HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO: FCC 47 CFR part 15 section 15.255

FOR:

Siklu Communication Ltd.

Point-to-Multipoint Wireless V-band link operating in 57-64 GHz

Model: MH-T201-CNN-PoE-MWB

FCC ID:2ACYESK-MH60CC-A1

Report ID: SIKRAD_FCC.31536.docx
Date of Issue: 4-Dec-18

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1 Applicant information

Client name:	Siklu Communication Ltd.
Address:	43 Hasivim street, Petach-Tikva 49517, Israel
Telephone:	+972 3921 4015
Fax:	+972 3921 4162
E-mail:	baruch@siklu.com
Contact name:	Mr. Baruch Schwarz

2 Equipment under test attributes

Product name:	Point-to-Multipoint Wireless V-band link operating in 57-64 GHz
Product type:	Transceiver
Model(s):	MH-T201-CNN-PoE-MWB
Brand name:	MultiHaul
Serial number:	S849000100
Hardware version:	A0
Software release:	2.2
Receipt date	11-Oct-18

3 Manufacturer information

Manufacturer name:	Siklu Communication Ltd.
Address:	43 Hasivim street, Petach-Tikva 49517, Israel
Telephone:	+972 3921 4015
Fax:	+972 3921 4162
E-Mail:	baruch@siklu.com
Contact name:	Mr. Baruch Schwarz

4 Test details

Project ID:	31536
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	11-Oct-18
Test completed:	02-Dec-18
Test specification(s):	FCC 47 CFR part 15 section 15.255

5 Tests summary

Test	Status
Transmitter characteristics	
FCC Section 15.255(b)(ii), (d), Transmitter power and power spectral density	Pass
FCC Section 15.215(c), Occupied bandwidth	Pass
FCC Section 15.255(c), Conducted spurious emissions	Not required
FCC Section 15.255(c)(2), Radiated spurious emissions below 40 GHz	Pass
FCC Section 15. 255(c)(3), Radiated emissions outside assigned band and above 40 GHz up to 200 GHz	Pass
FCC Section 15.255(e), Frequency tolerance	Tested without limit
FCC Section 15.255(f), RF exposure	Pass, exhibit included in Application for certification

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

	Name and Title	Date	Signature
Tested by:	Mr. S. Samokha, test engineer	December 2, 2018	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	December 3, 2018	
Approved by:	Mr. M. Nikishin, EMC and Radio group manager	December 4, 2018	

6 EUT description

6.1 General information

The EUT is an outdoor unit of point-to-multipoint high BW system, based on WiGi technology, operating in the 57-64 GHz regulated V-Band. The EUT radio supports up to 2.5 Gbps.
The system serves as an end point ("Terminal Unit" – TU).
Several combinations are possible for system assembly. Some of them are more P2P like, while others benefit from P2MP capability.
During the testing the EUT system was powered by POE+.

6.2 Ports and lines

Port type	Port description	Conected from	Connected to	Qty.	Cable type	Cable length, m
Telecom	Ethernet-POE	EUT ETH1	POE+	1	Shielded	2

6.3 Support and test equipment

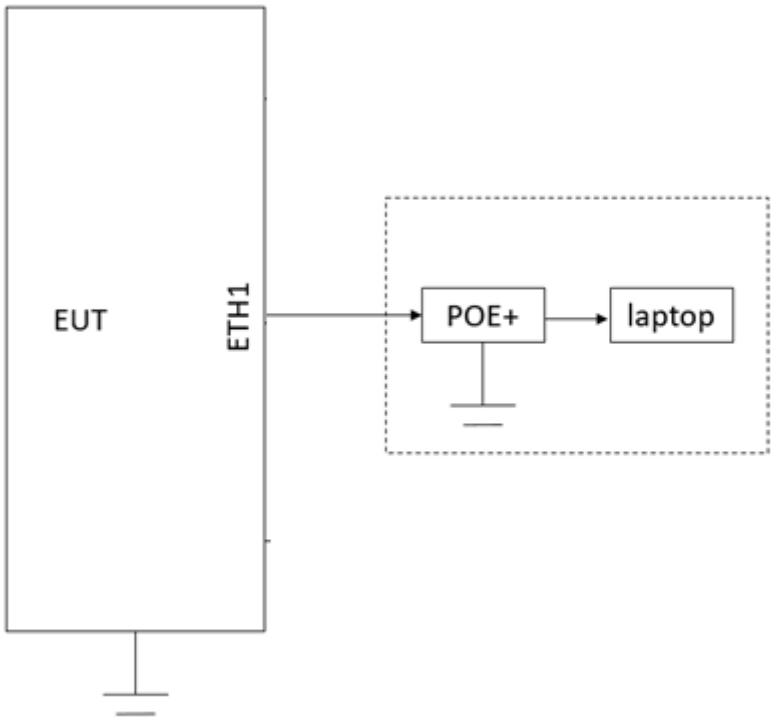
Description	Manufacturer	Model number	Serial number
Laptop	Dell	E7440	35868926774
POE	Power Dsine Microsemi	9001G/AC	D122765000001D6A00

6.4 Changes made in the EUT

No changes were performed in the EUT during testing.

6.5 Test configuration

6.5.1 EUT test configuration



6.6 Transmitter characteristics

Type of equipment	
V	Stand-alone (Equipment with or without its own control provisions)
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)
	Plug-in card (Equipment intended for a variety of host systems)

Intended use		**Condition of use**
V	fixed	Always at a distance more than 2 m from all people
	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 range	57.0 GHz – 64.0 GHz
Operating frequencies (tested)	58320 MHz, 60480 MHz, 62640 MHz
Maximum rated output power	EIRP 41.04 dBm

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

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
Integrated array of 32 dipole antenna	Siklu Ltd.	FARF042	22 dBi

Transmitter 99% power bandwidth, MHz	**Transmitter aggregate data rate/s, Mbps**	**Type of modulation**
2160	2500	QPSK

Type of multiplexing	TDD

Transmitter power source					
		Nominal rated voltage		Battery type	
V	DC	**Nominal rated voltage**	48 V		
		Voltage range	POE 42-57 V		
	AC mains	**Nominal rated voltage**		Frequency	

Common power source for transmitter and receiver	**V** yes	no

Test specification:	Section 15.255(b)(ii),(d), Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 241 ºC	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

7 Transmitter tests

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		EIRP, dBm	
	mW	dBm	Peak	Average
57000 – 64000	500	27.0	43	40

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(b)(ii),(d), Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 241 ºC	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Figure 7.1.1 Peak output power test setup

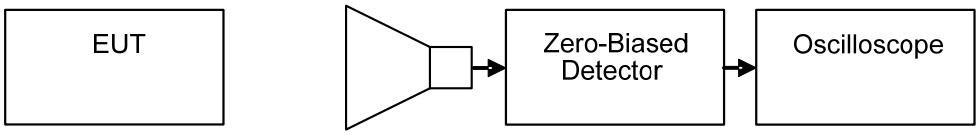


Figure 7.1.2 Peak output power test setup

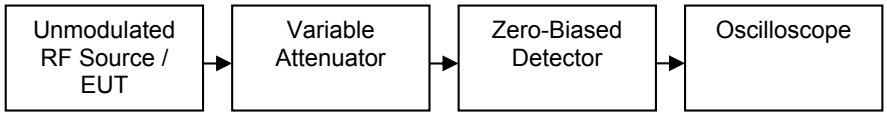
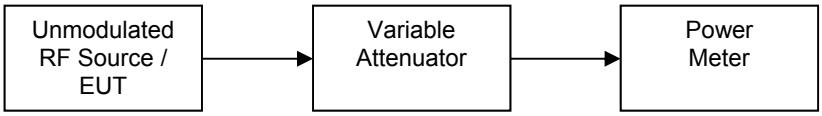


Figure 7.1.3 Peak output power test setup



Test specification:	Section 15.255(b)(ii),(d), Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 241 ºC	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Table 7.1.2 Peak output power test results

OPERATING FREQUENCY RANGE: 57.0 – 64.0 GHz
DETECTOR USED: Peak
MEASUREMENTS DISTANCE: 0.33 m
VIDEO BANDWIDTH: >10 MHz
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
MODULATION: QPSK

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
58320	0.005144	59.93	4.28	22.5	154.35	40.02	43.0	-2.98	Pass
60480	0.004960	55.89	4.98	22.5	155.37	41.04	43.0	-1.96	Pass
62640	0.004789	59.93	4.67	22.5	155.36	41.03	43.0	-1.97	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

Table 7.1.3 Average output power test results

OPERATING FREQUENCY RANGE: 57.0 – 64.0 GHz
DETECTOR USED: Average
MEASUREMENTS DISTANCE: 0.33 m
VIDEO BANDWIDTH: >10 MHz
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
MODULATION: QPSK

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
58320	0.005144	46.91	3.02	22.5	153.09	38.76	40.0	-1.24	Pass
60480	0.00496	45.78	3.30	22.5	153.67	39.36	40.0	-0.64	Pass
62640	0.004789	45.37	3.08	22.5	153.77	39.44	40.0	-0.56	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

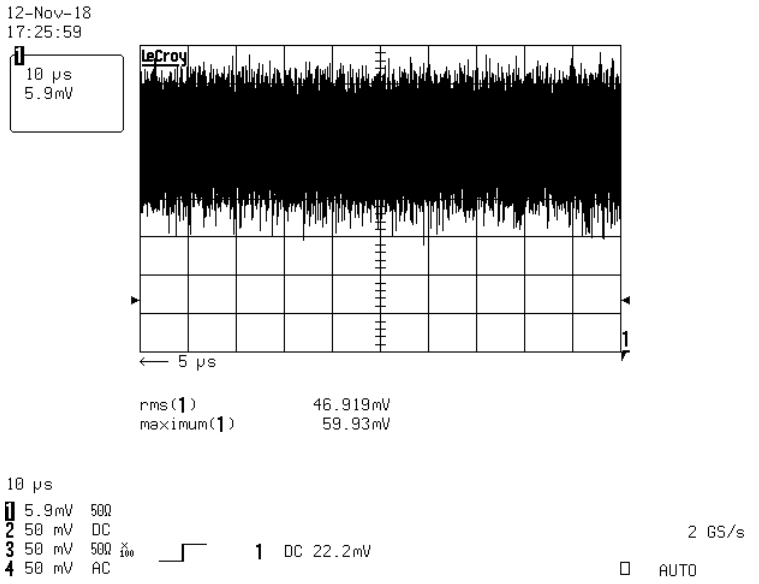
HL 0770	HL 0771	HL 3291	HL 3333	HL 3293	HL 3901	HL 4856	HL 5379

Full description is given in Appendix A.

Test specification:	Section 15.255(b)(ii),(d), Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 241 ºC	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

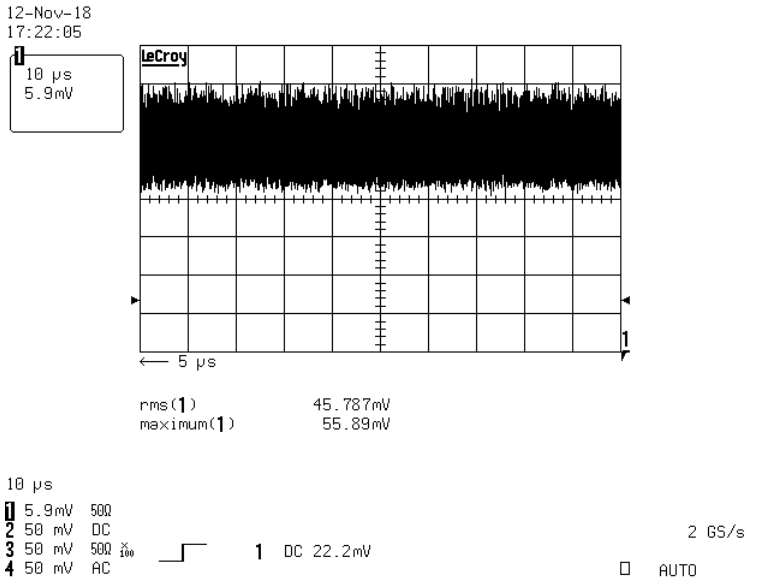
Plot 7.1.1 Output power test result at the 58.32 GHz frequency

DETECTOR:	Peak/Average



Plot 7.1.2 Output power test result at the 60.48 GHz frequency

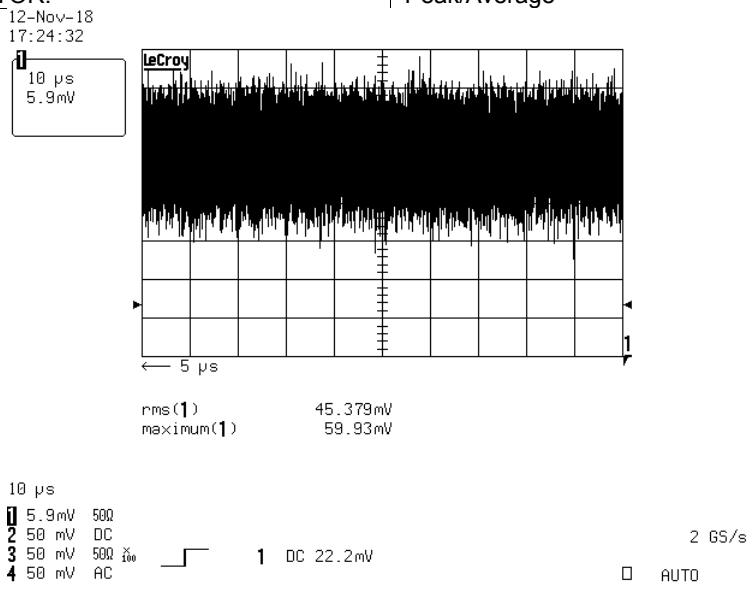
DETECTOR:	Peak/Average



Test specification:	Section 15.255(b)(ii),(d), Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 241 ºC	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.1.3 Output power test result at the 62.64 GHz frequency

DETECTOR:	Peak/Average



Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 48 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 - 64000	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 EUT was set to transmit modulated carrier as provided in Table 7.2.2.

7.2.2.3 The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope. The test results are provided in Table 7.2.2 and the associated plots.

Figure 7.2.1 Occupied bandwidth test setup

Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 48 VDC
Remarks:			

Table 7.2.2 Occupied bandwidth test results

OPERATING FREQUENCY RANGE: 57000 –64000 MHz
DETECTOR USED: Peak

Frequency, MHz	Modulation	Occupied bandwidth 99%, MHz	Occupied bandwidth 20 dBc MHz	Verdict
58320	QPSK	1970.4	2116	Pass
60480		1864.5	2060	Pass
62640		1890.9	2120	Pass

Reference numbers of test equipment used

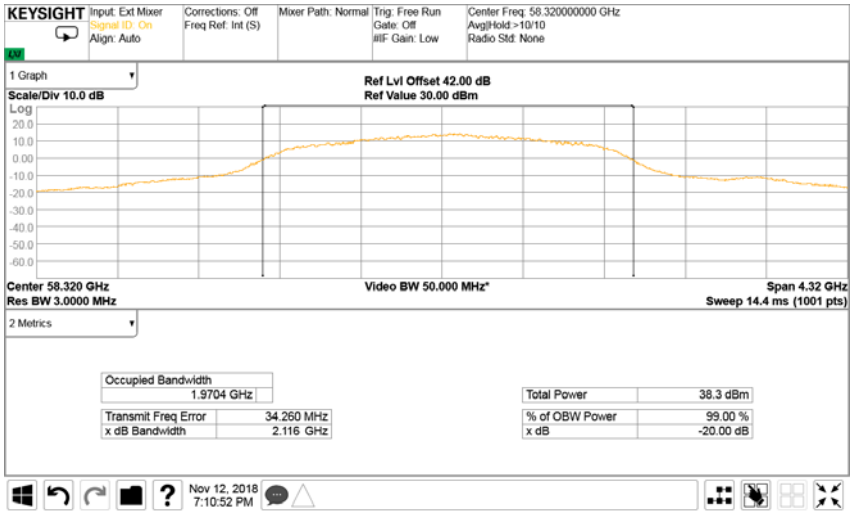
HL 0771	HL 3433	HL 3434	HL 5376				

Full description is given in Appendix A.

Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 48 VDC
Remarks:			

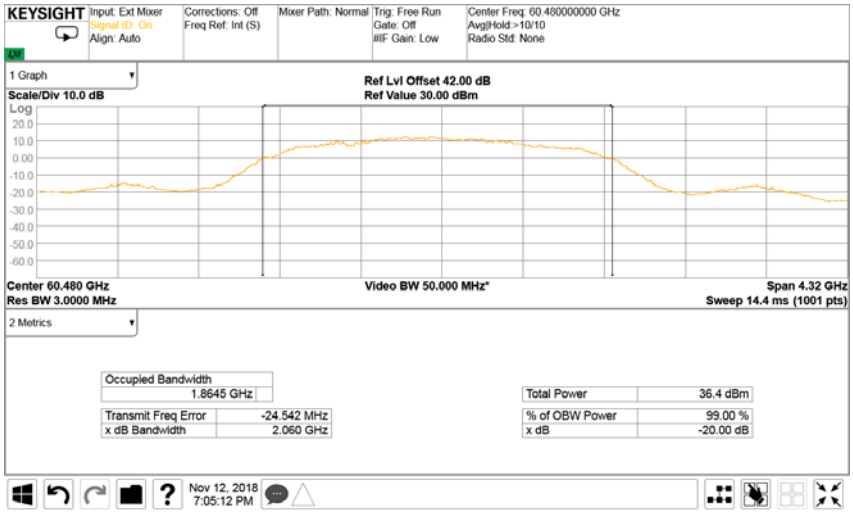
Plot 7.2.1 Occupied bandwidth at low frequency

FREQUENCY:	58.32 GHz
MODULATION:	QPSK



Plot 7.2.2 Occupied bandwidth mid frequency

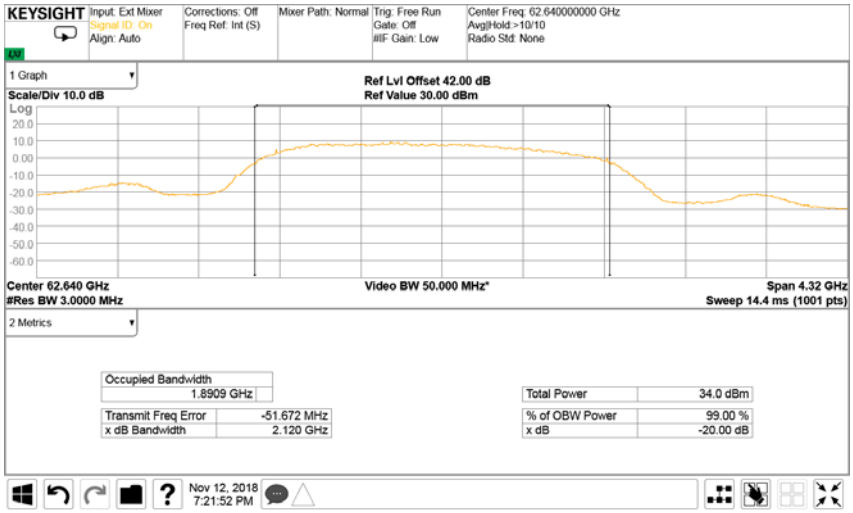
FREQUENCY:	60.48 GHz
MODULATION:	QPSK



Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	19-Nov-18		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 48 VDC
Remarks:			

Plot 7.2.3 Occupied bandwidth high frequency

FREQUENCY:	62.64 GHz
MODULATION:	QPSK



Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

7.3 Out of band radiated emissions below 40 GHz

7.3.1 General

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

Table 7.3.1 Spurious emission field strength limits

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

*- The above field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.
**- 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 loop antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna was rotated around its vertical axis and the measuring antenna polarization was switched from vertical to horizontal.
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 7.3.3 and shown in the associated plots.

Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Figure 7.3.1 Spurious emission field strength below 30 MHz test set up

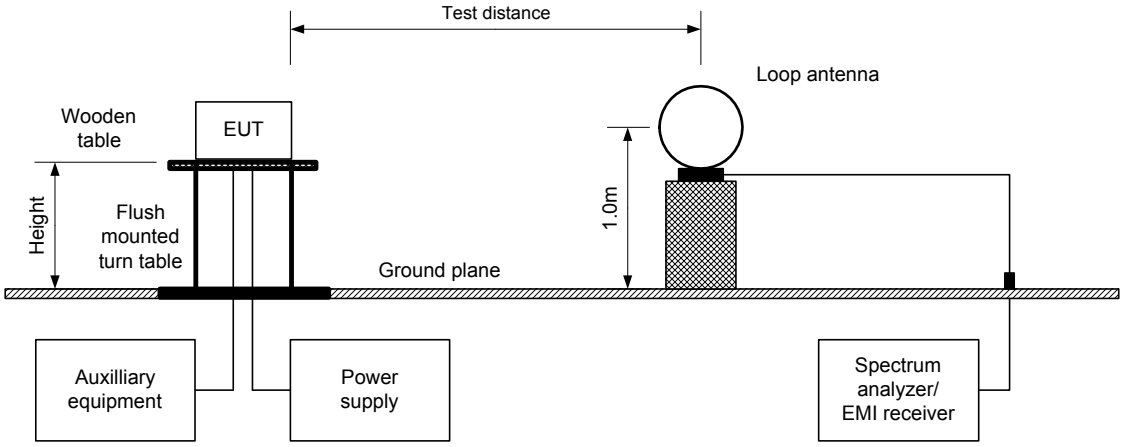
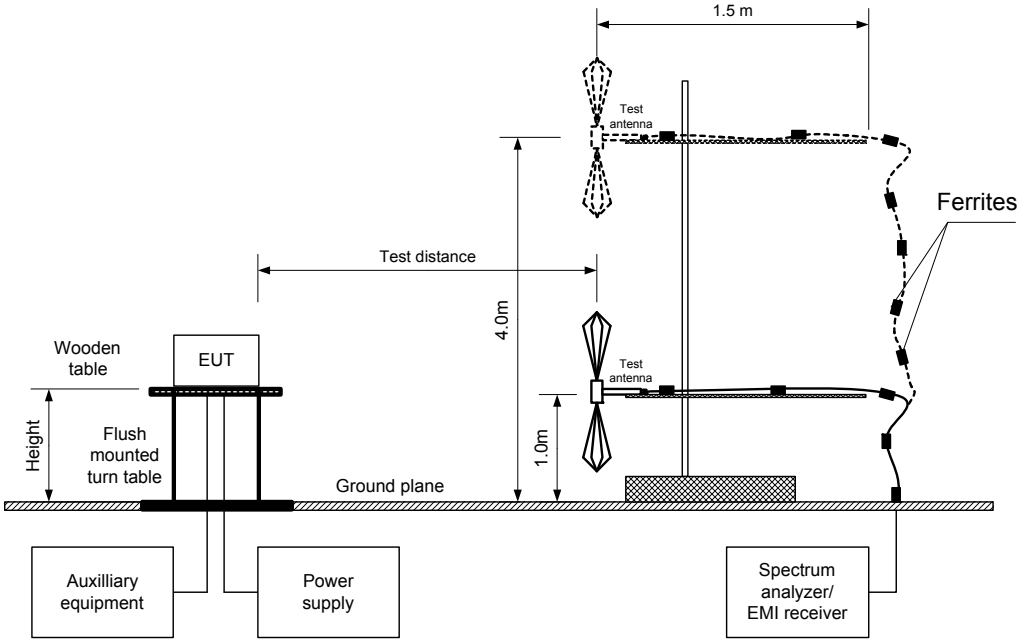
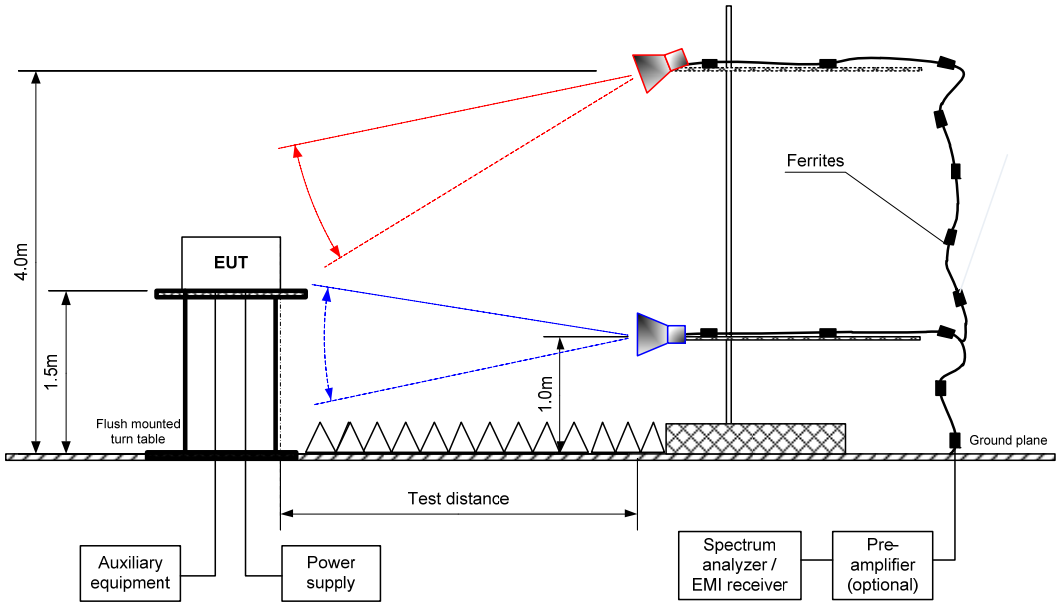


Figure 7.3.2 Radiated emissions in 30 MHz-1000 MHz test set up



Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 °C	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Figure 7.3.3 Spurious emission field strength above 1000 MHz test set up



Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Table 7.3.2 Spurious emission field strength test results below 1000 MHz

EUT SET UP:	TABLE-TOP
TEST SITE	SEMI ANECHOIC CHAMBER
TEST DISTANCE	3 m
DETECTORS USED	QUASI-PEAK
EUT POSITION:	Typical (Vertical)
MODULATION:	QPSK
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
INVESTIGATED FREQUENCY RANGE:	0.009 – 1000 MHz
RESOLUTION BANDWIDTH:	1.0 kHz (9 kHz – 150 kHz) 9.0 kHz (150 kHz – 30 MHz) 120 kHz (30 MHz – 1000 MHz)
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, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
Low carrier 58320 MHz								
30.648053	34.84	30.69	40.0	-9.31	Vertical	1.04	57	Pass
32.598416	33.67	29.69	40.0	-10.31	Vertical	1.02	295	
58.747036	31.52	26.58	40.0	-13.42	Vertical	1.04	103	
92.407490	33.82	30.92	43.5	-12.58	Vertical	1.02	13	
101.888377	41.23	39.43	43.5	-4.07	Vertical	1.02	13	
119.265551	32.47	29.62	43.5	-13.88	Vertical	1.02	7	
Mid carrier 60480 MHz								
30.607137	34.16	30.91	40.0	-9.09	Vertical	1.02	351	Pass
34.108892	32.55	29.04	40.0	-10.96	Vertical	1.04	360	
58.752249	31.25	26.29	40.0	-13.71	Vertical	1.04	0	
102.800882	41.47	35.58	43.5	-7.92	Vertical	1.02	360	
110.819986	36.63	33.21	43.5	-10.29	Vertical	1.02	281	
118.987334	32.14	29.42	43.5	-14.08	Vertical	1.04	318	
143.262704	29.37	25.91	43.5	-17.59	Vertical	1.04	225	
High frequency: 62640 MHz								
30.638931	34.58	31.20	40.0	-8.80	Vertical	1.02	58	Pass
34.630283	33.80	30.15	40.0	-9.85	Vertical	1.00	46	
47.798304	29.82	26.19	40.0	-13.81	Vertical	1.00	57	
58.738165	31.34	26.10	40.0	-13.90	Vertical	1.00	114	
81.511182	30.82	26.67	40.0	-13.33	Vertical	1.34	340	
92.393171	33.83	31.08	43.5	-12.42	Vertical	1.02	333	
101.897885	41.51	39.57	43.5	-3.93	Vertical	1.00	0	
110.805432	36.87	33.38	43.5	-10.12	Vertical	1.00	180	
119.945741	32.70	30.07	43.5	-13.43	Vertical	0.00	317	

*- Margin = Measured emission - specification limit.

**- EUT front panel refer to 0 degrees position of turntable

Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Table 7.3.3 Spurious emission field strength test results in 1000 – 40000 MHz range

TEST SITE:	SEMI ANECHOIC CHAMBER
EUT SET UP	TABLE-TOP
TEST DISTANCE:	3 m
EUT POSITION:	Typical (Vertical)
MODULATION:	QPSK
DETECTORS USED:	Peak/Average
MODULATING SIGNAL:	PRBS
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
INVESTIGATED FREQUENCY RANGE:	1000 – 40000 MHz
RESOLUTION BANDWIDTH:	1000 kHz
VIDEO BANDWIDTH:	≥ Resolution bandwidth
TEST ANTENNA TYPE:	Double-Ridged Waveguide Horn

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength (VBW=3 MHz)			Average field strength (VBW=30 Hz)			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 58320 MHz										
7290.250000	Horizontal	136.0	335	52.49	74.00	-21.51	47.30	54.00	-6.70	Pass
12295.407667	Vertical	400.0	154	52.84	74.00	-21.16	38.61	54.00	-15.39	
14717.827500	Vertical	100.0	347	55.79	74.00	-18.21	37.26	54.00	-16.74	
Mid carrier 60480 MHz										
3333.194833	Horizontal	342.0	206	55.91	74.00	-18.09	41.84	54.00	-12.16	Pass
4000.434833	Horizontal	154.0	179	50.14	74.00	-23.86	38.07	54.00	-15.93	
4666.674833	Horizontal	181.0	165	43.28	74.00	-30.72	29.69	54.00	-24.31	
5280.032333	Vertical	234.0	214	47.24	74.00	-26.76	40.53	54.00	-13.47	
7559.792500	Horizontal	234.0	129	51.40	74.00	-22.60	45.08	54.00	-8.92	
High frequency: 62640 MHz										
3333.642667	Horizontal	400.0	129	54.93	74.00	-19.07	38.94	54.00	-15.06	Pass
4000.434833	Horizontal	223.0	170	52.26	74.00	-21.74	38.09	54.00	-15.91	
4666.674833	Horizontal	128.0	142	46.13	74.00	-27.87	37.41	54.00	-16.59	
5279.980167	Horizontal	100.0	227	47.87	74.00	-26.13	40.26	54.00	-13.74	
7830.282333	Horizontal	210.0	118	51.55	74.00	-22.45	43.33	54.00	-10.67	

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

Reference numbers of test equipment used

HL 0446	HL 0521	HL 0604	HL 1424	HL 2909	HL 3901	HL 4278	HL 4353
HL 4956							

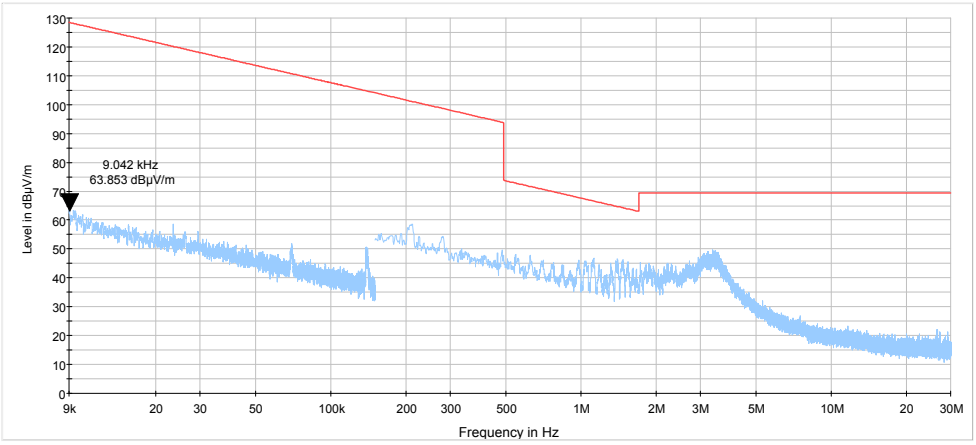
Full description is given in Appendix A.

Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.1 Spurious emission measurements in 9 kHz – 30 MHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

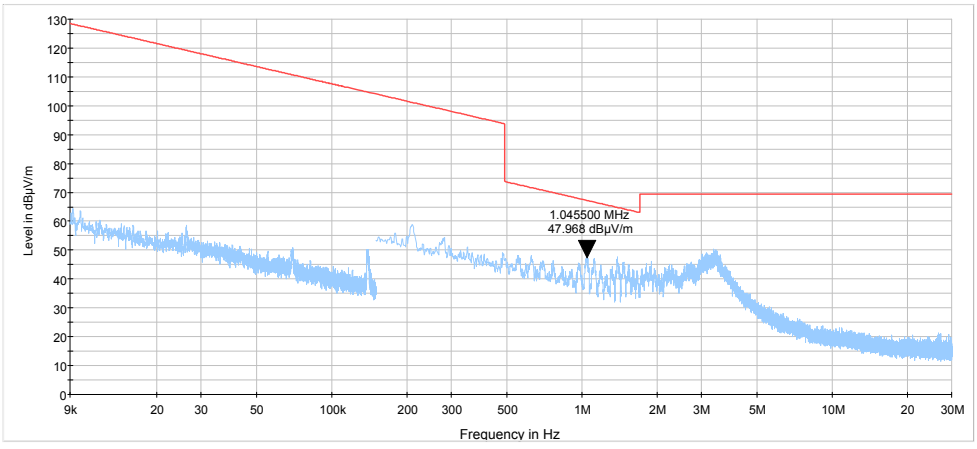
Low carrier frequency 58320 MHz



Plot 7.3.2 Spurious emission measurements in 9 kHz – 30 MHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

Mid carrier frequency 60480 MHz

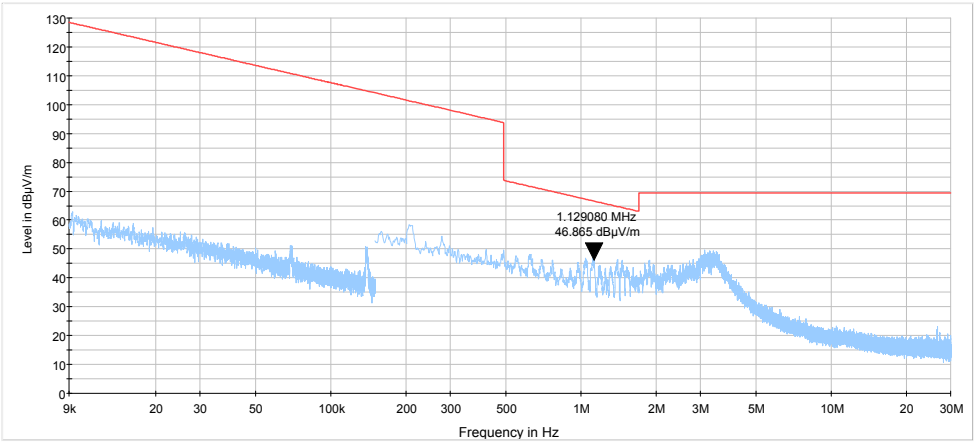


Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.3 Spurious emission measurements in 9 kHz – 30 MHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

High carrier frequency 62640 MHz

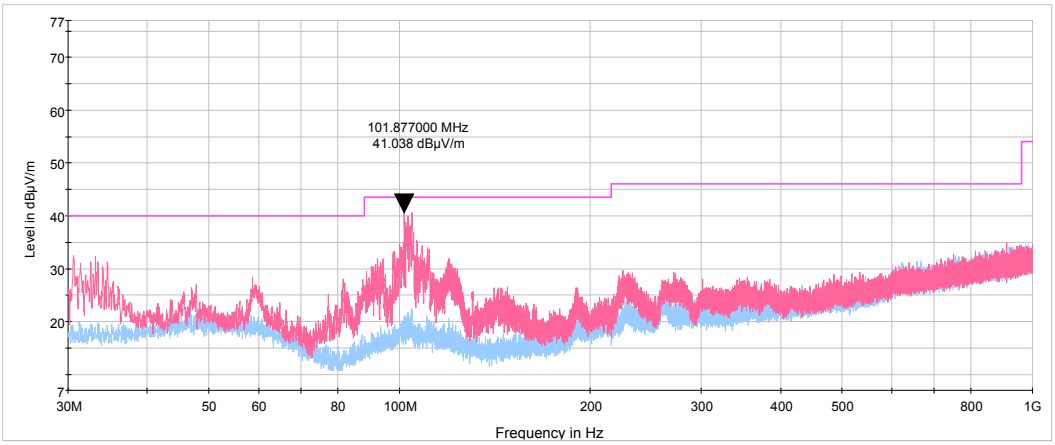


Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.4 Spurious emission measurements in 30 MHz – 1 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

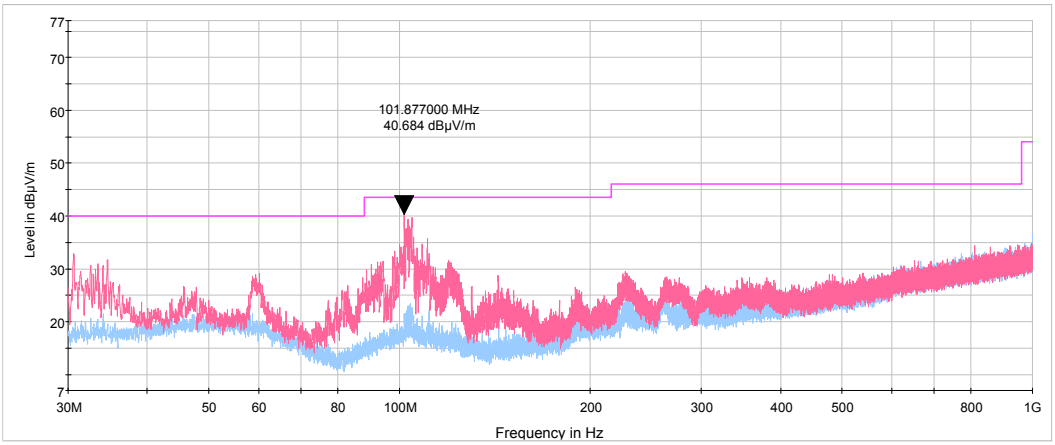
Low carrier frequency 58320 MHz



Plot 7.3.5 Spurious emission measurements in 30 MHz – 1 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

Mid carrier frequency 60480 MHz

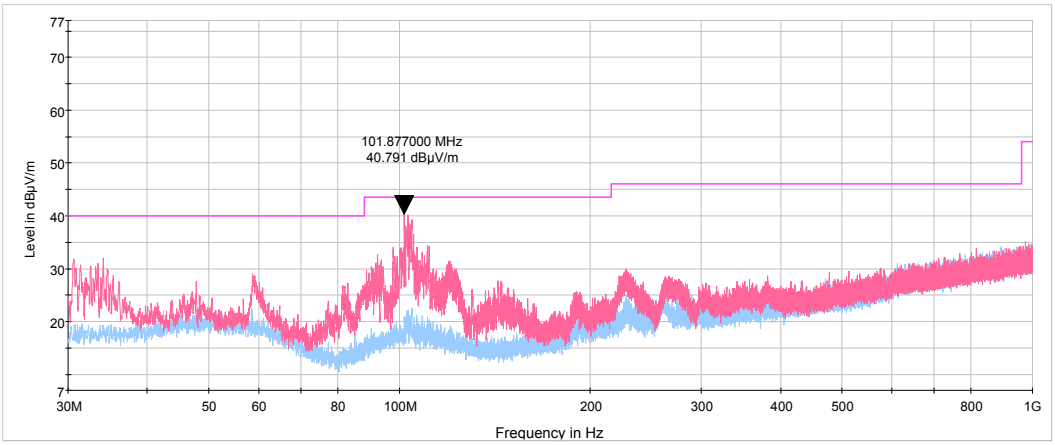


Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.6 Spurious emission measurements in 30 MHz – 1 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

High carrier frequency 62640 MHz

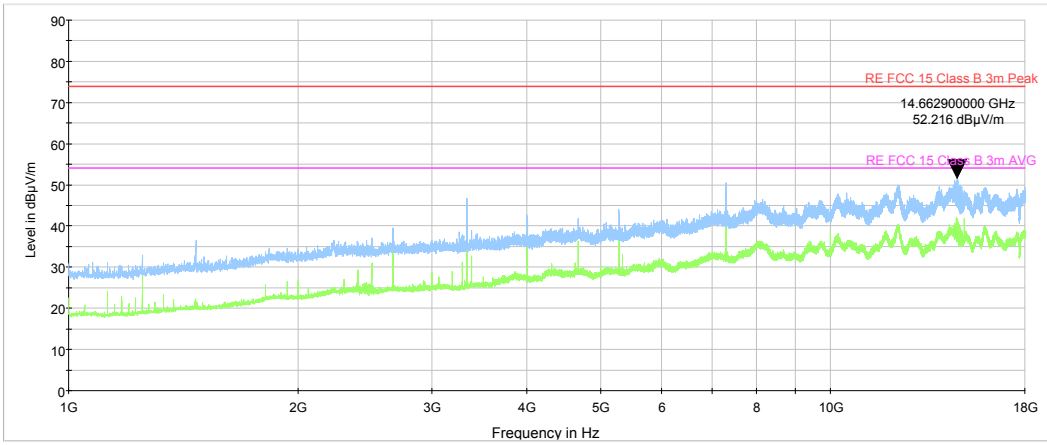


Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.7 Spurious emission measurements in 1 GHz – 18 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

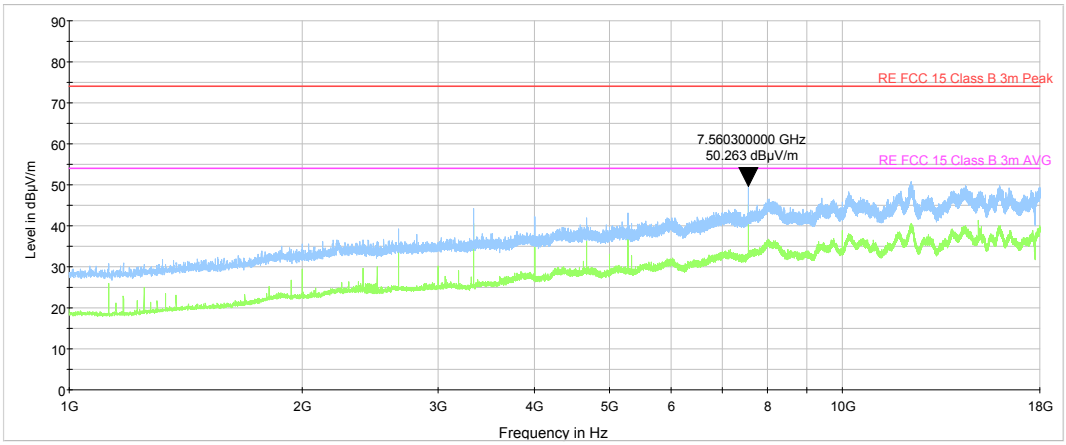
Low carrier frequency 58320 MHz



Plot 7.3.8 Spurious emission measurements in 1 GHz – 18 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

Mid carrier frequency 60480 MHz

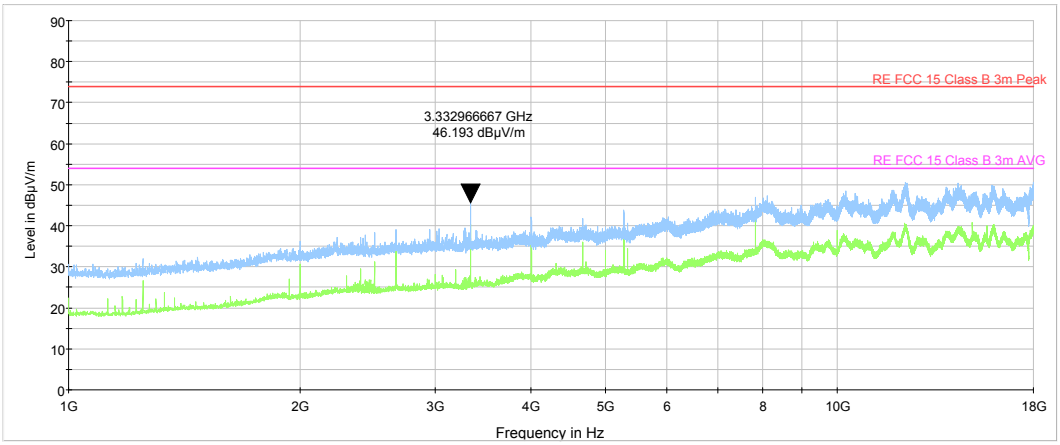


Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.9 Spurious emission measurements in 1 GHz – 18 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

High carrier frequency 62640 MHz

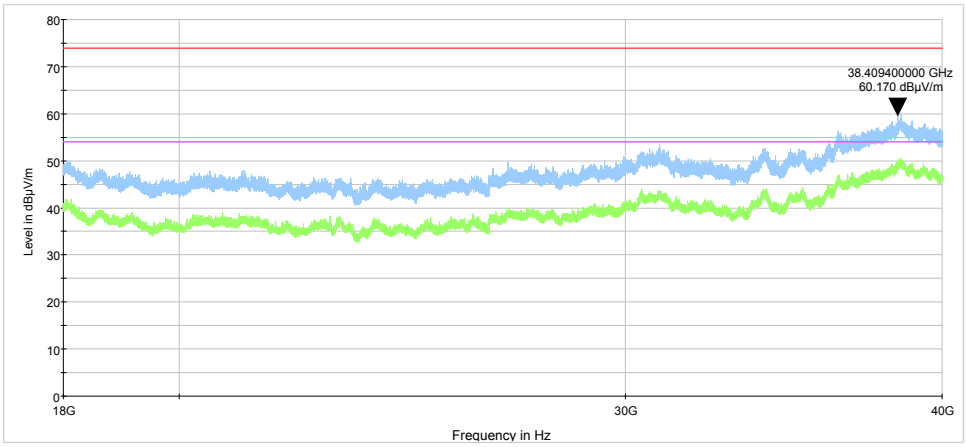


Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.10 Spurious emission measurements in 18 GHz – 40 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

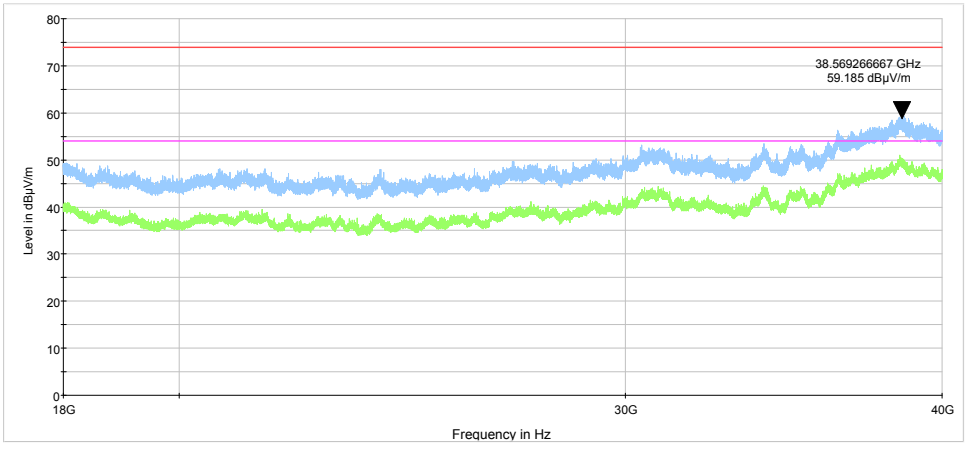
Low carrier frequency 58320 MHz



Plot 7.3.11 Spurious emission measurements in 18 GHz – 40 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

Mid carrier frequency 60480 MHz

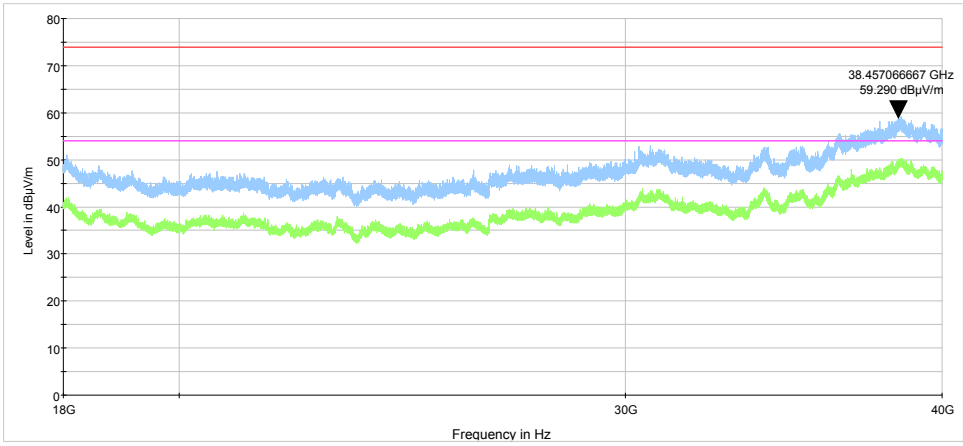


Test specification:	Section 15.255(c)(2), Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Nov-18		
Temperature: 24.1 ºC	Relative Humidity: 47 %	Air Pressure: 1010 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.12 Spurious emission measurements in 18 GHz – 40 GHz range

TEST SITE:	Anechoic chamber
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical
DETECTOR:	Peak

High carrier frequency 62640 MHz



Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 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 – 200	90.0	3.0	105.30	85.30
75 - 110	90.0	1.0	114.80**	94.80**
110 - 140	90.0	0.10	134.80**	114.80**
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

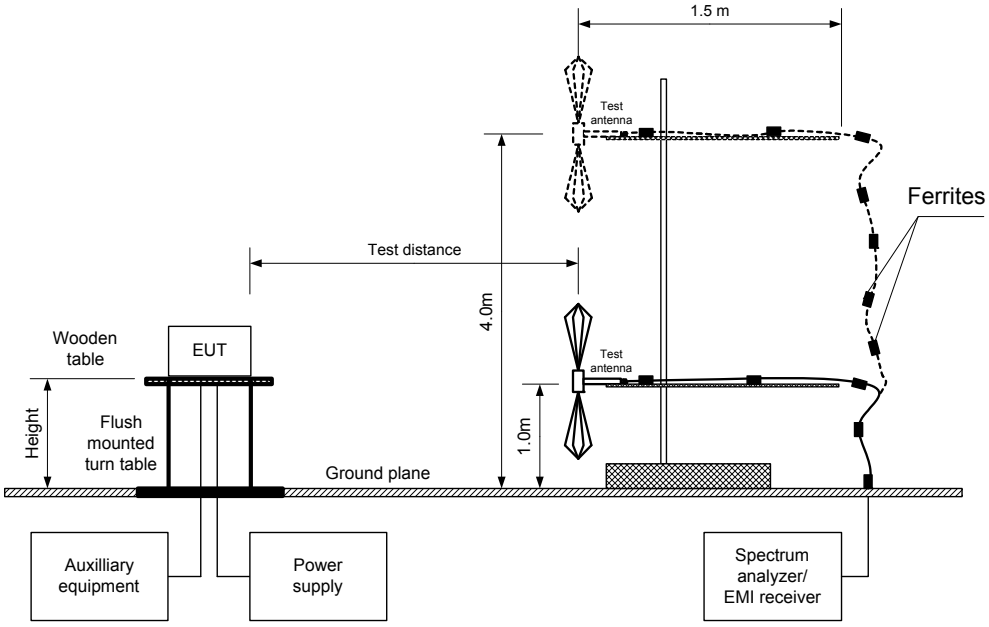
7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized and the performance check was conducted.

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.

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

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



Test specification:	**Section 15.255(c)(3), Out of band radiated emissions above 40 GHz**		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1009 hPa	**Power:** 48 VDC
Remarks:			

Table 7.4.2 Spurious emission field strength test results

TEST DISTANCE:	0.005 - 3 m
EUT POSITION:	Typical (Vertical)
MODULATION:	QPSK
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 58320 MHz										
No emissions were found										Pass
Mid carrier frequency 60480 MHz										
No emissions were found										Pass
High carrier frequency 62640 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.

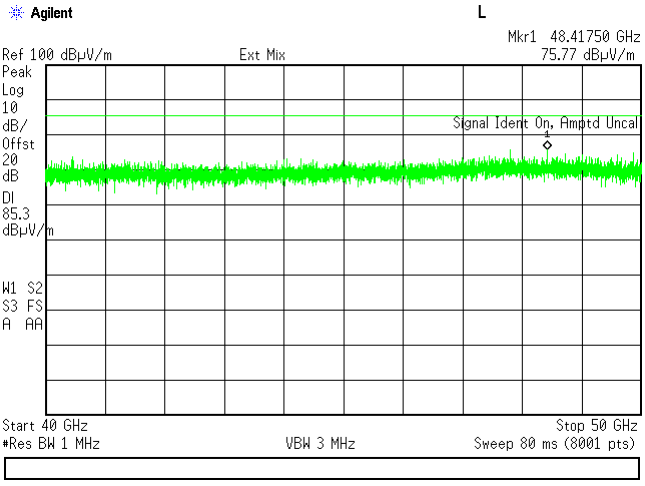
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

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

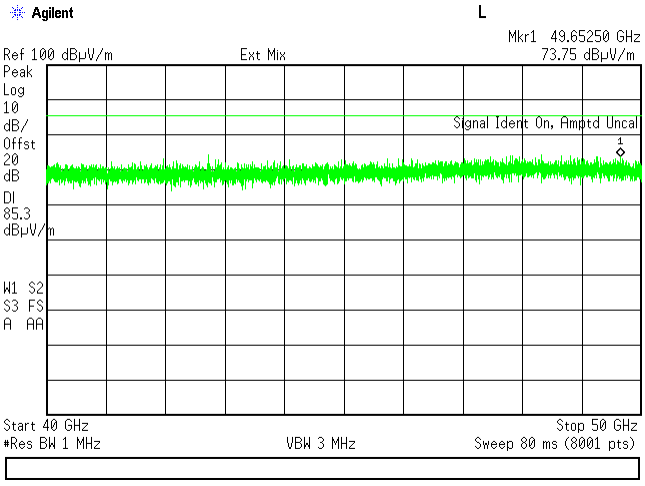
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
Peak

DETECTOR:

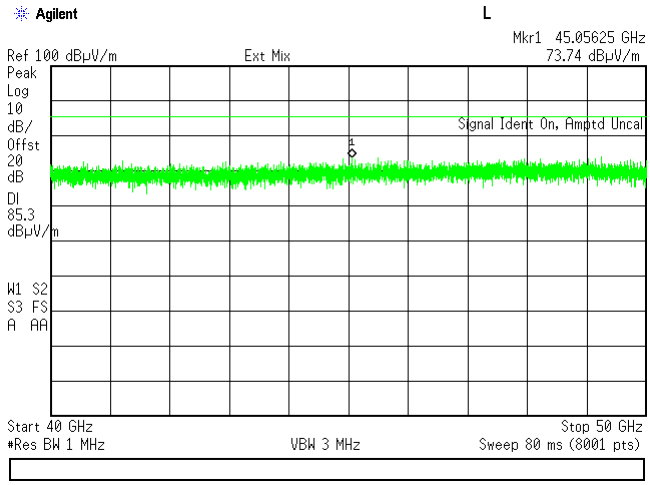
Low carrier frequency 58320 MHz



Mid carrier frequency 60480 MHz



High carrier frequency 62640 MHz

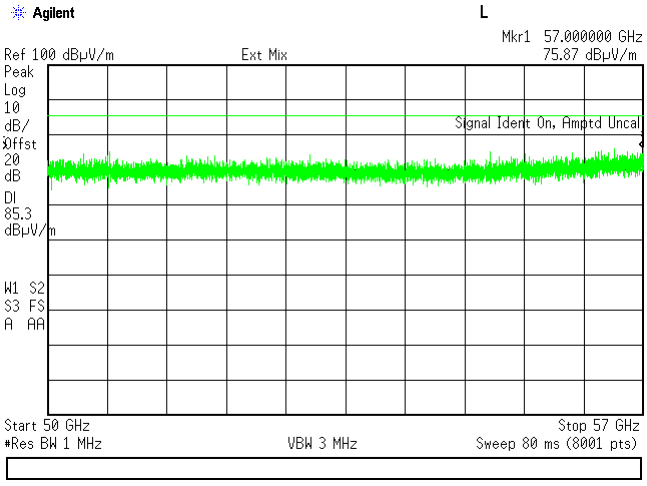


Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

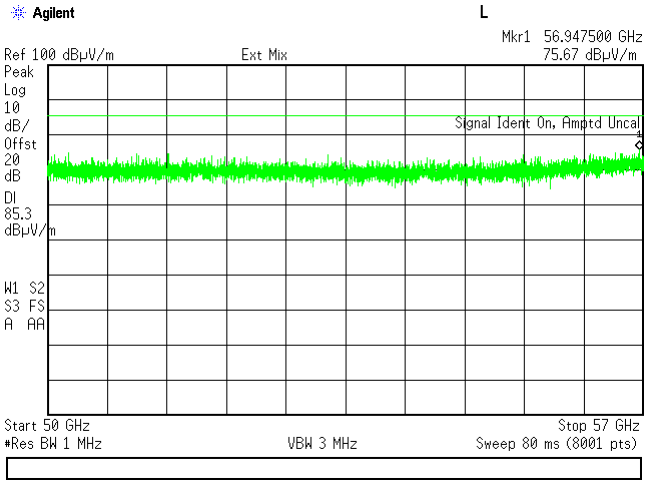
Plot 7.4.2 Spurious emission measurements in 50 – 57 GHz range

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

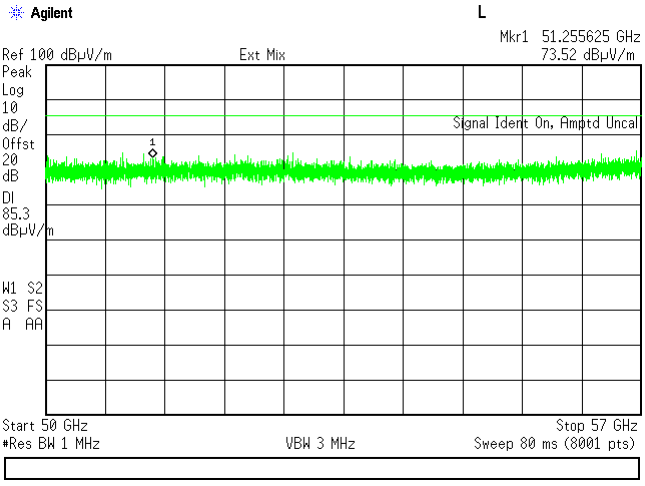
Low carrier frequency 58320 MHz



Mid carrier frequency 60480 MHz



High carrier frequency 62640 MHz

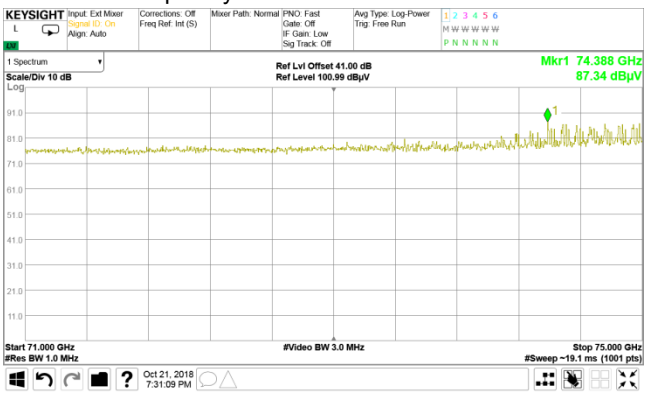


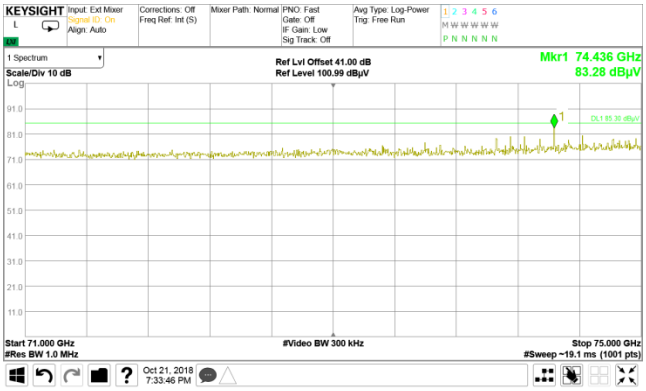
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.3 Spurious emission measurements in 71 – 75 GHz range

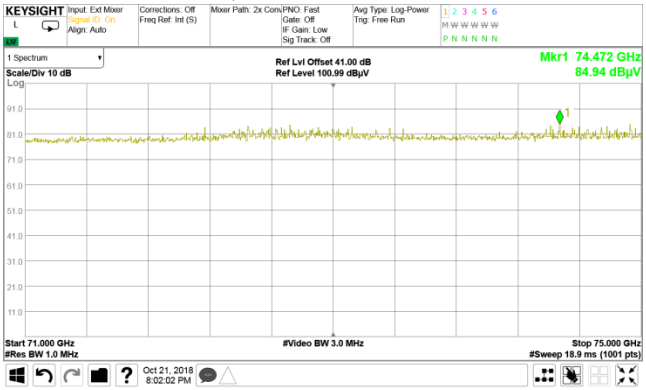
TEST SITE:	OATS
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 300 kHz

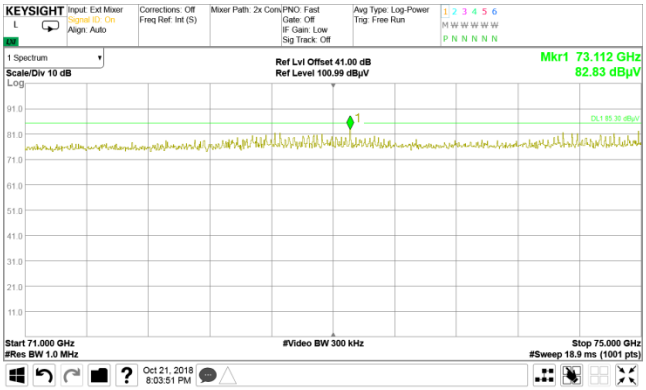
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





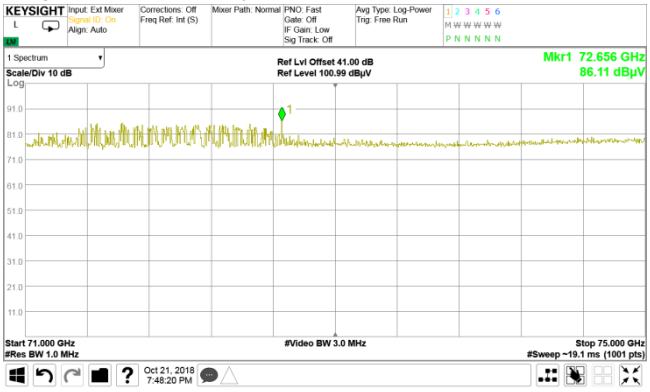
Limit 105.3 dBuV/m was applied

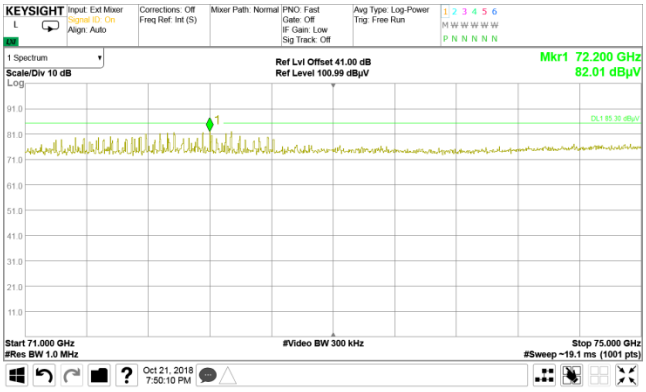
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.4 Spurious emission measurements in 71 – 75 GHz range

TEST SITE:	OATS
TEST DISTANCE:	3 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 300 kHz

High carrier frequency 62640 MHz





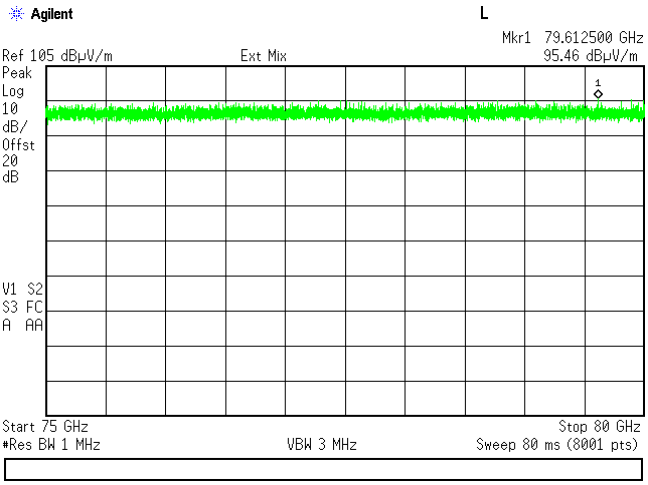
Limit 105.3 dBuV/m was applied

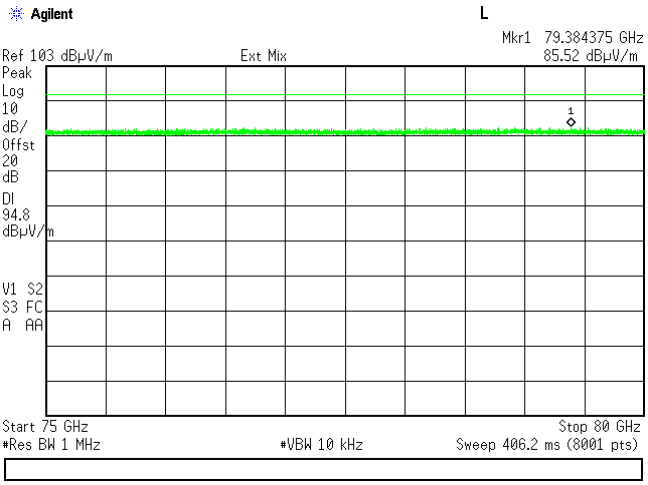
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.5 Spurious emission measurements in 75 – 80 GHz range

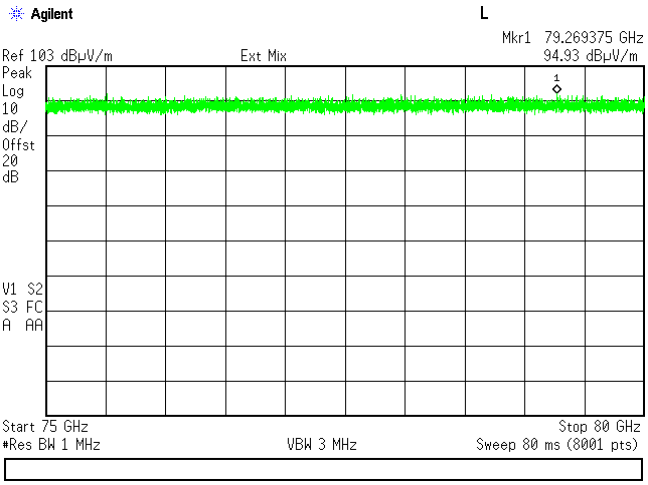
TEST SITE:	OATS
TEST DISTANCE:	1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 10 kHz

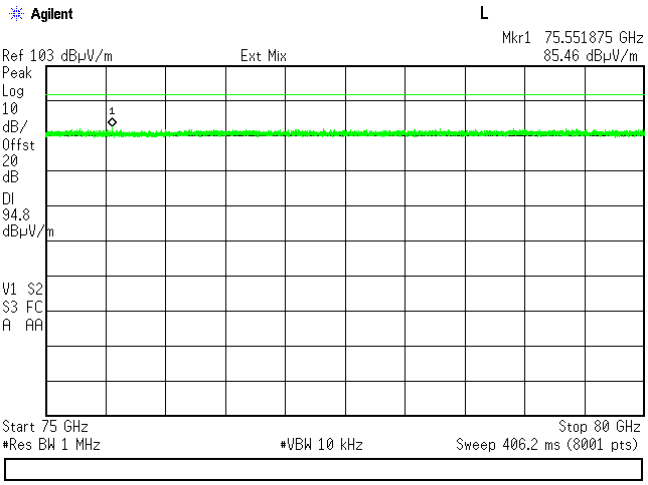
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





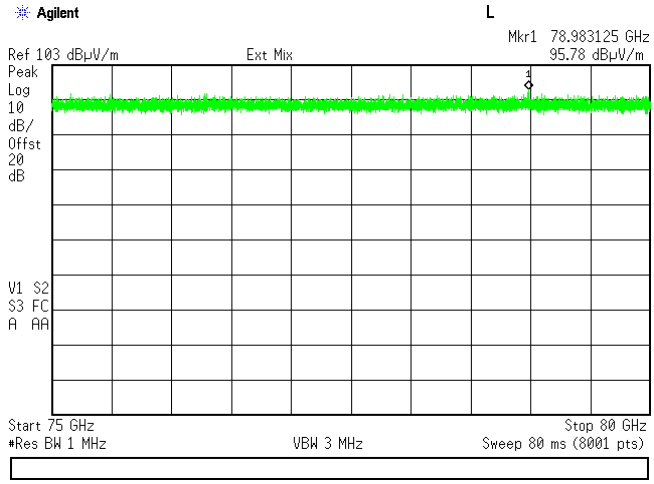
Limit 114.8 dBuV/m was applied

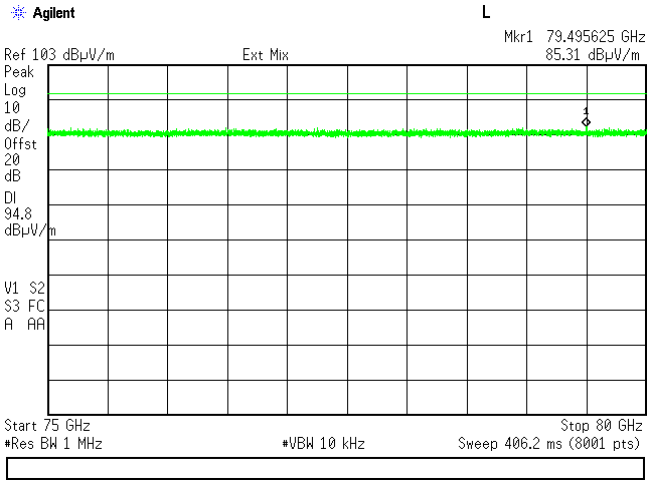
Test specification:	**Section 15.255(c)(3), Out of band radiated emissions above 40 GHz**		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1009 hPa	**Power:** 48 VDC
Remarks:			

Plot 7.4.6 Spurious emission measurements in 75 – 80 GHz range

TEST SITE:	OATS
TEST DISTANCE:	1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 10 kHz

High carrier frequency 62640 MHz





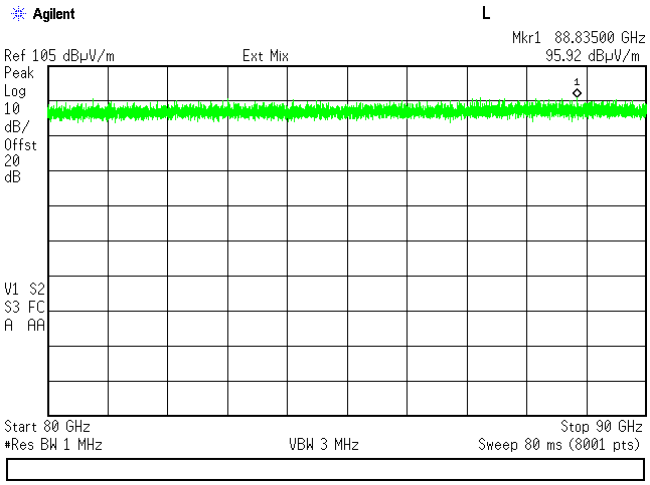
Limit 114.8 dBuV/m was applied

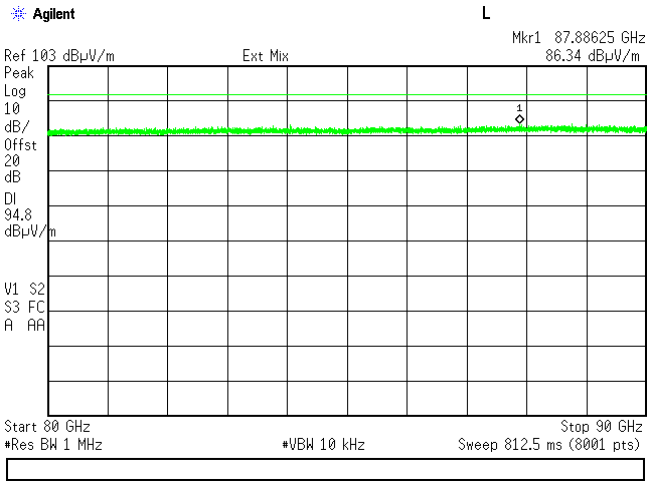
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.7 Spurious emission measurements in 80 – 90 GHz range

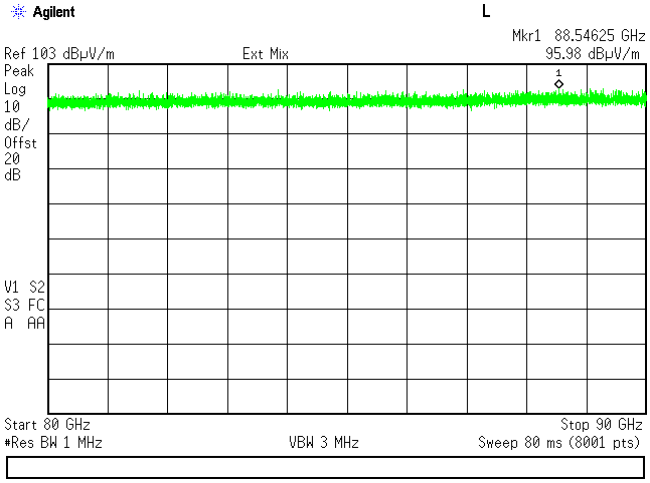
TEST SITE: OATS
TEST DISTANCE: 1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
DETECTOR: Peak
RBW = 1MHz; VBW = 10 kHz

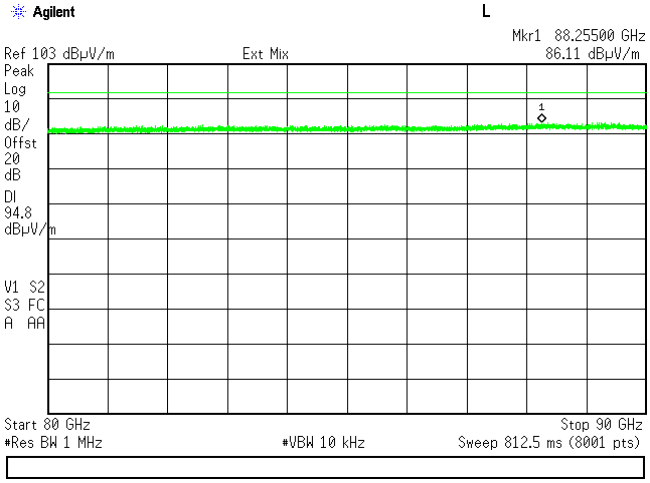
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





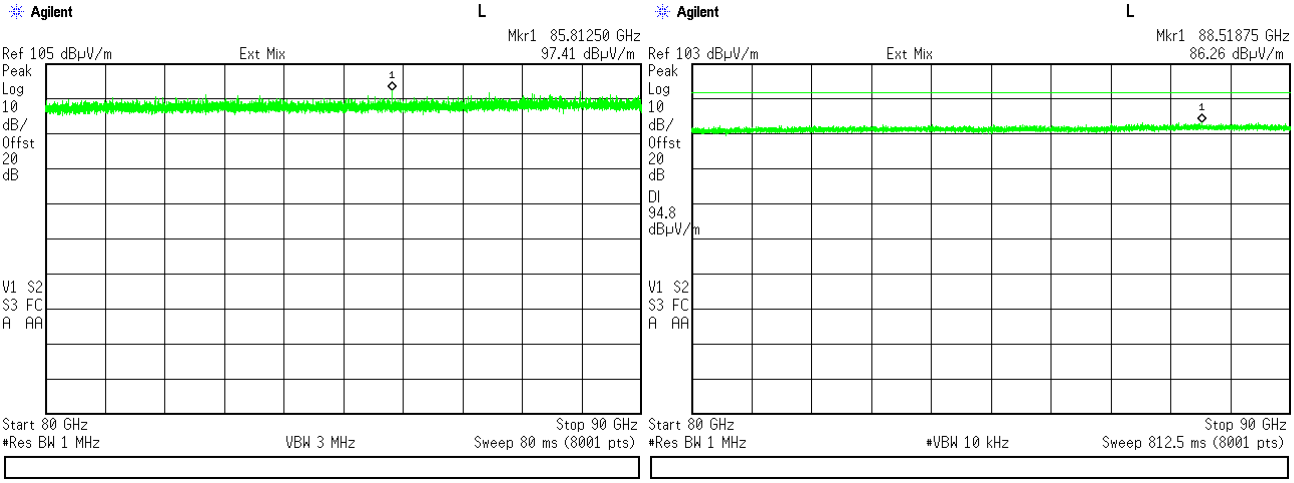
Limit 114.8 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.8 Spurious emission measurements in 80 – 90 GHz range

TEST SITE:	OATS
TEST DISTANCE:	1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 10 kHz

High carrier frequency 62640 MHz



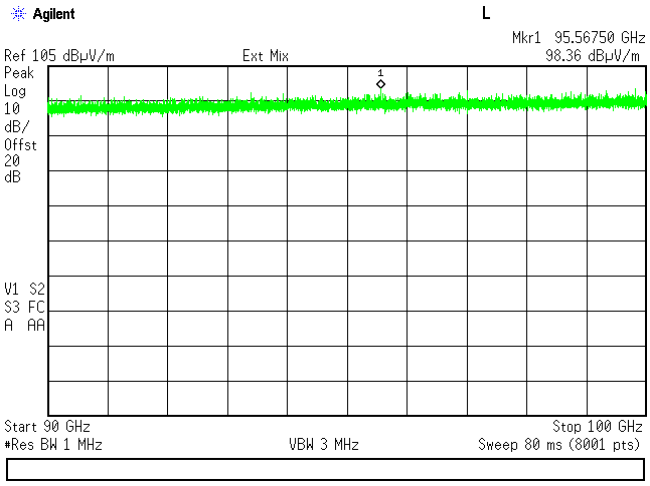
Limit 114.8 dBuV/m was applied

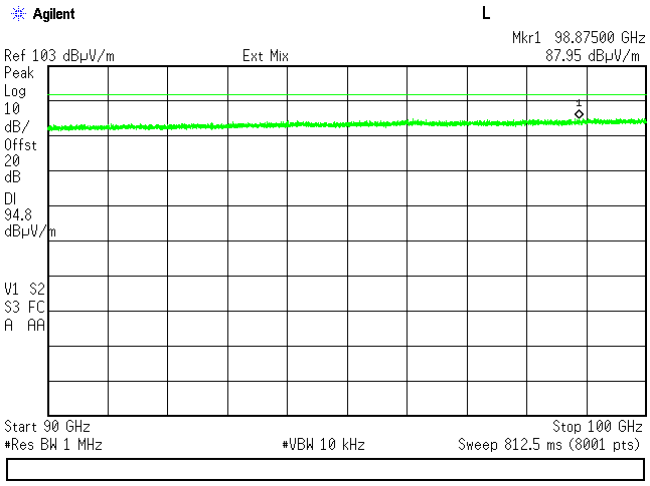
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.9 Spurious emission measurements in 90 – 100 GHz range

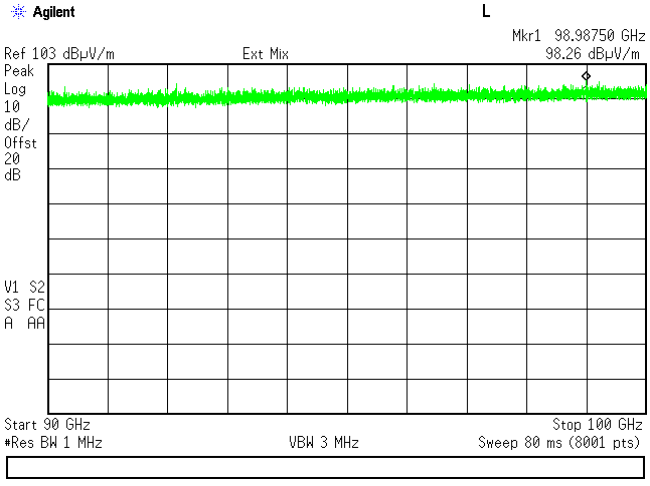
TEST SITE:	OATS
TEST DISTANCE:	1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 10 kHz

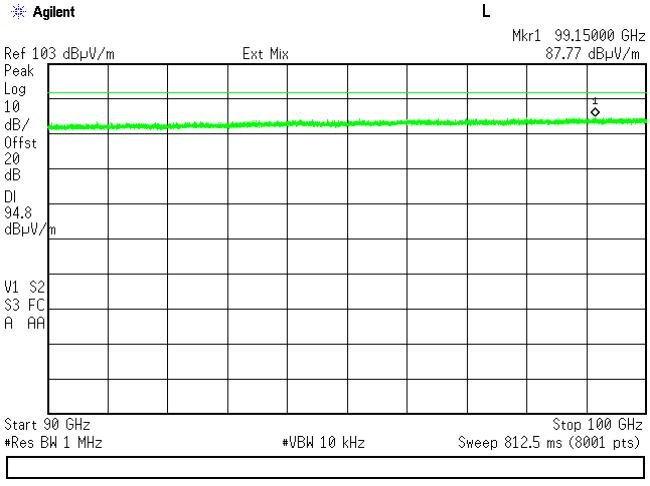
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





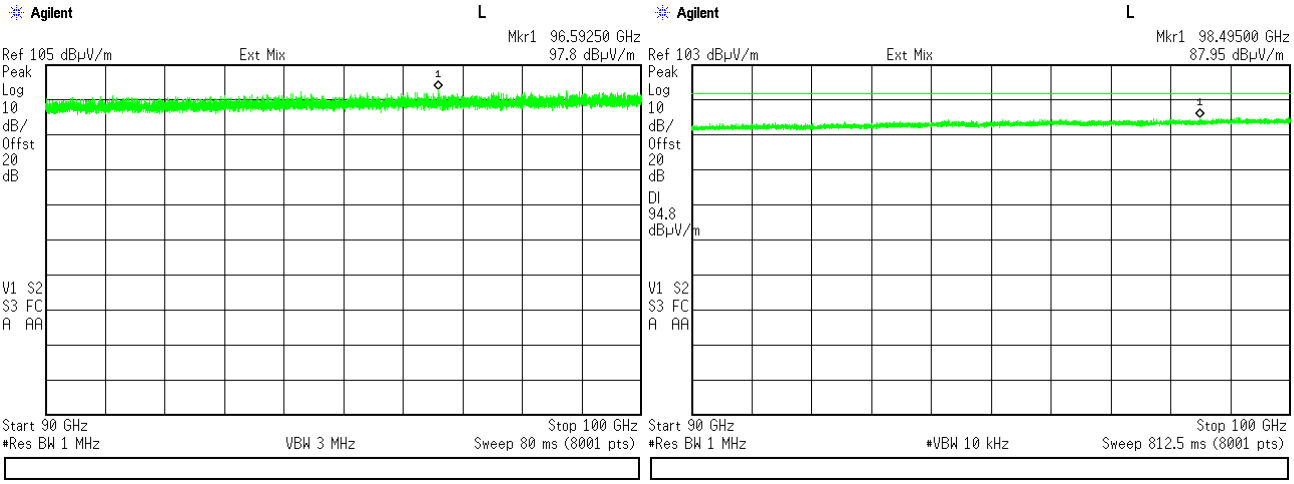
Limit 114.8 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.10 Spurious emission measurements in 90 – 100 GHz range

TEST SITE:	OATS
TEST DISTANCE:	1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 10 kHz

High carrier frequency 62640 MHz



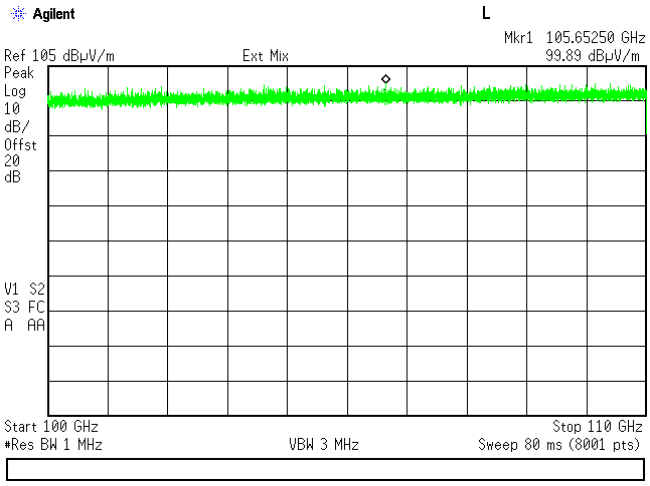
Limit 114.8 dBuV/m was applied

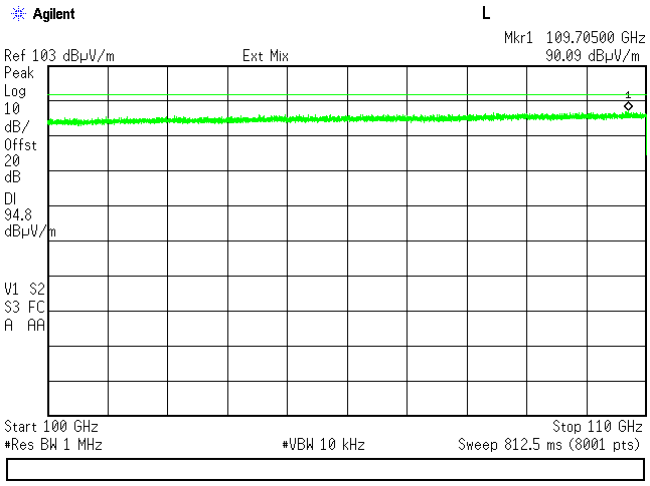
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.11 Spurious emission measurements in 100 – 110 GHz range

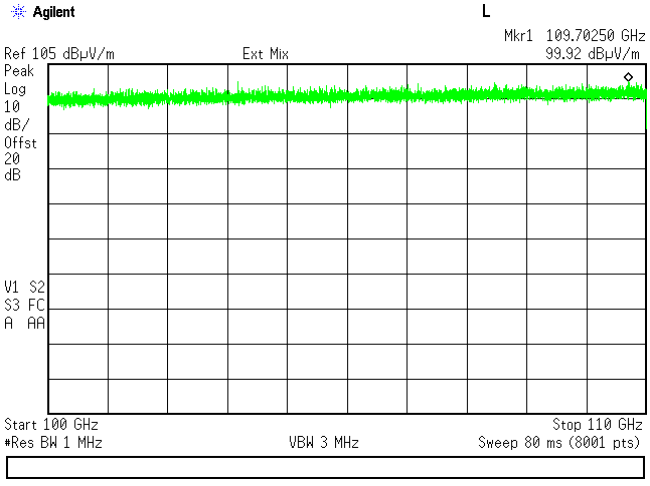
TEST SITE:	OATS
TEST DISTANCE:	1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 10 kHz

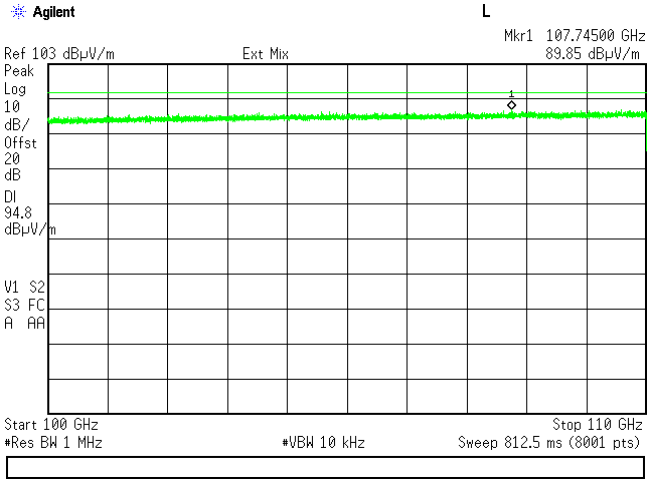
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





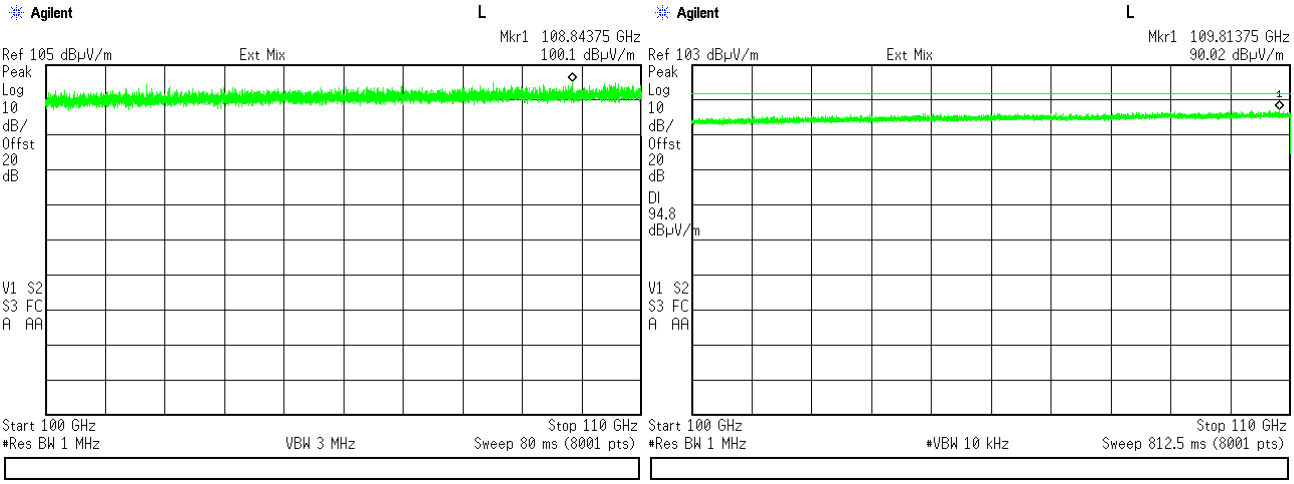
Limit 114.8 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.12 Spurious emission measurements in 100 – 110 GHz range

TEST SITE:	OATS
TEST DISTANCE:	1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 10 kHz

High carrier frequency 62640 MHz



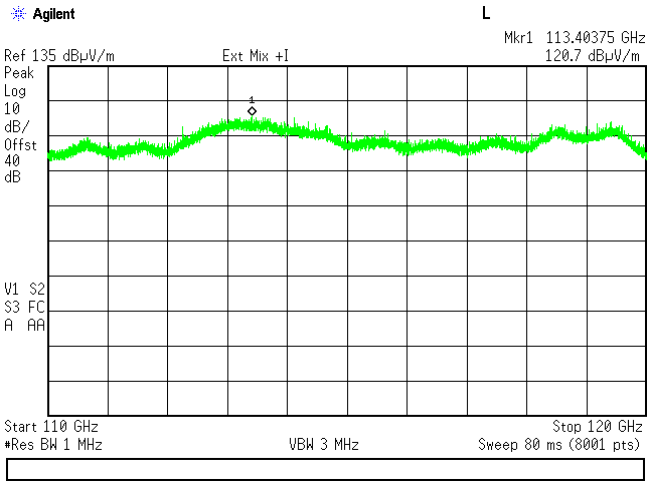
Limit 114.8 dBuV/m was applied

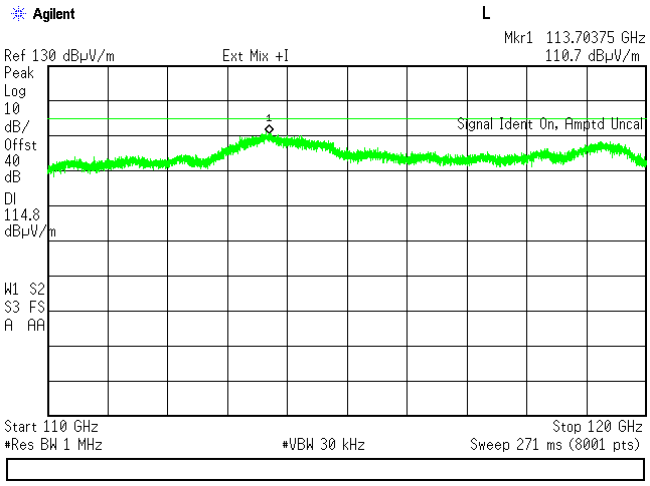
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.13 Spurious emission measurements in 110 – 120 GHz range

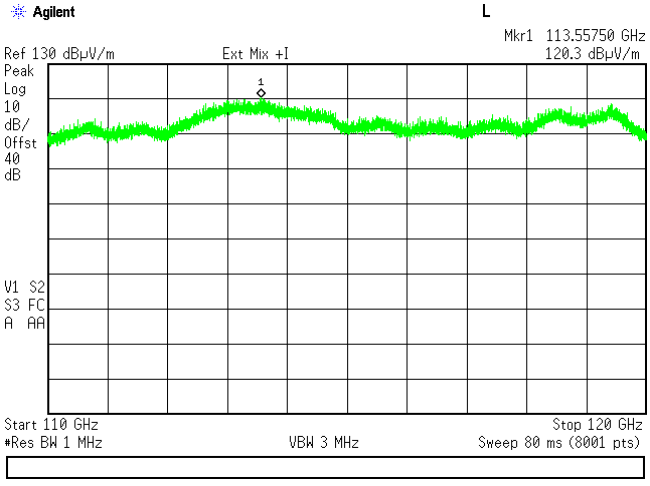
TEST SITE:	OATS
TEST DISTANCE:	0.1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

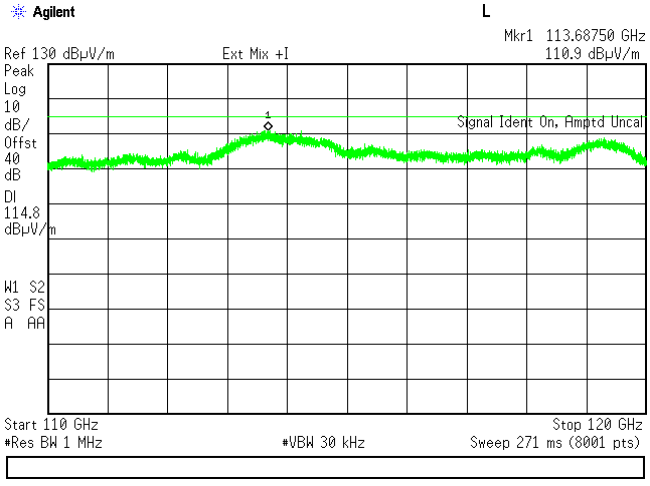
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





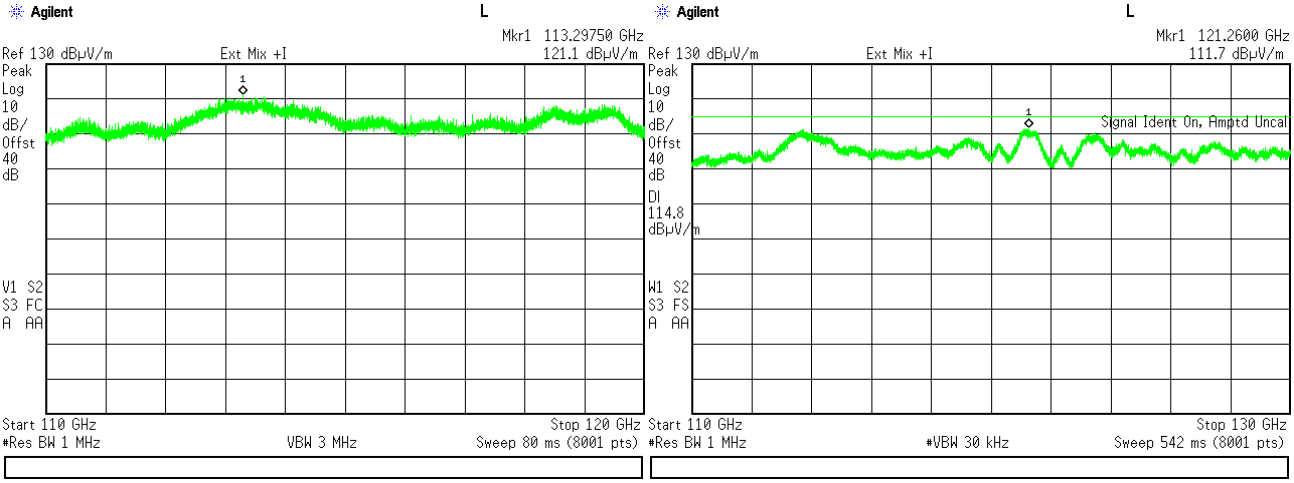
Limit 134.8 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.14 Spurious emission measurements in 110 – 120 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz



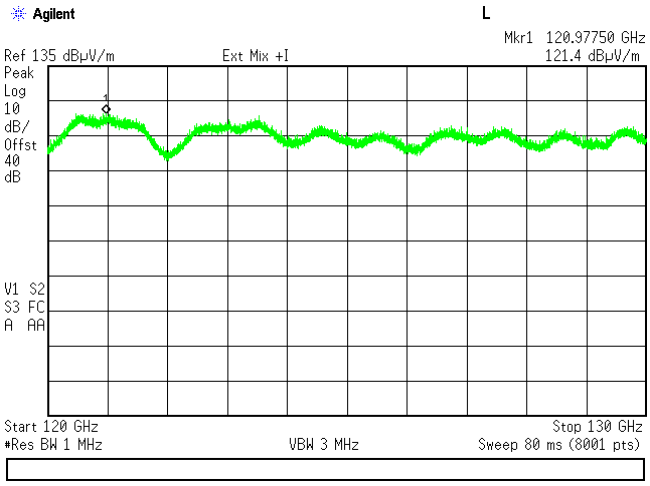
Limit 134.8 dBuV/m was applied

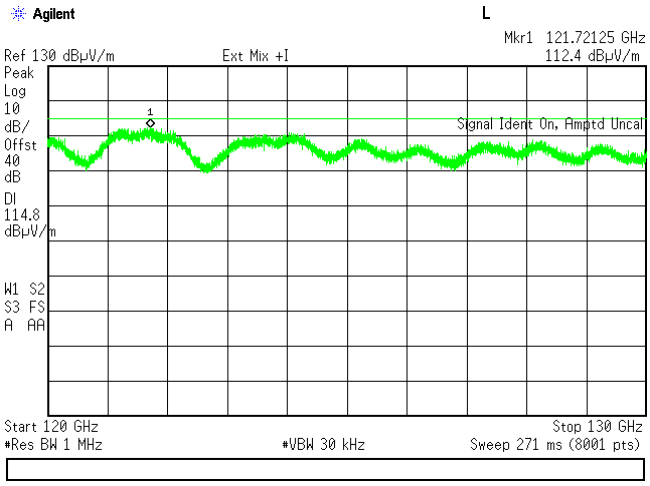
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.15 Spurious emission measurements in 120 – 130 GHz range

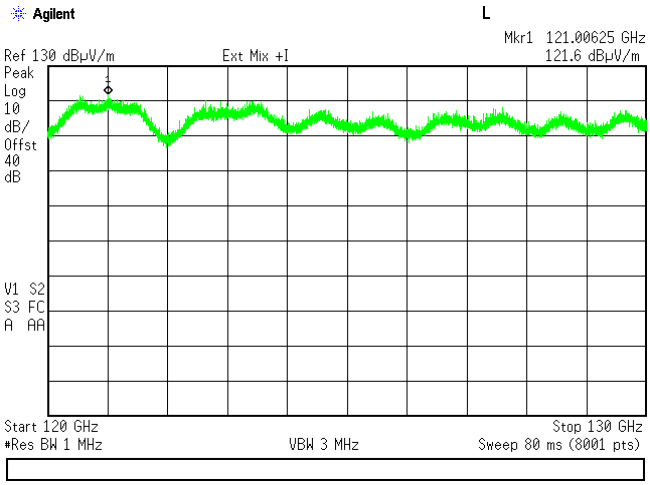
TEST SITE: OATS
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz
DETECTOR: Peak
RBW = 1MHz; VBW = 30 kHz

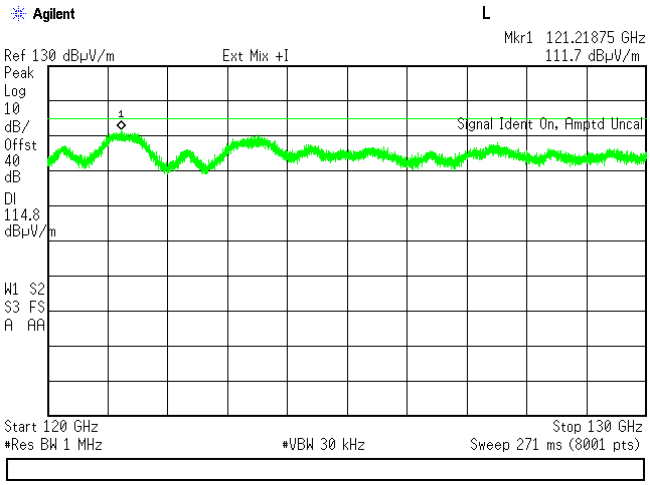
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





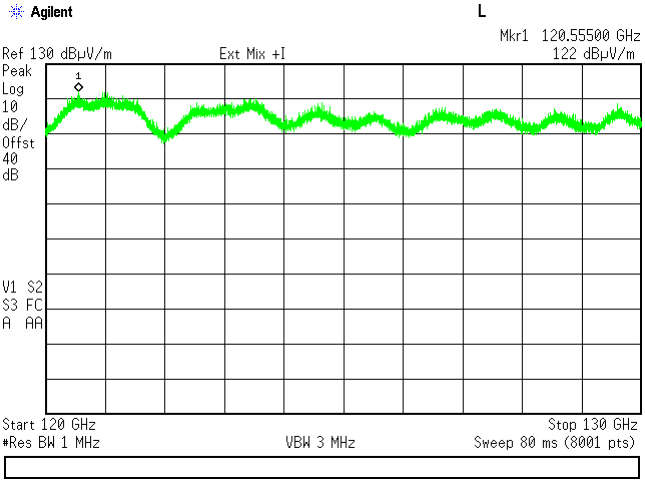
Limit 134.8 dBuV/m was applied

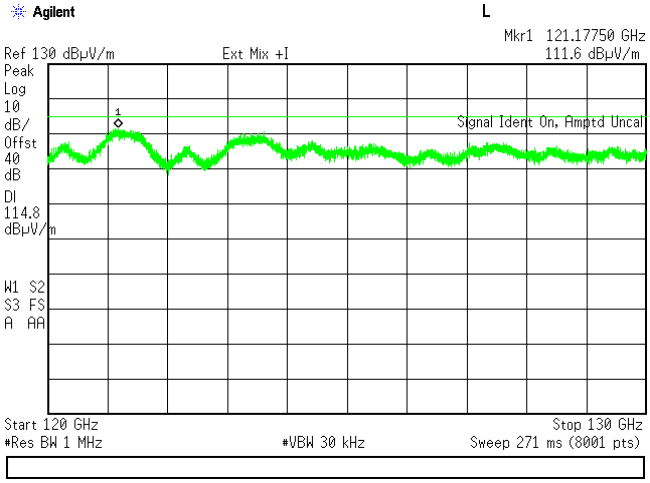
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.16 Spurious emission measurements in 120 – 130 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz





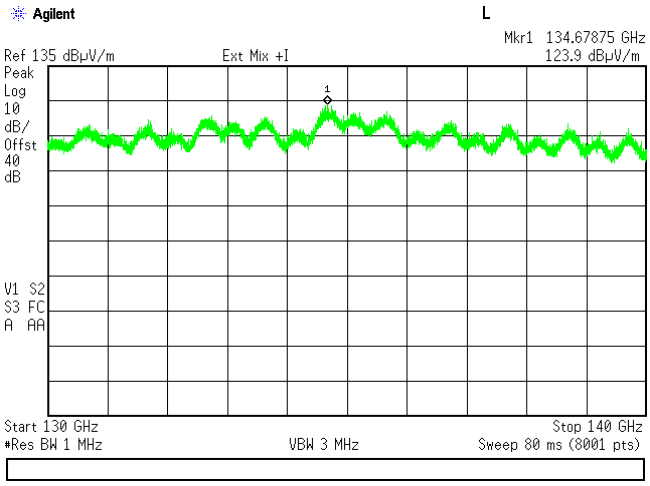
Limit 134.8 dBuV/m was applied

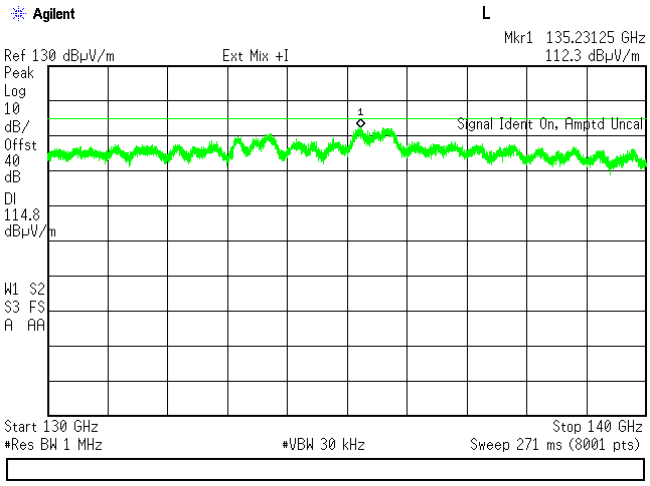
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.17 Spurious emission measurements in 130 – 140 GHz range

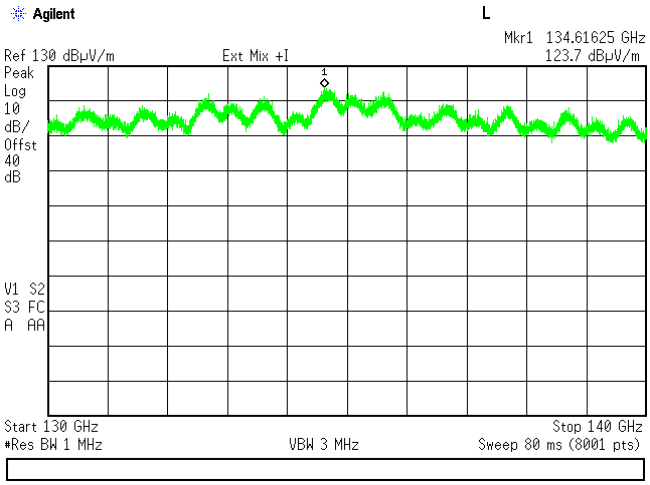
TEST SITE:	OATS
TEST DISTANCE:	0.1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

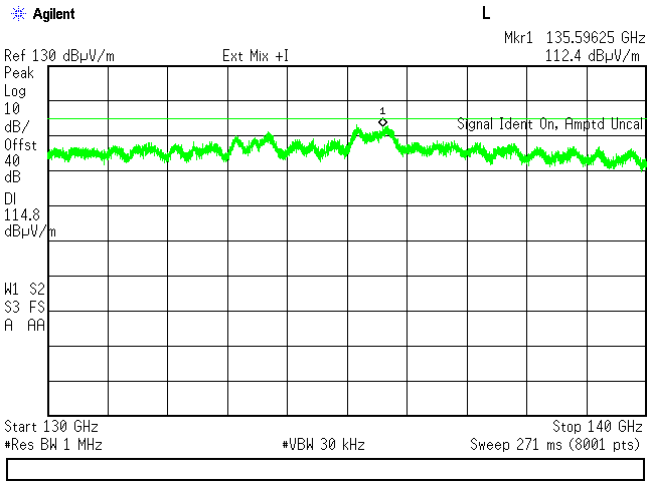
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





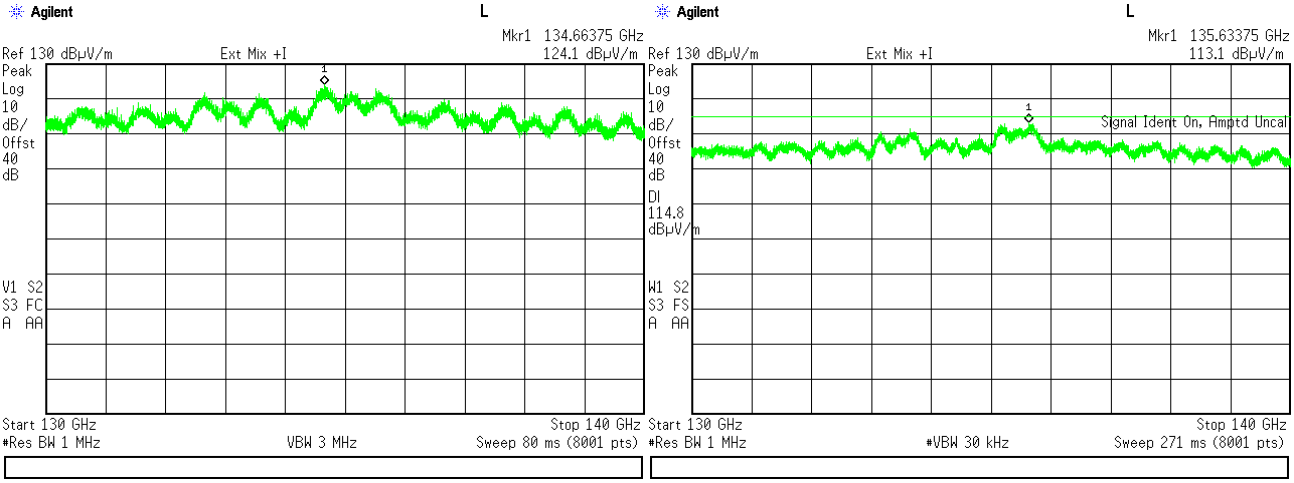
Limit 134.8 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.18 Spurious emission measurements in 130 – 140 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.1 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz



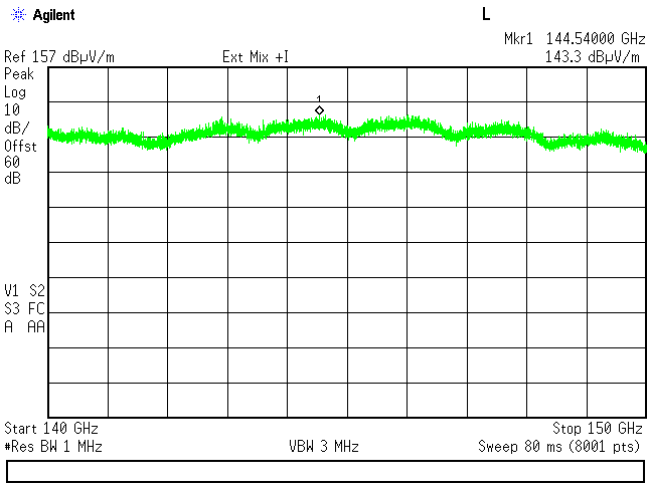
Limit 134.8 dBuV/m was applied

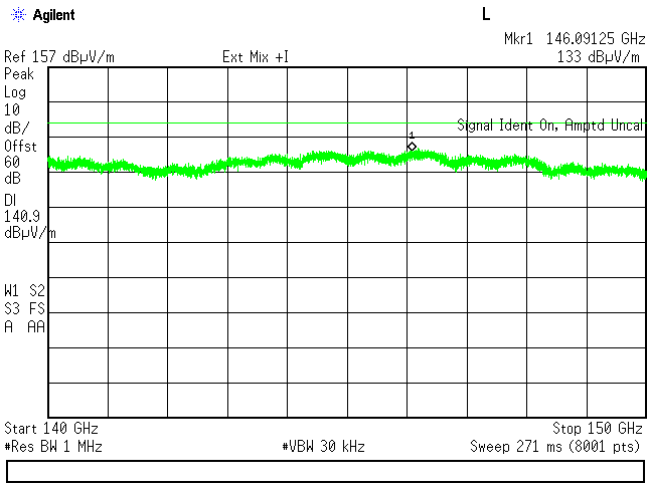
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.19 Spurious emission measurements in 140 – 150 GHz range

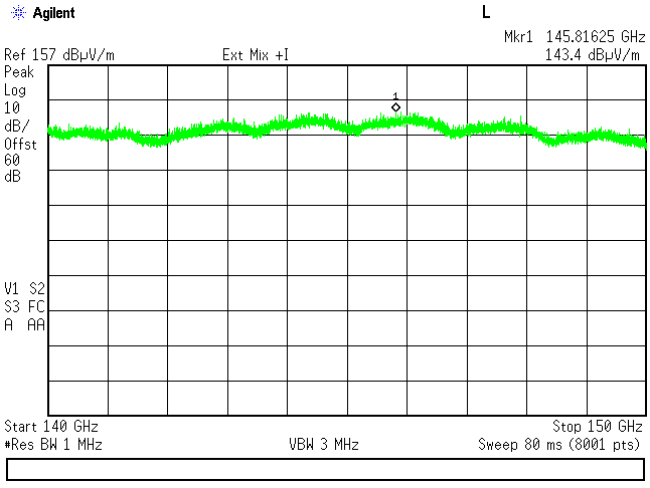
TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

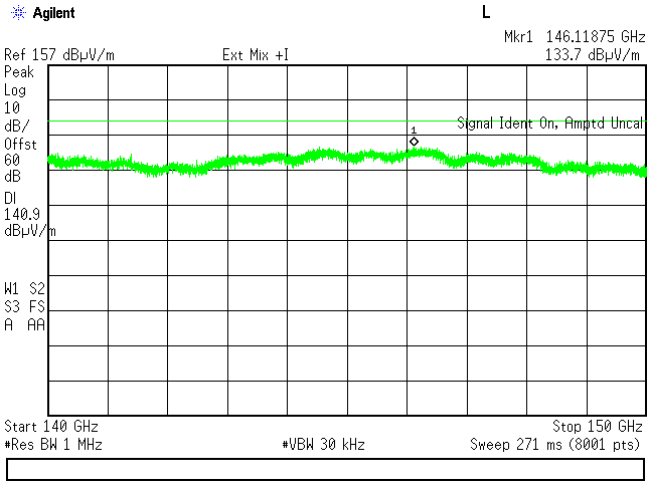
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





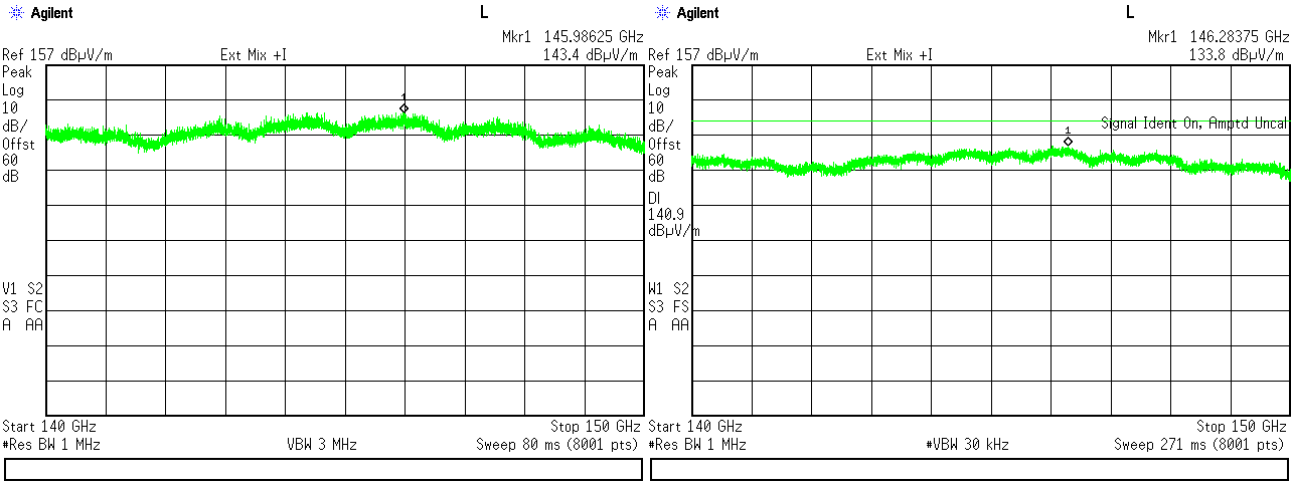
Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.20 Spurious emission measurements in 140 – 150 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz



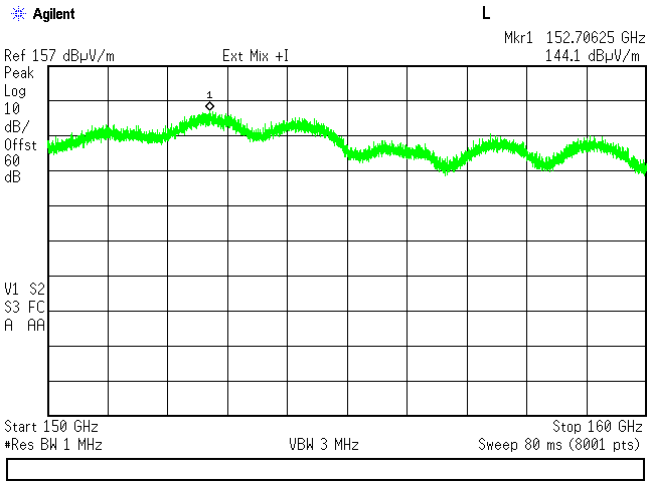
Limit 160.9 dBuV/m was applied

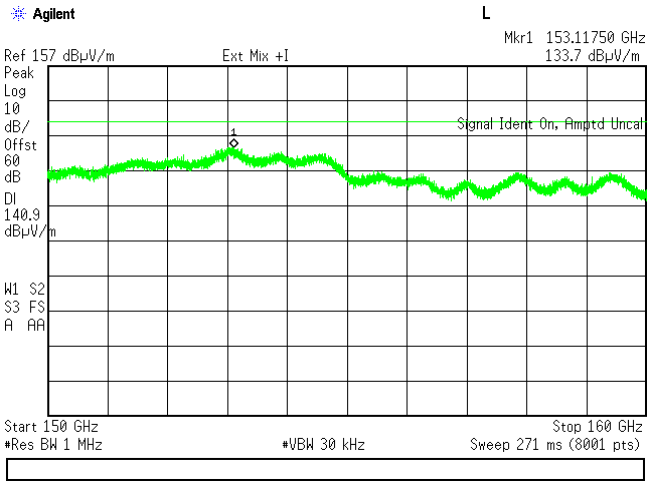
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.21 Spurious emission measurements in 150 – 160 GHz range

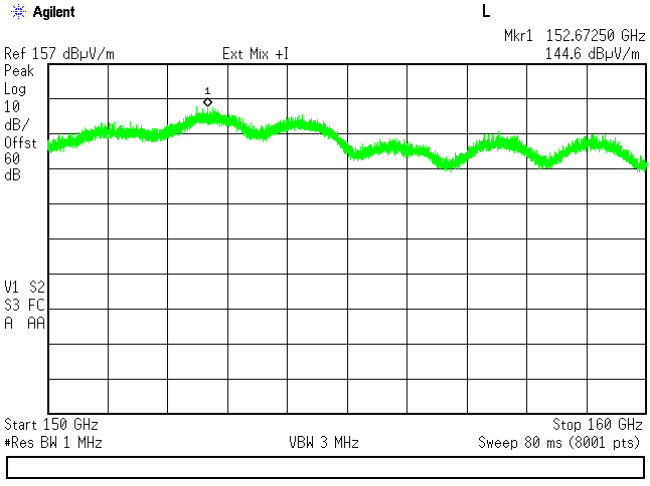
TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

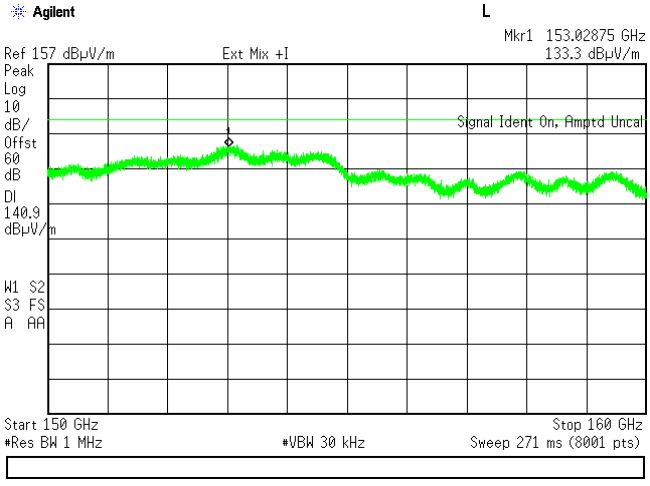
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





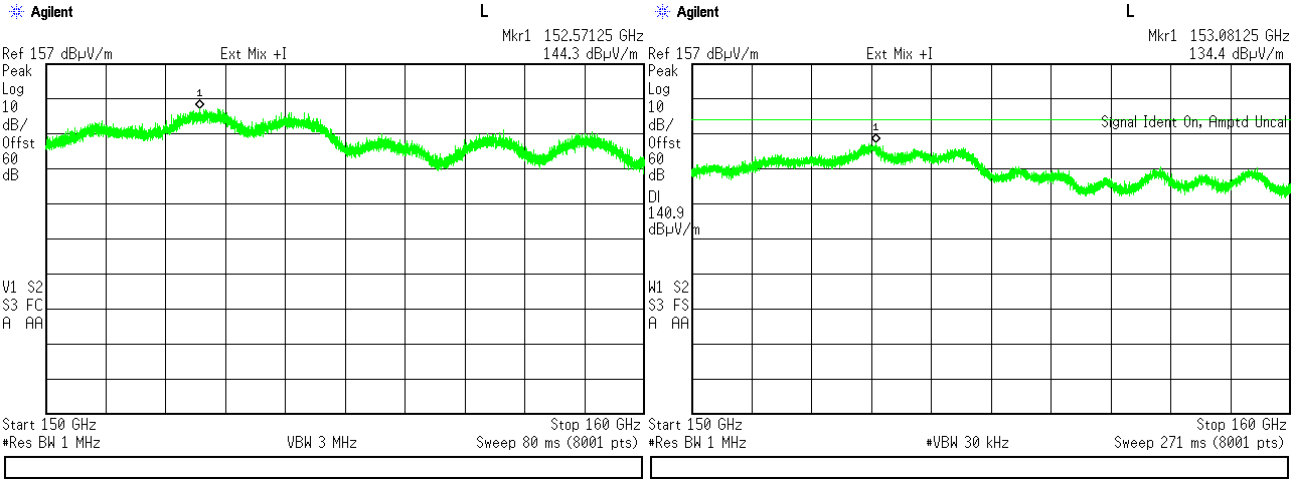
Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.22 Spurious emission measurements in 150 – 160 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz



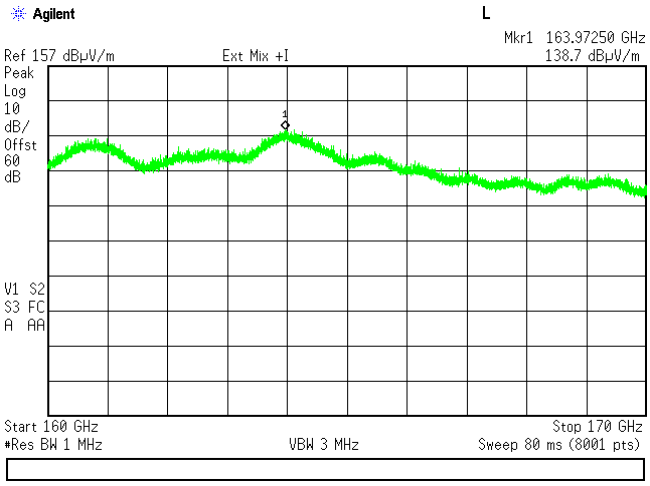
Limit 160.9 dBuV/m was applied

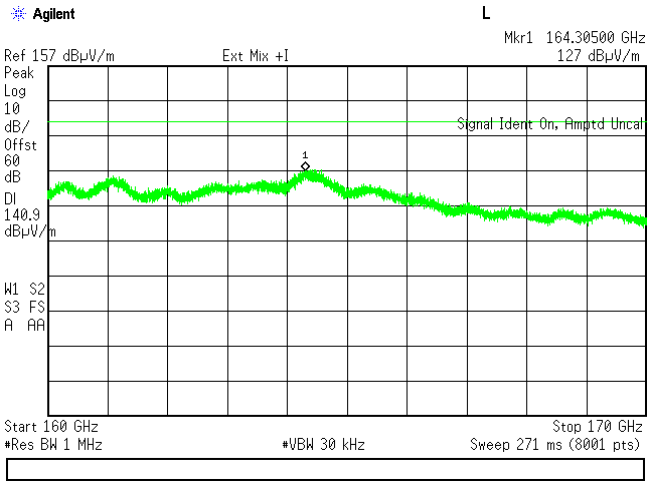
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.23 Spurious emission measurements in 160 – 170 GHz range

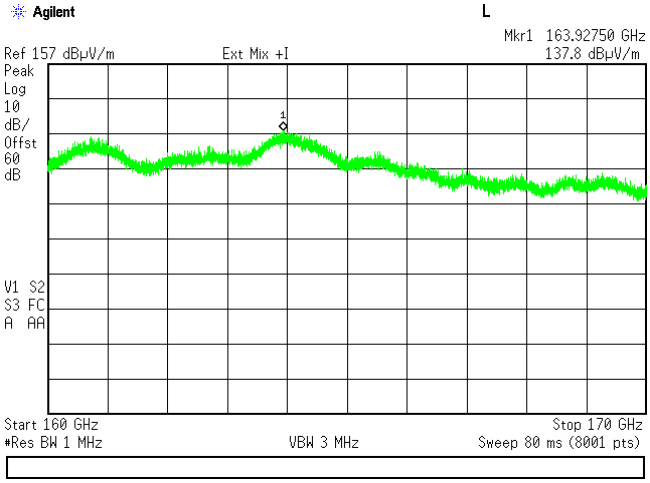
TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

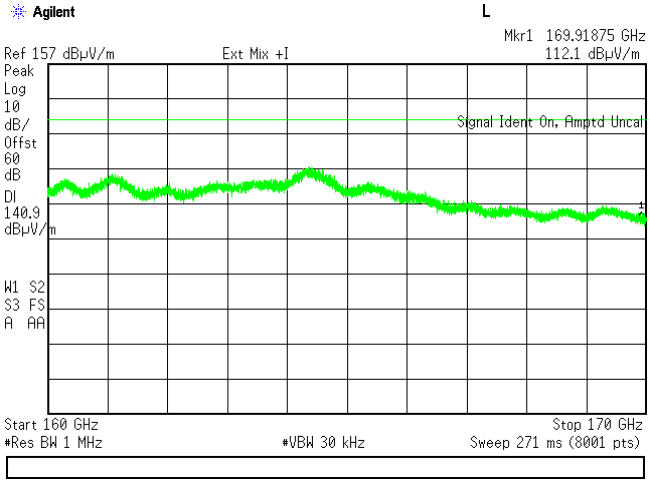
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





Limit 160.9 dBuV/m was applied

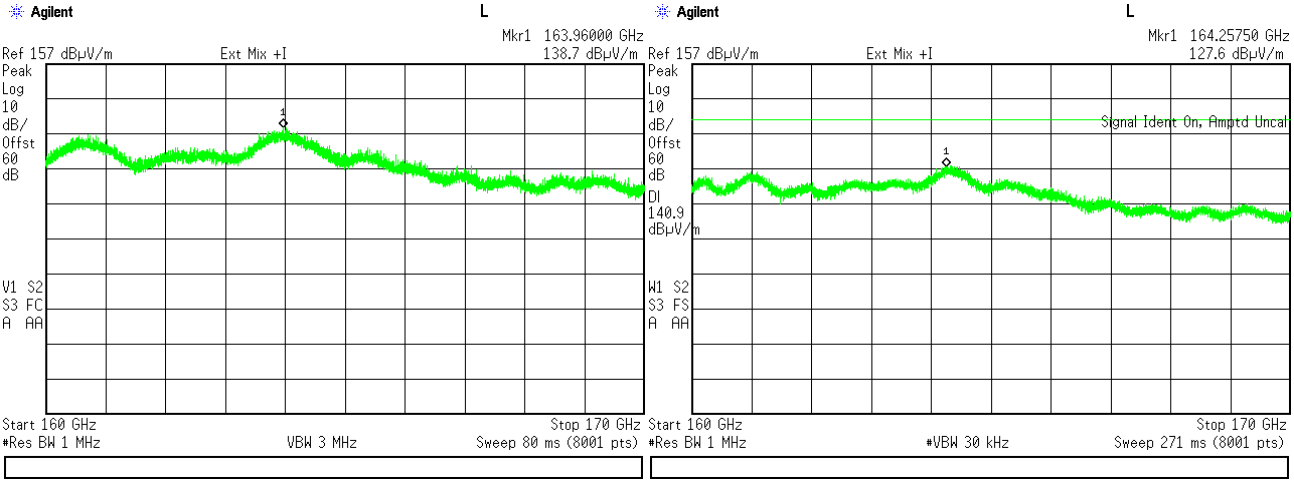
HERMON LABORATORIES

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.24 Spurious emission measurements in 160 – 170 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz



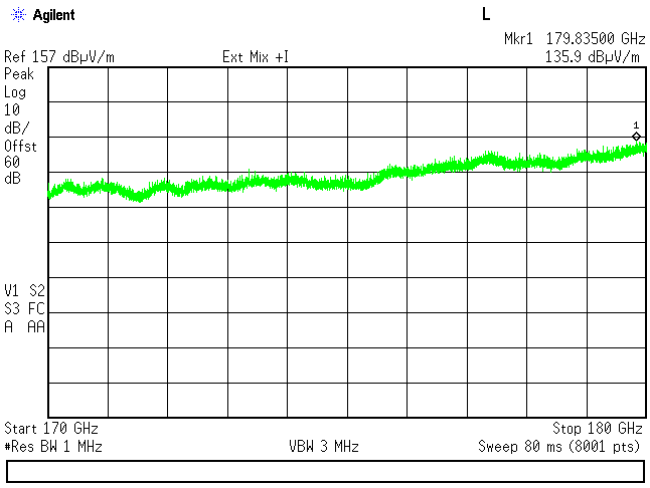
Limit 160.9 dBuV/m was applied

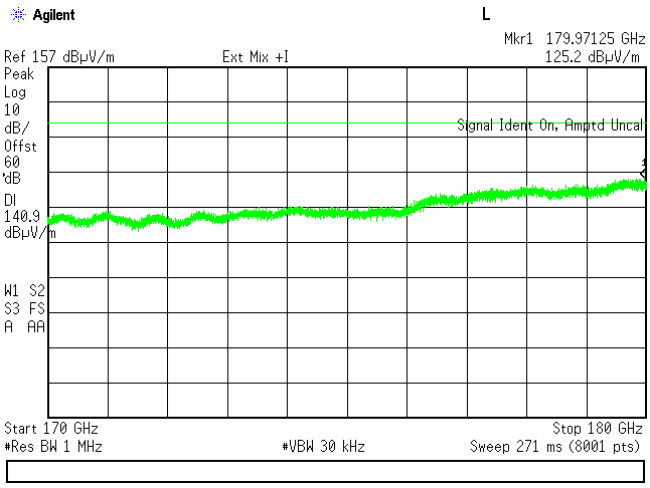
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.25 Spurious emission measurements in 170 – 180 GHz range

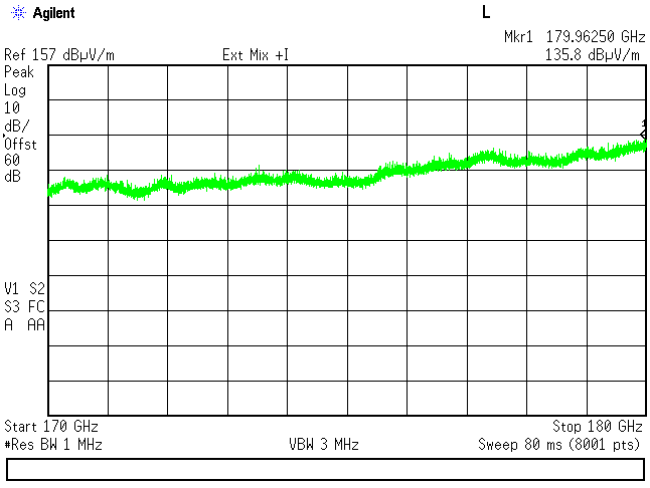
TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

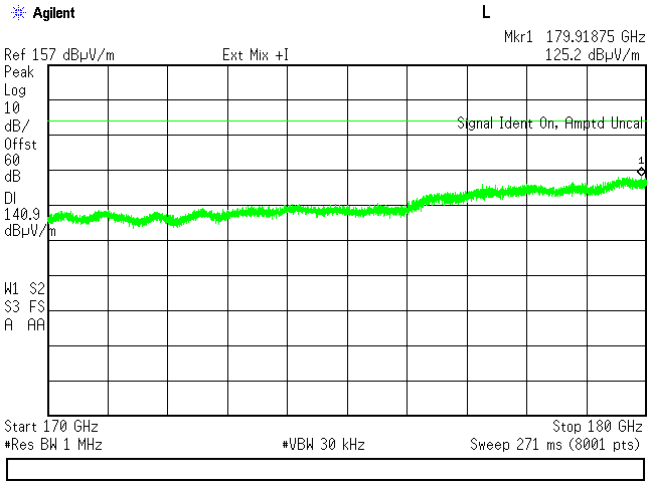
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





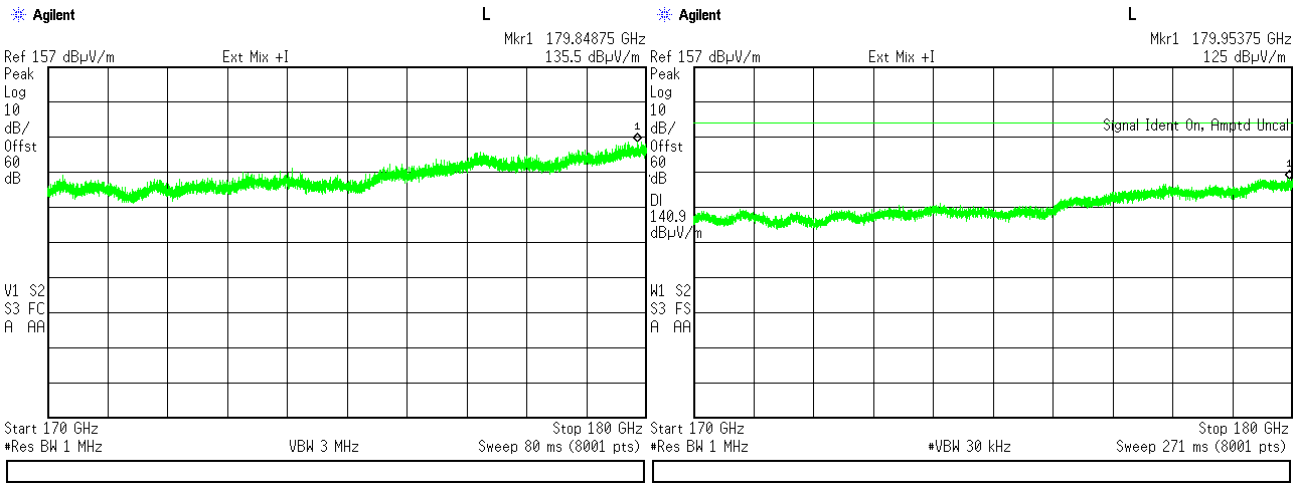
Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.26 Spurious emission measurements in 170 – 180 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz



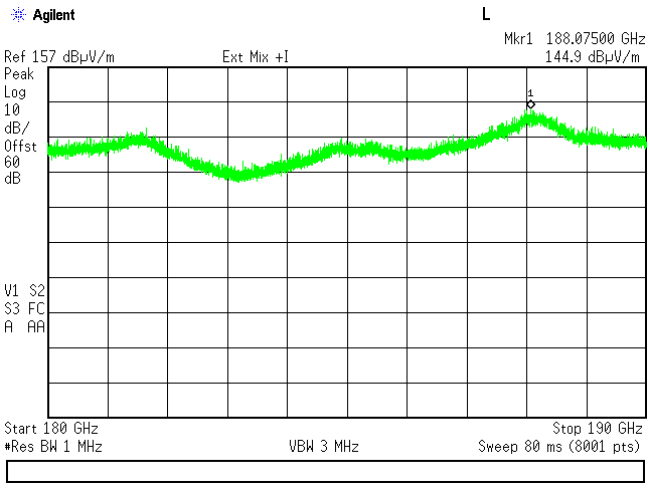
Limit 160.9 dBuV/m was applied

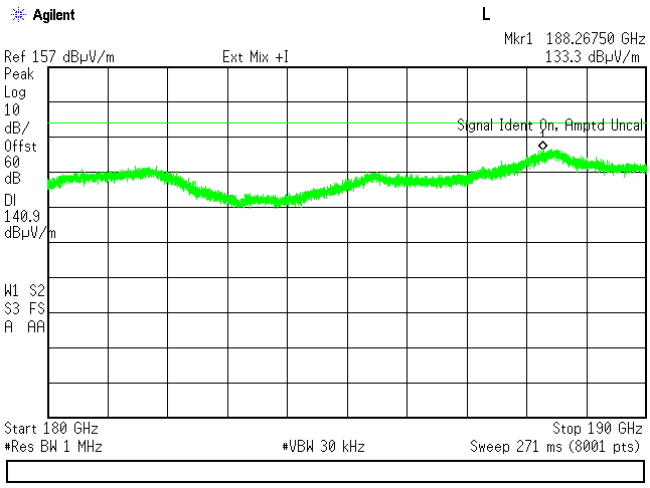
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.27 Spurious emission measurements in 180 – 190 GHz range

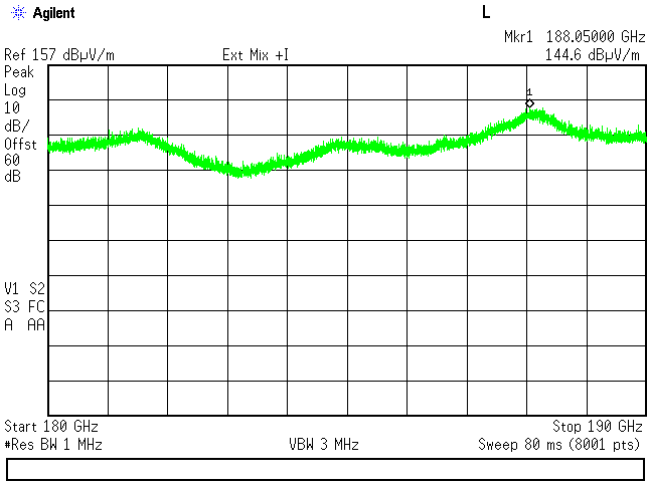
TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

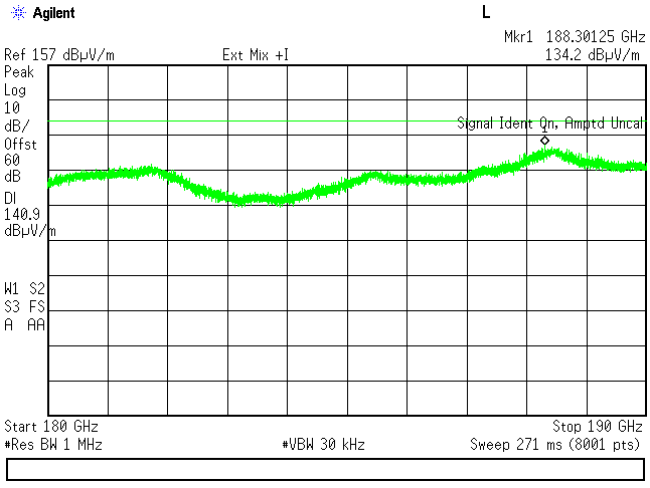
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





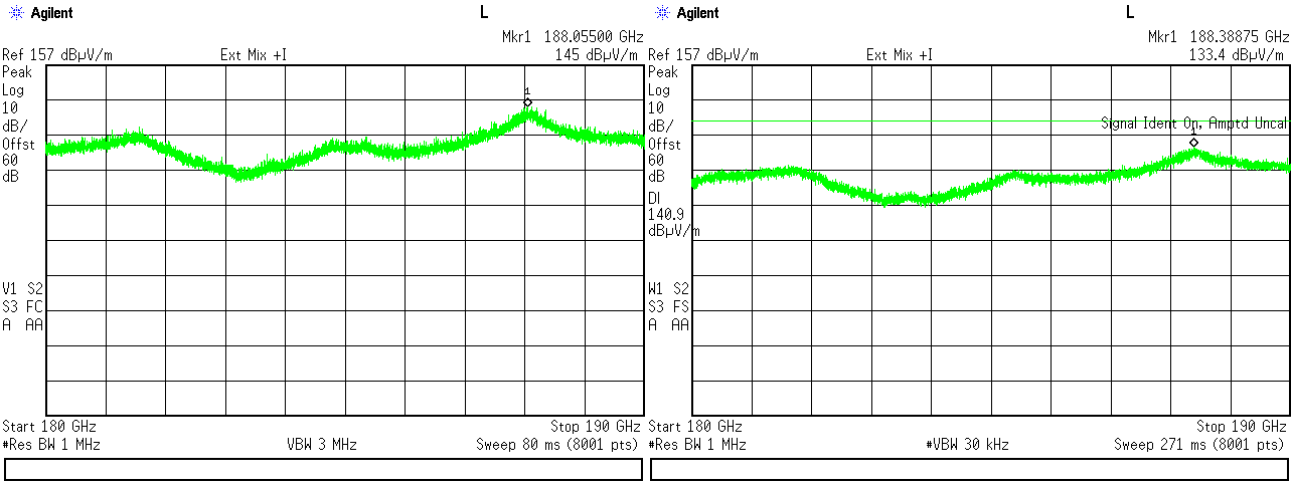
Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.28 Spurious emission measurements in 180 – 190 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz



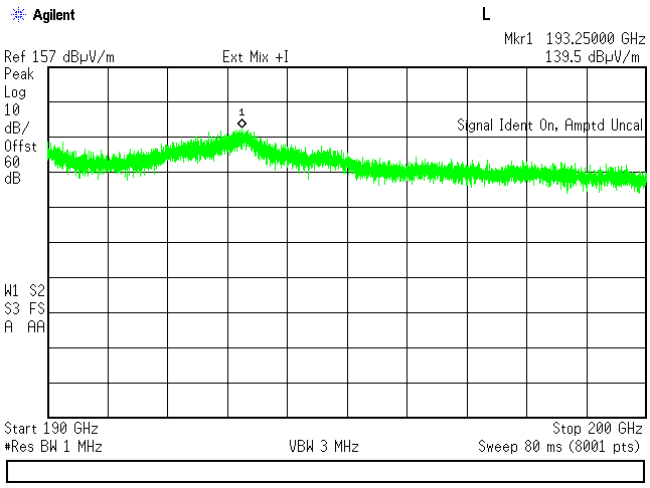
Limit 160.9 dBuV/m was applied

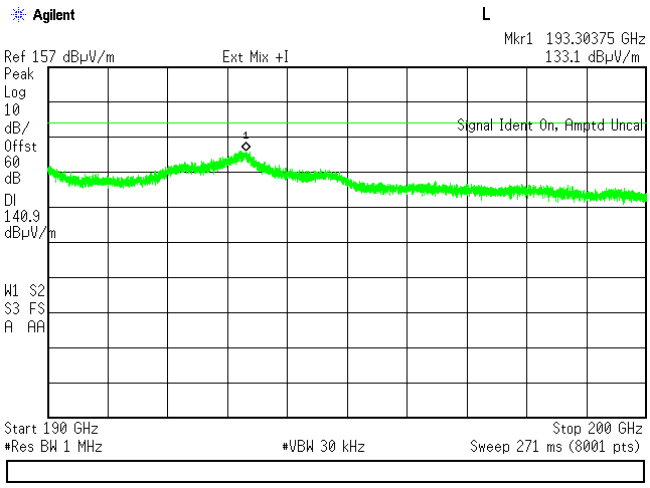
Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.29 Spurious emission measurements in 190 – 200 GHz range

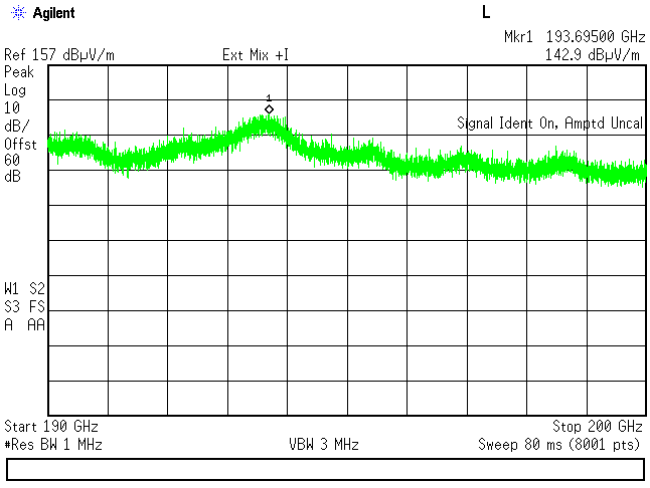
TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

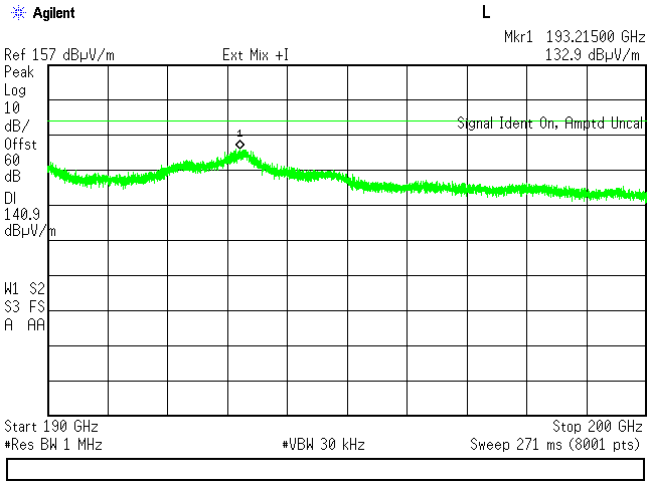
Low carrier frequency 58320 MHz





Mid carrier frequency 60480 MHz





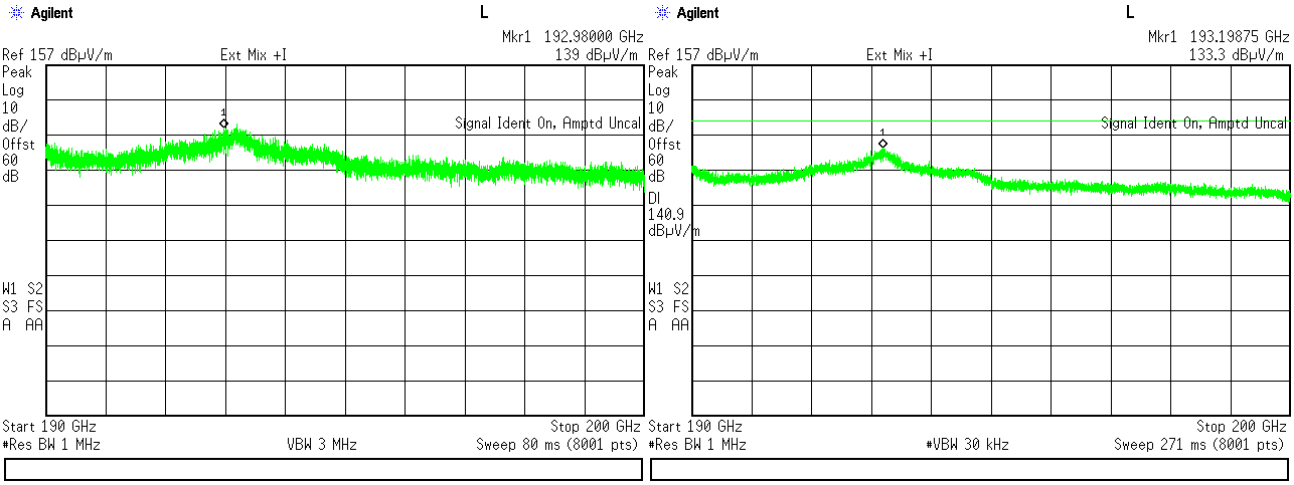
Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(c)(3), Out of band radiated emissions above 40 GHz		
Test procedure:	ANSI C63.10, Sections 9.9, 9.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Oct-18 - 19-Nov-18		
Temperature: 24.0 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 48 VDC
Remarks:			

Plot 7.4.30 Spurious emission measurements in 190 – 200 GHz range

TEST SITE:	OATS
TEST DISTANCE:	0.005 m
ANTENNA POLARIZATION:	Vertical and Horizontal
DETECTOR: Peak	DETECTOR: Peak
RBW = 1MHz; VBW = 3MHz	RBW = 1MHz; VBW = 30 kHz

High carrier frequency 62640 MHz



Limit 160.9 dBuV/m was applied

Test specification:	Section 15.255(e),Frequency stability		
Test procedure:	ANSI C63.10, Section 9.14		
Test mode:	Compliance	Verdict:	PASS
Date(s):	14-Nov-18		
Temperature: 24 ºC	Relative Humidity: 44 %	Air Pressure: 1012 hPa	Power: 48 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
58320	NA
60480	
62640	

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.

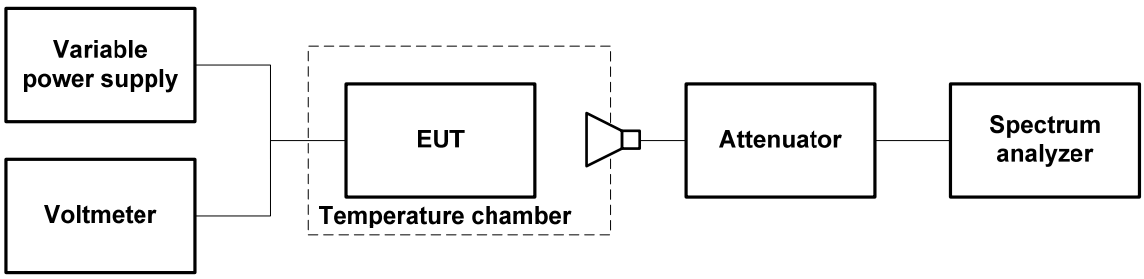
7.5.2.3 The EUT was powered on and carrier frequency was measured at start up moment and then every minute until frequency had been stabilized or 10 minutes elapsed whichever reached the last. The EUT was powered off.

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(e),Frequency stability**		
Test procedure:	ANSI C63.10, Section 9.14		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	14-Nov-18		
Temperature: 24 ºC	**Relative Humidity:** 44 %	**Air Pressure:** 1012 hPa	**Power:** 48 VDC
Remarks:			

Table 7.5.2 Frequency stability test results

OPERATING FREQUENCY: 57000 – 64000 MHz
NOMINAL POWER VOLTAGE: 48 V
TEMPERATURE STABILIZATION PERIOD: 20 min
POWER DURING TEMPERATURE TRANSITION: Off
SPECTRUM ANALYZER MODE: Counter
RESOLUTION BANDWIDTH: 3 kHz
VIDEO BANDWIDTH: 10 kHz
MODULATION: Unmodulated

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	58319.840	58319.841	58319.842	58319.841	58319.838	58319.841	58319.837	0.000	-473.180
-10	nominal	58319.664	NA	NA	NA	NA	NA	58319.662	0.000	-648.844
0	nominal	58319.662	58319.659	58319.659	58319.656	58319.658	58319.662	58319.655	0.000	-655.203
10	nominal	58319.903	NA	NA	NA	NA	NA	58319.901	0.000	-409.403
20	+15%	58320.307	NA	NA	NA	NA	NA	58320.317	6.082	-3.712
20	nominal	58320.305	NA	NA	NA	NA	NA	58320.316	5.601	-5.207
20	-15%	58320.268	NA	NA	NA	NA	NA	58320.311	0.000	-42.220
30	nominal	58320.041	58320.042	58320.046	58320.045	58320.039	58320.044	58320.036	0.000	-274.335
40	nominal	58320.038	NA	NA	NA	NA	NA	58320.041	0.000	-272.558
50	nominal	58321.304	NA	NA	NA	NA	NA	58321.305	994.141	0.000
Mid frequency 60.48GHz										
-20	nominal	60479.939	60479.939	60479.940	60479.939	60479.940	60479.940	60479.941	0.000	-387.209
-10	nominal	60479.703	NA	NA	NA	NA	NA	60479.706	0.000	-622.339
0	nominal	60479.647	60479.644	60479.643	60479.643	60479.643	60479.647	60479.651	0.000	-682.703
10	nominal	60479.702	NA	NA	NA	NA	NA	60479.701	0.000	-625.056
20	+15%	60480.337	NA	NA	NA	NA	NA	60480.333	11.047	0.000
20	nominal	60480.383	NA	NA	NA	NA	NA	60480.326	56.769	0.000
20	-15%	60480.334	NA	NA	NA	NA	NA	60480.334	8.593	0.000
30	nominal	60480.337	60480.326	60480.336	60480.337	60480.356	60480.330	60480.326	30.667	0.000
40	nominal	60480.597	NA	NA	NA	NA	NA	60480.595	270.769	0.000
50	nominal	60481.277	NA	NA	NA	NA	NA	60481.272	950.893	0.000
High frequency 62.64 GHz										
-20	nominal	62639.967	62639.964	62639.967	62639.967	62639.965	62639.967	62639.966	0.000	-221.782
-10	nominal	62639.701	NA	NA	NA	NA	NA	62639.964	0.000	-484.567
0	nominal	62639.657	62639.657	62639.652	62639.662	62639.654	62639.664	62639.655	0.000	-533.244
10	nominal	62639.661	NA	NA	NA	NA	NA	62639.654	0.000	-531.362
20	+15%	62640.247	NA	NA	NA	NA	NA	62640.245	61.284	0.000
20	nominal	62640.243	NA	NA	NA	NA	NA	62640.247	61.320	0.000
20	-15%	62640.189	NA	NA	NA	NA	NA	62640.185	0.000	-61.320
30	nominal	62.640.106	62640.097	62640.097	62640.098	62640.097	62640.096	62640.101	0.000	-89.240
40	nominal	62640.604	NA	NA	NA	NA	NA	62640.602	357.666	0.000
50	nominal	62640.600	NA	NA	NA	NA	NA	62640.604	357.124	0.000

* - Reference frequency

Reference numbers of test equipment used

HL 0770	HL 0771	HL 3294	HL 4164	HL 4482	HL 5376	HL 5380	

Full description is given in Appendix A.

8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 kHz - 30 MHz	EMCO	6502	2857	11-Feb-18	11-Feb-19
0521	EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz	Hewlett Packard	8546A	3617A 00319, 3448A002 53	31-Oct-18	31-Oct-19
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	03-Jun-18	03-Jun-19
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	1301	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
1424	Spectrum Analyzer, 30 Hz- 40 GHz	Agilent Technologies	8564EC	3946A002 19	30-Dec-17	30-Dec-18
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY414447 62	27-Mar-18	27-Mar-19
3235	Harmonic mixer 40 to 60 GHz	Agilent Technologies	11970U	MY300301 82	16-Aug-16	16-Aug-19
3291	Attenuator, direct reading, 60 to 90 GHz, 0.2 W	Quinstar Technology	QAD-E00000	10381009	10-Dec-17	10-Dec-18
3293	Frequency multiplier, input 20-30 GHz, output 60-90 GHz	Quinstar Technology	QPM-75003E	10381003	10-Dec-17	10-Dec-18
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	MY300301 49	16-Aug-16	16-Aug-19

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
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	NA	3329	14-Aug-18	14-Aug-19
3333	Oscilloscope, 1 GHz, 4 channels	LeCroy Corporation	LC584AL	10239	18-Jan-18	18-Jan-19
3433	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25679	28-Mar-18	28-Mar-19
3434	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25683	28-Mar-18	28-Mar-19
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
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1225/2A	07-Feb-18	07-Feb-19
4023	Diplexer for use OML mixers with Agilent spectrum analyzer	Oleson Microwave Labs	DPL.26	NA	10-Dec-17	10-Dec-18
4164	DC Power Supply, 60V, 5A	Standig	605D	NA	05-Nov-18	05-Nov-19
4278	Test Cable , DC-18 GHz, 4.6 m, N/M - N/M	Mini-Circuits	APC-15FT-NMNM+	0755A	01-Aug-18	01-Aug-19
4353	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	12025101003	15-Mar-18	15-Mar-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	19-Apr-17	19-Apr-19
4956	Active horn antenna, 18 to 40 GHz	Com-Power Corporation	AHA-840	105004	11-Jan-18	11-Jan-19
5376	EXA Signal Analyzer, 10 Hz - 32 GHz	Keysight Technologies	N9010B	MY57470404	16-Mar-18	16-Mar-19
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

9 APPENDIX B 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.

10 APPENDIX C Test facility 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 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-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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11 APPENDIX D Specification references

47CFR part 15: 2017	Radio Frequency Devices
47CFR part 1: 2017	Practice and procedure
47CFR part 2: 2017	Frequency allocations and radio treaty matters; general rules and regulations
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicemsed Wireless Devices
ANSI C63.2: 1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications.
ANSI C63.4: 2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

12 APPENDIX E Test equipment correction factors

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

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

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

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

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

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

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

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

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

Antenna factor
Active Horn Antenna,
Com-Power Corporation, model: AHA-840, s/n 105004, HL 4956

Frequency, MHz	Measured antenna factor (with preamplifier), dB/m
18000	2.5
18500	0.5
19000	-1.0
19500	-2.4
20000	-2.5
20500	-2.2
21000	-2.0
21500	-2.7
22000	-3.7
22500	-3.8
23000	-3.7
23500	-5.0
24000	-4.5
24500	-5.0
25000	-4.7
25500	-4.4
26000	-4.3
26500	-5.6
27000	-4.3
27500	-4.9
28000	-5.2
28500	-4.4

Frequency, MHz	Measured antenna factor (with preamplifier), dB/m
29000	-2.7
29500	-2.6
30000	-1.4
30500	-1.5
31000	-1.0
31500	-2.6
32000	-3.3
32500	-3.3
33000	-5.1
33500	-5.2
34000	-1.5
34500	-5.4
35000	-3.3
35500	-4.2
36000	-2.8
36500	-2.6
37000	-1.0
38000	1.8
38500	2.8
39000	1.3
39500	1.3
40000	0.3

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

Cable loss
Test Cable, Mini-Circuits, CBL-5FT-SMSM+, SMA-SMA, 18 GHz, 1.5 m, S/N 25679
Mini-Circuits, HL 3433

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

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

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

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

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

Cable loss
Test cable, Mini-Circuits, S/N 0755A, 18 GHz, 4.6 m, N/M - N/M
APC-15FT-NMNM+, HL 4278

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.24	4900	4.19	10000	6.47	15100	8.33
30	0.26	5000	4.25	10100	6.50	15200	8.35
50	0.34	5100	4.29	10200	6.52	15300	8.37
100	0.50	5200	4.32	10300	6.57	15400	8.40
200	0.72	5300	4.38	10400	6.59	15500	8.42
300	0.90	5400	4.41	10500	6.61	15600	8.46
400	1.06	5500	4.46	10600	6.64	15700	8.50
500	1.20	5600	4.51	10700	6.64	15800	8.52
600	1.32	5700	4.56	10800	6.65	15900	8.56
700	1.44	5800	4.59	10900	6.68	16000	8.61
800	1.54	5900	4.64	11000	6.68	16100	8.64
900	1.64	6000	4.69	11100	6.69	16200	8.66
1000	1.74	6100	4.72	11200	6.70	16300	8.70
1100	1.83	6200	4.77	11300	6.74	16400	8.73
1200	1.92	6300	4.80	11400	6.78	16500	8.74
1300	2.01	6400	4.83	11500	6.81	16600	8.75
1400	2.09	6500	4.89	11600	6.84	16700	8.78
1500	2.18	6600	4.90	11700	6.87	16800	8.79
1600	2.25	6700	4.95	11800	6.92	16900	8.81
1700	2.33	6800	5.01	11900	6.98	17000	8.85
1800	2.39	6900	4.99	12000	7.02	17100	8.90
1900	2.47	7000	5.04	12100	7.08	17200	8.95
2000	2.53	7100	5.11	12200	7.15	17300	8.99
2100	2.60	7200	5.14	12300	7.20	17400	9.03
2200	2.67	7300	5.21	12400	7.26	17500	9.07
2300	2.73	7400	5.29	12500	7.31	17600	9.11
2400	2.80	7500	5.33	12600	7.36	17700	9.15
2500	2.87	7600	5.38	12700	7.41	17800	9.19
2600	2.93	7700	5.46	12800	7.46	17900	9.24
2700	3.00	7800	5.52	12900	7.51	18000	9.28
2800	3.06	7900	5.58	13000	7.55		
2900	3.12	8000	5.64	13100	7.59		
3000	3.18	8100	5.69	13200	7.65		
3100	3.24	8200	5.75	13300	7.69		
3200	3.30	8300	5.80	13400	7.72		
3300	3.35	8400	5.84	13500	7.78		
3400	3.42	8500	5.90	13600	7.82		
3500	3.46	8600	5.97	13700	7.86		
3600	3.52	8700	5.99	13800	7.91		
3700	3.57	8800	6.04	13900	7.96		
3800	3.61	8900	6.10	14000	8.01		
3900	3.67	9000	6.13	14100	8.06		
4000	3.71	9100	6.17	14200	8.10		
4100	3.77	9200	6.23	14300	8.13		
4200	3.83	9300	6.27	14400	8.16		
4300	3.89	9400	6.30	14500	8.19		
4400	3.94	9500	6.35	14600	8.21		
4500	4.00	9600	6.37	14700	8.23		
4600	4.05	9700	6.40	14800	8.26		
4700	4.10	9800	6.44	14900	8.28		
4800	4.16	9900	6.45	15000	8.30		

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

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

13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
AVRG	average (detector)
BB	broad band
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
dB(μA)	decibel referred to one microampere
dBΩ	decibel referred to one Ohm
DC	direct current
EIRP	equivalent isotropically radiated power
ERP	effective radiated power
EUT	equipment under test
F	frequency
GHz	gigahertz
GND	ground
H	height
HL	Hermon laboratories
Hz	hertz
ITE	information technology equipment
k	kilo
kHz	kilohertz
LISN	line impedance stabilization network
LO	local oscillator
m	meter
MHz	megahertz
min	minute
mm	millimeter
ms	millisecond
μs	microsecond
NA	not applicable
NB	narrow band
NT	not tested
OATS	open area test site
Ω	Ohm
QP	quasi-peak
PM	pulse modulation
PS	power supply
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt
VA	volt-ampere

END OF DOCUMENT