Report on the Radio Testing

For

Navtech Radar Ltd

on

HDR300 Series Radar

Report no. TRA-027494-45-01D

13 March 2018

Report Number: TRA-027494-45-01D
Issue: D

REPORT ON THE RADIO TESTING OF A
Navtech Radar Ltd
HDR300 Series Radar
WITH RESPECT TO SPECIFICATION
FCC 47CFR 95 Subpart M

TEST DATE: 2017-02-09 to 2017-03-03

Written by: A Longley — A Longley, Radio Test Engineer

Approved by: 
Digitally signed by John Charters
DN: cn=John Charters, o, ou=Element Materials Technology Ltd., email=john.charters@element.com, c=GB
Reason: I am approving this document
Date: 2018.04.13 09:31:00 +01'00'
— J Charters, Department Manager - Radio

Date: 13 March 2018

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Company Reg No. 02536659

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	11th July 2017	Original
B	8th August 2017	Initial comments
C	6th March 2018	Conversion to FCC 47CFR 95 Subpart M
D	13th March 2018	Comments from TCB (removal of references to non-HDR311 units)

2 Summary

TEST REPORT NUMBER:	TRA-027494-45-01D
WORKS ORDER NUMBER	TRA-027494-03
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION(S):	47CFR95 Subpart M
EQUIPMENT UNDER TEST (EUT):	HDR300 Series Radar
FCC IDENTIFIER:	S7Y-BD3
EUT SERIAL NUMBER:	HDR300-0965
MANUFACTURER/AGENT:	Navtech Radar Ltd
ADDRESS:	16 Home Farm Ardington Wantage Oxfordshire OX12 8PD United Kingdom
CLIENT CONTACT:	Rick Poulton ☎ 01235 433592 ✉ richard.poulton@navtechradar.com
ORDER NUMBER:	12422
TEST DATE:	2017-02-09 to 2017-03-03
TESTED BY:	A Longley Element

2.1 Test Summary

Test Method and Description	*Requirement Clause* *47CFR95*	*Applicable to this equipment*	*Result / Note*
Radiated spurious emissions	95.3379(a)	☒	*Pass Note 1*
AC power line conducted emissions	15.207	☒	*Pass*
Occupied bandwidth	95.3379(b)	☒	*Pass*
Field strength of fundamental	95.3367 (a) 95.3367 (b)	☒	*Pass*
Calculation of duty correction	15.35(c)	☐	

Notes:

Note 1 emission only performed to 110GHz

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-027494-45-01D presents the results of the Radio testing on a Navtech Radar Ltd, HDR300 Series Radar to specification 47CFR95 Personal Radio Services.

The testing was carried out for Navtech Radar Ltd 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.

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 95 – Personal Radio Services.
- 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.

5.2 Deviations from Test Standards

The temperature range over which the EUT performance was assessed was wider than that required by the specification at the client's request.

This test report only covers emission up to 110 GHz.

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: HDR300 Series Radar
- Serial Number: HDR300-0965
- Model Number: HDR300
- Software Revision: Not Applicable
- Build Level / Revision Number: Not Applicable

7.2 Product Variants

The following variants of the unit tested are also covered by the testing in this report:
HDR311, HDR311-X, SMR311, SMR311-X.
(The HDR311 is also known as OCCULUS RADAR)
These are configured for operation at different ranges and rotational speeds. The –X indicates that the unit is fitted with a $cosec^2$ antenna to spread the beam in elevation.

For further information on product variants see Appendix A – Declarations.

7.3 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.

Not Applicable – No support/monitoring equipment required.

7.4 EUT Mode of Operation

7.4.1 Transmission

The mode of operation for transmit tests was as follows:

The EUT was operating with a swept frequency transmission, for radiated spurious measurements the EUT was operating in Normal mode with a rotating antenna assembly, for all other tests the EUT was operating in Staring mode with a stationary antenna assembly lined up with the measurement antenna.

7.4.2 Reception

The mode of operation for receive tests was as follows:

The EUT does not have a separate receive mode.

7.5 EUT Radio Parameters

7.5.1 General

Frequency of operation:	76 – 77 GHz
Modulation type(s):	FMCW
Channel spacing:	N/A (Swept RADAR signal)
ITU emission designator(s):	1G00F0N
Declared output power(s):	43dBm
Warning against use of alternative antennas in user manual (yes/no):	Yes
Nominal Supply Voltage:	24 Vdc
Location of notice for license exempt use:	Label / user manual / both.
Method of prevention of use on non-US / non-Canadian frequencies:	N/A
Duty cycle:	0.28% when rotating

7.5.2 Antennas

Type:	Custom pseudo optical horn lens assembly
Frequency range:	76 GHz to 77GHz
Impedance:	N/A
SWR:	N/A
Gain:	Unknown (built in antenna)
Polarisation:	Horizontal
Beam width:	1˚
Connector type:	N/A (not customer accessible)
Length:	N/A
Weight:	N/A
Environmental limits:	-20˚C to 60˚C
Mounting:	Internally mounted to a rotating assembly

7.6 EUT Description

The EUT is a Radar Unit for tracking ground targets such as vehicles or debris, operating in the 76 - 77 GHz band.

8 Modifications

The following modifications were incorporated in the equipment during testing, in the order detailed below giving reference to the associated test.

Any modifications carried out during the Transmitter testing are listed below:

No.	***Modification***	***Reason for Modification***
1	Ferrite cores were added to both the incoming and outgoing cables on the power supply internal to the EUT	Radiated Spurious Emissions

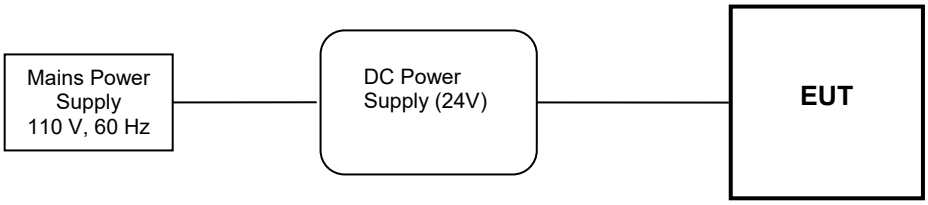
Upon completion of each modification, consideration was given to the previously conducted test(s). The modification(s) carried out were deemed not to have invalidated previous results.

Note: Opinions made above, fall outside the Element UKAS scope of laboratory accreditation, and are based entirely on rationale and assumption obtained from technical information, competence and experience, deemed correct at the time of test.

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:

Photographs removed short term confidential.

10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 24 V dc from the adaptor / 110 V ac, 60 Hz, from the mains.

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 and the manufacturer has declared sufficient frequency stability (refer to section 7.4).

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

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

11 Radiated emissions

11.1 Definitions

Out-of-band emissions
Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

Spurious emissions
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.

Restricted bands
A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab 16
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	Swept Frequency
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 kHz to 90 kHz and 110 kHz to 490 kHz: Average, RMS Other frequencies below 30 MHz: Quasi-peak. Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 ºC to +35 ºC (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	

11.3 Test Limit

Radiated emissions below 40 GHz shall not exceed the general field strength limits listed in FCC 47CFR95.3379 (a) (1) {see table below}.

General Field Strength Limits for License-Exempt Transmitters at Frequencies below 30 MHz

Frequency, f (kHz)	*Field Strength*	*Measurement Distance (m)*
9 to 490	2,400 / 377.f (µA/m) 2,400 / f (µV/m)	300
490 to 1,750	24,000 / 377.f (µA/m) 24,000 / f (µV/m)	30
1,750 to 30,000	30 (µV/m)	30

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

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

n.b. per FCC 47CFR15.35(b), peak limit is 20 dB above average.

Radiated emissions outside of the operating band and between 40 GHz and 200 GHz shall not exceed 600pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

Radiated emissions above 200 GHz shall not exceed 1000 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

The spectrum shall be investigated up to 231 GHz.

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, 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. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

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 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 different to limit distance);

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:

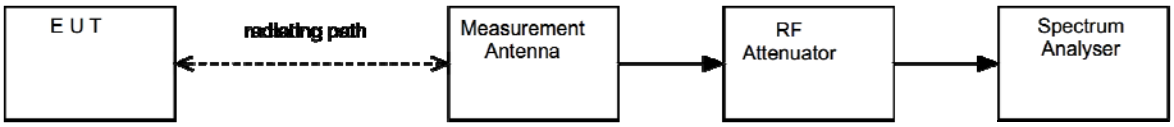
$$FS = PR + CL + AF - PA + DC - CF$$

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 (where used, e.g. harmonics of pulsed fundamental);
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 i Test Setup



11.5 Test Set-up Photograph

Photographs removed short term confidential.

11.6 Test Equipment

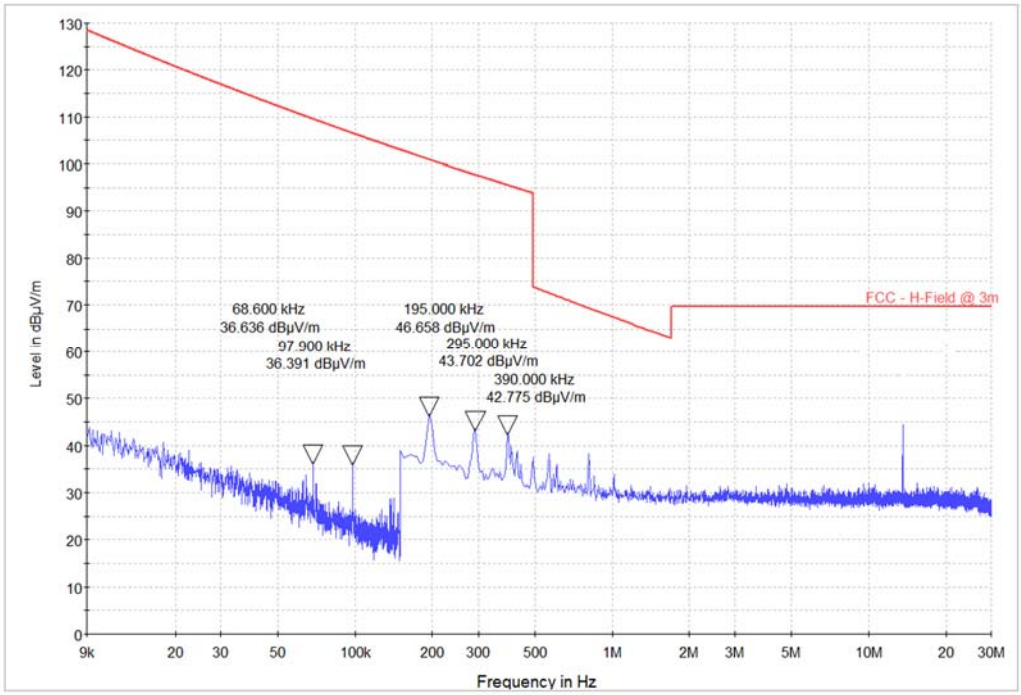
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
L007	hfh2	Loop Antenna	R&S	2018-04-12
U003	ESHS10	Receiver	R&S	2018-08-29
FSU46	R&S	Spectrum Analyser	REF910	2017-07-05
8563A	HP	Spectrum Analyser	L654	2017-12-12
310	Sonoma	Pre-Amp (9kHz – 1GHz)	REF927	2018-06-30
8449B	Agilent	Pre-Amp (1 – 26.5GHz)	REF913	2018-02-02
3109	EMCO	Biconical Antenna	RFG095	2019-05-17
3146	EMCO	Log Periodic Antenna	RFG191	2019-05-17
3115	EMCO	Horn Antenna	RFG129	2018-02-09
	Q-Par	Horn Antenna	RFG629	2017-09-30
2240-25	FM	Standard Gain Horn Antenna	REF820	2018-07-19
11970Q	Agilent	Harmonic Mixer (33-50)	U365	2018-05-05
11970V	Agilent	Harmonic Mixer (50-75)	U366	2018-05-04
11970W	Agilent	Harmonic Mixer (75-110)	U367	2018-05-17

11.7 Test Results

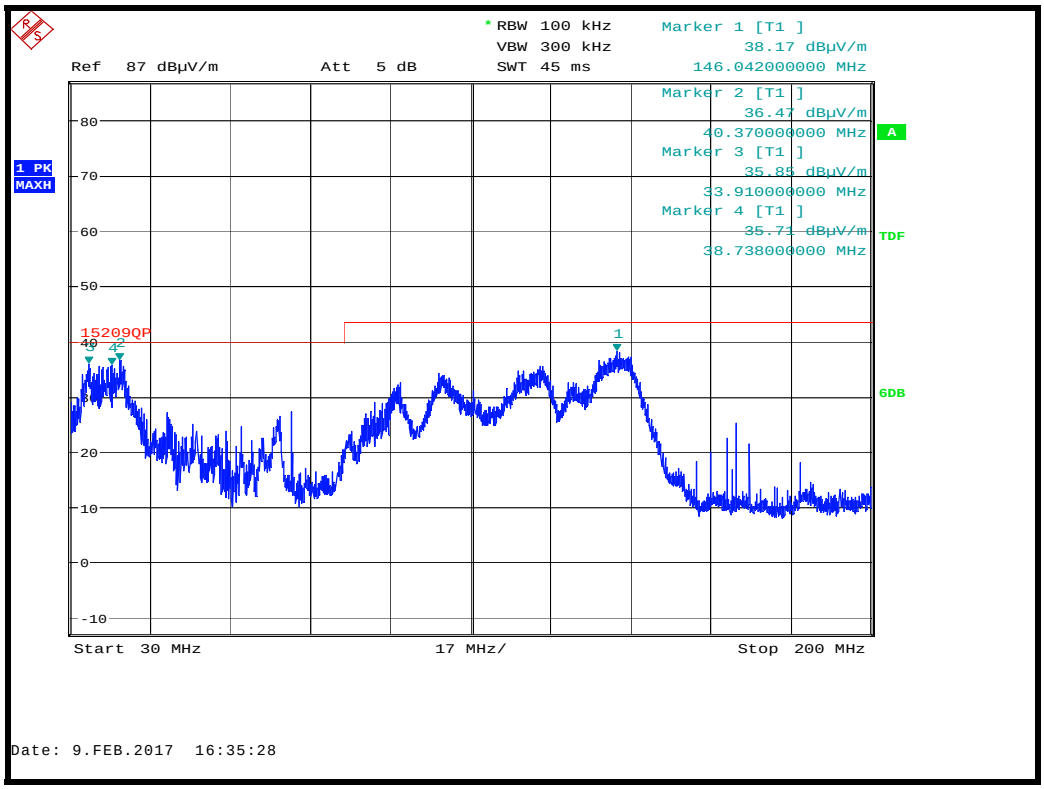
Pre-scan plots showing the emissions profile of the EUT are presented on the following pages.

Plots which show a -9.5 dB offset were performed with the measurement distance reduced to 1m in order to improve the noise floor of the measurement setup.

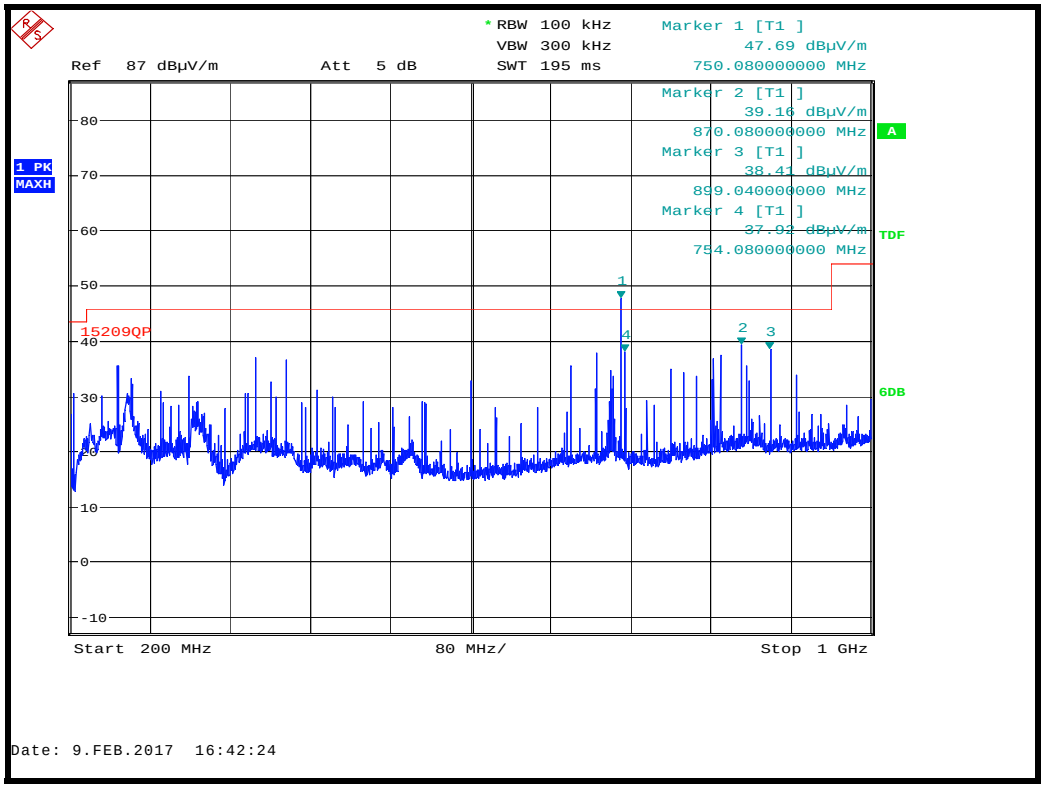
The RBW of the plot for 26.5 to 40 GHz was set to 100 kHz to reduce the noise floor of the measurement setup. No signals were visible above the noise floor. As the purpose of the pre-scans is to identify those frequencies which require formal measurement this was considered sufficient.



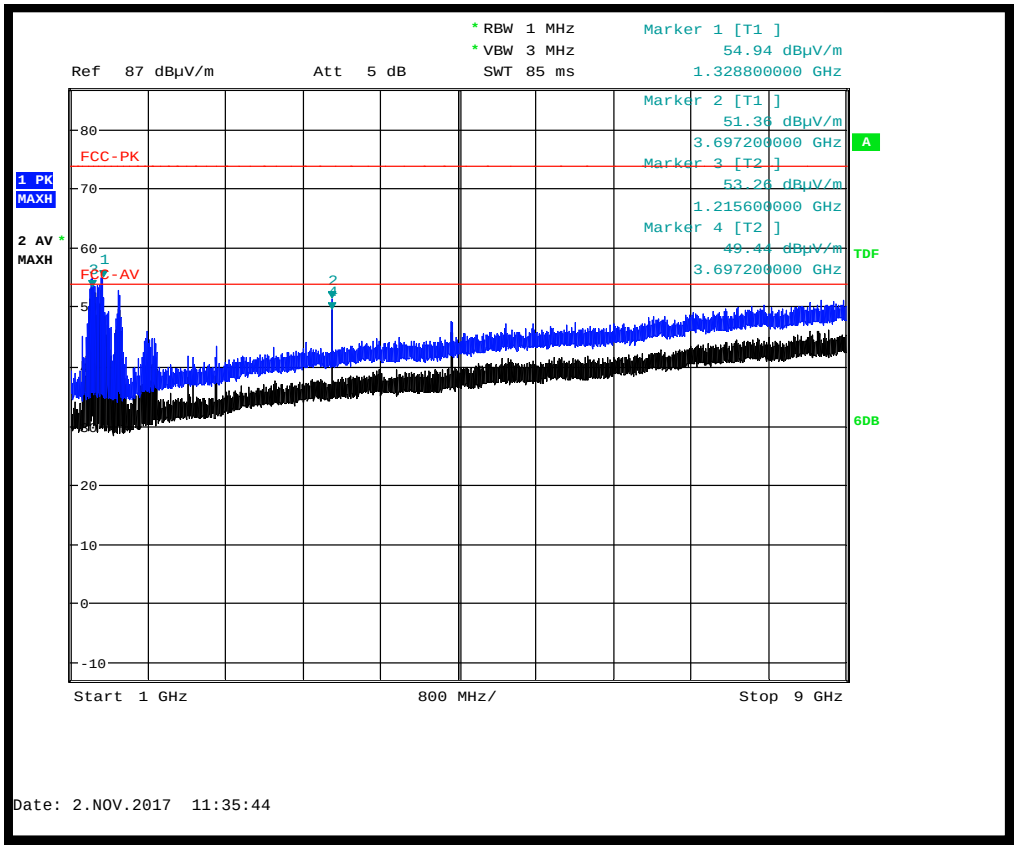
9 kHz -30 MHz



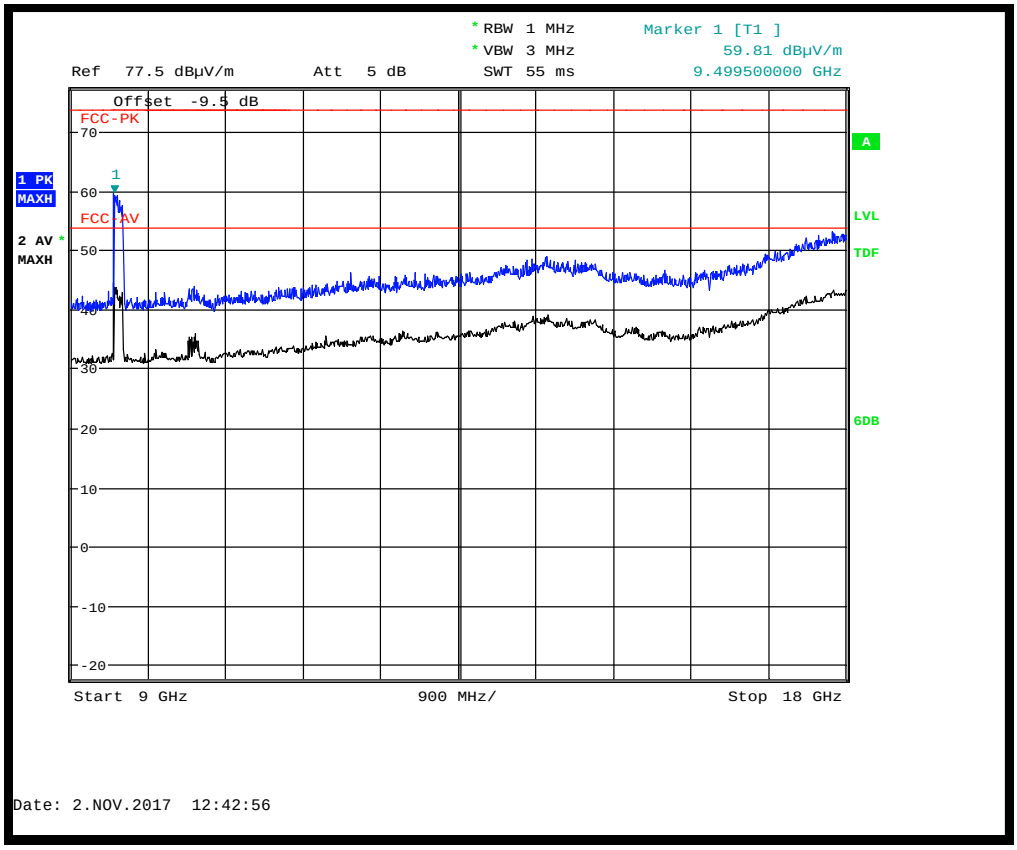
30 – 200 MHz



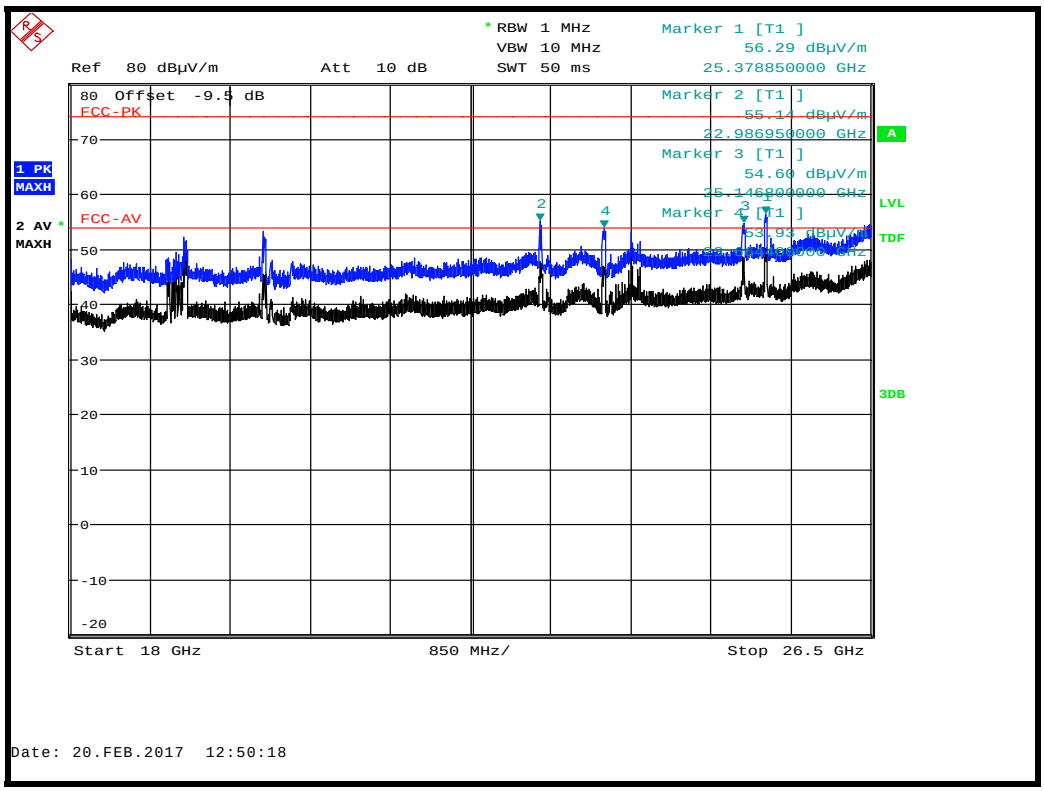
200 – 1000 MHz



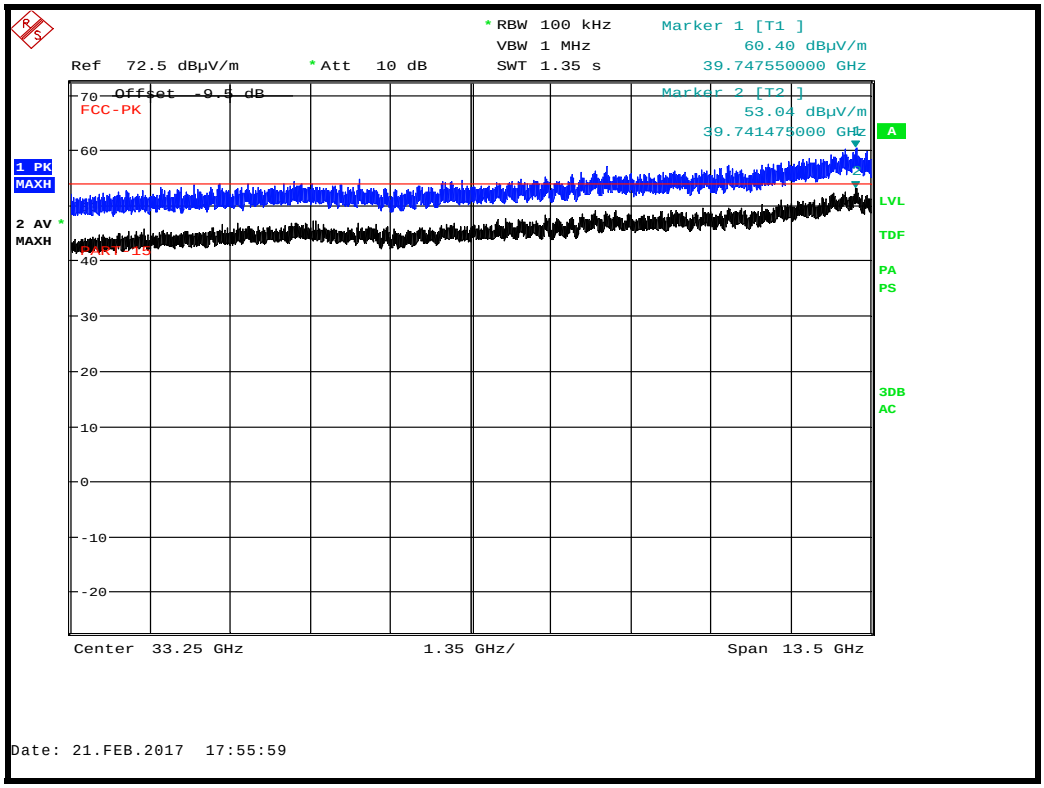
1 – 9 GHz



9 – 18 GHz



18 – 26.5 GHz


RBW 100 kHz
VBW 1 MHz
SWT 1.35 s
Marker 1 [T1]
60.40 dBµV/m
39.747550000 GHz
Marker 2 [T2]
53.04 dBµV/m
39.741475000 GHz
Ref 72.5 dBµV/m
Att 10 dB
Offset -9.5 dB
FCC-PK
1 PK
MAXH
2 AV
MAXH
70
60
40
30
20
10
0
-10
-20
A
LVL
TDF
PA
PS
3DB
AC
Center 33.25 GHz
1.35 GHz/
Span 13.5 GHz
Date: 21.FEB.2017 17:55:59

26.5 – 40 GHz

Frequency Scanning; Antenna Rotating										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
QP	32.31	50.30	0.6	13.8	32.5	0	0	32.2	40.74	100
QP	34.06	49.40	0.6	13.6	32.5	0	0	31.1	35.89	100
QP	38.74	43.20	0.7	13.0	32.5	0	0	24.4	16.60	100
QP	40.00	45.20	0.7	12.8	32.5	0	0	26.2	20.42	100
QP	41.29	45.80	0.7	12.6	32.5	0	0	26.6	21.38	100
QP	43.48	46.80	0.7	12.2	32.5	0	0	27.2	22.91	100
QP	130.86	47.50	1.2	12.5	32.5	0	0	28.7	27.23	150
QP	750.00	53.20	2.9	19.7	32.5	0	0	43.5	149.62	200
QP	754.00	44.40	2.9	19.7	32.5	0	0	34.6	53.70	200
QP	870.00	43.00	3.2	21.9	32.0	0	0	36.1	63.83	200
QP	899.00	45.30	3.2	21.7	31.9	0	0	38.4	83.18	200
Pk	1326.60	62.89	2.6	26.0	35.4	0	0	56.14	641.2	5000
Av	1326.60	32.21	2.6	26.0	35.4	0	0	25.46	18.7	500
Pk	3697.45	54.04	3.8	31.7	35.4	0	0	54.18	511.7	5000
Av	3697.45	51.01	3.8	31.7	35.4	0	0	51.15	361.0	500
Pk	4808.3	57.18	5.5	32.9	35.4	0	0	60.19	1022.12	5000
Av	4808.63	32.90	5.5	32.9	35.4	0	0	35.91	62.45	500
Pk	9518.36	61.22	7.8	37.8	36.1	0	0	70.71	3431.63	5000
Av	9518.36	33.22	7.8	37.8	36.1	0	0	42.71	136.62	500

The EUT radiated spurious emissions were investigated over the frequency range 30 MHz to 110 GHz, no further spurious emissions were detected.

12 AC power-line conducted emissions

12.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab7
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	Swept Frequency
Deviations From Standard:	None
Measurement BW:	See results table
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 ºC to +35 ºC (as declared)
Humidity: 39 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	

12.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	***Conducted limit (dBµV)***	
	Quasi-Peak	***Average****
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.
**A linear average detector is required.

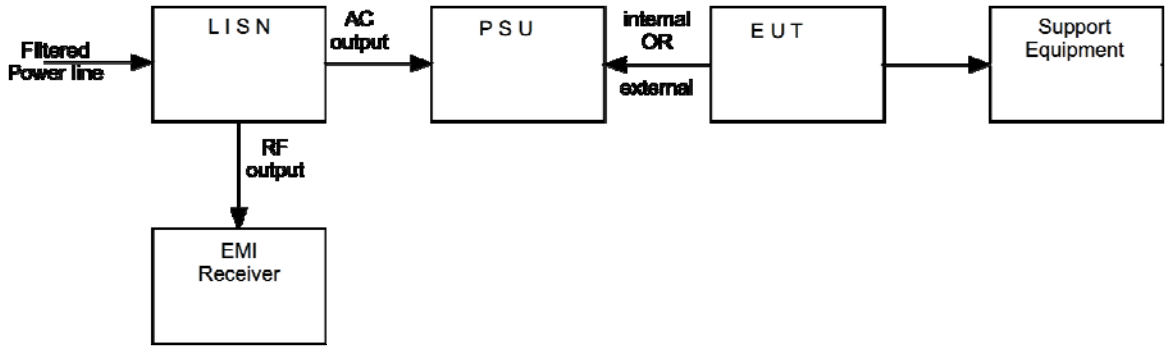
12.4 Test Method

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

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure ii Test Setup



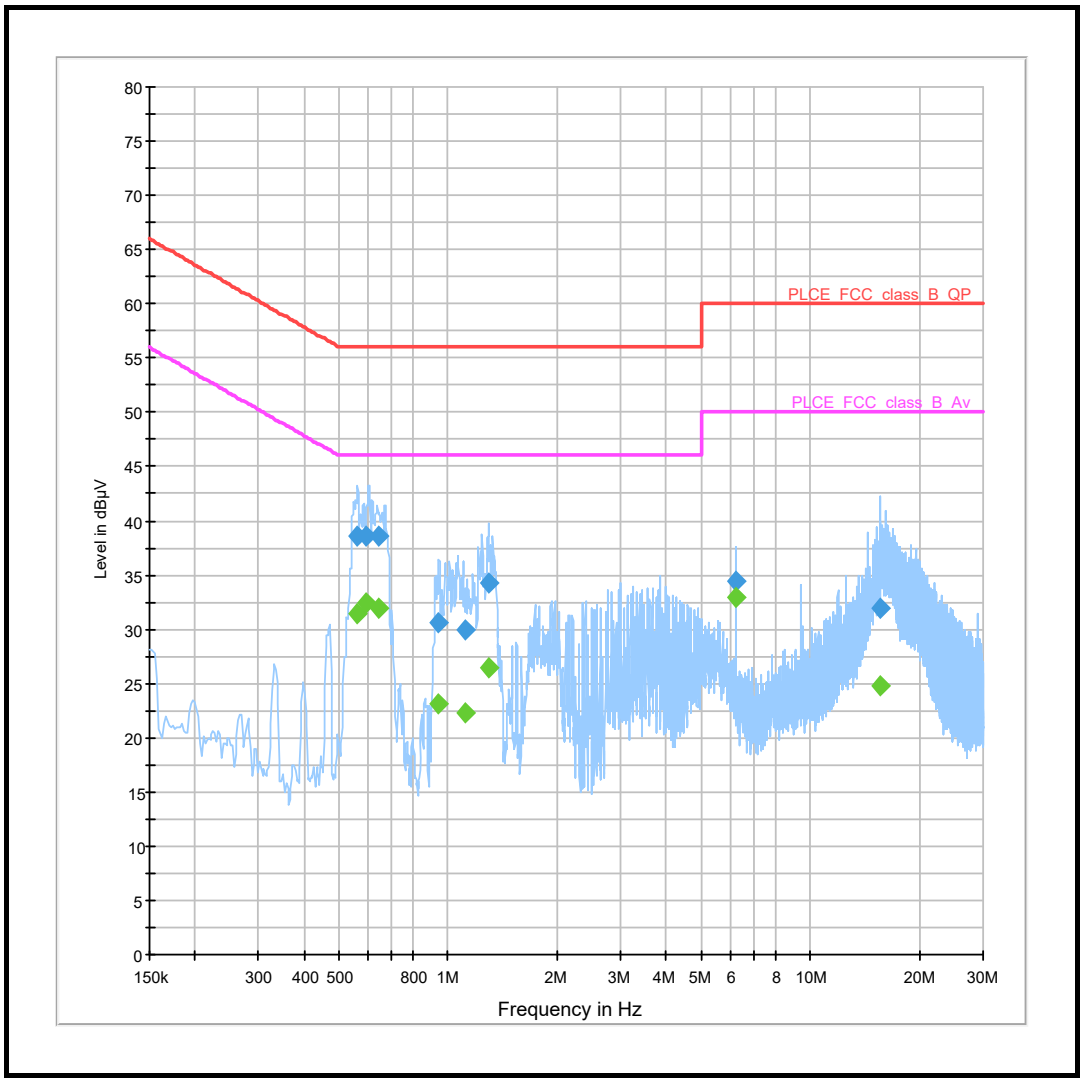
12.5 Test Set-up Photograph

Photographs removed short term confidential.

12.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESCI7	R&S	Measuring Receiver	RFG715	2017-10-06
ESH3-Z2	R&S	Pulse Limiter	RFG680	2017-06-14
ESH3-Z5	R&S	LISN	RFG189	2017-08-02

12.7 Test Results



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.562175	38.6	15000.0	9.000	GND	L1	10.3	17.4	56.0
0.593825	38.6	15000.0	9.000	GND	L1	10.3	17.4	56.0
0.646450	38.6	15000.0	9.000	GND	L1	10.3	17.4	56.0
0.938900	30.5	15000.0	9.000	GND	L1	10.3	25.5	56.0
1.113250	29.9	15000.0	9.000	GND	L1	10.3	26.1	56.0
1.296225	34.3	15000.0	9.000	GND	L1	10.4	21.7	56.0
6.247500	34.5	15000.0	9.000	GND	L1	10.8	25.5	60.0
15.583500	31.9	15000.0	9.000	GND	L1	11.6	28.1	60.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.562175	31.4	15000.0	9.000	GND	L1	10.3	14.6	46.0
0.593825	32.4	15000.0	9.000	GND	L1	10.3	13.6	46.0
0.646450	31.9	15000.0	9.000	GND	L1	10.3	14.1	46.0
0.938900	23.0	15000.0	9.000	GND	L1	10.3	23.0	46.0
1.113250	22.3	15000.0	9.000	GND	L1	10.3	23.7	46.0
1.296225	26.5	15000.0	9.000	GND	L1	10.4	19.5	46.0
6.247500	33.0	15000.0	9.000	GND	L1	10.8	17.0	50.0
15.583500	24.8	15000.0	9.000	GND	L1	11.6	25.2	50.0

13 Occupied Bandwidth

13.1 Definitions

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.

13.2 Test Parameters

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

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 ºC to +35 ºC (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	

13.3 Test Limit

Federal Communications Commission:
§ 2.202 a) *Occupied Bandwidth.* The frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total means power radiated by a given emission.

§ 95.3379 b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification in presented to demonstrate otherwise.

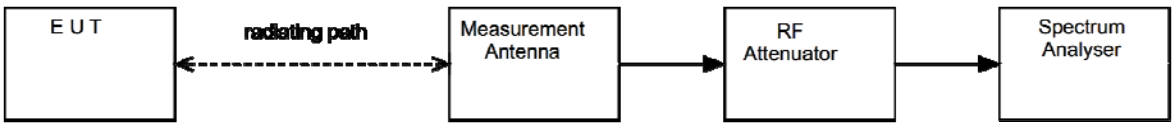
The frequency band covered by § 95.3379 is 76-81 GHz.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, 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 iii Test Setup



13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
8563A	HP	Spectrum Analyser	L654	2017-12-12
11970W	Agilent	Harmonic Mixer (75-110)	U367	2018-05-17

13.6 Test Results

The operating frequency range of the swept signal was measured using the Spectrum Analysers Signal Ident mode and the mixer/antenna combination which was lined up with the EUT's antenna, the EUT was set to transmit swept signals in staring mode (antenna array not rotating).

Measurements were carried out over the temperature range -20˚ to 60˚ Celcius at the client's request (47 CFR95.3379 (b) gives the range -20˚ to 50˚ Celcius).

FCC 15.253 (f). EUT in Swept mode				
Temperature (˚C)	***Voltage***	***F_L (GHz)***	***F_H (GHz)***	***Result***
20	Nominal	76.0537	76.9577	PASS
-20	Low Voltage	76.0530	76.9640	PASS
-20	High Voltage	76.0523	76.9633	PASS
60	Low Voltage	76.0508	76.9615	PASS
60	High Voltage	76.0500	76.9617	PASS

14 Transmitter output power (fundamental radiated emission)

14.1 Definition

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

14.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab 16
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 / 6.6
EUT Channels / Frequencies Measured:	Swept Frequency
Deviations From Standard:	None
Measurement BW:	1 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	3 MHz
Measurement Detector:	Up to 1 GHz: Quasi-peak Above 1 GHz: Average RMS and Peak
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 ºC to +35 ºC (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

The average power of any emission within the bands specified shall not exceed an EIRP of 50dBm.

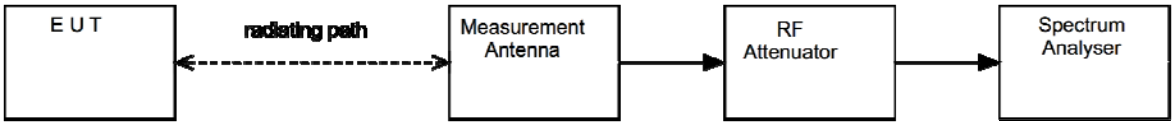
The peak power of any emission within the band 76-77 GHz shall not exceed an EIRP of 55dBm.

14.4 Test Method

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

Figure iv Test Setup



14.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
8563A	HP	Spectrum Analyser	L654	2017-12-12
11970W	Agilent	Harmonic Mixer (75-110)	U367	2018-05-17

14.6 Test Results

Model	*Head*	*Radome*	*Detector*	*Freq. (GHz)*	*Peak EIRP (dBm)*	*Peak Limit (dBm)*	*Average EIRP (dBm)*	*Average Limit (dBm)*
HDR300	Medium Power	No	Peak	76.275	50.8	55	25.3	50
HDR300	Medium Power	Yes	Peak	76.248	50.3	55	24.8	50
HDR300-X	Medium Power	No	Peak	76.250	47.7	55	22.1	50
HDR300-X	Medium Power	Yes	Peak	76.045	47.3	55	21.8	50

Measurements were initially made with the Radome removed to facilitate maximising the signal by lining up the EUT antenna with the measurement antenna.
Measurements were then carried out with the Radome fitted to represent actual conditions of use.

Average measurements for comparison with the average limits were made using the pulsed emissions correction factors from 47 CFR15.35 (c). The pulsed nature of the signal is generated by the rotation of the antenna assembly, the HDR300 series radars have a 1˚ beamwidth which implies a duty cycle of 1˚/360˚ or 0.28%

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] Carrier power

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

[2] Spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**
Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[3] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[4] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[5] Maximum frequency error

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

[6] Duty cycle

Uncertainty in test result = **7.98 %**

16 Appendix A - Declarations

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info@navtechradar.com
www.navtechradar.com

DECLARATION OF SIMILARITY

Date 01/03/2018

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

RE: Declaration of Similarity
FCC ID: S7Y-BD3

To Whom It May Concern:

Please be advised that Navtech Radar Market a number of product variants based on the HDR300 Series. At time of writing these are:

HDR311, SMR311, HDR311-X, SMR311-X,

The difference between the HDR and SMR variants in the internal and external data processing and the format/application the information is presented including different tracking algorithms.

The models HDR3xx and SMR3xx are electronically identical, all RF measurements and test results are exactly the same.

The difference between the models with and without the –X is the antenna. SMR3xx/HDR3xx have a 1°x3° antenna beam shape and the SMR3xx-X/HDR3xx-X has a 1°x25°. The –X models therefore have a lower EIRP measurement than the SMR3xx / HDR3xx.

Thank you for your attention to this matter.

Yours faithfully
Navtech Radar Ltd

R. Poulton

Mr Richard Poulton

TRL 51F050 iss04