A RADIO TEST REPORT

FOR

Scope Communications UK Ltd

ON

1W UHF Synthesized TX

DOCUMENT NO. TRA-020166-47-00-B

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TRaC Wireless Test Report	**:** TRA-020166-47-00-B
Applicant	**:** Scope Communications UK Ltd
Apparatus	**:** 1W UHF Synthesized TX
Specification(s)	**:** CFR47 Part 90 & RSS119
Purpose of Test	**: Certification**
FCCID	**:** JRNUSA1WTX
Authorised by	**:**
	: Radio Product Manager
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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.

Test performed by:

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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 5th – 10th July 2014:

1W UHF Synthesized TX

The 1W UHF Synthesized TX is a UHF paging transmitter capable of operating with 12.5 kHz & 25 kHz channel spacing.

1.5 Test Result Summary

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

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

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

Test Type	FCC Part	RSS Part	Appendix in Report	Measurement Standard
RF Power Output	90.205	RSS-119 5.4	A1	TIA-603 D 2.2.1
Emission Mask	90.210	RSS-119 5.5	A2	TIA-603 D 2.2.13
Occupied Bandwidth	90.210	RSS-119 5.5	A3	TIA-603 D 2.2.13
Spurious Emissions at Antenna Terminals	90.210	RSS-119 5.8	A4	TIA-603 D 2.2.13
Field Strength of Spurious Emissions	90.210	RSS-119 5.8	A5	TIA-603 D 2.2.12
Frequency Stability	90.213	RSS-119 5.3	A6	TIA-603 D 2.2.2
Transient behaviour	90.214	RSS-119 5.9	A7	TIA-603 D 2.2.19
AC Powerline Conducted Emissions	15.107	RSS-GEN 5.5	A8	TIA-603 D 2.1.3
Field Strength of Un-Intentional Spurious Emissions	15.109	RSS-GEN 6.0	A9	TIA-603 D 2.1.1
Audio Frequency Response	2.1047	RSS-119 5.5	N/A Note 1	TIA-603 D 3.2.6
Modulation Limiting	2.1047	RSS-119 5.5	N/A	TIA-603 D 3.2.3

1 The EUT does not contain audio circuitry; therefore the test was not performed.

Abbreviations used in the above table:

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

1.6 Standard References

47 CFR 2	Code of Federal Regulations, Title 47, Part 2, “Frequency allocations and Radio Telemetry Matters; General Rules and Regulations”
47 CFR 90	Code of Federal Regulations, Title 47, Part 90,”Land Mobile Radio Service”
47 CFR 15	Code of Federal Regulations, Title 47, Part 15,”Radio Frequency Devices” Subpart B, “Unintentional Radiators”
C63.10-2009	American National Standard for Testing Unlicensed Wireless Devices
C63.4-2003	American National Standards Institute (ANSI), “Methods of Measurement of Radio Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range 9 kHz to 40 GHz”
RSS-GEN	Radio Standards Specification - General Requirements and Information for the Certification of Radio Apparatus
RSS-119	Radio Transmitters and Receivers Operating in the Land Mobile and Fixed Services in the Frequency Range 27.41-960 MHz
TIA EIA-603-D	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

1.7 Notes Relating To Assesment

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

The results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

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

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

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

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

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

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

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

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

1.8 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2: Measurement Uncertainty

2.1 Measurement Uncertainty Values

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 (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 Output Power

Test Details:	
Regulation	Part 90.205, RSS-119 Section 5.4
Measurement standard	Part 2.1046, RSS-GEN Section 4.8, TIA EIA-603-D
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Frequency (MHz)	Carrier power (dBm)	Carrier power (W)	Rated Output Power (W)	Deviation (dB)
446.0	30.3	1.07	1	0.3
458.0	30.2	1.05	1	0.2
469.7	30.1	1.02	1	0.1

Limit

The output power shall be within ±1dB of the manufacturers rated output power

Result

The 1W UHF Synthesized TX was found to comply with the limits

A2 Emissions Mask

Test Details:	
Regulation	Part 90.210, RSS-119 Section 5.5
Measurement standard	Part 2.1051, TIA EIA-603-D
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Limit

Mask C – 25 kHz channels without audio filter

On any frequency removed from the assigned frequency by the following displacement frequency (f_d in kHz) or percentage of the authorised bandwidth

±5 kHz	-	10 kHz	83 Log (f_d / 5)	dB
±10 kHz	-	250 %	29 Log (f_d^2 / 11) or 50*	dB
> ±250%			43 + 10 log P dB	

Mask D – 12.5 kHz channels without audio filter

On any frequency removed from the centre of the authorised bandwidth (f_o) by the following frequency offsets

±0 kHz	-	5.625 kHz	0	dB
±5.625 kHz	-	12.5 kHz	7.27 (f_d -2.88 kHz)	dB
> ±12.5 kHz	-		50 + 10 Log P or 70*	dB
> ±50 kHz			43 + 10 Log P	dB#

Notes:
(10 log P_{watts}) – (43 + 10 Log (P_{watts} * 1000)) = LIMIT = -13 dBm
(10 log P_{watts}) – (50 + 10 Log (P_{watts} * 1000)) = LIMIT = -20 dBm
* whichever is the lesser attenuation

Not applicable for RSS-119

Results

The 1W UHF Synthesized TX was found to comply with the limits

See plots in Appendix B.

A3 Occupied Bandwidth

Test Details:	
Regulation	Part 90.210, RSS-119 Section 5.5
Measurement standard	Part 2.1049, RSS-GEN Section 4.6, TIA EIA-603-D
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Frequency Of Operation Channel	Channel Spacing	
	12.5 kHz	25 kHz
446.0	6.37	9.46
458.0	6.53	9.70
469.7	6.81	9.86

Limit

Channel Spacing	Bandwidth Limitation
12.5 kHz	11.25 kHz
25.0 kHz	20.00 kHz

Result

The 1W UHF Synthesized TX was found to comply with the limits

A4 Spurious Emissions at Antenna Terminals

Test Details:	
Regulation	Part 90.210, RSS-119 Section 5.5
Measurement standard	Part 2.1049, RSS-GEN Section 4.6, TIA EIA-603-D
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Bottom Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9 kHz – 5 GHz	No significant emissions with in 20 dB of limit				-13

Middle Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9 kHz – 5 GHz	No significant emissions with in 20 dB of limit				-13

Top channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9 kHz – 5 GHz	No significant emissions with in 20 dB of limit				-13

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

At least 43 + 10 log P dB

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

Limit reduces to $(10 \log P_{watts}) – (50 + 10 \text{ Log } (P_{watts} * 1000))$; LIMIT = -20 dBm for RSS-119 Mask D

Result

The 1W UHF Synthesized TX was found to comply with the limits

A5 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric filed emission test applies to all spurious and harmonic emissions. The EUT was set to transmit as required.
The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : ☐ 3m alternative test site : ☒

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

Test Details:	
Regulation	Part 90.210, RSS-119 Section 5.8
Measurement standard	Part 2.1053, RSS-GEN Section 4.9, TIA EIA-603-D
Frequency range	30 MHz – 5 GHz
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	1 & 2

Bottom Frequency

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30 MHz – 5 GHz	3121.952 3567.944 4013.904 4459.968	-25.3 -27.8 -31.2 -32.6	-13 -13 -13 -13

Middle Frequency

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30 MHz – 5 GHz	2289.984 3205.981 3663.955 4579.936	-26.3 -25.5 -22.5 -32.6	-13 -13 -13 -13

Top Frequency

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30 MHz – 5 GHz	2348.477 3757.484	-30.5 -14.5	-13 -13

Result

The 1W UHF Synthesized TX was found to comply with the limits

Notes:

1. Emissions Checked up to 10 times Fc.

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

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

   Peak Detector RBW = 1MHz; VBW = ≥RBW

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

   At least 43 + 10 log P dB

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

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

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

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

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

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

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

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

A6 Frequency Stability

Test Details:	
Regulation	Part 90.213, RSS-119 Section 5.3
Measurement standard	Part 2.1055, RSS-GEN Section 4.7, TIA EIA-603-D
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Voltage Variation					
Temperature °C	Vnom (Vdc)	Measured Frequency (MHz)	Frequency Difference (kHz)	ppm	Pass/Fail
+20	12 - 14	445.99998	-0.020	N/A	Reference*
+20	10.2	445.99998	0.000	0.00	Pass
+20	16.1	445.99989	-0.090	-0.20	Pass
Temperature Variation					
Temperature °C	Vnom (Vdc)	Measured Frequency (MHz)	Frequency Difference (kHz)	ppm	Pass/Fail
+50	12 - 14	445.99985	-0.130	-0.29	Pass
+40	12 - 14	445.99988	-0.100	-0.22	Pass
+30	12 - 14	445.99995	-0.030	-0.07	Pass
+20	12 - 14	445.99994	-0.040	-0.09	Pass
+10	12 - 14	446.00000	0.020	0.04	Pass
0	12 - 14	446.00000	0.020	0.04	Pass
-10	12 - 14	446.00005	0.070	0.16	Pass
-20	12 - 14	445.99997	-0.010	-0.02	Pass
-30	12 - 14	446.00003	0.050	0.11	Pass

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

Limit

±1.5 ppm (tightest applicable limit)

Result

The 1W UHF Synthesized TX was found to comply with the limits

Test Details:	
Regulation	Part 90.213, RSS-119 Section 5.3
Measurement standard	Part 2.1055, RSS-GEN Section 4.7, TIA EIA-603-D
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Voltage Variation					
Temperature °C	Vnom (Vdc)	Measured Frequency (MHz)	Frequency Difference (kHz)	ppm	Pass/Fail
+20	12 - 14	457.99997	-0.030	N/A	Reference*
+20	10.2	458.00000	0.030	0.07	Pass
+20	16.1	457.99989	-0.080	-0.17	Pass
Temperature Variation					
Temperature °C	Vnom (Vdc)	Measured Frequency (MHz)	Frequency Difference (kHz)	ppm	Pass/Fail
+50	12 - 14	457.99985	-0.120	-0.26	Pass
+40	12 - 14	457.99988	-0.090	-0.20	Pass
+30	12 - 14	457.99993	-0.040	-0.09	Pass
+20	12 - 14	457.99993	-0.040	-0.09	Pass
+10	12 - 14	458.00000	0.030	0.07	Pass
0	12 - 14	458.00000	0.030	0.07	Pass
-10	12 - 14	458.00005	0.080	0.17	Pass
-20	12 - 14	457.99997	0.000	0.00	Pass
-30	12 - 14	458.00003	0.060	0.13	Pass

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

Limit

±1.5 ppm (tightest applicable limit)

Result

The 1W UHF Synthesized TX was found to comply with the limits

Test Details:	
Regulation	Part 90.213, RSS-119 Section 5.3
Measurement standard	Part 2.1055, RSS-GEN Section 4.7, TIA EIA-603-D
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Voltage Variation					
Temperature °C	Vnom (Vdc)	Measured Frequency (MHz)	Frequency Difference (kHz)	ppm	Pass/Fail
+20	12 - 14	469.69996	-0.04	N/A	Reference*
+20	10.2	469.70000	0.04000	0.09	458.00000
+20	16.1	469.69988	-0.08000	-0.17	457.99989
Temperature Variation					
Temperature °C	Vnom (Vdc)	Measured Frequency (MHz)	Frequency Difference (kHz)	ppm	Pass/Fail
+50	12 - 14	469.69986	-0.10000	-0.21	Pass
+40	12 - 14	469.69986	-0.10000	-0.21	Pass
+30	12 - 14	469.69991	-0.05000	-0.11	Pass
+20	12 - 14	469.69992	-0.04000	-0.09	Pass
+10	12 - 14	469.69999	0.03000	0.06	Pass
0	12 - 14	469.70001	0.05000	0.11	Pass
-10	12 - 14	469.70005	0.09000	0.19	Pass
-20	12 - 14	469.69995	-0.01000	-0.02	Pass
-30	12 - 14	469.70002	0.06000	0.13	Pass

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

Limit

±1.5 ppm (tightest applicable limit)

Result

The 1W UHF Synthesized TX was found to comply with the limits

A7 Transient Behaviour

Test Details:	
Regulation	Part 90.214, RSS-119 Section 5.9
Measurement standard	Part 2.1055, TIA EIA-603-D
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Channel	446.0 MHz	458.0 MHz	469.7 MHz
Time, t1	Compliant	Compliant	Compliant
Time, t2	Compliant	Compliant	Compliant
Time, t3	Compliant	Compliant	Compliant

Limit

Time interval	Maximum Frequency Difference	All Equipment	
		150 – 174 MHz	421 – 512 MHz
25 kHz channels			
t1	±25 kHz	5.0 ms	10.0 ms
t2	±12.5 kHz	20.0 ms	25.0 ms
t3	±25 kHz	5.0 ms	10.0 ms
12.5 kHz channels			
t1	±12.5 kHz	5.0 ms	10.0 ms
t2	±6.25 kHz	20.0 ms	25.0 ms
t3	±12.5 kHz	5.0 ms	10.0 ms

Result

The 1W UHF Synthesized TX was found to comply with the limits

A8 Power Line Conducted Emissions

Preview power line conducted emission measurements were performed with a peak & average 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 an average and/or quasi peak detector.

Test Details:	
Regulation	Part 15.107, RSS-GEN Section 5.5
Measurement standard	ANSI C63.10:2003, RSS-GEN, TIA EIA-603-D
Frequency range	150kHz to 30MHz
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	3

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

Results measured using the average detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Emissions Within 20 dB of the Limit						

Results measured using the quasi-peak detector compared to the quasi–peak limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Emissions Within 20 dB of the Limit						

Specification limits:

Conducted emission limits (47 CFR Part 15: Clauses 15.107 & 15.207):

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

A9 Unintentional Radiated Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric filed emission test applies to all spurious emissions on directly related to the transmitter. The maximum permitted field strength is listed in Section 15.109. The EUT was set to operate in a transmit standby / receive mode.

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

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

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

Test Details:	
Regulation	Part 15.109, RSS-GEN 6.0
Measurement standard	ANSI C63.10:2003, TIA EIA-603-D
Frequency range	30 MHz – 5GHz
EUT sample number	S02
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	1 & 2

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
No Emissions Within 20 dB of the Limit									

Notes:

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

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

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

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

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

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

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

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

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

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

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

Appendix B: **Supporting Graphical Data**

This appendix contains graphical data obtained during testing.

Notes:

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

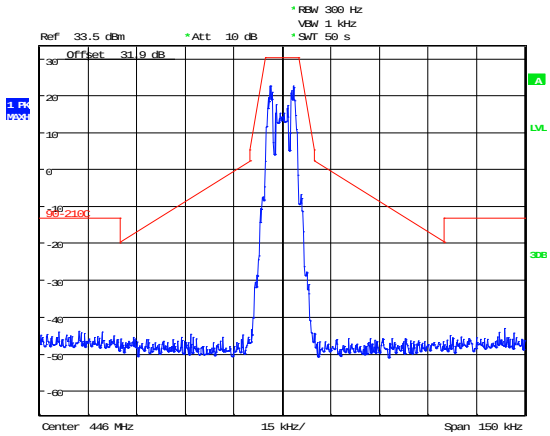
(b) The time and date on the plots do not necessarily equate to the time of the test.

(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.

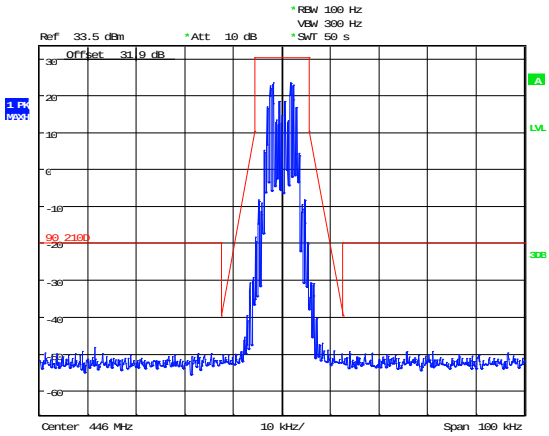
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.

Emissions Mask



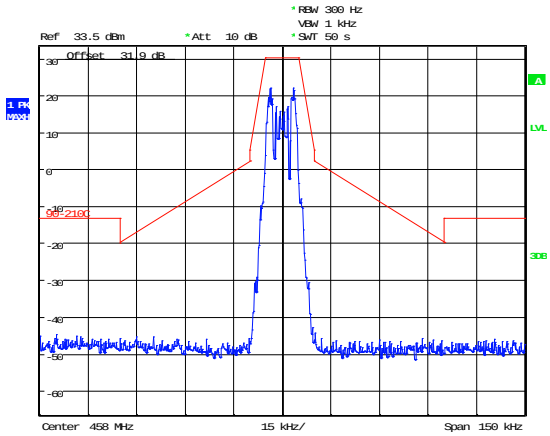
Date: 7.JUL.2014 13:37:28

446.0 MHz Mask C – 25 kHz



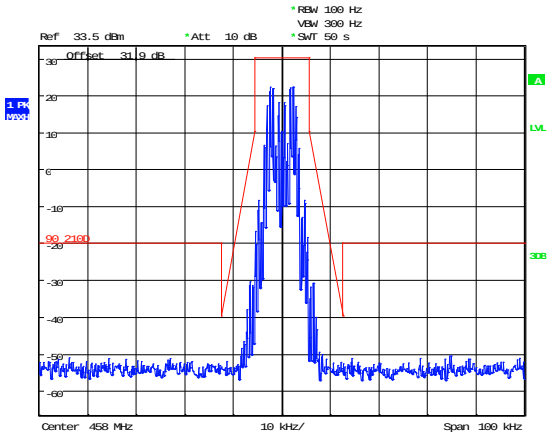
Date: 7.JUL.2014 14:03:03

446.0 MHz Mask D – 12.5 kHz



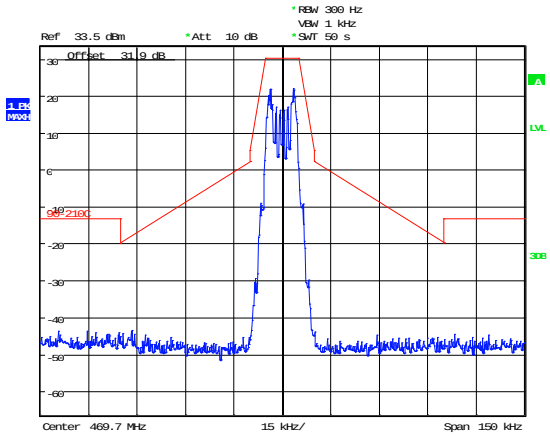
Date: 7.JUL.2014 13:34:31

458.0 MHz Mask C – 25 kHz



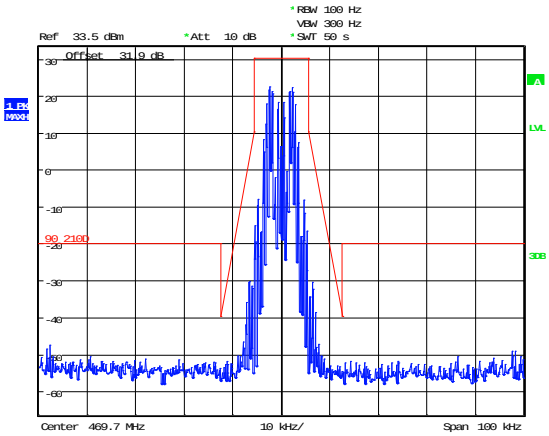
Date: 7.JUL.2014 14:05:20

458.0 MHz Mask D – 12.5 kHz



Date: 7.JUL.2014 13:32:49

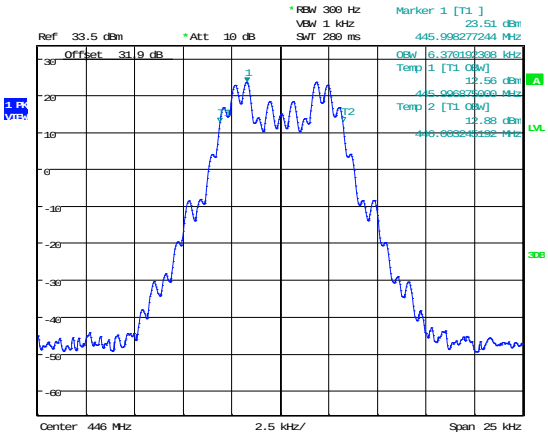
469.7 MHz Mask C – 25 kHz



Date: 7.JUL.2014 14:06:38

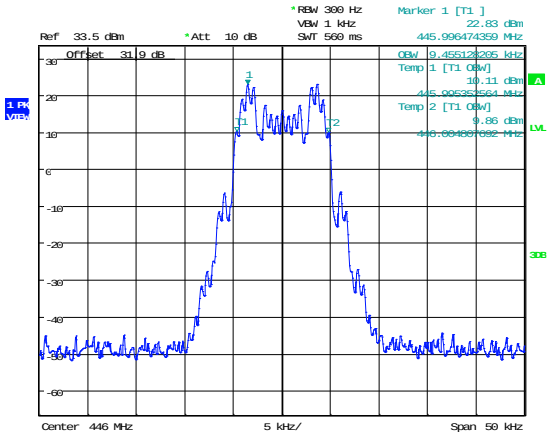
469.7 MHz Mask D – 12.5 kHz

99% Bandwidth



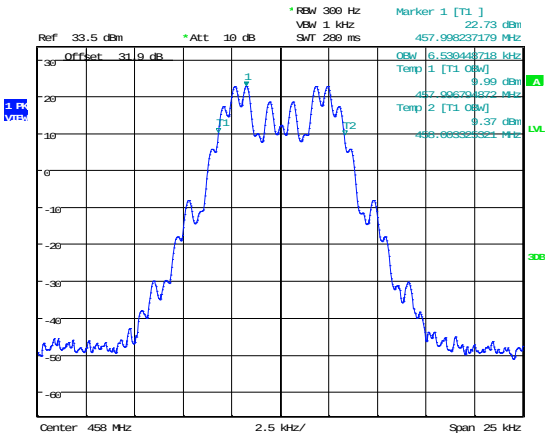
Date: 7.JUL.2014 12:24:38

446.0 MHz – 12.5 kHz



Date: 7.JUL.2014 12:28:04

446.0 MHz – 25 kHz



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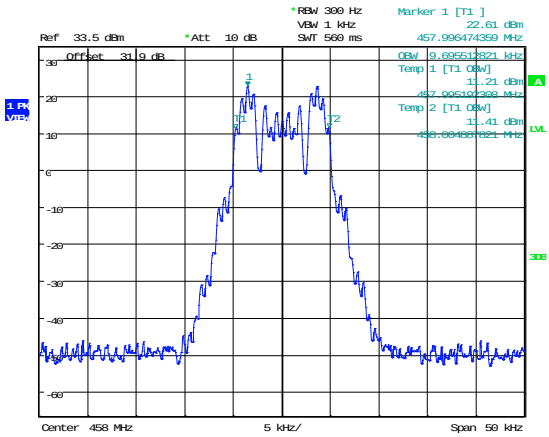
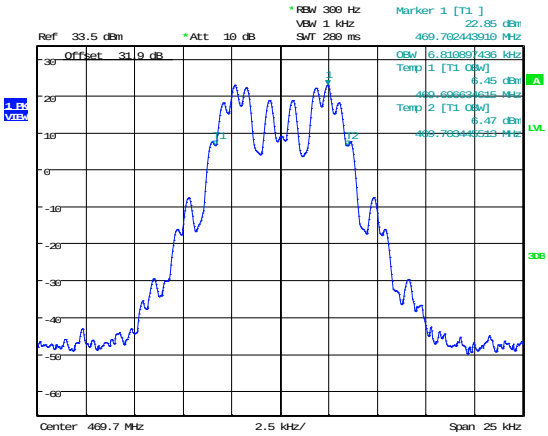
458.0 MHz – 12.5 kHz



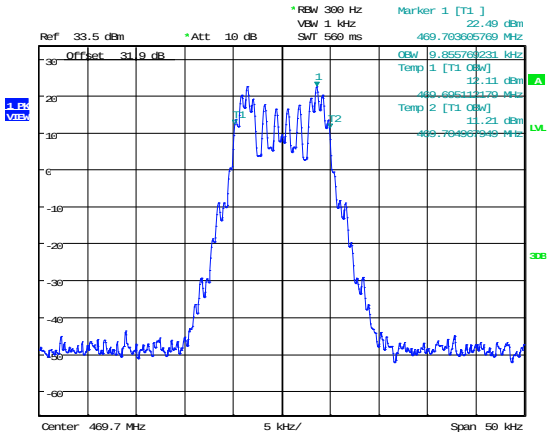
Date: 7.JUL.2014 12:29:05

458.0 MHz – 25 kHz



Date: 7.JUL.2014 12:31:50

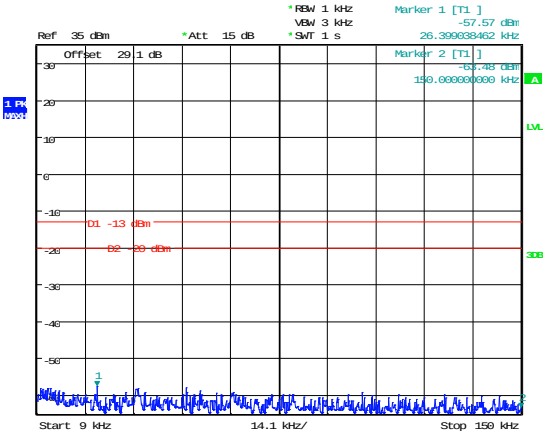
469.7 MHz – 12.5 kHz



Date: 7.JUL.2014 12:32:23

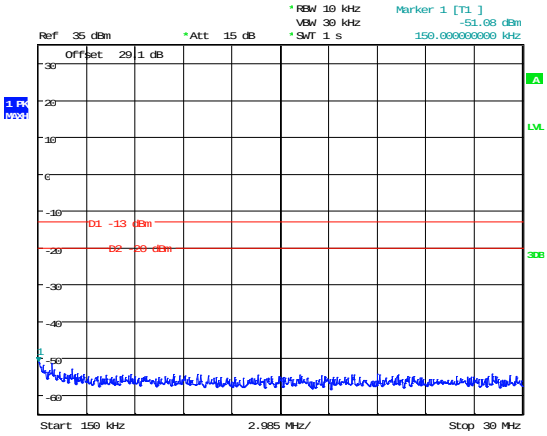
469.7 MHz – 25 kHz

Spurious Emissions at antenna Terminals 446.0 MHz



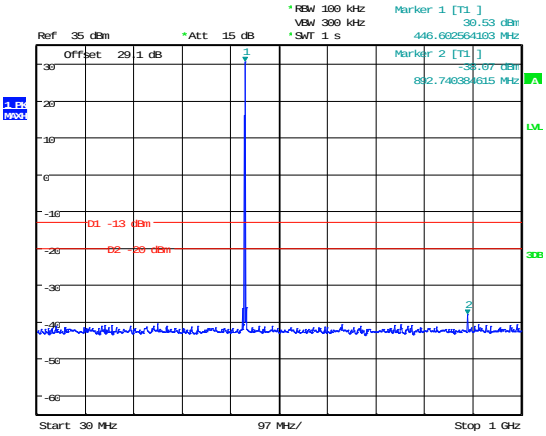
Date: 7.JUL.2014 14:47:25

9 kHz – 150 kHz



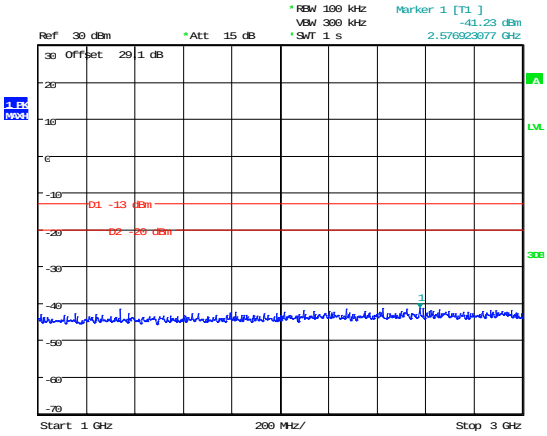
Date: 7.JUL.2014 14:47:48

150 kHz – 30 MHz



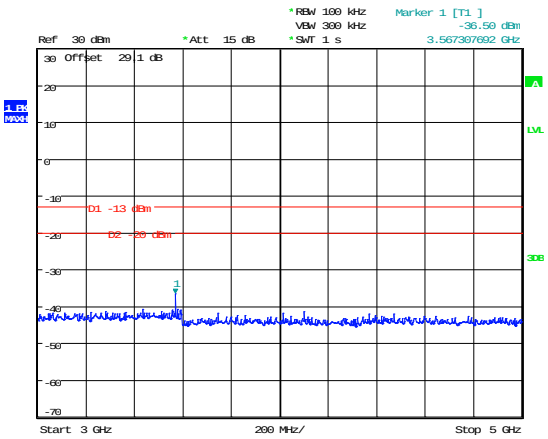
Date: 7.JUL.2014 14:47:06

30MHz – 1GHz



Date: 7.JUL.2014 14:48:31

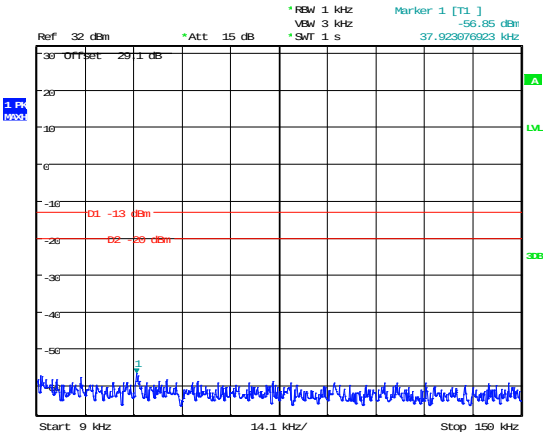
1GHz – 3GHz



Date: 7.JUL.2014 14:54:11

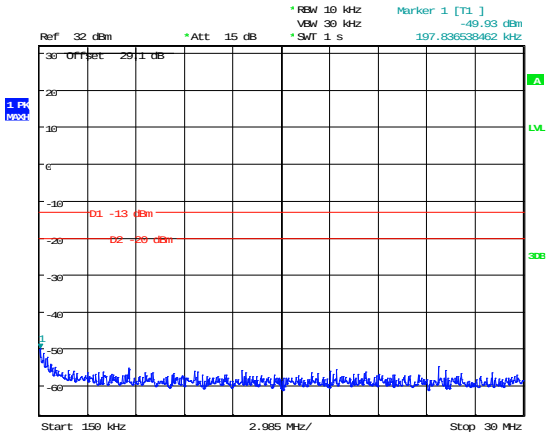
3GHz – 5GHz

Spurious Emissions at antenna Terminals 458.0 MHz



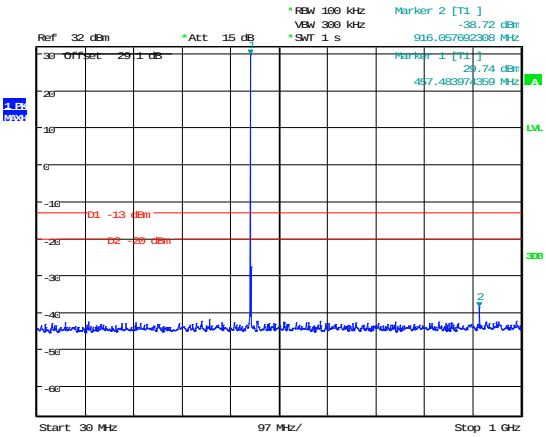
Date: 7.JUL.2014 14:55:47

9 kHz – 150 kHz



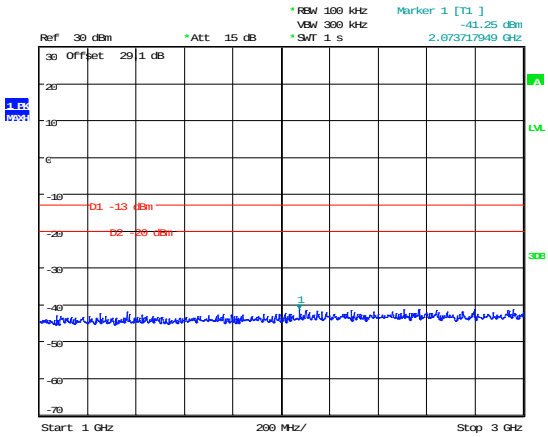
Date: 7.JUL.2014 14:56:06

150 kHz – 30 MHz



Date: 7.JUL.2014 14:55:29

30MHz – 1GHz



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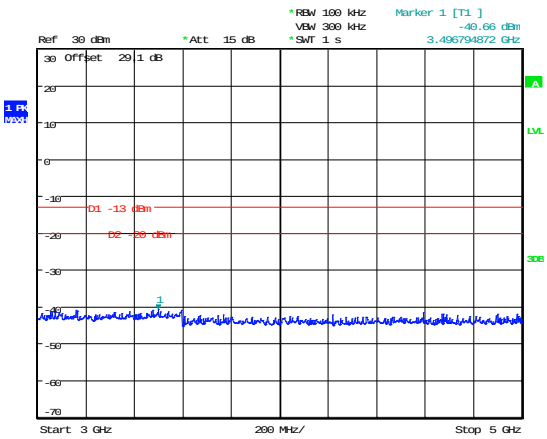
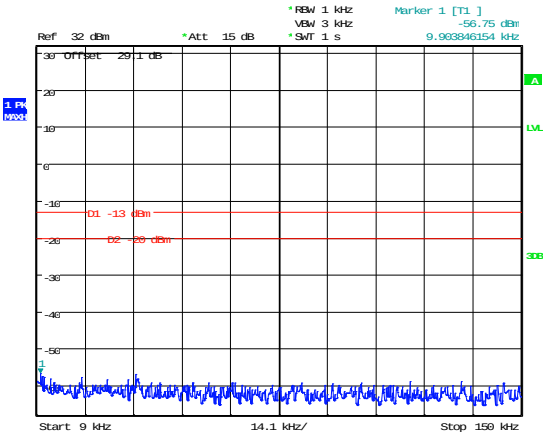
1GHz – 3GHz



Date: 7.JUL.2014 14:54:53

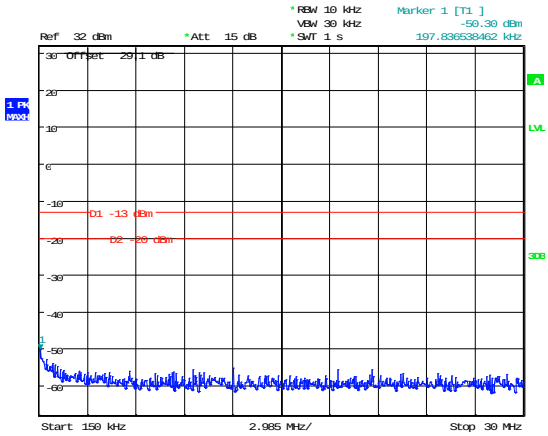
3GHz – 5GHz

Spurious Emissions at antenna Terminals 469.7 MHz



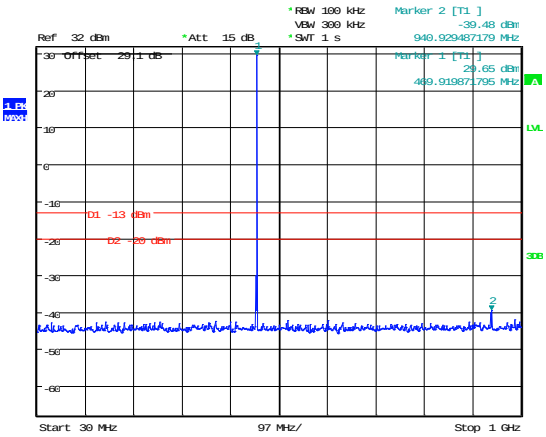
Date: 7.JUL.2014 14:56:49

9 kHz – 150 kHz



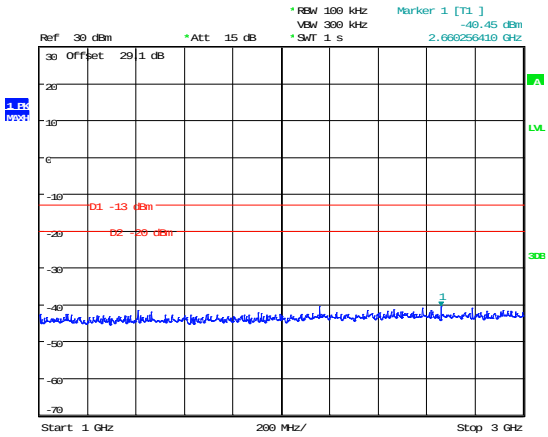
Date: 7.JUL.2014 14:56:31

150 kHz – 30 MHz



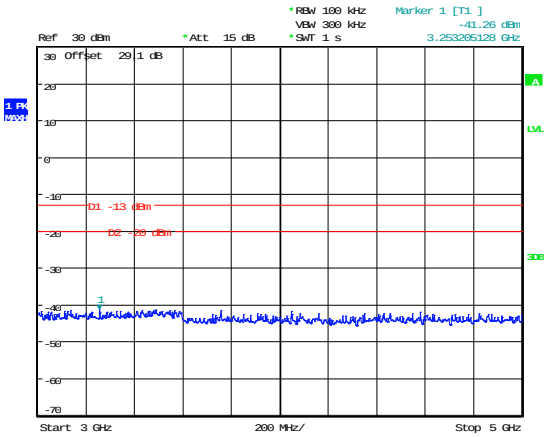
Date: 7.JUL.2014 14:57:13

30MHz – 1GHz



Date: 7.JUL.2014 14:57:40

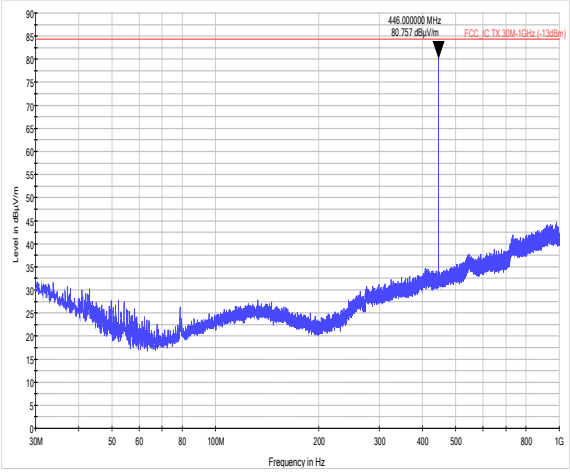
1GHz – 3GHz



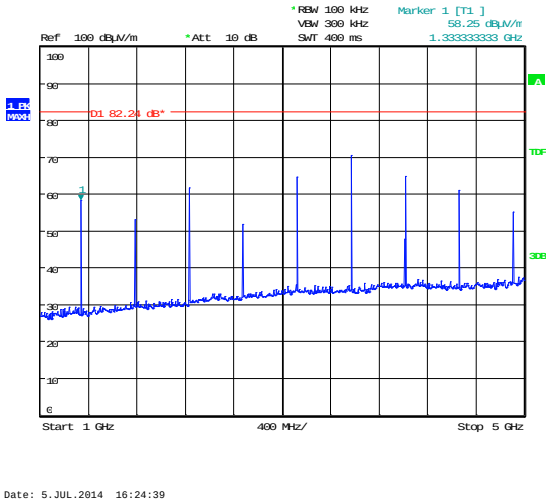
Date: 7.JUL.2014 14:57:58

3GHz – 5GHz

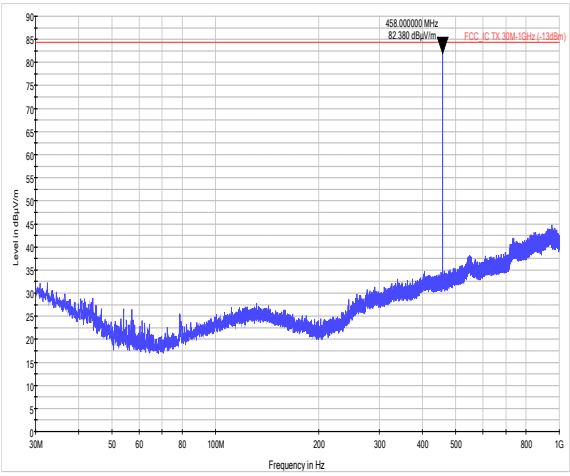
Field Strength of Spurious Emissions



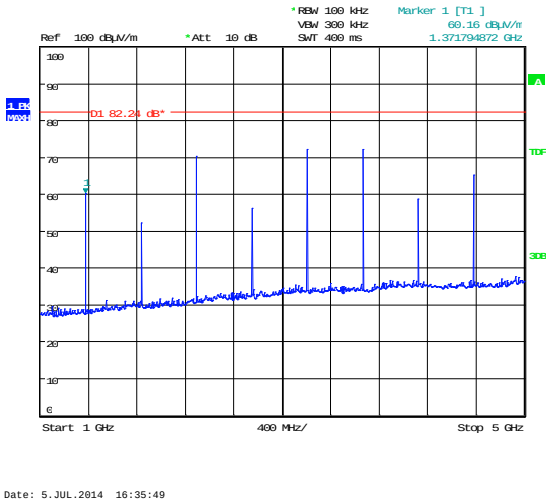
446.0 MHz - 30MHz – 1 GHz



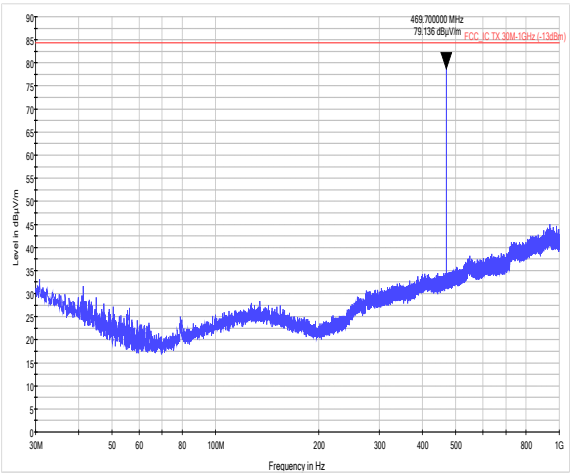
446.0 MHz - 1 GHz – 5 GHz



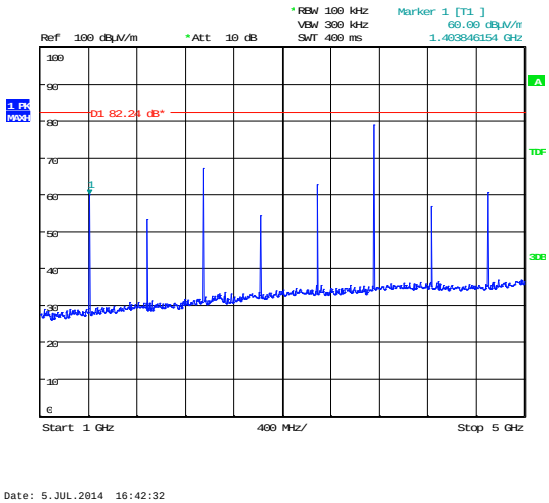
458.0 MHz - 30MHz – 1 GHz



458.0 MHz - 1 GHz – 5 GHz

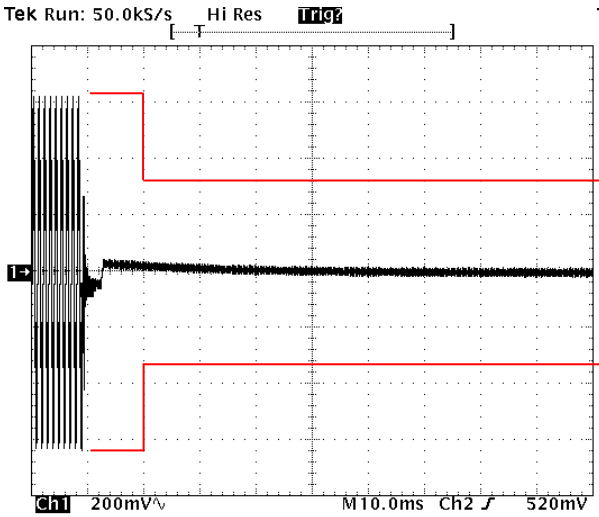


467.9 MHz - 30MHz – 1 GHz

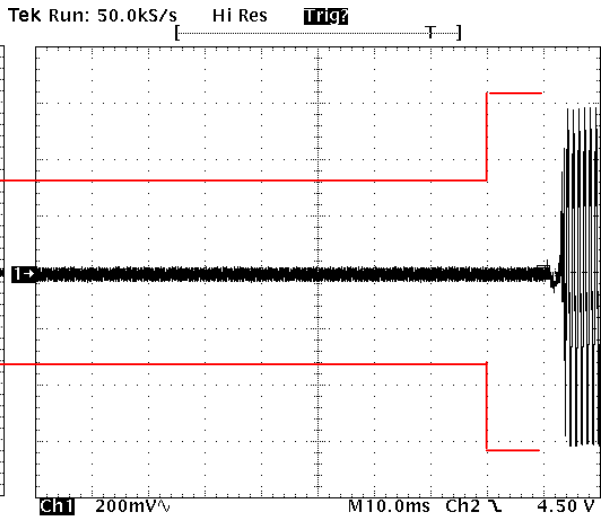


467.9 MHz - 1 GHz – 5 GHz

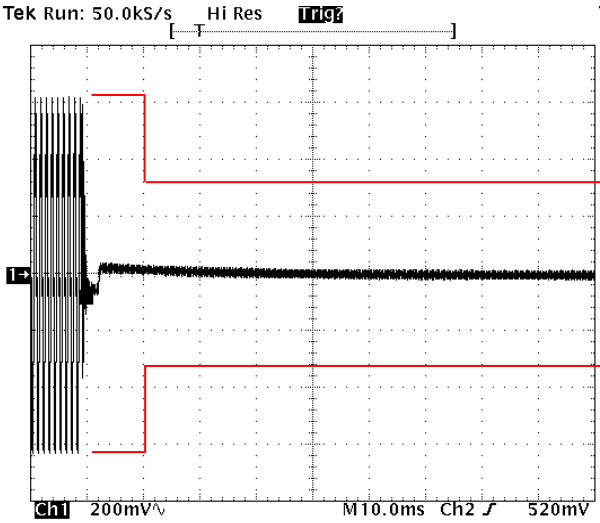
Transient – 12.5 kHz



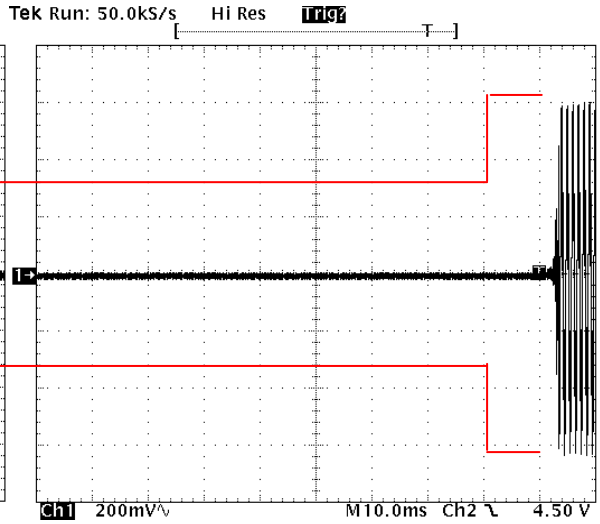
440 MHz On



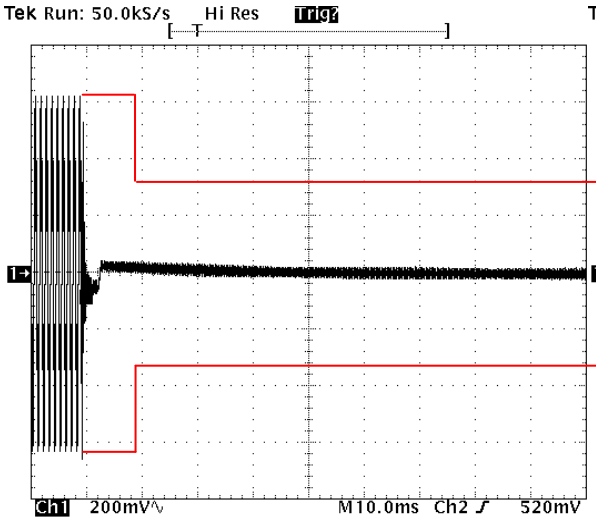
440 MHz Off



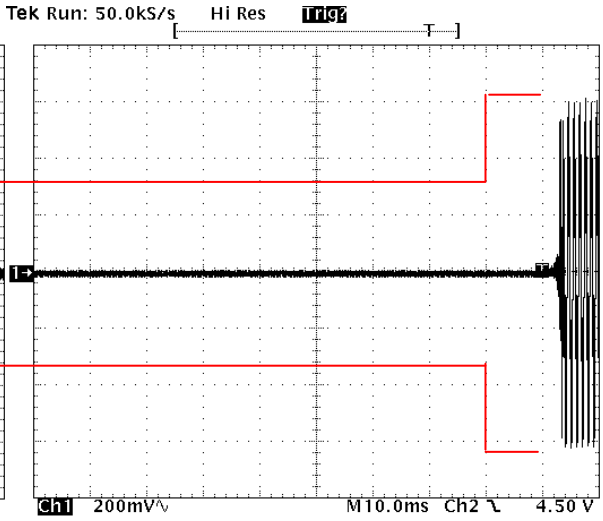
458.0 MHz On



458.0 MHz Off

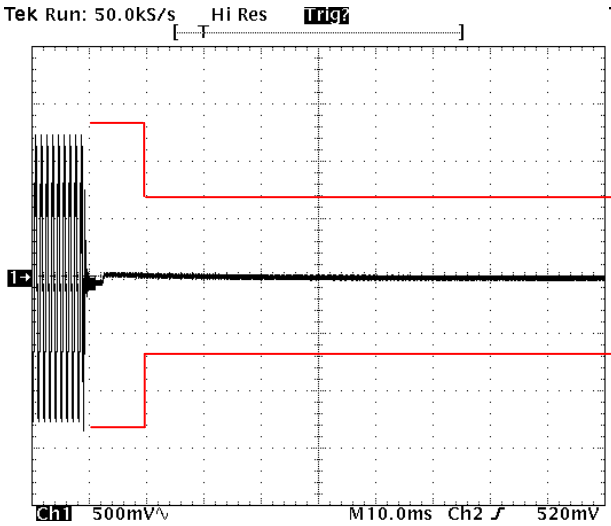


469.7 MHz On

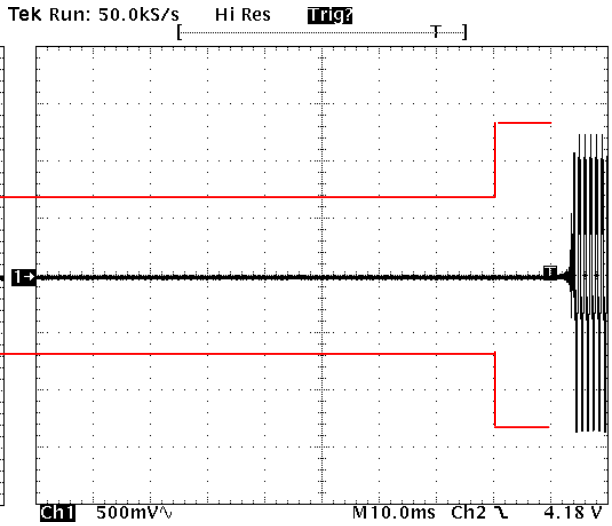


469.7 MHz Off

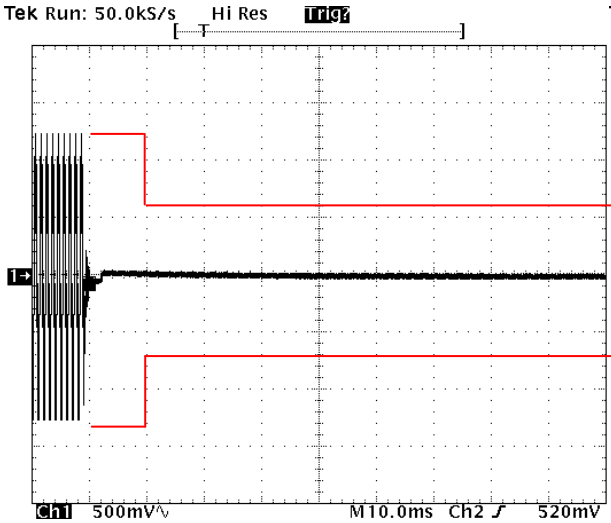
Transient – 25 kHz



440 MHz On



440 MHz Off



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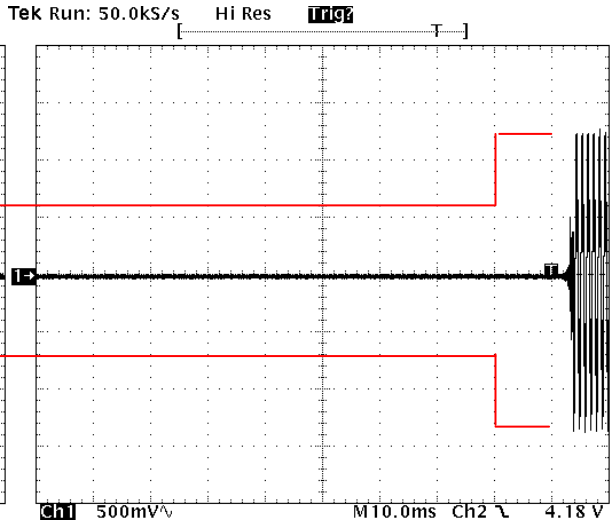
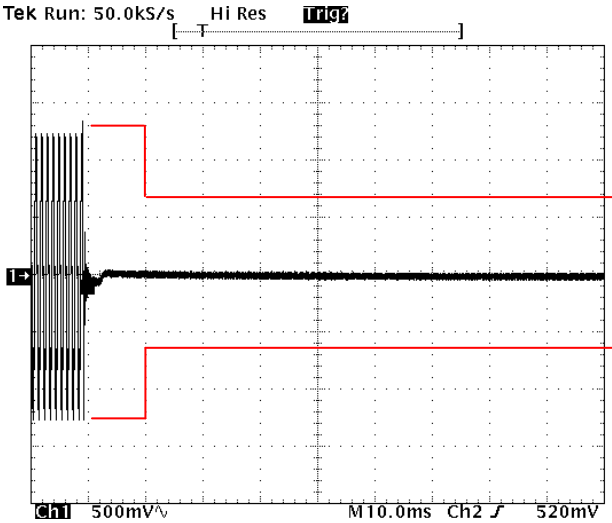
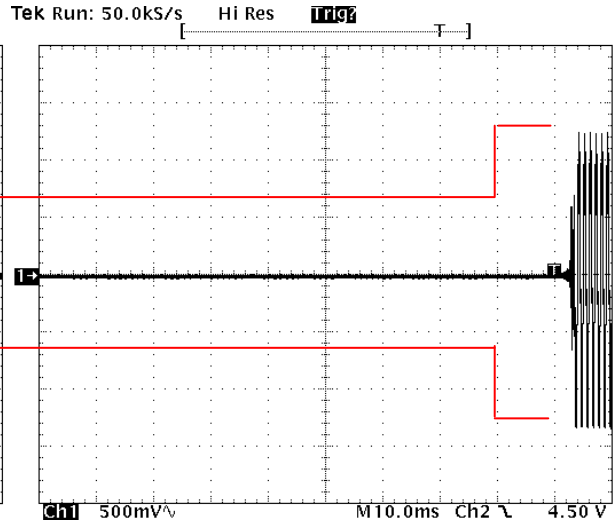


458.0 MHz Off

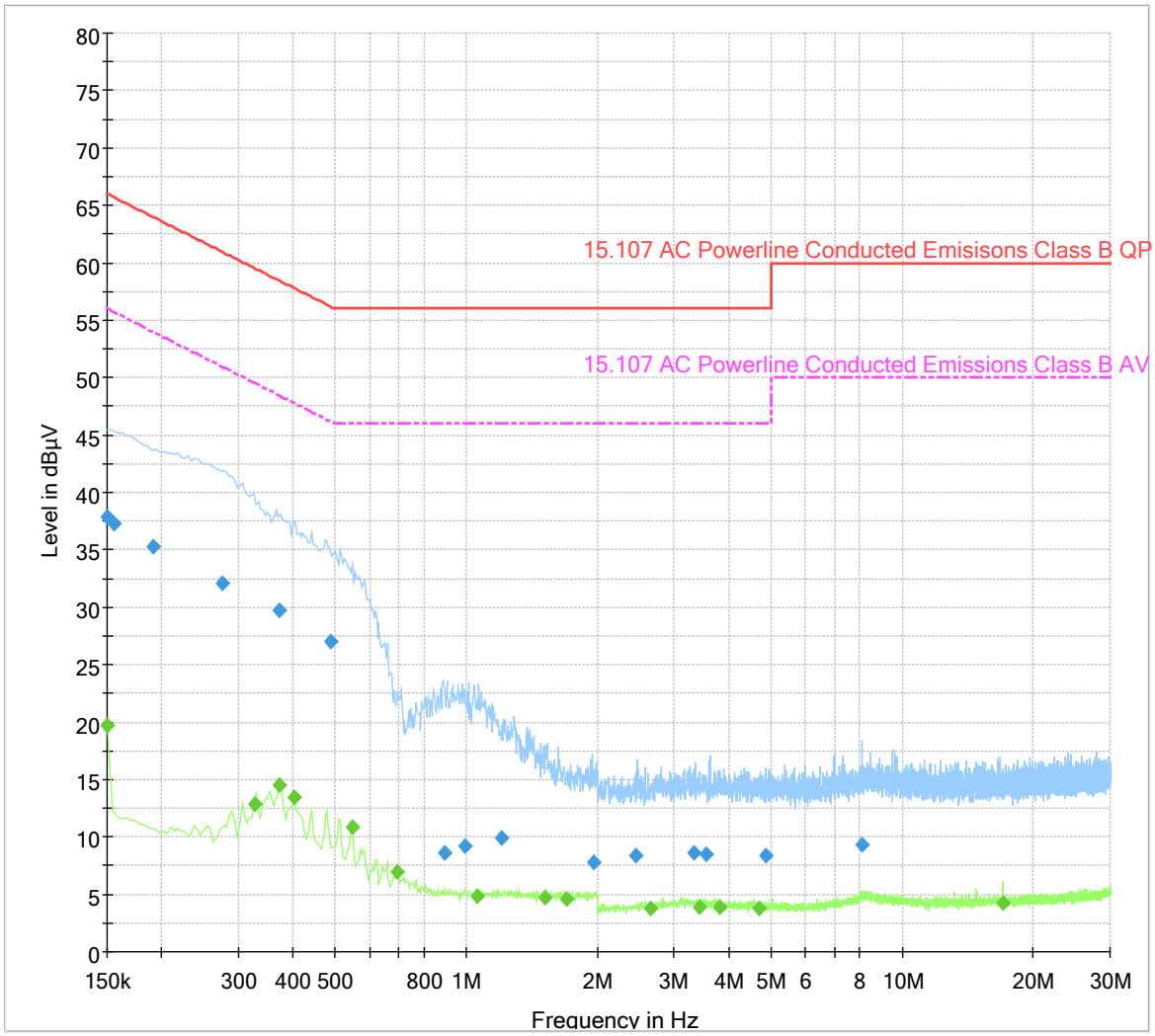


469.7 MHz On

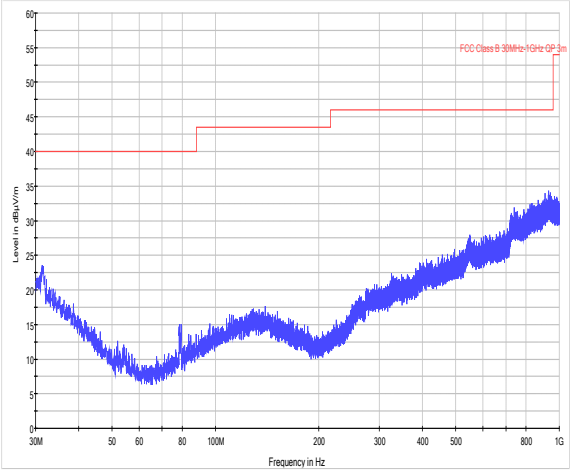


469.7 MHz Off

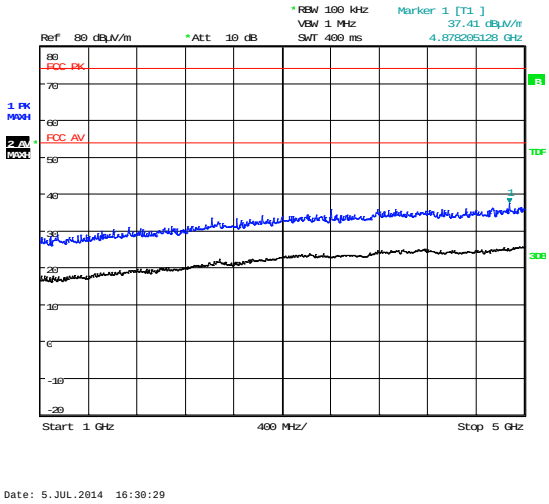
AC powerline Conducted Emissions



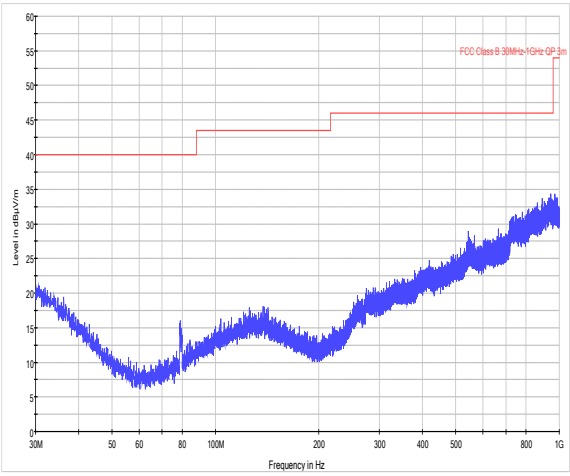
Field Strength of Unintentional Spurious Emissions



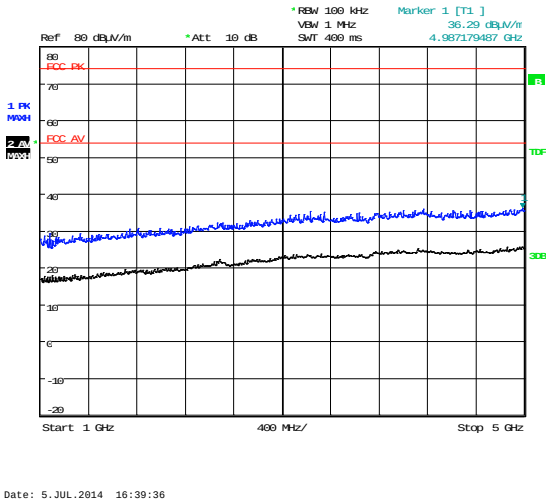
446.0 MHz - 30MHz – 1 GHz



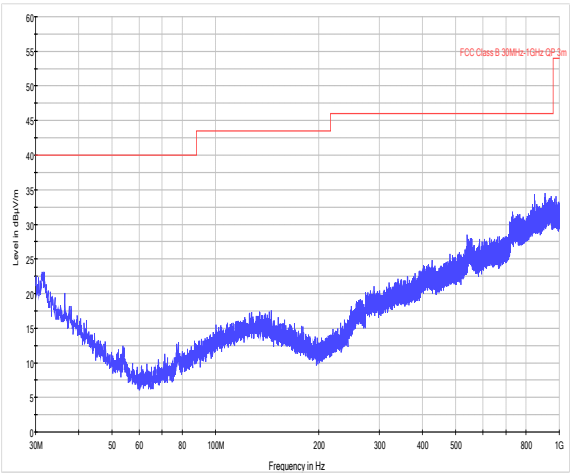
446.0 MHz - 1 GHz – 5 GHz



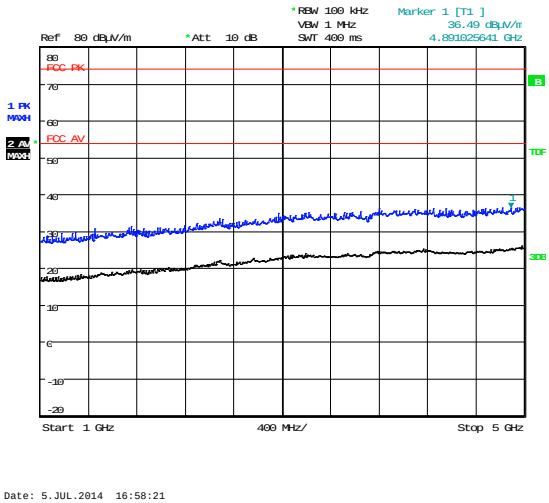
458.0 MHz - 30MHz – 1 GHz



458.0 MHz - 1 GHz – 5 GHz



467.9 MHz - 30MHz – 1 GHz



467.9 MHz - 1 GHz – 5 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
S02	1W UHF Synthesized TX	

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

Sample No.	Description	Identification
S01	TX Enable Switch	None

The following samples of apparatus were supplied by TRaC Global as support or drive equipment (auxiliary equipment):

Identification	Description
TRLUH100	Dual PSU

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode:
All tests detailed in this report	EUT operating at Maximum output power on the required frequency with modulation or CW as required.

Test	Description of Operating Mode:
PLCE	EUT operating at Maximum output power on the required frequency with modulation or CW as required.

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 : S02
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
CN1	2 Multicore wires (inc TX Enable Box)	0.8	PSU
CN2	2 Multicore wires	0.8m	PSU
JP1*	Multicore USB – Serial adapter	0.5m	PC

Sample : S02
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
CN1	2 Multicore wires (inc TX Enable Box)	0.8	PSU
CN2	2 Multicore wires	0.8m	PSU
JP1*	Multicore USB – Serial adapter	0.5m	PC

* Only connected during setup, removed during testing as required.

C5 Details of Equipment Used

TRaC No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
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
UH122	TDS520B	Oscilloscope	Tektronix	11/04/2012	24	11/04/2014
UH187	ESHS10	Receiver	R&S	19/02/2014	12	19/02/2015
UH191	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
UH281	FSU46	Spectrum Analyser	R&S	26/03/2014	12	26/03/2015
UH387	ATS	Chamber 1	Rainford EMC	04/07/2013	24	04/07/2015
UH388	ATS	Chamber 2	Rainford EMC	04/07/2013	24	04/07/2015
UH396	ENV216	Lisn	R&S	22/05/2014	12	22/05/2015
UH403	ESCI 7	Recevier	R&S	12/08/2013	12	12/08/2014
UH405	FSU26	Spectrum Analyser	R&S	16/04/2014	12	16/04/2015
L005	CMTA52	Communications Analyser	R&S	02/12/2013	12	02/12/2014
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
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
L352	ESVS10	Receiver	R&S	21/03/2014	12	21/03/2015
L426	52 Series II	Temperature Indicator	Fluke	22/05/2014	12	22/05/2015
L572	8449B	Pre Amp	Agilent	11/02/2014	12	11/02/2015
REF909	FSU26	Spectrum Analyser	R&S	12/02/2014	12	12/02/2015
REF940	ATS	Radio Chamber - PP	Rainford EMC	09/07/2013	24	09/07/2015
REF976	34405a	Multimeter	Agilent	19/05/2014	12	19/05/2015
REF977	SH4141	High Pass Filter	BSC	25/02/2013	24	25/02/2015

Appendix D: Additional Information

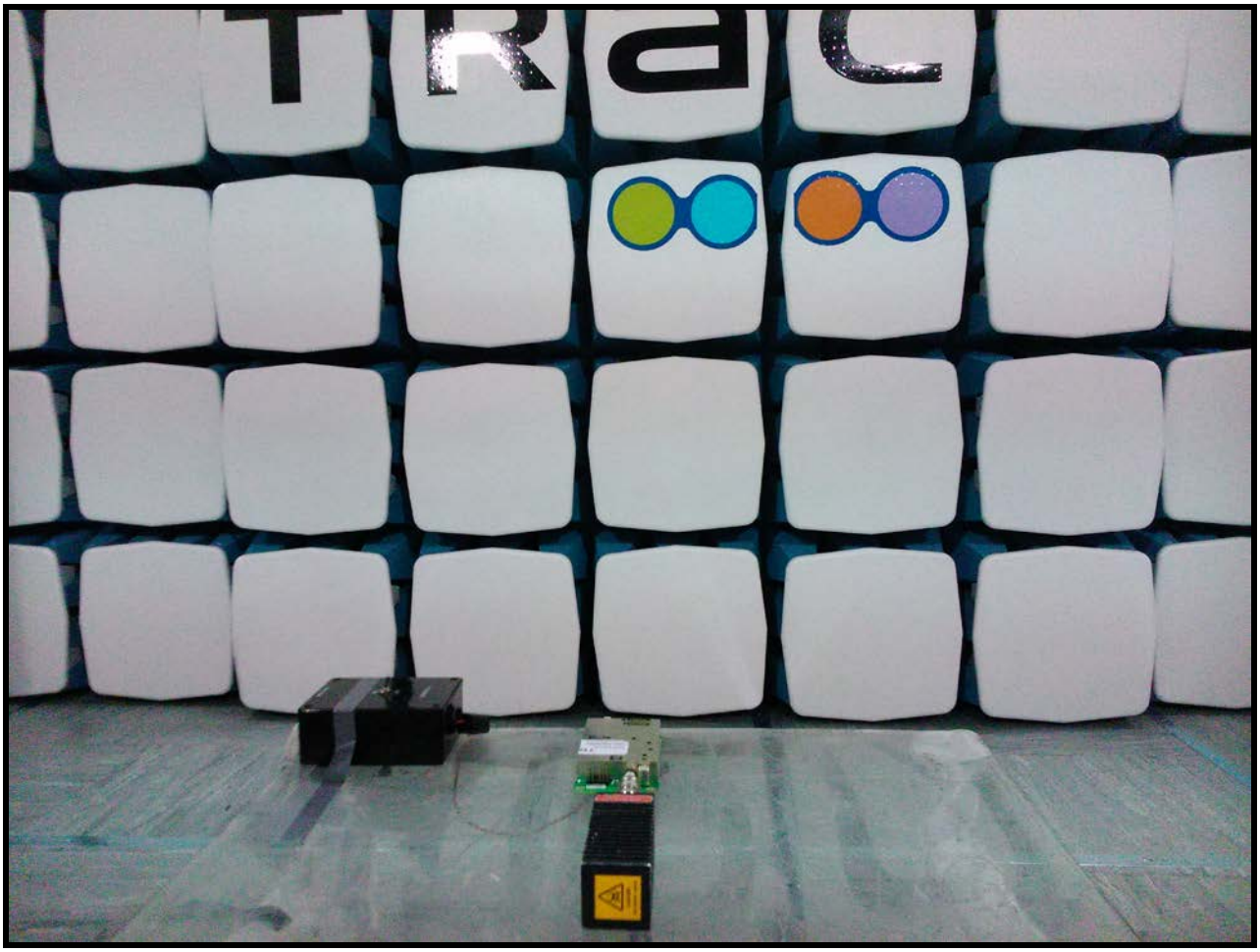
No additional information is included within this test report.

Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: Over view.
2. Radiated electric field emissions arrangement: Close up.
3. AC Powerline conducted emissions arrangement: Over view.

Photograph 1



Photograph 2

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Appendix G: MPE Calculation

As per KDB 447498

47 CFR §§1.1307 and 2.1091

2.1091 Radio frequency radiation exposure evaluation: Portable devices.

For purposes of these requirements mobile devices are defined by the FCC 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 centimetres is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than 0.6mW/cm^2 power density limit, as required under FCC rules

Prediction of MPE limit at a given distance

Equation from KDB 447498 D01

$$S = \frac{1.64ERP}{4\pi R^2} \quad \text{re-arranged } R = \sqrt{\frac{1.64ERP}{S4\pi}}$$

where:

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

Result:

Prediction Frequency (MHz)	Maximum ERP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 0.6mW/cm^2 (cm)
446.0	1007	0.6	14.8

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