

TEST REPORT

ACCORDING TO: FCC 47 CFR PART 15 subpart C, section 15.249

FOR:

Elta Systems Ltd.

Outdoor radar

Model: ELM-2114

P/N 1024Y010-001

FCC ID:XWR2114

This report is in conformity with ISO/ IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested.
This test report shall not be reproduced in any form except in full with the written approval of Hermon Laboratories Ltd.

Table of contents

1	Applicant information	3
2	Equipment under test attributes	3
3	Manufacturer information	3
4	Test details	3
5	Tests summary	4
6	EUT description	5
6.1	General information	5
6.2	Ports and lines	5
6.3	Support and test equipment	5
6.4	Changes made in EUT	5
6.5	Test configuration	6
6.6	Transmitter characteristics	7
7	Transmitter tests according to 47CFR part 15 subpart C requirements	8
7.1	Field strength of emissions	8
7.2	Occupied bandwidth test	37
7.3	Band edge emission	41
7.4	Antenna requirements	45
8	APPENDIX A Test equipment and ancillaries used for tests	46
9	APPENDIX B Measurement uncertainties	48
10	APPENDIX C Test laboratory description	49
11	APPENDIX D Specification references	49
12	APPENDIX E Test equipment correction factors	50
13	APPENDIX F Abbreviations and acronyms	62

1 Applicant information

Client name: Elta Systems Ltd.
Address: 100 Yitzchak Hanasi Blvd., P.O.B. 330, Ashdod, 77102, Israel
Telephone: +972 8857 2333
Fax: +972 8856 3930
E-mail: eliezer.melamed@gmail.com
Contact name: Mr. Eliezer Melamed

2 Equipment under test attributes

Product name: Outdoor radar
Product type: Transceiver
Model(s): ELM-2114
Part number: 1024Y010-001
Serial number: 112
Hardware version: 1024Y010-001C
Software release: Ver.02b
Receipt date 11-Jan-17

3 Manufacturer information

Manufacturer name: Elta Systems Ltd
Address: 100 Yitzchak Hanasi Blvd
Telephone: +972 8857 2333
Fax: +972 8856 3930
E-Mail: eliezer.melamed@gmail.com
Contact name: Mr. Eliezer Melamed

4 Test details

Project ID: 28562
Location: Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel
Test started: 11-Jan-17
Test completed: 12-Jan-17
Test specification(s): FCC 47 CFR Part 15, subpart C, §15.249

5 Tests summary

Test	Status
Transmitter characteristics	
Section 15.249(a)(d), Field strength of emissions	Pass
Section 15.215(c), Occupied bandwidth	Pass
Section 15.249(d), Band edge emissions	Pass
Section 15.207(a), Conducted emission	Not required
Section 15.203, Antenna requirement	Pass

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.
The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mr. K. Zushchuk, test engineer	January 12, 2017	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	January 29, 2017	
Approved by:	Mr. M. Nikishin, EMC and Radio group manager	February 22, 2017	

6 EUT description

6.1 General information

The EUT, model name ELM-2114, is a solid state, linear frequency modulation continuous wave (LFMCW) Radar operating in ISM K-frequency band.

The ELM-2114 radar uses concurrent multiple beams in azimuth to create a broad field of view (90°), thereby avoiding the need for mechanical or electronic scanning to cover the area of interest. The radar uses signal-to-signal integration to achieve an effective signal-to-noise ratio. To cover higher azimuth angles (360°/270°/180°), additional units (4/3/2) can be installed or the Radar can be mounted on a positioner.

6.2 Ports and lines

Port type	Port description	Connected from	Connected to	Qty.	Cable type	Cable length	Indoor / outdoor
Telecom & power	Ethernet & 48VDC	EUT	PoE adapter	1	FTP	3.5 m*	Outdoor

* Always shorter than 90 m.

6.3 Support and test equipment

Description	Manufacturer	Model number	Serial number
PoE adapter	PLANET	POE-163(V2)	AF 00415A00487
PC	HP	CompaqElite 8300 Microtower	TRF4070872
Monitor	NEC	MultiSync LCD2090UXi	87158962YA

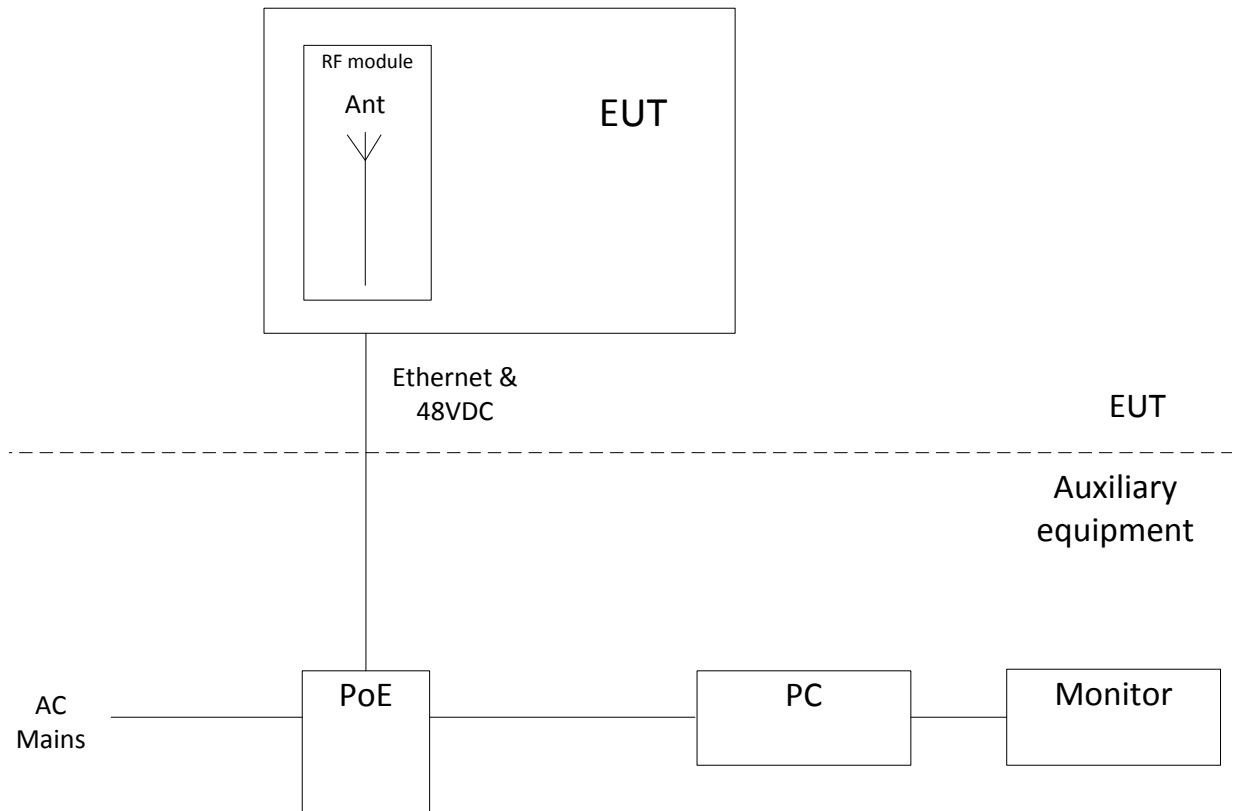
6.4 Changes made in EUT

To withstand the standard requirements, the following changes were made in the EUT during the testing.

Two capacitors C549 & C548 were removed.

It is manufacturer responsibility to implement the changes in the production version of the EUT. In any case the test report applies to the tested item only.

6.5 Test configuration





6.6 Transmitter characteristics

Type of equipment					
V	Stand-alone (Equipment with or without its own control provisions)				
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)				
	Plug-in card (Equipment intended for a variety of host systems)				
Assigned frequency range		24000 – 24250 MHz			
Operating frequency range		24100 – 24232MHz			
Maximum field strength of carrier		Peak 115.73 dBµV/m, average 106.65 dBµV/m at 3 m distance			
Is transmitter output power variable?		V	No		
			Yes	continuous variable	
				stepped variable with stepsize	
				minimum RF power	dBm
				maximum RF power	dBm
Antenna connection					
unique coupling		standard connector		V	Integral
				V	with temporary RF connector without temporary RF connector
Antenna/s technical characteristics					
Type		Manufacturer		Model number	
Integral		InnoSent		DBF-102	
Type of modulation		LFMCW			
Modulating test signal (baseband)		PRBS			
Transmitter power source					
	Battery	Nominal rated voltage		Battery type	
V	DC	Nominal rated voltage		48 VDC via PoE	
	AC mains	Nominal rated voltage		Frequency	Hz

Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C requirements

7.1 Field strength of emissions

7.1.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.1.1, Table 7.1.2 and Table 7.1.3, Table 7.1.4.

Table 7.1.1 Radiated fundamental emission limits

Fundamental frequency, MHz	Field strength at 3 m, dB(μV/m)		
	Peak	Average	Quasi-Peak
24000 – 24250	128.0	108.0	NA

Table 7.1.2 Harmonics limits

Fundamental frequency, MHz	Field strength at 3 m, dB(μV/m)	
	Peak	Average
24000 – 24250	88.0	68.0

Table 7.1.3 Radiated spurious emissions limits (other than harmonics)

Frequency, MHz	Field strength at 3 m, dB(μV/m)*			
	Peak	Quasi Peak	Average	Attenuation below carrier
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	50 dBc (whichever is the less stringent)
0.090 – 0.110	NA	108.5 – 106.8**	NA	
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**	
0.490 – 1.705	NA	73.8 – 63.0**	NA	
1.705 – 30.0*		69.5		
30 – 88		40.0		
88 – 216		43.5		
216 – 960		46.0		
960 - 1000		54.0		
Above 1000	74.0	NA	54.0	

*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$\text{Lim}_{S_2} = \text{Lim}_{S_1} + 20 \log (S_1/S_2),$$

where S_1 and S_2 – standard defined and test distance respectively in meters.

** - The limit decreases linearly with the logarithm of frequency.

Note: The above field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency but not exceeding 40 GHz for intentional radiators operated below 10 GHz and up to the fifth harmonic of the highest fundamental frequency but not exceeding 100 GHz for intentional radiators operated above 10 GHz.



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Table 7.1.4 Radiated spurious emissions limits (other than harmonics)

Frequency, GHz	Distance, m	Field strength dB(μV/m)*, peak	Field strength dB(μV/m)*, average
40 - 60	0.50	89.56*	69.56*
60 - 75	0.10	103.54*	83.54*
75 - 100	0.03	114.00*	94.00*

*- The limit for other test distance was calculated using the inverse distance extrapolation factor as follows:

$$\text{LimS2} = \text{LimS1} + 20 \log (S1/S2),$$

where S1 and S2 – standard defined and test distance respectively in meters.

Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

7.1.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and the performance check was conducted.

7.1.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.1.2.3 The worst test results (the lowest margins) were recorded in the associated tables and shown in the associated plots.

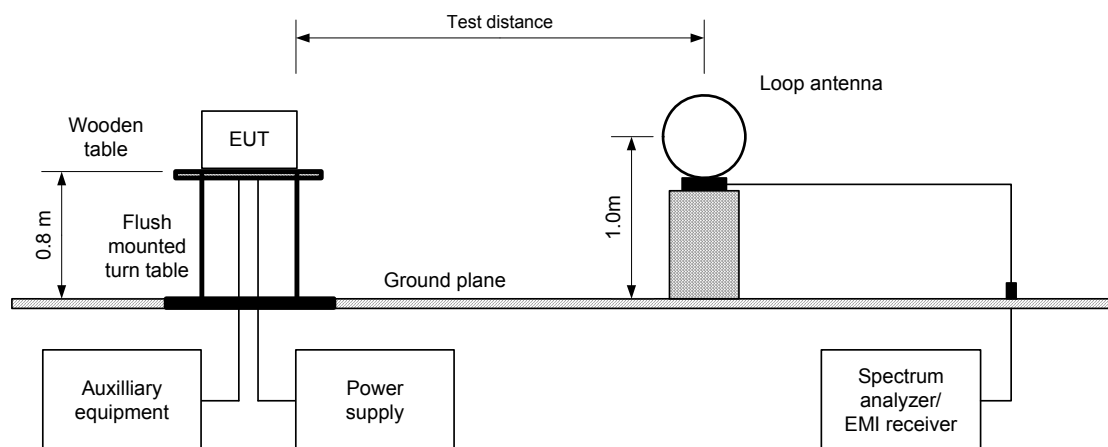
7.1.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.1.3.1 The EUT was set up as shown in Figure 7.1.2, Figure 7.1.3, energized and the performance check was conducted.

7.1.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

7.1.3.3 The worst test results (the lowest margins) were recorded in the associated tables and shown in the associated plots.

Figure 7.1.1 Setup for spurious emission field strength measurements below 30 MHz



Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Figure 7.1.2 Setup for spurious emission field strength measurements in 30 -1000 MHz

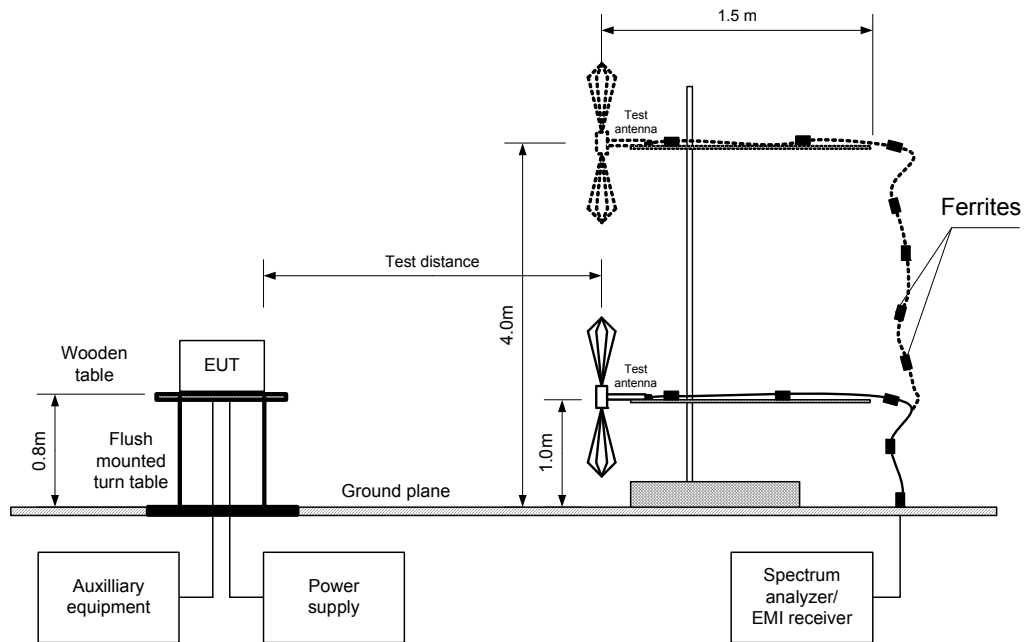
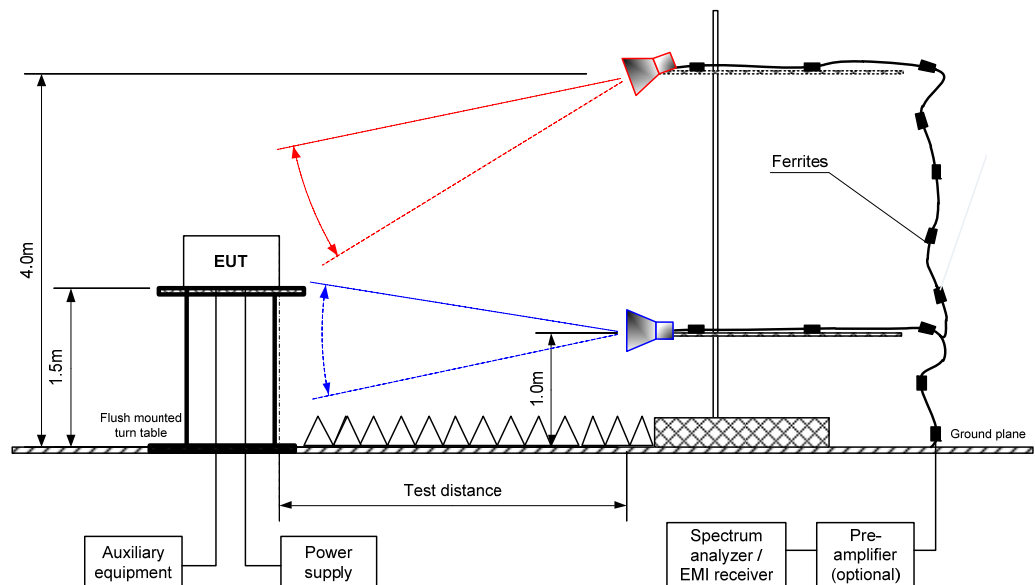


Figure 7.1.3 Setup for spurious emission field strength measurements above 1000 MHz





HERMON LABORATORIES

Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Table 7.1.5 Field strength of fundamental emission and spurious emissions

TEST DISTANCE:	3 m
EUT POSITION:	Vertical (typical)
MODULATION:	FMCW
INVESTIGATED FREQUENCY RANGE:	0.009 MHz – 100GHz
DETECTOR USED:	Peak
RESOLUTION BANDWIDTH:	1.0 kHz (9 kHz – 150 kHz) 9.0 kHz (150 kHz – 30 MHz) 120 kHz (30 MHz – 1000 MHz) 1.0 MHz (above 1000 MHz)
VIDEO BANDWIDTH:	≥ Resolution bandwidth
TEST ANTENNA TYPE:	Active loop (9 kHz – 30 MHz) Log periodic (200 MHz – 1000 MHz) Biconilog (30 MHz – 1000 MHz) Double ridged guide (above 1000 MHz)

F, MHz	Antenna		Azimuth, degrees*	Peak field strength			Avr factor, dB	Average field strength			Verdict
	Pol.	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
Fundamental emission											
24100.4	V	1.7	30	112.68	128.00	-15.32	NA	104.14	108.00	-3.86	Pass
24161.2	V	1.7	30	115.73	128.00	-12.27	NA	106.65	108.00	-1.35	
24232.0	V	1.6	30	113.06	128.00	-14.94	NA	104.80	108.00	-3.20	
Spurious emissions											
22590.0	V	1.7	30	48.90	74.00	-25.10	NA	42.50	54.00	-11.50	Pass
22655.3	V	1.7	30	50.10	74.00	-23.90	NA	42.30	54.00	-11.70	
22717.4	V	1.8	30	55.20	74.00	-18.80	NA	45.60	54.00	-8.40	
25596.8	V	1.7	30	49.70	74.00	-24.30	NA	42.40	54.00	-11.60	
25658.0	V	1.7	30	52.80	74.00	-21.20	NA	40.80	54.00	-13.20	

*- EUT front panel refers to 0 degrees position of turntable.

** - Margin, dB = Measured (calculated) value, dB(μV/m) - Limit, dB(μV/m).

Table 7.1.6 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
NA	NA	NA	NA	NA	NA

*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left(\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{\text{Train duration}} \times \text{Number of bursts within pulse train} \right)$$

for pulse train longer than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left(\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{100 \text{ ms}} \times \text{Number of bursts within 100 ms} \right)$$

Reference numbers of test equipment used

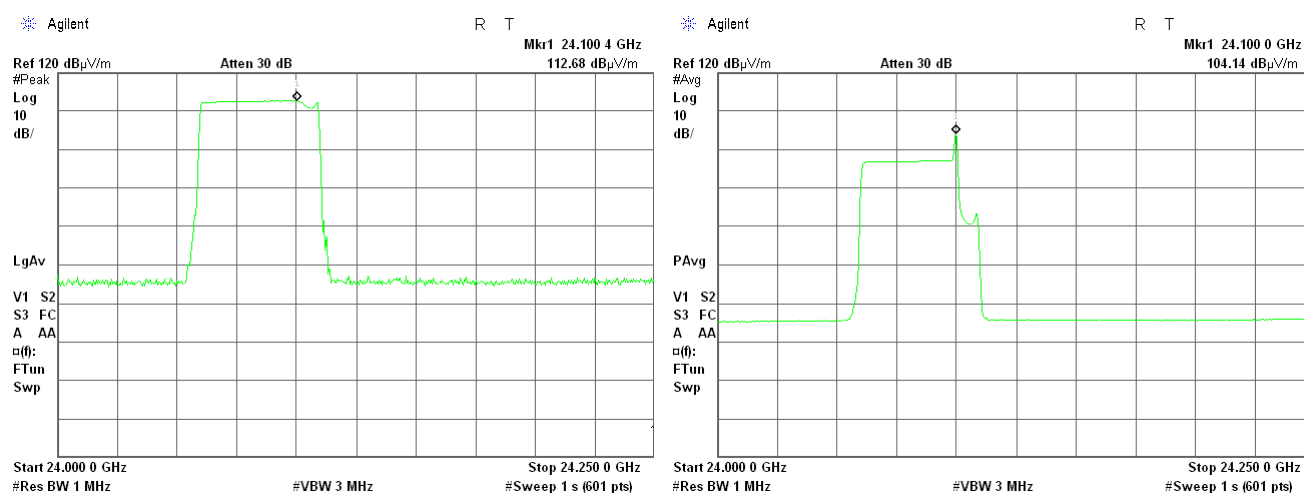
HL 0446	HL 0521	HL 0604	HL 0770	HL 0771	HL 0772	HL 1301	HL 1984
HL 2909	HL 3235	HL 3294	HL 3305	HL 3306	HL 3433	HL 3434	HL 3818
HL 3901	HL 4353	HL 4932	HL 5101	HL 5107	HL 5110		

Full description is given in Appendix A.

Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

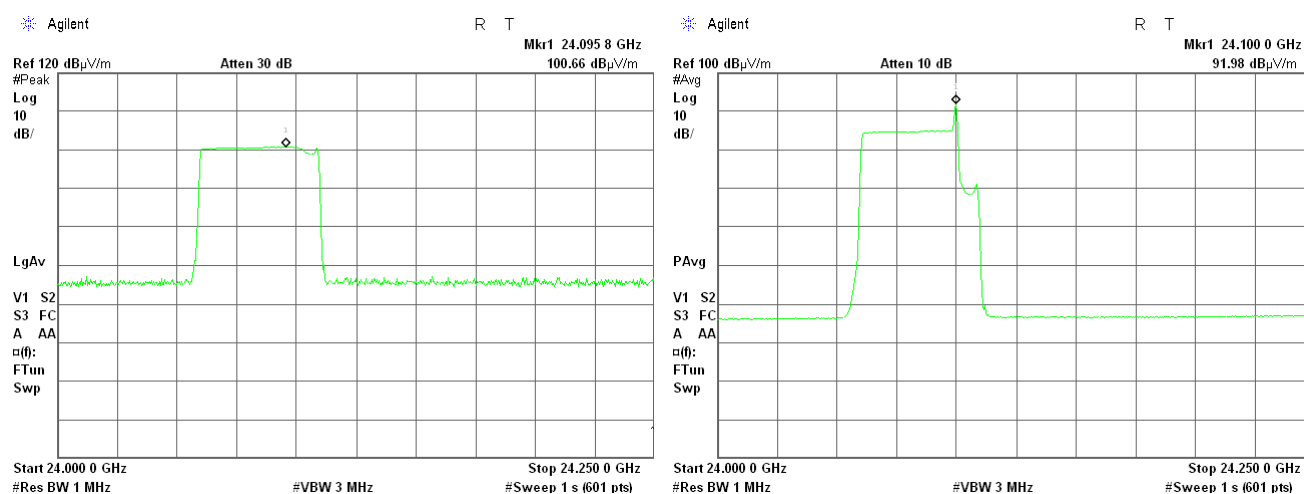
Plot 7.1.1 Radiated emission measurements at the low fundamental frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Plot 7.1.2 Radiated emission measurements at the low fundamental frequency

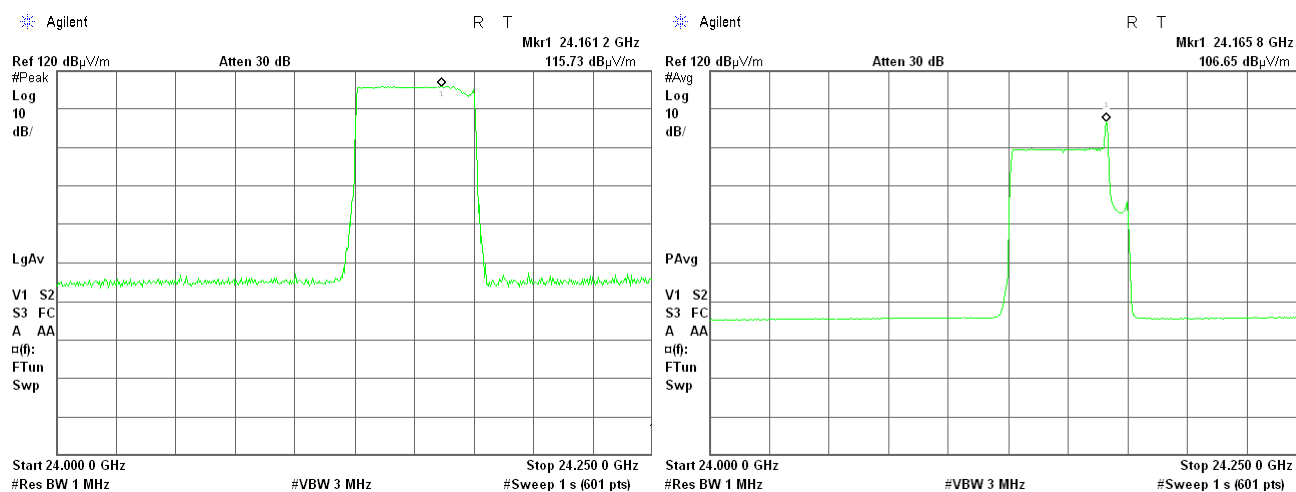
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

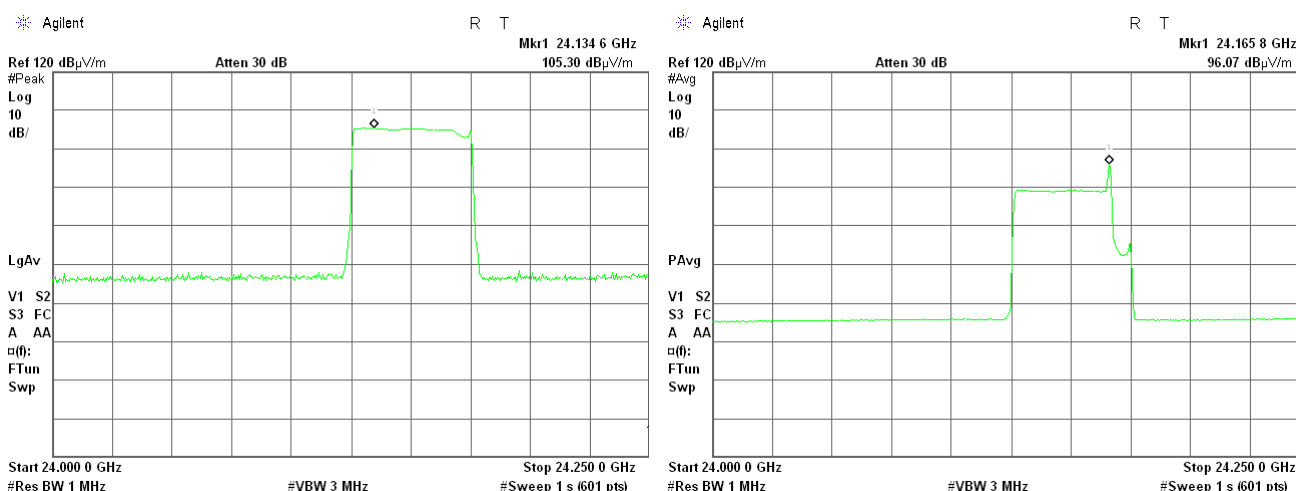
Plot 7.1.3 Radiated emission measurements at the mid fundamental frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Plot 7.1.4 Radiated emission measurements at the mid fundamental frequency

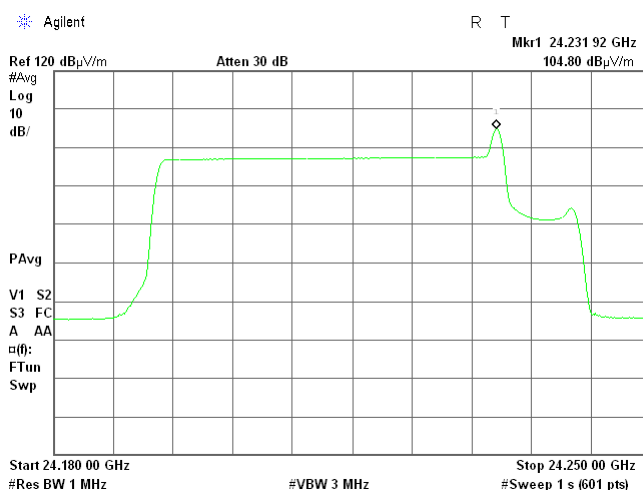
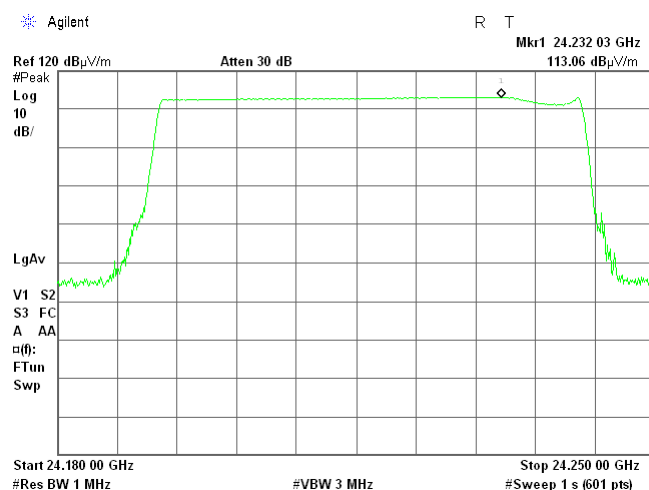
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

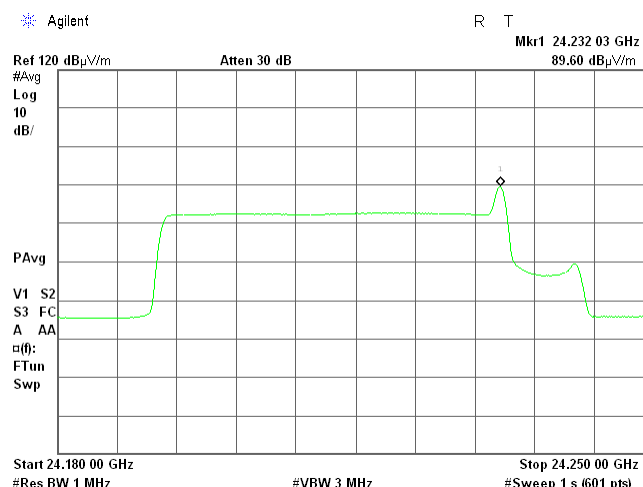
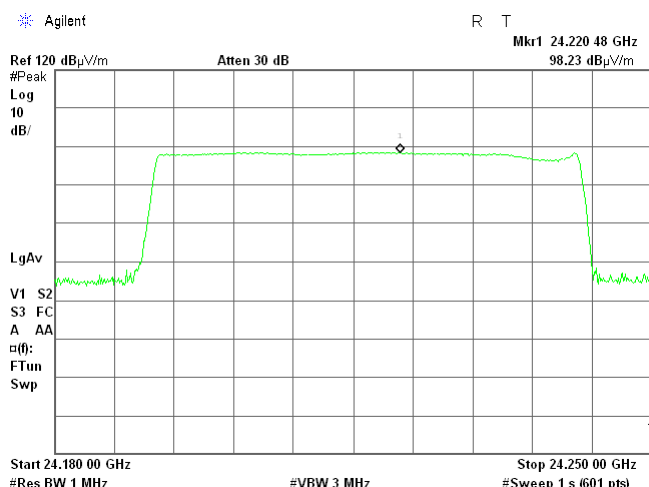
Plot 7.1.5 Radiated emission measurements at the high fundamental frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Plot 7.1.6 Radiated emission measurements at the high fundamental frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)





HERMON LABORATORIES

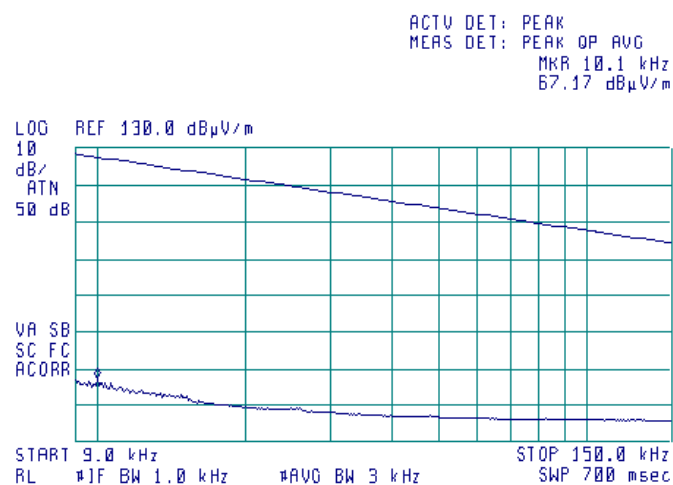
Report ID: ELTRAD_FCC.28562.docx

Date of Issue: 22-Feb-17

Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

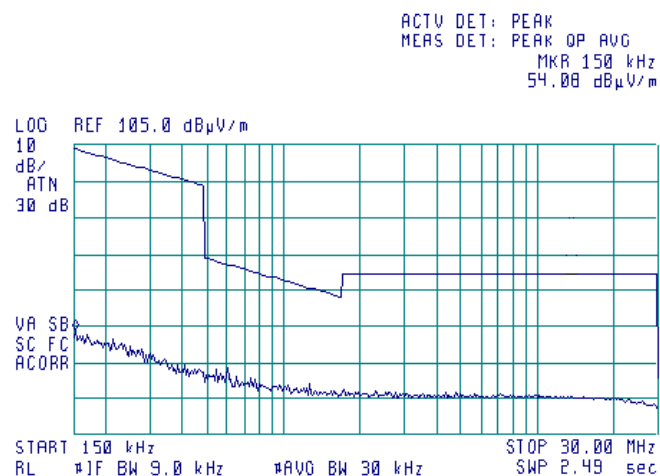
Plot 7.1.7 Radiated emission measurements from 9 to 150 kHz at low, mid, high frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)



Plot 7.1.8 Radiated emission measurements from 0.15 to 30 MHz at low, mid, high frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)



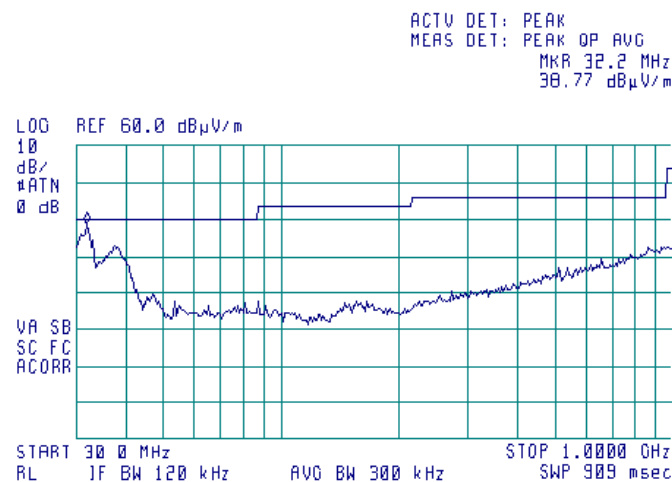


HERMON LABORATORIES

Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

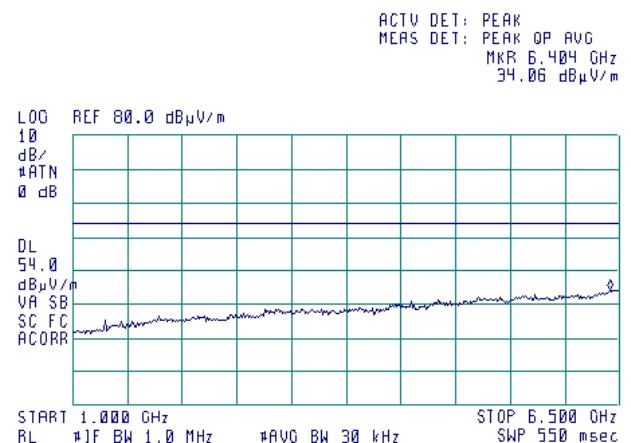
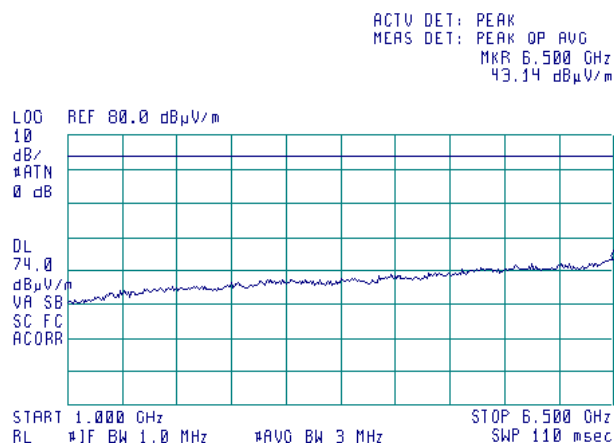
Plot 7.1.9 Radiated emission measurements from 30 to 1000 MHz at low, mid, high frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.10 Radiated emission measurements from 1.0 to 6.5 MHz at low, mid, high frequency

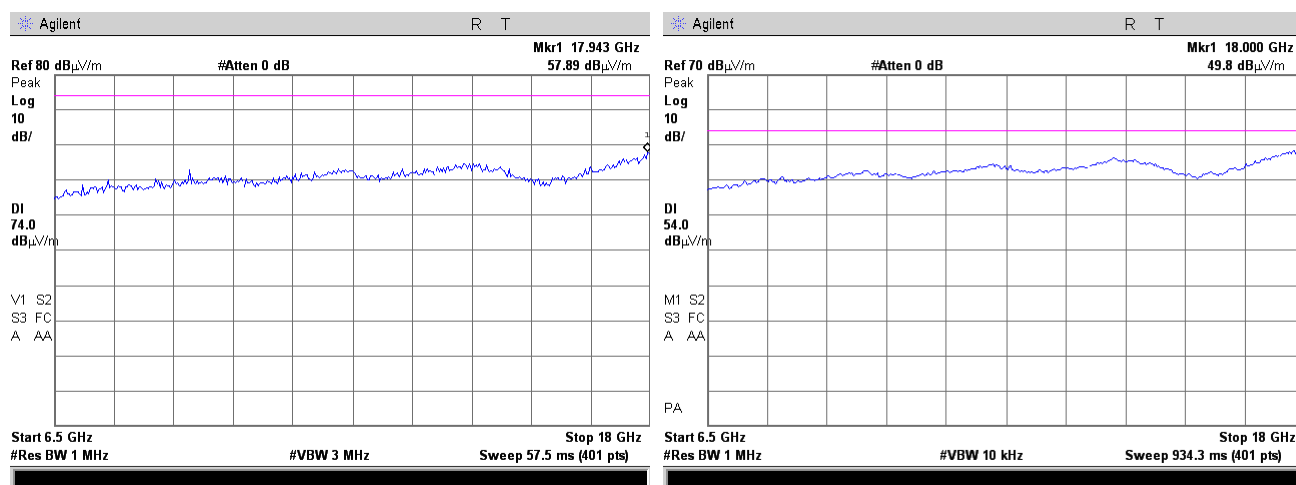
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.11 Radiated emission measurements from 6.5 to 18.0 GHz at low, mid, high frequency

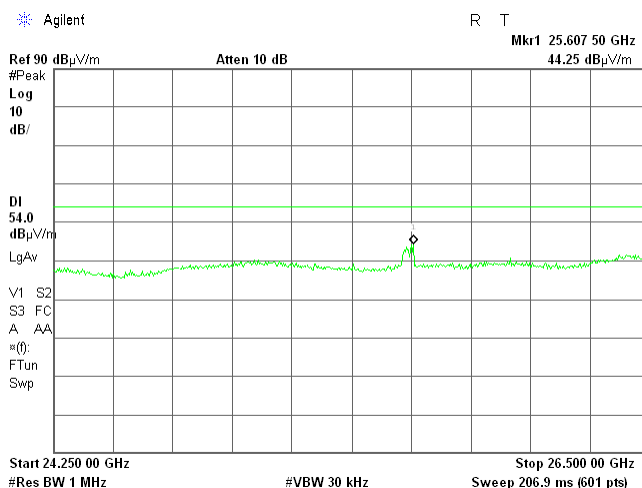
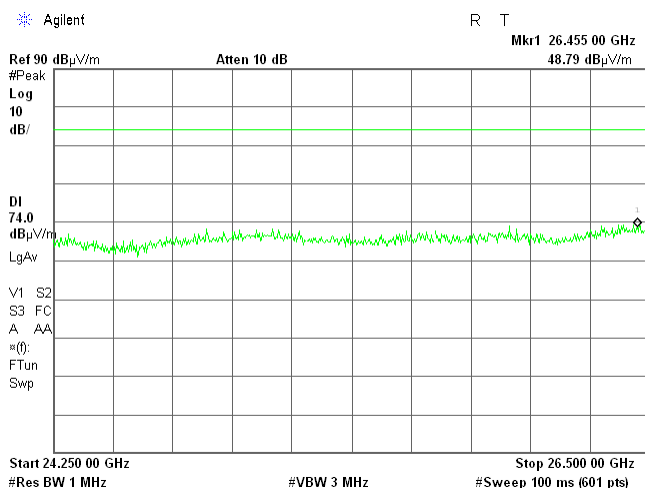
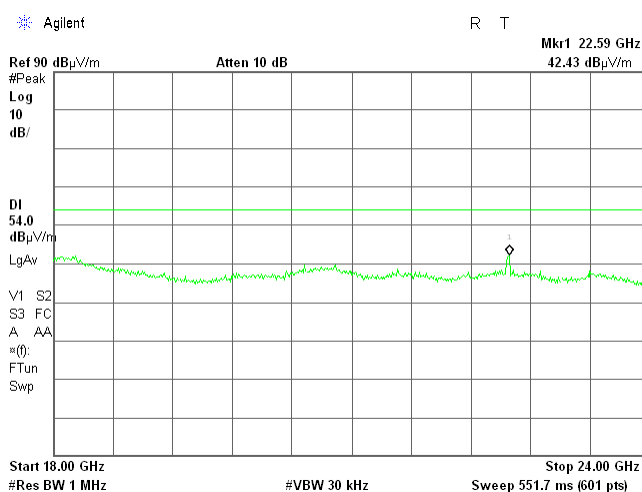
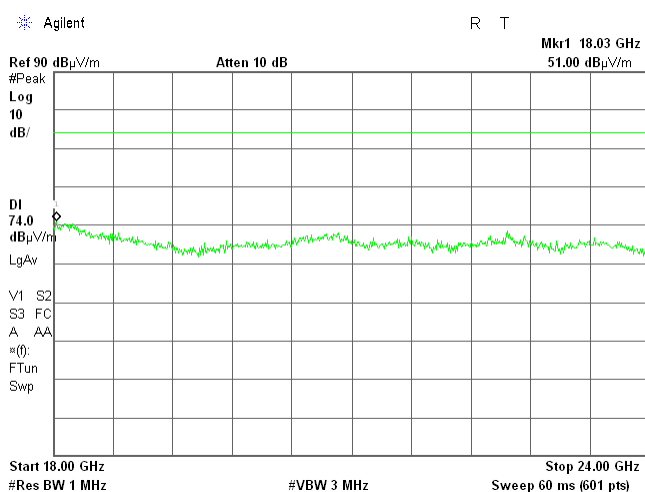
TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.12 Radiated emission measurements from 18.0 to 26.5 GHz at low frequency

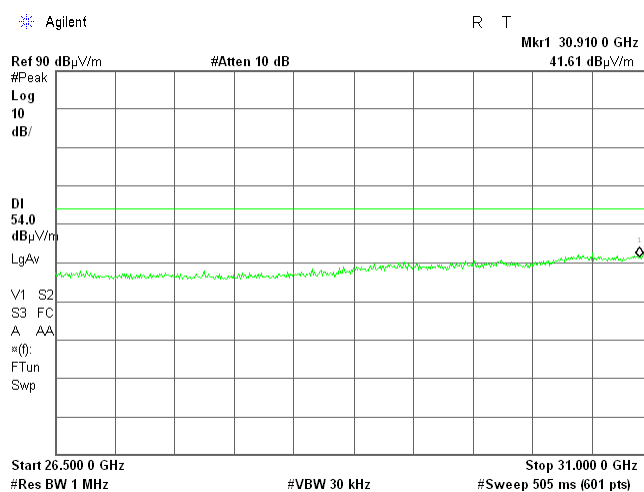
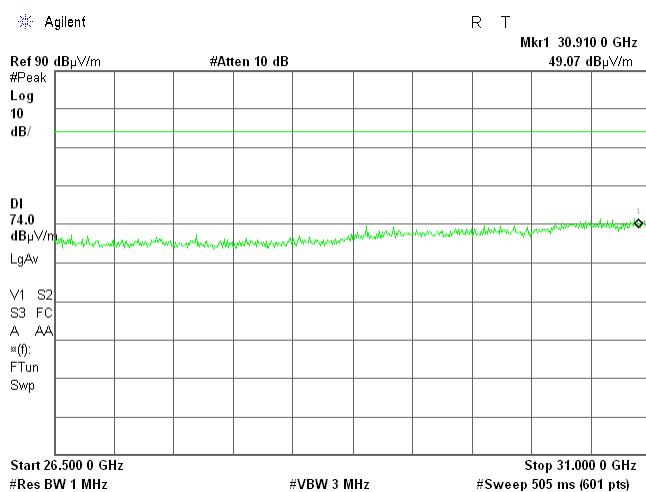
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.13 Radiated emission measurements from 26.5 to 31.0 GHz at low frequency

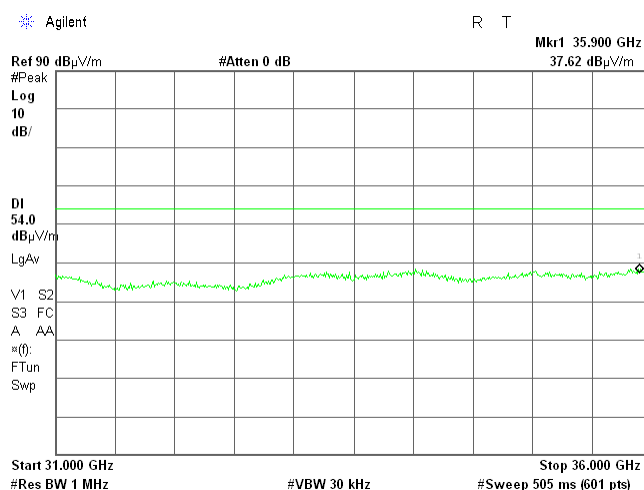
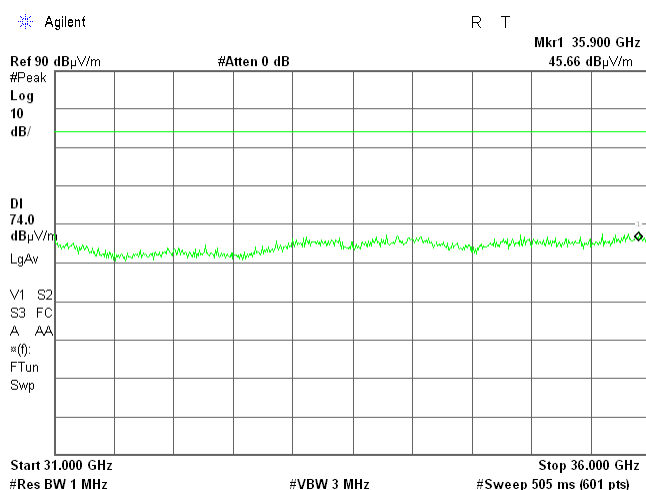
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

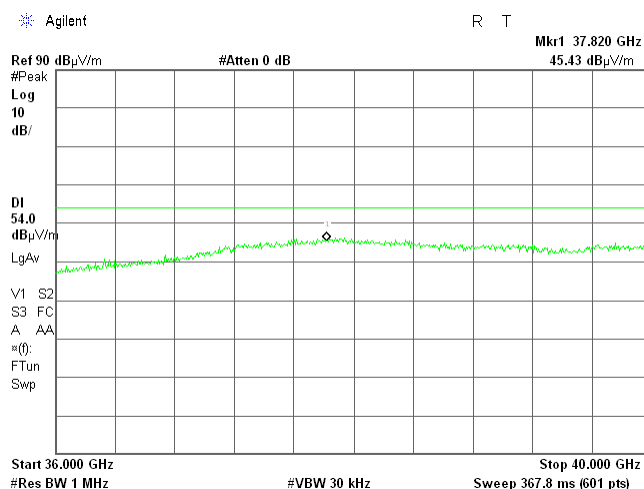
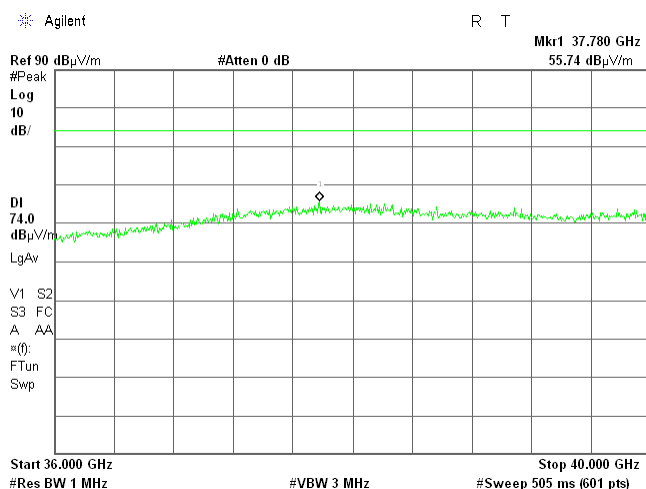
Plot 7.1.14 Radiated emission measurements from 31.0 to 36.0 GHz at low frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.15 Radiated emission measurements from 36.0 to 40.0 GHz at low frequency

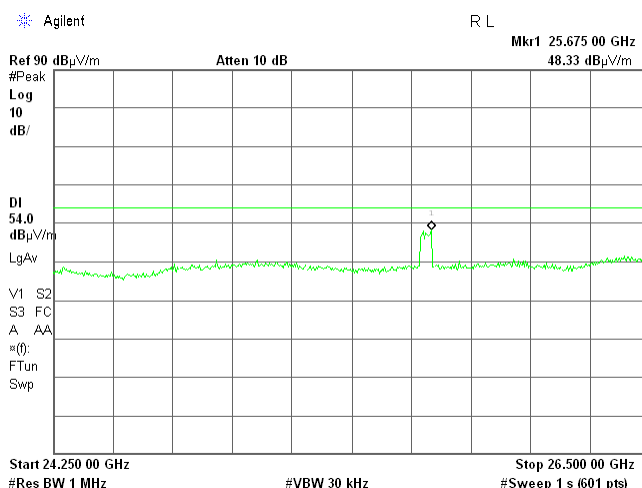
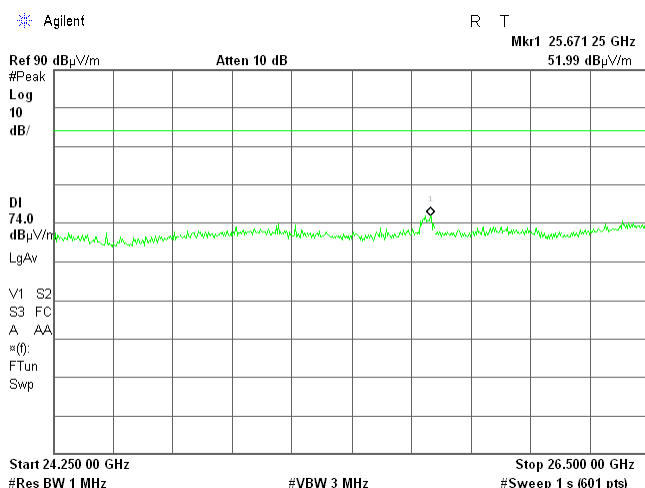
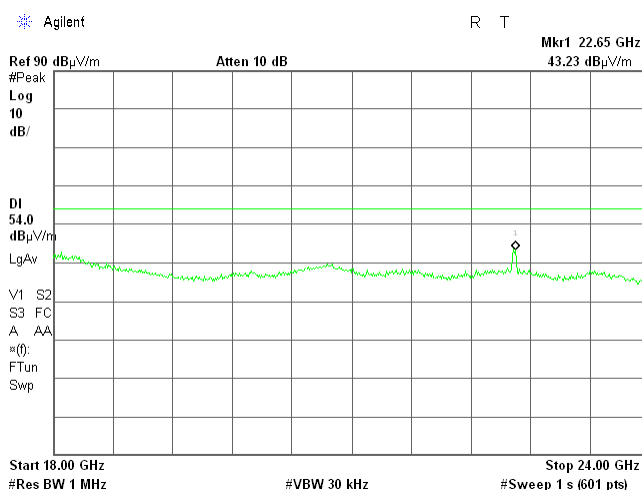
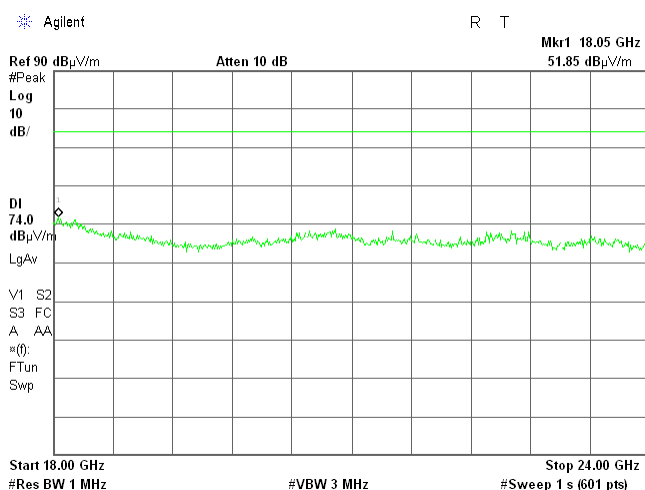
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.16 Radiated emission measurements from 18.0 to 26.5 GHz at mid frequency

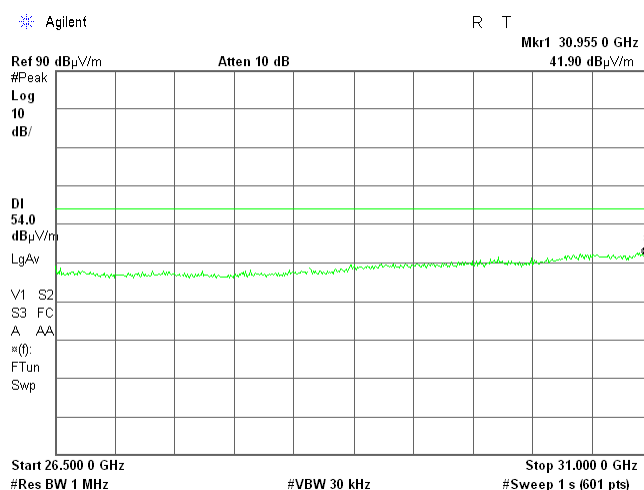
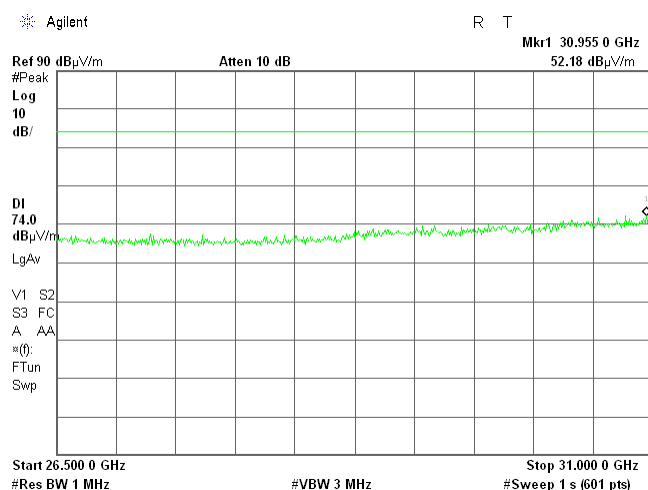
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

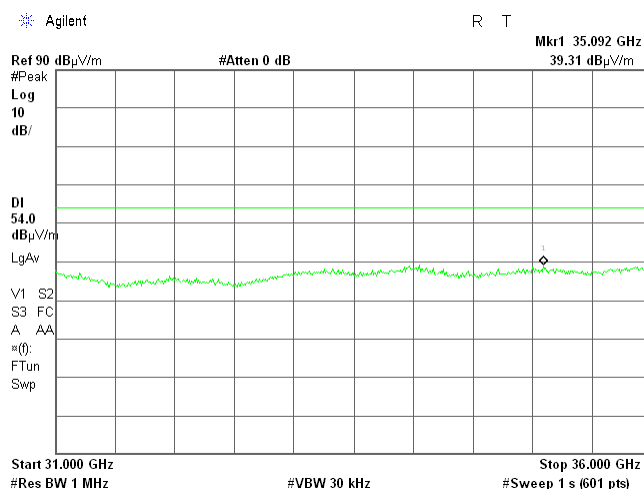
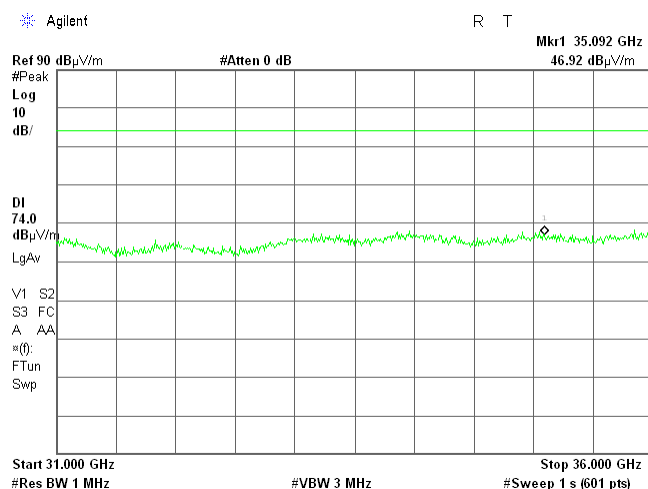
Plot 7.1.17 Radiated emission measurements from 26.5 to 31.0 GHz at mid frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.18 Radiated emission measurements from 31.0 to 36.0 GHz at mid frequency

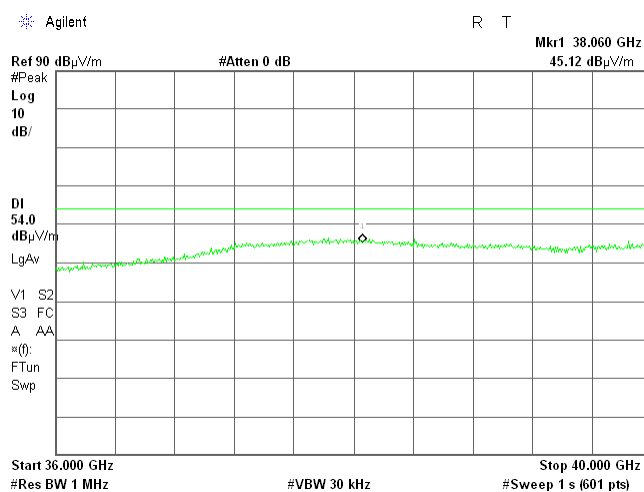
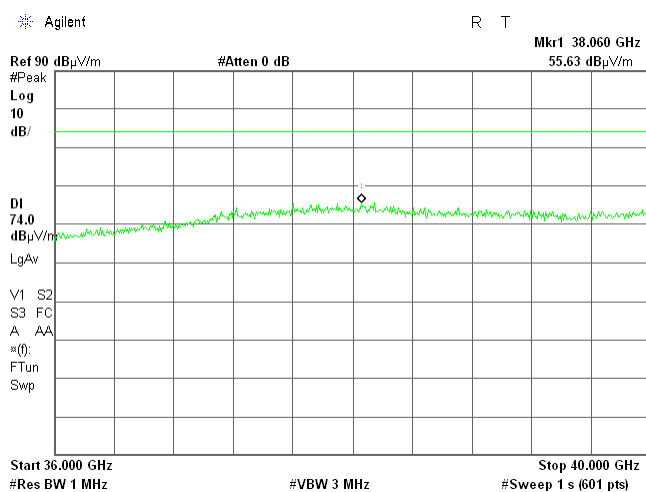
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.19 Radiated emission measurements from 36.0 to 40.0 GHz at mid frequency

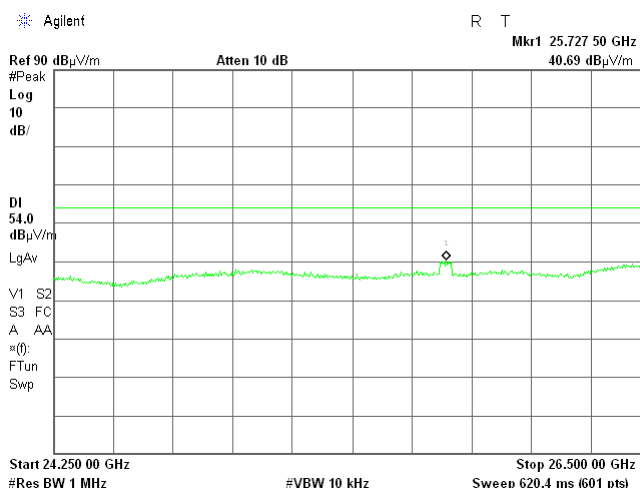
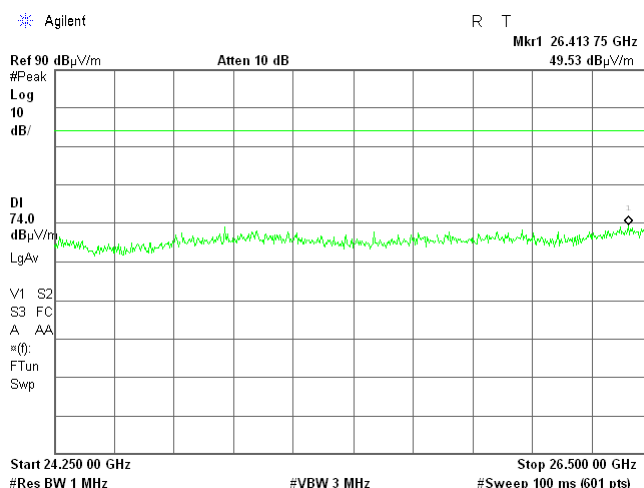
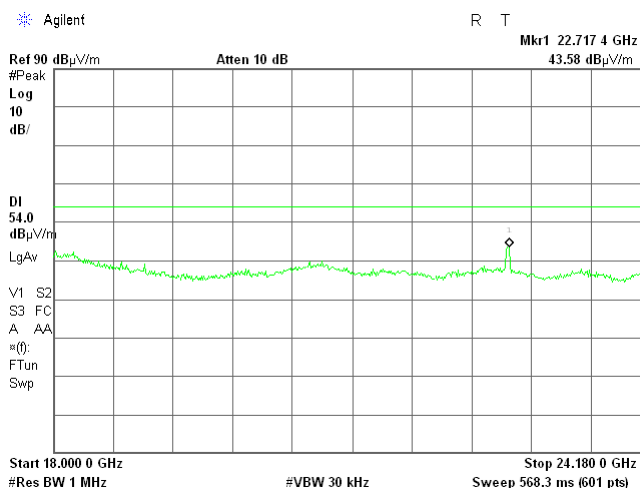
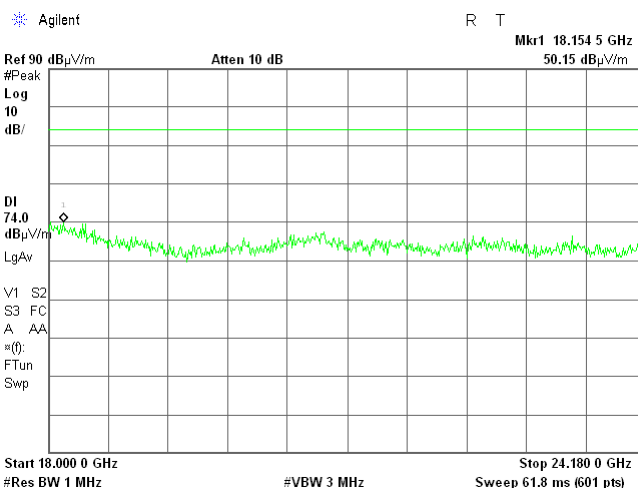
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.20 Radiated emission measurements from 18.0 to 26.5 GHz at high frequency

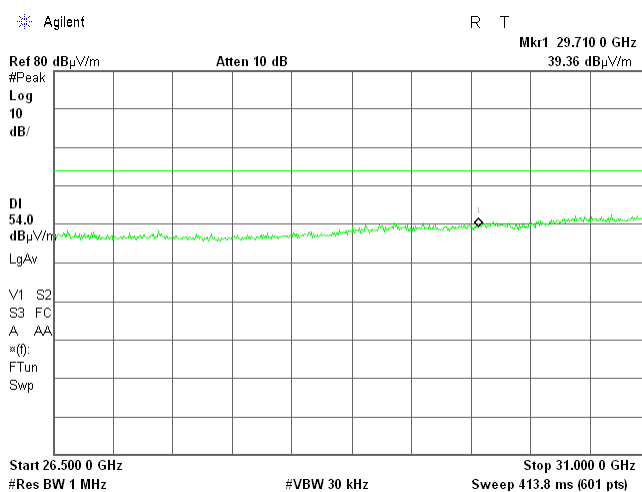
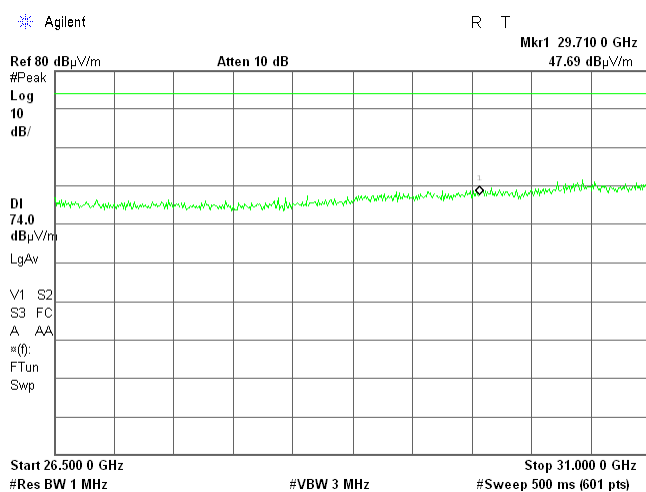
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

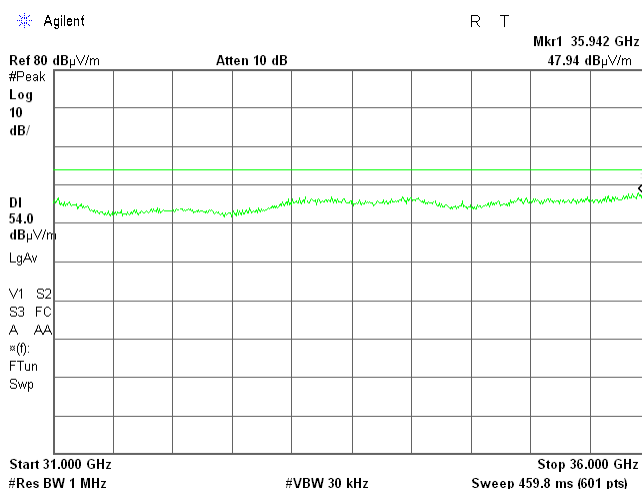
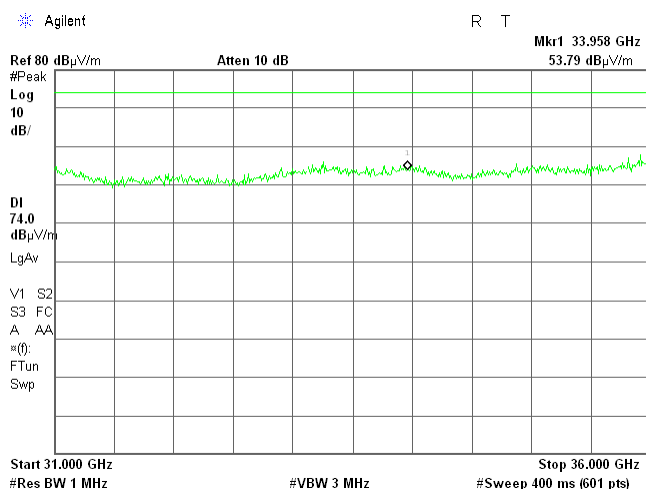
Plot 7.1.21 Radiated emission measurements from 26.5 to 31.0 GHz

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.22 Radiated emission measurements from 31.0 to 36.0 GHz

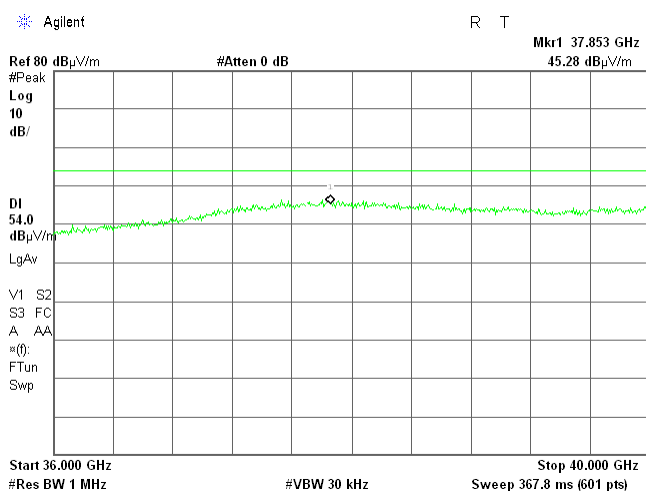
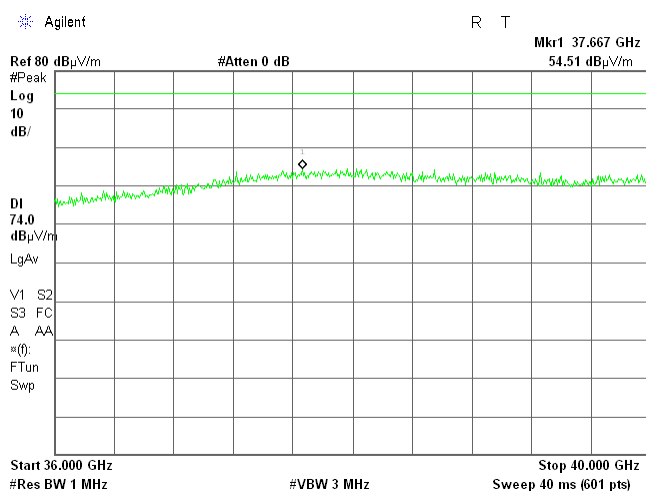
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.23 Radiated emission measurements from 36.0 to 40.0 GHz

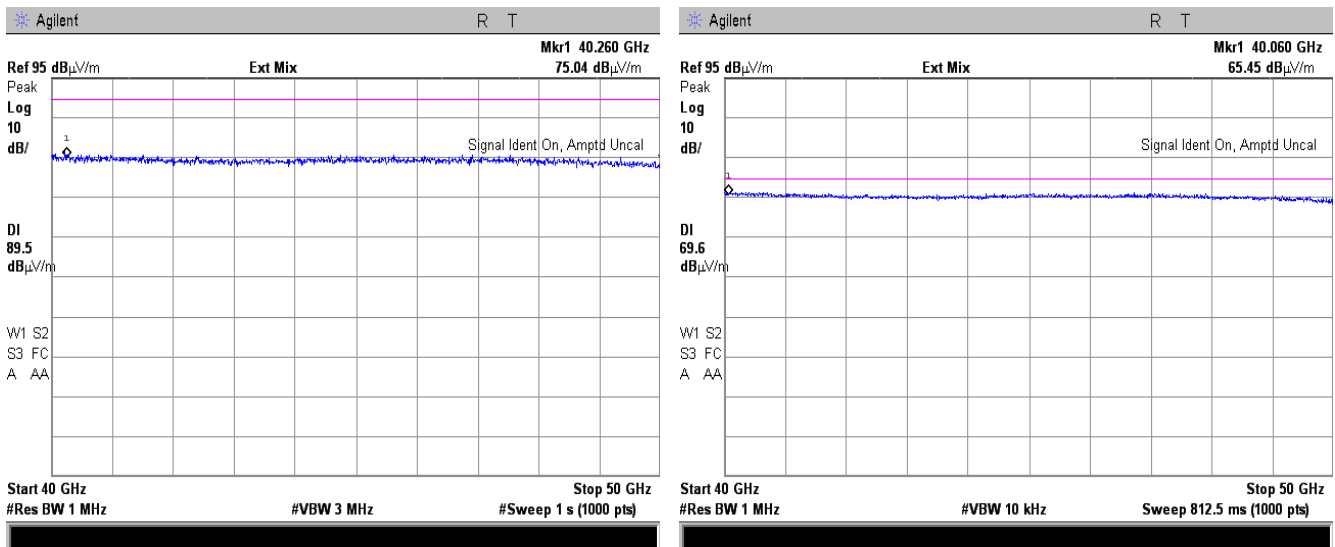
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

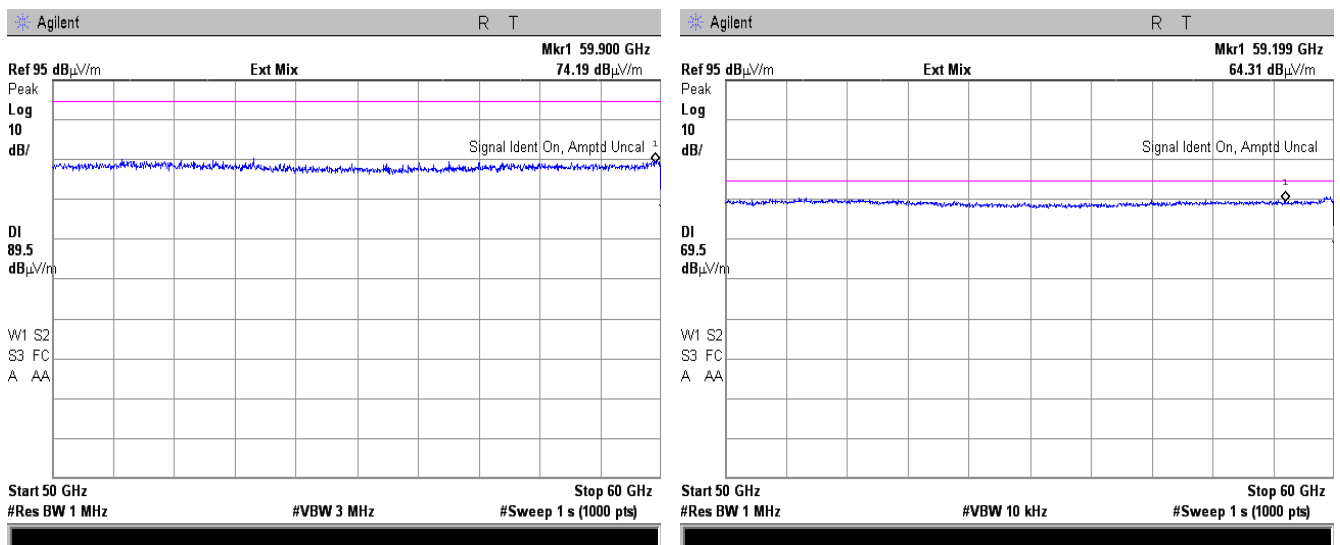
Plot 7.1.24 Radiated emission measurements from 40.0 to 50.0 GHz at low, mid, high frequency

TEST SITE: OATS
TEST DISTANCE: 0.5 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.25 Radiated emission measurements from 50.0 to 60.0 GHz at low, mid, high frequency

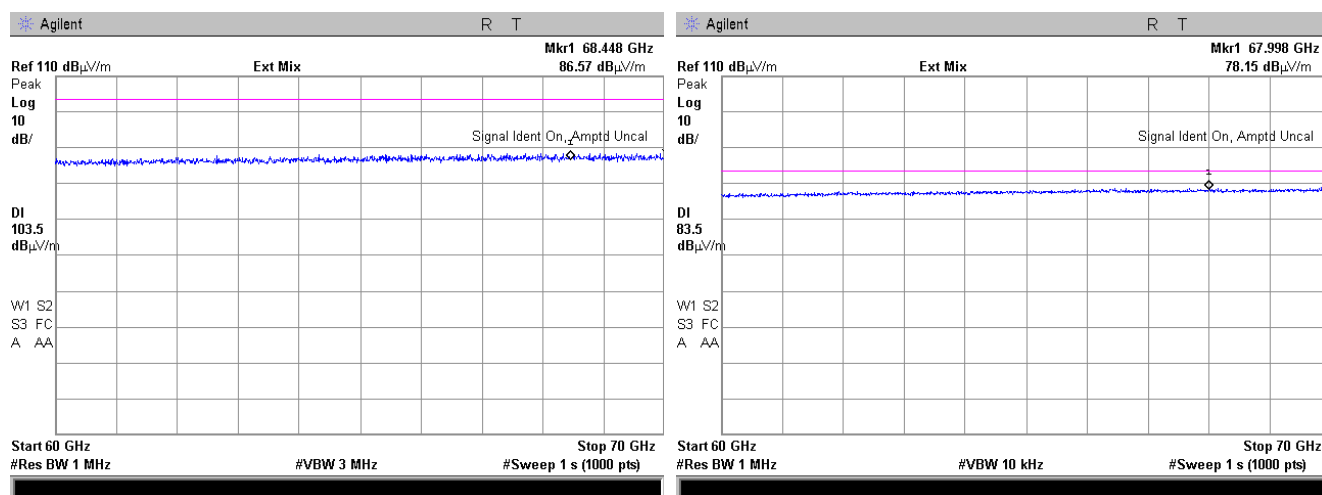
TEST SITE: OATS
TEST DISTANCE: 0.5 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

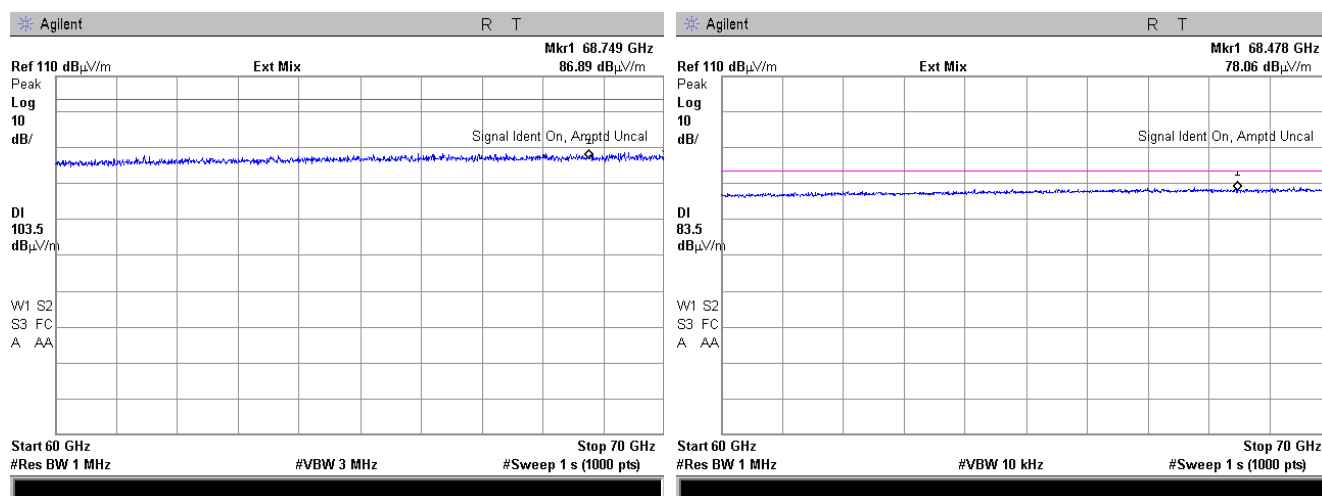
Plot 7.1.26 Radiated emission measurements from 60.0 to 70.0 GHz at low frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.27 Radiated emission measurements from 60.0 to 70.0 GHz at mid frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)





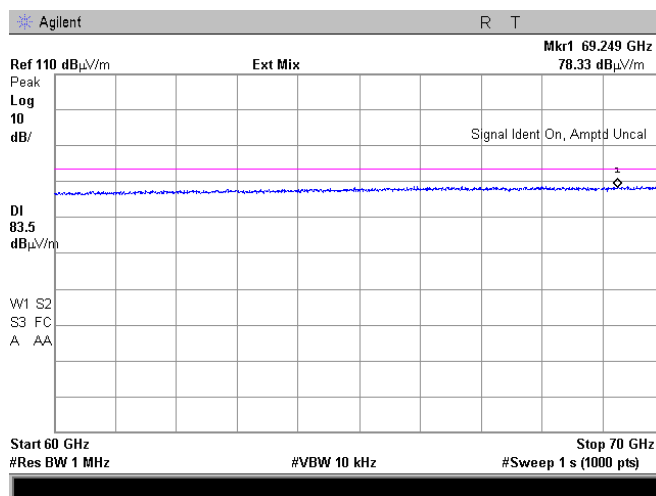
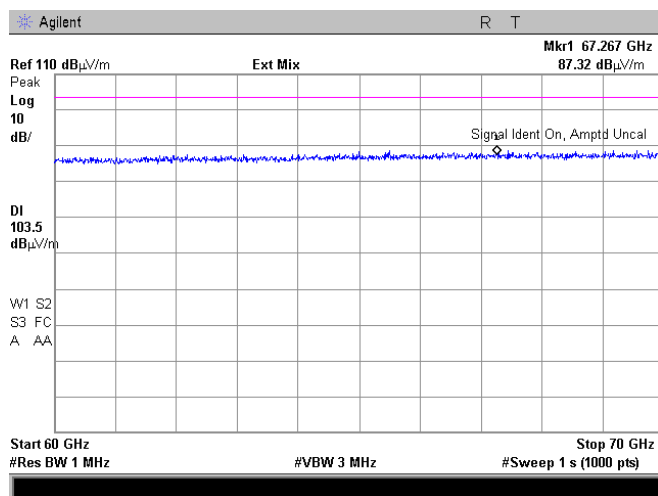
HERMON LABORATORIES

Report ID: ELTRAD_FCC.28562.docx
Date of Issue: 22-Feb-17

Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

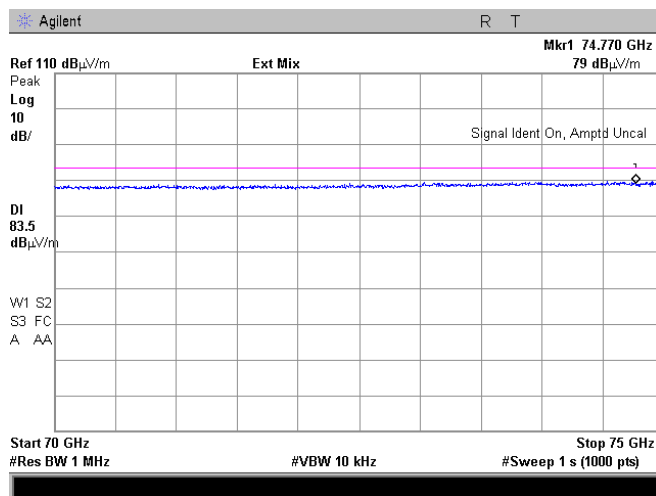
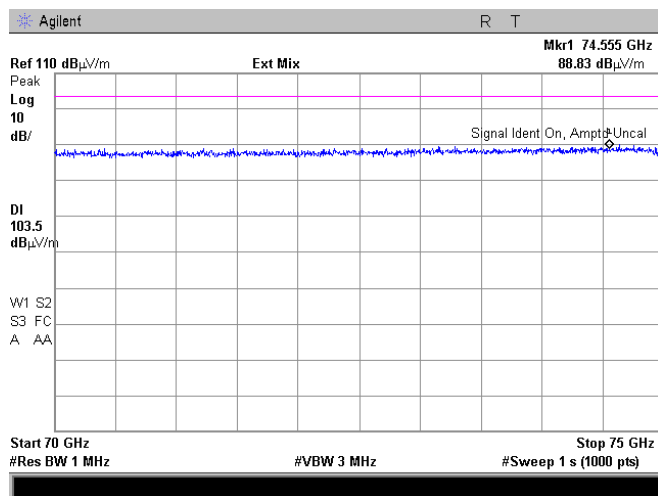
Plot 7.1.28 Radiated emission measurements from 60.0 to 70.0 GHz at high frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.29 Radiated emission measurements from 70.0 to 75.0 GHz at low frequency

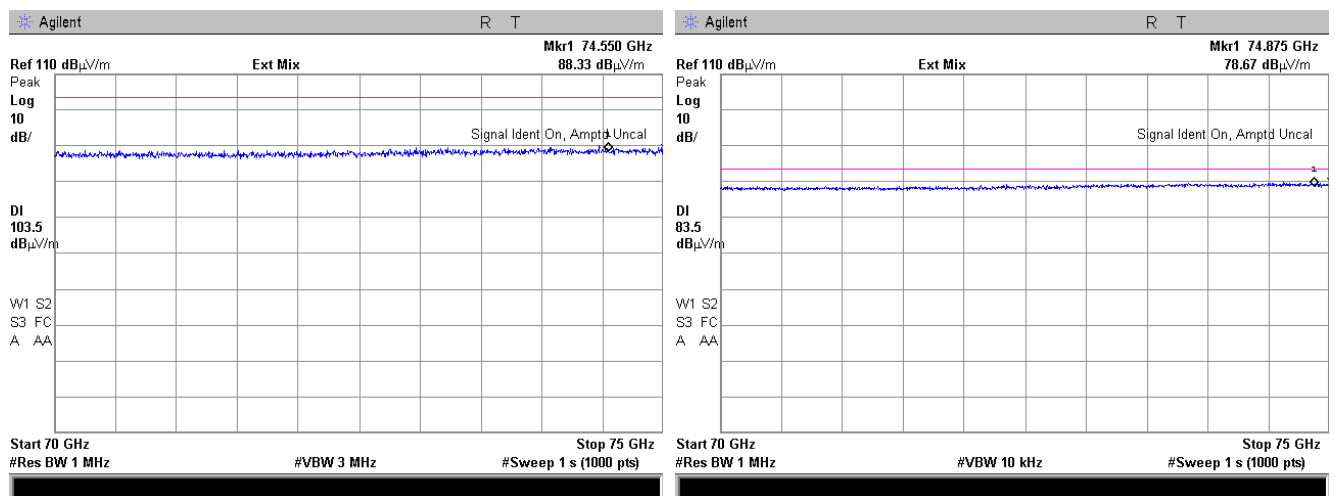
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

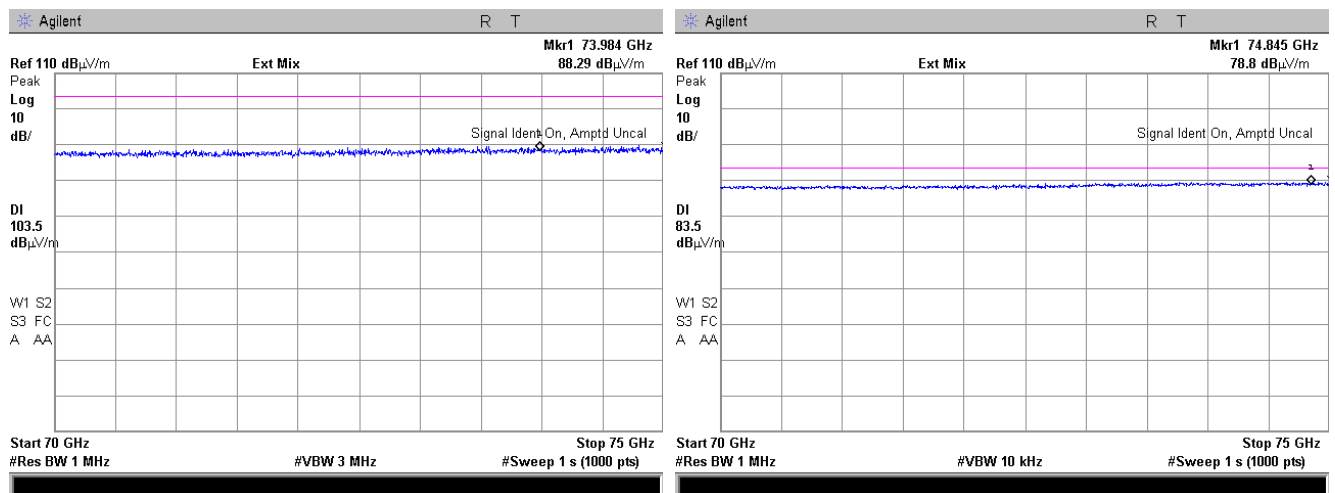
Plot 7.1.30 Radiated emission measurements from 70.0 to 75.0 GHz at mid frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.31 Radiated emission measurements from 70.0 to 75.0 GHz at high frequency

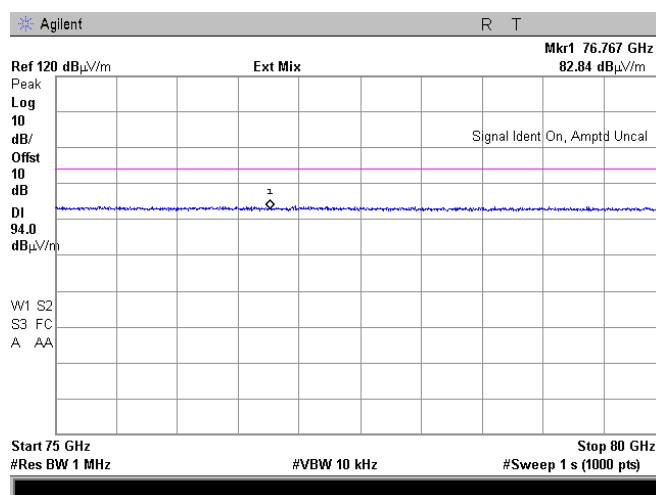
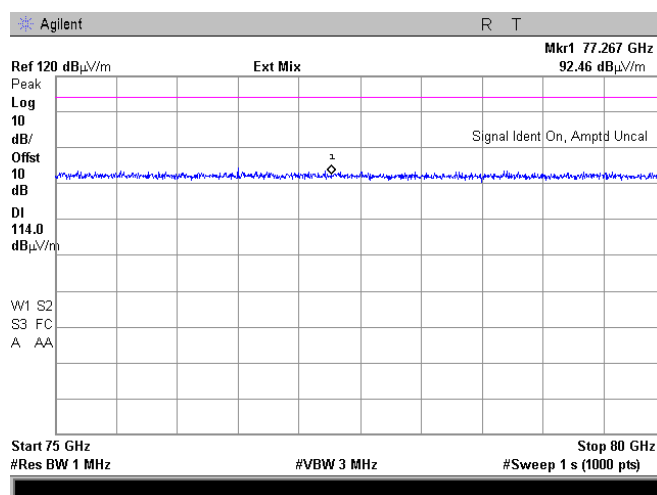
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

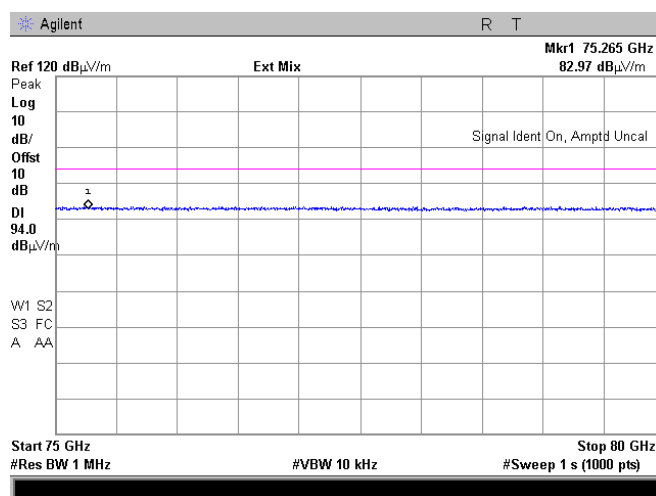
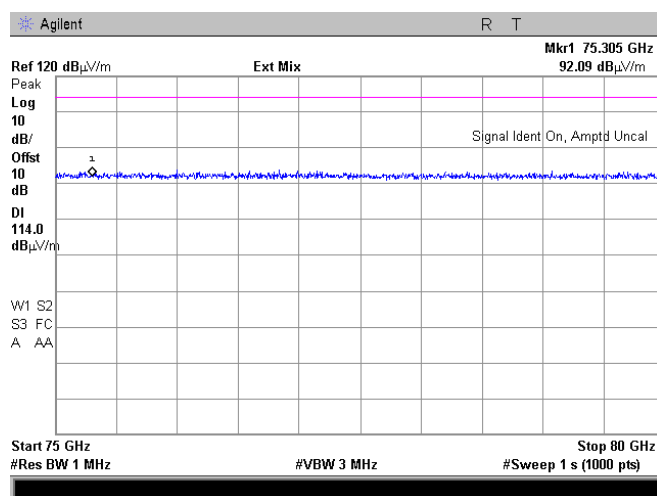
Plot 7.1.32 Radiated emission measurements from 75.0 to 80.0 GHz at low frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.33 Radiated emission measurements from 75.0 to 80.0 GHz at mid frequency

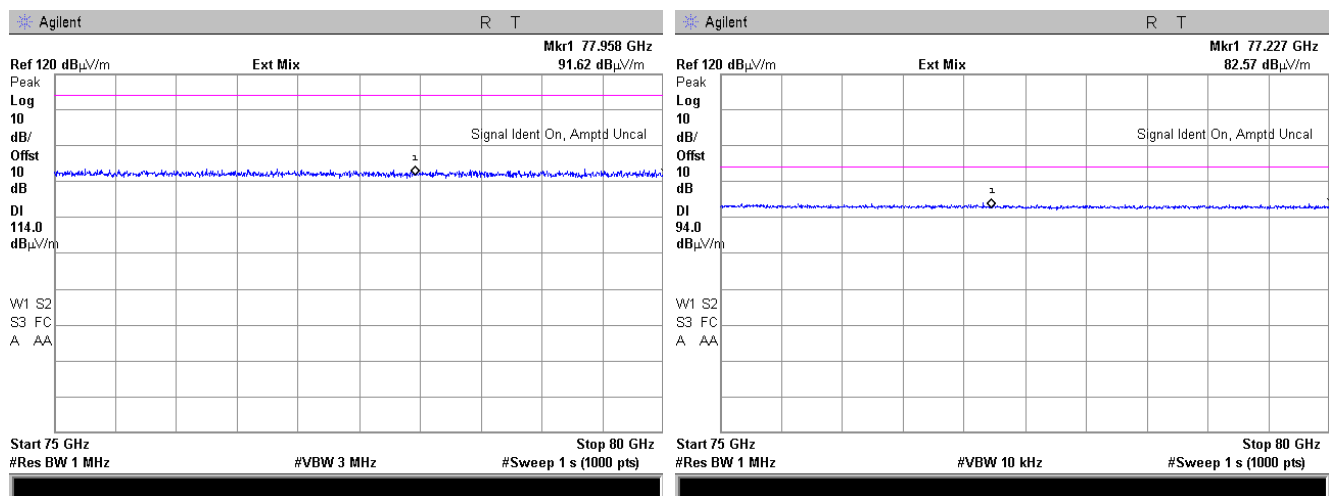
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

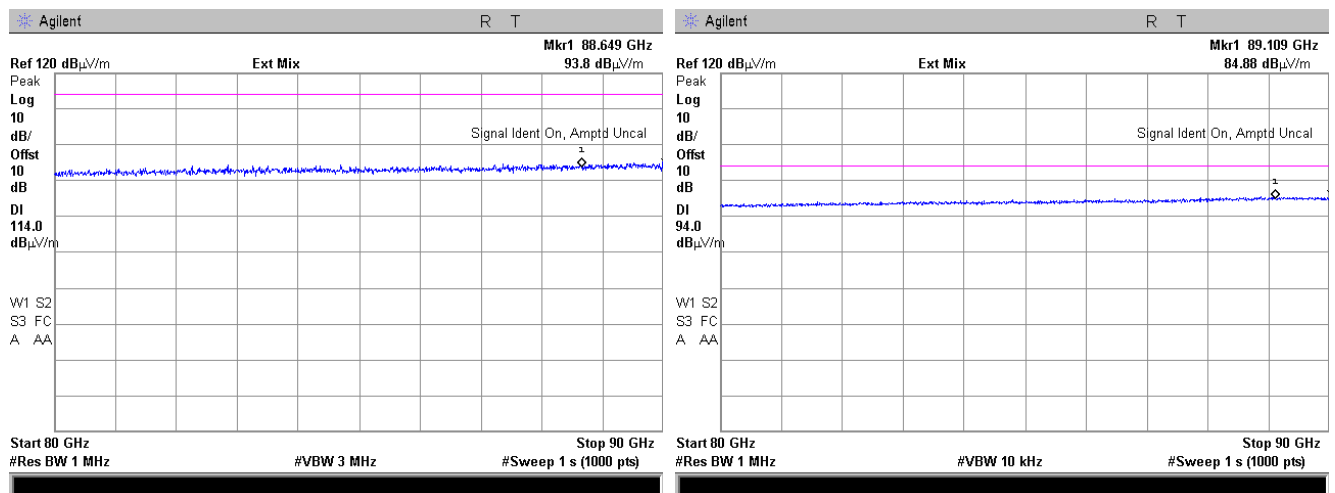
Plot 7.1.34 Radiated emission measurements from 75.0 to 80.0 GHz at high frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.35 Radiated emission measurements from 80.0 to 90.0 GHz at low frequency

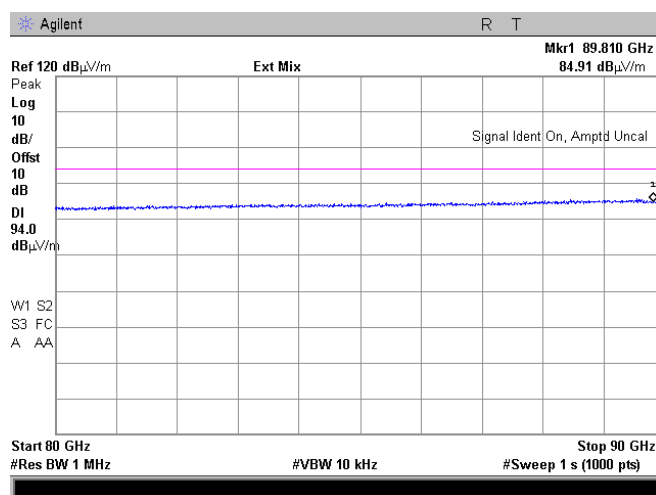
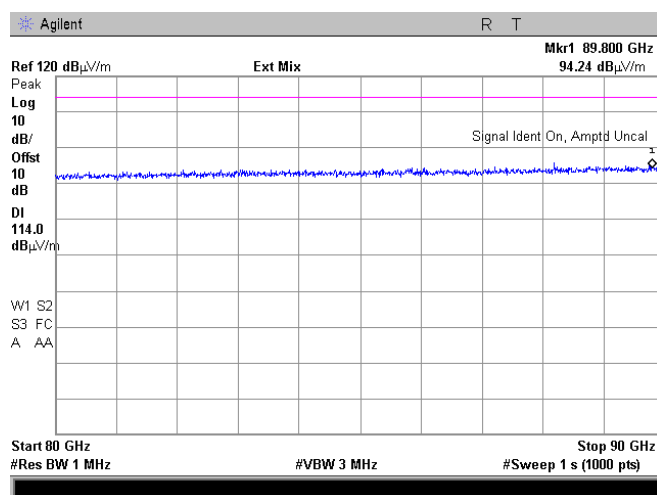
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

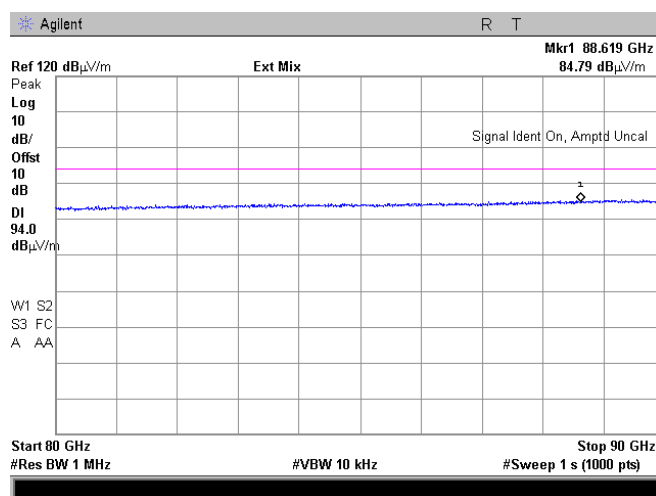
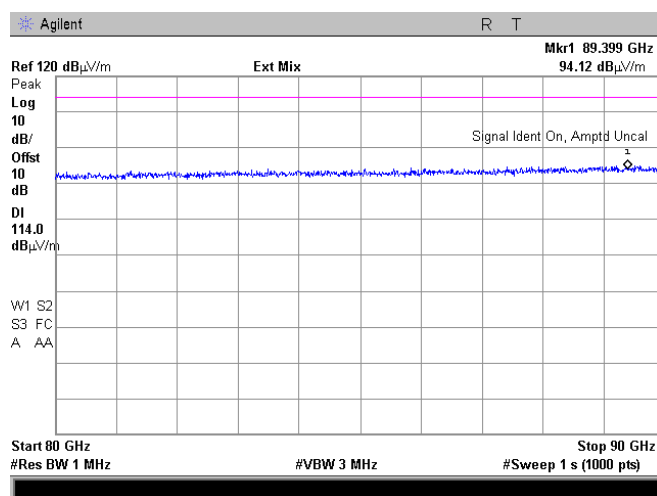
Plot 7.1.36 Radiated emission measurements from 80.0 to 90.0 GHz at mid frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.37 Radiated emission measurements from 80.0 to 90.0 GHz at high frequency

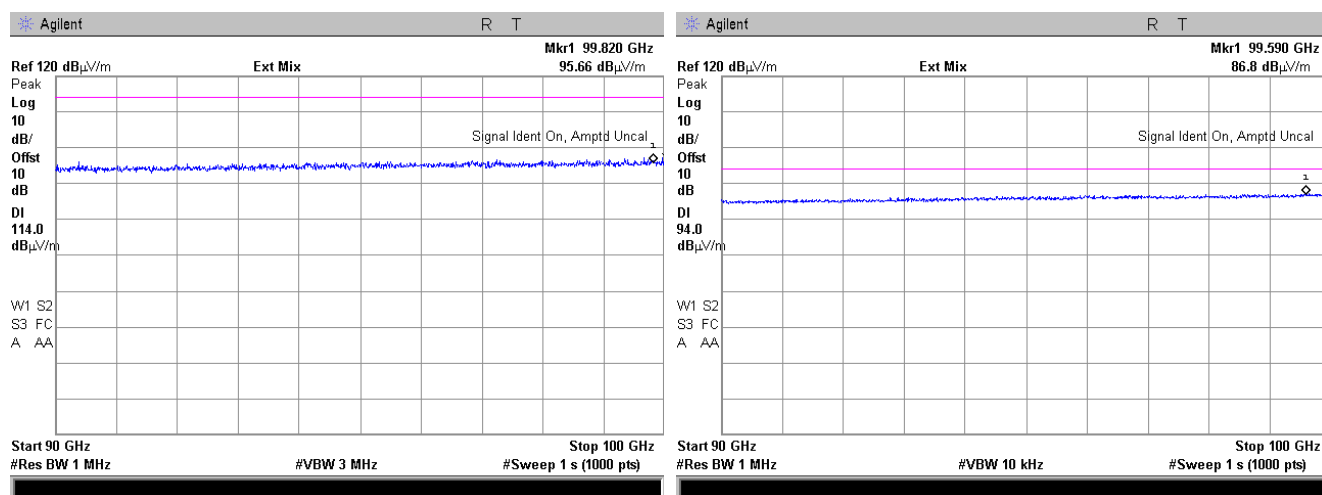
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

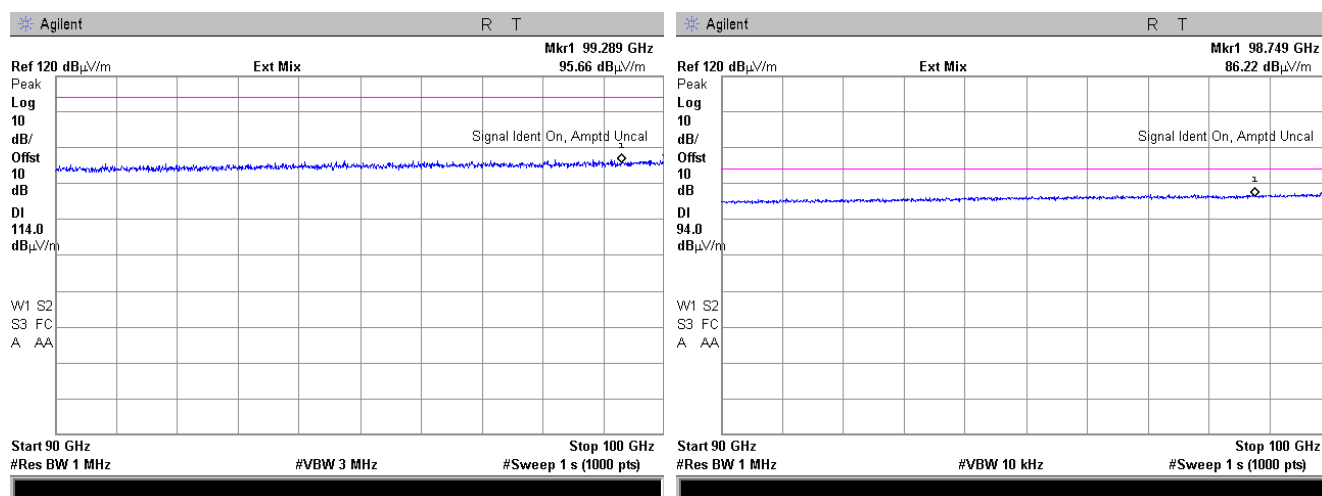
Plot 7.1.38 Radiated emission measurements from 90.0 to 100.0 GHz at low frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.1.39 Radiated emission measurements from 90.0 to 100.0 GHz at mid frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



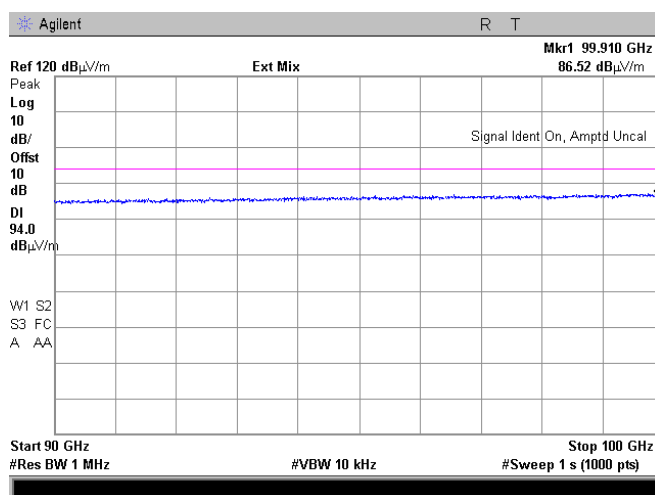
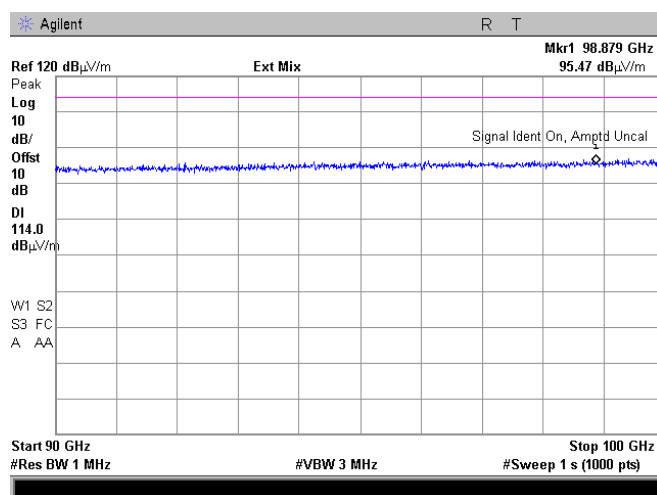


HERMON LABORATORIES

Test specification: Section 15.249(a)(d), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.40 Radiated emission measurements from 90.0 to 100.0 GHz at high frequency

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.215(c), Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jan-17			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

7.2 Occupied bandwidth test

7.2.1 General

This test was performed to verify that the 20 dB bandwidth of the emissions was contained within the standard specified frequency band according to FCC §15.215 requirements. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Occupied bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc
902 - 928	20.0
2400 – 2483.5	
5725 – 5875	
24000 – 24250	

*- Modulation envelope reference points provided in terms of attenuation below modulated carrier.

7.2.2 Test procedure

- 7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and its proper operation was checked.
- 7.2.2.2 The spectrum analyzer sweep time and bandwidth were set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.
- 7.2.2.3 The peak of emission was measured. The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.2.1 and associated plots.
- 7.2.2.4 Modulation bandwidth was calculated by adding of the negative frequency drift to the lower measured frequency and the positive frequency drift to the higher measured frequency. The obtained modulation bandwidth was verified to be within the allowed frequency range.

Figure 7.2.1 Occupied bandwidth test setup





HERMON LABORATORIES

Test specification: Section 15.215(c), Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jan-17			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Table 7.2.2 Occupied bandwidth test results

OPERATING FREQUENCY RANGE: 24000 – 24250 MHz
DETECTOR USED: Peak

Frequency, MHz	Modulation	Occupied bandwidth 99%, MHz	Occupied bandwidth 20 dBc MHz	Verdict
24085	FMCW	49.418	52.416	Pass
24150		49.421	52.463	Pass
25215		49.574	52.619	Pass

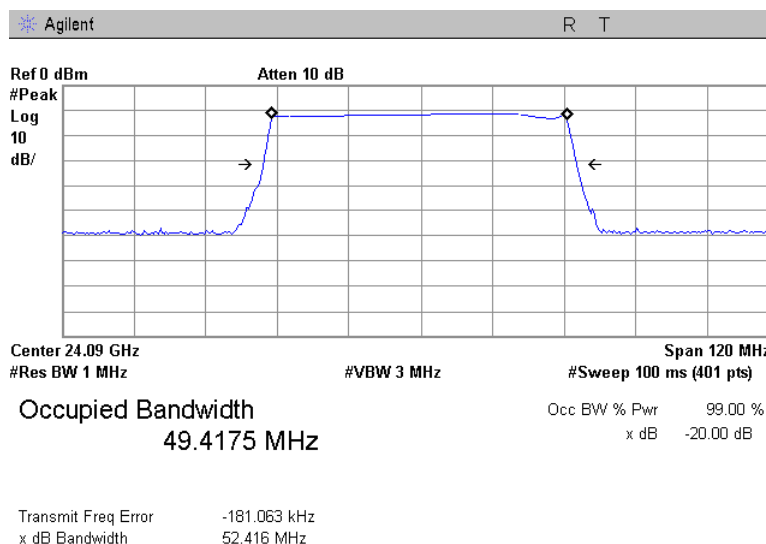
Reference numbers of test equipment used

HL 2909								
---------	--	--	--	--	--	--	--	--

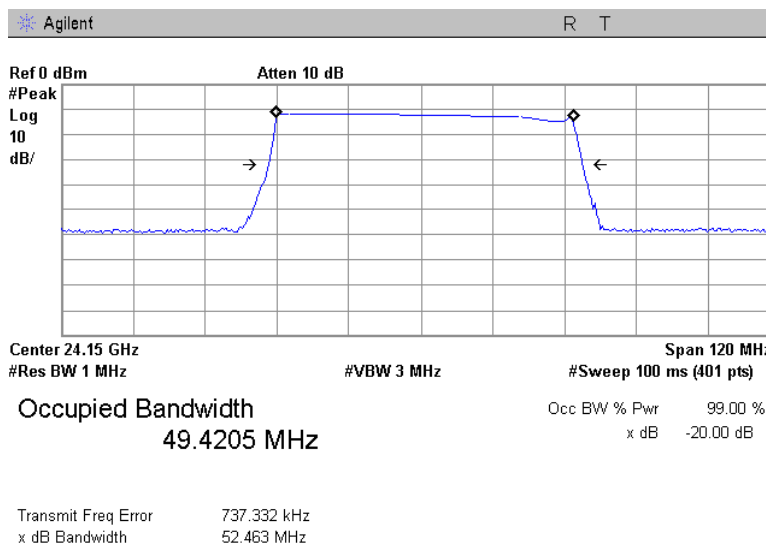
Full description is given in Appendix A.

Test specification: Section 15.215(c), Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jan-17			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.2.1 Occupied bandwidth test result at low frequency

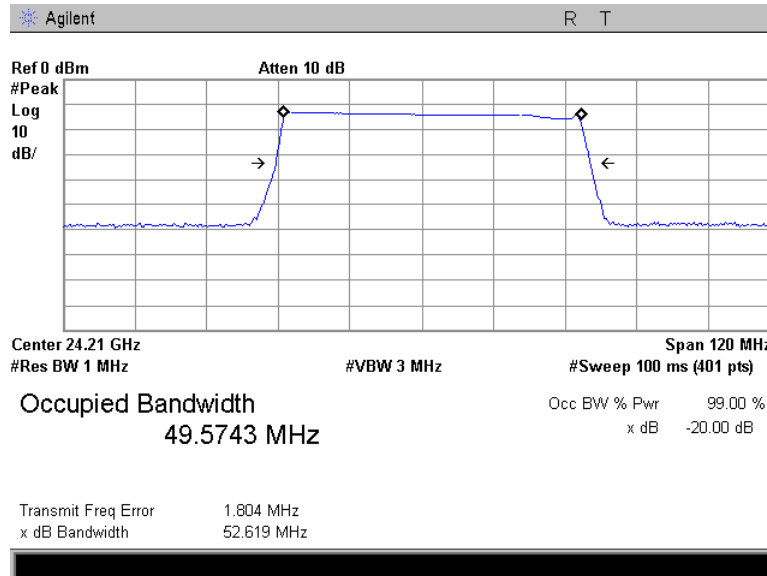


Plot 7.2.2 Occupied bandwidth test result at mid frequency



Test specification: Section 15.215(c), Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jan-17			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Plot 7.2.3 Occupied bandwidth test result at high frequency





Test specification: Section 15.249(d), Band edge emissions			
Test procedure: ANSI C63.10 section 6.10			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

7.3 Band edge emission

7.3.1 General

This test was performed to verify the EUT band edge emission including all associated side bands was attenuated at least 50 dB below the unmodulated carrier level or below the general spurious emission limit. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Band edge emission limits

Frequency band, MHz	Field strength limit at 3 m, dBμV/m		Attenuation below carrier, dBc
	Peak	Average	
24000 – 24250	74.0	54.0	50

7.3.2 Test procedure

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and the performance check was conducted.

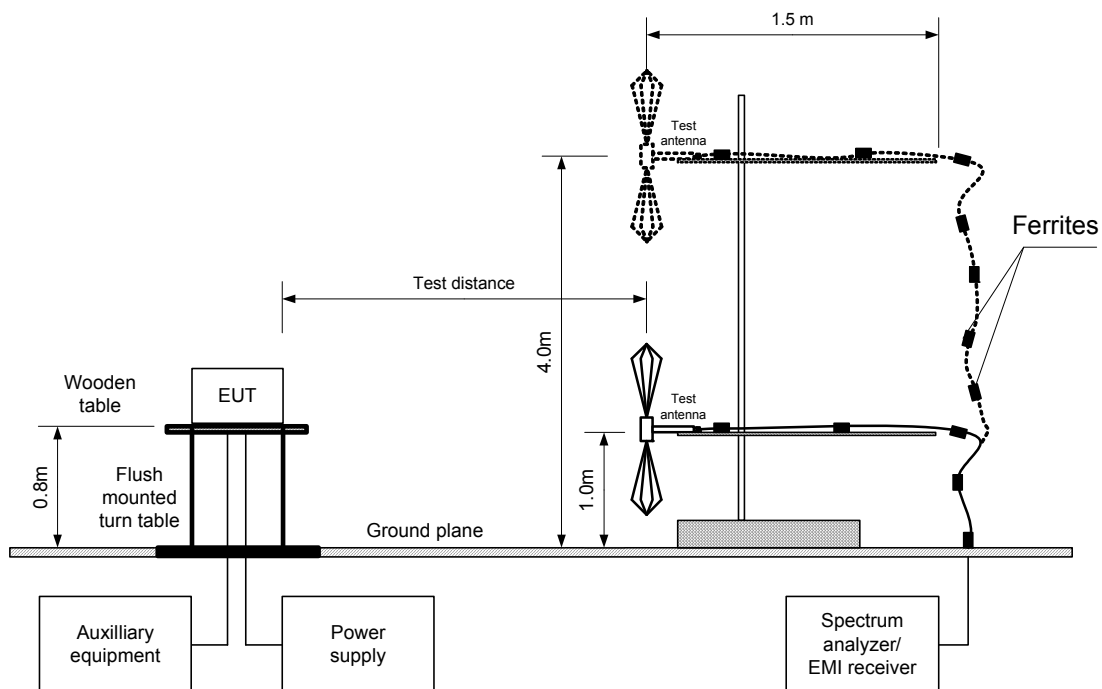
7.3.2.2 The spectrum analyzer frequency span was set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.

7.3.2.3 The frequency of modulation envelope points beyond which power level drops below the band edge emission limit was measured.

7.3.2.4 The test results were recorded in Table 7.3.2 and shown in the associated plots.

Test specification: Section 15.249(d), Band edge emissions			
Test procedure: ANSI C63.10 section 6.10			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Figure 7.3.1 Band edge emission measurement set up





HERMON LABORATORIES

Test specification: Section 15.249(d), Band edge emissions			
Test procedure: ANSI C63.10 section 6.10			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

Table 7.3.2 Band edge emission test results

OPERATING FREQUENCY RANGE: 24000 – 24250 MHz
 DETECTOR USED: Peak hold
 RESOLUTION BANDWIDTH: 1 MHz
 VIDEO BANDWIDTH: 3 MHz
 MODULATION: FMCW
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Modulation envelope			Band edge limit (peak), MHz	Margin, (peak) MHz**	Band edge limit (Average), MHz	Margin, (Average) kHz**	Verdict
Edge	Cross point frequency (peak), MHz*	Cross point frequency (average), MHz*					
Low	24055.36	24054.40	24000.00	-55.36	24000.00	-54.40	Pass
High	24245.75	24239.13	24250.00	4.25	24250.00	10.87	Pass

* - Measured frequency beyond which the emission dropped 50 dB below the carrier emission or below the field strength limit whichever was a less stringent

** - Margin = Band edge limit – Cross point frequency

Reference numbers of test equipment used

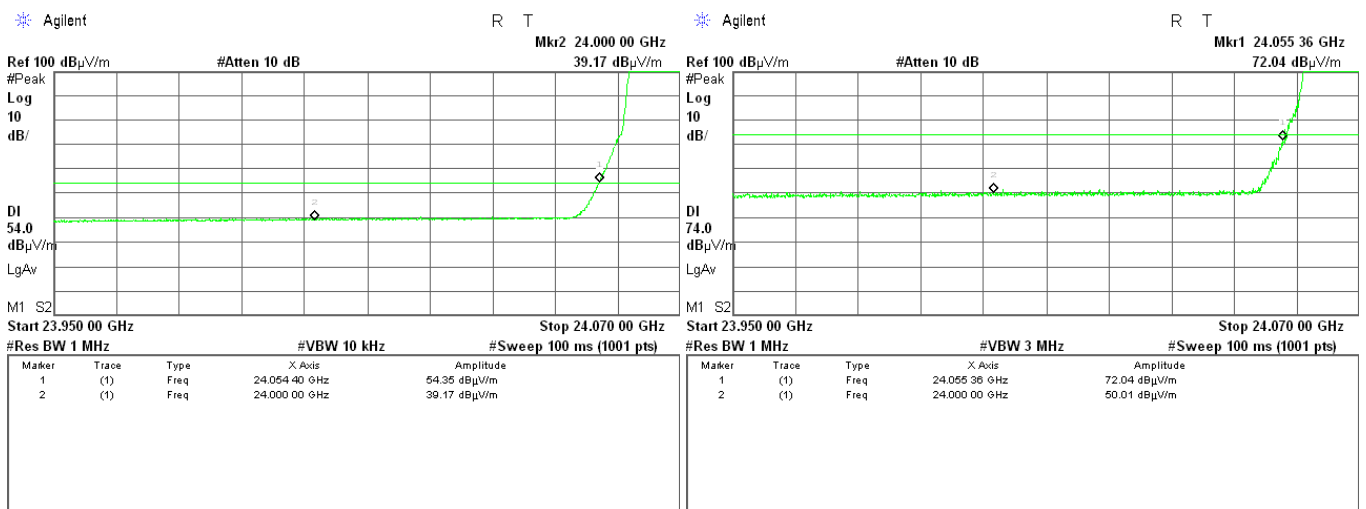
HL 3818	HL 4956	HL 5111					
---------	---------	---------	--	--	--	--	--

Full description is given in Appendix A.

Test specification: Section 15.249(d), Band edge emissions			
Test procedure: ANSI C63.10 section 6.10			
Test mode: Compliance		Verdict: PASS	
Date(s): 11-Jan-17			
Temperature: 25 °C	Relative Humidity: 44 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

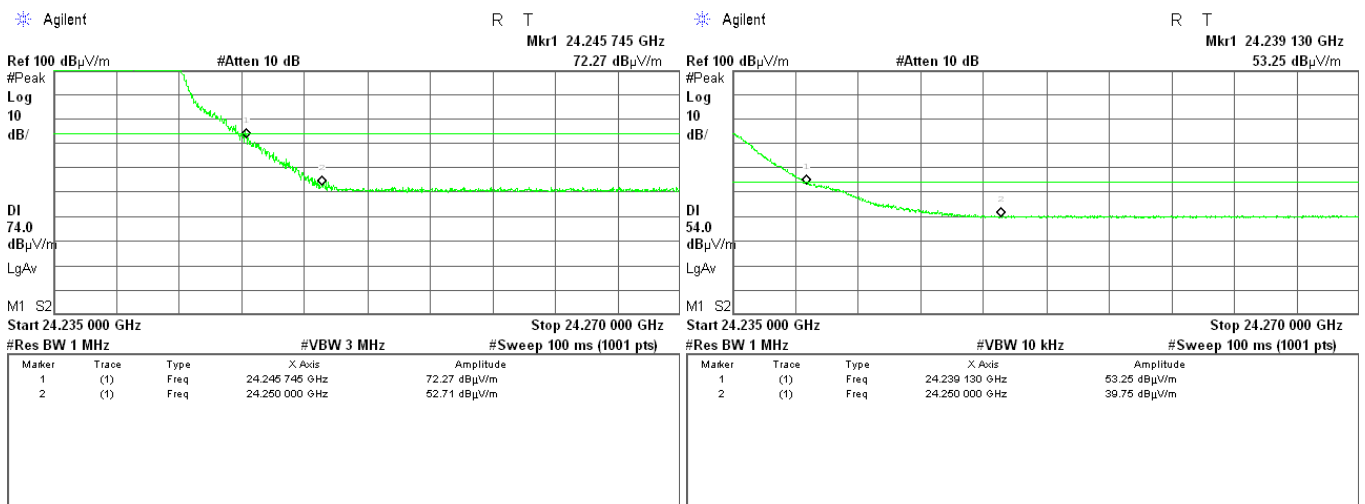
Plot 7.3.1 Low band edge emission test result

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Vertical



Plot 7.3.2 High band edge emission test result

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Vertical



Test specification: Section 15.203, Antenna requirement			
Test procedure: Visual inspection / supplier declaration			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jan-17			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1022 hPa	Power: 48 VDC
Remarks:			

7.4 Antenna requirements

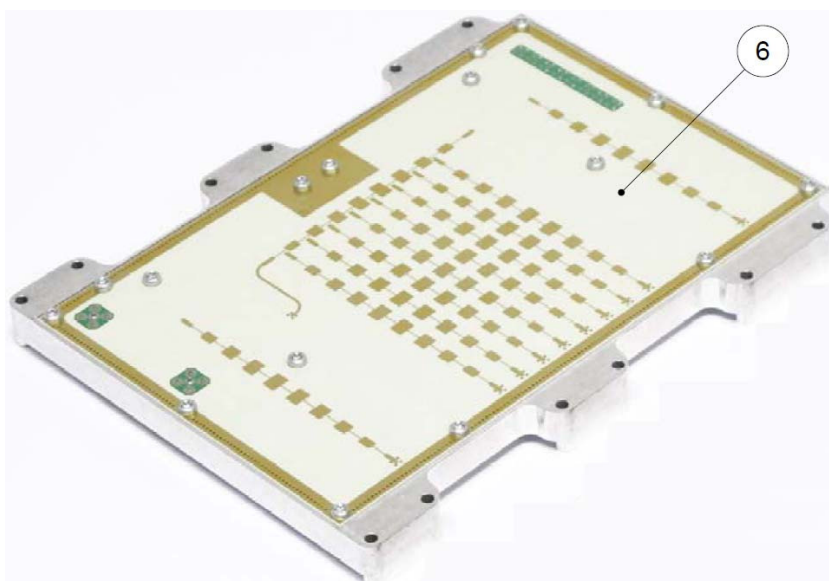
The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.

The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.4.1.

Table 7.4.1 Antenna requirements

Requirement	Rationale	Verdict
The transmitter antenna is permanently attached	Visual inspection	Comply
The transmitter employs a unique antenna connector	NA	
The transmitter requires professional installation	Supplier declaration	

Photograph 7.4.1 Antenna assembly



8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 kHz - 30 MHz	EMCO	6502	2857	19-Jan-17	19-Jan-18
0521	EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz	Hewlett Packard	8546A	3617A 00319, 3448A002 53	27-Oct-16	27-Oct-17
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	10-May-16	10-May-17
0770	Antenna Standard Gain Horn, 40-60 GHz WR-19, U-band, 24 dB mid-band gain	Quinstar Technology	QWH-1900-AA	118	17-Jul-16	17-Jul-17
0771	Antenna Standard Gain Horn, 60-90 GHz, WR-12, 24 dB mid-band gain	Quinstar Technology	QWH-1200-AA	111	14-Jul-16	14-Jul-17
0772	Antenna Standard Gain Horn, 75-110 GHz, WR-10, 24 dB mid-band gain	Quinstar Technology	QWH-0800-AA	110	14-Jul-16	14-Jul-17
1301	Transition waveguide ET28S -12R	Custom Microwave	ET28S -12R	1301	30-Jul-15	30-Jul-18
1984	Antenna, Double-Ridged Waveguide Horn, 1 to 18 GHz, 300 W	EMC Test Systems	3115	9911-5964	28-Mar-16	28-Mar-17
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY414447 62	21-Feb-16	21-Feb-17
3235	Harmonic mixer 40 to 60 GHz	Agilent Technologies	11970U	MY300301 82	16-Aug-16	16-Aug-19
3294	Tapered transition, WR-28, UG-599 to WR-15, UG-385 (26.5-40 GHz to 50-75 GHz)	Quinstar Technology	QWP-AV0000	10381004	30-Jul-15	30-Jul-18
3305	Harmonic mixer 50 to 75 GHz	Agilent Technologies	11970V	MY300301 49	16-Aug-16	16-Aug-19
3306	Harmonic mixer 75 to 110 GHz	Agilent Technologies	11970W	MY252102 73	16-Aug-16	16-Aug-19
3433	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25679	20-Mar-16	20-Mar-17
3434	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25683	20-Mar-16	20-Mar-17
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY482502 88	03-May-16	03-May-17
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFLE X 102A	1225/2A	15-Feb-16	15-Feb-17
4353	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	12025101 003	15-Mar-16	15-Mar-17
4932	Microwave preamplifier, 500 MHz to 18 GHz, 40 dB Gain	Com-Power Corporation	PAM-118A	551029	01-Sep-16	01-Sep-17
4956	Active horn antenna, 18 to 40 GHz	Com-Power Corporation	AHA-840	105004	17-Jan-17	17-Jan-18
5101	RF cable, 18 GHz, 6 m, N-type	Huber-Suhner	SF106A/1 1N/11N/6 000MM	500847/6A	26-Jul-16	26-Jul-17



HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
5107	RF cable, 18 GHz, 4.5 m, N-type	Huber-Suhner	SF106A/1 1N/11N/4 500MM	500845/6A	26-Jul-16	26-Jul-17
5110	RF cable, 18 GHz, 3 m, N-type	Huber-Suhner	ST18A/N m/Nm/300 0	600818/18 A	26-Jul-16	26-Jul-17
5111	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/ 11SK/11S K/5500M M	502493/2E A	26-Jul-16	26-Jul-17

9 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Radiated emissions at 10 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.0 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.1 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 5.5 dB Biconical antenna: ± 5.5 dB Log periodic antenna: ± 5.6 dB Double ridged horn antenna: ± 5.8 dB
Radiated emissions at 3 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 6.0 dB Biconical antenna: ± 5.7 dB Log periodic antenna: ± 6.0 dB Double ridged horn antenna: ± 6.0 dB
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: ± 2.6 dB 2.9 GHz to 6.46 GHz: ± 3.5 dB 6.46 GHz to 13.2 GHz: ± 4.3 dB 13.2 GHz to 22.0 GHz: ± 5.0 dB 22.0 GHz to 26.8 GHz: ± 5.5 dB 26.8 GHz to 40.0 GHz: ± 4.8 dB
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Occupied bandwidth	± 8.0 %

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.

Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.

In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

10 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, safety, environmental and telecommunication testing facility.

Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-869 for RE measurements above 1 GHz, C-845 for conducted emissions site, T-1606 for conducted emissions at telecommunication ports). The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing and environmental simulation (for exact scope please refer to Certificate No. 839.01).

Address: P.O. Box 23, Binyamina 30500, Israel.
Telephone: +972 4628 8001
Fax: +972 4628 8277
e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

Person for contact: Mr. Alex Usoskin, CEO.

11 APPENDIX D Specification references

FCC 47CFR part 15: 2015	Radio Frequency Devices
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.2: 1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications

12 APPENDIX E Test equipment correction factors

Antenna factor
Active loop antenna
Model 6502, S/N 2857, HL 0446

Frequency, MHz	Magnetic antenna factor, dB	Electric antenna factor, dB
0.009	-32.8	18.7
0.010	-33.8	17.7
0.020	-38.3	13.2
0.050	-41.1	10.4
0.075	-41.3	10.2
0.100	-41.6	9.9
0.150	-41.7	9.8
0.250	-41.6	9.9
0.500	-41.8	9.8
0.750	-41.9	9.7
1.000	-41.4	10.1
2.000	-41.5	10.0
3.000	-41.4	10.2
4.000	-41.4	10.1
5.000	-41.5	10.1
10.000	-41.9	9.6
15.000	-41.9	9.6
20.000	-42.2	9.3
25.000	-42.8	8.7
30.000	-44.0	7.5

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μ V) to convert it into field strength in dB(μ V/m).

Antenna factor
Standard gain horn antenna
Quinstar Technology
Model QWH
Ser.No.112, HL 0768, 0769, 0770, 0771, 0772

Frequency min, GHz	Frequency max, GHz	Antenna factor, dB(1/m)
18.000	26.500	32.01
26.500	40.000	35.48
40.000	60.000	39.03
60.000	90.000	42.55
90.000	140.000	46.23
140.000	220.000	50.11

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μ V) to convert it into field intensity in dB(μ V/m).

Antenna factor
Biconilog antenna EMCO Model 3141
Ser.No.1011, HL 0604

Frequency, MHz	Antenna factor, dB(1/m)	Frequency, MHz	Antenna factor, dB(1/m)	Frequency, MHz	Antenna factor, dB(1/m)
26	7.8	580	20.6	1320	27.8
28	7.8	600	21.3	1340	28.3
30	7.8	620	21.5	1360	28.2
40	7.2	640	21.2	1380	27.9
60	7.1	660	21.4	1400	27.9
70	8.5	680	21.9	1420	27.9
80	9.4	700	22.2	1440	27.8
90	9.8	720	22.2	1460	27.8
100	9.7	740	22.1	1480	28.0
110	9.3	760	22.3	1500	28.5
120	8.8	780	22.6	1520	28.9
130	8.7	800	22.7	1540	29.6
140	9.2	820	22.9	1560	29.8
150	9.8	840	23.1	1580	29.6
160	10.2	860	23.4	1600	29.5
170	10.4	880	23.8	1620	29.3
180	10.4	900	24.1	1640	29.2
190	10.3	920	24.1	1660	29.4
200	10.6	940	24.0	1680	29.6
220	11.6	960	24.1	1700	29.8
240	12.4	980	24.5	1720	30.3
260	12.8	1000	24.9	1740	30.8
280	13.7	1020	25.0	1760	31.1
300	14.7	1040	25.2	1780	31.0
320	15.2	1060	25.4	1800	30.9
340	15.4	1080	25.6	1820	30.7
360	16.1	1100	25.7	1840	30.6
380	16.4	1120	26.0	1860	30.6
400	16.6	1140	26.4	1880	30.6
420	16.7	1160	27.0	1900	30.6
440	17.0	1180	27.0	1920	30.7
460	17.7	1200	26.7	1940	30.9
480	18.1	1220	26.5	1960	31.2
500	18.5	1240	26.5	1980	31.6
520	19.1	1260	26.5	2000	32.0
540	19.5	1280	26.6		
560	19.8	1300	27.0		

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μ V) to convert it into field strength in dB(μ V/m).

Antenna factor
Double-ridged wave guide horn antenna
Model 3115, S/N 9911-5964, HL1984

Frequency, MHz	Antenna factor, dB(1/m)
1000.0	24.7
1500.0	25.7
2000.0	27.6
2500.0	28.9
3000.0	31.2
3500.0	32.0
4000.0	32.5
4500.0	32.7
5000.0	33.6
5500.0	35.1
6000.0	35.4
6500.0	34.9
7000.0	36.1
7500.0	37.8
8000.0	38.0
8500.0	38.1
9000.0	39.1
9500.0	38.3
10000.0	38.6
10500.0	38.2
11000.0	38.7
11500.0	39.5
12000.0	40.0
12500.0	40.4
13000.0	40.5
13500.0	41.1
14000.0	41.6
14500.0	41.7
15000.0	38.7
15500.0	38.2
16000.0	38.8
16500.0	40.5
17000.0	42.5
17500.0	45.9
18000.0	49.4

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μ V) to convert it into field strength in dB(μ V/m).

Antenna factor, HL 4956



Active Horn Antenna Factor Calibration

18 GHz to 40 GHz

Equipment:			ACTIVE HORN ANTENNA		
Model:			AHA-840		
Serial Number:			105004		
Calibration Distance:			3 meter		
Polarization:			Horizontal		
Calibration Date:			1/26/2015		
Frequency (GHz)	Preamplifier Gain (dB)	Antenna Factor with pre-amp (dB/m)	Frequency (GHz)	Preamplifier Gain (dB)	Antenna Factor with pre-amp (dB/m)
18	38.83	-1.06	29.5	42.47	-5.33
18.5	39.34	-2.65	30	41.91	-4.86
19	39.71	-3.88	30.5	41.60	-4.64
19.5	39.87	-4.35	31	41.52	-4.60
20	39.98	-3.97	31.5	41.56	-4.79
20.5	40.42	-3.68	32	41.80	-5.21
21	41.12	-4.06	32.5	42.29	-5.54
21.5	41.74	-5.46	33	42.79	-5.63
22	42.14	-6.22	33.5	42.88	-5.38
22.5	42.35	-6.42	34	42.62	-4.76
23	42.50	-6.59	34.5	42.63	-4.84
23.5	42.65	-6.82	35	43.15	-5.13
24	42.81	-7.01	35.5	43.91	-5.83
24.5	42.86	-7.37	36	44.59	-6.39
25	42.73	-7.53	36.5	45.04	-6.64
25.5	42.77	-7.45	37	45.08	-6.40
26	42.85	-7.21	37.5	44.82	-5.75
26.5	42.98	-7.17	38	44.16	-4.58
27	43.14	-7.22	38.5	42.90	-2.66
27.5	43.18	-7.32	39	42.39	-1.71
28	43.04	-7.10	39.5	43.76	-2.49
28.5	43.01	-6.73	40	45.98	-5.21
Calibration per ANSI C63.5: 2006 Standard Site Method, Equations 1-6 (3-antenna) Corrected Reading (dBμV/m) = Meter Reading (dBμV) + AFE(dB/m)					

Cable loss
Test Cable, Mini-Circuits, CBL-5FT-SMSM+, SMA-SMA, 18 GHz, 1.5 m
Mini-Circuits, HL 3433

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10.0	0.06	9000	2.01
100	0.17	9500	2.06
500	0.41	10000	2.05
1000	0.58	10500	2.18
1500	0.72	11000	2.26
2000	0.86	11500	2.28
2500	0.96	12000	2.43
3000	1.04	12500	2.53
3500	1.13	13000	2.52
4000	1.23	13500	2.56
4500	1.31	14000	2.60
5000	1.41	14500	2.59
5500	1.49	15000	2.67
6000	1.55	15500	2.76
6500	1.63	16000	2.86
7000	1.71	16500	2.91
7500	1.78	17000	2.95
8000	1.86	17500	3.02
8500	1.92	18000	3.07

Cable loss
Test Cable, Mini-Circuits, CBL-5FT-SMSM+, SMA-SMA, 18 GHz, 1.5 m, S/N 25683
Mini-Circuits, HL 3434

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10.0	0.06	9000	1.96
100	0.16	9500	2.01
500	0.40	10000	2.01
1000	0.57	10500	2.14
1500	0.72	11000	2.21
2000	0.85	11500	2.24
2500	0.95	12000	2.36
3000	1.03	12500	2.47
3500	1.11	13000	2.46
4000	1.21	13500	2.50
4500	1.29	14000	2.53
5000	1.39	14500	2.53
5500	1.46	15000	2.62
6000	1.52	15500	2.70
6500	1.60	16000	2.80
7000	1.68	16500	2.86
7500	1.75	17000	2.88
8000	1.83	17500	2.94
8500	1.88	18000	3.00

Cable loss
Microwave Cable Assembly, Huber-Suhner, 40 GHz, 3.5 m, SMA-SMA, S/N 1225/2A
HL 3901

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.09	9500	4.29	21000	6.67
100	0.41	10000	4.40	22000	6.92
500	0.93	10500	4.52	23000	7.00
1000	1.33	11000	4.64	24000	7.18
1500	1.63	11500	4.76	25000	7.29
2000	1.90	12000	4.87	26000	7.55
2500	2.12	12500	4.99	27000	7.70
3000	2.33	13000	5.11	28000	7.88
3500	2.50	13500	5.20	29000	8.02
4000	2.67	14000	5.31	30000	8.15
4500	2.82	14500	5.42	31000	8.35
5000	2.99	15000	5.51	32000	8.40
5500	3.16	15500	5.58	33000	8.62
6000	3.32	16000	5.68	34000	8.73
6500	3.51	16500	5.78	35000	8.78
7000	3.65	17000	5.91	36000	8.94
7500	3.79	17500	5.99	37000	9.21
8000	3.92	18000	6.07	38000	9.37
8500	4.04	19000	6.36	39000	9.45
9000	4.18	20000	6.49	40000	9.52

Cable loss
Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,
NC29-N1N1-244S/N 12025101 003,
HL 4353

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
50	0.20	9000	2.71
100	0.27	9500	2.81
300	0.47	10000	2.90
500	0.61	10500	2.97
1000	0.87	11000	3.06
1500	1.07	11500	3.13
2000	1.24	12000	3.20
2500	1.39	12500	3.26
3000	1.53	13000	3.34
3500	1.65	13500	3.39
4000	1.77	14000	3.47
4500	1.89	14500	3.54
5000	1.99	15000	3.62
5500	2.07	15500	3.69
6000	2.20	16000	3.76
6500	2.30	16500	3.83
7000	2.39	17000	3.86
7500	2.51	17500	3.94
8000	2.58	18000	4.02
8500	2.65		

Cable loss
RF Cable, Huber-Suhner, 18 GHz, 6 m, N- type,
SF106A/11N/11N/6000MM, S/N 500847/6A
HL 5101

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.01	5500	2.42
50	0.22	6000	2.53
100	0.31	6500	2.65
200	0.43	7000	2.76
300	0.53	7500	2.86
400	0.62	8000	2.96
500	0.69	8500	3.06
600	0.76	9000	3.16
700	0.82	9500	3.26
800	0.87	10000	3.35
900	0.93	10500	3.44
1000	0.98	11000	3.54
1100	1.03	11500	3.62
1200	1.08	12000	3.70
1300	1.12	12500	3.80
1400	1.17	13000	3.88
1500	1.21	13500	3.97
1600	1.25	14000	4.04
1700	1.29	14500	4.13
1800	1.33	15000	4.22
1900	1.37	15500	4.31
2000	1.41	16000	4.39
2500	1.59	16500	4.47
3000	1.75	17000	4.54
3500	1.90	17500	4.61
4000	2.04	18000	4.68
4500	2.17		
5000	2.30		

Cable loss
RF Cable, Huber-Suhner, 18 GHz, 6 m, N- type,
SF106A/11N/11N/4500MM, S/N 500845/6A
HL 5107

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.01	5500	1.75
50	0.16	6000	1.84
100	0.22	6500	1.92
200	0.31	7000	2.00
300	0.38	7500	2.07
400	0.44	8000	2.15
500	0.49	8500	2.23
600	0.54	9000	2.29
700	0.58	9500	2.38
800	0.63	10000	2.43
900	0.67	10500	2.50
1000	0.71	11000	2.57
1100	0.74	11500	2.63
1200	0.77	12000	2.69
1300	0.81	12500	2.76
1400	0.84	13000	2.82
1500	0.87	13500	2.87
1600	0.91	14000	2.93
1700	0.93	14500	3.00
1800	0.96	15000	3.06
1900	0.99	15500	3.12
2000	1.01	16000	3.18
2500	1.14	16500	3.22
3000	1.26	17000	3.28
3500	1.37	17500	3.36
4000	1.47	18000	3.43
4500	1.57		
5000	1.66		

Cable loss
RF Cable, Huber-Suhner, 18 GHz, 3 m, N- type,
ST18A/Nm/Nm/3000, S/N 600818/18A
HL 5110

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.01	5500	1.99
50	0.17	6000	2.10
100	0.24	6500	2.20
200	0.34	7000	2.29
300	0.42	7500	2.38
400	0.48	8000	2.47
500	0.54	8500	2.57
600	0.59	9000	2.65
700	0.64	9500	2.74
800	0.69	10000	2.83
900	0.73	10500	2.91
1000	0.77	11000	2.99
1100	0.82	11500	3.07
1200	0.86	12000	3.14
1300	0.89	12500	3.22
1400	0.93	13000	3.29
1500	0.96	13500	3.37
1600	1.00	14000	3.45
1700	1.03	14500	3.52
1800	1.06	15000	3.59
1900	1.10	15500	3.66
2000	1.13	16000	3.74
2500	1.28	16500	3.80
3000	1.41	17000	3.88
3500	1.54	17500	4.00
4000	1.66	18000	4.02
4500	1.78		
5000	1.89		

Cable loss
RF Cable, Huber-Suhner, 40 GHz, 5.5 m, K type,
SF102EA/11SK/11SK/5500MM, S/N 502493/2EA
HL 5111

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
100	0.68	20500	10.17
200	0.97	21000	10.30
300	1.18	21500	10.43
500	1.52	22000	10.58
1000	2.14	22500	10.73
1500	2.62	23000	10.85
2000	3.03	23500	10.98
2500	3.39	24000	11.11
3000	3.72	24500	11.20
3500	4.03	25000	11.32
4000	4.32	25500	11.47
4500	4.59	26000	11.59
5000	4.84	26500	11.72
5500	5.09	27000	11.83
6000	5.32	27500	11.94
6500	5.55	28000	12.04
7000	5.77	28500	12.16
7500	5.99	29000	12.28
8000	6.19	29500	12.40
8500	6.40	30000	12.50
9000	6.60	30500	12.59
9500	6.79	31000	12.68
10000	6.98	31500	12.80
10500	7.16	32000	12.94
11000	7.34	32500	13.09
11500	7.51	33000	13.23
12000	7.68	33500	13.32
12500	7.84	34000	13.44
13000	8.00	34500	13.54
13500	8.15	35000	13.68
14000	8.31	35500	13.81
14500	8.46	36000	13.90
15000	8.62	36500	13.99
15500	8.76	37000	14.12
16000	8.91	37500	14.22
16500	9.06	38000	14.33
17000	9.21	38500	14.47
17500	9.35	39000	14.54
18000	9.49	39500	14.62
18500	9.62	40000	14.75
19000	9.76		
19500	9.90		
20000	10.05		

13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
AVRG	average (detector)
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μ V)	decibel referred to one microvolt
dB(μ V/m)	decibel referred to one microvolt per meter
dB(μ A)	decibel referred to one microampere
DC	direct current
EIRP	equivalent isotropically radiated power
ERP	effective radiated power
EUT	equipment under test
F	frequency
GHz	gigahertz
GND	ground
H	height
HL	Hermon laboratories
Hz	hertz
k	kilo
kHz	kilohertz
LO	local oscillator
m	meter
MHz	megahertz
min	minute
mm	millimeter
ms	millisecond
μ s	microsecond
NA	not applicable
NB	narrow band
OATS	open area test site
Ω	Ohm
PM	pulse modulation
PS	power supply
ppm	part per million (10^{-6})
QP	quasi-peak
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt
WB	wideband

END OF DOCUMENT