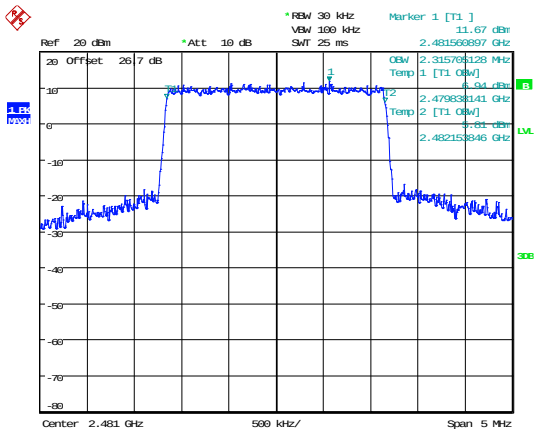
Date: 24.NOV.2015 14:14:37

2452.50 MHz



Date: 24.NOV.2015 14:18:56

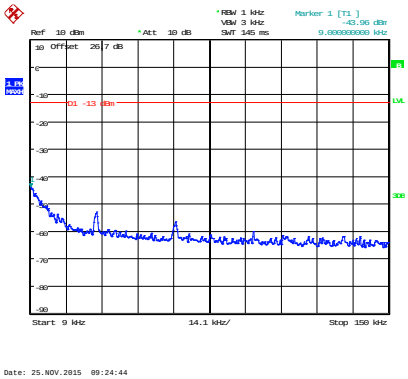
2466.75 MHz



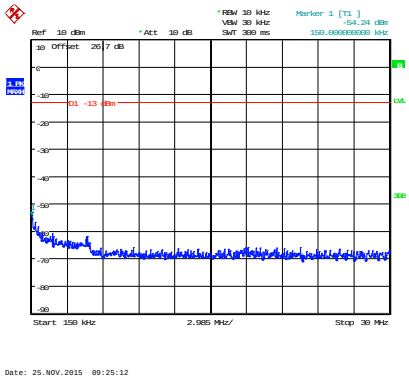
Date: 24.NOV.2015 14:24:33

2481.00 MHz

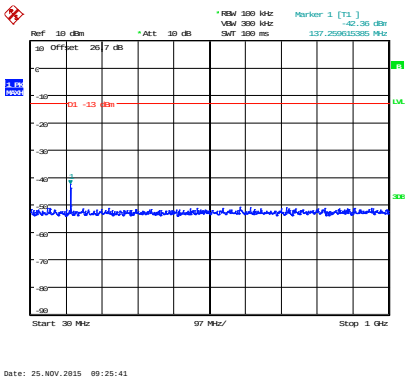
Conducted Spurious Emissions – 2452.50 MHz



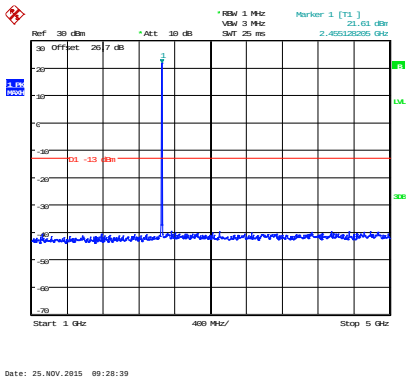
9 kHz – 150 kHz



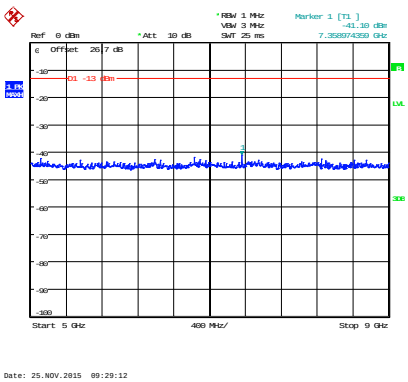
150 kHz - 30 MHz



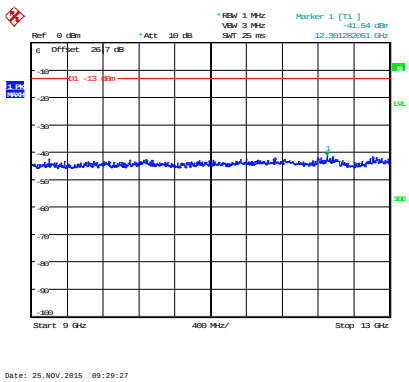
30 MHz – 1 GHz



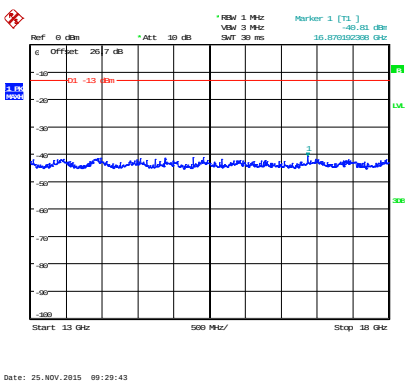
1 GHz – 5 GHz



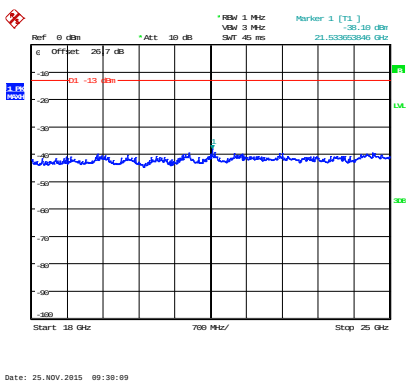
5 GHz – 9 GHz



9 GHz – 13 GHz

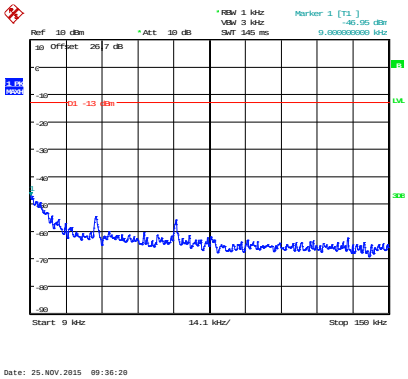


13 GHz – 18 GHz

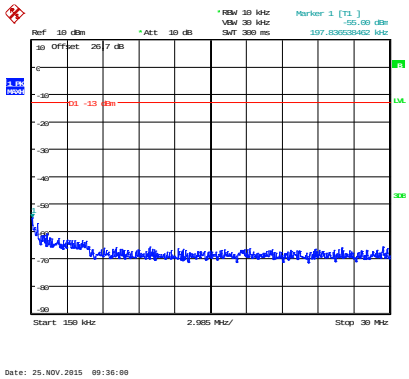


18 GHz – 25 GHz

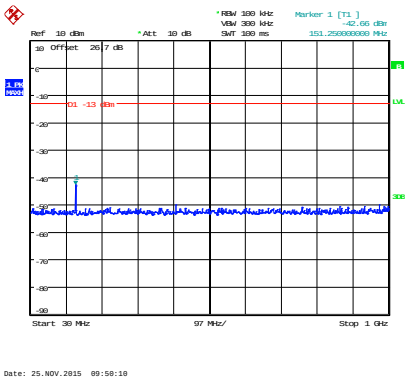
Conducted Spurious Emissions – 2466.75 MHz



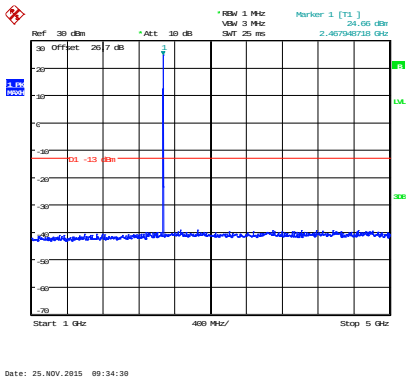
9 kHz – 150 kHz



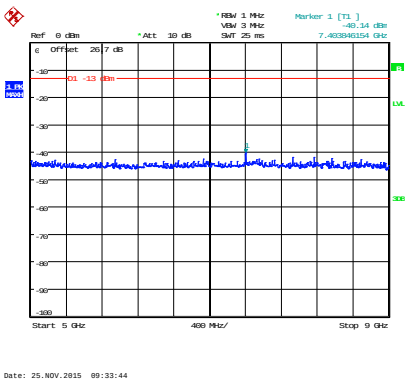
150 kHz - 30 MHz



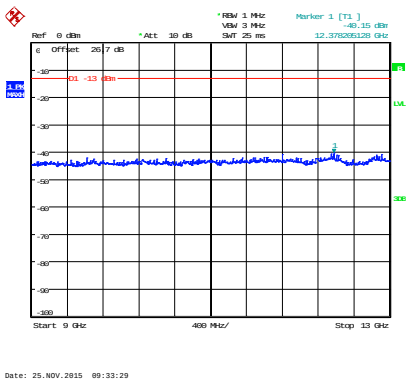
30 MHz – 1 GHz



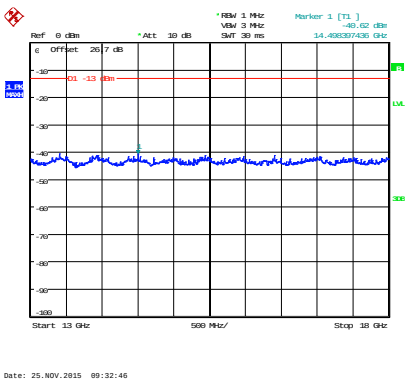
1 GHz – 5 GHz



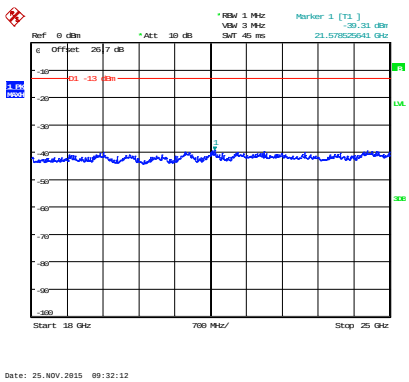
5 GHz – 9 GHz



9 GHz – 13 GHz

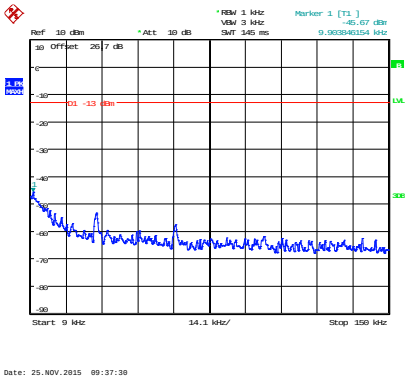


13 GHz – 18 GHz

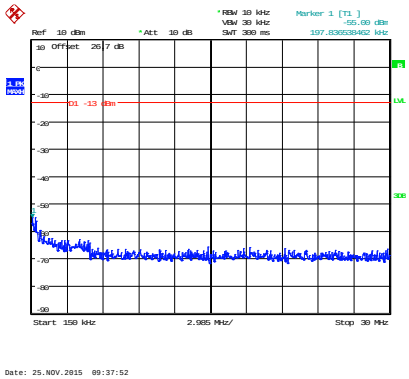


18 GHz – 25 GHz

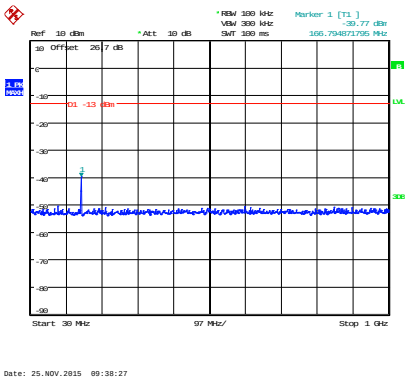
Conducted Spurious Emissions – 2481.00 MHz



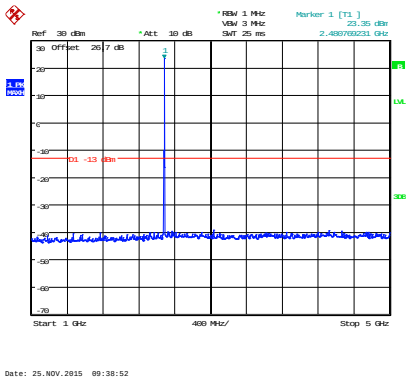
9 kHz – 150 kHz



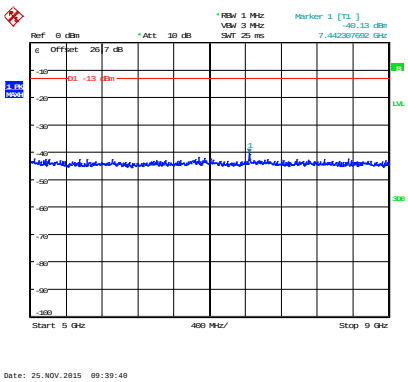
150 kHz - 30 MHz



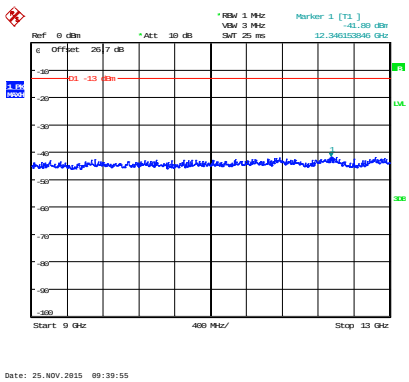
30 MHz – 1 GHz



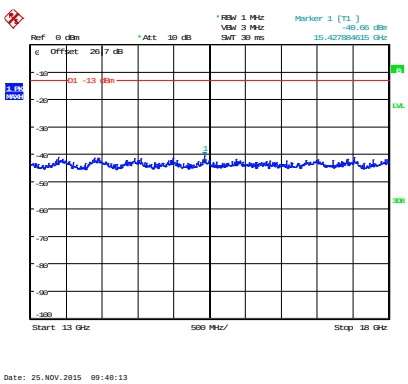
1 GHz – 5 GHz



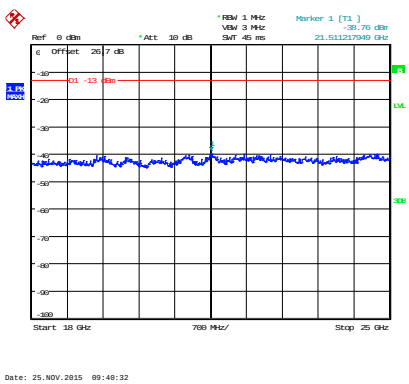
5 GHz – 9 GHz



9 GHz – 13 GHz

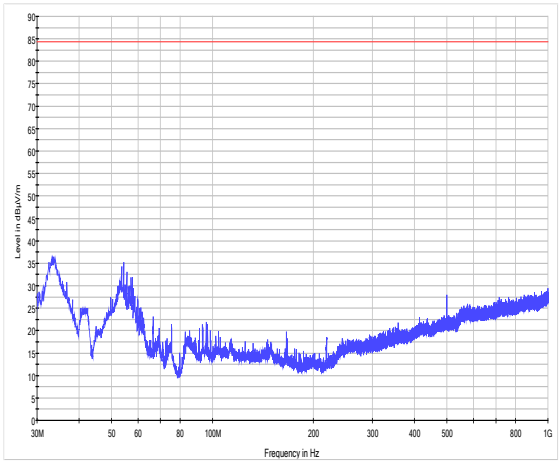


13 GHz – 18 GHz

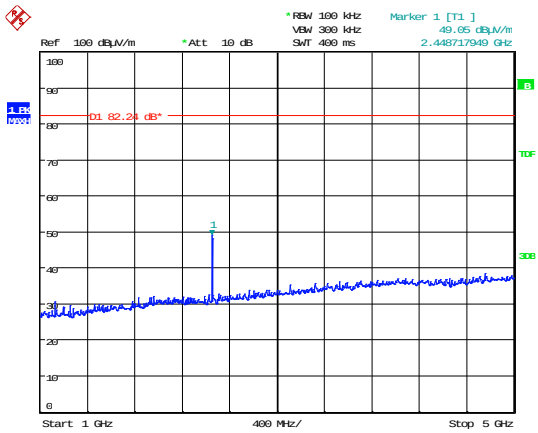


18 GHz – 25 GHz

Radiated Spurious Emissions – 2452.50 MHz

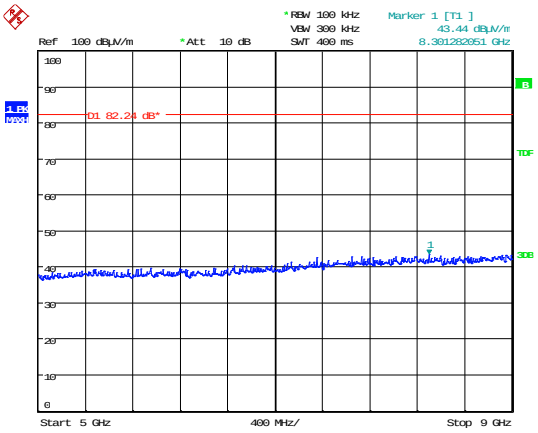


30 MHz – 1 GHz



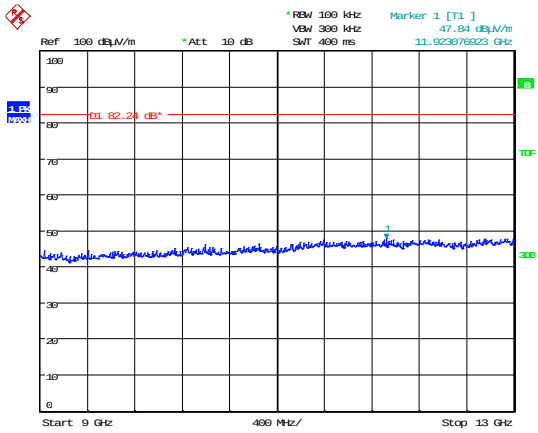
Date: 27.NOV.2015 10:30:35

1 GHz – 5 GHz



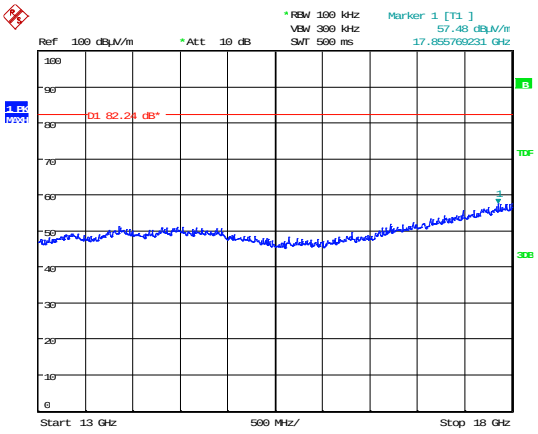
Date: 27.NOV.2015 10:31:15

5 GHz – 9 GHz



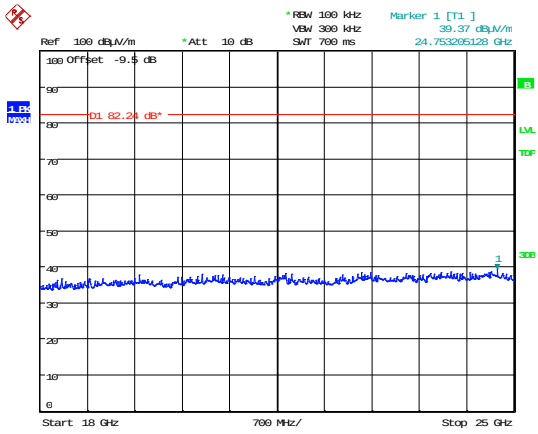
Date: 27.NOV.2015 10:31:59

9 GHz – 13 GHz



Date: 27.NOV.2015 10:32:42

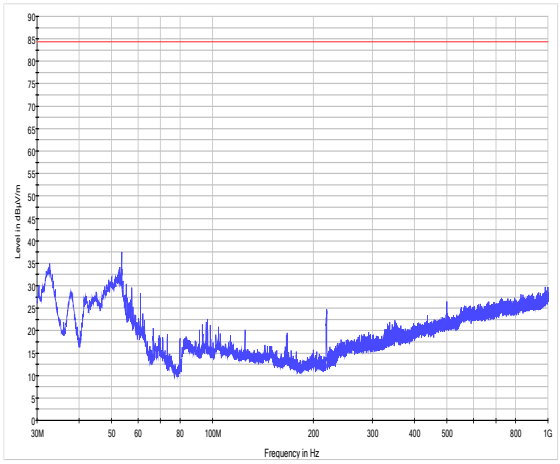
13 GHz – 18 GHz



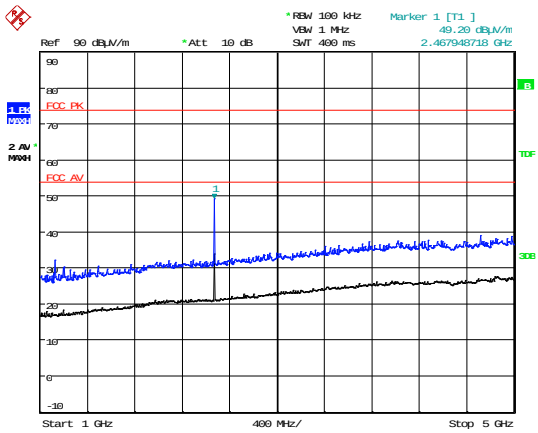
Date: 27.NOV.2015 12:50:01

18 GHz – 25 GHz

Radiated Spurious Emissions – 2466.75 MHz

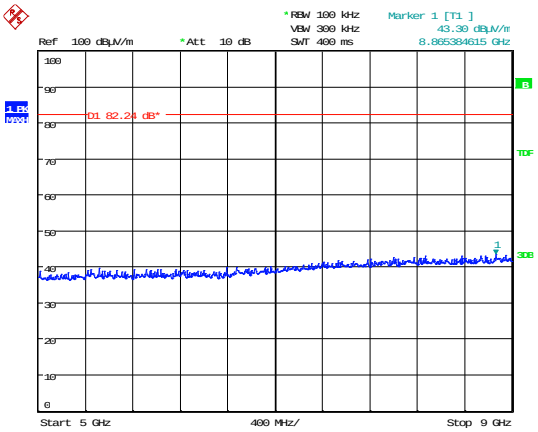


30 MHz – 1 GHz



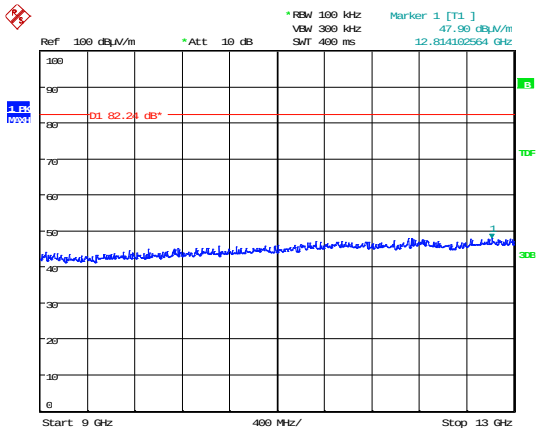
Date: 27.NOV.2015 11:37:51

1 GHz – 5 GHz



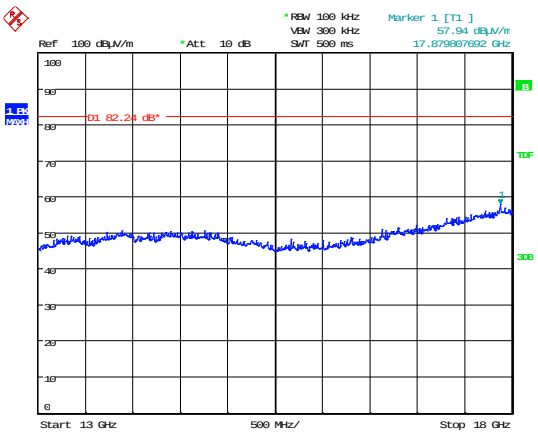
Date: 27.NOV.2015 11:04:10

5 GHz – 9 GHz



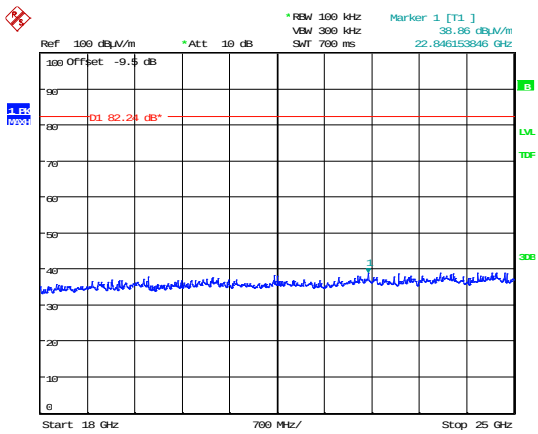
Date: 27.NOV.2015 11:03:40

9 GHz – 13 GHz



Date: 27.NOV.2015 11:02:53

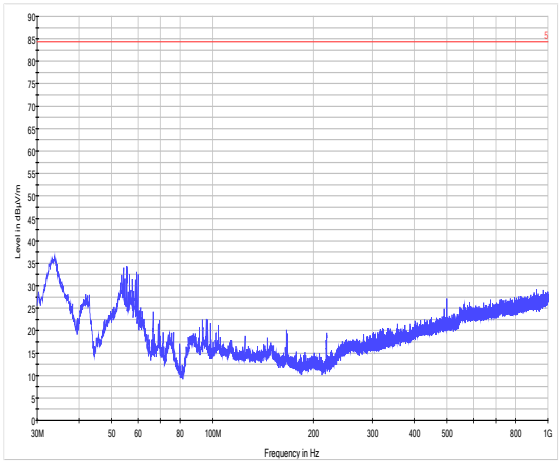
13 GHz – 18 GHz



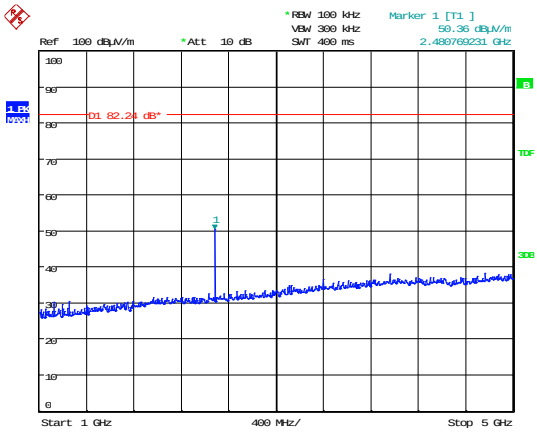
Date: 27.NOV.2015 12:47:04

18 GHz – 25 GHz

Radiated Spurious Emissions – 2481.00 MHz

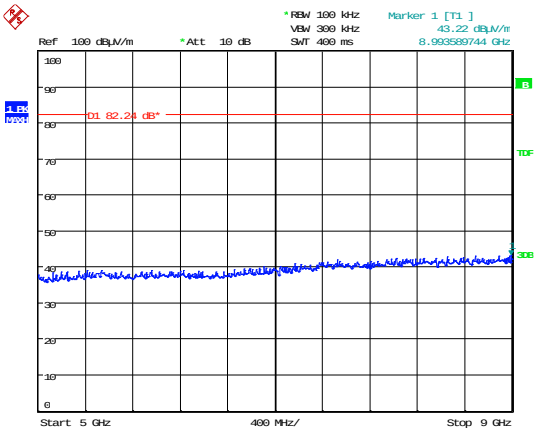


30 MHz – 1 GHz



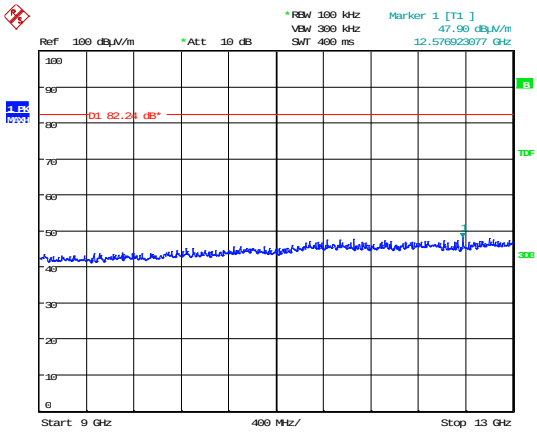
Date: 27.NOV.2015 11:06:32

1 GHz – 5 GHz



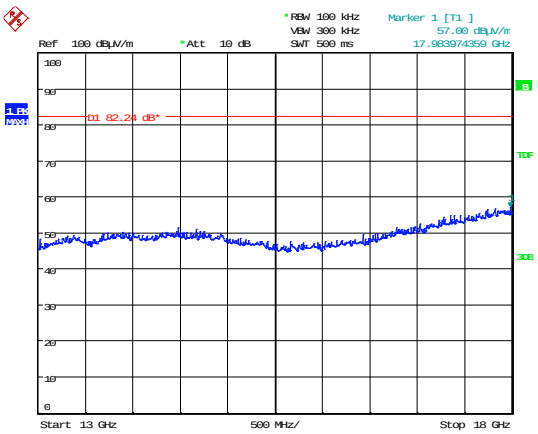
Date: 27.NOV.2015 11:06:59

5 GHz – 9 GHz



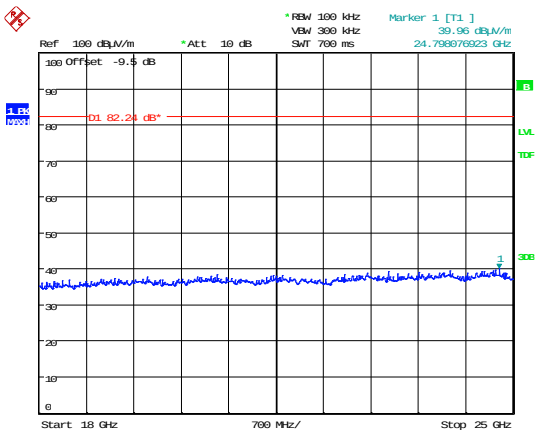
Date: 27.NOV.2015 11:07:31

9 GHz – 13 GHz



Date: 27.NOV.2015 11:07:58

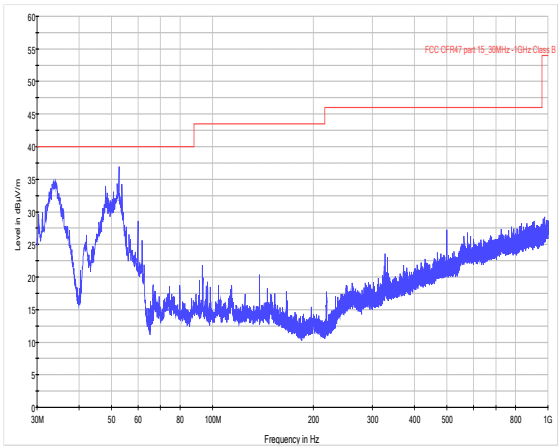
13 GHz – 18 GHz



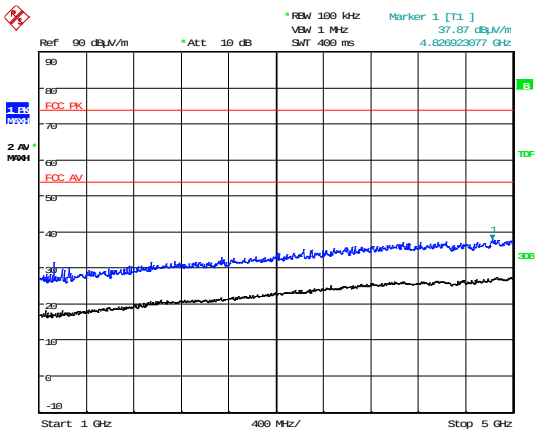
Date: 27.NOV.2015 12:48:27

18 GHz – 25 GHz

Unintentional Radiated Spurious Emissions – 2452.50 MHz

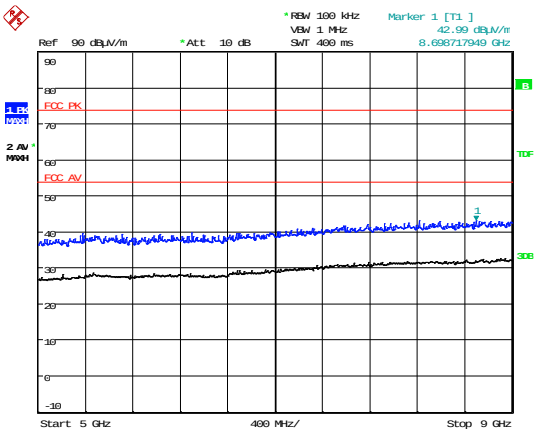


30 MHz – 1 GHz



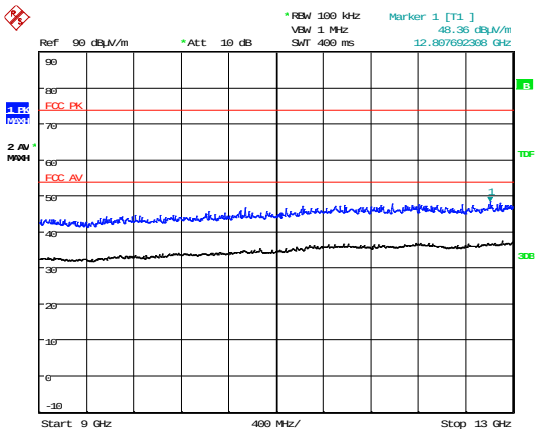
Date: 27.NOV.2015 11:31:41

1 GHz – 5 GHz



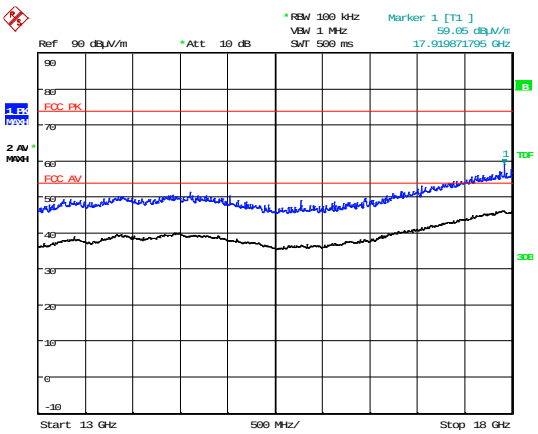
Date: 27.NOV.2015 11:30:53

5 GHz – 9 GHz



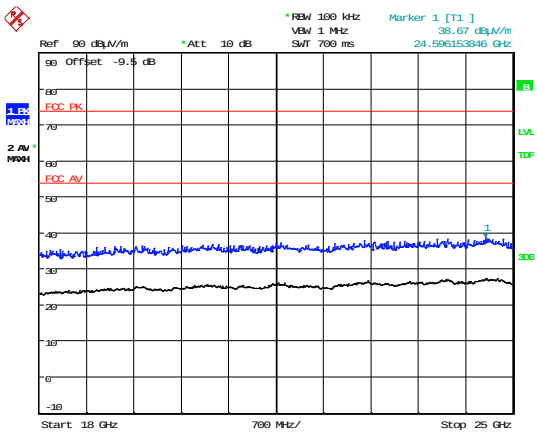
Date: 27.NOV.2015 11:30:07

9 GHz – 13 GHz



Date: 27.NOV.2015 11:29:17

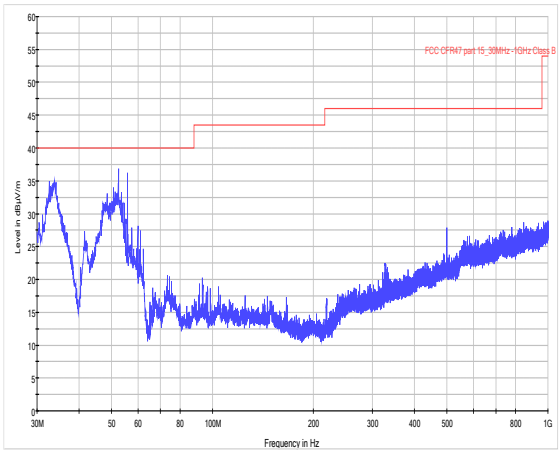
13 GHz – 18 GHz



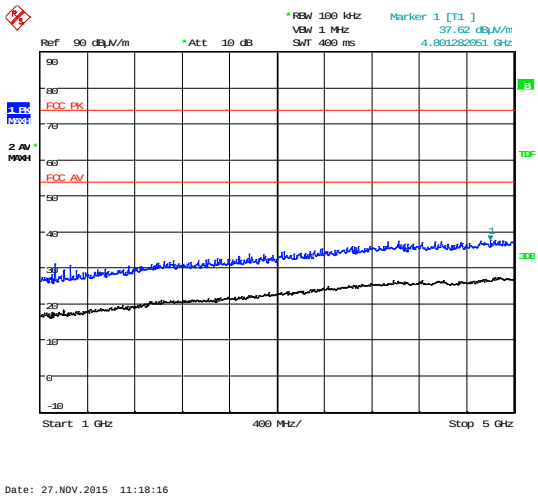
Date: 27.NOV.2015 12:35:40

18 GHz – 25 GHz

Unintentional Radiated Spurious Emissions – 2466.75 MHz

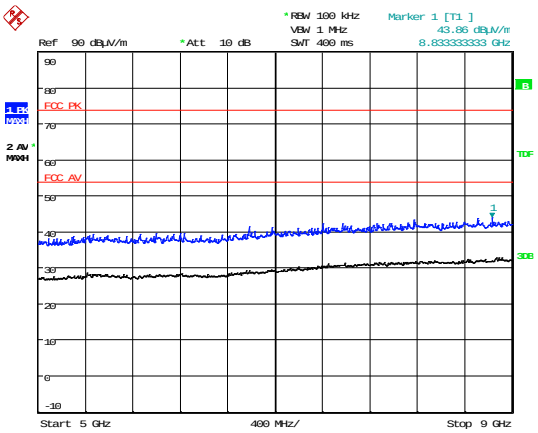


30 MHz – 1 GHz



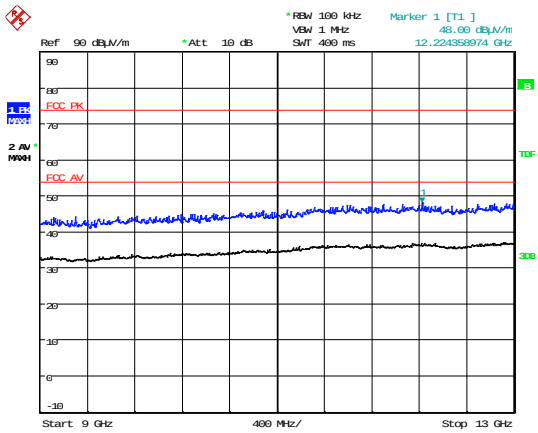
Date: 27.NOV.2015 11:18:16

1 GHz – 5 GHz



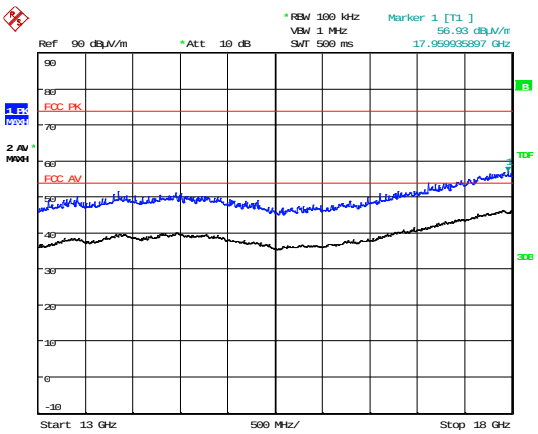
Date: 27.NOV.2015 11:19:06

5 GHz – 9 GHz



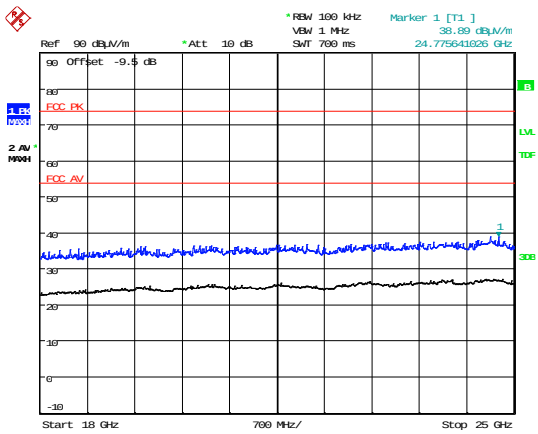
Date: 27.NOV.2015 11:19:52

9 GHz – 13 GHz



Date: 27.NOV.2015 11:20:42

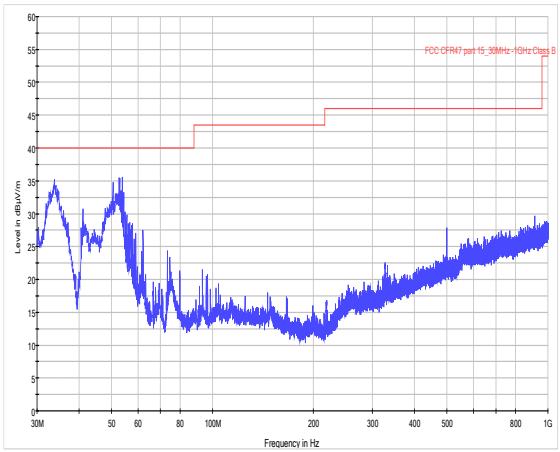
13 GHz – 18 GHz



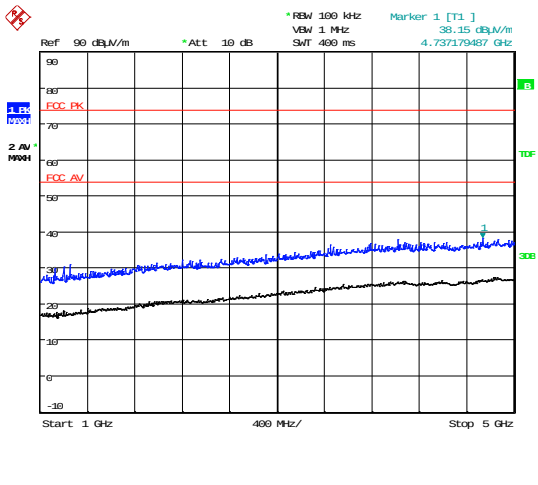
Date: 27.NOV.2015 12:31:01

18 GHz – 25 GHz

Unintentional Radiated Spurious Emissions – 2481.00 MHz

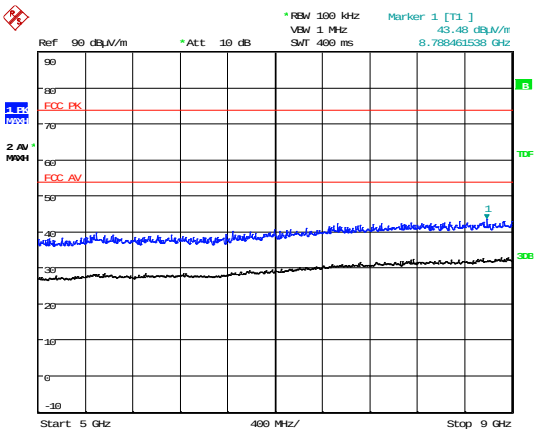


30 MHz – 1 GHz



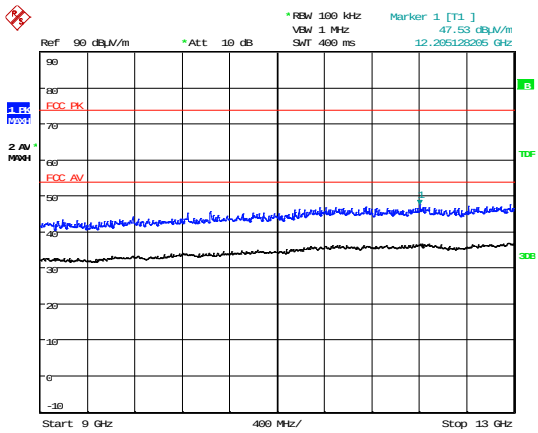
Date: 27.NOV.2015 11:16:42

1 GHz – 5 GHz



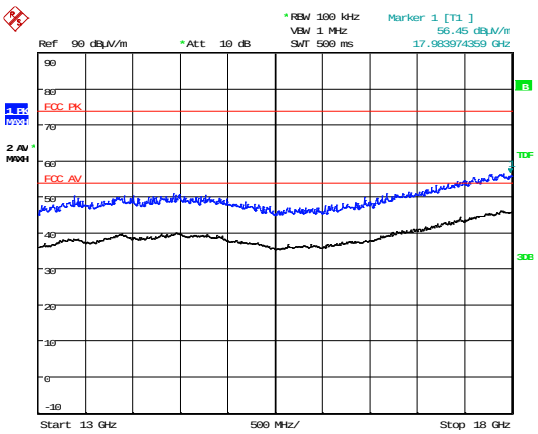
Date: 27.NOV.2015 11:16:05

5 GHz – 9 GHz



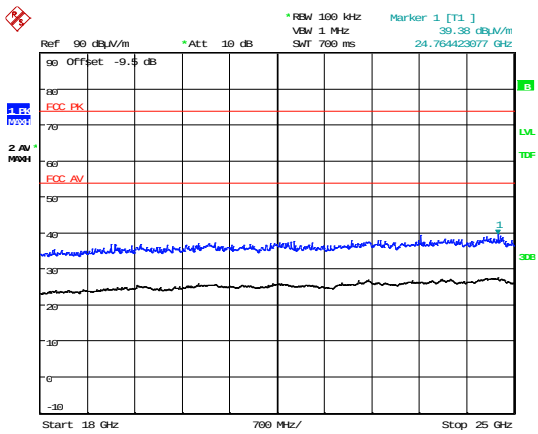
Date: 27.NOV.2015 11:15:31

9 GHz – 13 GHz



Date: 27.NOV.2015 11:15:09

13 GHz – 18 GHz



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18 GHz – 25 GHz

Appendix C: Additional Test and Sample Details

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and it's modification state:

Sample No: Sxx Mod w

where:

xx = sample number eg. S01
w = modification number eg. Mod 2

The following terminology is used throughout the test report:

Support Equipment (SE) is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

EUT configuration refers to the internal set-up of the EUT. It may include for example:

Positioning of cards in a chassis.
Setting of any internal switches.
Circuit board jumper settings.
Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as “single possible configuration”.

EUT arrangement refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by element upon request.

C1) Test samples

The following samples of the apparatus were submitted by the client for testing:

Sample No.	Description	Identification
S01	Phase 4, Agile Mesh Netnode Module D1707	None

The following samples of apparatus were submitted by the client as host, support or drive equipment (auxiliary equipment):

Sample No.	Description	Identification
S02	Phase 4, Agile Mesh Netnode Module D1707	None

C2) EUT Operating Mode during Testing

During testing, the EUT was exercised as described in the following tables:

Test	Description of Operating Mode
All tests detailed in this report except unintentional radiated spurious emissions	EUT in communication with a companion device on bottom, middle and top channels.
Unintentional radiated spurious emissions	EUT in receive mode most of the time on bottom, middle and top channels.

C3) EUT Configuration Information

The EUT was submitted for testing in one single possible configuration.

C4) List of EUT Ports

The tables below describe the termination of EUT ports:

Sample : S01
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
Tx/Rx Antenna	Coaxial	1 m	Spectrum analyzer
Rx Antenna	n/a	n/a	Antenna

Sample : S01
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Tx/Rx Antenna	Coaxial	4 m	S02
Rx Antenna	n/a	n/a	Antenna

C5 Details of Equipment Used

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Bilog	Chase	CBL611/A	U191	26/02/2017
Spectrum Analyser	R&S	FSU46	U281	24/04/2016
1-18GHz Horn	EMCO	3115	L139	25/09/2017
Signal Generator	Marconi	2042	L176	17/12/2015
Horn 18-26GHz (&U330)	Flann	20240-20	L300	10/02/2016
Receiver	R&S	ESVS10	L317	26/02/2016
Temperature Indicator	Fluke	52 Series II	L426	30/05/2016
Pre Amp	Agilent	8449B	L572	10/02/2016
Radio Chamber - PP	Rainford EMC	ATS	REF940	08/09/2016
Multimeter	Agilent	34405a	REF976	03/06/2016
PSU	Thandar	-	UH100	Cal with REF976
Temp Chamber	Sharetree	-	L011	Cal with L426

Appendix D: **Additional Information**

No additional information is included within this test report.

Appendix E: General SAR test reduction and exclusion guidance

KDB 447498

Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when SAR Exclusion Threshold requirement in KDB 447498 is satisfied, standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

The SAR Test Exclusion Threshold for 100 MHz to 6 GHz will be determined as follows.

SAR Exclusion Threshold (SARET) = Step 1 + Step 2

Step 1

$$NT = [(MP/TSD^{A}) * \sqrt{f_{GHz}}]$$

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)
MP = Max Power of channel (mW) (including tune-up tolerance)
TSD^{A} = Min Test separation Distance or 50mm (whichever is lower) = 50mm (in this case)

We can transpose this formula to allow us to find the maximum power of a channel allowed and compare this to the measured maximum power.

$$= [(NT \times TSD^{A}) / \sqrt{f_{GHz}}]$$

For Distances Greater than 50 mm Step 2 applies

Step 2

$$(TSD^{B} - 50mm) * 10$$

Where:
TSD^{B} = Min Test separation Distance (mm) = 50

Note: Step 2 doesn't apply here as the TSD^{A} is less than 50 mm

Operating Frequency 2452.5 MHz

SARET = [(3.0 x 50) / √0.24525]
SARET = 95.8 mW

Operating Frequency 2466.75 MHz

SARET = [(3.0 x 50) / √0.246675]
SARET = 95.5 mW

Operating Frequency 2481.00 MHz

SARET = [(3.0 x 50) / √0.2481]
SARET = 95.2 mW

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold (mW)	SAR Evaluation
2452.50	55.0	95.8	Not Required
2466.75	58.9	95.5	Not Required
2481.00	60.3	95.2	Not Required

Note: EIRP calculated by adding maximum conducted power and maximum antenna gain (i.e. 2dBi).

Therefore standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

Prediction of MPE limit at a given distance

For purposes of these requirements mobile devices are defined by the as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than the power density limit, as required under FCC rules.

Equation from IEEE C95.1

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re-arranged } R = \sqrt{\frac{EIRP}{S4\pi}}$$

Where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance required to be less than the power density limit (R) (cm)
2481.00	60.3	1.0	2.2

Note: EIRP calculated by adding maximum conducted power and maximum antenna gain (i.e. 2dBi).