Report on the Radio Testing

For

Triumph Designs Limited

on

Chassis Control Unit

Report no. TRA-029047-01-47-02B

1st March 2016

Report Number: TRA-029047-01-47-02B
Issue: A

REPORT ON THE RADIO TESTING OF A
Triumph Designs Limited
Chassis Control Unit
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.209 & IC RSS-210 Annex 2.6

TEST DATE: 19th January - 24th February 2016

Tested by: A Tosif

P Darragh - A Tosif
Radio Test Engineers

John Charters

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Approved by:

J Charters
Department Manager- Radio

Date: 1st March 2016

Element Materials Technology Warwick Ltd.
Registered in England and Wales. Registered Office: 5 Fleet Place, London, EC4M 7RD
Company Reg No. 02536659

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	1st March 2016	Original
B	1st March 2016	Typos corrected

2 Summary

TEST REPORT NUMBER:	TRA-029047-01-47-02B
WORKS ORDER NUMBER	TRA-029047-01
PURPOSE OF TEST:	Certification
TEST SPECIFICATION(S):	47CFRPart 15.209 / RSS-210
EQUIPMENT UNDER TEST (EUT):	Chassis Control Unit
FCC IDENTIFIER:	AQO004
IC IDENTIFIER:	10176A-004
EUT SERIAL NUMBER:	10000524 and 10000525
MANUFACTURER/AGENT:	Triumph Designs Limited
ADDRESS:	Normandy Way (off Dodwells Road) HINCKLEY Leicestershire LE10 3BZ United Kingdom
CLIENT CONTACT:	Neil Whitford ☎ ✉ neil.whitford@triumph.co.uk
ORDER NUMBER:	DES034471
TEST DATE:	19th January - 24th February 2016
TESTED BY:	P Darragh - A Tosif Element

2.1 Test Summary

Test Method and Description	*Requirement Clause*		*Applicable to this equipment*	*Result / Note*
	RSS	*47CFR15*		
Field strength of fundamental	210, 2.5	15.209	☒	Pass
Radiated spurious emissions	210, 2.5	15.209	☒	Pass
Unintentional radiated emissions	Gen, 7.1	15.109	☒	Pass
Occupied bandwidth	Gen, 6.6	15.215(c)	☒	Pass
AC power line conducted emissions	Gen, 8.8	15.207	☐	N/A[#]

[#] EUT is a battery powered device.

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, 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. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

3 Contents

4 Introduction

This report TRA-029047-01-47-02B presents the results of the Radio testing on a Triumph Designs Limited, Chassis Control Unit to specification 47CFR15 Radio Frequency Devices and RSS-210 Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.

The testing was carried out for Triumph Designs Limited by Element, at the address(es) detailed below.

☒ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☐ Element North West
Unit 1
Pendle Place
Skemersdale
West Lancashire
WN8 9PN
UK

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:
Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

IC Registration Number(s):
Element Hull 3483A

The test site requirements of ANSI C63.4-2014 are met up to 1 GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- Industry Canada RSS-210, Issue 8, December 2010 – Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
- Industry Canada RSS-Gen, Issue 4, November 2014 – General Requirements for Compliance of Radio Apparatus

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

7 Equipment under Test

7.1 EUT Identification

- Name: Chassis Control Unit
- Serial Number: 10000524 and 10000525
- Model Number: 2502433
- Software Revision: 0771A10E_T2
- Build Level / Revision Number: Not Applicable

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Load Box
Manual Test Rig
Harness
Fujitsu Monitor
PC
433 MHz Transmitter Box
Can/Lin Interface

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Tx tests was as follows.

EUT transmitting permanent modulated carrier at 134.2 kHz

7.3.2 Reception

EUT in receive mode at 433.92 MHz.

7.4 EUT Radio Parameters

Frequencies of operation:	134.2 kHz 433.92 MHz (Receiver only)
Antenna type(s) and gain(s):	Integral
Nominal Supply Voltage:	12 Vdc

7.5 EUT Description

The EUT contains a 134.2 kHz Transceiver and a 433.92 MHz Receiver. This report covers both.

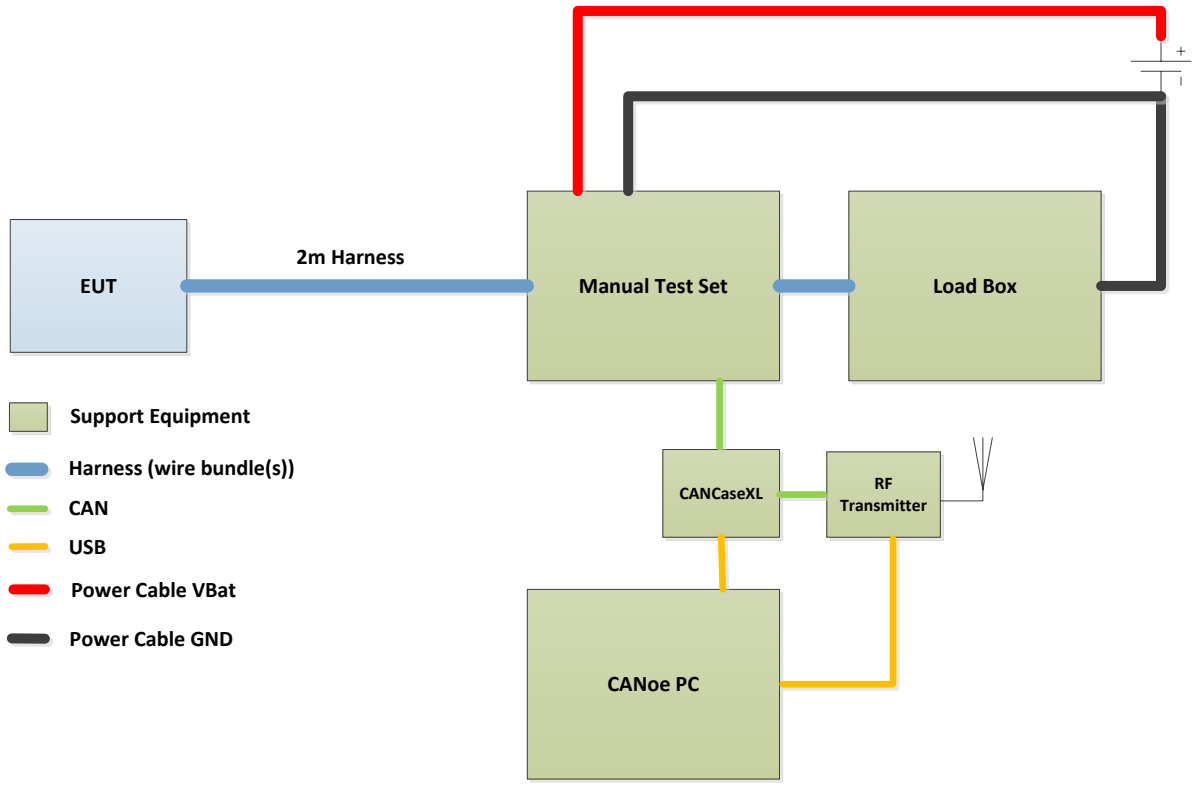
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

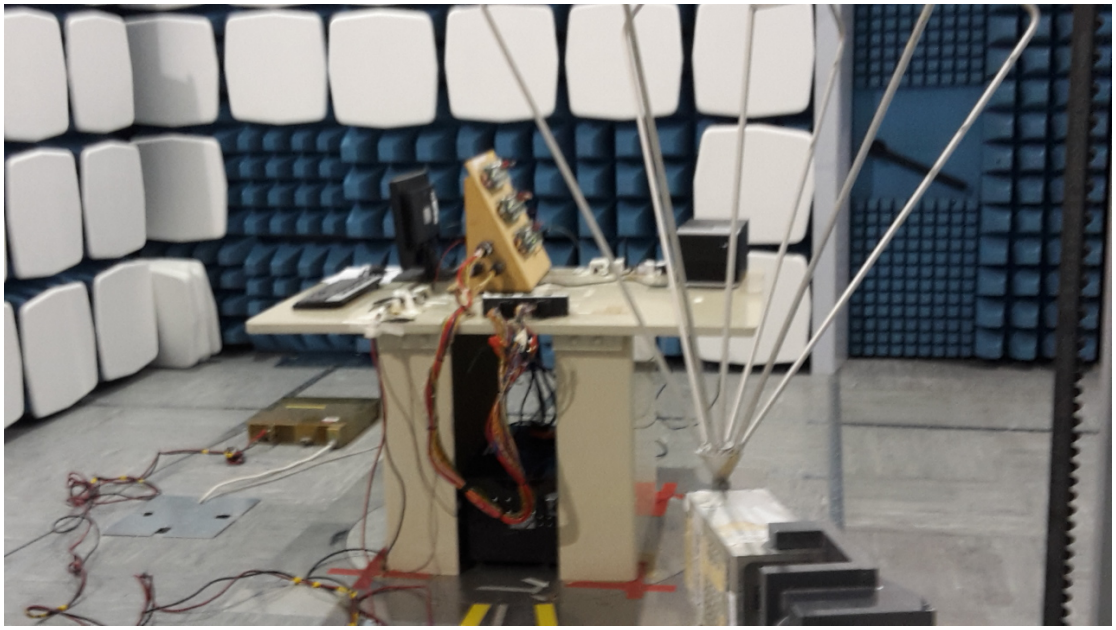
9.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



10 General Technical Parameters

10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 12 Vdc.

10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band.

Variation of supply voltage is required to ensure stability of the declared output power. During carrier powers testing the following variations were made:

	Category	***Nominal***	***Variation***
☐	Mains	110V ac +/-2%	85% and 115%
☒	Battery	New battery	N/A

11 Transmitter output power (fundamental radiated emission)

11.1 Definition

The RF power dissipated in the standard output termination when operating under the rated duty cycle selected by the applicant for approval.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	REF886
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
EUT Channels / Frequencies Measured:	134.2 kHz
Deviations From Standard:	None
Measurement BW:	10 kHz
Measurement Detector:	Quasi-peak

Environmental Conditions (Normal Environment)

Temperature:	26 °C	+15 ºC to +35 ºC
Humidity:	32 %RH	20%RH to 75%RH

Test Limits

The field strength measured at 300 meters shall not exceed the limits in the following table:

Field Strength Limits for License-Exempt Transmitters for Any Application

Frequency, f (kHz)	Field Strength (µV/m)	Measurement Distance (m)
0.009-0.490	2400/F(kHz)	300

11.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the resolution bandwidth of the spectrum analyser / receiver was increased above the EUT occupied bandwidth and the peak emission data noted.
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in µV/m at the regulatory distance, using:

$$FS = 10^{(PR - CF) / 20}$$

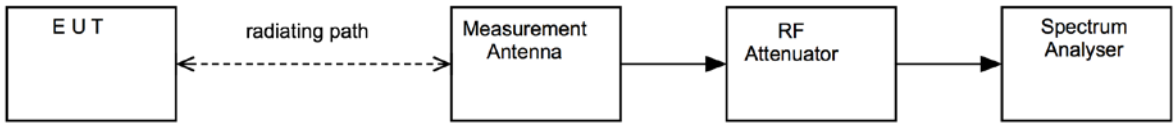
Where,

PR is the power recorded on the receiver / spectrum analyzer in dBµV and includes any cable loss, antenna factor and pre-amplifier gain;
CF is the distance extrapolation factor in dB (where measurement distance is different to limit distance);

Per FCC 47CFR15.31 (f) (2) and RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

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

Figure v Test Setup



11.4 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration	Calibration Interval Months
Receiver	R&S	ESCI 7	RFG715	06/10/2016	12
Spectrum Analyser	R&S	FSU46	REF910	28/05/2016	12
Active Loop Antenna	R&S	HFH2-Z2	RFG023	01/12/2017	24
Ferrite Lined Chamber	Rainford	ATS	REF886	21/07/2016	24

11.5 Test Results

Channel Frequency (MHz)	Receiver Level (dBµV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (µV/m)	Limit (µV/m)	Result
0.1342	67.7	3	300	80	0.243	17.9	PASS

12 Occupied Bandwidth

12.1 Definition

Occupied bandwidth
The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 % of the emitted power. This is also known as the *99 % emission bandwidth*. For transmitters in which there are multiple carriers, contiguous or non-contiguous in frequency, the occupied bandwidth is to be the sum of the occupied bandwidths of the individual carriers.

20 dB bandwidth
The emission bandwidth (20 dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated -20 dB below the maximum in-band spectral density of the modulated signal.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	REF886
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	134.2 kHz
Deviations From Standard:	None
Measurement BW: (Irequirement: 1% to 5% OBW)	500 Hz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	2 kHz
Measurement Span: (requirement 2 to 5 times OBW)	80 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 ºC to +35 ºC
Humidity: 29 %RH	20%RH to 75%RH
Supply: 12 Vdc	New battery

Test Limits

Industry Canada:
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99 % emission bandwidth, as calculated or measured.

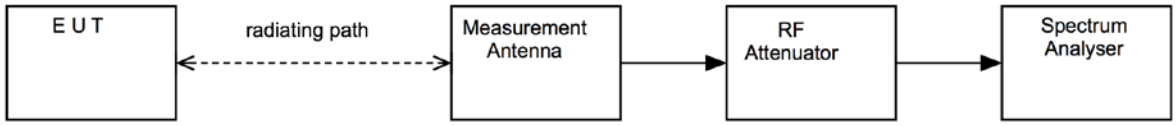
Federal Communications Commission:
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

12.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the bandwidth of the EUT was measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iv Test Setup

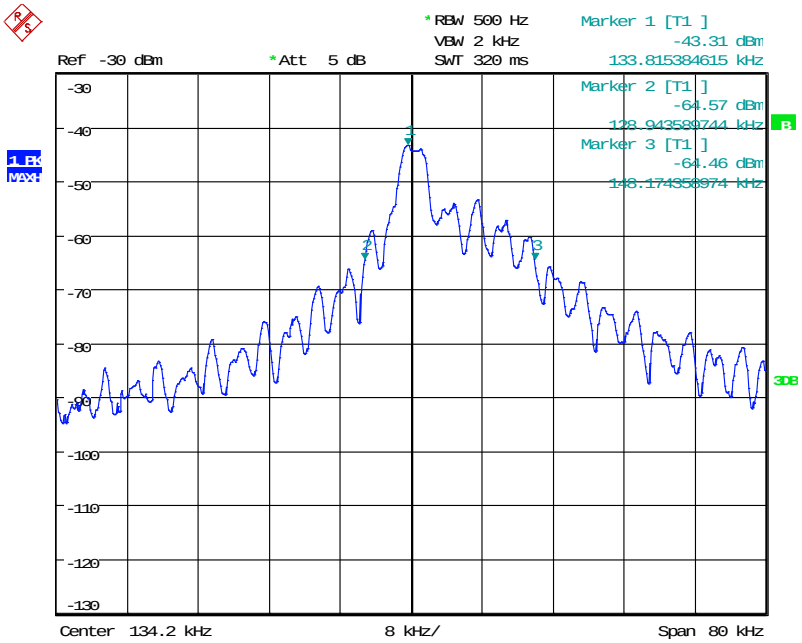


12.4 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration	Calibration Interval Months
Spectrum Analyser	R&S	FSU46	REF910	28/05/2016	12
Active Loop Antenna	R&S	HFH2-Z2	RFG023	01/12/2017	24

12.5 Test Results

15.215 (c)				
Channel Frequency (kHz)	F_L (kHz)	F_H (kHz)	20dB Bandwidth (kHz)	Result
134.2	128.944	148.174	19.230	PASS



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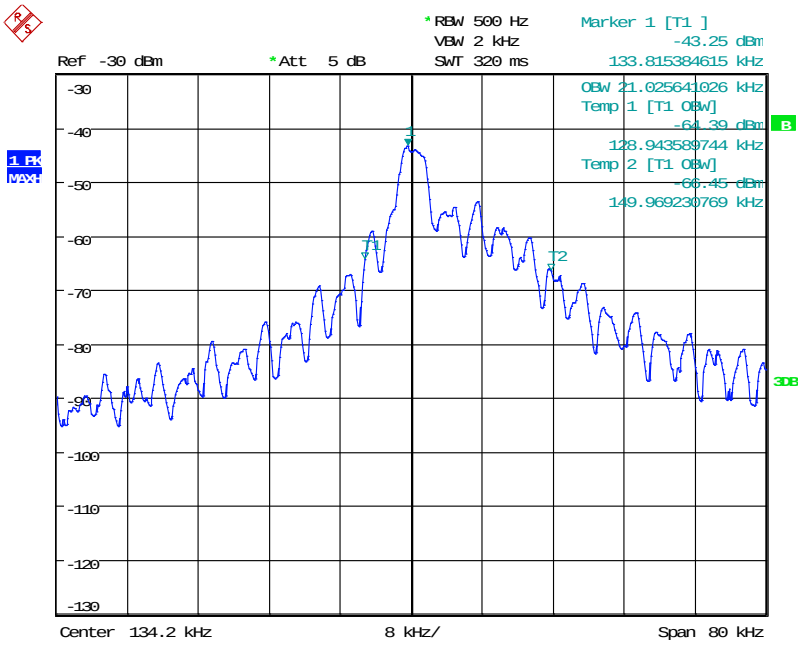
RSS-210				
Channel Frequency (kHz)	F_L (kHz)	F_H (kHz)	99 % Bandwidth (kHz)	Result
134.2	128.944	149.969	21.025	PASS



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13 Radiated emissions

13.1 Definitions

Spurious emissions
Spurious emissions are the emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	REF886
Test Standard and Clause:	ANSI C63.10-2013, Clauses 6.4, 6.5 and 6.6
EUT Channels / Frequencies Measured:	134.2 kHz
Deviations From Standard:	None
Measurement BW:	9 kHz to 150 kHz: 200 Hz 150 kHz to 30 MHz: 9 kHz 30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	9 – 90 kHz and 110 – 490 kHz: Average RMS 30 MHz - 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature:	26 °C	+15 ºC to +35 ºC
Humidity:	34 %RH	20%RH to 75%RH
Supply:	12 Vdc	New battery

Test Limits

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exempt Transmitters

Frequency, f (kHz)	Field Strength (µV/m)	Measurement Distance (m)
9 – 490	2400/F(kHz)	300
490 – 1,750	24000/F(kHz)	30
1,750 – 30,000	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

13.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure ii, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

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).

Emissions between 9 kHz and 30 MHz

Emissions between 9 kHz and 30 MHz are measured using a calibrated 60cm active loop antenna. 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.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in µV/m at the regulatory distance, using:

$$FS = 10^{(PR - CF) / 20}$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dBµV and includes any cable loss, antenna factor and pre-amplifier gain;
CF is the distance extrapolation factor in dB (where measurement distance is different to limit distance);

Per FCC 47CFR15.31 (f) (2) and RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

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

Emissions above 30 MHz

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 degrees 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.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dBµV/m at the regulatory distance, using:

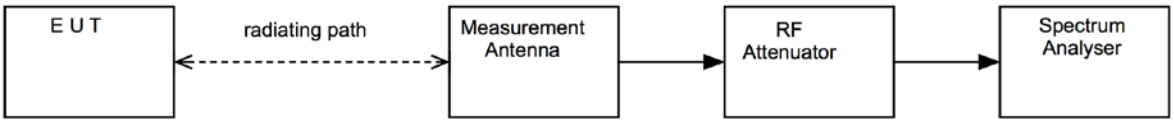
$$FS = PR + CL + AF - PA + DC - CF$$

Where,

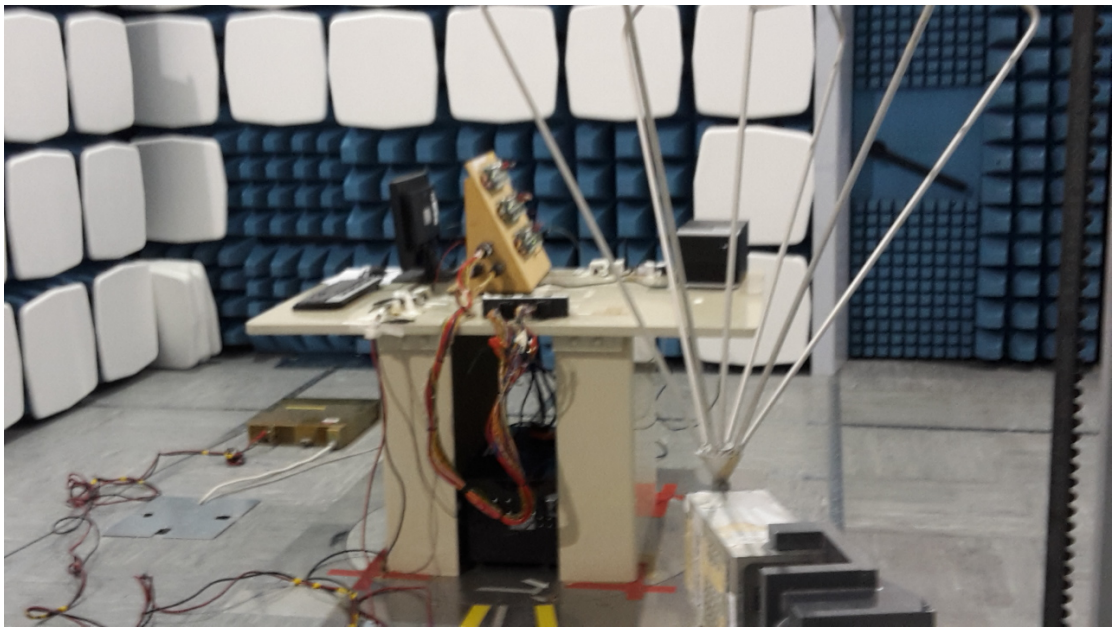
PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB
CF is the distance factor in dB (where measurement distance different to limit distance);

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

Figure ii Test Setup



Test Setup Photograph(s)



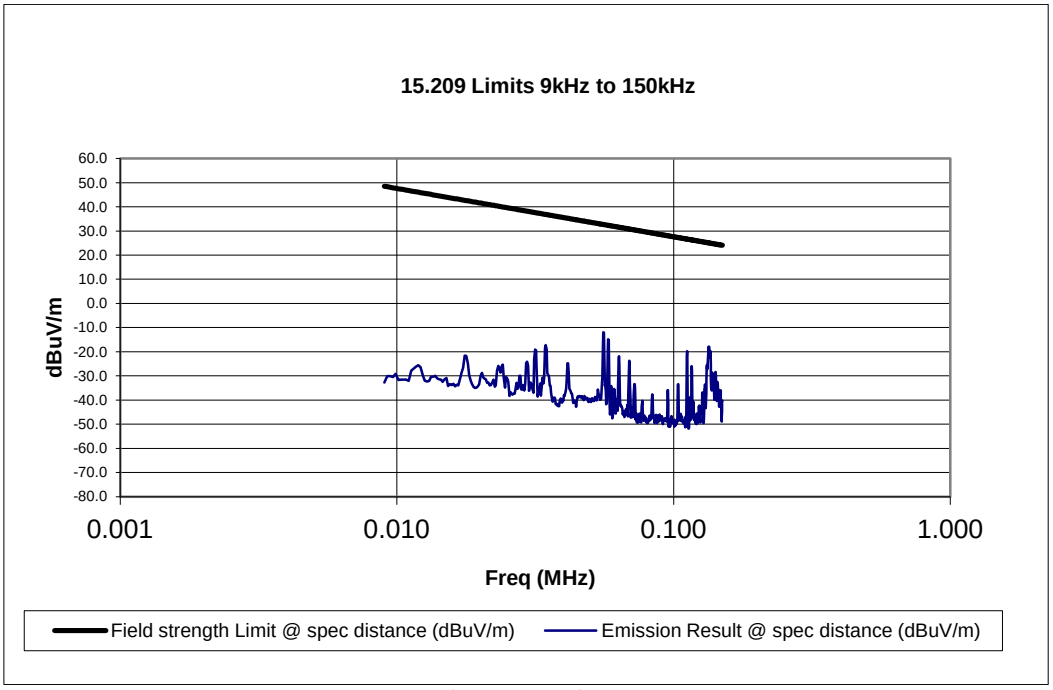
13.4 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration	Calibration Interval months
Ferrite Lined Chamber	Rainford	ATS	REF886	21/07/2016	24
Spectrum Analyser	R&S	FSU46	REF910	28/05/2016	12
EMI Test Receiver	R&S	ESVS20	RFG126	17/04/2016	12
Measuring Receiver	R & S	ESCI7	RFG715	06/10/2016	12
Active Loop Antenna	R&S	HFH2-Z2	RFG023	01/12/2017	24
Biconical Antenna	EMCO	3109	RFG095	09/05/2016	24
Log Periodic Antenna	EMCO	3146	RFG191	09/05/2016	24
Horn Antenna	EMCO	3115	RFG129	09/02/2018	24
Pre-Amp (9kHz – 1GHz)	Sonoma	310	REF927	01/07/2016	24
Pre-Amp (1 – 26.5GHz)	Agilent	8449B	REF913	02/02/2018	24

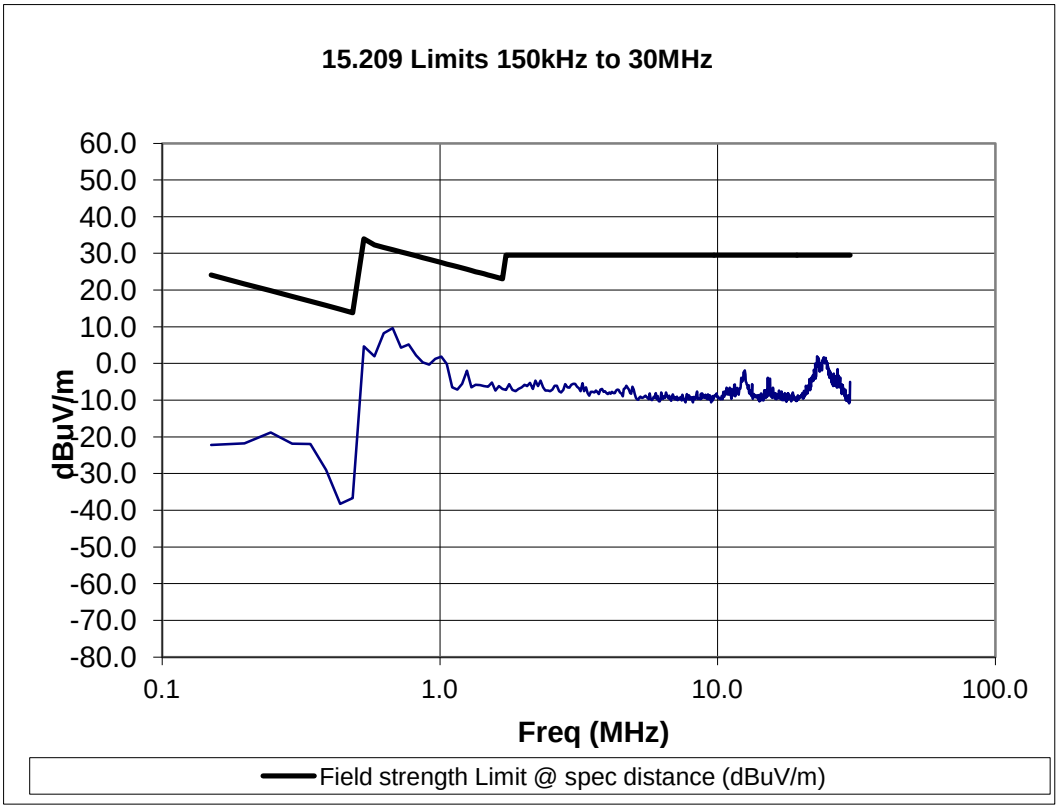
13.5 Test Results

Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
No emissions were detected within 20 dB of the limit								

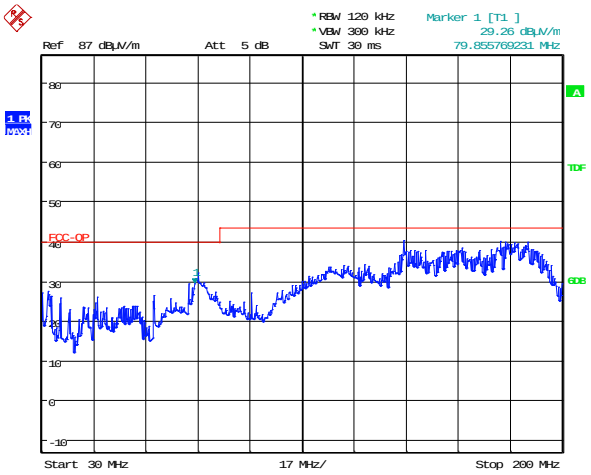
Radiated Spurious Emission



9 kHz – 150 kHz



150 kHz – 30 MHz



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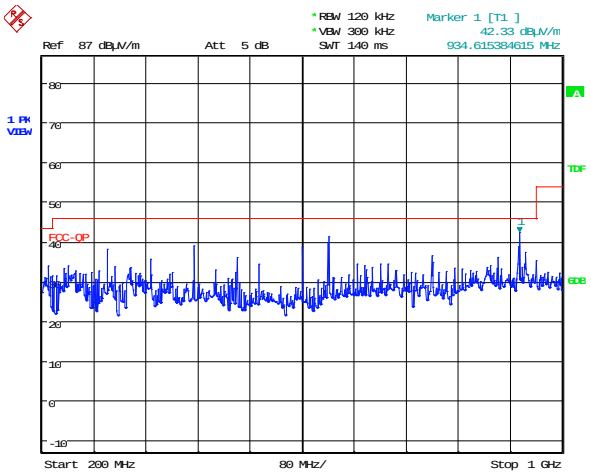
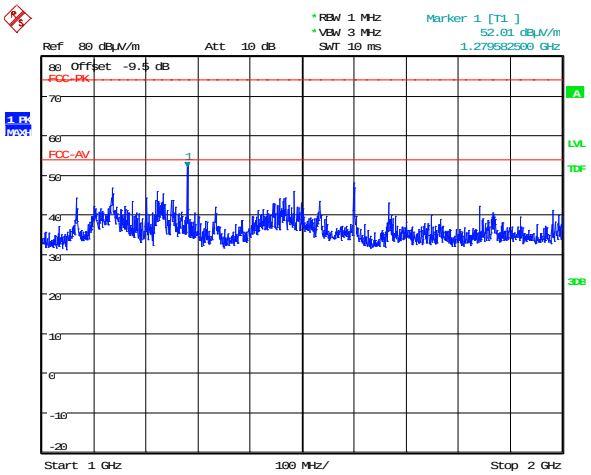
30 MHz – 200 MHz



Date: 21.JAN.2016 14:17:31

200 MHz – 1 GHz



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1 GHz – 2 GHz

14 Radiated emissions – unintentional radiation / receiver emissions

14.1 Definitions

Receiver spurious emissions
The radio frequency signals generated within the receiver, which may cause interference to other equipment. This includes the period during which the equipment is scanning or switching channels.

Unintentional radiator
A device that generates RF energy which is not intended to be radiated for reception by a radio receiver.

14.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	REF886
Test Standard and Clause:	ANSI C63.10-2013, Clauses 6.4, 6.5 and 6.6
EUT Channels / Frequencies Measured:	433.92 MHz
Deviations From Standard:	None
Measurement BW:	9 kHz to 150 kHz: 200 Hz 150 kHz to 30 MHz: 9 kHz 30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	9 – 90 kHz and 110 – 490 kHz: Average RMS 30 MHz - 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature:	26 °C	+15 ºC to +35 ºC
Humidity:	34%RH	20%RH to 75%RH
Supply:	12 Vdc	New battery

Test Limits

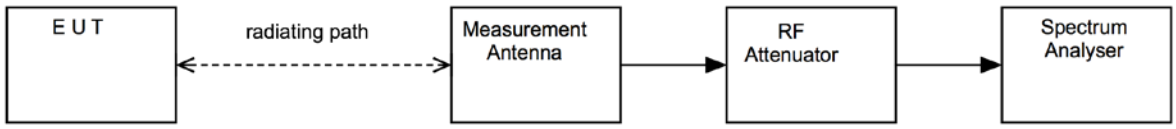
Receiver Radiated Limits

Frequency (MHz)	Field Strength (µV/m at 3m)
30-88	100
88-216	150
216-960	200
Above 960	500

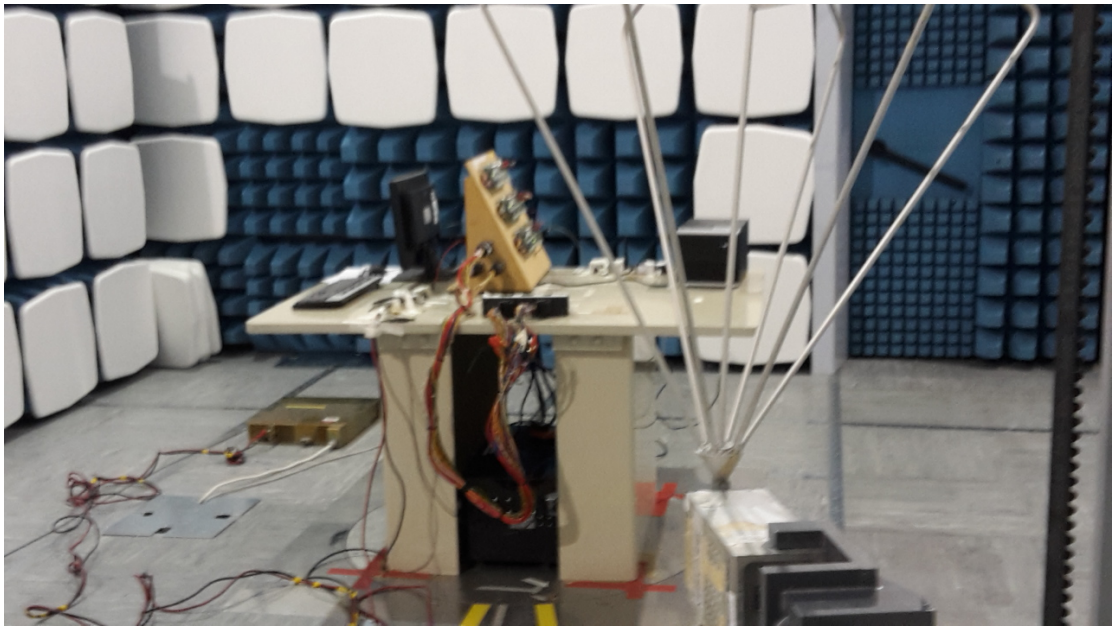
14.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure viii, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver. The EUT was rotated in three orthogonal planes and the measurement antenna height scanned (below 1GHz, from 1 to 4 m; above 1GHz as necessary) in order to maximise emissions.
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration at each frequency. Pre-scan plots are shown with a peak detector.

Figure viii Test Setup



Test Setup Photograph(s)



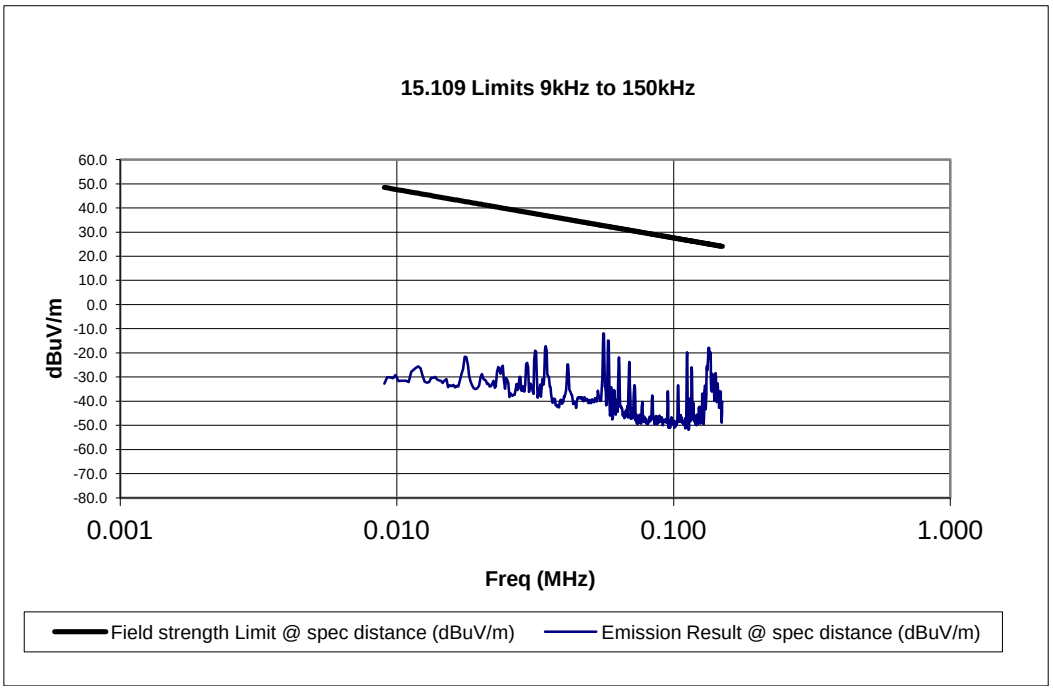
14.4 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration	Calibration Interval months
Ferrite Lined Chamber	Rainford	ATS	REF886	21/07/2016	24
Spectrum Analyser	R&S	FSU46	REF910	28/05/2016	12
EMI Test Receiver	R&S	ESVS20	RFG126	17/04/2016	12
Measuring Receiver	R & S	ESCI7	RFG715	06/10/2016	12
Active Loop Antenna	R&S	HFH2-Z2	RFG023	01/12/2017	24
Biconical Antenna	EMCO	3109	RFG095	09/05/2016	24
Log Periodic Antenna	EMCO	3146	RFG191	09/05/2016	24
Horn Antenna	EMCO	3115	RFG129	09/02/2018	24
Pre-Amp (9kHz – 1GHz)	Sonoma	310	REF927	01/07/2016	24
Pre-Amp (1 – 26.5GHz)	Agilent	8449B	REF913	02/02/2018	24

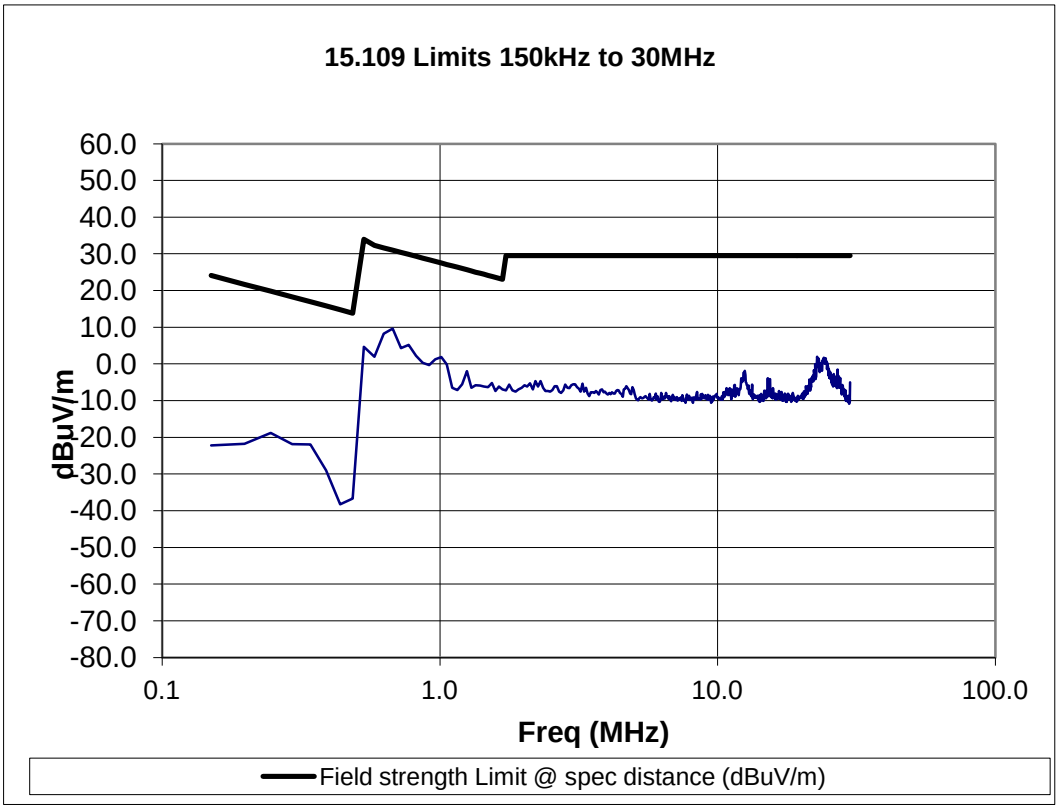
14.5 Test Results

Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
Qp	30.0	57.5	0.5	12.8	31.6	39.2	91.2	100.0
Qp	33.0	54.8	0.5	12.4	31.5	36.2	64.6	100.0
Qp	54.3	56.8	0.6	9.0	31.6	34.8	55.0	100.0
Qp	77.9	59.5	0.8	7.2	31.6	35.9	62.4	100.0
Qp	78.0	60.6	0.8	7.2	31.6	37.0	70.8	100.0
Qp	79.8	61.8	0.9	7.1	31.6	38.2	81.3	100.0
Qp	81.0	56.8	0.9	7.1	31.6	33.2	45.7	100.0
Qp	136.7	54.7	1.1	12.6	31.5	36.9	70.0	150.0
Qp	149.7	54.9	1.2	12.4	31.5	37.0	70.8	150.0
Qp	161.3	53.8	1.5	12.2	31.5	36.0	63.1	150.0
Qp	181.7	57.6	1.5	12.3	31.5	39.9	98.9	150.0
Qp	182.8	56.2	1.5	12.4	31.5	38.6	85.1	150.0
Qp	209.9	54.6	1.7	10.4	31.5	35.2	57.5	150.0
Qp	366.7	50.1	2.4	14.3	31.5	35.3	58.2	200.0
Qp	433.3	54.4	2.7	15.8	31.5	41.4	117.5	200.0
Qp	600.0	48.5	3.1	18.6	31.6	38.6	85.1	200.0
Qp	683.8	44.8	3.3	20.5	31.6	37.0	70.8	200.0
Qp	900.1	37.1	3.7	22.3	30.7	32.4	41.7	200.0
Qp	933.3	46.3	3.9	22.8	30.4	42.6	134.9	200.0
Av	1279.6	65.2	3.9	25.6	35.1	50.1	319.9	500.0
Av	1066.0	56.4	3.7	25.4	35.5	40.5	105.9	500.0
Av	1600.0	54.9	4.8	26.2	34.7	41.7	121.6	500.0
Av	1197.0	55.4	3.6	25.5	35.2	39.8	97.7	500.0
Av	1133.0	54.1	3.7	25.4	35.4	38.4	83.2	500.0

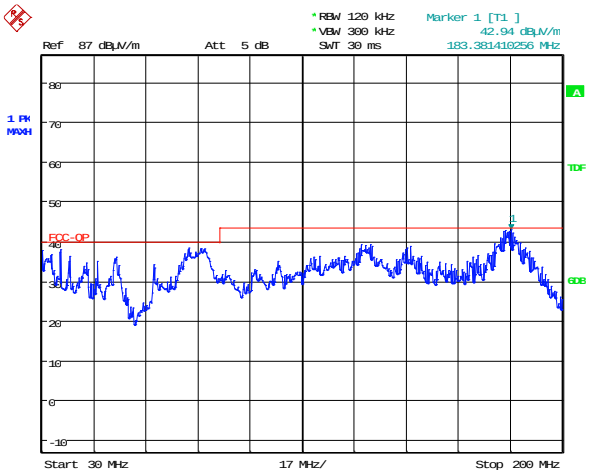
Unintentional Radiated Spurious Emission



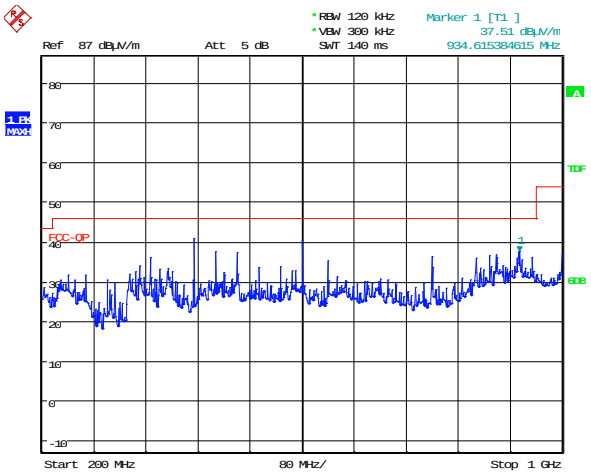
9 kHz – 150 kHz



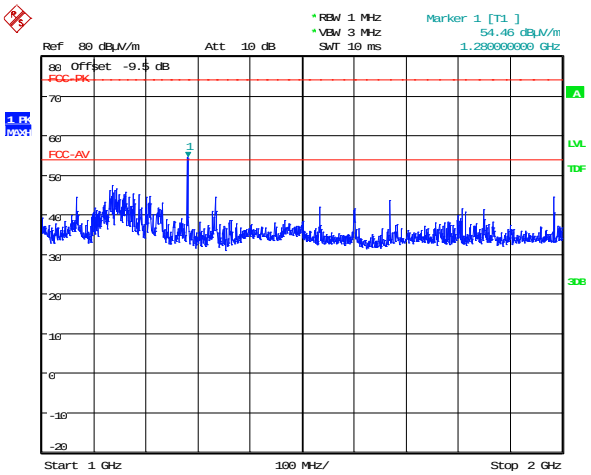
150 kHz – 30 MHz



30 MHz – 200 MHz



200 MHz – 1 GHz



1 GHz – 2 GHz

15 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence:

[1] Radiated emissions

Uncertainty in test result (9 kHz – 30 MHz) = 2.3 dB
Uncertainty in test result (30 MHz – 1GHz) = 4.6 dB
Uncertainty in test result (1 GHz to 18 GHz) = 4.7 dB

[2] Occupied bandwidth

Uncertainty in test result = 15.5%

16 General SAR test reduction & exclusion guidance

KDB 447498

Section 4.3 General SAR test reduction and exclusion guidance

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

The SAR Test Exclusion Threshold for frequency range below 100 MHz will be determined as follows.

SAR Exclusion Threshold (SARET) = Step 2 * Step 3

Step 1

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

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)

MP = Max Power of channel (mW) (including tune-up tolerance)

TSD^{A} = Min Test separation Distance or 50mm (whichever is lower) = 5mm (in this case)

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

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

Step 2

$$\text{Step 2} = \text{Step 1} + (TSD^{B} - 50\text{mm}) * 10$$

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

So,

$$\text{Step 2} = \text{Step 1} = [(NT \times TSD^{A}) / \sqrt{f_{GHz}}]$$

Step 3

a) the power threshold at the corresponding test separation distance at 100 MHz in step 2 is multiplied by $[1 + \log (100/ f_{MHz})]$ for test separation distances > 50 mm and < 200 mm

b) the power threshold determined by the equation (a) for 50 mm and 100 MHz is multiplied by ½ for test separation distances ≤ 50 mm

$$SARET = [(NT \times TSD^{A}) / \sqrt{0.1}] * [1 + \log (100/ f_{MHz})] * {}^{1}/_{2}$$
$$SARET = [(3.0 \times 50) / \sqrt{0.1}] * [1 + \log (100/ 0.1342)] * {}^{1}/_{2}$$

SARET = 918.4 mW

The calculated output power is 1.8×10^{-7} mW (eirp) and is less than the SAR Exclusion Threshold of 918.4 mW, at a test separation distance ≤ 50mm, for general population and uncontrolled exposure. Therefore standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

17 MPE Calculation

Prediction of MPE limit at a given distance

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

Equation from IEEE C95.1

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

Where:

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

Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than the power density limit
0.1342	1.8×10^{-7}	100.0	1.2×10^{-5}

Note: EIRP is calculated from maximum radiated field strength.

18 RF Exposure Technical Brief

RSS-102 issue 5

Section 2.5.1 Exemption Limits for Routine Evaluation – SAR Evaluation

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance.

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold at distance of ≤ 5 mm (mW)	SAR Evaluation
0.1342	1.8×10^{-7}	71.0	Not Required

Note: EIRP Calculated From Field Strength as per ANSI C63.10