A RADIO TEST REPORT

FOR

ANALOG DEVICES (IRE)

ON

EVAL-ADF7024DB2Z

DOCUMENT NO. TRA-022289-47-03-A

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TRaC Wireless Test Report	**:** TRA-022289-47-03-A
Applicant	**:** Analog Devices (IRE)
Apparatus	**:** EVAL-ADF7024DB2Z
Specification(s)	**:** CFR47 Parts 15.247(d), 15.209 & 15.109
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: 2014.10.15 14:55:00 +01'00'
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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.

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1.2 Tests Requested By

This testing in this report was requested by :

Analog Devices (IRE)
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1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 22nd to 28th September 2014

EVAL-ADF7024DB2Z

The above equipment was a FHSS transmitter operating in the 902MHz – 928MHz band.

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
Conducted spurious emissions (Non-restricted bands)	Title 47 of the CFR: Part 15 Subpart (c) 15.247	ANSI C63.10:2009	Pass
Radiated spurious emissions (Restricted bands)	Title 47 of the CFR: Part 15 Subpart (c) 15.247	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.109	ANSI C63.10:2009	Pass

Abbreviations used in the above table:

Mod : Modification
CFR : Code of Federal Regulations
REFE : Radiated Electric Field Emissions
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

Only radiated and conducted emissions testing contained within FCC rule Part 15.247 were performed at the request of the client.

Section 2: Measurement Uncertainty

2.1 Measurement Uncertainty Values

For the test data recorded in accordance with note (iii) of Section 2.1 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 (Frequency Counter) = **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 dBuV/m at the regulatory distance, using:

$$FS = PR + AF + CL - PA + KG + DC - CF \text{ (dBuV/m)}$$

Where:

PR is the power recorded on receiver / spectrum analyzer (dBuV),
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 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 100kHz and the VBW>RBW. Frequencies were scanned up through to the 10th harmonic with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	9 kHz to 10 GHz
EUT sample number	S03
Modification state	0
SE in test environment	S02
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

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

Bottom Frequency – 902.5 MHz				
Ref No.	Measured Freq (MHz)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1	No Significant Emissions Within 20 dB of the Limit			

Middle Frequency – 915.0 MHz				
Ref No.	Measured Freq (MHz)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1	No Significant Emissions Within 20 dB of the Limit			

Top Frequency – 927.5 MHz				
Ref No.	Measured Freq (MHz)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1	No Significant Emissions Within 20 dB of the Limit			

Notes:

1. The conducted emission limit for emissions outside the restricted bands, defined in 47CFR15.205(a) are based on a transmitted carrier level of 15.247(b). 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) using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated up to the 10th harmonic in accordance15.33 (a)(1).
3. 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. All other emissions were at least 20dB below the test limit

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

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

A2 Radiated Electric Field Emissions Within The Restricted Bands

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric filed emission test applies to spurious emissions and harmonics that fall within the restricted bands listed in Section 15.205. The maximum permitted field strength is listed in Section 15.209. The EUT was set to transmit on its lowest, centre and highest carrier frequency.

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

Radiated Electric Field Emissions Within The Restricted Band - continued:

Test Details: 902.5 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz – 10GHz
EUT sample number	S03, S09
Modification state	0
SE in test environment	S02
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

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

Det	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
PK	2707.46	64.56	3.4	29.2	36.0	61.2	0.00	1148.15	5011.9
AV	2707.46	63.36	3.4	29.2	36.0	60.0	0.00	1000.00	500.0
DCAV	2707.46	64.56	3.4	29.2	36.0	61.2	-9.01	406.91	500.0
PK	3609.91	62.48	3.3	31.3	35.8	61.3	0.00	1161.45	5011.9
AV	3609.91	61.04	3.3	31.3	35.8	59.9	0.00	988.55	500.0
DCAV	3609.91	62.48	3.3	31.3	35.8	61.3	-9.01	411.62	500.0
PK	4512.36	57.45	3.7	32.2	35.6	57.7	0.00	767.36	5011.9
AV	4512.36	54.56	3.7	32.2	35.6	54.8	0.00	549.54	500.0
DCAV	4512.36	57.45	3.7	32.2	35.6	57.7	-9.01	271.96	500.0
PK	5414.98	52.37	4.1	34.0	35.7	54.8	0.00	549.54	5011.9
AV	5414.98	46.92	4.1	34.0	35.7	49.4	0.00	295.12	500.0
DCAV	5414.98	52.37	4.1	34.0	35.7	54.8	-9.01	194.76	500.0

DCAV = Duty Cycle corrected Peak Value to determine compliance with average limits.
See appendix E for Duty Cycle correction Information.

Radiated Electric Field Emissions Within The Restricted Band - continued:

Test Details: 915.0 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz – 10GHz
EUT sample number	S03, S09
Modification state	0
SE in test environment	S02
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

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

Det	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
Pk	2744.98	64.27	3.3	29.1	36.0	60.7	0.00	1083.93	5011.9
Av	2744.98	63.02	3.3	29.1	36.0	59.5	0.00	944.06	500.0
DCAV	2744.98	64.27	3.3	29.1	36.0	60.7	-9.01	384.15	500.0
Pk	3659.94	60.93	3.2	31.5	35.7	59.9	0.00	988.55	5011.9
Av	3659.94	59.10	3.2	31.5	35.7	58.1	0.00	803.53	500.0
DCAV	3659.94	60.93	3.2	31.5	35.7	59.9	-9.01	350.35	500.0
Pk	4574.91	58.42	3.8	32.3	35.6	58.9	0.00	881.05	5011.9
Av	4574.91	56.14	3.8	32.3	35.6	56.6	0.00	676.08	500.0
DCAV	4574.91	58.42	3.8	32.3	35.6	58.9	-9.01	312.25	500.0
Pk	7319.91	50.68	4.7	36.5	36.1	55.7	0.00	609.54	5011.9
Av	7319.91	44.00	4.7	36.5	36.1	49.1	0.00	285.10	500.0
DCAV	7319.91	50.68	4.7	36.5	36.1	55.7	-9.01	216.02	500.0

DCAV = Duty Cycle corrected Peak Value to determine compliance with average limits.
See appendix E for Duty Cycle correction Information.

Radiated Electric Field Emissions Within The Restricted Band - continued:

Test Details: 927.5 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz – 10 GHz
EUT sample number	S03, S09
Modification state	0
SE in test environment	S02
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

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

Det	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	CORR FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
Pk	2782.44	66.12	3.4	29.1	36.0	62.7	0.00	1364.58	5011.9
Av	2782.44	65.13	3.4	29.1	36.0	61.7	0.00	1216.19	500.0
DCAV	2782.44	66.12	3.4	29.1	36.0	62.7	-9.01	483.62	500.0
Pk	3709.89	58.59	3.2	31.8	35.7	57.9	0.00	785.24	5011.9
Av	3709.89	56.37	3.2	31.8	35.7	55.7	0.00	609.54	500.0
DCAV	3709.89	58.59	3.2	31.8	35.7	57.9	-9.01	278.29	500.0
Pk	4637.48	60.08	3.6	32.3	35.6	60.4	0.00	1047.13	5011.9
Av	4637.48	58.51	3.6	32.3	35.6	58.8	0.00	870.96	500.0
DCAV	4637.48	60.08	3.6	32.3	35.6	60.4	-9.01	371.11	500.0

DCAV = Duty Cycle corrected Peak Value to determine compliance with average limits.
See appendix E for Duty Cycle correction Information.

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10:2009: section 4.5, Table 1

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= 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 C63.10:2009 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 47 CFR Part 15: Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits (47 CFR Part 15: Clause 15.209) for emissions falling within the restricted bands defined in 15.205(a):

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

Notes:

(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

A3 Unintentional Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.109. 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:	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz to 10 GHz
EUT sample number	S03, S09
Modification state	0
SE in test environment	S02
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

The worst case radiated emission measurements for spurious

902.5 MHz									
Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
Pk	1804.631	51.93	2.9	27	36.3	45.55	-9.54	63.15	5011.9
Av	1804.631	43.07	2.9	27	36.3	36.69	-9.54	22.77	500.0

915.0 MHz									
Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
Pk	1829.647	52.14	3.1	27.1	36.3	46.08	-9.54	67.12	5011.9
Av	1829.647	43.44	3.1	27.1	36.3	37.38	-9.54	24.65	500.0

915.0 MHz									
Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
Pk	1854.625	51.97	2.8	27.3	36.2	45.84	-9.54	65.29	5011.9
Av	1854.625	42.97	2.8	27.3	36.2	36.84	-9.54	23.17	500.0

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10:2009: section 4.5, Table 1
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= 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 C63.10:2009 and DA 00-705.

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

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:

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

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

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 and Appendix B.

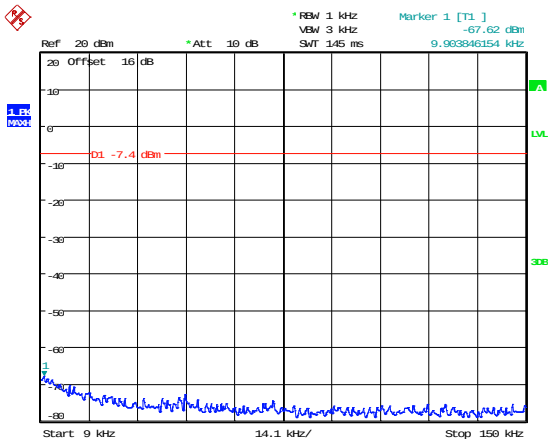
(b) The time and date on the plots do not necessarily equate to the time of the test.

(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.

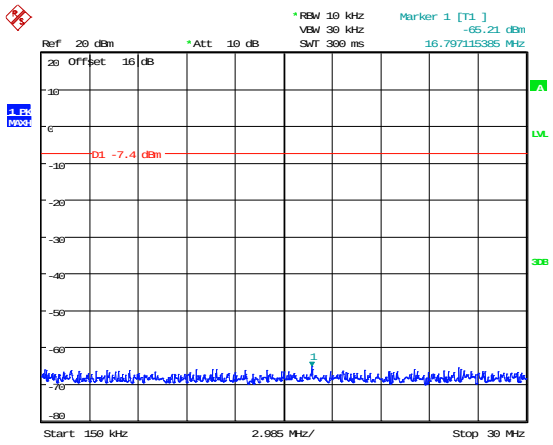
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.

Conducted Spurious emissions 902.5MHz



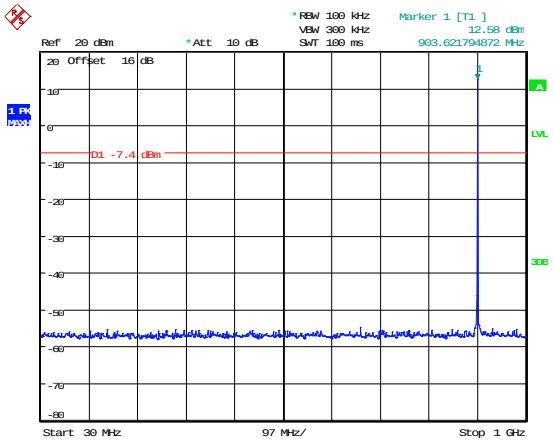
Date: 22.SEP.2014 10:44:42

9kHz – 150 kHz



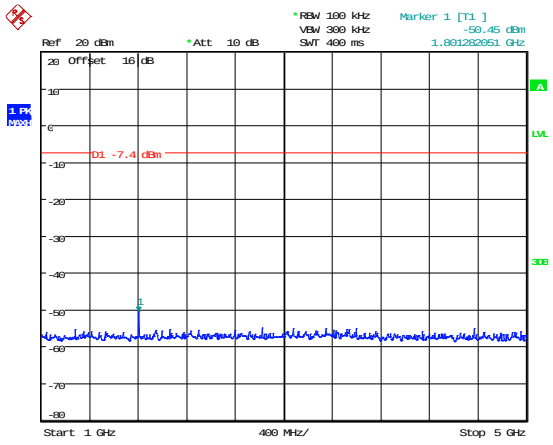
Date: 22.SEP.2014 10:43:42

150 kHz – 30 MHz



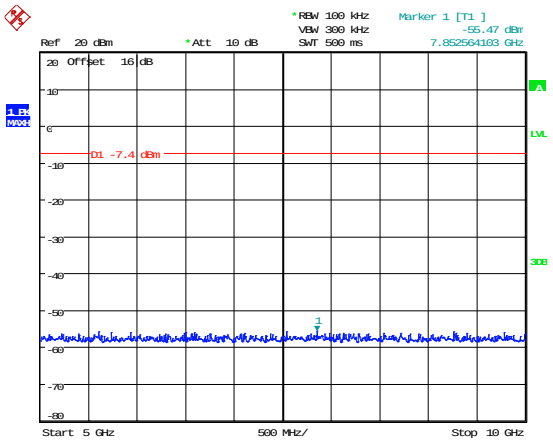
Date: 22.SEP.2014 10:42:34

30 MHz to 1 GHz



Date: 22.SEP.2014 10:42:56

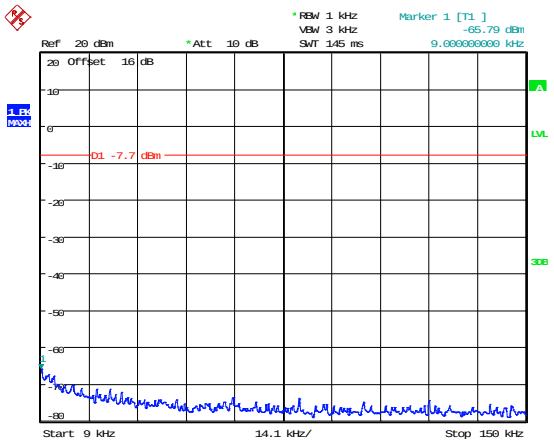
1 GHz to 5 GHz



Date: 22.SEP.2014 10:43:13

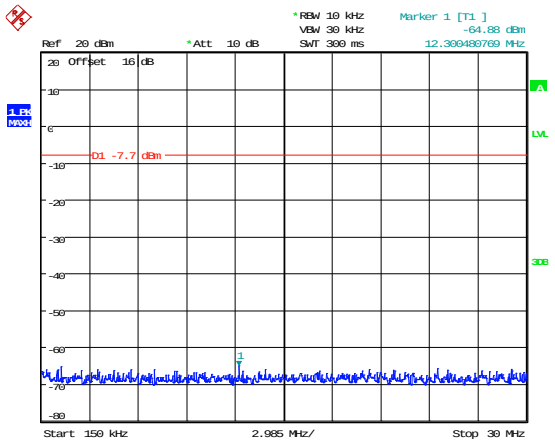
5 GHz to 10 GHz

Conducted Spurious emissions 915.0MHz



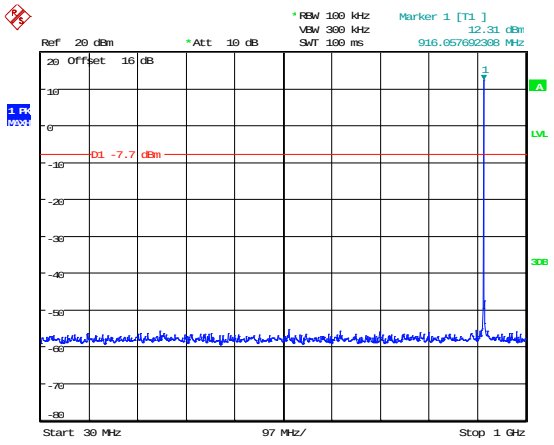
Date: 22.SEP.2014 10:50:50

9kHz – 150 kHz



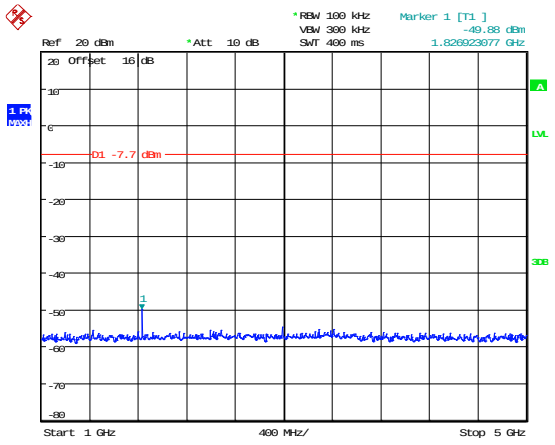
Date: 22.SEP.2014 10:52:43

150 kHz – 30 MHz



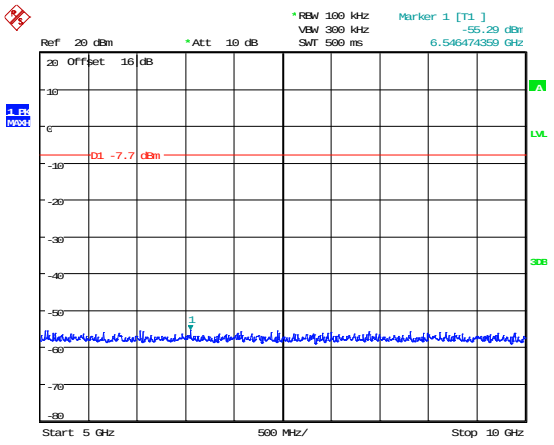
Date: 22.SEP.2014 10:48:50

30 MHz to 1 GHz



Date: 22.SEP.2014 10:49:14

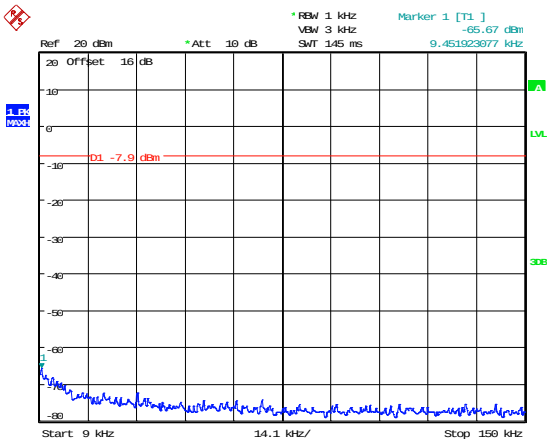
1 GHz to 5 GHz



Date: 22.SEP.2014 10:49:34

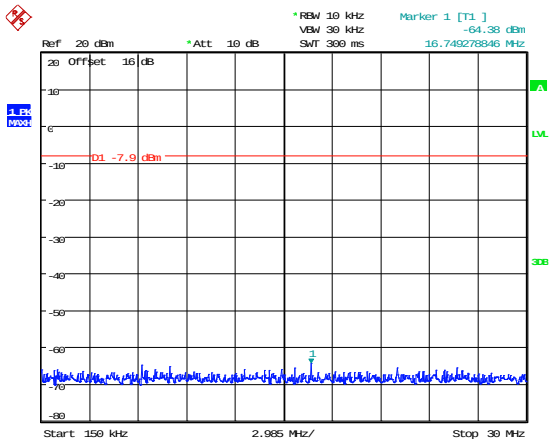
5 GHz to 10 GHz

Conducted Spurious emissions 927.5 MHz



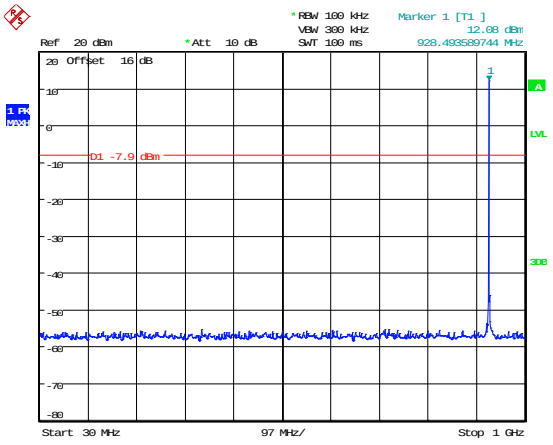
Date: 22.SEP.2014 10:57:04

9kHz to 150 kHz



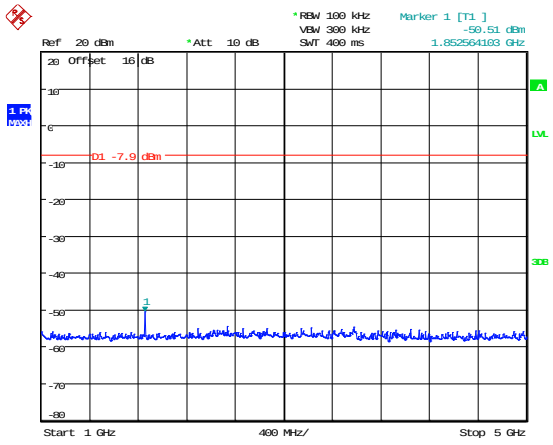
Date: 22.SEP.2014 10:57:29

150 kHz to 30 MHz



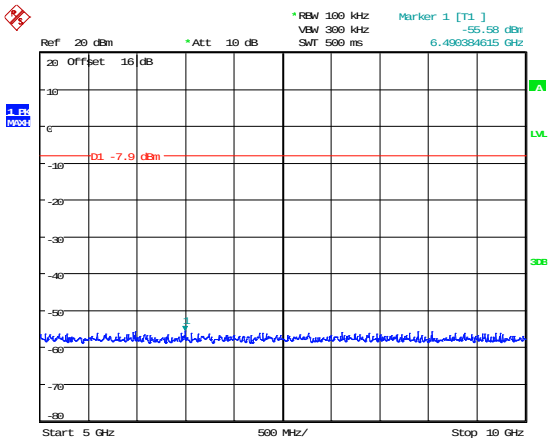
Date: 22.SEP.2014 10:54:46

30 MHz to 1 GHz



Date: 22.SEP.2014 10:55:38

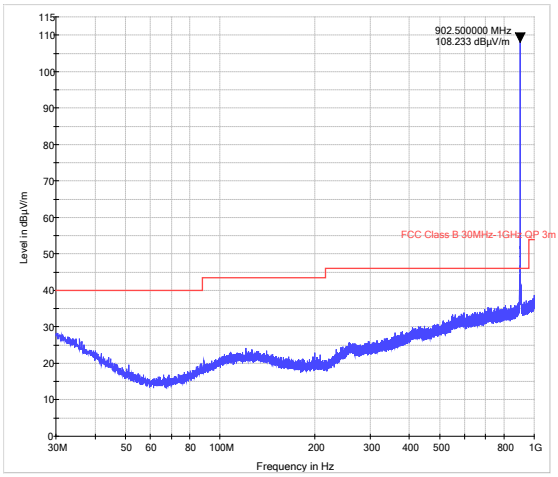
1 GHz to 5 GHz



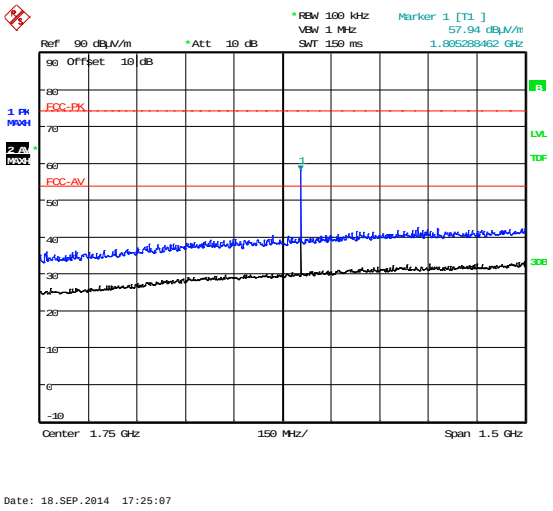
Date: 22.SEP.2014 10:55:54

5 GHz to 10 GHz

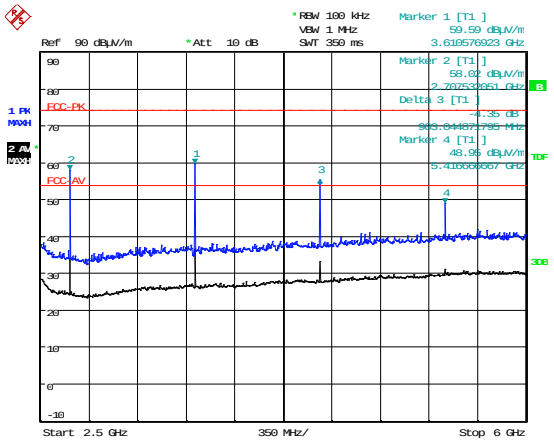
Radiated Spurious emissions 902.5MHz



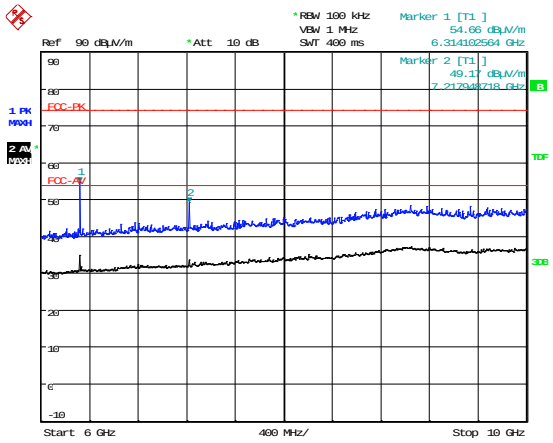
30 MHz to 1 GHz



1 GHz to 2.5 GHz

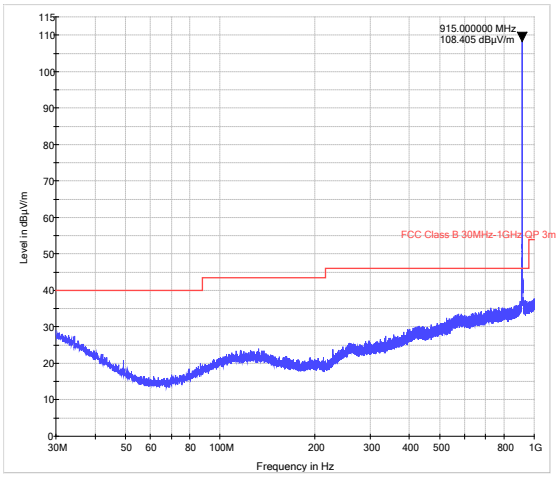


2.5 GHz to 6 GHz

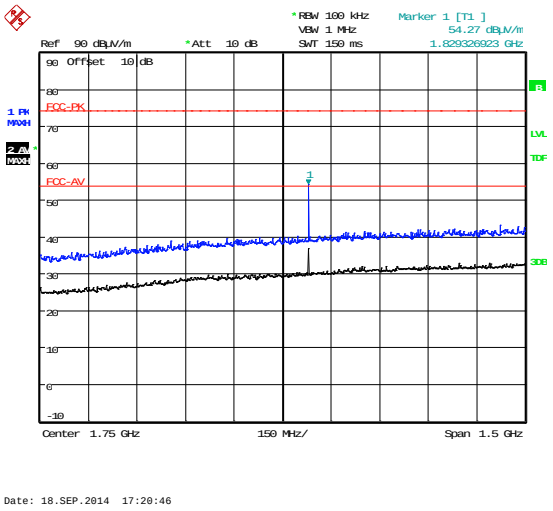


6 GHz to 10 GHz

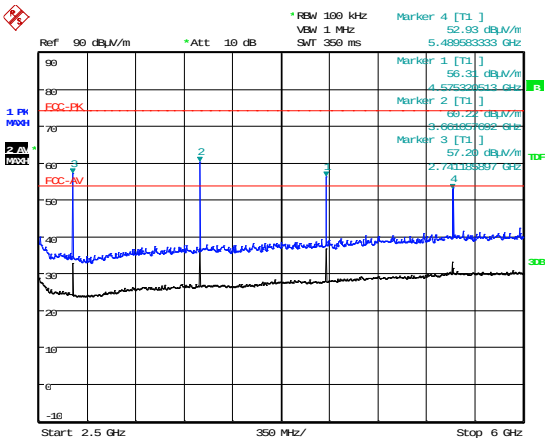
Radiated Spurious emissions 915.0MHz



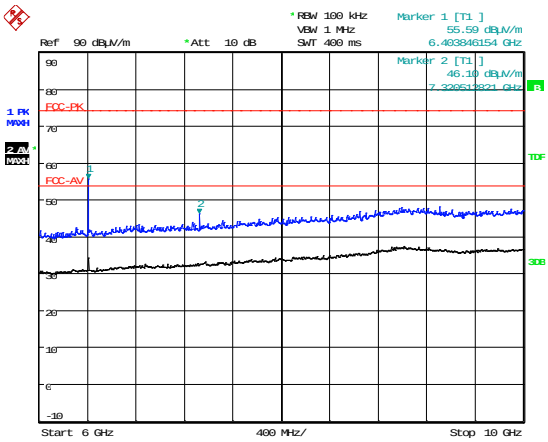
30 MHz to 1 GHz



1 GHz to 2.5 GHz

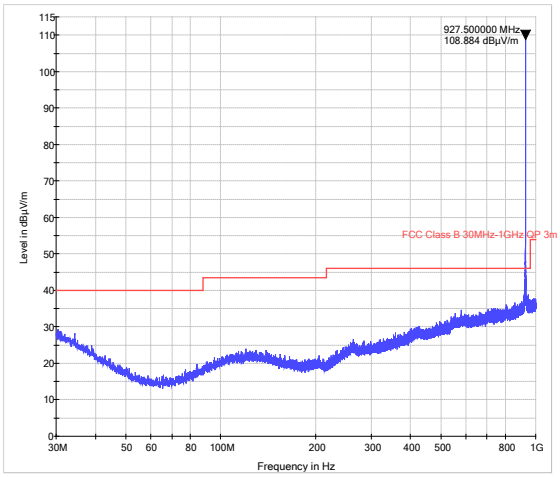


2.5 GHz to 6 GHz

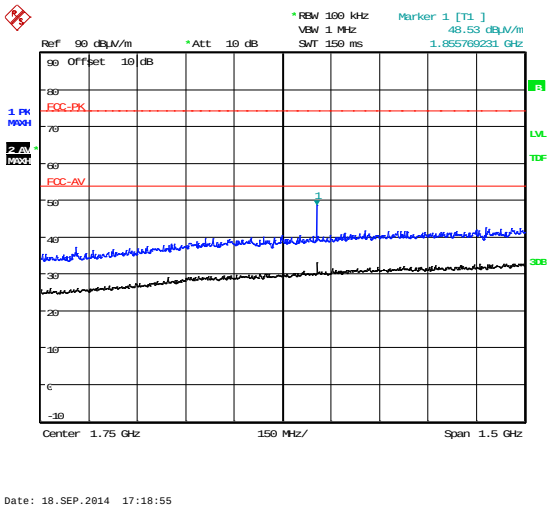


6 GHz to 10 GHz

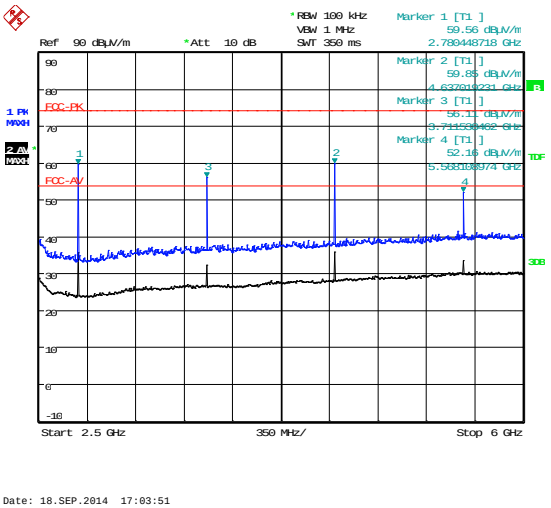
Radiated Spurious emissions 927.5 MHz



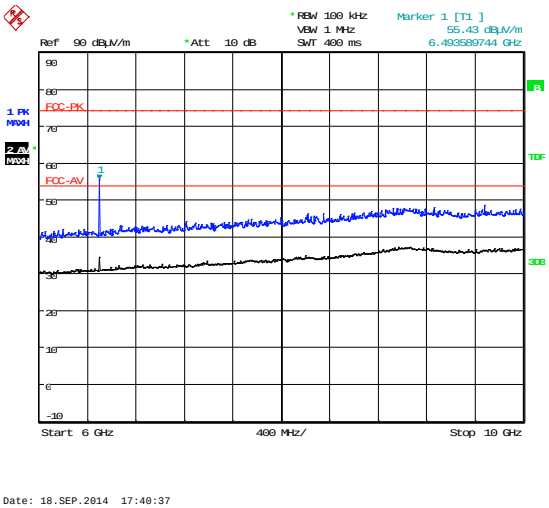
30 MHz to 1 GHz



1 GHz to 2.5 GHz

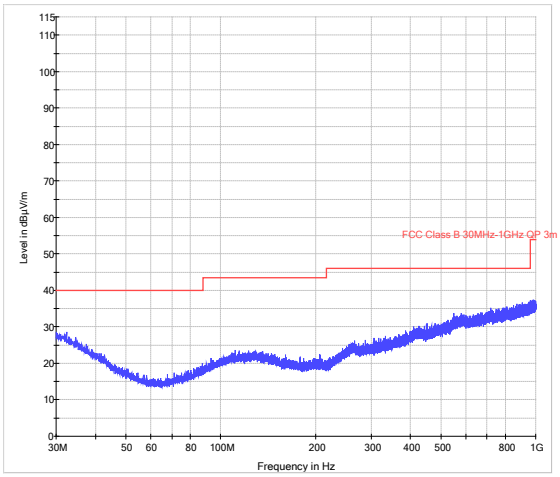


2.5 GHz to 6 GHz

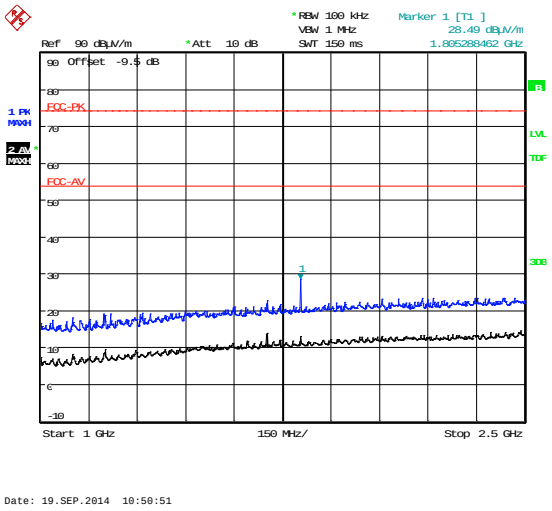


6 GHz to 10 GHz

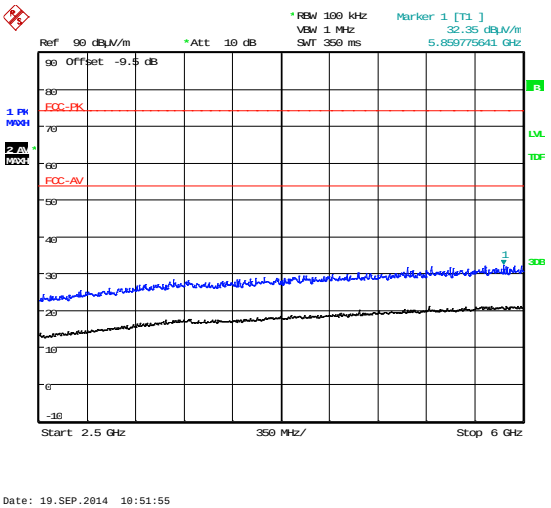
Unintentional Radiated Spurious emissions 902.5MHz



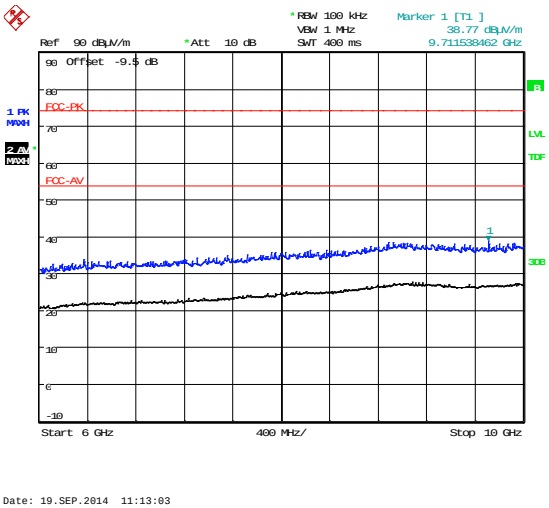
30 MHz to 1 GHz



1 GHz to 2.5 GHz

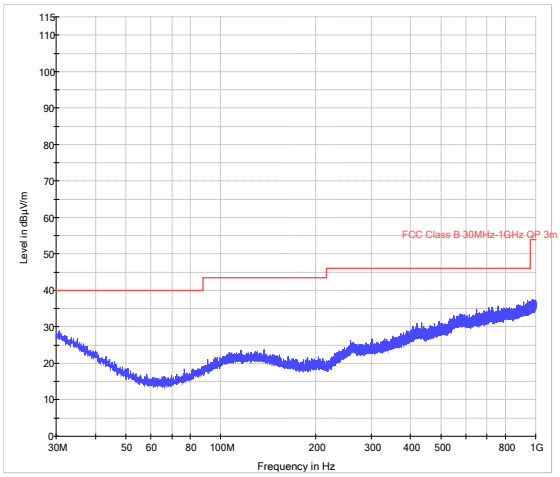


2.5 GHz to 6 GHz

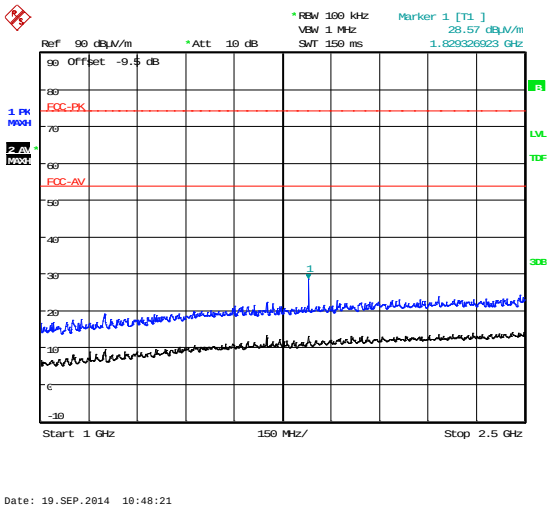


6 GHz to 10 GHz

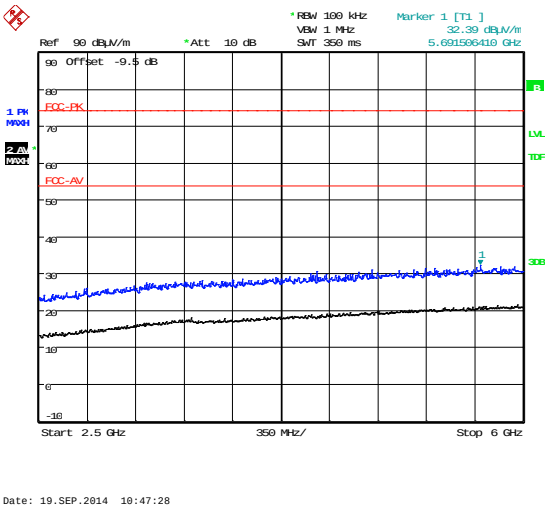
Unintentional Radiated Spurious emissions 915.0MHz



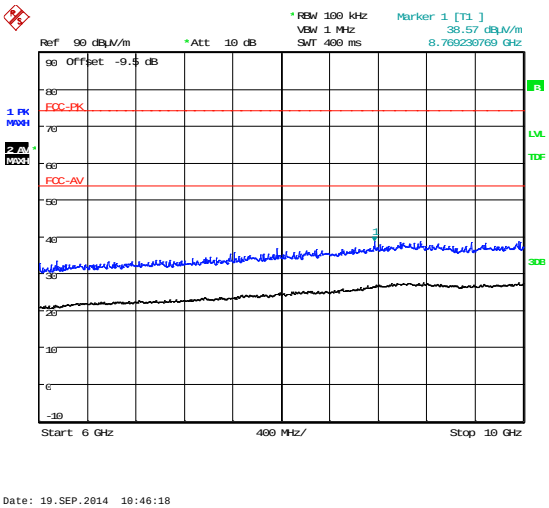
30 MHz to 1 GHz



1 GHz to 2.5 GHz

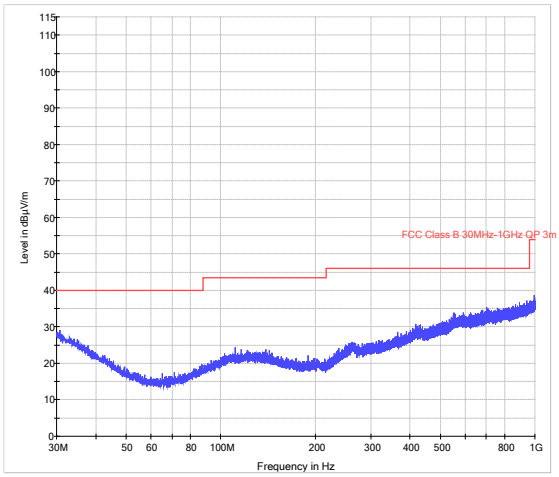


2.5 GHz to 6 GHz

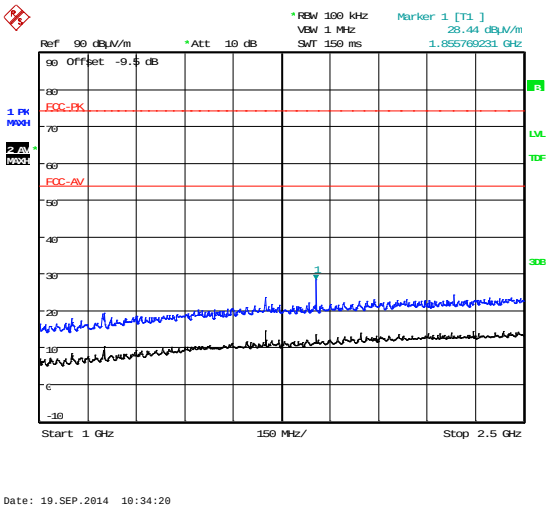


6 GHz to 10 GHz

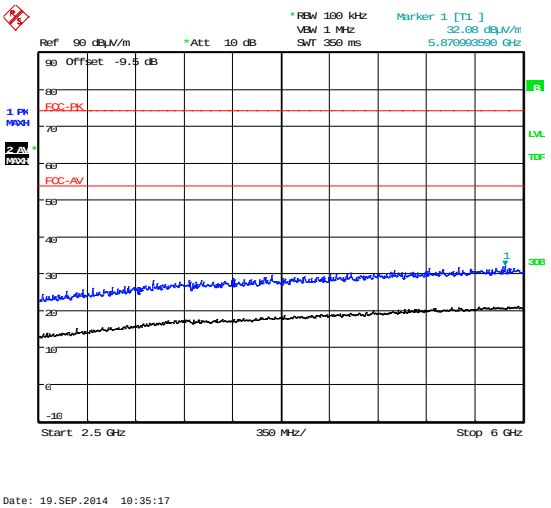
Unintentional Radiated Spurious emissions 927.5 MHz



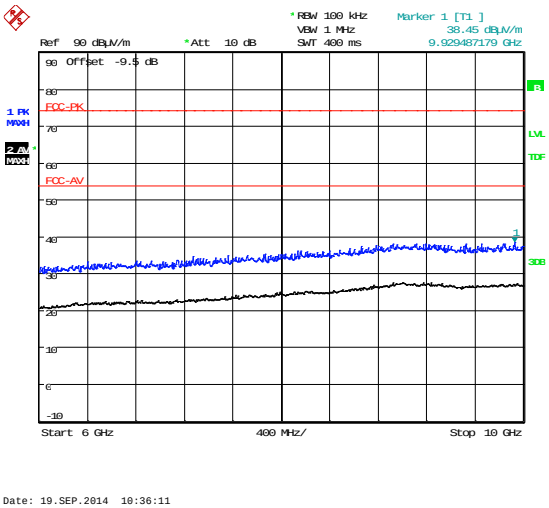
30 MHz to 1 GHz



1 GHz to 2.5 GHz



2.5 GHz to 6 GHz



6 GHz to 10 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
S01	Board EVAL-ADF7xxxMB4Z	None
S02	Board EVAL-ADF7xxxMB4Z	None
S03	Board EVAL-ADF7024DB2Z	None
S04	Board EVAL-ADF7024DB2Z	None
S05	Board EVAL-ADF7023DB2Z	None
S06	Board EVAL-ADF7023DB2Z	None
S07	USB Cable	None
S08	868 MHz Antenna	None
S09	915 MHz Antenna	None

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode: Transmit
Spurious Emissions	The device will be configured for GFSK modulation, 50kbps data rate and 25KHz frequency deviation for all tests (FCC and ETSI);

Test	Description of Operating Mode: Receive/Standby mode
Spurious Emissions	Receive Mode

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 : S03 & S09
Tests : Radiated

Port	Description of Cable Attached	Cable length	Equipment Connected
Header	None	0	S01

Sample : S03
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
Antenna	Coaxial	<1m	Measurement System
Header	None	0	S01

* Only connected during setup.

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	27/02/2014	12	27/02/2015
UH028	UHALP 9108	Log Periodic Ant	Schwarbeck	08/07/2013	24	08/07/2015
UH029	VHBA 9123	Bicone Antenna	Schwarbeck	19/08/2013	24	19/08/2015
UH281	FSU46	Spectrum Analyser	R&S	26/03/2014	12	26/03/2015
UH403	ESCI 7	Recevier	R&S	20/08/2014	12	20/08/2015
UH405	FSU26	Spectrum Analyser	R&S	16/04/2014	12	16/04/2015
UH420	CBL6112	Bilog	Chase	25/07/2014	24	25/07/2016
UH456	ESR7	EMI Receiver	R&S	16/04/2014	12	16/04/2015
L138	3115	1-18GHz Horn	EMCO	17/10/2013	24	17/10/2015
L139	3115	1-18GHz Horn	EMCO	20/09/2013	24	20/09/2015
L176	2042	Signal Generator	Marconi	29/11/2013	12	29/11/2014
L254	2042	Signal Generator	Marconi	08/01/2014	12	08/01/2015
L193	VHA 9103 balu	Bicone Antenna	Chase	25/06/2014	24	25/06/2016
L203	UPA6108	Log Periodic Ant	Chase	25/06/2014	24	25/06/2016
L290	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
L317	ESVS10	Receiver	R&S	12/02/2014	12	12/02/2015
L352	ESVS10	Receiver	R&S	21/03/2014	12	21/03/2015
REF909	FSU26	Spectrum Analyser	R&S	12/02/2014	12	12/02/2015
REF916	SMBV100A	Signal Generator	R&S	19/02/2014	12	19/02/2015
REF977	SH4141	High Pass Filter	BSC	25/02/2013	24	25/02/2015

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 was set accordingly to capture the pulse train. The transmit pulsewidths and period was measured. A plots of the pulse train is contained in Appendix B of this test report.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulsewidths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was calculated by averaging the sum of the pulsewidths 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 100ms), divided by the length of the period (or 100ms). The duty cycle correction factor was 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)

Therefore the calculated duty cycle was determined:

The pulse train period was greater than >100ms and in as shown from the plots in contained in appendix B of this test report.

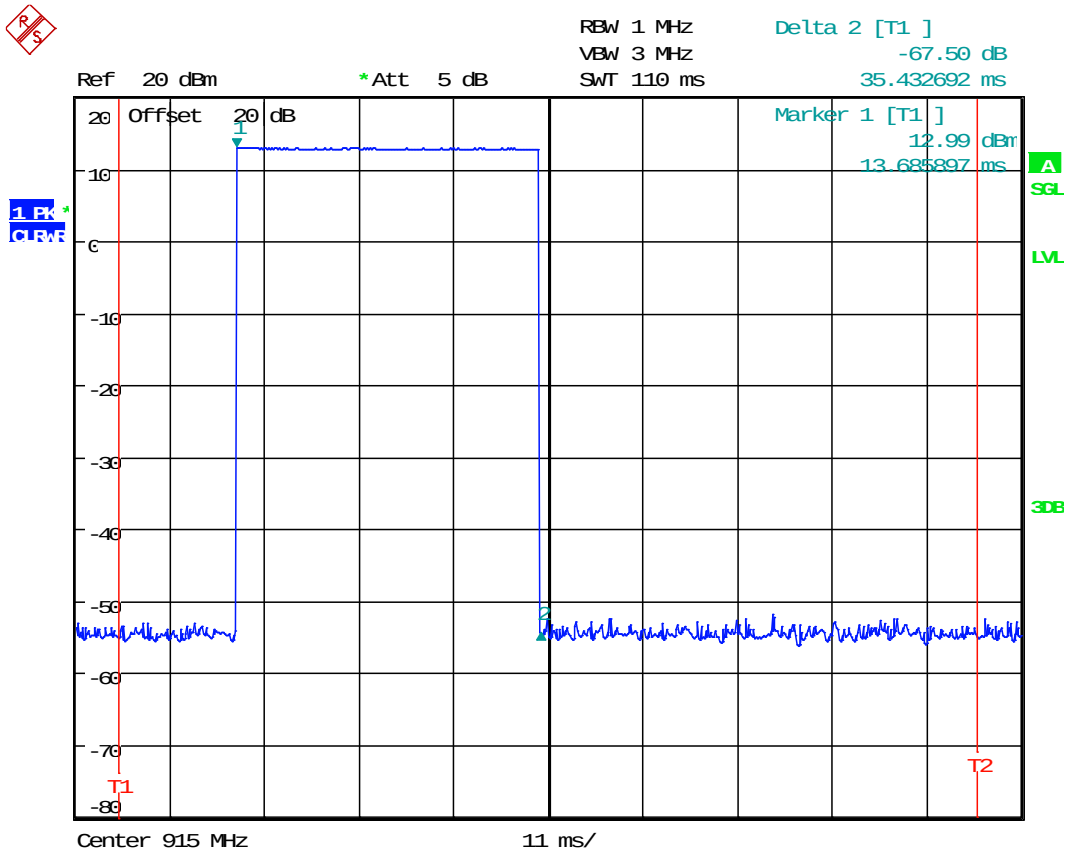
$$\text{Duty cycle} = \frac{\text{the sum of the highest average value pulsewidths over 100ms}}{100\text{ms}}$$

e.g

$$= \frac{35.43ms}{100ms} = 0.3543$$

0.3543 or 35.43%

Correction factor (dB) = 20 x (Log_{10} 0.3543) = -9.01dB



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