HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO: FCC 47 CFR part 15 section 15.255

FOR:

Sysmetric Ltd

Radio Sensor

Model: GSET

FCC ID: 2ATMP-GSET

Table of contents

1 Applicant information

Client name:	Sysmetric Ltd.
Address:	26 Hataasia st. Afula Ilit, Israel
Telephone:	04-6069717
Fax:	04-6405911
E-mail:	erezm@sysmetric-ltd.com
Contact name:	Mr. Erez Margalit

2 Equipment under test attributes

Product name:	Radio Sensor
Product type:	Industrial Measurement Sensor
Model(s):	GSET
Serial number:	GSET0001
Hardware version:	Vr1.0
Software release:	FW322
Receipt date	07-Apr-19

3 Manufacturer information

Manufacturer name:	Sysmetric Ltd.
Address:	26 Hataasia st. Afula Ilit, Israel
Telephone:	04-6069717
Fax:	04-6405911
E-Mail:	erezm@sysmetric-ltd.com
Contact name:	Mr.Erez Margalit

4 Test details

Project ID:	32839
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	29-Apr-19
Test completed:	27-May-19
Test specification(s):	FCC 47 CFR part 15 section 15.255

5 Tests summary

Test	Status
Transmitter characteristics	
FCC section 15.255(c)(3), Transmiter power test	Pass
FCC section 15.215(c), Occupied bandwidth	Pass
FCC section 15.255(c)(2), Out of band radiated emissions below 40 GHz	Pass
FCC section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200 GHz	Pass
FCC Section 15.255(f), Frequency stability test	Pass
FCC Section 15.207(a) Conducted emissions	Pass
FCC Section 15.202, 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.

This test report supersedes the previously issued test report identified by Doc ID:SYSRAD_FCC.32839.

	Name and Title	Date	Signature
Tested by:	Mr. A. Troupiansky test engineer EMC & Radio	29 Apr 19 – 27 May 19	
Reviewed by:	Mrs. S Peysahov Sheynin test engineer EMC & Radio	16 June 19	
Approved by:	Mr. S. Samokha, technical manager, EMC and Radio	01 July 19	

6 EUT description

Note: The following data in this clause is provided by the customer and represents his sole responsibility

6.1 General information

GSET is Radio Sensor for measuring plastic pipe thickness and dimensions (Mad Ovi), operating @57 GHz - 65 GHz band, bandwidth 8 GHz, FMCW modulation. The EUT powered from 120VAC, 60 Hz.

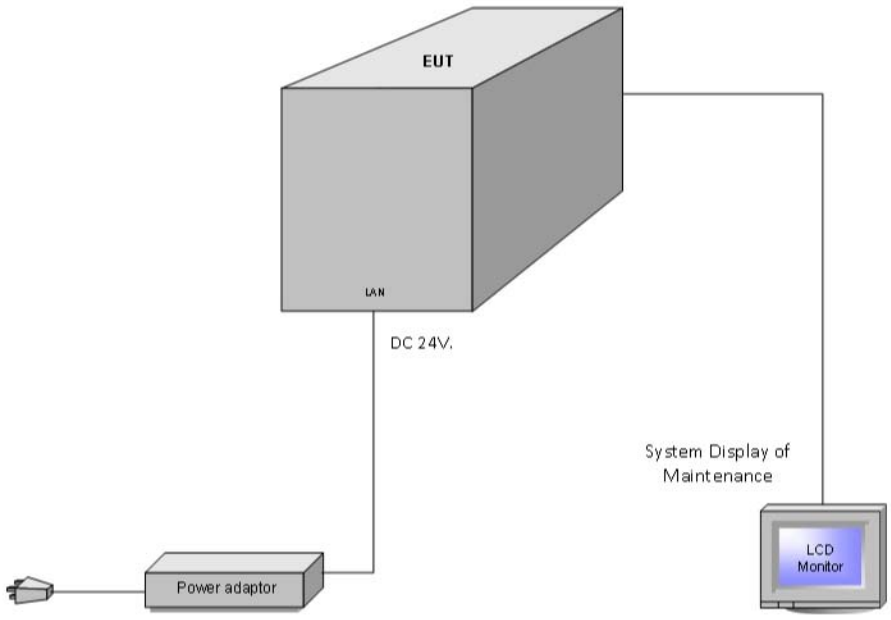
6.2 Ports and lines

Port type	Port description	Conn. from	Conn. to	Qty.	Cable type	Cable length, m	Indoor / outdoor
Control	Ethernet	EUT	PC	1	UTP	2	Indoor
Power	Ethernet	EUT	Power Supply	1	Twisted pairs	2	Indoor

6.3 Changes made in EUT

No changes were implemented in the EUT during testing.

6.4 Test configuration



6.5 Transmitter characteristics

Type of equipment		
X	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)	

Intended use		**Condition of use**
	fixed	Always at a distance more than 2 m from all people
X	mobile	Always at a distance more than 20 cm from all people
	portable	May operate at a distance closer than 20 cm to human body

Assigned frequency ranges	57000 – 65000 MHz
Operating frequencies	57024 – 65000 MHz

Maximum rated output power	At transmitter 50 Ω RF output connector	-4.5 dBm
	EIRP with maximum declared antenna gain	8.79 dBm

Is transmitter output power variable?	V	No			
		Yes		continuous variable	
				stepped variable with stepsize	dB
			minimum RF power		dBm
			maximum RF power		dBm

Antenna connection				
unique coupling	standard connector*	V	integral	with temporary RF connector
				without temporary RF connector

Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
Integral	Sysmetric-LTD	HRN1.0	24dBi

Transmitter aggregate data rate/s	2500bps
Type of modulation	FMCW
Modulating test signal (baseband)	57024-65000MHz

Transmitter power source						
X	Battery	**Nominal rated voltage**	24 VDC	Battery type	Alkaline	
	DC	**Nominal rated voltage**				
X	AC mains	**Nominal rated voltage**	100-240 VAC	Frequency	50/60 Hz	

Common power source for transmitter and receiver	X	yes		no

Test specification:	Section 15.255(c)(3), Transmitter power and power spectral density		
Test procedure:	ANSI C63.10, Section 9.11		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1001 hPa	Power: 24 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C

7.1 Transmitter power test

7.1.1 General

This test was performed to measure the peak output power. Specification test limits are given in Table 7.1.1.

Table 7.1.1 Output power limits

Assigned frequency range, MHz	Maximum output power	
	Peak conducted output power dBm	EIRP, dBm
57000 – 66000	-10	10

7.1.2 Test procedure

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

7.1.2.2 The EUT was adjusted to produce maximum available for end user RF output power.

7.1.2.3 The average and peak voltage was measured at the low and high frequency channels with oscilloscope connected to RF detector and provided in the associated plots.

7.1.2.4 The unmodulated signal was applied to Zero-Biased Detector via variable attenuator as shown in Figure 7.1.2.

7.1.2.5 The variable attenuator was adjusted such that the oscilloscope indicated a voltage equal to the peak voltage recorded in the step 7.1.2.3.

7.1.2.6 The variable attenuator was disconnected from the Zero-Biased Detector.

7.1.2.7 Without changing any settings, the variable attenuator was connected to a power meter as shown in Figure 7.1.3.

7.1.2.8 The power was measured and result was recorded in Table 7.1.2 and Table 7.1.3.

7.1.2.9 The steps 7.1.2.4 through 7.1.2.8 were repeated for the average voltage recorded in the step 7.1.2.3 and 7.1.2.4.

Test specification:	Section 15.255(c)(3), Transmitter power and power spectral density		
Test procedure:	ANSI C63.10, Section 9.11		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1001 hPa	Power: 24 VDC
Remarks:			

Figure 7.1.1 Peak output power test setup

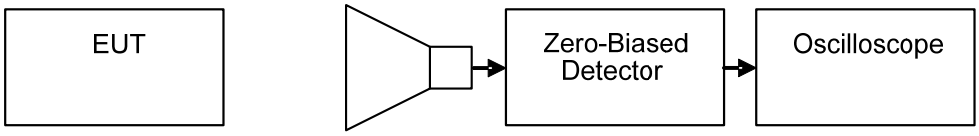


Figure 7.1.2 Peak output power test setup

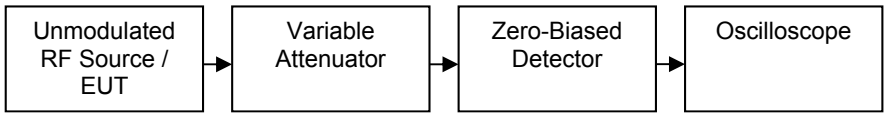
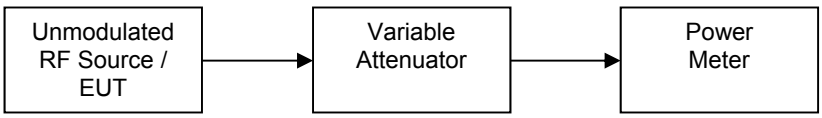


Figure 7.1.3 Peak output power test setup



Test specification:	**Section 15.255(c)(3), Transmitter power and power spectral density**		
Test procedure:	ANSI C63.10, Section 9.11		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	**Relative Humidity:** 55 %	**Air Pressure:** 1001 hPa	**Power:** 24 VDC
Remarks:			

Table 7.1.2 Peak output power test results

OPERATING FREQUENCY RANGE: 57.0 – 66.0 GHz
DETECTOR USED: Peak
MEASUREMENTS DISTANCE: 0.03 m
VIDEO BANDWIDTH: >10 MHz
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
MODULATION: FMCW

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
57024.0	0.005261	3.6	-4.50	24.0	143.878	8.72	10	-1.28	Pass
61000.0	0.004918	3.6	-5.02	24.0	143.944	8.79	10	-1.21	Pass
65000.0	0.004615	3.6	-5.75	24.0	143.765	8.61	10	-1.39	Pass

* - λ = 300/Frequency(MHz)
** - E_{meas}= 126.8 – 20log(λ) + Power measured – Measurement Antenna Gain
*** - EIRP= E_{meas} + 20log(Measurements distance) – 104.7
**** - Margin = EIRP – Limit

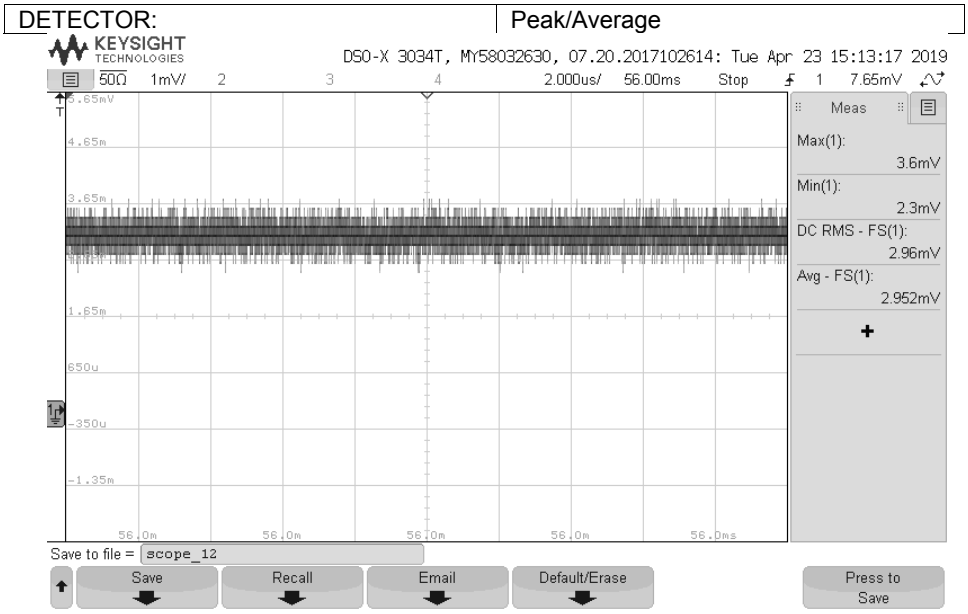
Reference numbers of test equipment used

HL 0770	HL 0771	HL 3291	HL 3727	HL 3293	HL 3901	HL 4856	HL 5379

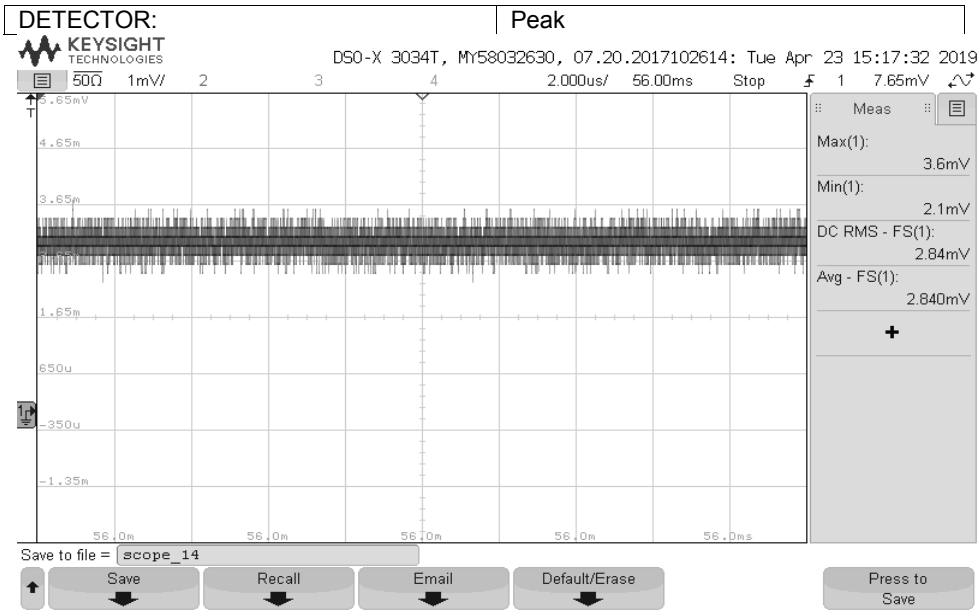
Full description is given in Appendix A.

Test specification:	Section 15.255(c)(3), Transmitter power and power spectral density		
Test procedure:	ANSI C63.10, Section 9.11		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1001 hPa	Power: 24 VDC
Remarks:			

Plot 7.1.1 Output power test result of EUT at the 61 GHz frequency



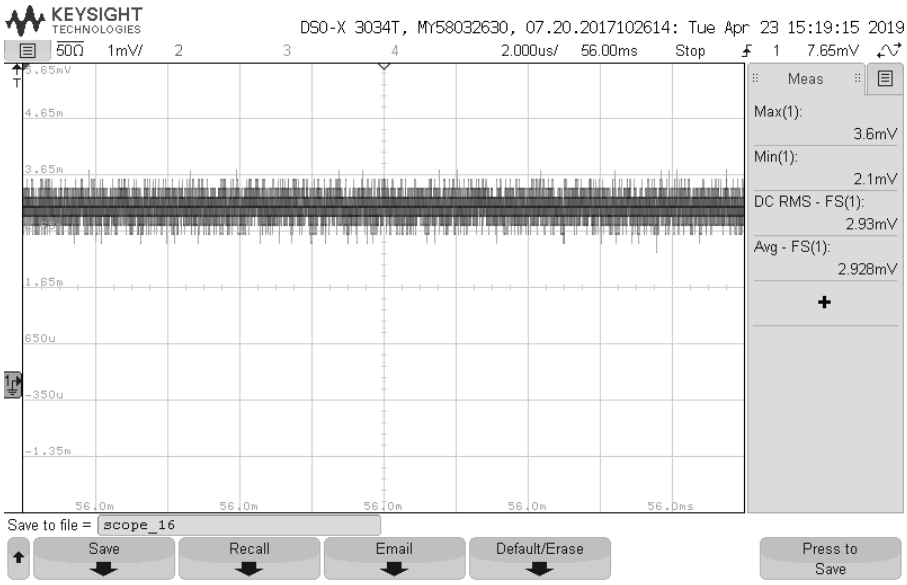
Plot 7.1.2 Output power test result at the 57024.0 MHz frequency



Test specification:	Section 15.255(c)(3), Transmitter power and power spectral density		
Test procedure:	ANSI C63.10, Section 9.11		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1001 hPa	Power: 24 VDC
Remarks:			

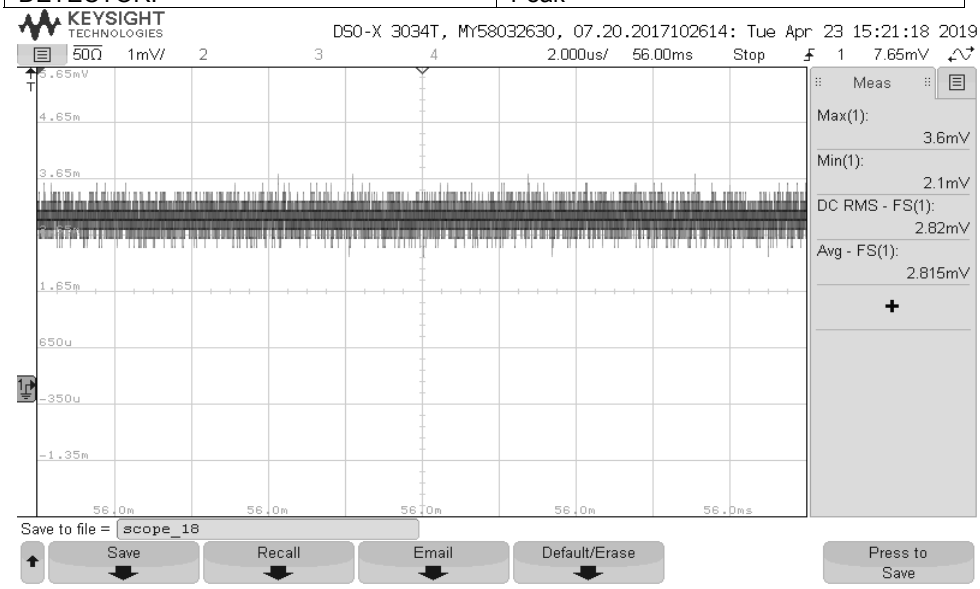
Plot 7.1.3 Output power test result at the 61000.0 MHz frequency

DETECTOR:	Peak



Plot 7.1.4 Output power test result at the 65000.0 MHz frequency

DETECTOR:	Peak



Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24 VDC
Remarks:			

7.2 Occupied bandwidth test

7.2.1 General

This test was performed to measure transmitter occupied bandwidth. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Occupied bandwidth limits

Assigned frequency range, MHz	Modulation envelope reference points
57000 - 66000	20 dBc

NOTE: Modulation envelope reference points provided in terms of attenuation below unmodulated 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 1.1.2 and associated plot.

Figure 7.2.1 Occupied bandwidth test setup

Table 7.2.2 Occupied bandwidth test results

OPERATING FREQUENCY RANGE: 57000 –65000 MHz
DETECTOR USED: Peak

Frequency, GHz	Frequency Center , GHz	Modulation	Occupied bandwidth 20 dBc MHz	Verdict
57024.0 – 65000.0	61012.0	FMCW	7976	Pass

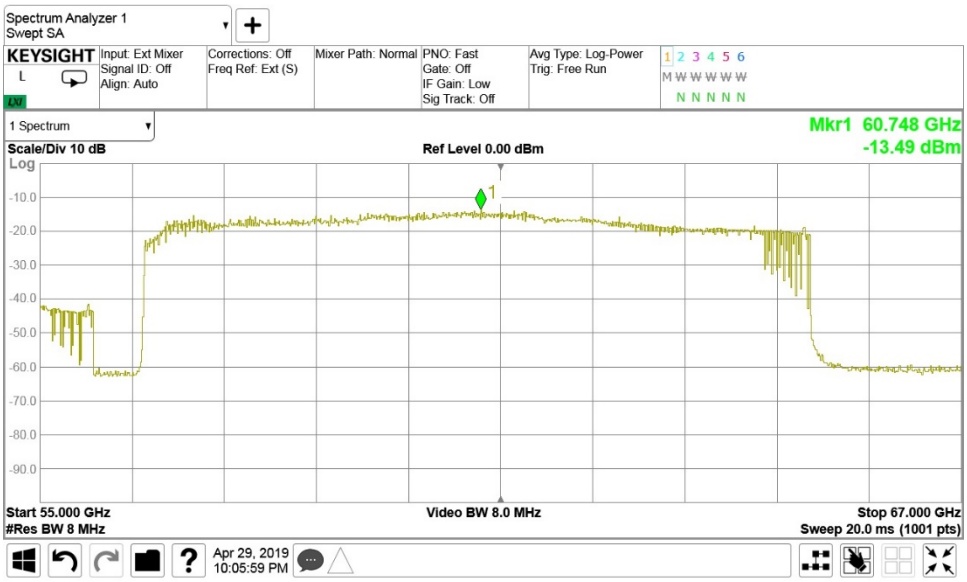
Reference numbers of test equipment used

HL 5376	HL 5380	HL						

Full description is given in Appendix A.

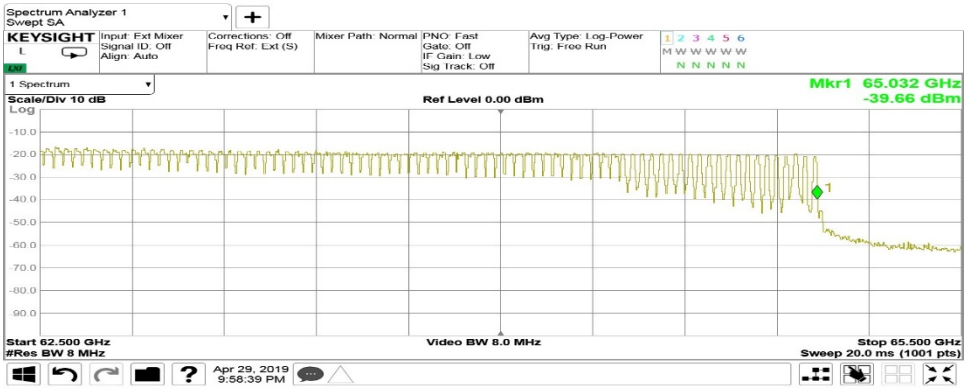
Test specification:	**Section 15.215(c), Occupied bandwidth**		
Test procedure:	ANSI C63.10, Section 9.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	**Relative Humidity:** 48 %	**Air Pressure:** 1013 hPa	**Power:** 24 VDC
Remarks:			

Plot 7.2.1 Occupied bandwidth test result

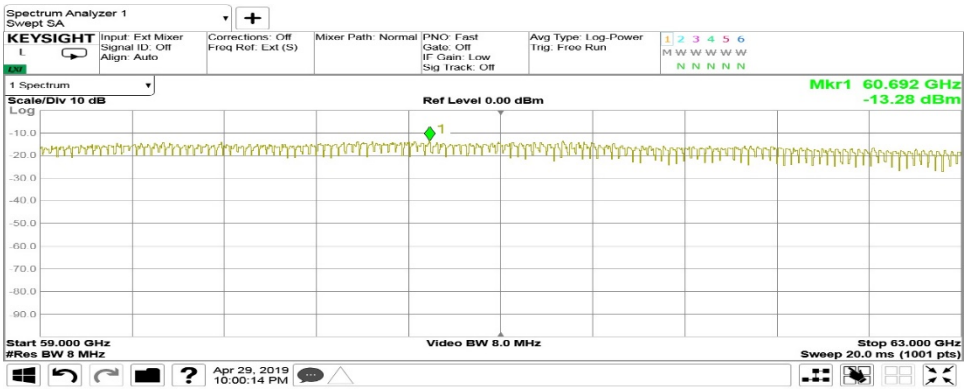


Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24 VDC
Remarks:			

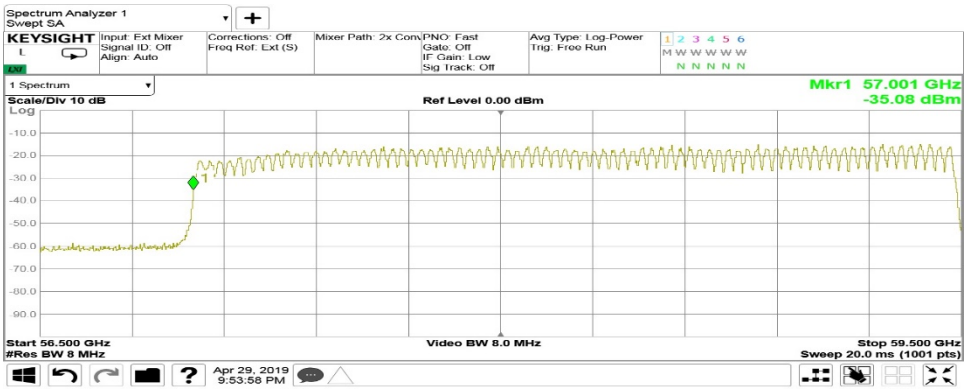
Plot 7.2.2 Occupied bandwidth test result – right side



Plot 7.2.3 Occupied bandwidth test result – central side



Plot 7.2.4 Occupied bandwidth test result – left side



Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24VDC
Remarks:			

7.3 Out of band radiated emmisions below 40GHz

7.3.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m, dB(μV/m)*				
	Within restricted bands			Harmonics outside restricted bands	
	Peak	Quasi Peak	Average	Peak	Average
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	NA	NA
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			
1000 – 40000	74.0	NA	54.0		

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

$$Lim_{S2} = Lim_{S1} + 40 \log (S_1/S_2),$$

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

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

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

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 specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna was rotated around its vertical axis.

7.3.2.3 The worst test results (the lowest margins) were recorded in Table 7.3.2 and shown in the associated plots.

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

7.3.3.1 The EUT was set up as shown in Figure 7.3.2, Figure 7.3.3 energized and the performance check was conducted.

7.3.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

7.3.3.3 The worst test results (the lowest margins) were recorded in Table 7.3.2, Table 7.3.4 and shown in the associated plots.

Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24VDC
Remarks:			

Figure 7.3.3Figure 7.3.1 Setup for spurious emission field strength measurements below 30 MHz

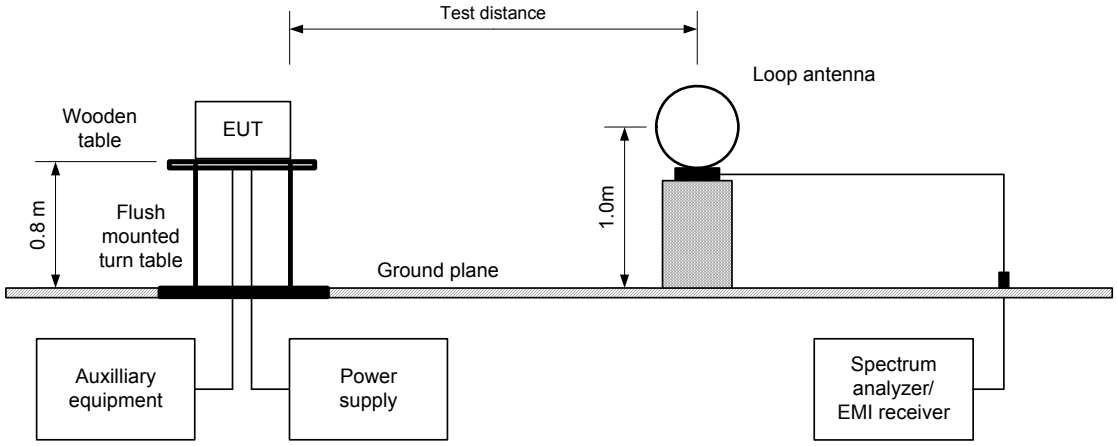
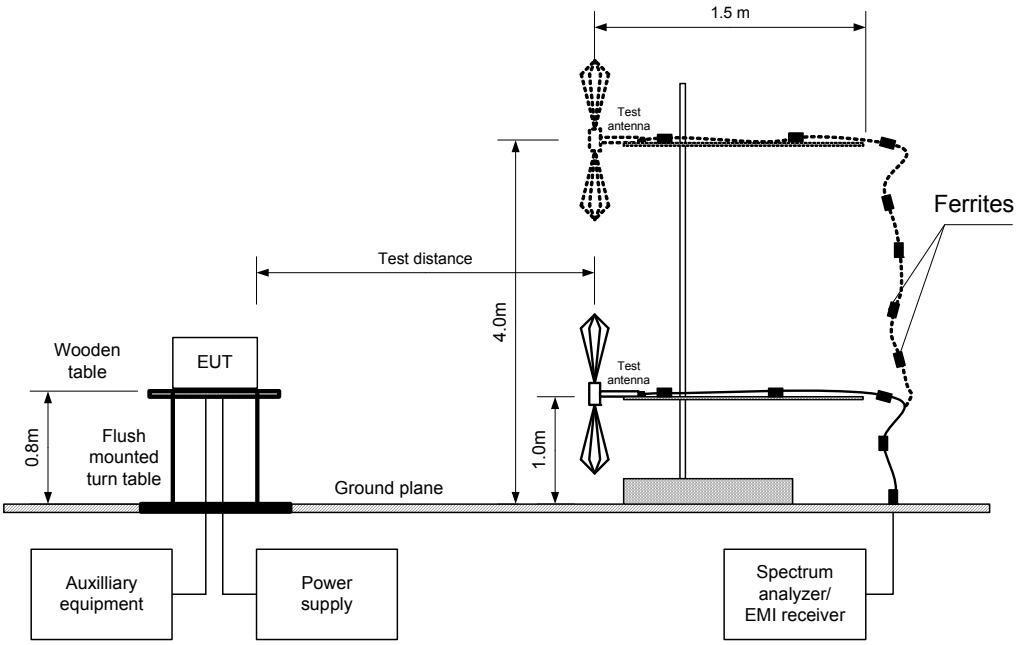
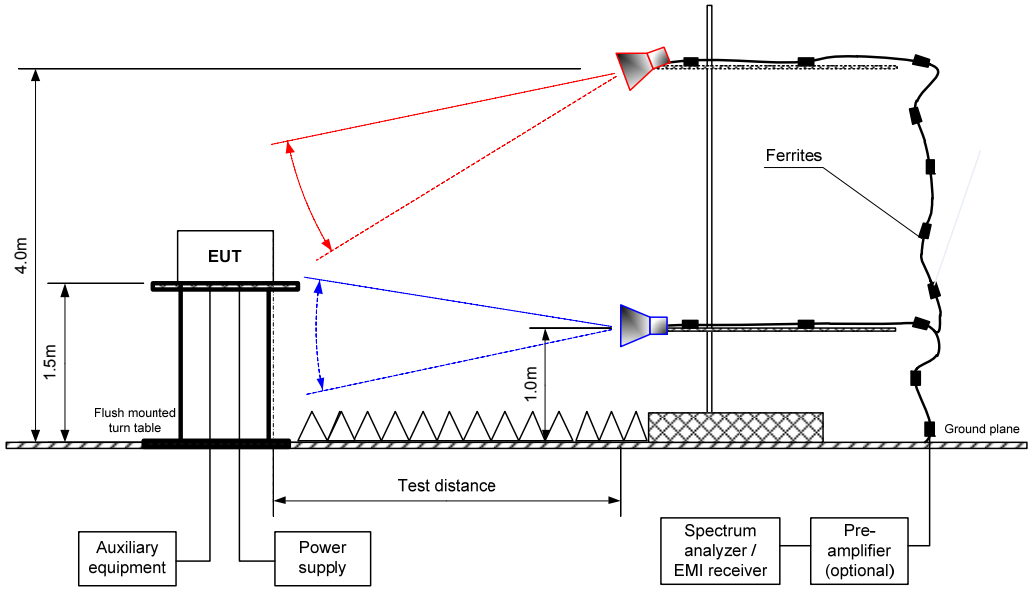


Figure 7.3.2 Setup for spurious emission field strength measurements in 30 – 1000 MHz



Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24VDC
Remarks:			

Figure 7.3.3 Setup for spurious emission field strength measurements above1000 MHz



Test specification:	**Section 15.255(c)(2), Out of band radiated emissions below 40 GHz**		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	**Relative Humidity:** 48 %	**Air Pressure:** 1013 hPa	**Power:** 24VDC
Remarks:			

Table 7.3.2 Field strength emission, spurious emissions at frequencies above 1 GHz

TEST DISTANCE:	3 m
EUT POSITION:	Typical (Vertical)
MODULATION:	FMCW
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
INVESTIGATED FREQUENCY RANGE:	0.009 - 40000 MHz
DETECTOR USED:	Peak
RESOLUTION BANDWIDTH:	0.2 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:	Double ridged guide (above 1000 MHz)

F, MHz	Antenna		Azimuth, degrees*	Peak field strength			Average field strength			Verdict
	Polarization	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
9103.79	Vertical	102.0	-9.0	59.70	74.00	14.30	42.76	54.00	-11.24	Pass
17496.0	Horizontal	166.0	-167.0	51.92	74.00	22.08	37.99	54.00	-16.01	
28512.3	Vertical	100.0	-122.0	50.05	74.00	-23.95	43.53	54.00	-10.47	
32500.2	Horizontal	100.0	-165.0	53.43	74.00	-20.57	48.18	54.00	-5.82	
38429.9	Horizontal	100.0	-180.0	60.48	74.00	-13.52	51.84	54.00	-2.16	

*- EUT front panel refers to 0 degrees position of turntable.
**- Margin = dB below (negative if above) specification limit.
*** Max value was obtained in X (Y, Z)-axis orthogonal position and at Unom (115%Unom, 85%Unom) input power voltage.

Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24VDC
Remarks:			

Table 7.3.3 Field strength of emissions below 1 GHz

TEST DISTANCE:	3 m
EUT POSITION:	Typical (Horizontal)
MODULATION:	FMCW
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
INVESTIGATED FREQUENCY RANGE:	0.009 – 1000 MHz
DETECTOR USED:	Peak
RESOLUTION BANDWIDTH:	0.2 kHz (9 kHz – 150 kHz) 9.0 kHz (150 kHz – 30 MHz) 120 kHz (30 MHz – 1000 MHz) 1 MHz above 1 GHz
VIDEO BANDWIDTH:	≥ Resolution bandwidth
TEST ANTENNA TYPE:	Active loop (9 kHz – 30 MHz) Biconilog (30 MHz – 1000 MHz)

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, cm	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
1.576258	58.31	52.87	63.68	-10.81	Vertical	100.0	-70.0	Pass
3.294326	59.69	55.84	69.50	-13.66	Vertical	100.0	-7.0	
129.481333	39.79	35.10	43.50	-8.40	Vertical	100.0	-29.0	
140.051000	38.10	33.16	43.50	-10.34	Vertical	101.0	22.0	
150.492000	35.57	30.60	43.50	-12.90	Horizontal	220.0	-162.0	
207.778167	33.52	30.17	43.50	-13.33	Horizontal	131.0	-172.0	
469.472333	40.20	33.16	46.00	-12.84	Horizontal	174.0	-97.0	
669.480167	41.04	34.49	46.00	-11.51	Horizontal	131.0	38.0	

*- Margin = Measured emission - specification limit.
**- EUT front panel refer to 0 degrees position of turntable.

Reference numbers of test equipment used

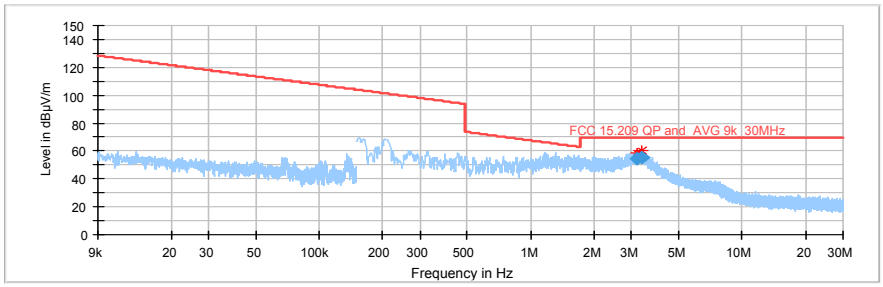
HL 4360	HL 5288	HL 4933	HL 4956	HL 5032	HL 3903
HL 5111	HL 5405	HL 446			

Full description is given in Appendix A.

Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24VDC
Remarks:			

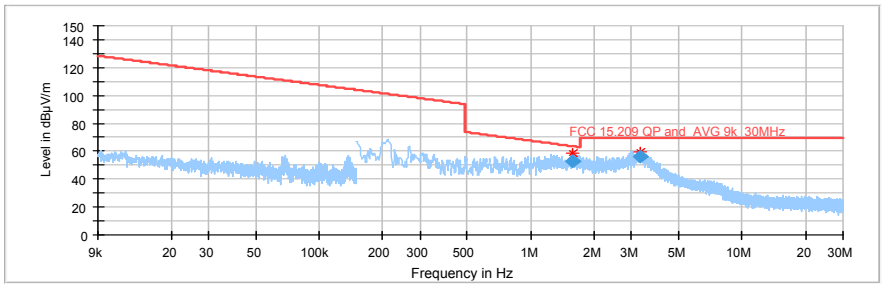
Plot 7.3.1 Radiated emission measurements from 9 kHz – 30 MHz, low frequency

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



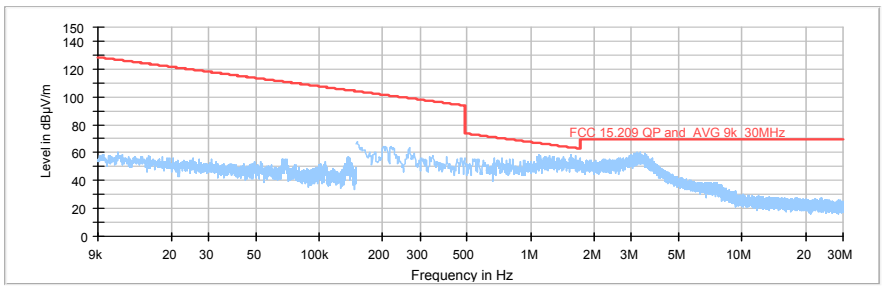
Plot 7.3.2 Radiated emission measurements from 9 kHz – 30 MHz, mid frequency

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



Plot 7.3.3 Radiated emission measurements from 9 kHz – 30 MHz, high frequency

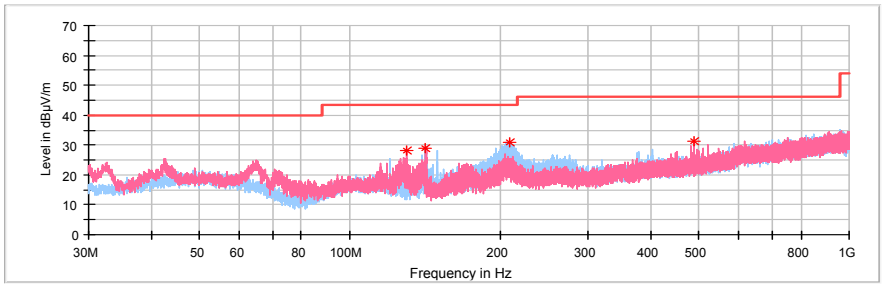
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Horizontal)



Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24VDC
Remarks:			

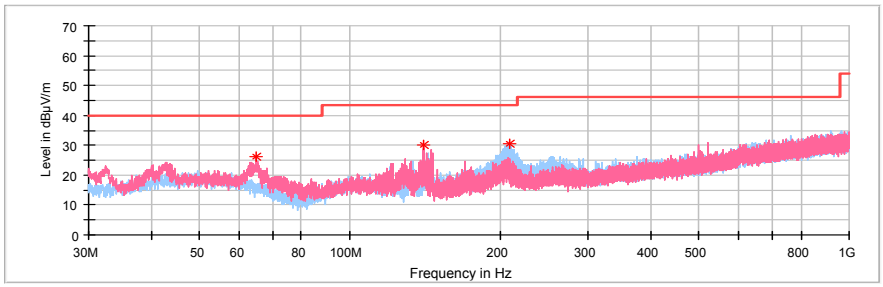
Plot 7.3.4 Radiated emission measurements from 30 to 1000 MHz, low frequency

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



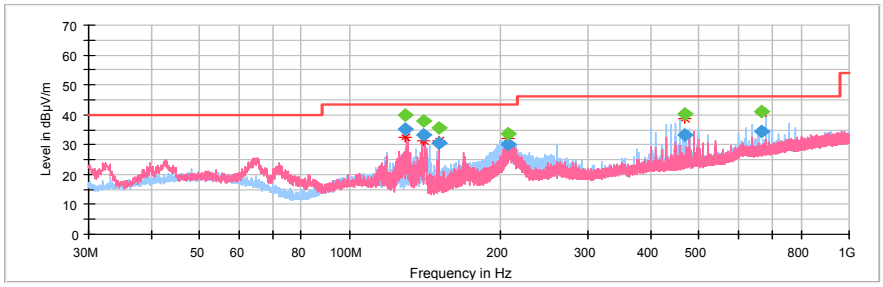
Plot 7.3.5 Radiated emission measurements from 30 to 1000 MHz, mid frequency

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



Plot 7.3.6 Radiated emission measurements from 30 to 1000 MHz, high frequency

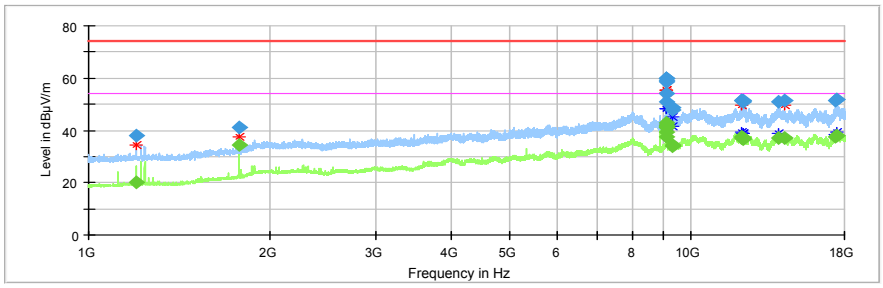
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Horizontal)



Plot 7.3.7 Radiated emission measurements from 1.0 to 18 GHz, low frequency

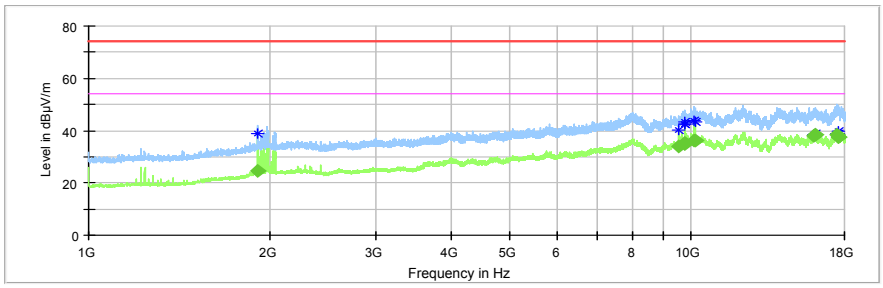
Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24VDC
Remarks:			

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



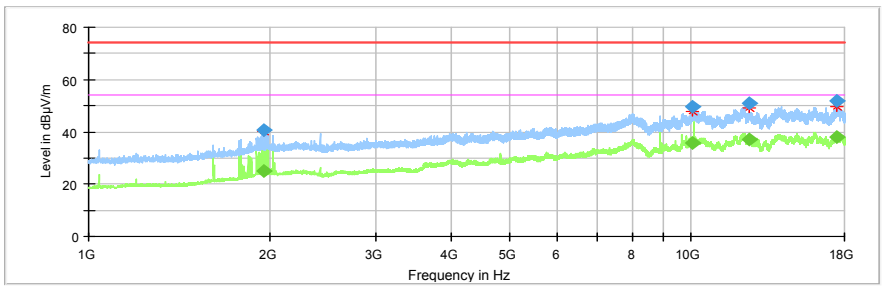
Plot 7.3.8 Radiated emission measurements from 1.0 to 18 GHz, mid frequency

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



Plot 7.3.9 Radiated emission measurements from 1.0 to 18 GHz, high frequency

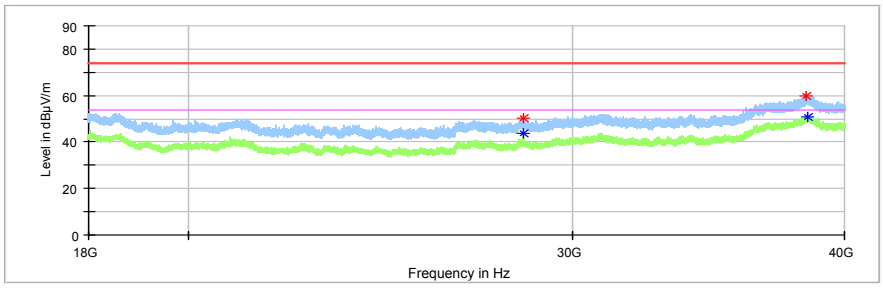
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Horizontal)



Plot 7.3.10 Radiated emission measurements from 18.0 to 40.0 GHz, low frequency

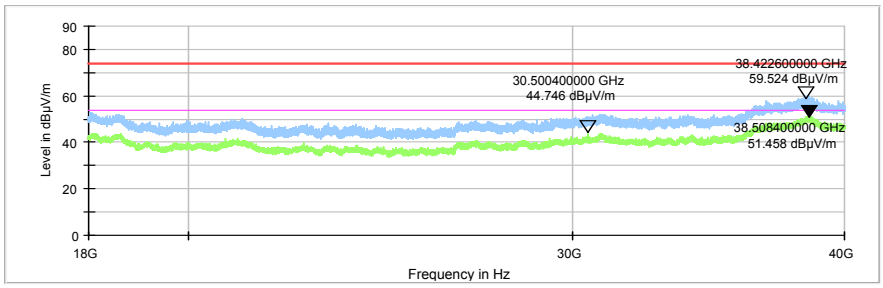
Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19 - 27-May-19		
Temperature: 22 ºC	Relative Humidity: 48 %	Air Pressure: 1013 hPa	Power: 24VDC
Remarks:			

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



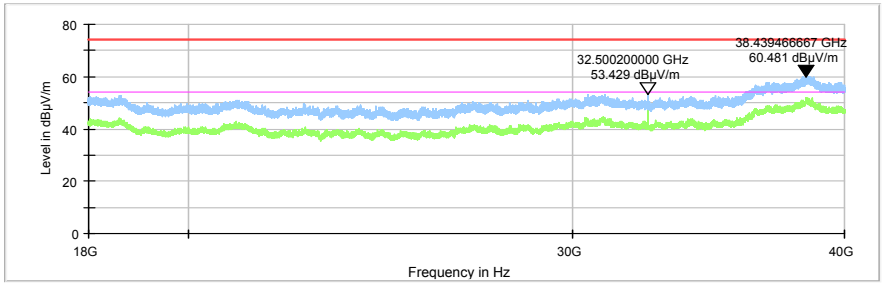
Plot 7.3.11 Radiated emission measurements from 18.0 to 40.0 GHz, mid frequency

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



Plot 7.3.12 Radiated emission measurements from 18.0 to 40.0 GHz, high frequency

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



Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

7.4 Out of band radiated emissions above 40 GHz up to 200 GHz

7.4.1 General

This test was performed to measure radiated spurious emissions from the EUT. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Spurious emission field strength limits

Frequency, GHz	Power density at 3 m distance pW/cm^2	Distance, m	Field strength dB(μV/m)*, peak	Field strength dB(μV/m)*, average
40 – 220	90.0	3.0	105.30	85.30
60 - 90	90.0	1.0	114.8**	94.8
90 - 140	90.0	0.10	114.8**	114.8**
140 - 200	90.0	0.005	160.90**	140.90**

*- The limit is provided in average values.

**- The limit for 1 m and other test distance was calculated using the inverse distance extrapolation factor as follows:

for far field: $Lim_{S2} = Lim_{S1} + 20 \log (S_1/S_2)$,

where S_1 – standard defined distance in meters;

S_2 – measurement distance in meters (according to ANSI C63.10)

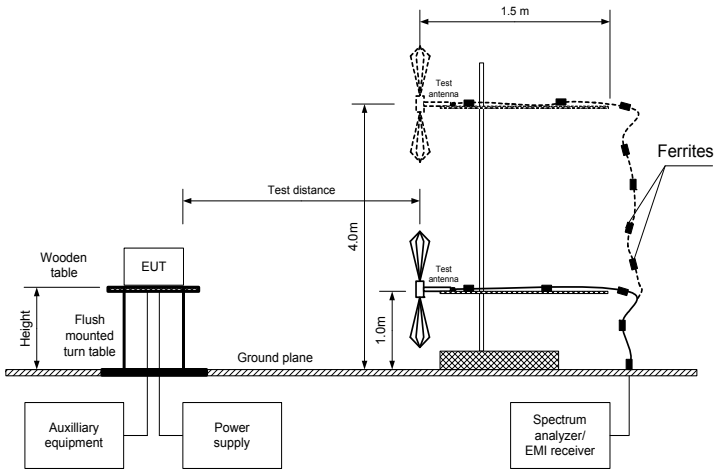
7.4.2 Test procedure for spurious emission field strength measurements

7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized and the performance check was conducted.

7.4.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

7.4.2.3 The test results were recorded in Table 7.4.2 and are shown in the associated plots.

Figure 7.4.1 Spurious emission field strength above 40 GHz test set up



Test specification:	**Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz**		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	**Relative Humidity:** 54 %	**Air Pressure:** 1002 hPa	**Power:** 24 VDC
Remarks:			

Test specification:	**Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz**		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	**Relative Humidity:** 54 %	**Air Pressure:** 1002 hPa	**Power:** 24 VDC
Remarks:			

Table 7.4.2 Spurious emission field strength test results

TEST DISTANCE:	0.005 - 3 m
EUT POSITION:	Typical (Vertical)
MODULATION:	FMCW
TRANSMITTER OUTPUT POWER:	Maximum
INVESTIGATED FREQUENCY RANGE:	40 – 200 GHz
RESOLUTION BANDWIDTH:	1000 kHz
VIDEO BANDWIDTH:	≥ Resolution bandwidth
TEST ANTENNA TYPE:	Standard Gain Horn 24 dB (40-60 GHz) Standard Gain Horn 24 dB (50-75 GHz) Standard Gain Horn 24 dB (75-110 GHz) Standard Gain Horn 24dB (90-140 GHz) Standard Gain Horn 24 dB (140-220 GHz)

Frequency, MHz	**Antenna**		**Azimuth, degrees***	**Peak field strength(VBW=3 MHz)**			**Average field strength(VBW=1 kHz)**			**Verdict**
	Polariz.	**Height, m**		**Measured, dB(μV/m)**	**Limit, dB(μV/m)**	**Margin, dB****	**Measured, dB(μV/m)**	**Limit, dB(μV/m)**	**Margin, dB****	
Low carrier frequency 57024.0 MHz										
No emissions were found										Pass
Mid carrier frequency 61000.0 MHz										
No emissions were found										Pass
High carrier frequency 65000.0 MHz										
No emissions were found										Pass

*- EUT front panel refer to 0 degrees position of turntable.
**- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

HL 0747	HL 0770	HL 0771	HL 0772	HL 1301	HL 1303	HL 1312	HL 2909
HL 3235	HL 3295	HL 3296	HL 3297	HL 3305	HL 3306	HL 3329	HL 3433
HL 3434	HL 3536	HL 4023					

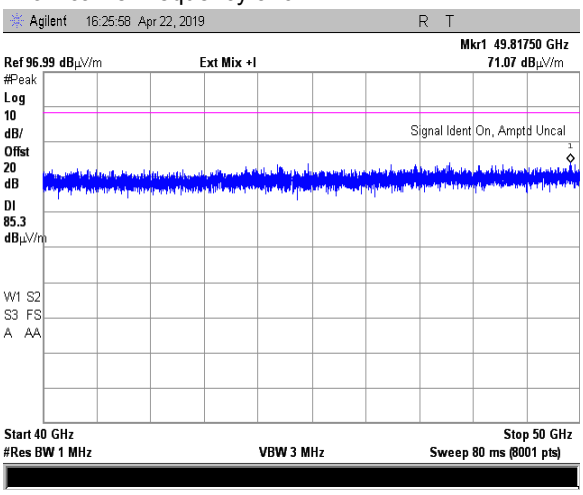
Full description is given in Appendix A.

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

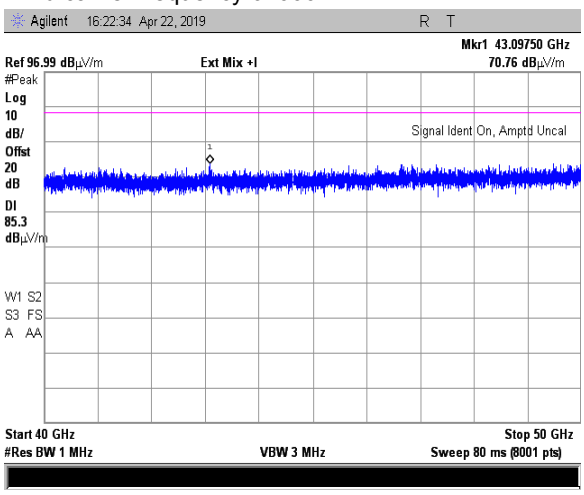
Plot 7.4.1 Spurious emission measurements from 40 to 50 GHz at the low frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak

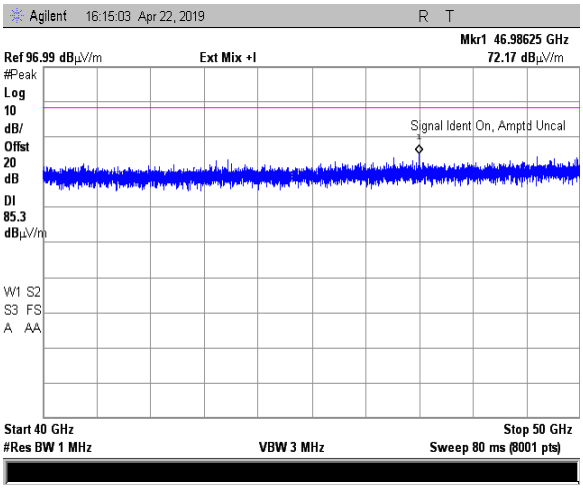
Low carrier frequency 57024 MHz



Mid carrier frequency 61000 MHz



High carrier frequency 65000 MHz

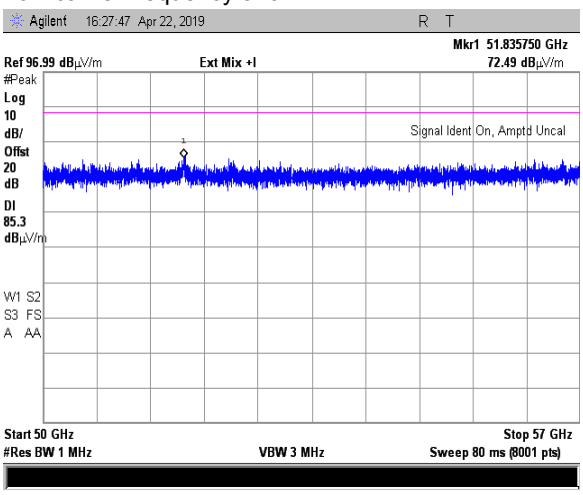


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

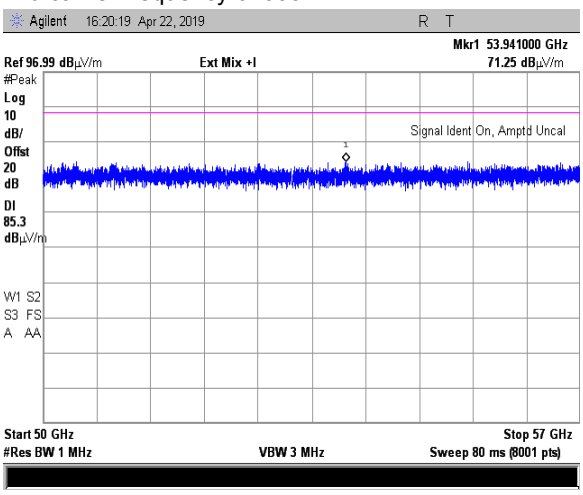
Plot 7.4.2 Spurious emission measurements in 50 – 57 GHz range

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak

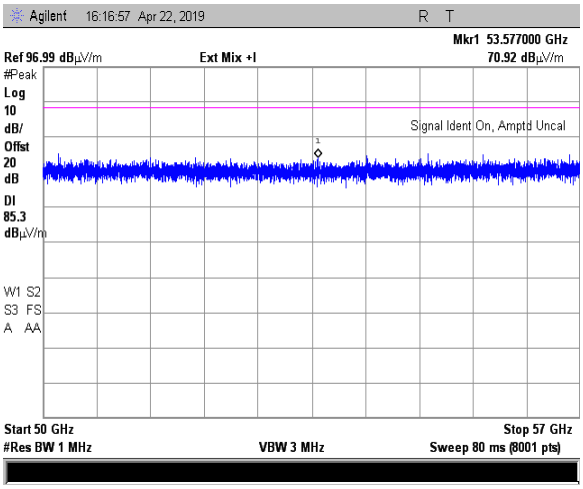
Low carrier frequency 57024 MHz



Mid carrier frequency 61000 MHz



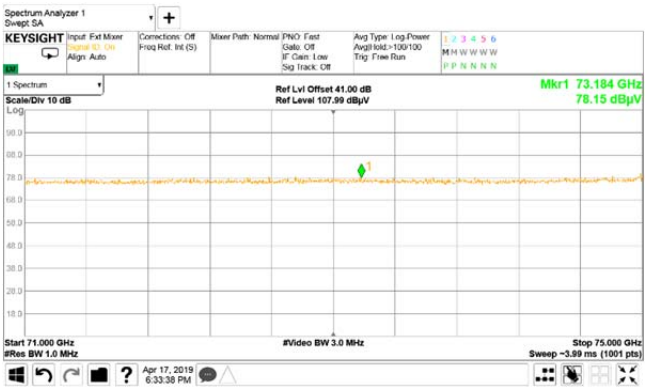
High carrier frequency 65000 MHz



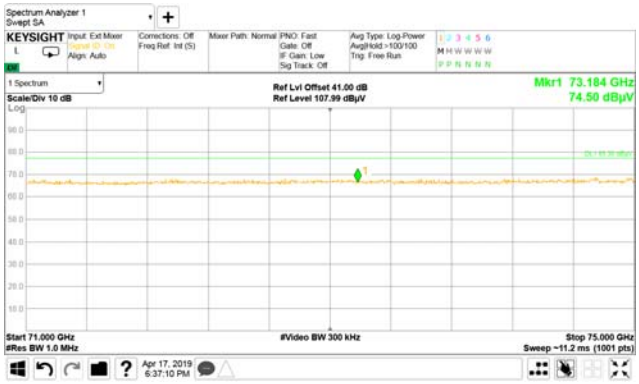
Test specification:	**Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz**		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	**Relative Humidity:** 54 %	**Air Pressure:** 1002 hPa	**Power:** 24 VDC
Remarks:			

Plot 7.4.3 Spurious emission measurements in 71 – 75 GHz range

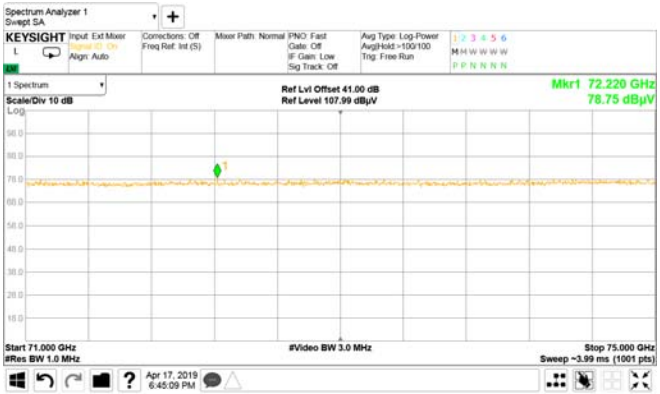
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz

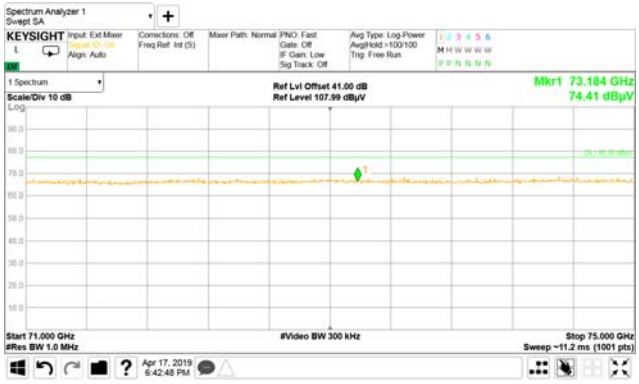


DETECTOR: Peak
RBW = 1MHz; VBW = 300 kHz



Mid carrier frequency 61000 MHz

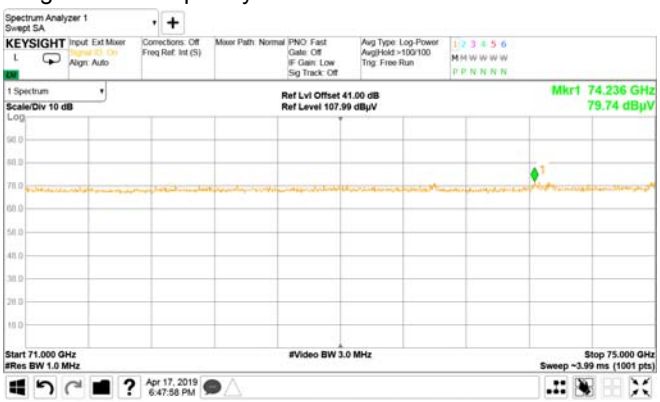


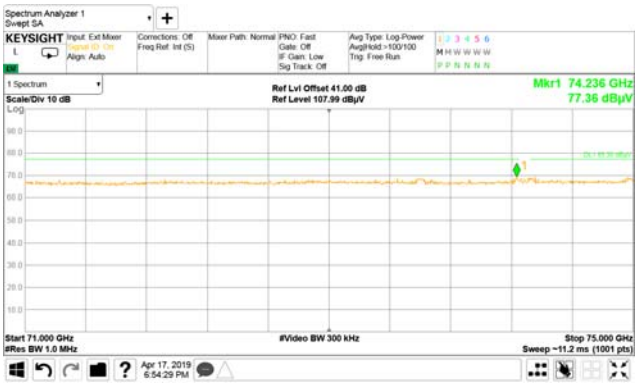


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.3 Spurious emission measurements in 71 – 75 GHz range (continued)

High carrier frequency 65000 MHz



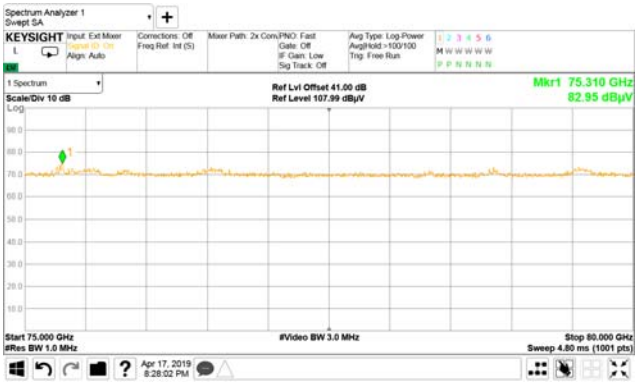


Limit 105.3 dBuV/m was applied

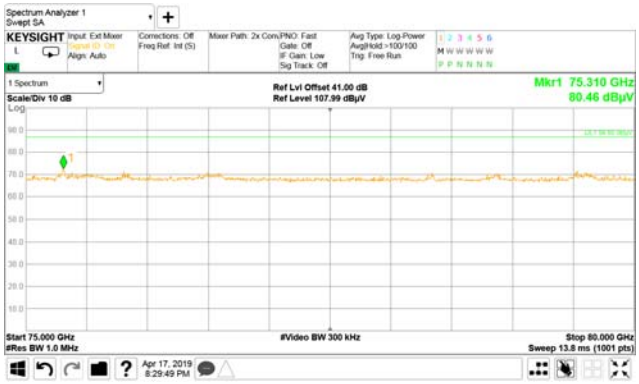
Test specification:	**Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz**		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	**Relative Humidity:** 54 %	**Air Pressure:** 1002 hPa	**Power:** 24 VDC
Remarks:			

Plot 7.4.4 Spurious emission measurements in 75 – 80 GHz range

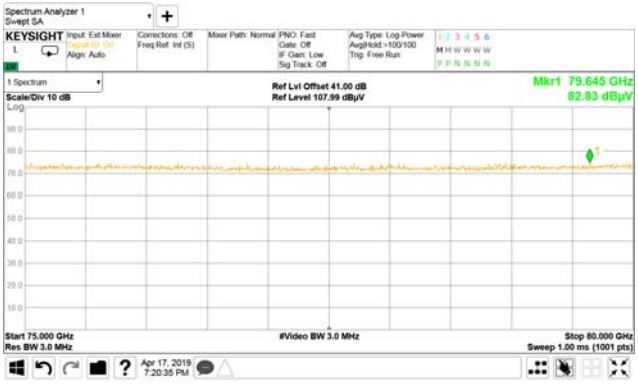
TEST SITE: OATS
TEST DISTANCE: 1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz

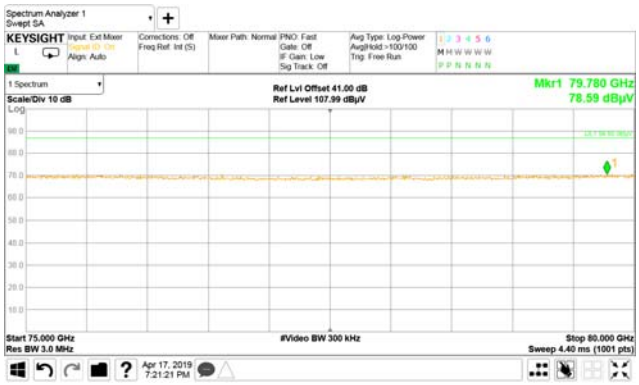


DETECTOR: Peak
RBW = 1MHz; VBW = 300 kHz



Mid carrier frequency 6100 MHz

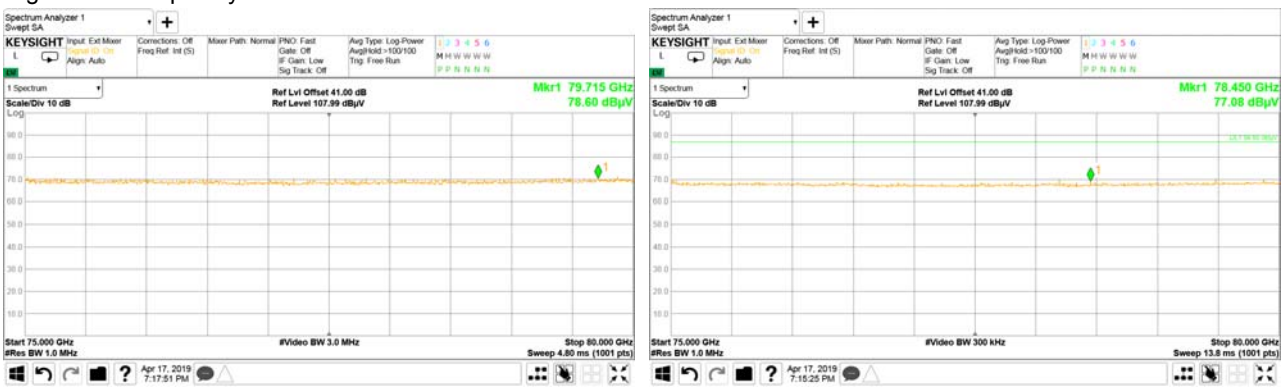




Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.4 Spurious emission measurements in 75 – 80 GHz range (continued)

High carrier frequency 6500 MHz

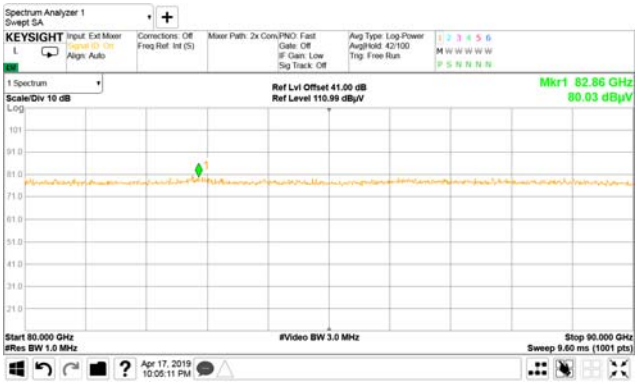


Limit 114.8 dBuV/m was applied

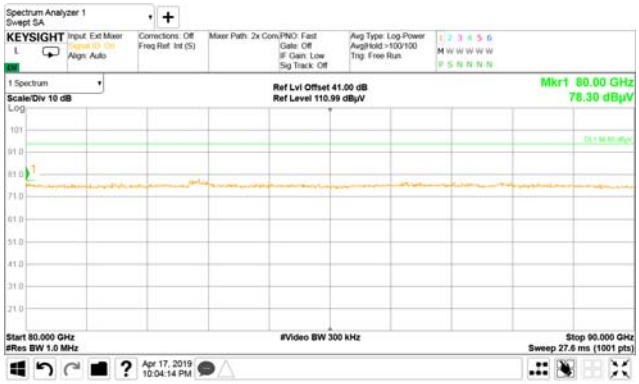
Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.5 Spurious emission measurements in 80 – 90 GHz range

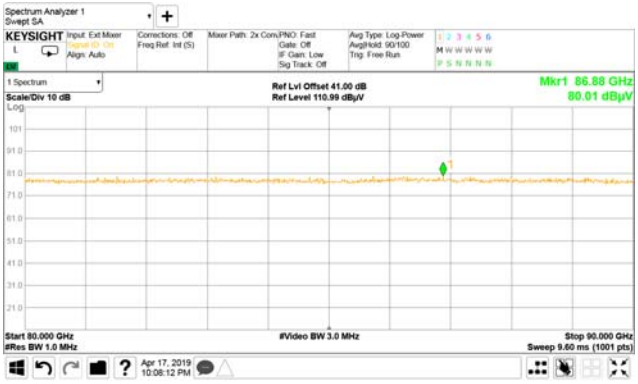
TEST SITE: OATS
TEST DISTANCE: 1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz

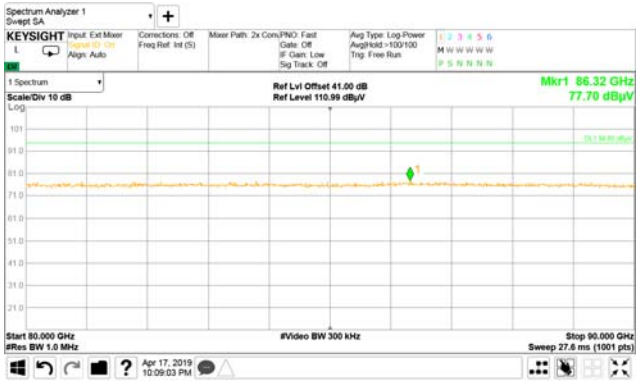


DETECTOR: Peak
RBW = 1MHz; VBW = 10 kHz



Mid carrier frequency 61000 MHz

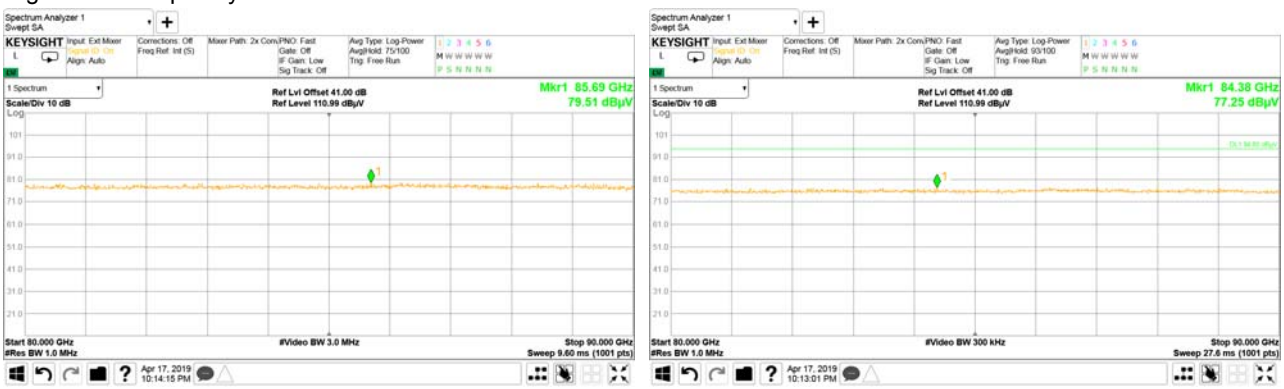




Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.5 Spurious emission measurements in 80 – 90 GHz range (continued)

High carrier frequency 65000 MHz

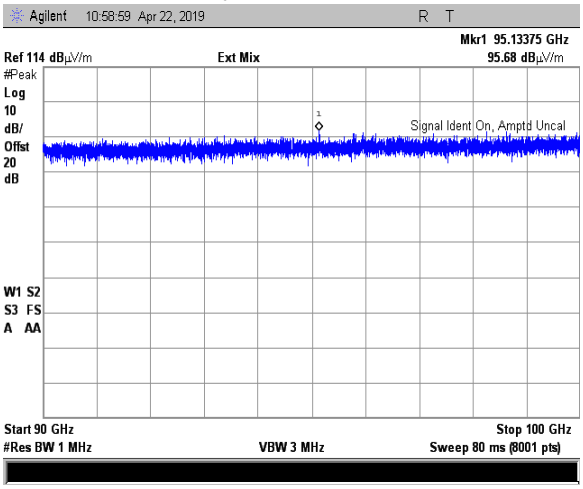


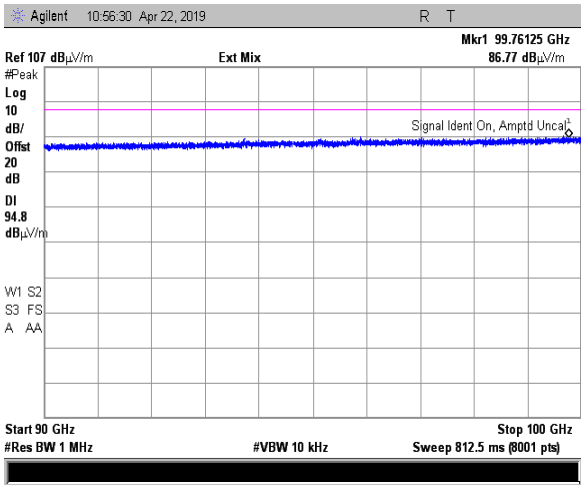
Limit 114.8 dBuV/m was applied

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

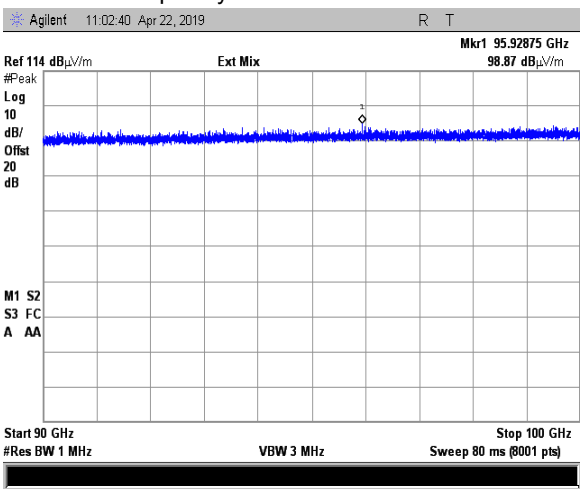
Plot 7.4.6 Spurious emission measurements in 90 – 100 GHz range

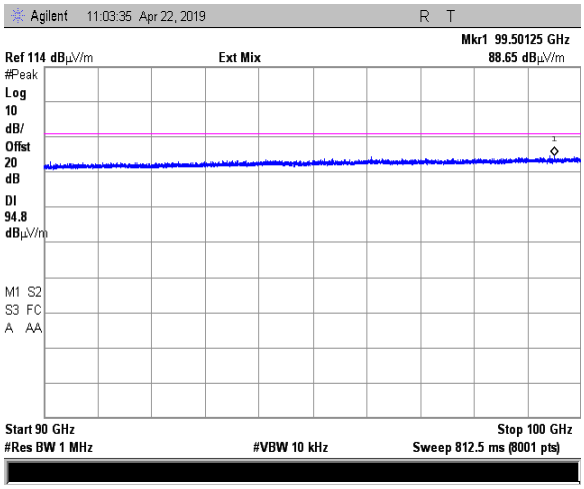
TEST SITE: OATS
TEST DISTANCE: 1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz





Mid carrier frequency 61000 MHz

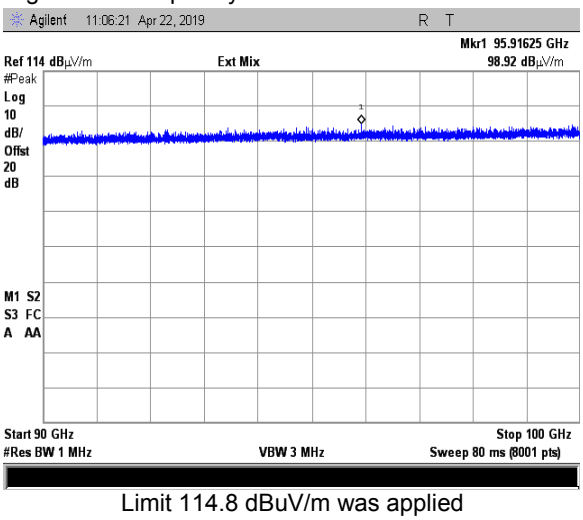


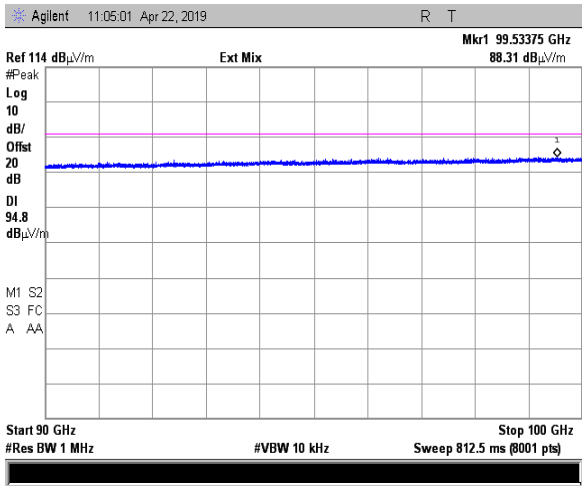


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.6 Spurious emission measurements in 90 – 100 GHz range (continued)

High carrier frequency 65000 MHz



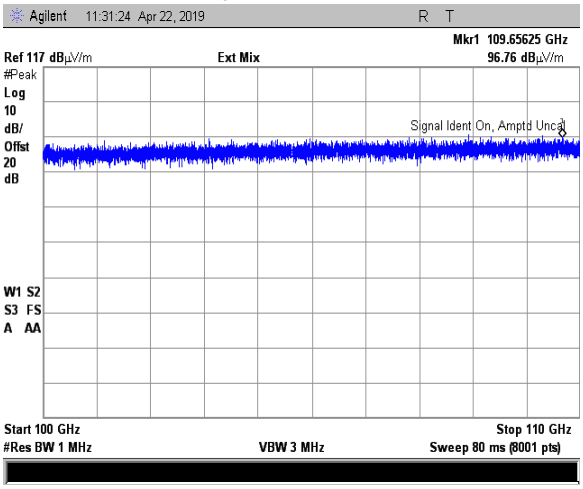


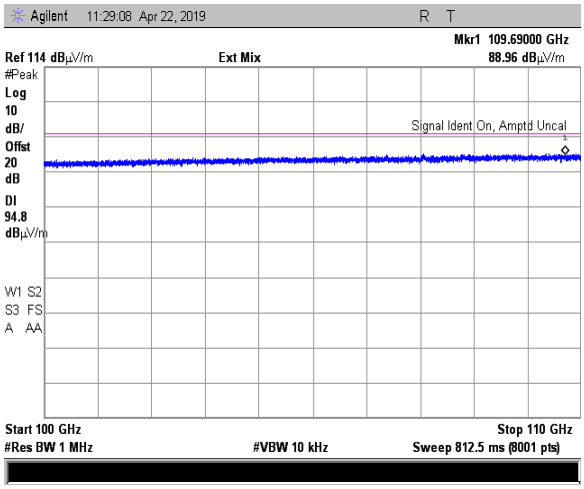
Limit 114.8 dBuV/m was applied

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

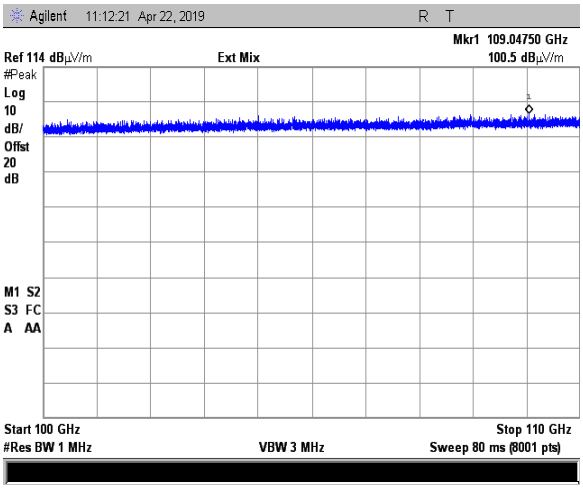
Plot 7.4.7 Spurious emission measurements in 100 – 110 GHz range

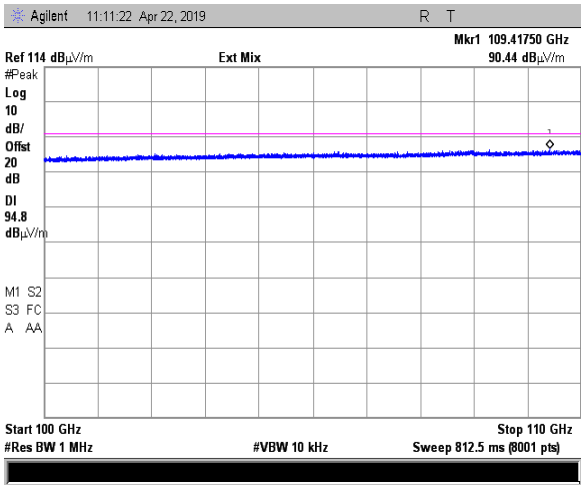
TEST SITE: OATS
TEST DISTANCE: 1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz





Mid carrier frequency 61000 MHz

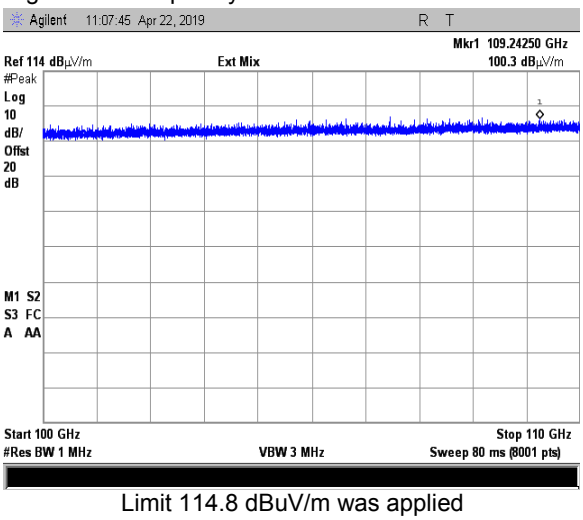


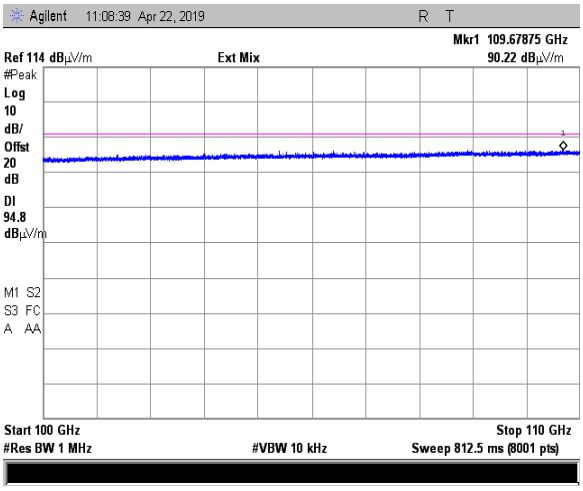


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.7 Spurious emission measurements in 100 – 110 GHz range (continued)

High carrier frequency 65000 MHz



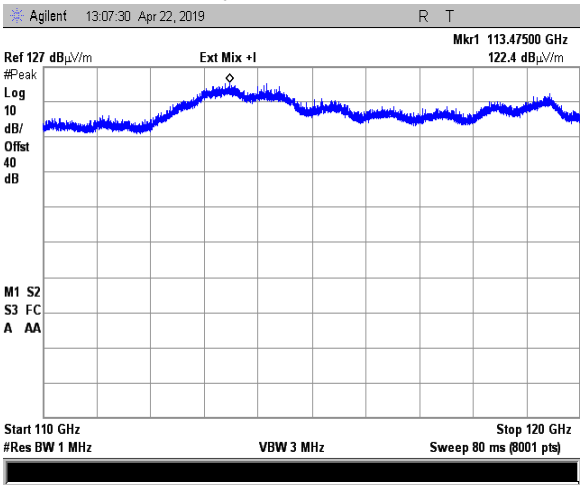


Limit 114.8 dBuV/m was applied

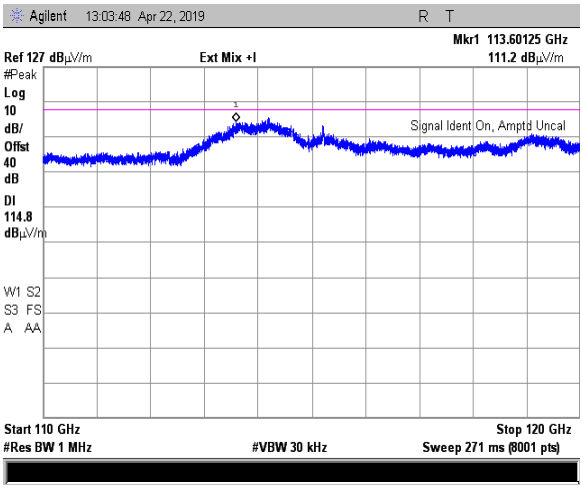
Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.8 Spurious emission measurements in 110 – 120 GHz range

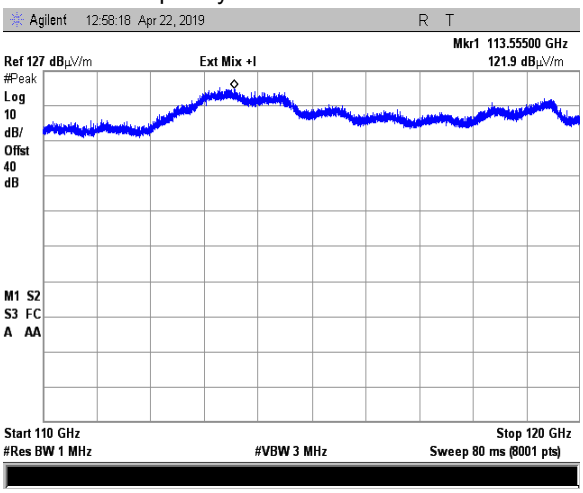
TEST SITE: OATS
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz

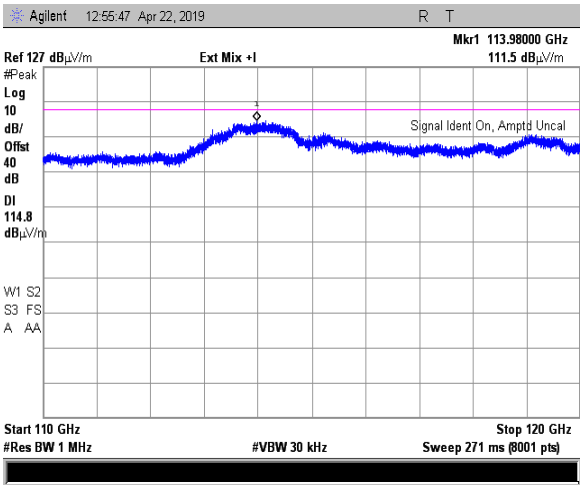


DETECTOR: Peak
RBW = 1MHz; VBW = 30 kHz



Mid carrier frequency 61000 MHz

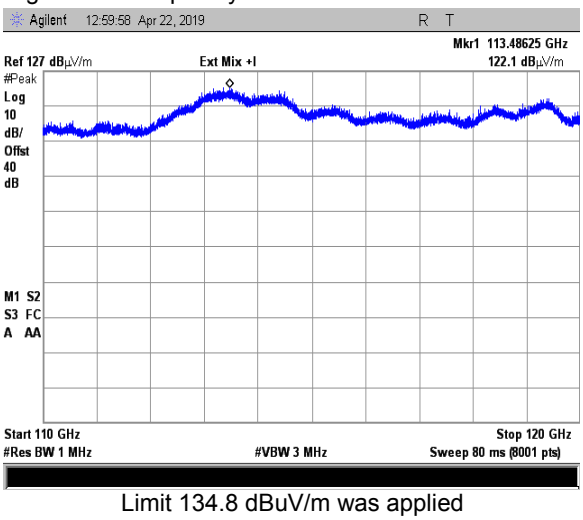


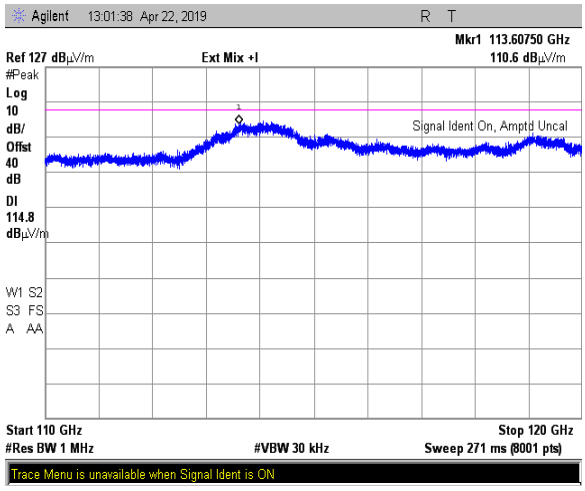


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.8 Spurious emission measurements in 110 – 120 GHz range (continued)

High carrier frequency 65000 MHz



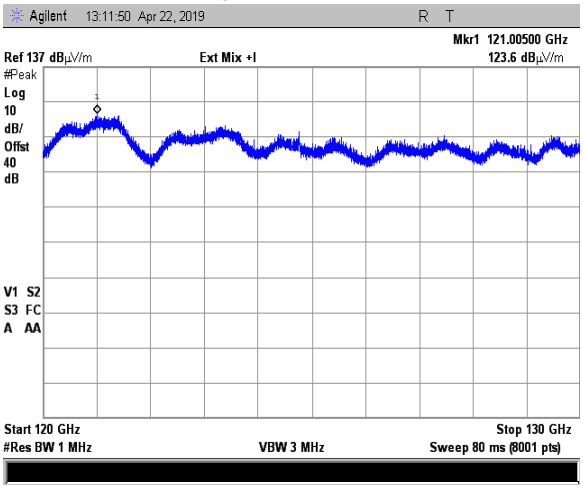


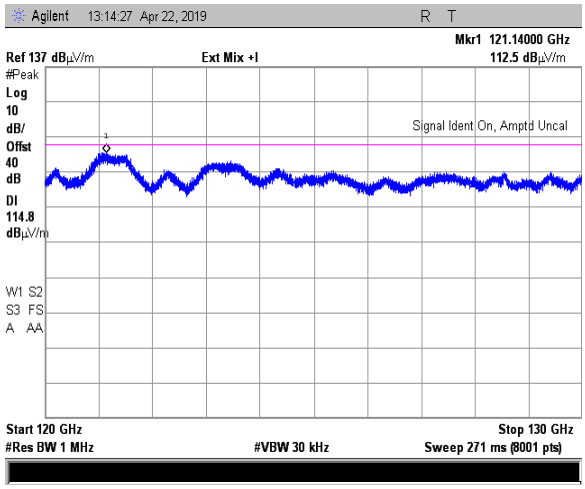
Limit 134.8 dBuV/m was applied

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

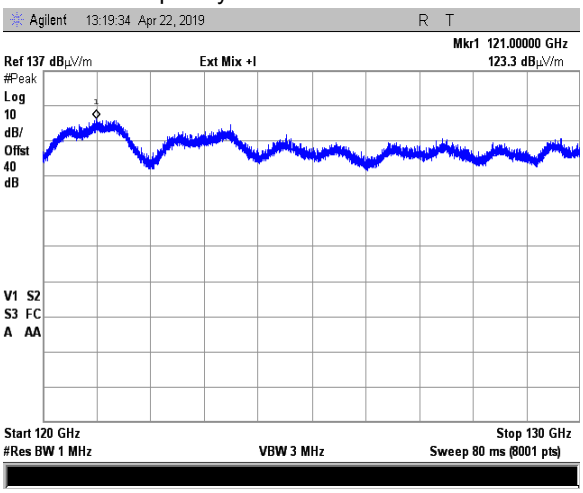
Plot 7.4.9 Spurious emission measurements in 120 – 130 GHz range

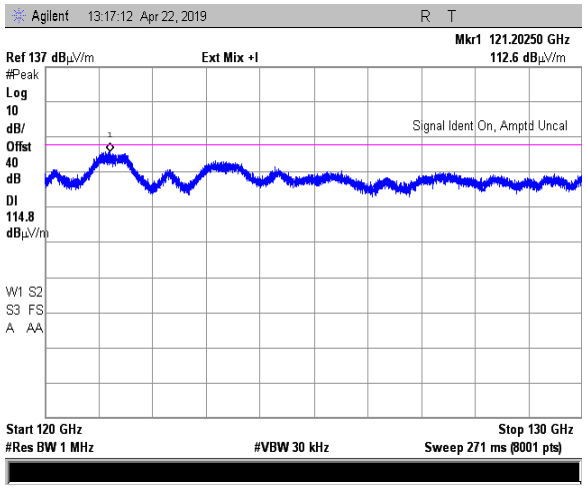
TEST SITE: OATS
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz





Mid carrier frequency 61000 MHz

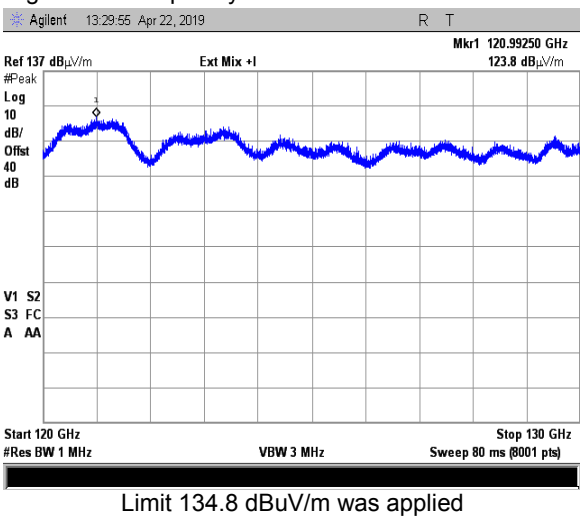


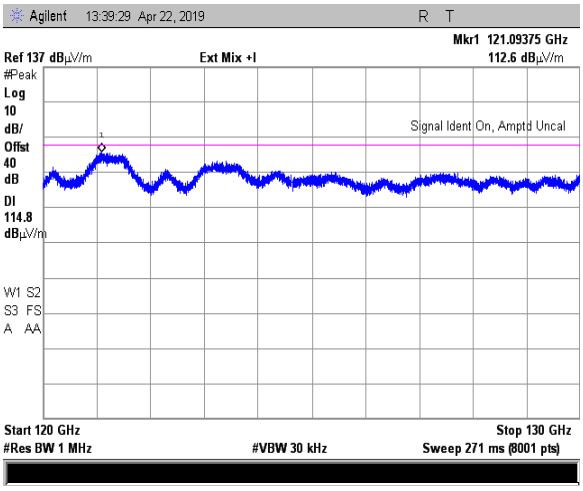


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.9 Spurious emission measurements in 120 – 130 GHz range (continued)

High carrier frequency 65000 MHz



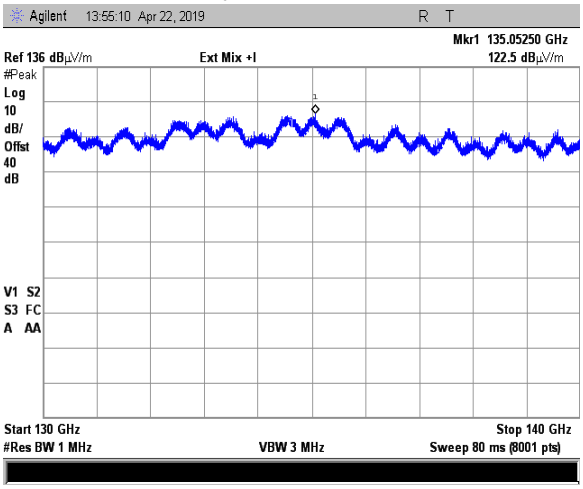


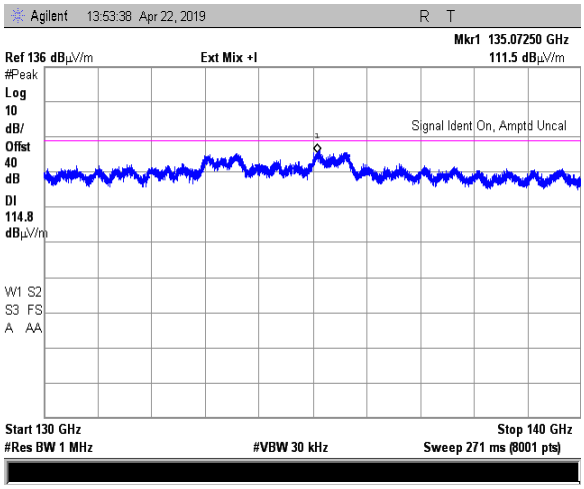
Limit 134.8 dBuV/m was applied

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

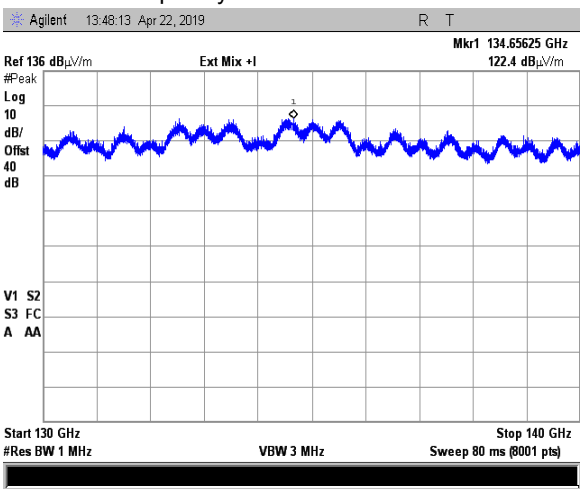
Plot 7.4.10 Spurious emission measurements in 130 – 140 GHz range

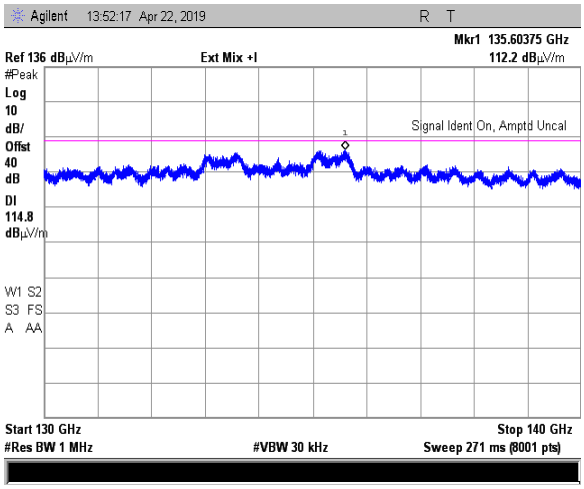
TEST SITE: OATS
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz





Mid carrier frequency 61000 MHz

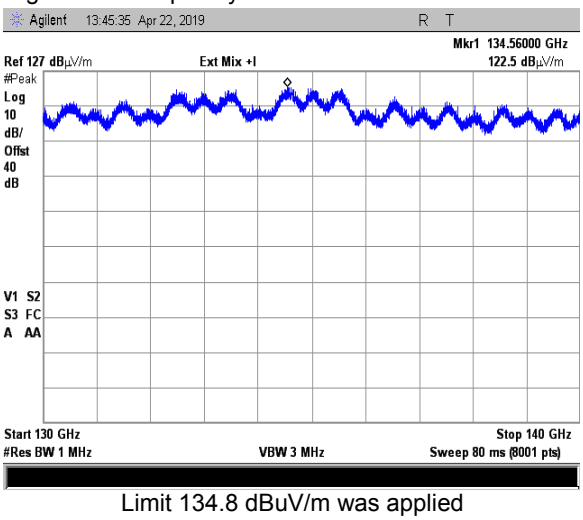


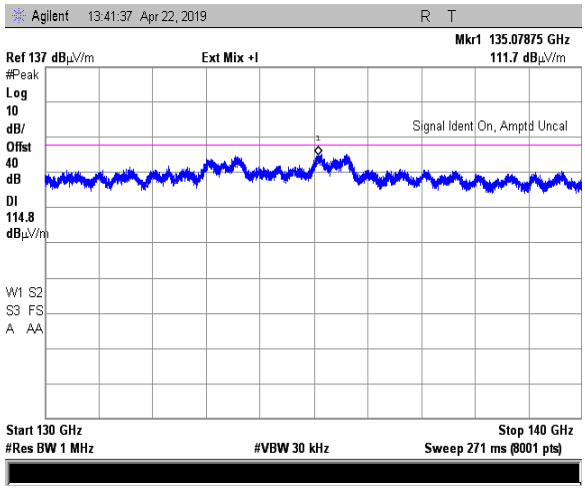


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.10 Spurious emission measurements in 130 – 140 GHz range (continued)

High carrier frequency 65000 MHz



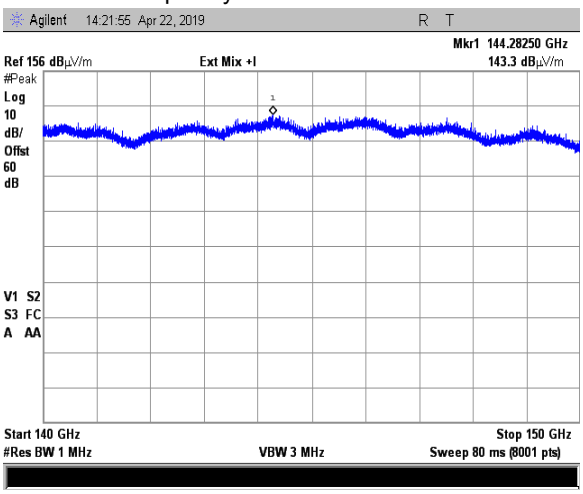


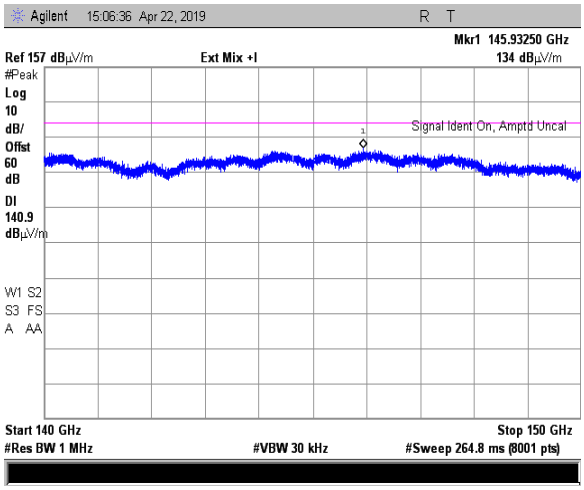
Limit 134.8 dBuV/m was applied

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

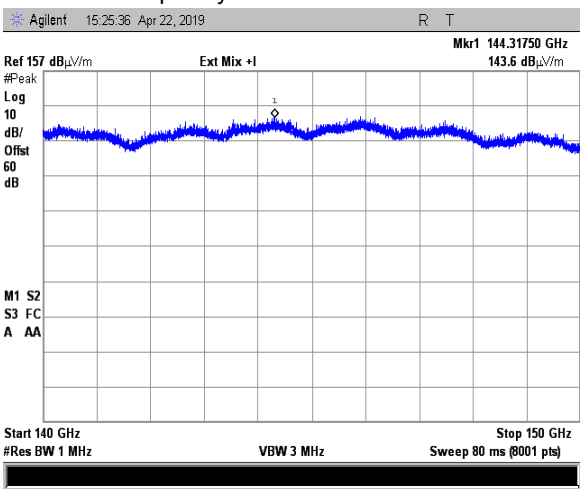
Plot 7.4.11 Spurious emission measurements in 140 – 150 GHz range

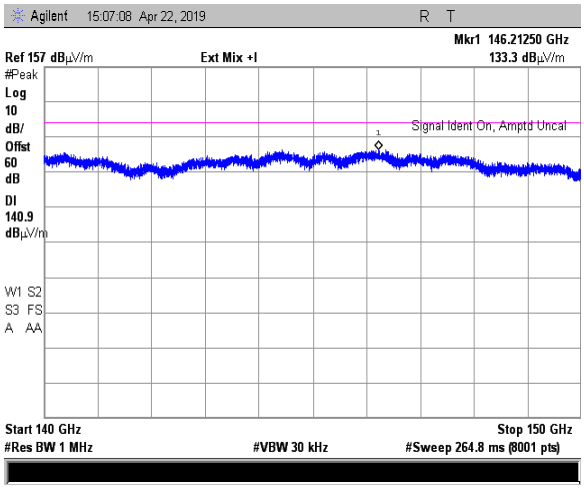
TEST SITE: OATS
TEST DISTANCE: 0.005 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz





Mid carrier frequency 61000 MHz

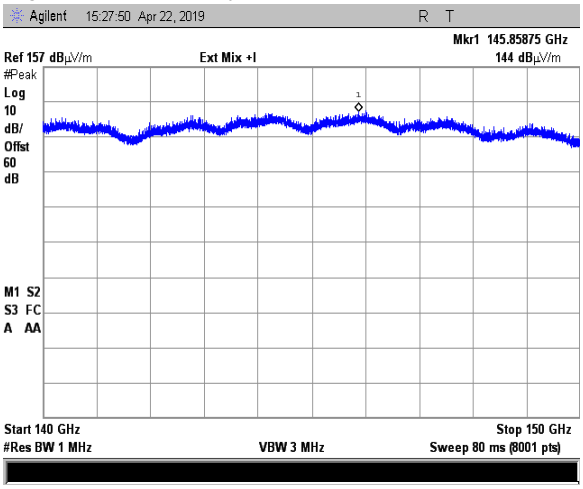


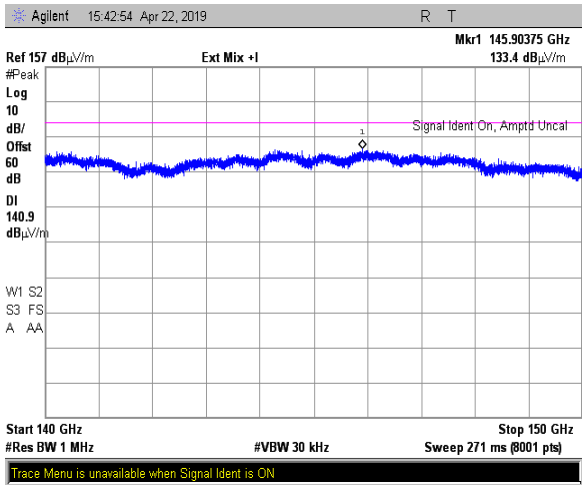


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.11 Spurious emission measurements in 140 – 150 GHz range (continued)

High carrier frequency 65000 MHz



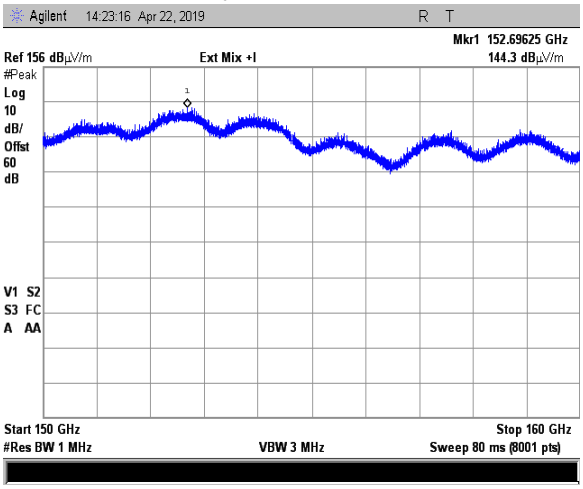


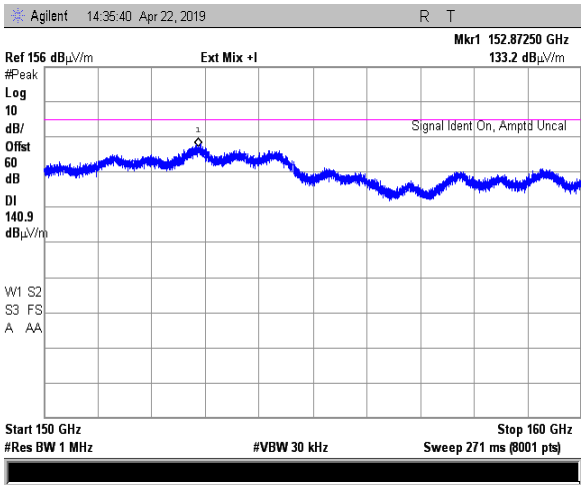
Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

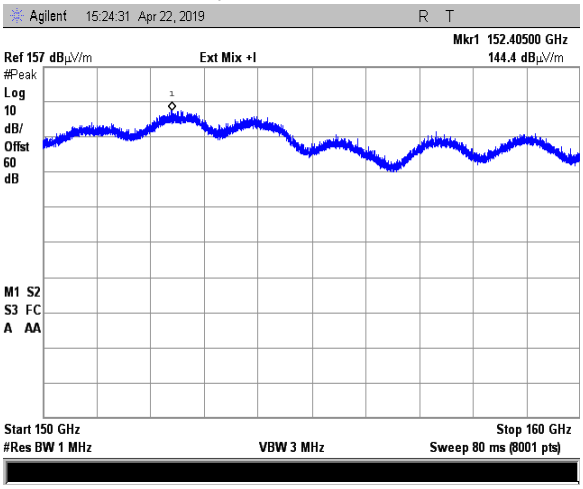
Plot 7.4.12 Spurious emission measurements in 150 – 160 GHz range

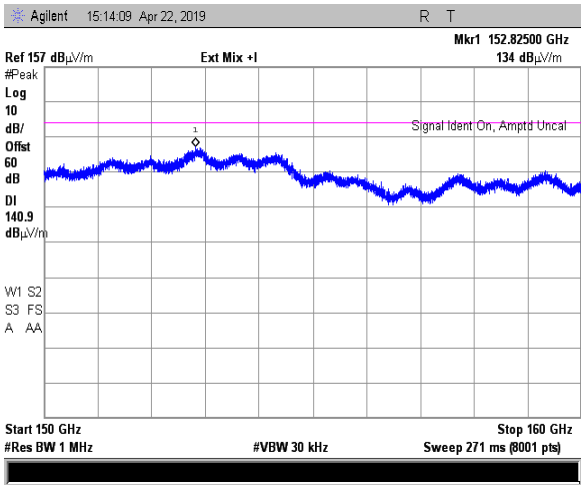
TEST SITE: OATS
TEST DISTANCE: 0.005 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz





Mid carrier frequency 61000 MHz

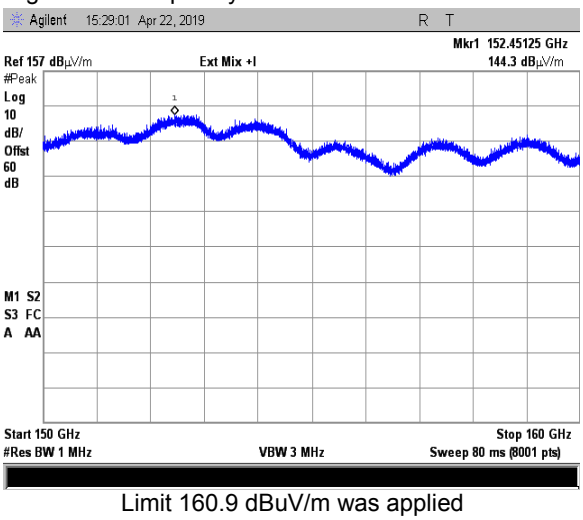


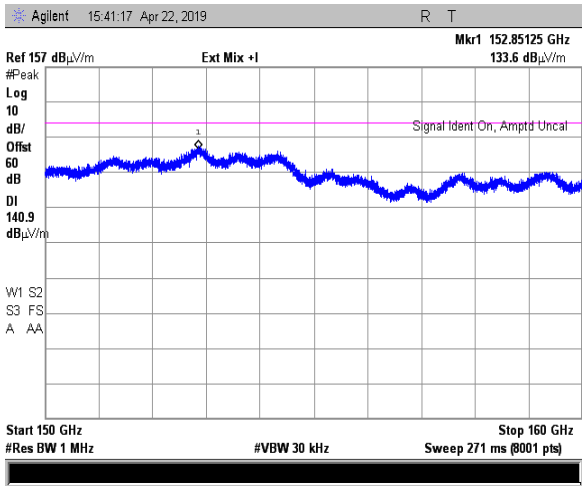


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.12 Spurious emission measurements in 150 – 160 GHz range (continued)

High carrier frequency 65000 MHz



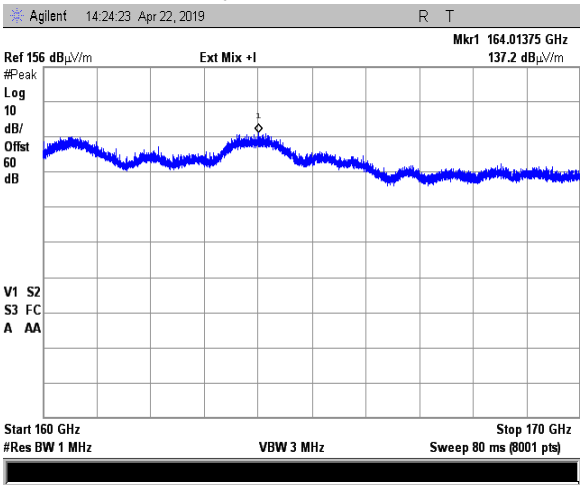


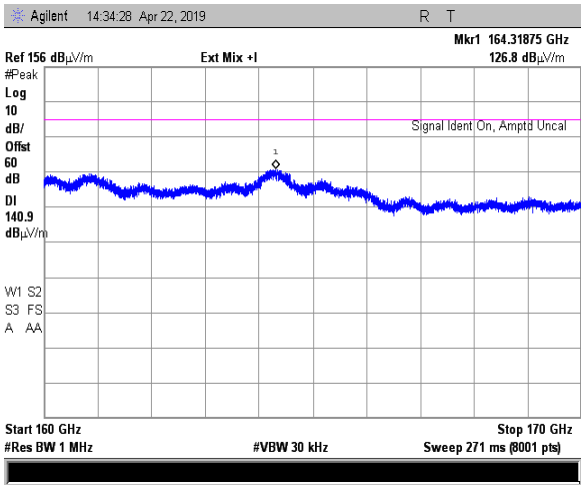
Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

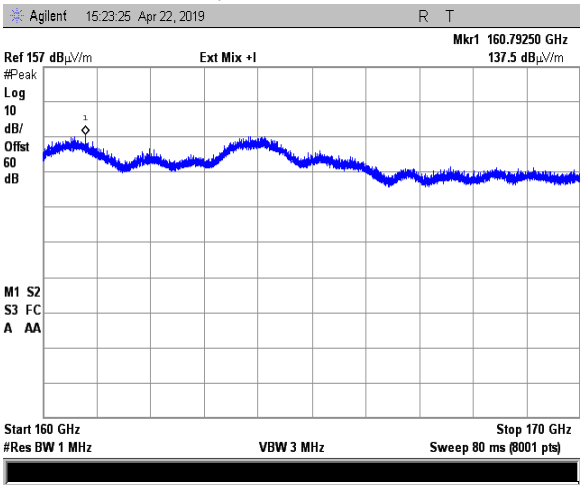
Plot 7.4.13 Spurious emission measurements in 160 – 170 GHz range

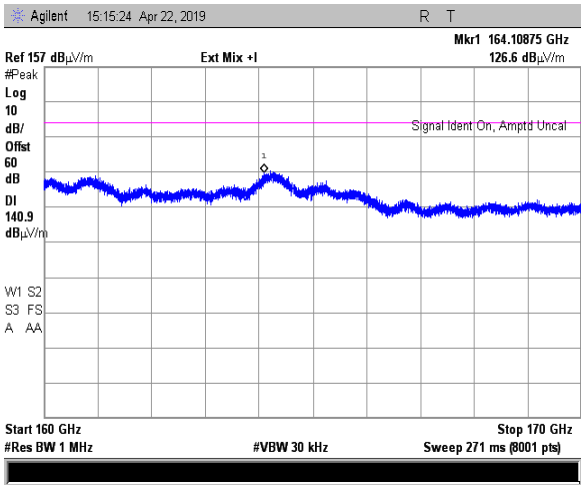
TEST SITE: OATS
TEST DISTANCE: 0.005 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 57024 MHz





Mid carrier frequency 61000 MHz

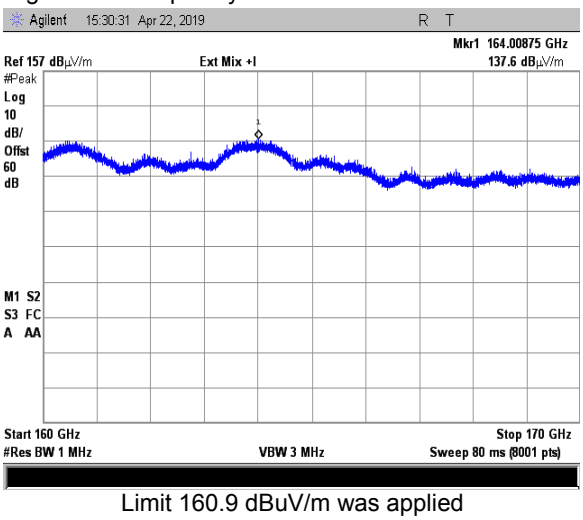


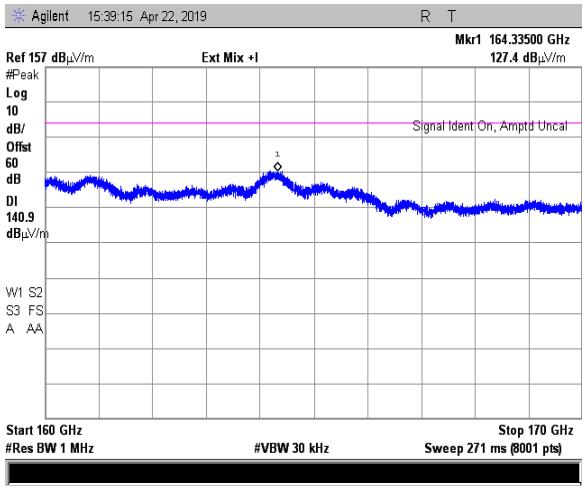


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.13 Spurious emission measurements in 160 – 170 GHz range (continued)

High carrier frequency 65000 MHz



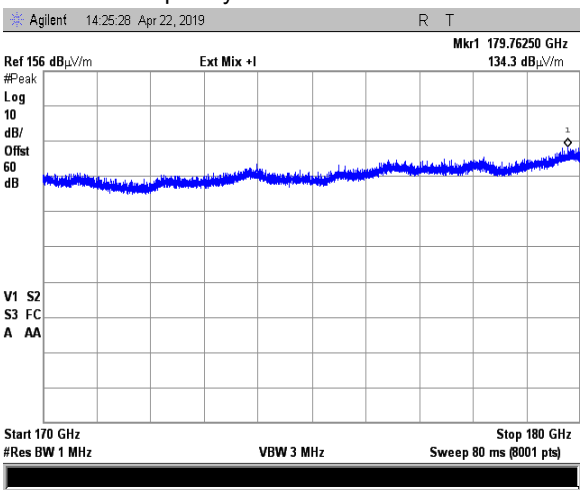


Limit 160.9 dBuV/m was applied

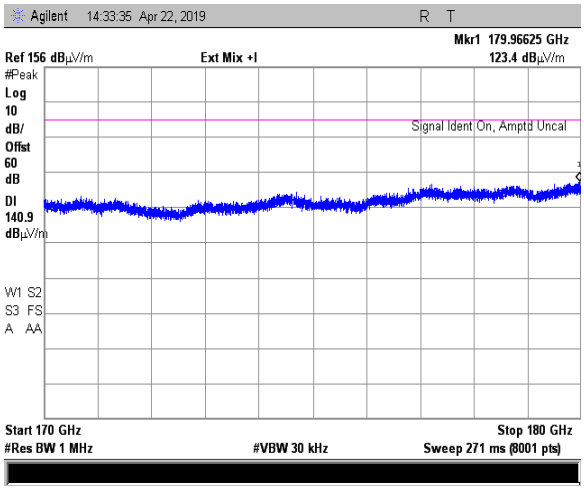
Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.14 Spurious emission measurements in 170 – 180 GHz range

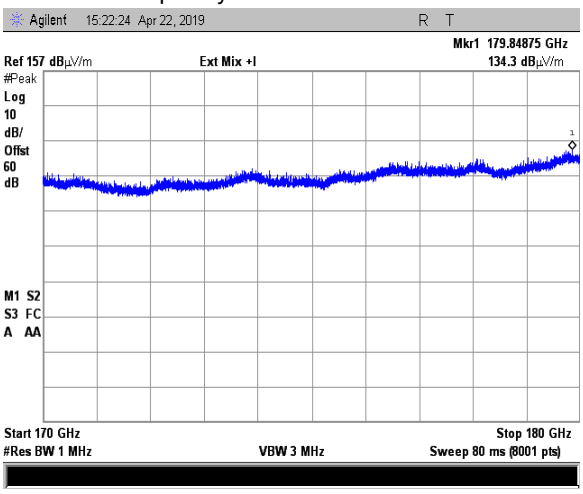
TEST SITE: OATS
TEST DISTANCE: 0.005 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 58320 MHz

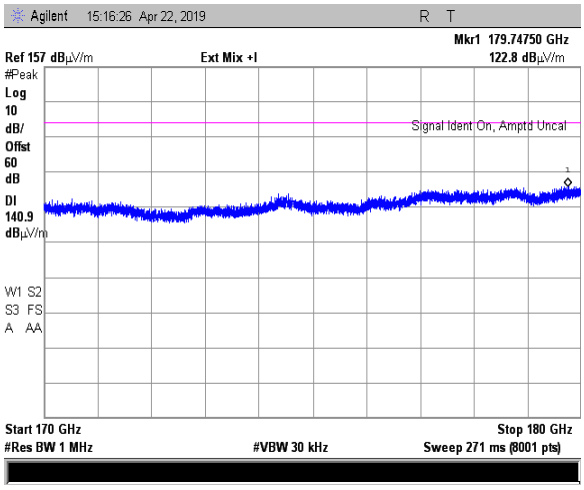


DETECTOR: Peak
RBW = 1MHz; VBW = 30 kHz



Mid carrier frequency 61000 MHz

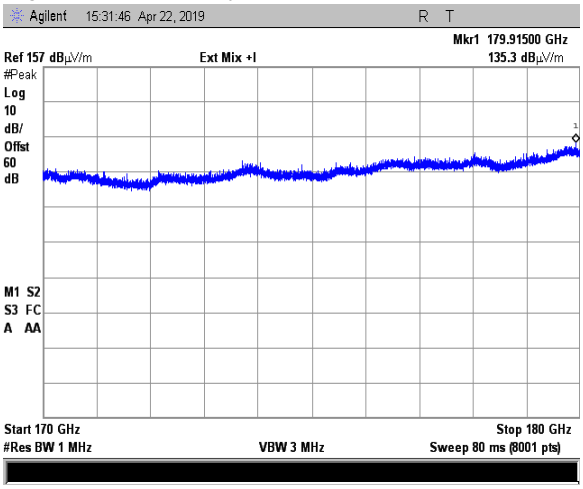


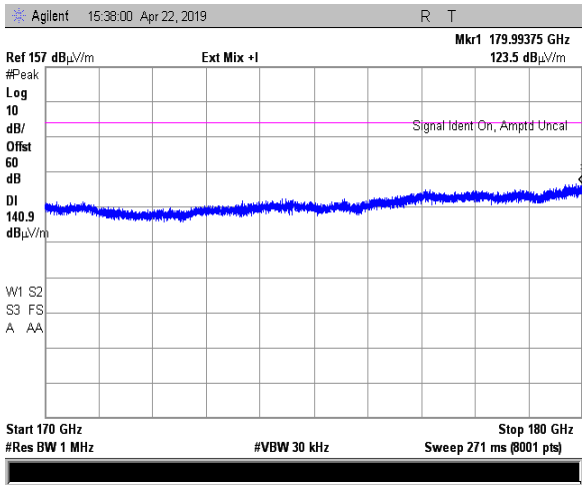


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.14 Spurious emission measurements in 170 – 180 GHz range (continued)

High carrier frequency 65000 MHz



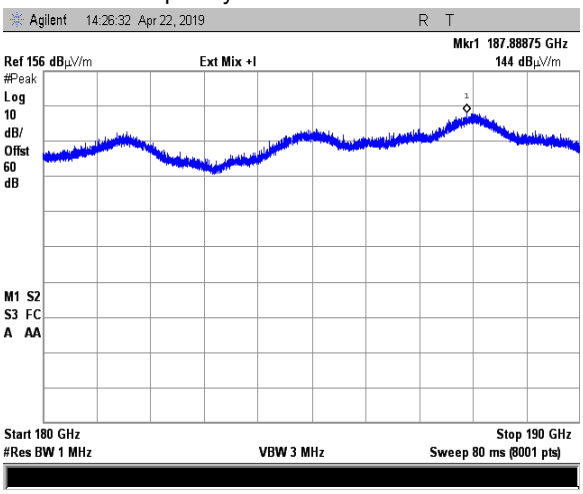


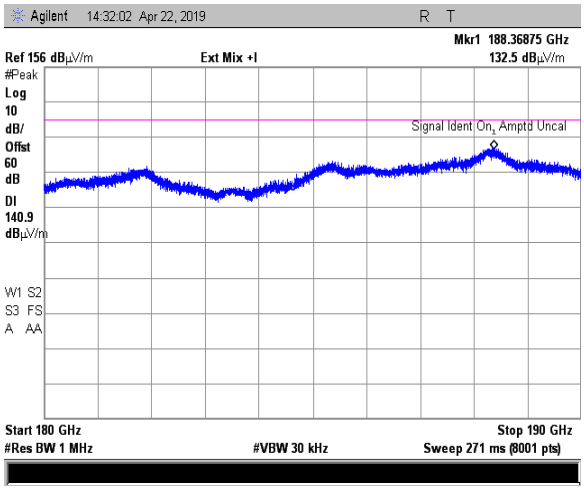
Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

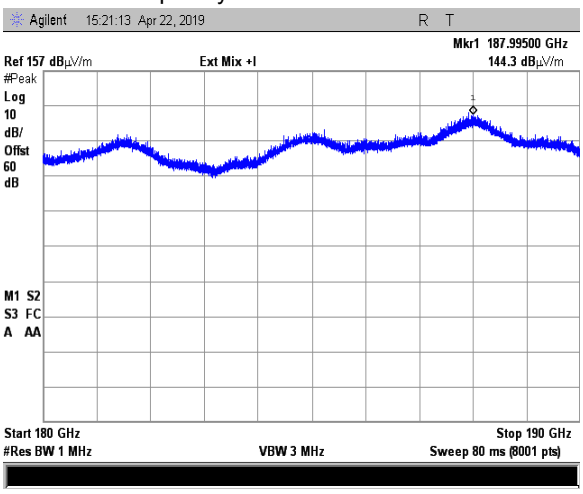
Plot 7.4.15 Spurious emission measurements in 180 – 190 GHz range

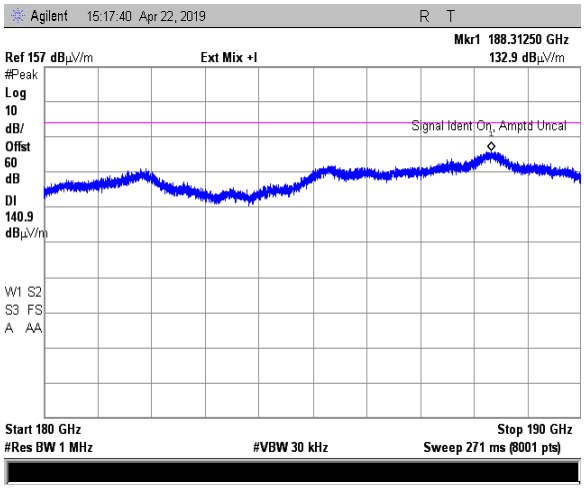
TEST SITE: OATS
TEST DISTANCE: 0.005 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 58320 MHz





Mid carrier frequency 61000 MHz

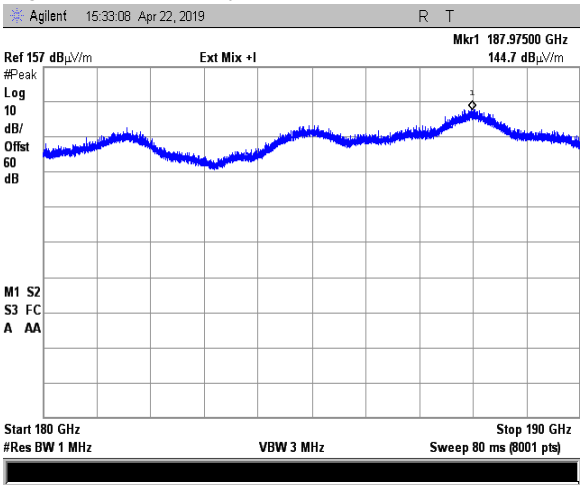


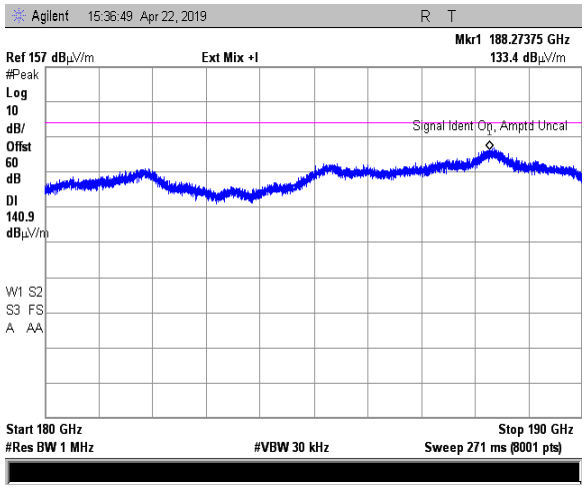


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.15 Spurious emission measurements in 180 – 190 GHz range (continued)

High carrier frequency 65000 MHz



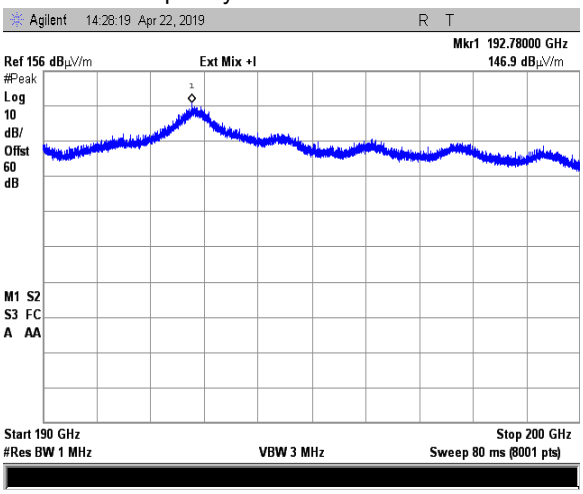


Limit 160.9 dBuV/m was applied

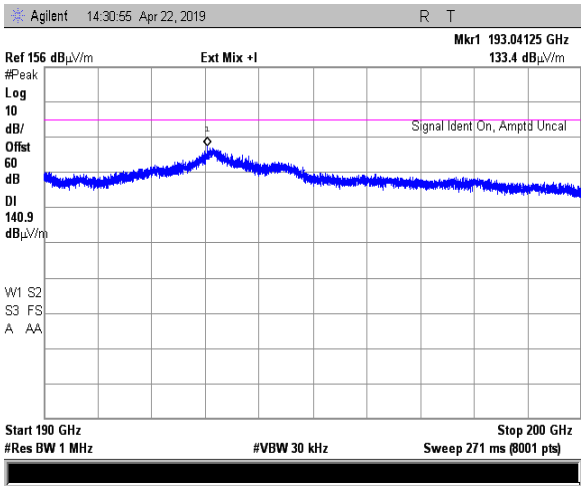
Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.16 Spurious emission measurements in 190 – 200 GHz range

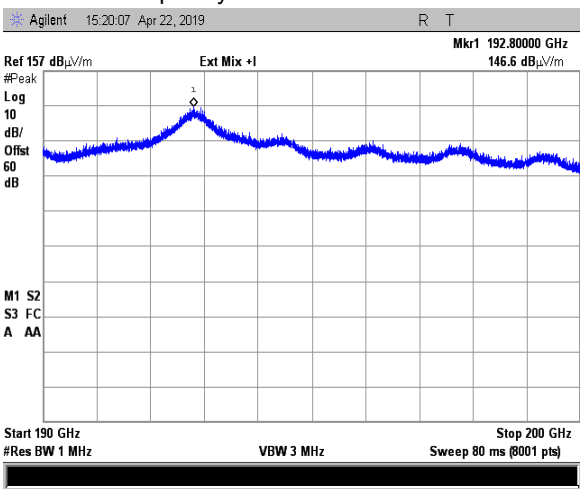
TEST SITE: OATS
TEST DISTANCE: 0.005 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
Low carrier frequency 58320 MHz

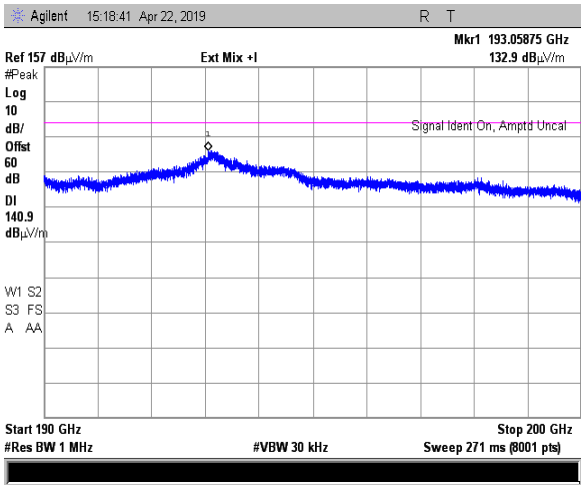


DETECTOR: Peak
RBW = 1MHz; VBW = 30 kHz



Mid carrier frequency 61000 MHz

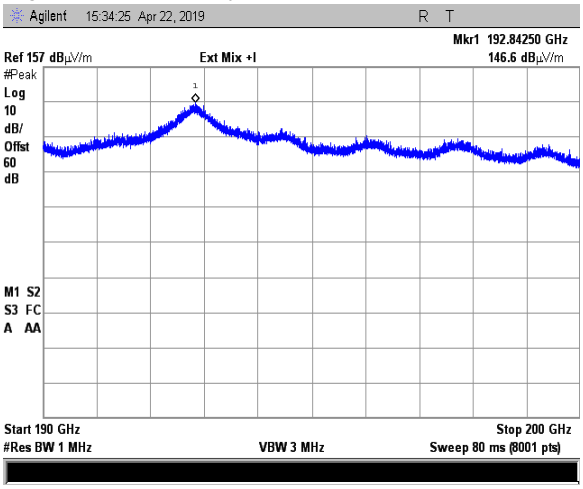


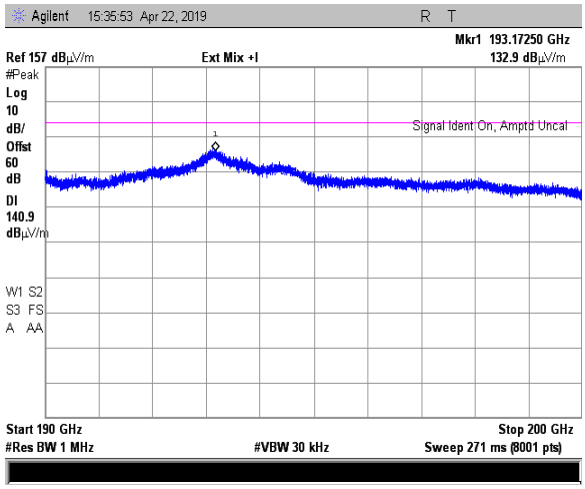


Test specification:	Section 15.255(d)(3), Out of band radiated emissions above 40 GHz up to 200GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1002 hPa	Power: 24 VDC
Remarks:			

Plot 7.4.16 Spurious emission measurements in 190 – 200 GHz range (continued)

High carrier frequency 65000 MHz





Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(f), Frequency stability		
Test procedure:	ANSI C63.10, Section 9.14		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	Relative Humidity: 54 %	Air Pressure: 1003 hPa	Power: 24 VDC
Remarks:			

7.5 Frequency stability test

7.5.1 General

This test was performed to measure frequency stability of transmitter RF carrier. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Frequency stability limits

Assigned frequency, MHz	Maximum allowed frequency displacement
57024	NA
61000	
65000	

7.5.2 Test procedure

7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.

7.5.2.2 The EUT power was turned off. Temperature within test chamber was set to +30˚C and a period of time sufficient to stabilize all of the oscillator circuit components was allowed.

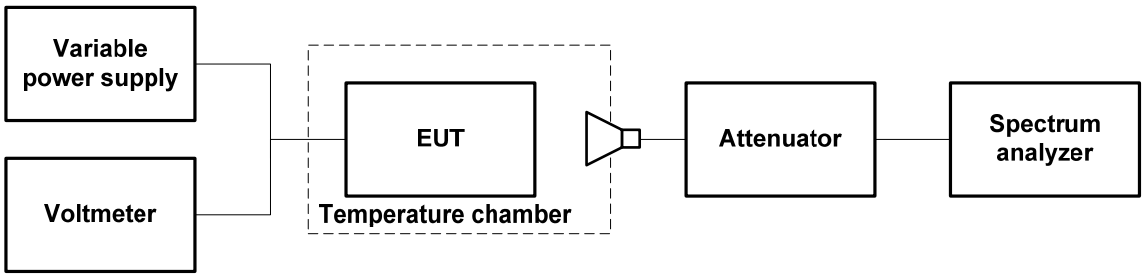
7.5.2.3 The EUT was powered on and carrier frequency was measured at start up moment and then every minute until frequency had been stabilized or 10 minutes elapsed whichever reached the last. The EUT was powered off.

7.5.2.4 The above procedure was repeated at 0˚C and at the lowest test temperature.

7.5.2.5 The EUT was powered on and carrier frequency was measured at start up moment and at the end of stabilization period at the rest of test temperatures and voltages. The EUT was powered off.

7.5.2.6 Frequency displacement was calculated and compared with the limit as provided in Table 7.5.2.

Figure 7.5.1 Frequency stability test setup



Test specification:	**Section 15.255(f), Frequency stability**		
Test procedure:	ANSI C63.10, Section 9.14		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	29-Apr-19		
Temperature: 24 ºC	**Relative Humidity:** 54 %	**Air Pressure:** 1003 hPa	**Power:** 24 VDC
Remarks:			

Table 7.5.2 Frequency stability test results

OPERATING FREQUENCY: 57024 – 65000 MHz
NOMINAL POWER VOLTAGE: 24 V output
TEMPERATURE STABILIZATION PERIOD: 20 min
POWER DURING TEMPERATURE TRANSITION: Off
SPECTRUM ANALYZER MODE: Counter
RESOLUTION BANDWIDTH: 3 kHz
VIDEO BANDWIDTH: 10 kHz
MODULATION: FMCW

T, ºC	Voltage, V	Frequency, MHz							Max frequency drift, kHz	
		Start up	1st min	2nd min	3rd min	4th min	5th min	10th min	Posit	Negative
Low frequency 58.32 GHz										
-20	nominal	57023.914	NA	NA	NA	NA	NA	57023.914	0.000	-54.054
-10	nominal	57023.919	NA	NA	NA	NA	NA	57023.919	0.000	-49.126
0	nominal	57023.919	57023.919	57023.919	57023.919	57023.919	57023.919	57023.919	0.000	-49.167
10	nominal	57023.927	NA	NA	NA	NA	NA	57023.926	0.000	-41.708
20	+15%	57023.967	NA	NA	NA	NA	NA	57023.968	0.000	-0.744
20	nominal	57023.959	NA	NA	NA	NA	NA	57023.959	0.000	-9.408
20	-15%	57023.967	NA	NA	NA	NA	NA	57023.968	0.000	-0.678
30	nominal	57023.959	57023.960	57023.961	57023.960	57023.959	57023.961	57023.961	0.000	-8.802
40	nominal	57023.971	NA	NA	NA	NA	NA	57023.971	3.333	0.000
50	nominal	57023.960	NA	NA	NA	NA	NA	57023.959	0.000	-9.021
Mid frequency 60.48GHz										
-20	nominal	61000.008	NA	NA	NA	NA	NA	61000.008	0.000	-50.892
-10	nominal	61000.010	NA	NA	NA	NA	NA	61000.010	0.000	-48.897
0	nominal	61000.014	61000.014	61000.014	61000.014	61000.014	61000.014	61000.014	0.000	-44.935
10	nominal	61000.021	NA	NA	NA	NA	NA	61000.022	0.000	-37.260
20	+15%	61000.066	NA	NA	NA	NA	NA	61000.064	7.209	0.000
20	nominal	61000.060	NA	NA	NA	NA	NA	61000.059	1.216	0.000
20	-15%	61000.065	NA	NA	NA	NA	NA	61000.066	7.141	0.000
30	nominal	61000.065	61000.065	61000.066	61000.066	61000.066	61000.066	61000.067	7.796	0.000
40	nominal	61000.070	NA	NA	NA	NA	NA	61000.070	10.997	0.000
50	nominal	61000.016	NA	NA	NA	NA	NA	61000.056	0.000	-42.920
High frequency 62.64 GHz										
-20	nominal	65000.011	NA	NA	NA	NA	NA	65000.011	0.000	-56.439
-10	nominal	65000.011	NA	NA	NA	NA	NA	65000.011	0.000	-56.584
0	nominal	65000.016	65000.016	65000.016	65000.000	65000.016	65000.016	65000.016	0.000	-67.404
10	nominal	65000.023	NA	NA	NA	NA	NA	65000.023	0.000	-44.494
20	+15%	65000.067	NA	NA	NA	NA	NA	65000.067	0.000	-0.436
20	nominal	65000.066	NA	NA	NA	NA	NA	65000.066	0.000	-1.566
20	-15%	65000.067	NA	NA	NA	NA	NA	65000.067	1.566	0.000
30	nominal	65000.071	65000.071	65000.071	65000.071	65000.071	65000.072	65000.072	5.871	0.000
40	nominal	65000.072	NA	NA	NA	NA	NA	65000.074	7.733	0.000
50	nominal	65000.061	NA	NA	NA	NA	NA	65000.061	0.000	-5.259

* - Reference frequency

Reference numbers of test equipment used

HL 770	HL 771	HL 3294	HL 4164	HL 4482	HL 5376	HL 5380	

Full description is given in Appendix A.

Test specification:	Section 15.207(a), Conducted emission		
Test procedure:	ANSI C63.10, Section 6.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	27-May-19		
Temperature: 23 ºC	Relative Humidity: 51 %	Air Pressure: 1013 hPa	Power: 120 VAC, 60 Hz
Remarks:			

7.6 Conducted emissions

7.6.1 General

This test was performed to measure common mode conducted emissions at the power port. Specification test limits are given in Table 7.6.1. The worst test results (the lowest margins) were recorded in Table 7.6.2 and shown in the associated plots.

Table 7.6.1 Limits for conducted emissions

Frequency, MHz	Class B limit, dB(μV)	
	QP	AVRG
0.15 - 0.5	66 - 56*	56 - 46*
0.5 - 5.0	56	46
5.0 - 30	60	50

* The limit decreases linearly with the logarithm of frequency.

7.6.2 Test procedure

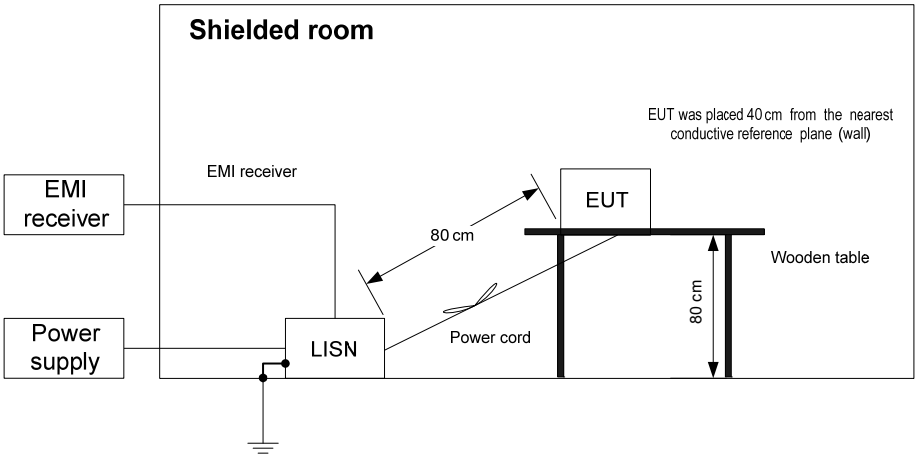
7.6.2.1 The EUT was set up as shown in Figure 7.6.1 and associated photographs, energized and the performance check was conducted.

7.6.2.2 The measurements were performed at power terminals with the LISN, connected to a spectrum analyzer in the frequency range referred to in Table 7.6.2. Unused coaxial connector of the LISN was terminated with 50 Ohm. Quasi-peak and average detectors were used throughout the testing.

7.6.2.3 The position of the device cables was varied to determine maximum emission level.

Test specification:	Section 15.207(a), Conducted emission		
Test procedure:	ANSI C63.10, Section 6.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	27-May-19		
Temperature: 23 ºC	Relative Humidity: 51 %	Air Pressure: 1013 hPa	Power: 120 VAC, 60 Hz
Remarks:			

Figure 7.6.1 Setup for conducted emission measurements, table-top equipment



Test specification:	**Section 15.207(a), Conducted emission**		
Test procedure:	ANSI C63.10, Section 6.2		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	27-May-19		
Temperature: 23 ºC	**Relative Humidity:** 51 %	**Air Pressure:** 1013 hPa	**Power:** 120 VAC, 60 Hz
Remarks:			

Table 7.6.2 Conducted emission test results

LINE: AC mains
LIMIT: Class B
EUT OPERATING MODE: Transmitter mode
EUT SET UP: TABLE-TOP
TEST SITE: SHIELDED ROOM
DETECTORS USED: PEAK / QUASI-PEAK / AVERAGE
FREQUENCY RANGE: 150 kHz - 30 MHz
RESOLUTION BANDWIDTH: 9 kHz

Frequency, MHz	Peak emission, dB(μV)	Quasi-peak			Average			Line ID	Verdict
		Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*	Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*		
0.152250	52.97	49.17	65.88	-16.71	40.98	55.88	-14.89	L1	Pass
0.177000	50.13	46.69	64.63	-17.94	39.08	54.63	-15.54		
0.201750	48.90	44.10	63.54	-19.43	37.03	53.54	-16.5		
0.228750	47.05	42.62	62.50	-19.88	35.67	52.50	-16.83		
0.314396	44.06	36.65	59.85	-23.21	30.74	49.85	-19.12		
0.407119	43.70	39.90	57.71	-17.80	35.77	47.71	-11.94		
0.152250	54.07	49.03	65.88	-16.85	40.98	55.88	-14.90	L2	Pass
0.179250	50.93	46.17	64.52	-18.35	38.71	54.52	-15.81		
0.201750	49.17	44.07	63.54	-19.46	36.98	53.54	-16.56		
0.253500	47.22	40.61	61.64	-21.03	34.16	51.64	-17.48		
0.404903	42.94	38.28	57.75	-19.47	33.44	47.75	-14.31		
0.557959	39.73	33.46	56.00	-22.54	27.71	46.00	18.29		

*- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

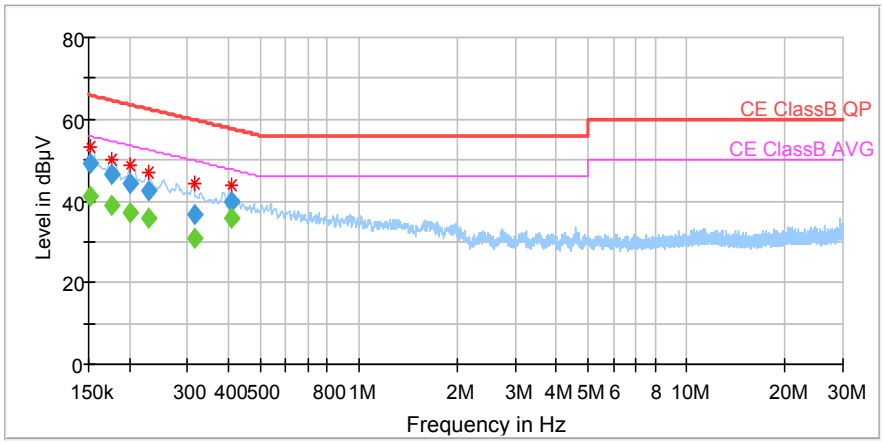
HL 5372	HL 4227	HL 2888	HL 2382	HL 495	HL 3979

Full description is given in Appendix A.

Test specification:	Section 15.207(a), Conducted emission		
Test procedure:	ANSI C63.10, Section 6.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	27-May-19		
Temperature: 23 ºC	Relative Humidity: 51 %	Air Pressure: 1013 hPa	Power: 120 VAC, 60 Hz
Remarks:			

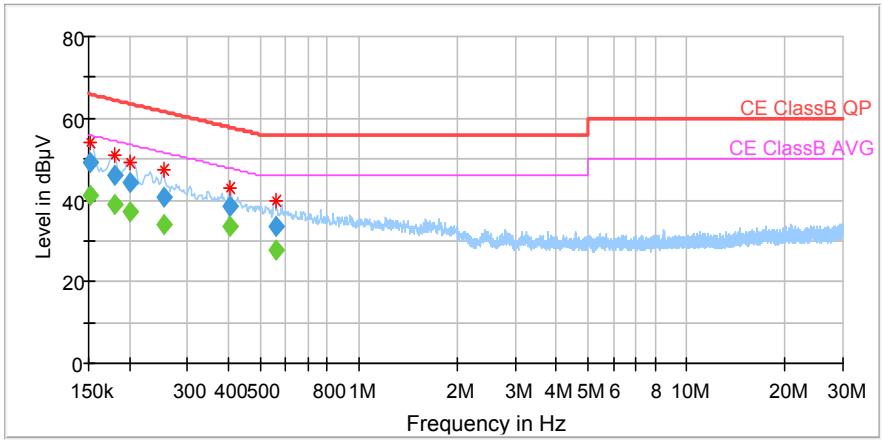
Plot 7.6.1 Conducted emission measurements

LINE: L1
LIMIT: Class B
EUT OPERATING MODE: Transmitter mode
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Plot 7.6.2 Conducted emission measurements

LINE: L2
LIMIT: Class B
EUT OPERATING MODE: Transmitter mode
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Test specification:	Section 15.203, Antenna requirement		
Test procedure:	Visual inspection / supplier declaration		
Test mode:	Compliance	Verdict:	PASS
Date(s):	02-Jun-19		
Temperature: 24.2 ºC	Relative Humidity: 48 %	Air Pressure: 1009 hPa	Power: 100-240VAC, 50-60Hz
Remarks:			

7.7 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 7.7.1.

Table 7.7.1 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	NA	

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 (9) kHz - 30 MHz	EMCO	6502	2857	24-Feb-19	24-Feb-20
0747	Mixer, Millimeter Wave Harmonic 90 - 140 GHZ	Oleson Microwave Labs	M08HW	F80429-1	03-Mar-17	03-Mar-20
0770	Antenna Standard Gain Horn, 40-60 GHz WR-19, U-band, 24 dB mid-band gain	Quinstar Technology	QWH-1900-AA	118	05-Jul-18	05-Jul-19
0771	Antenna Standard Gain Horn, 60-90 GHz, WR-12, 24 dB mid-band gain	Quinstar Technology	QWH-1200-AA	111	05-Jul-18	05-Jul-19
0772	Antenna Standard Gain Horn, 75-110 GHz, WR-10, 24 dB mid-band gain	Quinstar Technology	QWH-0800-AA	110	05-Jul-18	05-Jul-19
1301	Transition waveguide ET28S -12R	Custom Microwave	ET28S -12R		18-Nov-18	18-Nov-20
1303	Transition waveguide ET28S -12R	Custom Microwave	ET28S -12R	S0951	18-Nov-18	18-Nov-20
1312	Mixer Millimeter Wave Harmonic 140-220 GHz	Oleson Microwave Labs	M05HWD	G91112-1	03-Mar-17	03-Mar-20
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY41444762	04-Apr-19	04-Apr-20
3235	Harmonic mixer 40 to 60 GHz	Agilent Technologies	11970U	MY30030182	16-Aug-16	16-Aug-19
3291	Attenuator, direct reading, 60 to 90 GHz, 0.2 W	Quinstar Technology	QAD-E00000	10381009	01-Apr-19	01-Apr-20
3293	Frequency multiplier, input 20-30 GHz, output 60-90 GHz	Quinstar Technology	QPM-75003E	10381003	01-Apr-19	01-Apr-20
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	18-Nov-18	18-Nov-20
3295	Tapered transition, WR-28, UG-599 to WR-15, UG-385 (26.5-40 GHz to 50-75 GHz)	Quinstar Technology	QWP-AV0000	10381005	18-Nov-18	18-Nov-20
3296	Tapered transition, WR-28, UG-599 to WR-10, UG-387 (26.5-40 GHz to 75-100 GHz)	Quinstar Technology	QWP-AW0000	10381006	18-Nov-18	18-Nov-20
3297	Tapered , WR-28, UG-599 to WR-10, UG-387 (26.5-40 GHz to 75-100 GHz)	Quinstar Technology	QWP-AW0000	10381007	18-Nov-18	18-Nov-20
3305	Harmonic mixer 50 to 75 GHz	Agilent Technologies	11970V	MY30030149	16-Aug-16	16-Aug-19
3306	Harmonic mixer 75 to 110 GHz	Agilent Technologies	11970W	MY25210273	16-Aug-16	16-Aug-19
3329	Antenna Standard Gain Horn, 140-220 GHz, WR-5, 24 dB mid-band gain	Quinstar Technology			14-Aug-18	14-Aug-19
3433	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25679	15-Apr-19	15-Apr-20
3434	Test Cable , DC-18 GHz, 1.5 m, SMA -	Mini-Circuits	CBL-5FT-	25683	15-Apr-19	15-Apr-20

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
	SMA		SMSM+			
3536	Antenna Standard Gain Horn, 90-140 GHz, WR-8, 24 dB mid-band gain	Quinstar Technology	QWH-FPRR00	11159004001	03-Jun-18	03-Jun-19
3727	Oscilloscope, 1 GHz, 4 channels	LeCroy Corporation	LC584AL	10449	14-Jun-18	14-Jun-19
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1225/2A	07-Apr-19	07-Apr-20
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	07-Apr-19	07-Apr-20
4023	Diplexer for use OML mixers with Agilent spectrum analyzer	Oleson Microwave Labs	DPL.26	NA	01-Apr-19	01-Apr-20
4164	DC Power Supply, 60V, 5A	Standig	605D	NA	05-Nov-18	05-Nov-19
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	31-Dec-18	31-Dec-19
4482	WR28 to WR22 Waveguide Transition, Freq. Range: 33-50GHz, Flange: FBP320/FUGP400 Material: Cu Length: 50mm	A-info (HK) Limited	2822WA-50	J5031121024001	18-Nov-18	18-Nov-20
4856	Amplifier, solid state, 18 GHz to 40 GHz, 20 dBm output power	Quinstar Technology	QGW-18402023-JO	16779001001	28-May-19	28-May-20
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	06-Jan-19	06-Jan-20
4956	Active horn antenna, 18 to 40 GHz	COM-POWER CORPORATION	AHA-840	105004	25-Jan-19	25-Jan-20
5032	Amplifier, 18 GHz to 40 GHz	COM-POWER CORPORATION	AHAPA-840	502001	05-Aug-18	05-Aug-19
5111	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/11SK/11SK/5500MM	502493/2EA	18-Apr-19	18-Apr-20
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22
5376	EXA Signal Analyzer, 10 Hz - 32 GHz	Keysight Technologies	N9010B	MY57470404	18-Mar-19	18-Mar-20
5379	1/4" Free-field Micriphone Preamplifier	Bruel & Kjaer	2670	3166281	06-Aug-18	06-Aug-19
5380	Wavequide Harmonic Mixer 55-90GHz	Keysight Technologies	M1971E	MY56130239	01-Jun-18	01-Jun-19
5405	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500023/118	01-Aug-18	01-Aug-19

9 APPENDIX B Test equipment correction factors

HL 5288: Trilog Antenna
Frankonia, model: ALX-8000E, s/n: 00809
30-1000 MHz

Frequency, MHz	Antenna factor, dB/m
30	14.96
35	15.33
40	16.37
45	17.56
50	17.95
60	16.87
70	13.22
80	10.56
90	13.61
100	15.46
120	14.03
140	12.23

Frequency, MHz	Antenna factor, dB/m
160	12.67
180	13.34
200	15.40
250	16.42
300	17.28
400	19.98
500	21.11
600	22.90
700	24.13
800	25.25
900	26.35
1000	27.18

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

above 1000 MHz

Frequency, MHz	Antenna factor, dB/m
1000	26.9
1100	28.1
1200	28.4
1300	29.6
1400	29.1
1500	30.4
1600	30.7
1700	31.5
1800	32.3
1900	32.6
2000	32.5
2100	32.9
2200	33.5
2300	33.2
2400	33.7
2500	34.6
2600	34.7
2700	34.6
2800	35.0
2900	35.5
3000	36.2
3100	36.8
3200	36.8
3300	37.0
3400	37.5
3500	38.2

Frequency, MHz	Antenna factor, dB/m
3600	38.9
3700	39.4
3800	39.4
3900	39.6
4000	39.7
4100	39.8
4200	40.5
4300	40.9
4400	41.1
4500	41.4
4600	41.3
4700	41.6
4800	41.9
4900	42.3
5000	42.7
5100	43.0
5200	42.9
5300	43.5
5400	43.6
5500	44.3
5600	44.7
5700	45.0
5800	45.0
5900	45.3
6000	45.9

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

HL 4933 Active Horn Antenna
1 GHz to 18 GHz
COM-POWER CORPORATION AHA-118 , s/n 701046 HL 4933

Frequency, MHz	Measured antenna factor, dB/m
1000	-16.1
1050	-16.0
1100	-15.1
1150	-16.4
1200	-16.0
1250	-15.6
1300	-15.1
1350	-14.8
1400	-15.1
1450	-15.1
1500	-15.5
1550	-15.2
1600	-14.7
1650	-14.4
1700	-14.4
1750	-14.0
1800	-13.6
1850	-12.7
1900	-11.9
1950	-11.9
2000	-11.8
2050	-11.3
2100	-11.3
2150	-11.7
2200	-12.3
2250	-12.3
2300	-12.4
2350	-12.2
2400	-11.7
2450	-11.5
2500	-11.5
2550	-11.5
2600	-11.5
2650	-11.3
2700	-11.3
2750	-11.1
2800	-11.1
2850	-11.3
2900	-11.1
2950	-11.0
3000	-11.1
3050	-10.9
3100	-10.7
3150	-10.6

Frequency, MHz	Measured antenna factor, dB/m
3200	-11.2
3250	-10.8
3300	-10.8
3350	-10.7
3400	-10.3
3450	-10.2
3500	-10.1
3550	-10.4
3600	-10.5
3650	-10.4
3700	-10.4
3750	-10.3
3800	-10.1
3850	-10.0
3900	-9.9
3950	-9.8
4000	-9.7
4050	-9.3
4100	-8.6
4150	-8.2
4200	-8.3
4250	-8.5
4300	-8.5
4350	-8.3
4400	-8.0
4450	-7.7
4500	-7.6
4550	-7.4
4600	-7.5
4650	-7.8
4700	-7.6
4750	-6.8
4800	-6.1
4850	-5.7
4900	-5.8
4950	-5.8
5000	-6.0
5050	-5.7
5100	-5.4
5150	-5.1
5200	-4.6
5250	-4.6
5300	-4.8
5350	-5.1

Frequency, MHz	Measured antenna factor, dB/m
5400	-5.1
5450	-4.6
5500	-4.0
5550	-3.5
5600	-3.1
5650	-3.3
5700	-3.8
5750	-4.3
5800	-4.3
5850	-4.0
5900	-3.5
5950	-3.2
6000	-3.2
6050	-3.2
6100	-3.3
6150	-3.3
6200	-3.1
6250	-2.9
6300	-2.8
6350	-3.0
6400	-3.2
6450	-3.4
6500	-3.7
6550	-3.6
6600	-3.4
6650	-2.9
6700	-2.6
6750	-2.5
6800	-2.6
6850	-2.8
6900	-2.7
6950	-2.3
7000	-2.0
7050	-1.9
7100	-1.8
7150	-1.8
7200	-1.7
7250	-1.7
7300	-1.6
7350	-1.5
7400	-1.5
7450	-1.3
7500	-1.4
7550	-1.3
7600	-1.0
7650	-0.7
7700	-0.3
7750	0.1
7800	0.3
7850	0.4
7900	0.2
7950	0.1
8000	0.2
8050	0.3
8100	0.8
8150	1.1
8200	1.1
8250	1.0
12400	2.1
12500	1.2
12600	1.3
12700	2.4
12800	1.8

Frequency, MHz	Measured antenna factor, dB/m
8300	0.8
8350	0.5
8400	0.3
8450	0.5
8500	0.8
8550	0.9
8600	0.9
8650	0.6
8700	0.0
8750	-0.3
8800	0.0
8850	0.5
8900	0.6
8950	0.4
9000	-0.3
9050	-1.0
9100	-1.2
9150	-0.6
9200	-0.1
9250	0.0
9300	-0.1
9350	-0.5
9400	-0.7
9450	-0.4
9500	0.2
9550	0.5
9600	0.5
9650	0.3
9700	0.0
9750	0.0
9800	0.6
9850	1.4
9900	1.8
9950	1.7
10000	1.4
10100	0.8
10200	1.2
10300	1.5
10400	1.1
10500	1.6
10600	3.0
10700	2.9
10800	1.3
10900	1.0
11000	1.1
11100	0.7
11200	1.1
11300	1.5
11400	1.4
11500	0.6
11600	1.0
11700	1.4
11800	0.7
11900	0.9
12000	2.1
12100	2.1
12200	0.9
12300	1.6

12900	0.6
13000	0.9
13100	1.1
13200	0.7
13300	0.9
13400	1.8
13500	2.1
13600	1.2
13700	0.8
13800	1.2
13900	1.5
14000	1.7
14100	2.2
14200	2.8
14300	3.0
14400	3.0
14500	3.3
14600	4.0
14700	5.4
14800	5.4
14900	4.7
15000	3.1
15100	2.0
15200	1.5
15300	1.4
15400	1.7
15500	1.9
15600	1.2
15700	0.2
15800	0.6
15900	1.2
16000	0.6
16100	0.6
16200	1.9
16300	2.2
16400	0.9
16500	0.7
16600	1.7
16700	1.3
16800	1.0
16900	2.0
17000	2.4
17100	1.8
17200	1.8
17300	2.5
17400	2.7
17500	3.1
17600	3.7
17700	4.3
17800	4.8
17900	5.7
18000	5.1

HL 4956: Active horn antenna
COM-POWER Corp., model: AHA-840, s/n 105004

Frequency, MHz	Measured antenna factor, dB/m	Frequency, MHz	Measured antenna factor, dB/m
18000	5.1	29500	1.4
18500	3.6	30000	2.9
19000	2.2	30500	2.9
19500	0.7	31000	2.9
20000	0.7	31500	1.2
20500	0.8	32000	0.7
21000	0.5	32500	0.2
21500	-1.3	33000	-1.7
22000	-2.1	33500	-2.2
22500	-2.0	34000	2.3
23000	-1.6	34500	-1.1
23500	-2.9	35000	0.7
24000	-2.3	35500	-1.1
24500	-2.6	36000	0.1
25000	-1.8	36500	1.4
25500	-1.2	37000	3.7
26000	-0.5	37500	5.8
26500	-1.2	38000	6.6
27000	-0.1	38500	7.3
27500	-1.0	39000	6.5
28000	-0.7	39500	7.3
28500	0.5	40000	7.1

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

HL 0446: Active Loop Antenna
EMCO, model: 6502, s/n 2857

Frequency,	Measured antenna factor, dBS/m	Measurement uncertainty, dB	Frequency,	Measured antenna factor, dBS/m	Measurement uncertainty, dB
10	-33.4	±1.0	2000	-41.4	±1.0
20	-37.8	±1.0	3000	-41.4	±1.0
50	-40.5	±1.0	4000	-41.5	±1.0
75	-41.0	±1.0	5000	-41.5	±1.0
100	-41.2	±1.0	10000	-41.7	±1.0
150	-41.2	±1.0	15000	-42.1	±1.0
250	-41.1	±1.0	20000	-42.7	±1.0
500	-41.2	±1.0	25000	-44.2	±1.0
750	-41.3	±1.0	30000	-45.8	±1.0
1000	-41.3	±1.0			

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμA/m.

HL 2888 LISN Two-line V-Network 50 Ohm / 50 uH + 5 Ohm, 16A
Rolf Heine, model: NNB-2/16Z, s/n 02/10018, HL 2888

Voltage division factor (insertion loss)

Frequency,	L1, dB	L2, dB	Uncertainty, dB
150	0.09	0.07	±0.09
170	0.08	0.07	±0.09
200	0.08	0.06	±0.09
250	0.09	0.06	±0.09
300	0.09	0.06	±0.09
350	0.09	0.07	±0.09
400	0.09	0.07	±0.09
500	0.09	0.07	±0.09
600	0.09	0.07	±0.09
700	0.10	0.08	±0.09
800	0.10	0.08	±0.09
900	0.11	0.08	±0.09
1000	0.11	0.08	±0.09
1200	0.11	0.09	±0.16
1500	0.12	0.10	±0.16
2000	0.14	0.12	±0.16
2500	0.15	0.12	±0.16
3000	0.16	0.14	±0.16
4000	0.19	0.16	±0.16
5000	0.23	0.19	±0.16
7000	0.30	0.25	±0.16
10000	0.46	0.40	±0.16
15000	0.71	0.62	±0.16
20000	0.94	0.85	±0.16
30000	1.41	1.33	±0.32

HL 5111: RF cable

Huber-Suhner, SF102EA/11SK/11SK/5500MM, s/n 502493/2EA

Set / Applied, MHz	Measured, dB	Uncertainty, dB
100	0.70	±0.07
200	0.99	±0.08
300	1.21	±0.08
500	1.56	±0.08
1000	2.20	±0.08
1500	2.69	±0.08
2000	3.11	±0.08
2500	3.50	±0.10
3000	3.85	±0.10
3500	4.16	±0.10
4000	4.47	±0.10
4500	4.74	±0.10
5000	5.03	±0.10
5500	5.30	±0.10
6000	5.57	±0.10
6500	5.76	±0.10
7000	6.00	±0.10
7500	6.20	±0.10
8000	6.44	±0.10
8500	6.67	±0.10
9000	6.82	±0.10
9500	7.04	±0.10
10000	7.18	±0.10
10500	7.36	±0.10
11000	7.55	±0.10
11500	7.75	±0.10
12000	7.90	±0.10
12500	8.08	±0.13
13000	8.19	±0.13
13500	8.39	±0.13
14000	8.58	±0.13
14500	8.76	±0.18
15000	8.92	±0.18
15500	9.03	±0.18
16000	9.18	±0.18
16500	9.34	±0.18
17000	9.51	±0.18
17500	9.66	±0.18
18000	9.80	±0.18
18500	9.94	±0.23
19000	10.05	±0.23
19500	10.22	±0.23
20000	10.32	±0.23
20500	10.48	±0.23
21000	10.60	±0.23
21500	10.73	±0.23
22000	10.87	±0.23
22500	10.97	±0.29
23000	11.09	±0.29
23500	11.26	±0.29
24000	11.37	±0.29
24500	11.50	±0.29
25000	11.61	±0.23
25500	11.72	±0.23
26000	11.87	±0.23
26500	11.99	±0.23
27000	12.09	±0.33
27500	12.24	±0.33
28000	12.34	±0.40
28500	12.47	±0.40
29000	12.61	±0.40
29500	12.70	±0.40
30000	12.86	±0.40
30500	12.92	±0.33
31000	13.09	±0.33
31500	13.16	±0.33
32000	13.33	±0.33
32500	13.40	±0.33
33000	13.62	±0.33
33500	13.70	±0.33
34000	13.88	±0.33
34500	13.97	±0.40
35000	14.05	±0.40
35500	14.23	±0.40
36000	14.25	±0.40
36500	14.46	±0.40
37000	14.49	±0.33
37500	14.72	±0.33
38000	14.77	±0.33
38500	14.97	±0.33
39000	15.04	±0.33
39500	15.22	±0.33
40000	15.63	±0.47

HL 3901 Microwave Cable Assembly, 40.0 GHz
3.5 m, SMA/SMA
Huber-Suhner, model: SUCOFLEX 102A, s/n: 1225/2A

HL 3901: Insertion loss

Set / Applied, MHz	Measured, dB	Uncertainty, dB
50	0.34	±0.06
100	0.47	±0.06
150	0.58	±0.07
200	0.67	±0.07
300	0.82	±0.07
400	0.94	±0.07
500	1.05	±0.07
600	1.15	±0.07
700	1.24	±0.07
800	1.33	±0.07
900	1.41	±0.07
1000	1.49	±0.07
1100	1.56	±0.07
1200	1.62	±0.07
1300	1.69	±0.07
1400	1.76	±0.07
1500	1.82	±0.07
1600	1.88	±0.07
1700	1.94	±0.07
1800	2.00	±0.07
1900	2.05	±0.07
2000	2.11	±0.07
2100	2.16	±0.07
2200	2.21	±0.07
2300	2.26	±0.07
2400	2.32	±0.07
2500	2.36	±0.09
2600	2.42	±0.09
2700	2.47	±0.09
2800	2.52	±0.09
2800	2.52	±0.09
2900	2.57	±0.09
3000	2.62	±0.09
3100	2.67	±0.09
3200	2.72	±0.09
3300	2.76	±0.09
3400	2.80	±0.09
3500	2.84	±0.09
3600	2.88	±0.09
3700	2.93	±0.09
3800	2.96	±0.09
3900	3.00	±0.09
4000	3.04	±0.09
4100	3.08	±0.13
4200	3.11	±0.13
4300	3.15	±0.13
4400	3.19	±0.13
4500	3.22	±0.13
4600	3.26	±0.13

Set / Applied, MHz	Measured, dB	Uncertainty, dB
4700	3.29	±0.13
4800	3.33	±0.13
4900	3.36	±0.13
5000	3.40	±0.13
5100	3.43	±0.13
5200	3.46	±0.13
5300	3.50	±0.13
5400	3.53	±0.13
5500	3.56	±0.13
5600	3.59	±0.13
5700	3.62	±0.13
5800	3.65	±0.13
5900	3.68	±0.13
6000	3.71	±0.13
6100	3.74	±0.13
6200	3.78	±0.13
6300	3.81	±0.13
6400	3.84	±0.13
6500	3.88	±0.13
6600	3.91	±0.13
6700	3.95	±0.13
6800	3.99	±0.13
6900	4.02	±0.13
7000	4.05	±0.13
7100	4.09	±0.13
7200	4.12	±0.13
7300	4.16	±0.13
7400	4.19	±0.13
7500	4.23	±0.13
7600	4.26	±0.13
7700	4.30	±0.13
7800	4.33	±0.13
7900	4.36	±0.13
8000	4.39	±0.13
8100	4.42	±0.13
8200	4.45	±0.13
8300	4.48	±0.13
8400	4.50	±0.13
8500	4.53	±0.13
8600	4.56	±0.13
8700	4.58	±0.13
8800	4.61	±0.13
8900	4.63	±0.13
9000	4.66	±0.13
9100	4.67	±0.13
9200	4.69	±0.13
9300	4.72	±0.13
9400	4.75	±0.13
9500	4.77	±0.13

HL 3901: Insertion loss

Set / Applied, MHz	Measured, dB	Uncertainty, dB
9600	4.79	±0.13
9700	4.81	±0.13
9800	4.84	±0.13
9900	4.87	±0.13
10000	4.89	±0.13
10100	4.92	±0.13
10200	4.94	±0.13
10300	4.96	±0.13
10400	4.98	±0.13
10500	5.01	±0.13
10600	5.02	±0.13
10700	5.05	±0.13
10800	5.07	±0.13
10900	5.10	±0.13
11000	5.12	±0.13
11100	5.15	±0.13
11200	5.18	±0.13
11300	5.21	±0.13
11400	5.23	±0.13
11500	5.26	±0.13
11600	5.30	±0.13
11700	5.33	±0.13
11800	5.36	±0.13
11900	5.39	±0.13
12000	5.42	±0.13
12100	5.45	±0.16
12200	5.48	±0.16
12300	5.52	±0.16
12400	5.56	±0.16
12500	5.59	±0.22
12600	5.61	±0.22
12700	5.65	±0.22
12800	5.69	±0.22
12900	5.72	±0.22
13000	5.74	±0.22
13100	5.78	±0.22
13200	5.80	±0.22
13300	5.83	±0.22
13400	5.85	±0.22
13500	5.87	±0.22
13600	5.89	±0.22
13700	5.91	±0.22
13800	5.94	±0.22
13900	5.95	±0.22
14000	5.97	±0.22
14100	5.99	±0.22
14200	6.02	±0.22
14300	6.02	±0.22
14400	6.04	±0.22
14500	6.06	±0.22

Set / Applied, MHz	Measured, dB	Uncertainty, dB
14600	6.08	±0.22
14700	6.09	±0.22
14800	6.12	±0.22
14900	6.14	±0.22
15000	6.15	±0.22
15100	6.18	±0.22
15200	6.21	±0.22
15300	6.23	±0.22
15400	6.25	±0.22
15500	6.28	±0.22
15600	6.31	±0.22
15700	6.33	±0.22
15800	6.36	±0.22
15900	6.39	±0.22
16000	6.40	±0.22
16100	6.43	±0.22
16200	6.47	±0.22
16300	6.50	±0.22
16400	6.52	±0.22
16500	6.55	±0.22
16600	6.58	±0.22
16700	6.62	±0.22
16800	6.63	±0.22
16900	6.67	±0.22
17000	6.69	±0.22
17100	6.72	±0.22
17200	6.74	±0.22
17300	6.74	±0.22
17400	6.76	±0.22
17500	6.79	±0.22
17600	6.82	±0.22
17700	6.80	±0.22
17800	6.81	±0.22
17900	6.82	±0.22
17200	6.74	±0.22
17300	6.74	±0.22
17400	6.76	±0.22
17500	6.79	±0.22
17600	6.82	±0.22
17700	6.80	±0.22
17800	6.81	±0.22
17900	6.82	±0.22
18000	6.85	±0.22
18500	6.95	±0.42
19000	7.08	±0.42
19500	7.15	±0.42
20000	7.19	±0.42
20500	7.24	±0.42
21000	7.32	±0.42
21500	7.42	±0.42

HL 3901: Insertion loss

Set / Applied, MHz	Measured, dB	Uncertainty, dB
22000	7.57	±0.42
22500	7.70	±0.42
23000	7.81	±0.42
23500	7.85	±0.42
24000	7.86	±0.42
24500	7.94	±0.42
25000	8.02	±0.42
25500	8.12	±0.42
26000	8.23	±0.42
26500	8.33	±0.42
27000	8.39	±0.57
27500	8.42	±0.57
28000	8.43	±0.57
28500	8.48	±0.57
29000	8.57	±0.57
29500	8.65	±0.57
30000	8.70	±0.57
30500	8.77	±0.57

Set / Applied, MHz	Measured, dB	Uncertainty, dB
31000	8.84	±0.57
31500	8.93	±0.57
32000	9.07	±0.57
33500	9.25	±0.57
34000	9.32	±0.57
34500	9.39	±0.57
35000	9.49	±0.57
35500	9.59	±0.57
36000	9.68	±0.57
36500	9.76	±0.57
37000	9.85	±0.57
37500	9.98	±0.57
38000	10.07	±0.57
38500	10.12	±0.57
39000	10.19	±0.57
39500	10.29	±0.57
40000	10.36	±0.57

10 APPENDIX C Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted emissions with LISN	9 kHz to 150 kHz: ± 3.9 dB 150 kHz to 30 MHz: ± 3.8 dB
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

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.

11 APPENDIX D Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, Radio, Safety, Environmental and Telecommunication testing facility.
Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for relevant parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; Recognized by Innovation, Science and Economic Development Canada for wireless and terminal testing (ISED), ISED #2186A, CAB identifier is IL1001; Certified by VCCI, Japan (the registration numbers are R-10808 for OATS, R-1082 for anechoic chamber, G-10869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-11606 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, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

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12 APPENDIX E Specification references

47CFR part 15: 2018	Radio Frequency Devices.
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicemsed Wireless Devices

END OF DOCUMENT