A RADIO TEST REPORT

FOR

DRUCK LTD T/A GE MEASUREMENT & CONTROL

ON

ADTS

DOCUMENT NO. TRA-026611-01-47-00B

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TRaC Wireless Test Report	**:** TRA-026611-01-47-00B
Applicant	**:** Druck Ltd t/a GE Measurement & Control
Apparatus	**:** ADTS
Specification(s)	**:** CFR47 Part 15.247 & RSS-247 Issue 1
FCCID	**:** 2AAVWADTS552F-01
Certification Number	**:** 12097A-ADTS552F01
Purpose of Test	**:** Certification
Authorised by	**:** John Charters Digitally signed by John Charters DN: cn=John Charters, o=TRAC Global Ltd, ou=Radio Product Manager, email=john.charters@tracglobal.com, c=GB Date: 2015.09.29 15:03:26 +01'00'
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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.

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1.2 Tests Requested By

This testing in this report was requested by:

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1.3 Manufacturer

As above

1.4 Apparatus Assessed

The following apparatus was assessed between 21st May 2015 and 10th July 2015.

- Name: ADTS
- Serial Number: 5520012
- Model Number: ADTS552F
- Software Revision: DK429_V02.00.16
- Build Level / Revision Number: Not Applicable

The EUT is device containing a FHSS Bluetooth module operating with standard and enhanced data rates.

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	Regulation		Measurement standard	Result
	Title 47 of the CFR: Part 15 Subpart (c)	RSS Gen Issue 4, Nov 2014 and RSS – 247 Issue 1, May 2015		
Radiated spurious emissions (Restricted bands)	15.247	-	ANSI C63.10:2013	Pass
Conducted spurious emissions (Non-restricted bands)	15.247	RSS – 247 Section 5.5	ANSI C63.10:2013	Pass
AC Power conducted emissions	15.207	RSS Gen Section 8.8	ANSI C63.10:2013	Pass
20dB Bandwidth and Channel Spacing	15.247(a)(1)(i)	RSS – 247 Section 5.1(1)(2)	ANSI C63.10:2013	Pass
Conducted Carrier Power	15.247(b)(2)	RSS – 247 Section 5.4(2)	ANSI C63.10:2013	Pass
Hopping Frequencies	15.247(a)(1)	RSS – 247 Section 5.1(4)	ANSI C63.10:2013	Pass
Channel Occupancy	15.247(a)(1)(i)	RSS – 247 Section 5.1(4)	ANSI C63.10:2013	Pass
Unintentional Radiated Spurious Emissions	15.109	RSS – Gen Section 7.1	ANSI C63.10:2013	Pass
Antenna requirements	15.203	-	15.203	Pass

Abbreviations used in the above table:

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

1.6 Notes Relating To the 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.

1.7 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2: Measurement Uncertainty

2.1 Measurement Uncertainty Values

For the test data recorded the following measurement uncertainty was calculated:

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

Section 4 General Test Procedures

4.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst case determined for function, operation, orientation etc for both vertical and horizontal polarisations

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

For devices with intentional emissions below 30 MHz, a shielded loop antenna is used as the test antenna. It is placed at a 1 meter receive height and appropriate low frequency magnetic field extrapolation to the regulatory limit distance is employed. The EUT is rotated through 360˚in the azimuth.

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360˚ in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Where regulations allow for direct measurement of field strength, power values measured on the test receiver / analyzer are converted to dBµV/m at the regulatory distance, using:

$$FS = PR + AF + CL - PA + KG + DC - CF \ (dB\mu V/m)$$

Where:

PR is the power recorded on receiver / spectrum analyzer (dBµV),
AF is the test antenna factor in dB/m,
CL is the cable loss in dB,
PA is the pre-amplifier gain dB (when applicable),
DC is duty correction factor (when applicable) in dB, and
CF is a distance correction (employed only for measurements at alternate distance to limit) in dB.

This field strength value is then compared with the regulatory limit.

If effective radiated power (ERP) or effective isotropic radiated power (EIRP) is required, it is computed as per ANSI C63.10

$$P = \frac{(Ed)^2}{30G}$$

Where

P is the power, in W
E is the measured peak field strength, in V/m
d is the distance at which the measurement was made, in m
G is the numeric gain of the radiating element

If the gain of the radiating element is not known, then either the effective radiated power (ERP) or the effective isotropic radiated power (EIRP) may be calculated from the measured peak field strength, by using either G = 1.64 or G = 1, respectively.

4.2 AC Powerline Conducted Emissions Test Setup and Procedures

AC Powerline Conducted Emissions from the EUT are checked first by preview scans with Peak and average detectors covering both live and neutral lines. A spectrum analyser is used to determine if any periodic emissions are present. Preview scans are performed in standby or receive mode if the device is subject to these requirements. For transmit mode of operation the device is set to one of the following modes.

- Transmitting operating at full power (single mode device)
- Transmitting at freq / modulation that gives highest output power (multi mode device)
- Transmitter operating in normal TX mode (e.g. FHSS, TDMA etc)

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans.

Battery Power devices are not subject to power line conducted emissions measurements when it is powered solely by its internal battery.

4.3 Antenna Port Conducted Emissions

Antenna port conducted emissions can include, but are not limited to, Carrier power, Power Spectral Density, Occupied bandwidth and spurious emission.

Spurious Emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked to identify frequencies to perform formal measurements on.

Formal measurements are made on frequencies identified from the preview scans and fundamental emission(s). Measurements are made using the correct instrumentation (inc. power meter, receiver, spectrum analyser) that operate with the required detector(s) and bandwidth.

Care is taken to ensure the measurement instrument is not overloaded by the presence of the transmitted signal by use of external attenuation and filtering where required.

Measured levels are corrected for cables, attenuators, and filters. If applicable, for the specific measurement, antenna gain is also taken into account.

4.4 Power Supply Variation

Tests at extreme supply voltages are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case the EUT is designed for operation from a lead-acid battery power source, the extreme test voltages are evaluated between 90% and 130% of the nominal battery voltage declared by the manufacturer.

For float charge applications using gel-cell type batteries, extreme test voltages are evaluated between 85% and 115% of the nominal battery voltage declared.

For all battery operated equipment, worst case intentional and spurious emissions are re-checked employing a new (fully charged) battery.

4.5 Thermal Variation

Tests at extreme temperatures are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

Tests are performed at the upper and lower extremes as required and typically at 10˚ steps between.

Before any temperature measurements are made, the equipment is allowed to reach a thermal balance in the test chamber.

4.6 Time Domain Measurements

Time domain measurements are made for (but not limited to) use in duty cycle correction, to ensure compliance with time restrictions on certain types of devices.

If measurements of a transmitter's on time are required these are performed with a spectrum analyser in the time domain or with an oscilloscope and RF detector. If time on a specific frequency is required (e.g. FHSS timing) the measurement can only be made with a spectrum analyser.

The triggering, timescale and amplitude settings are adjusted according to the signal to be measured on a case by case basis.

For devices with sharp rise/fall times measurements are made between RF reaching full power (T_{on}) and RF dropping to the measurement instrument noise floor (T_{off}). For longer rise times measurements are made for T_{on} and T_{off} at the RF level required by the occupied bandwidth measurement (e.g. 6 dB, 20 dB etc).

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 Transmitter Peak Output Power

Carrier power was verified with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

Test Details:	
Regulation	Part 15.247(b)(1) RSS – 247, Section 5.4(2)
Measurement standard	ANSI C63.10, RSS-GEN
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25°C

Data Rate = 1Mbps				
Channel Frequency (MHz)	Peak Conducted Output Power (dBm)	Peak Conducted Output Power (W)	Limit (W)	Result
2402.0	11.75	0.0150	1	Pass
2441.0	12.54	0.0180		Pass
2480.0	13.16	0.0207		Pass
Data Rate = 2Mbps				
Channel Frequency (MHz)	Peak Conducted Output Power (dBm)	Peak Conducted Output Power (W)	Limit (W)	Result
2402.0	8.21	0.0066	1	Pass
2441.0	8.65	0.0073		Pass
2480.0	8.25	0.0067		Pass
Data Rate = 3Mbps				
Channel Frequency (MHz)	Peak Conducted Output Power (dBm)	Peak Conducted Output Power (W)	Limit (W)	Result
2402.0	8.54	0.0071	1	Pass
2441.0	8.96	0.0079		Pass
2480.0	8.65	0.0073		Pass

A2 RF Antenna Conducted Spurious Emissions

Measurement of conducted spurious emissions at the antenna port was performed using a peak detector with the RBW set to 100 kHz and the VBW>RBW. Frequencies were scanned up through to the 10th harmonic. The EUT was set to transmit on its lowest, centre and highest carrier frequency and operating at data rates of 1Mbps, 2Mbps & 3Mbps at each frequency. Plots were taken of all data rates and frequencies. Only plots of top, middle and bottom frequencies for the data rate producing highest output power are contained in appendix B.

Test Details:	
Regulation	Part 15.247(d) and Clause 15.205, RSS-247 Section 5.5
Measurement standard	ANSI C63.10:2013, RSS – GEN, ANSI C63.4:2014
Frequency range	9 kHz to 25 GHz
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23°C

The worst case conducted emission measurements at the antenna port are listed below:

Test Details : 1 Mbps – 2402 MHz, 2441 MHz & 2480 MHz						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBµV)	15.247(d) Limit (dBµV)	Summary
No significant emissions within 20 dB of the limit						

Test Details : 2 Mbps - 2402 MHz, 2441 MHz & 2480 MHz						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBµV)	15.247(d) Limit (dBµV)	Summary
No significant emissions within 20 dB of the limit						

Test Details : 3 Mbps - 2402 MHz, 2441 MHz & 2480 MHz						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBµV)	15.247(d) Limit (dBµV)	Summary
No significant emissions within 20 dB of the limit						

Notes:

1. The conducted emission limit for emissions is based on a transmitted carrier level of 15.247(b) and Section 5.4. With the EUT transmitting on its lowest, centre and highest carrier frequencies in turn, emissions from the EUT are required to be 20 dB below the level of the highest fundamental as measured within a 100 kHz RBW in accordance with 15.247(d) and Section 5.5 using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated in accordance with 15.33 (a) (1) and RSS – GEN 4.9.
3. The measurements at 2400 MHz were made to ensure band edge compliance.
4. The carrier level was measured whilst varying the supply voltage between 85% and 105% of the nominal supply voltage as required by 15.31(e). No variation in carrier level was observed.

The limit outside the restricted band in 100 kHz RBW is defined using the following formula in accordance with 15.247(d) and Section 5.5:

The limit in 100 kHz RBW = (Maximum Peak Conducted Carrier in 100 kHz) – 20 dB

A3 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 spurious emissions and harmonics that fall within the restricted bands. The EUT was set to transmit on its lowest, centre and highest carrier frequency and operating at data rates of 1Mbps, 2Mbps & 3Mbps at each frequency. Plots were taken of all data rates and frequencies. Only plots of top, middle and bottom frequencies for the data rate producing highest output power are contained in appendix B.

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 : ☒

Test Details:	
Regulation	Part 15.247(d) and 15.205
Measurement standard	ANSI C63.10
Frequency range	30MHz – 25GHz
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	27°C
Photographs (Appendix F)	Photograph 1 and 2

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

2402 MHz – 1 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
1.	1601.7	Av	56.5	2.3	25.6	36.6	N/A	47.8	244.6	500.0	-6.2
2.	4804.0	Av	46.6	3.8	32.7	35.9	0.3	47.5	238.0	500.0	-6.5
2441 MHz – 1 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
3.	4882.0	Av	40.3	3.7	33.0	35.9	0.3	41.4	118.0	500.0	-12.6
2480 MHz – 1 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
4.	4960.0	Av	42.5	3.6	33.2	35.9	0.2	43.6	151.7	500.0	-10.4

Radiated Electric Field Emissions continued:

2402 MHz – 2 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
1.	1601.7	Av	56.6	2.3	25.6	36.6	N/A	47.9	248.3	500.0	-6.1
2.	4804.0	Av	39.6	3.8	32.7	35.9	0.3	40.5	106.0	500.0	-13.5
2441 MHz – 2 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
3.	4882.0	Av	35.0	3.7	33.0	35.9	0.3	36.1	63.5	500.0	-18.0
2480 MHz – 2 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
4.	4960.0	Av	34.3	3.6	33.2	35.9	0.2	35.4	59.0	500.0	-18.6

2402 MHz – 3 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
1.	1601.7	Av	56.6	2.3	25.6	36.6	N/A	47.9	248.3	500.0	-6.1
2.	4804.0	Av	39.6	3.8	32.7	35.9	0.3	40.5	105.6	500.0	-13.5
2441 MHz – 3 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
3.	4882.0	Av	35.0	3.7	33.0	35.9	0.3	36.1	63.7	500.0	-17.9
2480 MHz – 3 Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**HPF LOSS (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**	**Margin (dB)**
4.	4960.0	Av	34.3	3.6	33.2	35.9	0.2	35.5	59.2	500.0	-18.6

Radiated Electric Field Emissions continued:

Radiated Upper Bandedge Compliance

The EUT was set to transmit on its highest carrier frequency (non-hopping mode) and also in hopping mode, operating at data rates of 1Mbps, 2Mbps & 3Mbps in each mode. Results of worst case mode (i.e. non-hopping mode) are given in the table below and the corresponding plots are contained in Appendix B of this test report.

Data Rate	1 Mbps		2 Mbps		3 Mbps	
Detector	peak	Average	peak	Average	peak	Average
Power in 2MHz RBW	110.2	108.1	105.9	101.5	106.2	101.4
Delta in 100kHz (dB)	-47.1	-55.1	-45.1	-48.1	-45.2	-47.6
Power at band edge (dBµV/m)	63.1	53.0	60.8	53.4	61.1	53.8
Limit (dBµV/m)	74.0	54.0	74.0	54.0	74.0	54.0
Margin (dB)	-10.9	-1.0	-13.2	-0.6	-13.0	-0.2
Summary	Pass	Pass	Pass	Pass	Pass	Pass

Notes:

1 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.

2 Measurements at 2483.5 MHz were made to ensure band edge compliance.

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= 100 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

These settings as per ANSI C63.10:2013 and DA 00-705.

5 In accordance with DA 00-705, the average level of the spurious radiated emission may be reduced by the duty cycle correction factor. If the dwell time per channel (refer to the measured channel occupancy time, section A7 of this test report) of the hopping signal is less than 100ms then the average measurement may be further adjusted by the duty cycle correction factor which is derived from

$$20\log_{10}\left(\frac{\text{dwell time}}{100ms}\right)$$

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

Radiated emission limits for emissions falling within the restricted bands.

Frequency of emission (MHz)	Field strength (μV/m)	Measurement Distance (m)	Field strength (dBμV/m)
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:

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

The results displayed take into account applicable antenna factors and cable losses.

(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

A4 Power Line Conducted Emissions

Preview power line conducted emission measurements were performed with a peak detector in a screened room. The effect of the EUT set-up on the measurements is summarised in note (b). Where applicable formal measurements of the emissions were performed with a peak, average and/or quasi peak detector. The EUT was set to transmit on its lowest, centre and highest carrier frequency in turn. The formal measurements are detailed below:

Test Details:	
Regulation	Part 15 Clause 15.207, RSS – GEN, Section 8.8
Measurement standard	ANSI C63., RSS – GEN, ANSI C63.4:2014
Frequency range	150kHz to 30MHz
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

The worst-case power line conducted emission measurements are listed below:

Transmit Mode						
Results measured using the average detector compared to the average limit						
Ref No.	Freq (MHz)	Conductor	Result (dBµV)	Spec Limit (dBµV)	Margin (dB)	Result Summary
1.	0.300	L	42.9	50.2	7.4	Pass
2.	0.150	L	45.1	56.0	10.9	Pass
3.	0.225	L	38.7	52.6	13.9	Pass
4.	0.375	L	29.3	48.4	19.1	Pass
Results measured using the quasi-peak detector compared to the quasi–peak limit						
Ref No.	Freq (MHz)	Conductor	Result (dBµV)	Spec Limit (dBµV)	Margin (dB)	Result Summary
1.	0.300	L	46.7	60.2	13.6	Pass
2.	0.150	L	51.4	66.0	14.6	Pass
3.	0.225	L	43.9	62.6	18.8	Pass

Receive Mode						
Results measured using the average detector compared to the average limit						
Ref No.	Freq (MHz)	Conductor	Result (dBµV)	Spec Limit (dBµV)	Margin (dB)	Result Summary
1.	0.300	N	43.0	50.2	7.2	Pass
2.	0.150	L	45.4	56.0	10.6	Pass
3.	0.225	L	38.8	52.6	13.8	Pass
4.	0.375	L	29.8	48.4	18.5	Pass
Results measured using the quasi-peak detector compared to the quasi–peak limit						
Ref No.	Freq (MHz)	Conductor	Result (dBµV)	Spec Limit (dBµV)	Margin (dB)	Result Summary
1.	0.300	N	46.9	60.2	13.3	Pass
2.	0.150	L	51.8	66.0	14.2	Pass
3.	0.225	L	44.0	62.6	18.6	Pass

Specification limits:

Conducted emission limits (47 CFR 15: Clause 15.207 and RSS – GEN, Section 8.2 Table 3 :)

Conducted disturbance at the mains ports

Frequency range MHz	Limits dBμV	
	Quasi-peak	Average
0.15 to 0.5	66 to 56[2]	56 to 46[2]
0.5 to 5	56	46
5 to 30	60	50

Notes:
1. The lower limit shall apply at the transition frequency.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.

Notes:

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

(b) The following table summarises the effect of the EUT operating mode and internal configuration 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		✓		

(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

A5 20 dB Bandwidth

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(1)(i) and RSS-247 Section 5.1(1) requires the measurement of the bandwidth of the transmission between the -20 dB points on the transmitted spectrum. The results of this test determine the limits for channel spacing.

Test Details:	
Regulation	Part 15.247(a)(1)(i), RSS-247 Section 5.1(1)
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	22°C
EUT set up	Refer to Appendix C

1Mbps	
Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)
2402	1308
2441	1293
2480	1313
2Mbps	
Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)
2402	1370
2441	1370
2480	1370
3Mbps	
Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)
2402	1380
2441	1380
2480	1385

Plots of the 20 dB bandwidth and channel spacing are contained in Appendix B of this test report.

A6 Carrier Frequency Separation

For systems with an output power greater than 125 mW, the channel separation shall be a minimum of 25 kHz or the 20 dB bandwidth, whichever is the greater. For systems with output power less than 125 mW the channel separation shall be a minimum of 25 kHz or two-thirds of the 20 dB bandwidth whichever is the greater. The formal measurements are detailed below:

Test Details:	
Regulation	Part 15.247(a)(1)(i), RSS-247 Section 5.1(2)
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	22°C
EUT set up	Refer to Appendix C

Operational Data Rate	Measured Channel Spacing (kHz)	Limit (kHz)	Result
1Mbps	1006	≥ 875	Pass
2Mbps	1003	≥ 913	Pass
3Mbps	1003	≥ 923	Pass
Limit	≥ 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel whichever is greater		

Plots of the channel spacing are contained in Appendix B of this test report.

A7 Hopping frequencies

Hopping frequencies were verified using a spectrum analyser, while the EUT was operating in its normal frequency hopping mode.

Test Details:	
Regulation	Part 15.247(a)(1)(i), RSS – 247, Section 5.1(4)
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	28^{o}C
EUT set up	Refer to Appendix C

No. of Hopping Channels	Requirement	Result
79	≥ 15	Pass

Plots showing the hopping channels are contained in Appendix B

A8 Channel Occupancy

Channel occupancy time was verified using a spectrum analyser in zero span mode, centred on a hopping channel frequency, while the EUT was operating in its normal frequency hopping mode. The other channels were then verified to ensure that the channel occupancy was identical for all channels.

Test Details:	
Regulation	Part 15.247(a)(1), RSS – 247 Section 5.1(4)
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	26°C
EUT set up	Refer to Appendix C

Measured Channel Occupancy Time (ms)	Measurement Period (s)	Number of Transmissions in Measurement Period	Average on Time (s)	Limit (s)	Result
2.94	31.6	18	0.053	0.4	PASS

Plots showing the channel occupancy time and number of transmissions in measurement period are contained in Appendix B of this test report. These are identical for all modulation modes.

Average Channel Retention Time Calculation:

Number of utilised hopping channels (N) = 79
Measured channel occupancy time (T_{occ}) = 2.94 ms
Measurement Period = 0.4 x N = 0.4 x 79 = 31.6 s
Number of Transmissions in Measurement Period = 18

∴ **The Average Retention Time =**

Total activation time T_{occ} x No. of Transmissions in Measurement Period

Average Channel Occupancy Time = 2.94 ms x 18 = 0.053 s

A9 Unintentional Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The EUT was set to receive mode only on its lowest, centre and highest carrier frequency in turn.

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: 2402 MHz	
Regulation	Part 15.109, RSS – GEN, Section 7.1
Measurement standard	ANSI C63.10, RSS – GEN,
Frequency range	30MHz to 25 GHz
EUT sample number	S20
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	29
Photographs (Appendix F)	Photograph 1 and 2

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Ref No.	FREQ. (MHz)	Detector	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)
2402 MHz									
1.	1600.3	Av	57.8	2.3	25.6	36.6	49.1	283.8	500.0
2441 MHz									
2.	1626.3	Av	55.8	2.4	25.7	36.6	47.4	233.1	500.0
2480 MHz									
3.	1652.3	Av	56.5	2.6	25.8	36.6	48.4	262.4	500.0
Emissions unrelated to operating frequency									
4.	30.5	Qp	5.3	0.8	18.8	N/A	24.9	17.5	100.0
5.	64.9	Qp	15.5	1.2	6.0	N/A	22.6	13.6	100.0
6.	150.0	Qp	15.9	1.7	11.2	N/A	28.8	27.7	150.0
7.	200.0	Qp	15.0	1.9	8.2	N/A	25.1	18.1	150.0

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= 1MHz, VBW ≥ RBW
Average	RBW= 1MHz, VBW ≥ RBW

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33

Radiated emission limits 47 CFR Part 15: Clause 15.209 and RSS – Gen Section 7.1.2 for all emissions:

Frequency of emission (MHz)	Field strength (µV/m)	Measurement Distance (m)	Field strength (dBµV/m)
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.

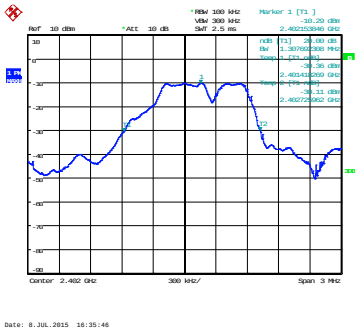
(b) The time and date on the plots do not necessarily equate to the time of the test.

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

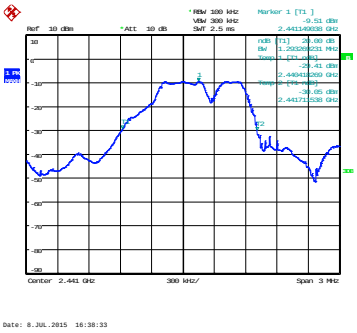
(d) Appendix C details the numbering system used to identify the sample and its modification state.

(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.

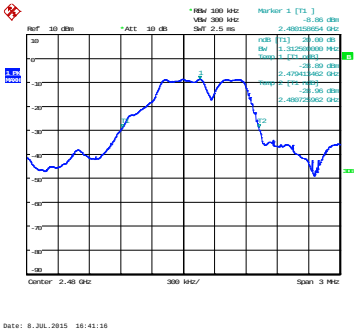
20dB Bandwidth



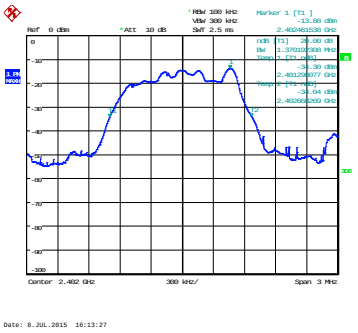
1 Mbps - 2402 MHz



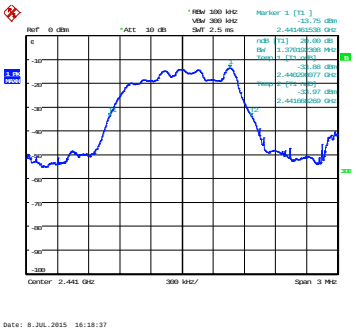
1 Mbps - 2441 MHz



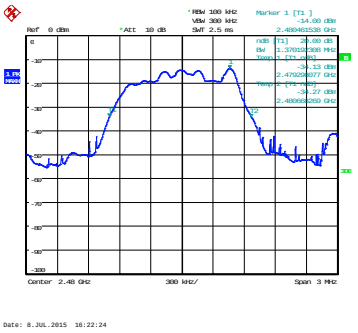
1 Mbps – 2480 MHz



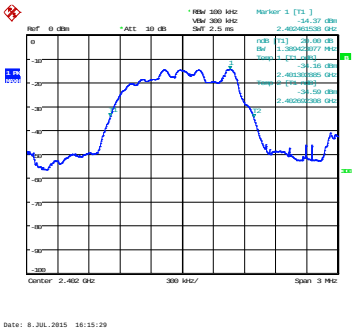
2 Mbps - 2402 MHz



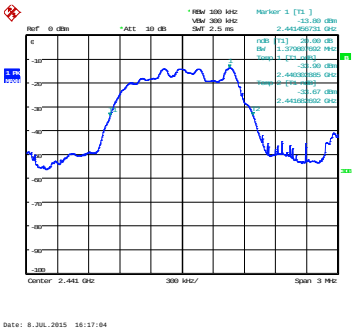
2 Mbps - 2441 MHz



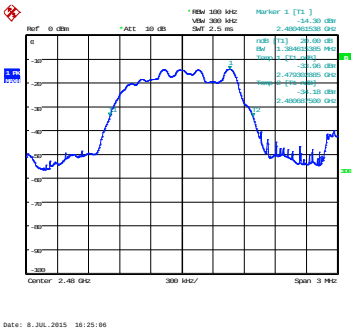
2 Mbps – 2480 MHz



3 Mbps - 2402 MHz

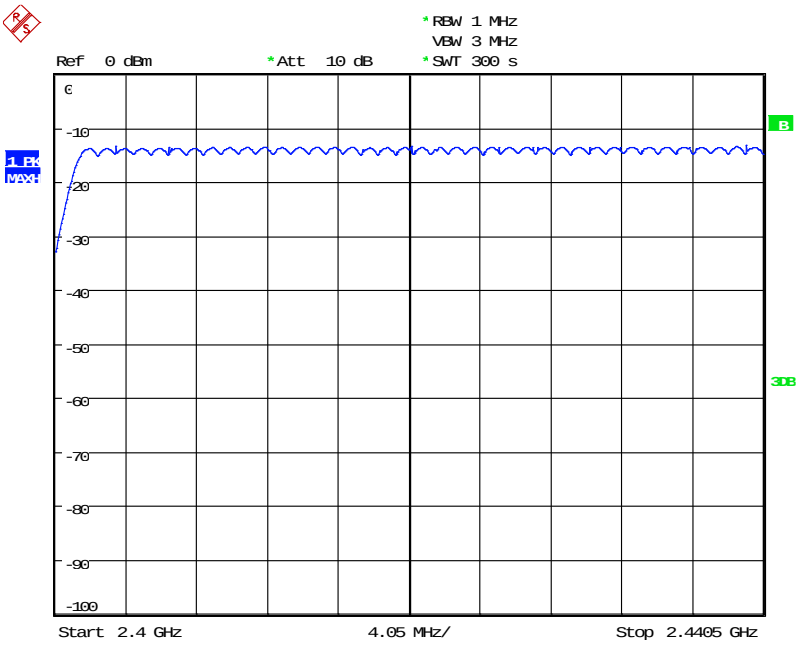


3 Mbps - 2441 MHz

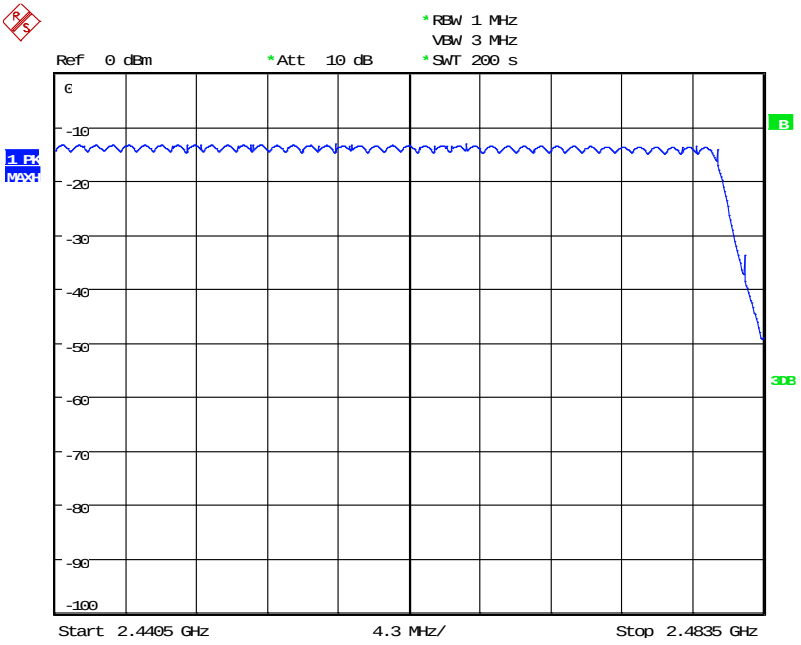


3 Mbps – 2480 MHz

Number of Hopping Channels

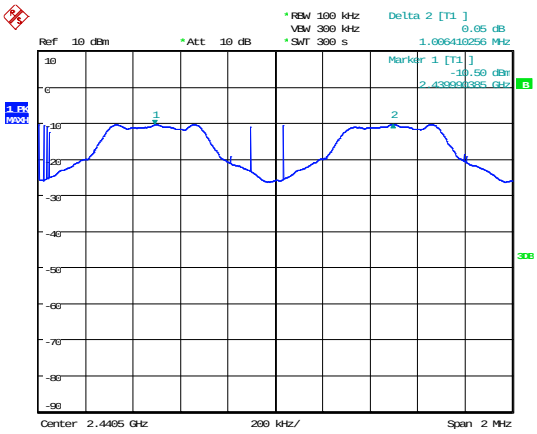


Channels 1 - 39

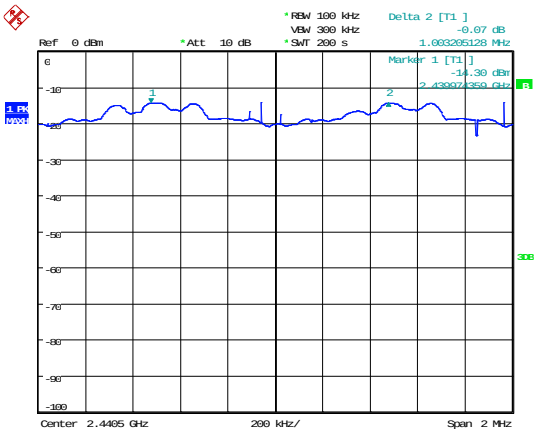


Channels 40 – 79

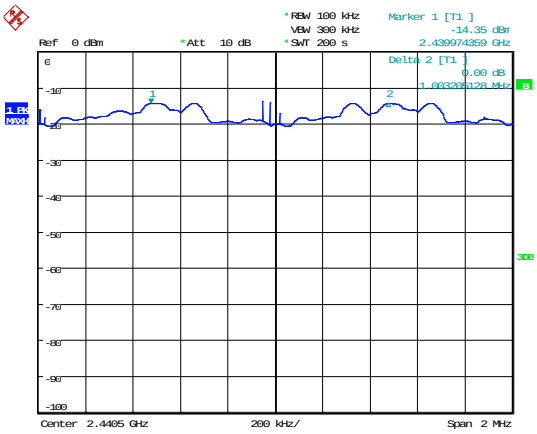
Channel Spacing



Channel Spacing – 1 Mbps

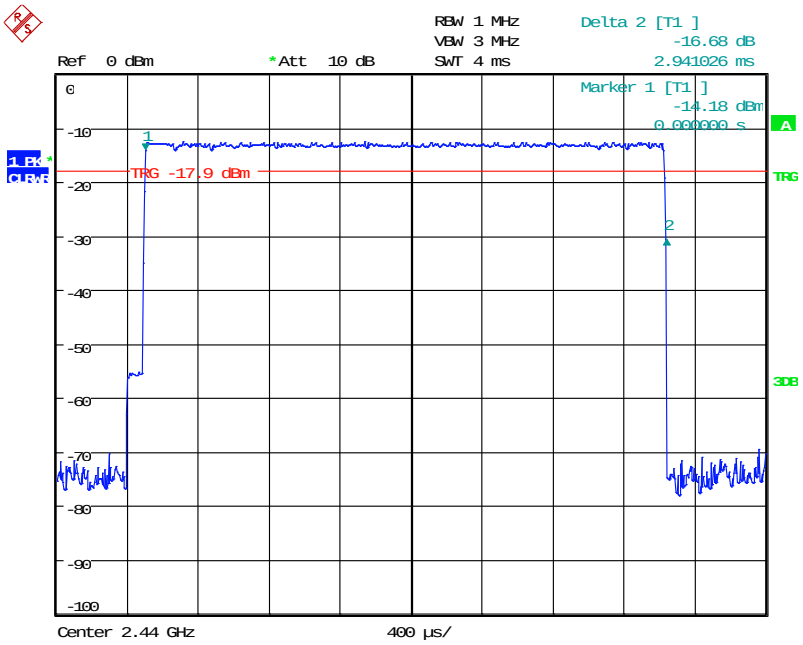


Channel Spacing – 2 Mbps



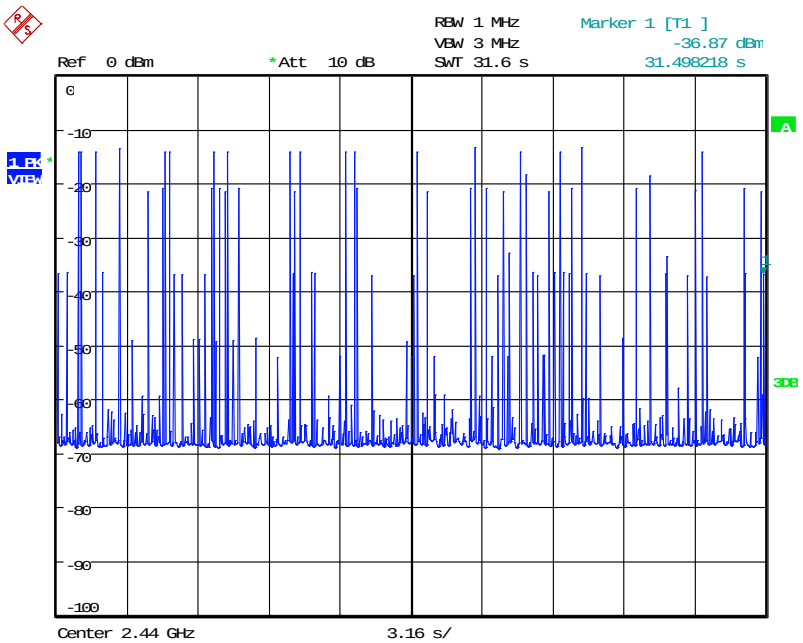
Channel Spacing – 3 Mbps

Channel Occupancy Time & No. of Transmission in Measurement period



Date: 9.JUL.2015 15:54:01

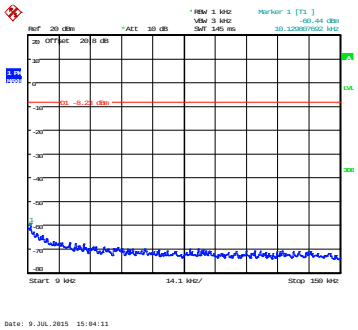
Channel Occupancy Time



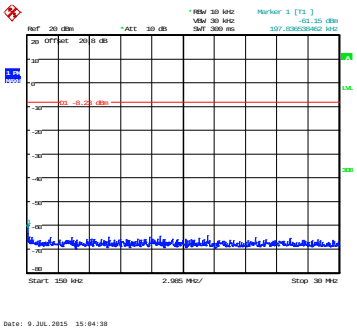
Date: 9.JUL.2015 16:28:49

No. of Transmission in Measurement period

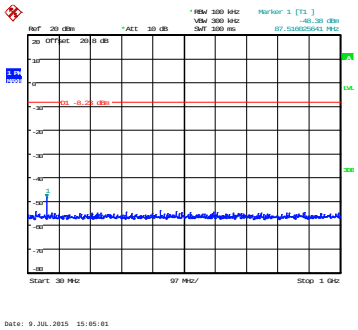
Conducted spurious emissions - 2402 MHz



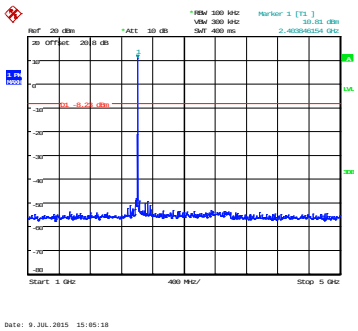
9 kHz – 150 kHz



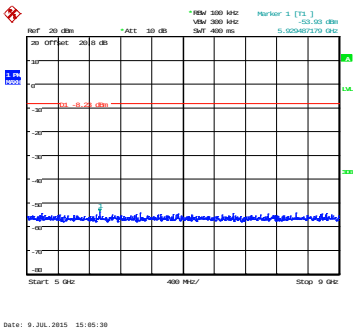
150 kHz – 30 MHz



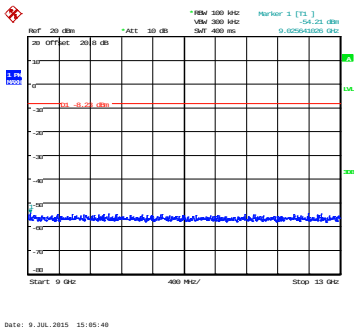
30 MHz – 1 GHz



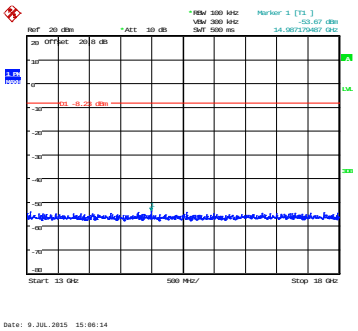
1 GHz – 5 GHz



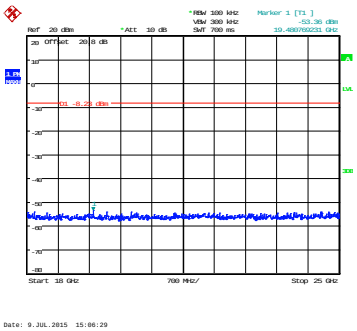
5 GHz – 9 GHz



9 GHz – 13 GHz

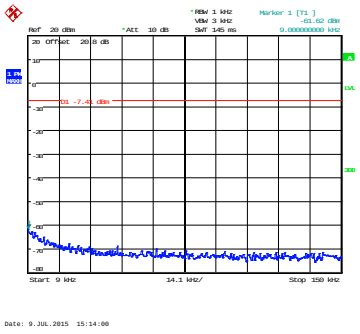


13 GHz – 18 GHz

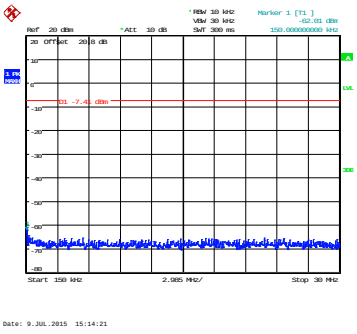


18 GHz – 25 MHz

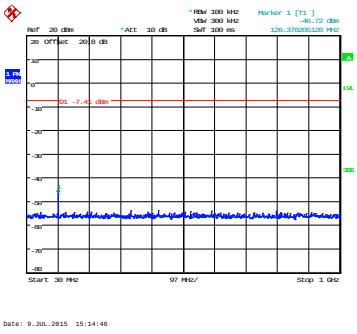
Conducted spurious emissions - 2441 MHz



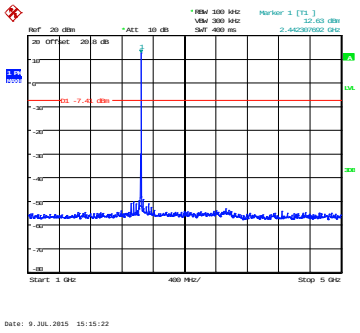
9 kHz – 150 kHz



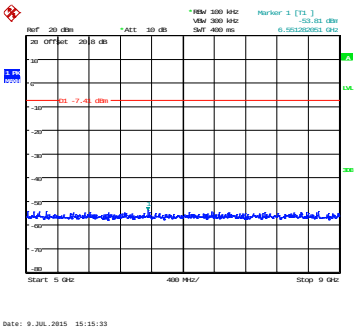
150 kHz – 30 MHz



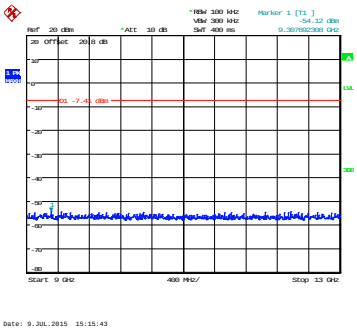
30 MHz – 1 GHz



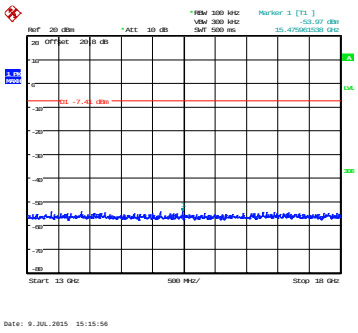
1 GHz – 5 GHz



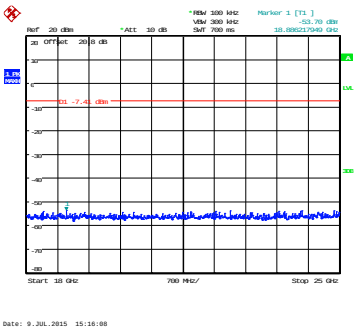
5 GHz – 9 GHz



9 GHz – 13 GHz

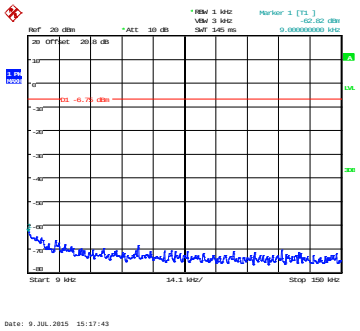


13 GHz – 18 GHz

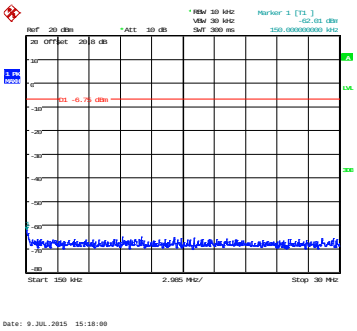


18 GHz – 25 MHz

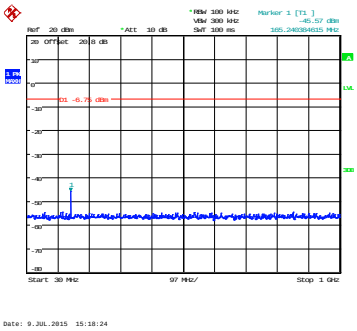
Conducted spurious emissions - 2480 MHz



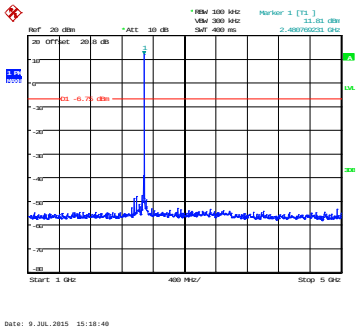
9 kHz – 150 kHz



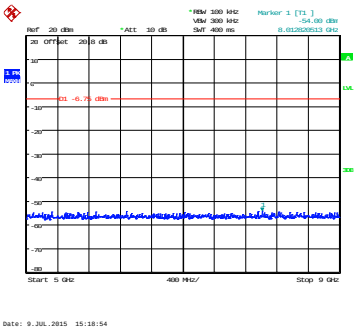
150 kHz – 30 MHz



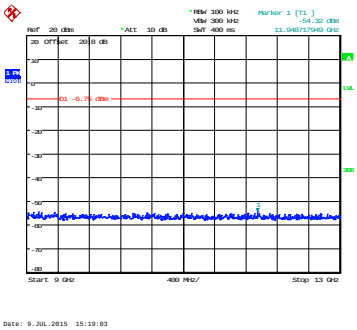
30 MHz – 1 GHz



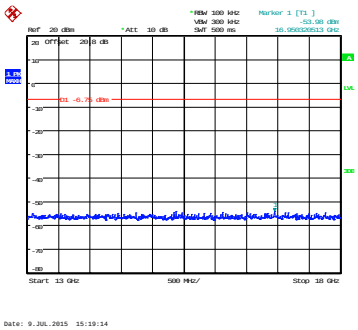
1 GHz – 5 GHz



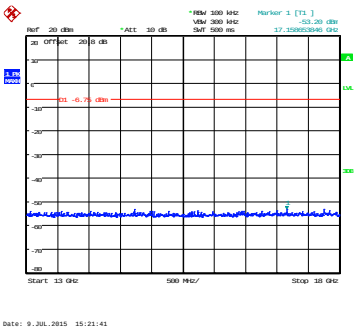
5 GHz – 9 GHz



9 GHz – 13 GHz

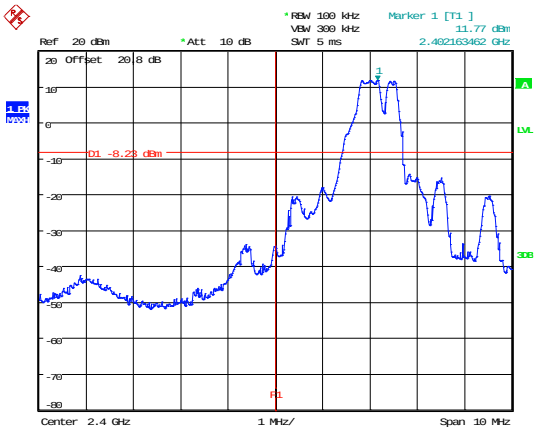


13 GHz – 18 GHz

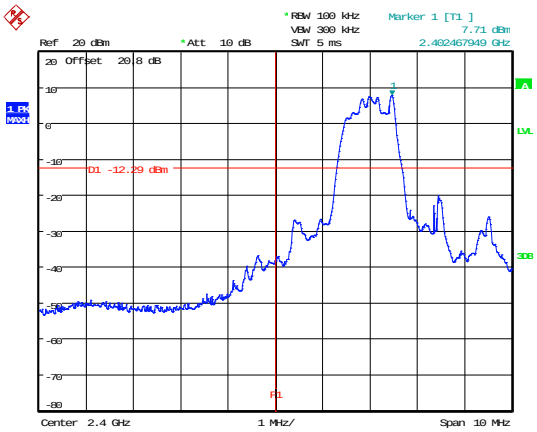


18 GHz – 25 MHz

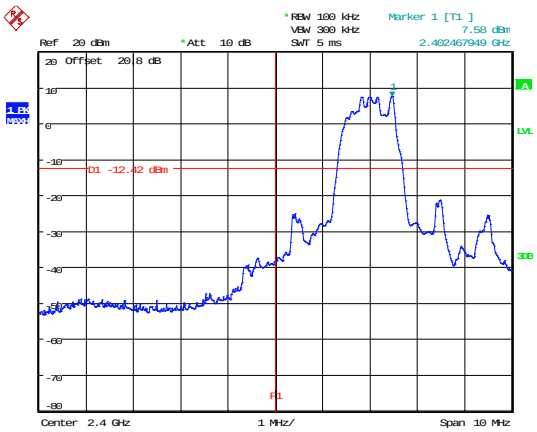
Conducted Lower band-edge compliance



Conducted Lower band-edge compliance – 1 Mbps

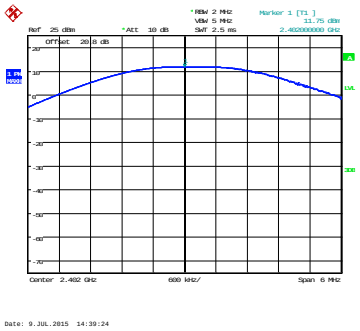


Conducted Lower band-edge compliance – 2 Mbps

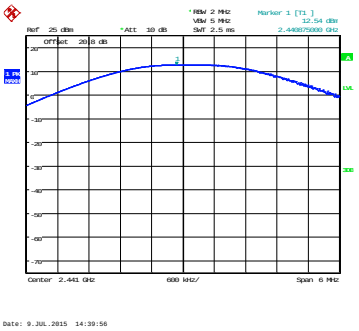


Conducted Lower band-edge compliance – 3 Mbps

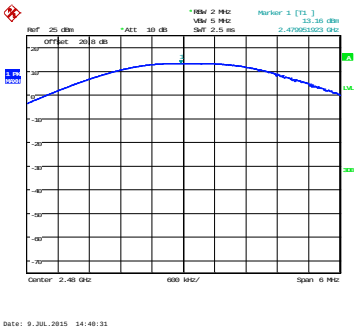
Conducted carrier power



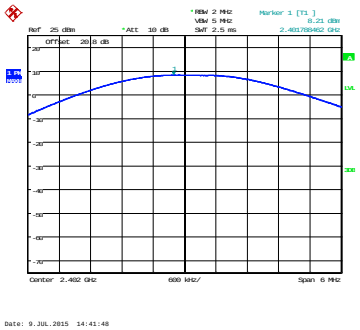
1 Mbps - 2402 MHz



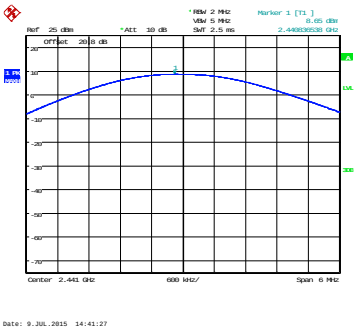
1 Mbps - 2441 MHz



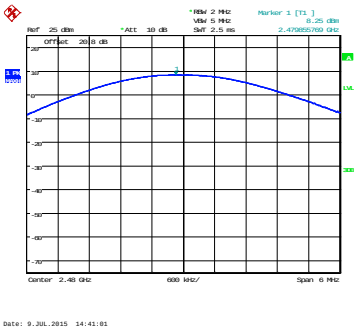
1 Mbps – 2480 MHz



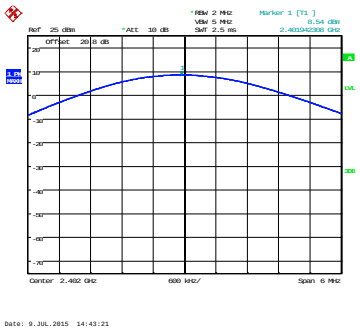
2 Mbps - 2402 MHz



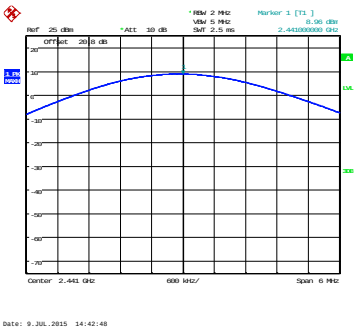
2 Mbps - 2441 MHz



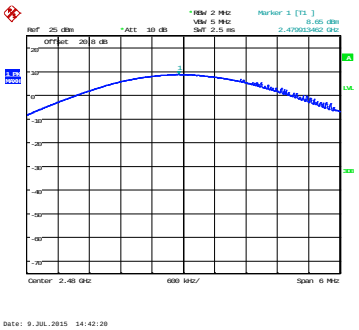
2 Mbps – 2480 MHz



3 Mbps - 2402 MHz

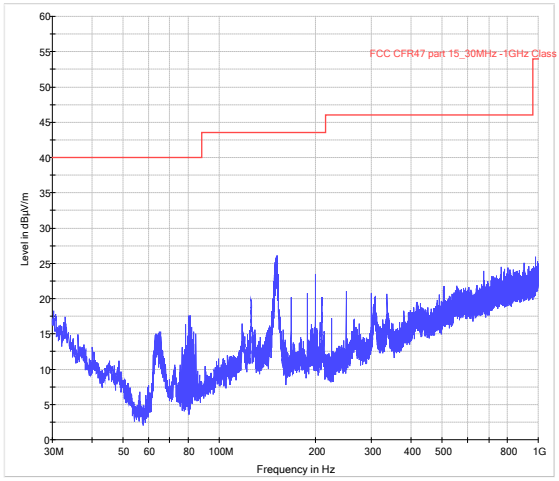


3 Mbps - 2441 MHz

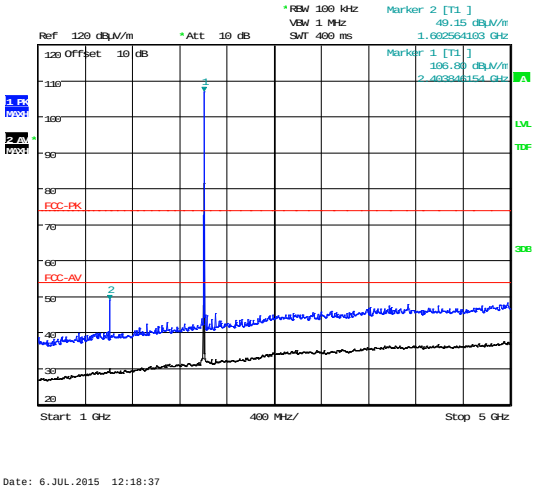


3 Mbps – 2480 MHz

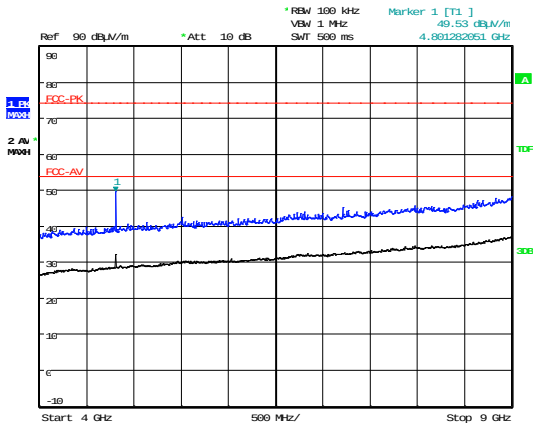
Radiated Spurious emissions - 2402 MHz



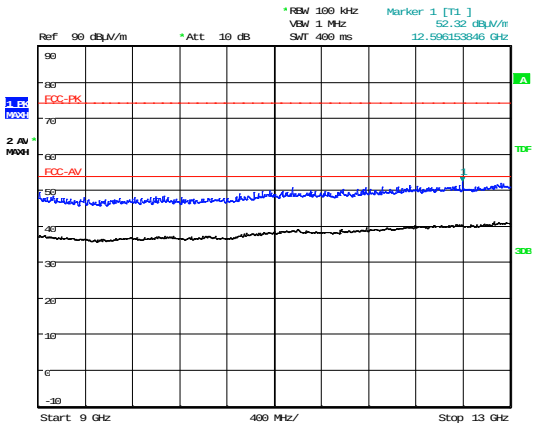
30 MHz to 1 GHz



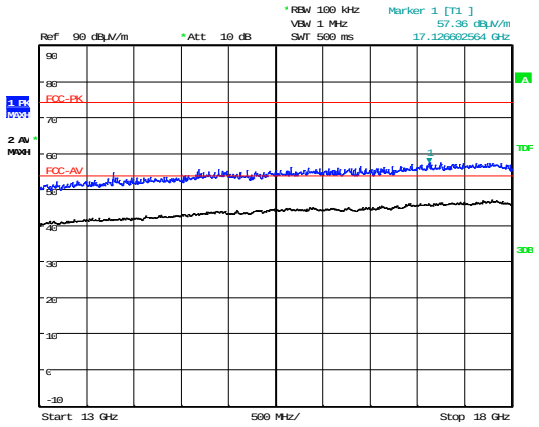
1 GHz to 4 GHz



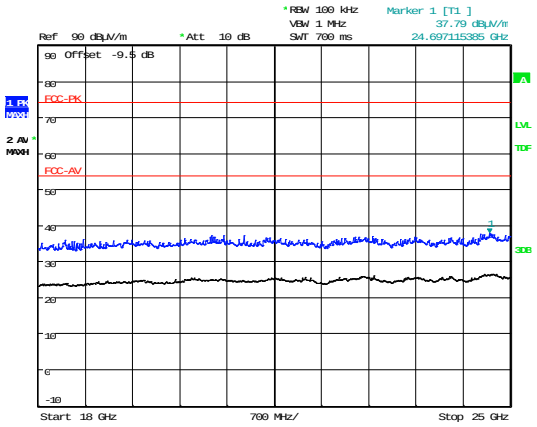
4 GHz to 9 GHz



9 GHz to 13 GHz

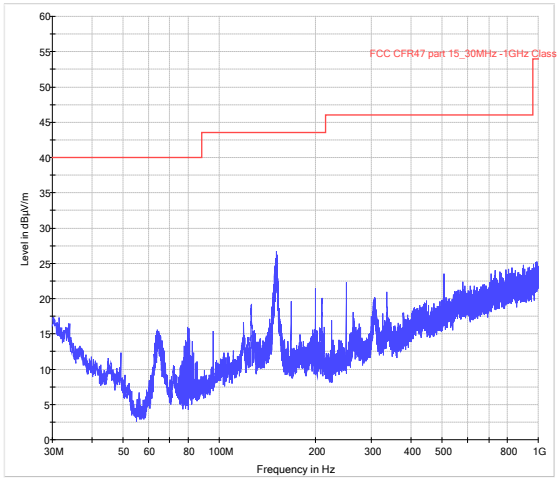


13 GHz to 18 GHz

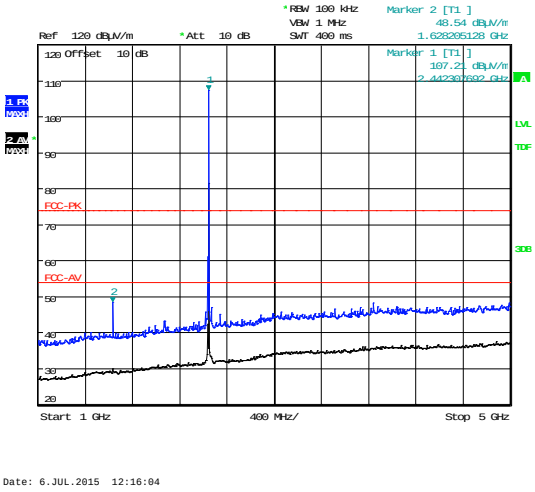


18 GHz to 25 GHz

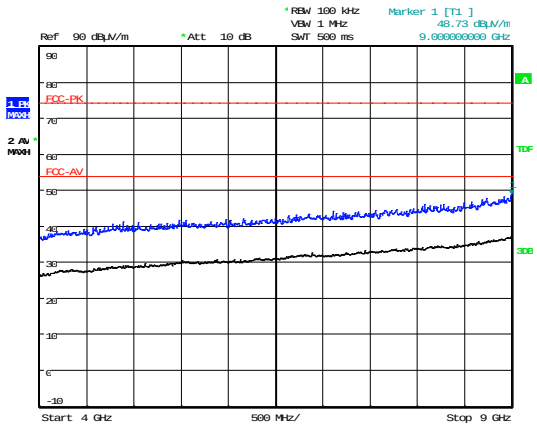
Radiated spurious emissions - 2441 MHz



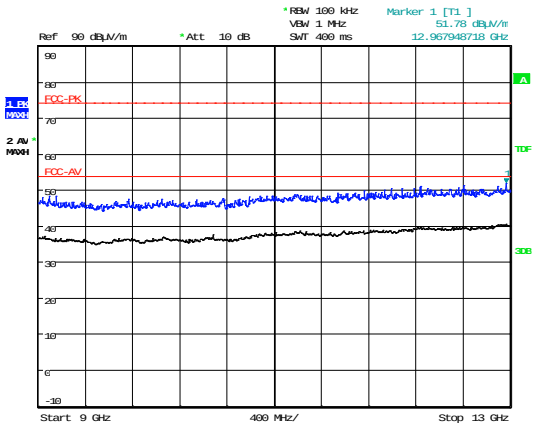
30 MHz to 1 GHz



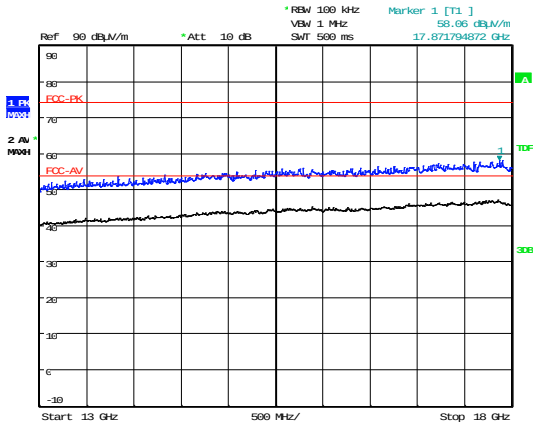
1 GHz to 4 GHz



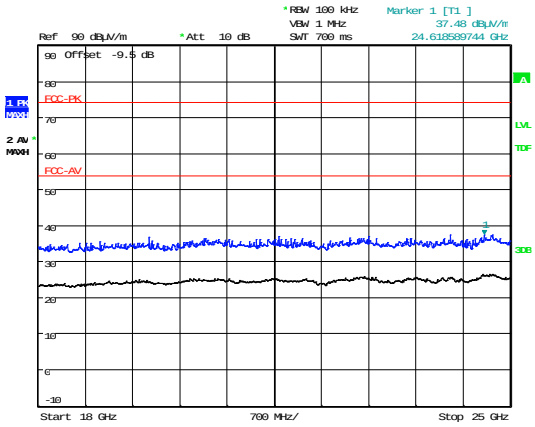
4 GHz to 9 GHz



9 GHz to 13 GHz

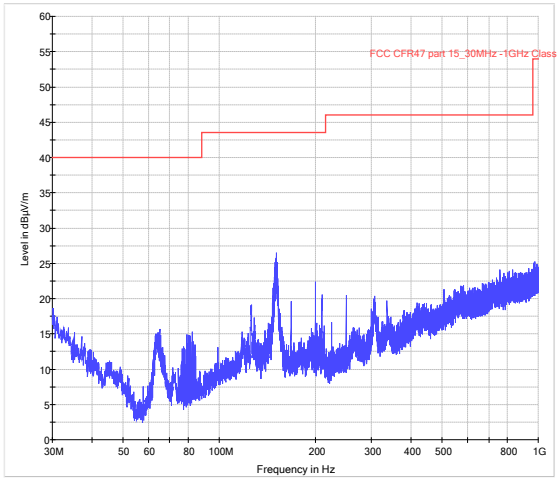


13 GHz to 18 GHz

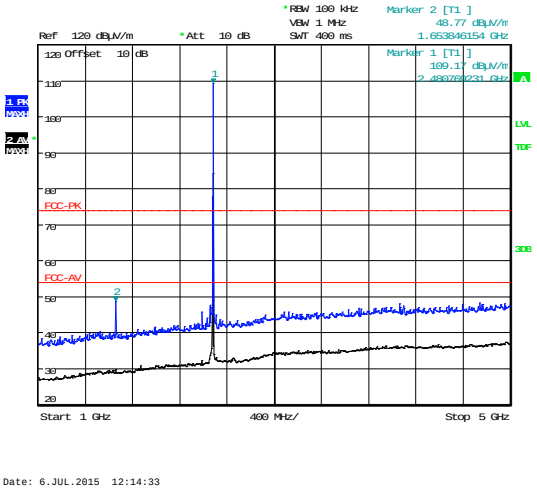


18 GHz to 25 GHz

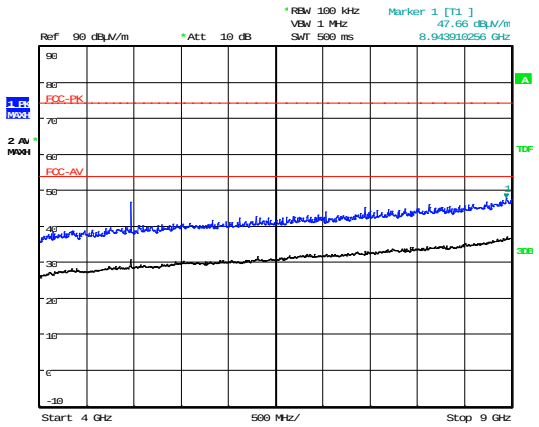
Radiated spurious emissions - 2480 MHz



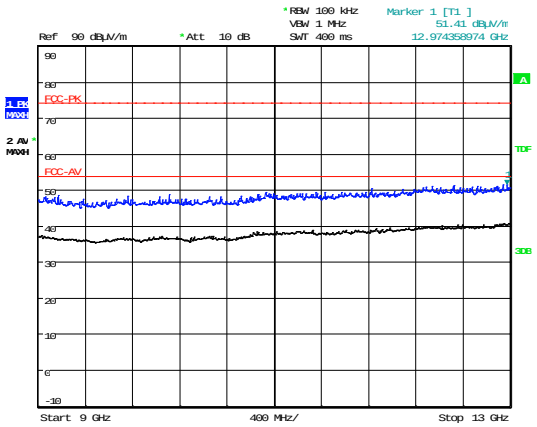
30 MHz to 1 GHz



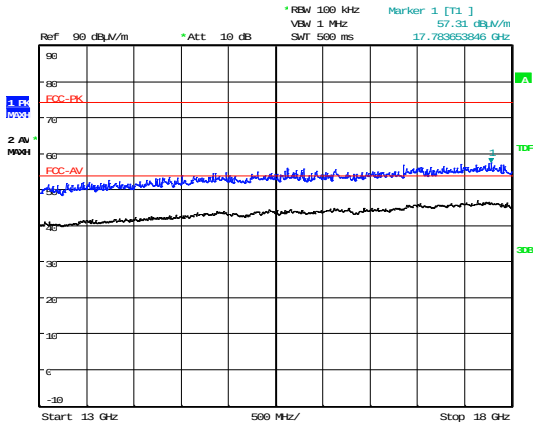
1 GHz to 4 GHz



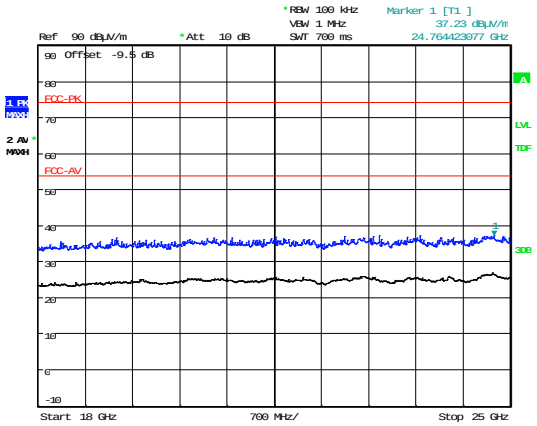
4 GHz to 9 GHz



9 GHz to 13 GHz

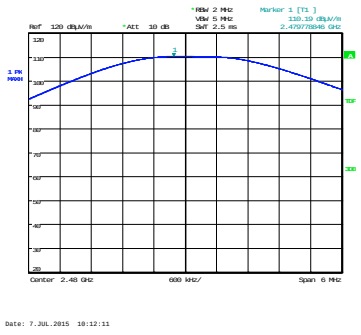


13 GHz to 18 GHz

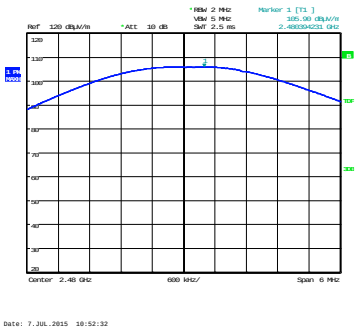


18 GHz to 25 GHz

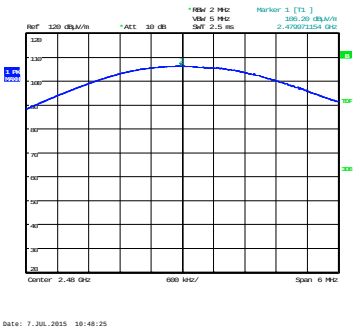
Radiated Upper band-edge compliance



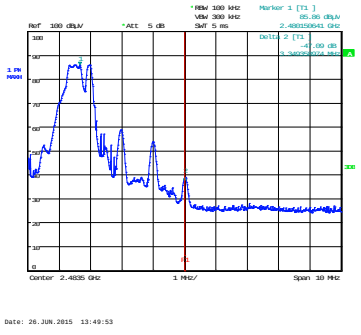
1 Mbps - Pk Power



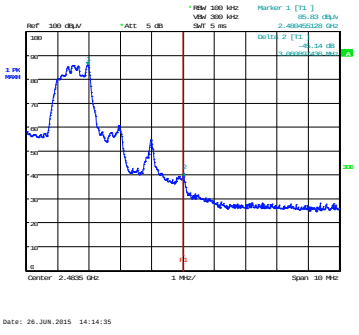
2 Mbps - Pk Power



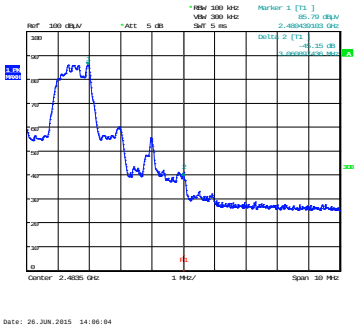
3 Mbps - Pk Power



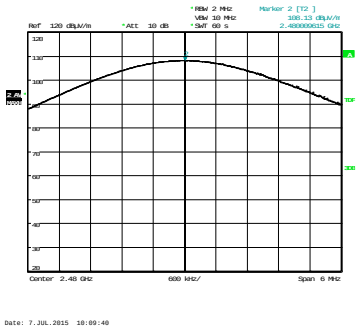
1 Mbps - Pk Delta in 100 kHz



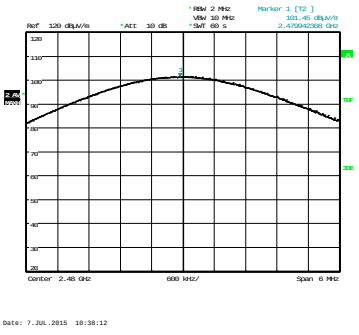
2 Mbps - Pk Delta in 100 kHz



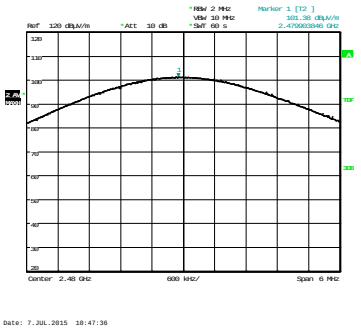
3 Mbps - Pk Delta in 100 kHz



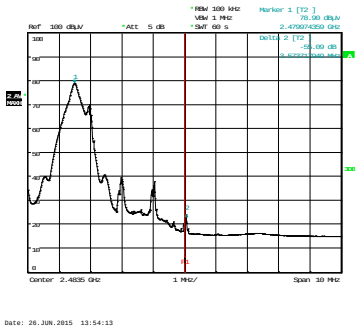
1 Mbps - Av Power



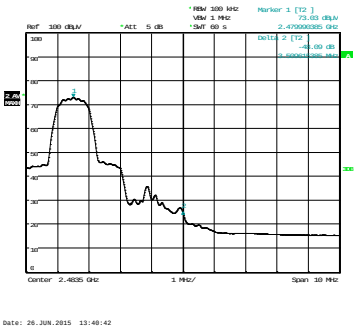
2 Mbps - Av Power



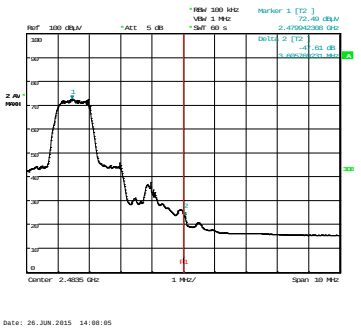
3 Mbps - Av Power



1 Mbps - Av Delta in 100 kHz

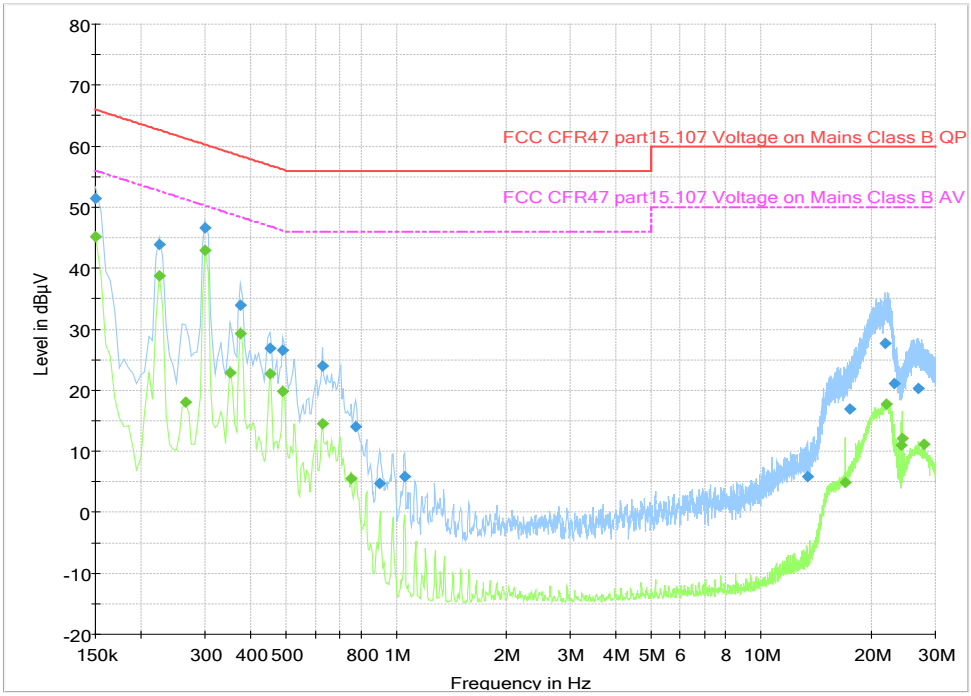


2 Mbps - Av Delta in 100 kHz

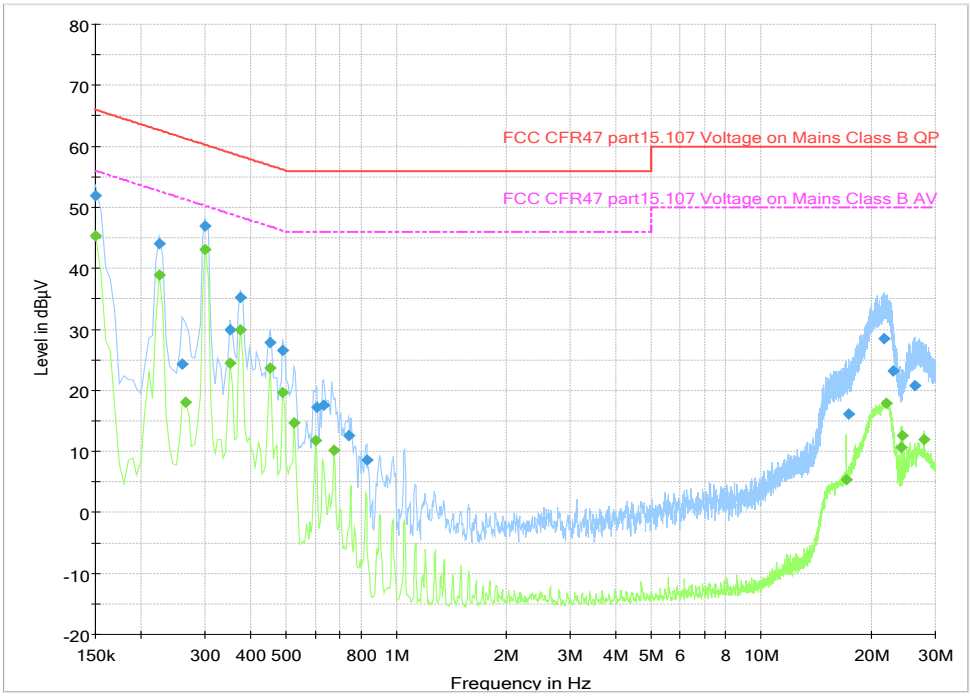


3 Mbps – Av Delta in 100 kHz

AC Powerline Conducted Emissions

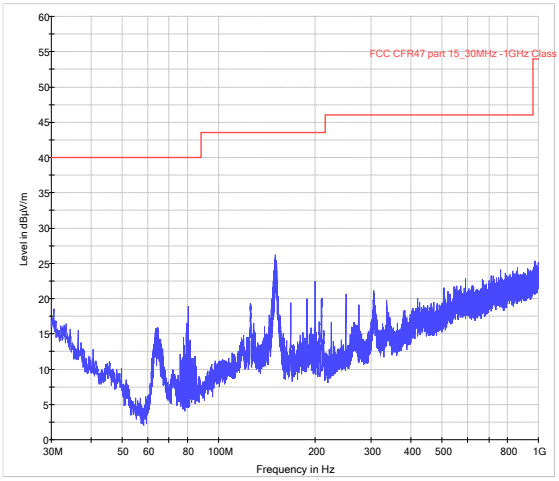


Transmit mode

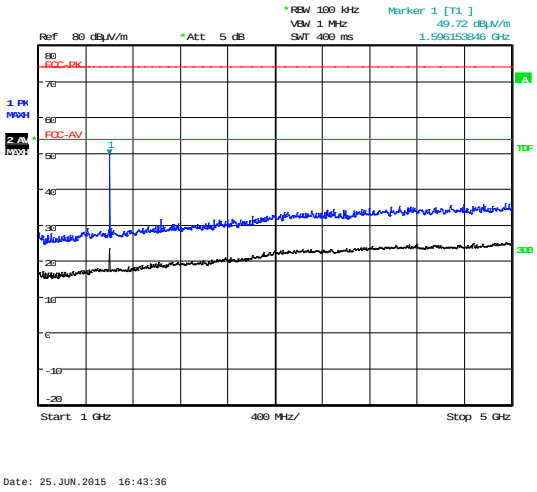


Receive Mode

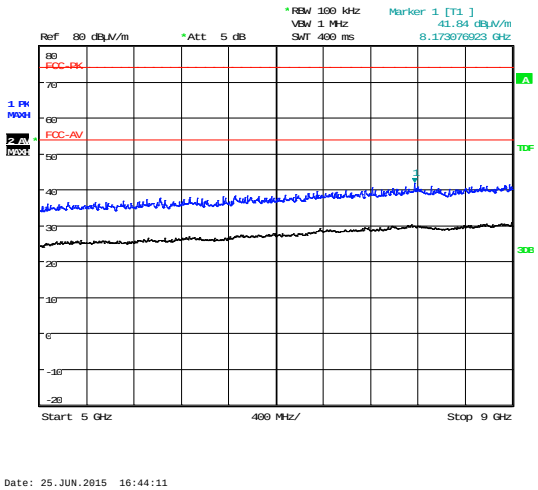
Unintentional Radiated Spurious emissions - 2402 MHz



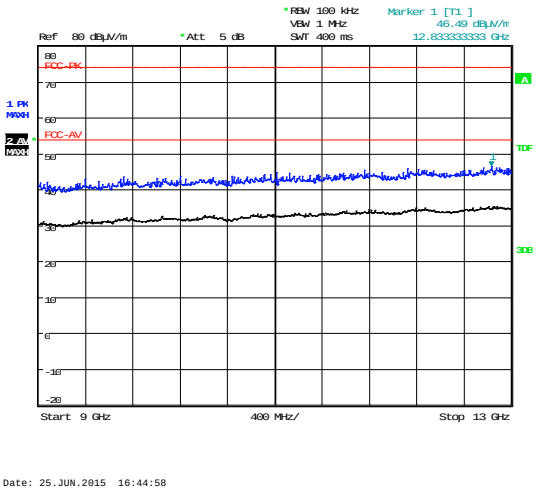
30 MHz to 1 GHz



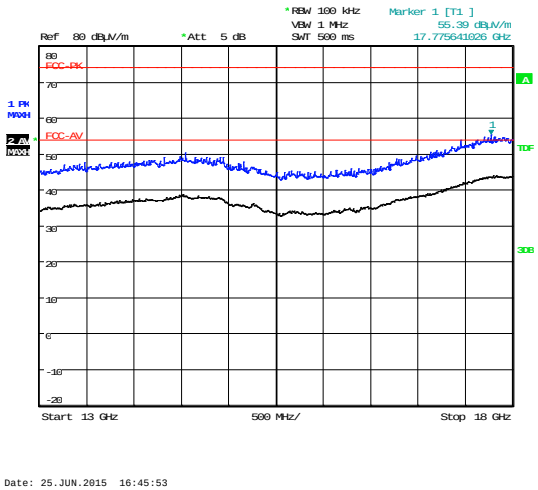
1 GHz to 5 GHz



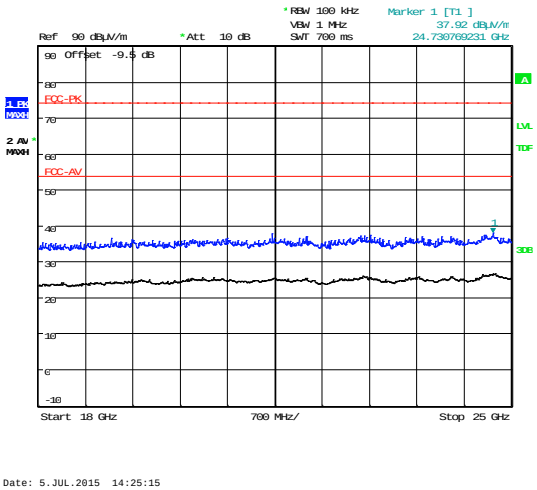
5 GHz to 9 GHz



9 GHz to 13 GHz

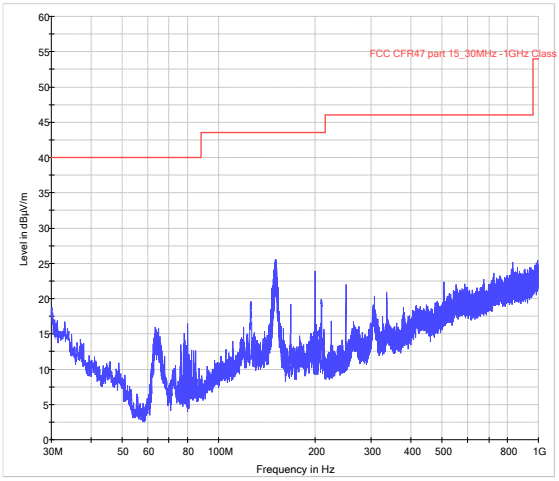


13 GHz to 18 GHz

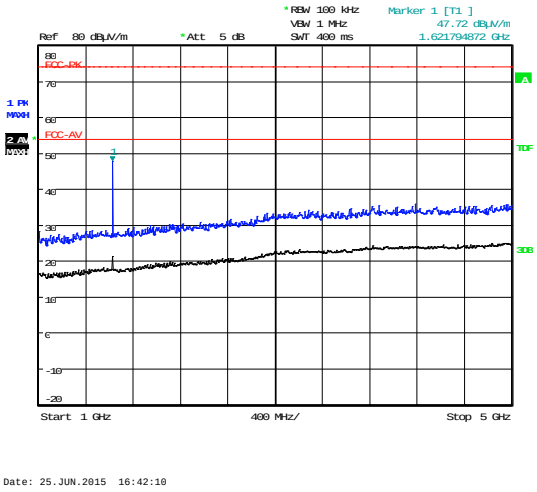


18 GHz to 25 GHz

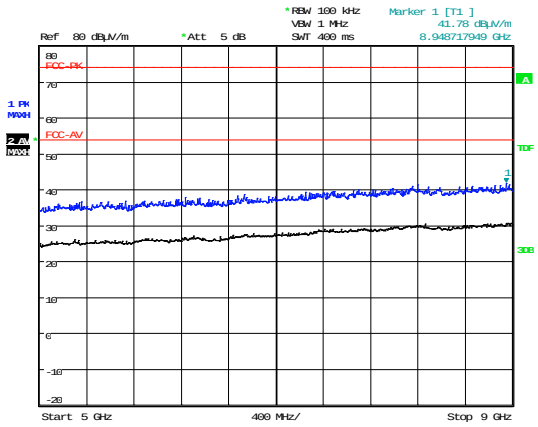
Unintentional Radiated Spurious emissions - 2441 MHz



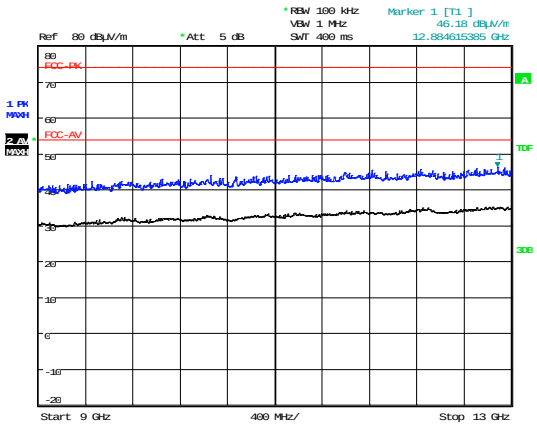
30 MHz to 1 GHz



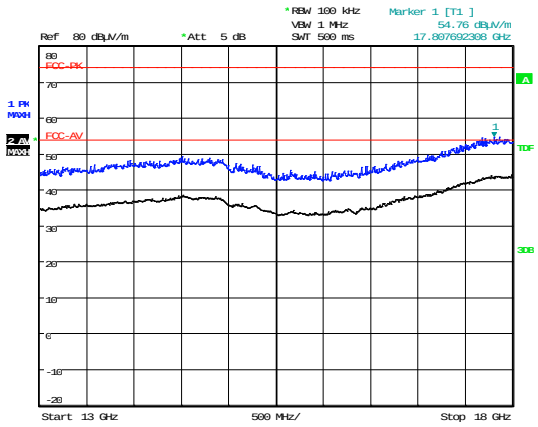
1 GHz to 5 GHz



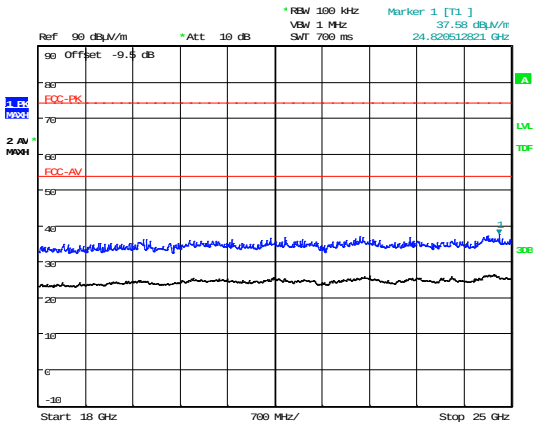
5 GHz to 9 GHz



9 GHz to 13 GHz

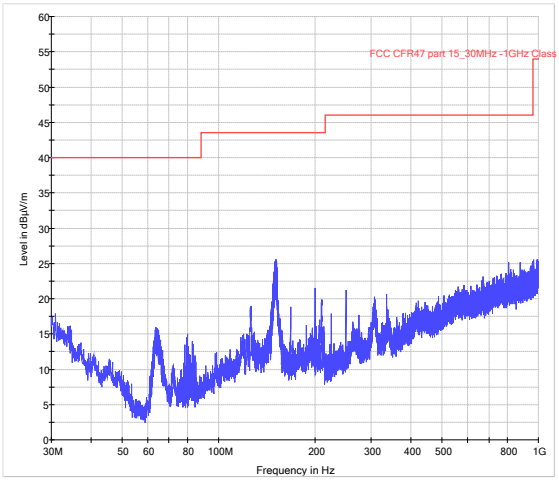


13 GHz to 18 GHz

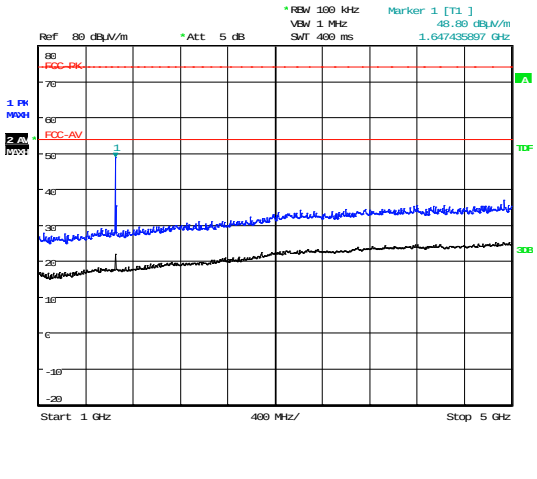


18 GHz to 25 GHz

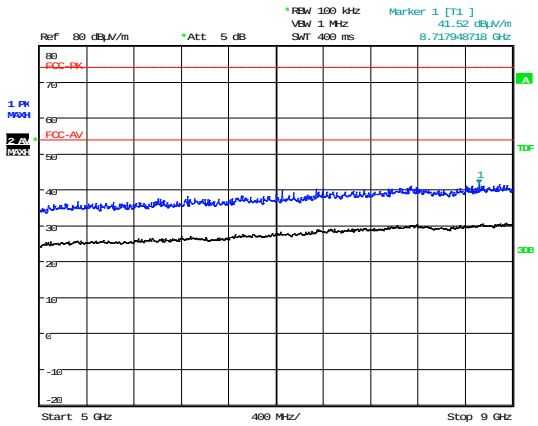
Unintentional Radiated Spurious emissions - 2480 MHz



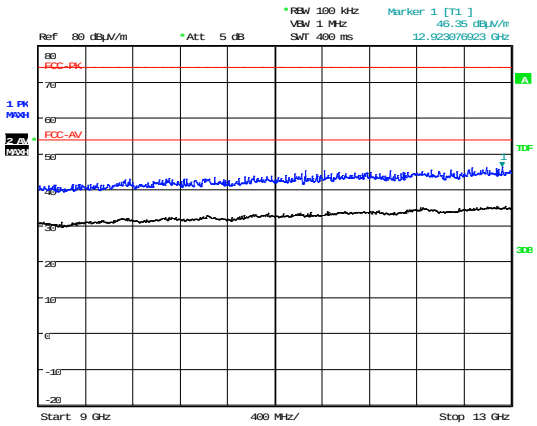
30 MHz to 1 GHz



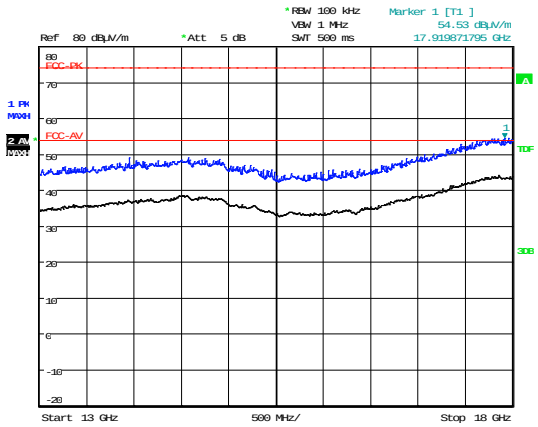
1 GHz to 5 GHz



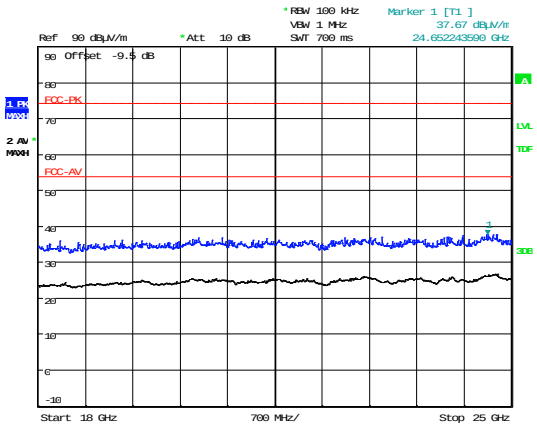
5 GHz to 9 GHz



9 GHz to 13 GHz



13 GHz to 18 GHz



18 GHz to 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 TRaC Global upon request.

C1) Test samples

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

Sample No.	Description	Identification
S20	ADTS552F	5520012

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

Sample No.	Description	Identification
S21	ADTS Touch	4434050

C2) EUT Operating Mode during Testing

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

Test	Description of Operating Mode: Transmit
All transmitter tests detailed in this report	EUT actively transmitting, operating at 1 Mbps (DH5), 2 Mbps (2-DH5) and 3 Mbps (3-DH5) data rates and on highest, middle and lowest operating frequencies and in hopping mode. Power setting for 1 Mbps (DH5): 7 Power setting for 2 Mbps (2-DH5) and 3 Mbps (3-DH5): 14

Test	Description of Operating Mode: Receive
Receiver conducted and radiated spurious emissions	EUT active but non-transmitting.

Test	Description of Operating Mode: Transmit and Receive
PLCE	EUT in transmit and receive modes

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 : S20
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
Power	Power Cable	1.5 m	Power Supply
Antenna	Coaxial	<1 m	Measurement system

Sample : S20
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Power	Power Cable	1.5 m	Power Supply

C5 Details of Equipment Used

TRaC No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
UH004	ESVS10	Receiver	R&S	24/03/2015	12	24/03/2016
UH195	ESH3-Z5.831.5	Lisn	R&S	21/07/2014	12	21/07/2015
UH281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
UH387	ATS	Chamber 1	Rainford EMC	06/09/2014	12	06/09/2015
UH387	ATS	IC Reg - Chamber 1	Rainford EMC	19/11/2014	36	19/11/2017
UH405	FSU26	Spectrum Analyser	R&S	11/05/2015	12	11/05/2016
UH420	CBL6112	Bilog	Chase	25/07/2014	24	25/07/2016
L138	3115	1-18GHz Horn	EMCO	17/10/2013	24	17/10/2015
L290	CBL611/A	Bilog	Chase	02/12/2014	24	02/12/2016
L300	20240-20	Horn 18-26GHz (&UH330)	Flann	10/02/2014	24	10/02/2016
L317	ESVS10	Receiver	R&S	26/02/2015	12	26/02/2016
L572	8449B	Pre Amp	Agilent	10/02/2015	12	10/02/2016
REF909	FSU26	Spectrum Analyser	R&S	13/02/2015	12	13/02/2016
REF916	SMBV100A	Signal Generator	R&S	17/02/2015	12	17/02/2016
REF940	ATS	Radio Chamber - PP	Rainford EMC	08/09/2014	24	08/09/2016
REF940	ATS	IC Reg Radio Chamber - PP	Rainford EMC	19/11/2014	36	19/11/2017
REF977	SH4141	High Pass Filter	BSC	25/02/2015	24	25/02/2017

Appendix D: Additional Information

No additional information is included within this test report.

Appendix E: Calculation of the duty cycle correction factor

Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time is set accordingly to capture the pulse train. The transmit pulse widths and period is measured. Any applicable plot will be contained in appendix B of this test report.

If the pulse train is less than 100 ms, including blanking intervals, the duty cycle is calculated by averaging the sum of the pulse widths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle is calculated by averaging the sum of the pulse widths over the 100ms width with the highest average value. (The duty cycle is the value of the sum of the pulse widths in one period (or 100 ms), divided by the length of the period (or 100 ms). The duty cycle correction factor is then expressed in dB and the peak emissions adjusted accordingly to give an average value of the emission.

Correction factor (dB) = 20 x Log_{10} (Calculated Duty Cycle)

For the pulse train period greater than 100 ms

Duty cycle = (the sum of the highest average value pulse widths over 100ms) / 100 ms

e.g.

$$= \frac{7.459ms}{100ms} = 0.07459$$

0.07459 Or 7.459 %

So

Correction factor (dB) = 20 x Log_{10} (0.07459) = -22.54 dB

Duty cycle correction may not be applicable / required by the device covered in this report. The correction factor above is for example of how the correction is calculated. Any applicable duty cycle used will be recorded in the relevant results sections of this report.

Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: overview
2. Radiated electric field emissions arrangement: close up

Photograph 1

Photograph 2

Appendix G: 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 50 mm (whichever is lower) = 50 mm (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 2.402 GHz

SARET = [(3.0 x 50) / √2.402]
SARET = 96.8 mW

Operating Frequency 2.441 GHz

SARET = [(3.0 x 50) / √2.441]
SARET = 96.0 mW

Operating Frequency 2.480 GHz

SARET = [(3.0 x 50) / √2.480]
SARET = 95.3 mW

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold (mW)	SAR Evaluation
2402	23.9	96.8	Not Required
2441	38.1	96.0	Not Required
2480	31.3	95.3	Not Required

Note: EIRP is calculated from maximum radiated field strength.

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

Appendix H: MPE Calculation

Prediction of MPE limit at a given distance

For purposes of these requirements mobile devices are defined by the FCC and Industry Canada 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 and Industry Canada 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 and Industry Canada 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

FCC Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 0.98 mW/cm^2
2441	38.1	1.0	1.8

IC Result

Prediction Frequency (MHz)	Maximum EIRP (W)	Exemption limit (W)	RF Exposure
2441	0.0381	2.7	Not required

Note: EIRP is calculated from maximum radiated field strength.