FCC 47 CFR PART 90 SUBPART F & I

CERTIFICATION TEST REPORT

FOR

SLOPE STABILITY RADAR MODULE

MODEL NUMBER: SSR-X

FCC ID: S490917SSR04

REPORT NUMBER: 11938449-E3V1

ISSUE DATE: NOVEMBER 9, 2017

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Revision History

Rev.	Issue Date	Revisions	Revised By
V1	11/9/2017	Initial Issue	Michael Heckrotte

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME:	**GROUNDPROBE PTY LTD 72 NEWMARKET ROAD, WINDSOR, QLD 4030, AUSTRALIA**
EUT DESCRIPTION:	**SLOPE STABILITY RADAR MODULE**
MODEL:	**SSR-X**
SERIAL NUMBER:	**PO2**
DATE TESTED:	**SEPTEMBER 13TH TO 21st, 2017**

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 90 Subpart F & I	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For
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UL Verification Services Inc.

Tested By:

STEVE AGUILAR
TEST ENGINEER
UL Verification Services Inc.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.26-2015, FCC CFR 47 Part 90, FCC CFR 47 Part 2 and FCC OET Bulletin 65.

3. SCOPE OF REPORT

This report covers the 9.5525 GHz Slope Stability Radar only, excluding the embedded WIFI device, power generator and power supply.

4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street
☐ Chamber A	☐ Chamber D
☒ Chamber B	☐ Chamber E
☒ Chamber C	☐ Chamber F
	☐ Chamber G
	☐ Chamber H

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

5. CALIBRATION AND UNCERTAINTY

5.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

5.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

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PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	±3.52 dB
Radiated Disturbance, 30 to 1000 MHz	±4.94 dB
Radiated Disturbance, 1 to 6 GHz	±3.86 dB
Radiated Disturbance, 6 to 18 GHz	±4.23 dB
Radiated Disturbance, 18 to 26 GHz	±5.30 dB
Radiated Disturbance, 26 to 40 GHz	±3.23 dB
Radiated Disturbance, 40 GHz above	±3.50dB

Uncertainty figures are valid to a confidence level of 95%.

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6. EQUIPMENT UNDER TEST

6.1. DESCRIPTION OF EUT

The EUT is a slope stability radar module that detects the movements and potential hazards of mine sites.

6.2. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna is an external dish antenna, 180 cm in diameter, with a maximum gain of 46 dBi.

6.3. SOFTWARE AND FIRMWARE

Platform	REM
SSR Viewer	8.4.12786.4
FPGA Firmware	7.62 pre
Test Software	SSR Control Version 8.4.18438.4
Waveform	SR_SYN_WAVEFORM, ER_RPN_WAVEFORM

6.4. WORST-CASE MODES

The Manufacturer has determined that the worst-case (highest power) mode is ER_RPN_WAVEFORM and worst-case (widest bandwidth) mode is SR_SYN_WAVEFORM.

Waveform	Bandwidth	Power	Power
	(MHz)	(dBm)	(mW)
ER_RPN_WAVEFORM	44.121	14.98	31.5
SR_SYN_WAVEFORM	95.84	7.00	5.01

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6.5. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST			
Description	**Manufacturer**	**Model**	**Serial Number**
Monitor	Digital Systems	MCM215R-T	57746

I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	3-PRONG	UNSHIELDED	1.5M	--
2	DC	1	D38999 Series III 26FE6SN	SHIELDED	4.0m	--
3	UI Signal	1	D38999 Series III 26FC35PN	SHIELDED (5 core coax and Cat5e)	9.8m	--
4	UI Power	1	D38999 Series III 26FA98PN	SHIELDED	9.8m	--

TEST SETUP

The EUT is powered via an adjustable DC power supply. The appropriate waveforms were programmed using test software: SSR Control Version 8.4.18438.4.

The coaxial feed cable from the FEED HORN port of the circulator is part of the EUT, therefore all measurements are made at the RF Output (antenna) end of this cable.

Radiated tests were conducted by terminating the RF output (antenna) end at the end of the coaxial feed cable from the FEED HORN port of the circulator.

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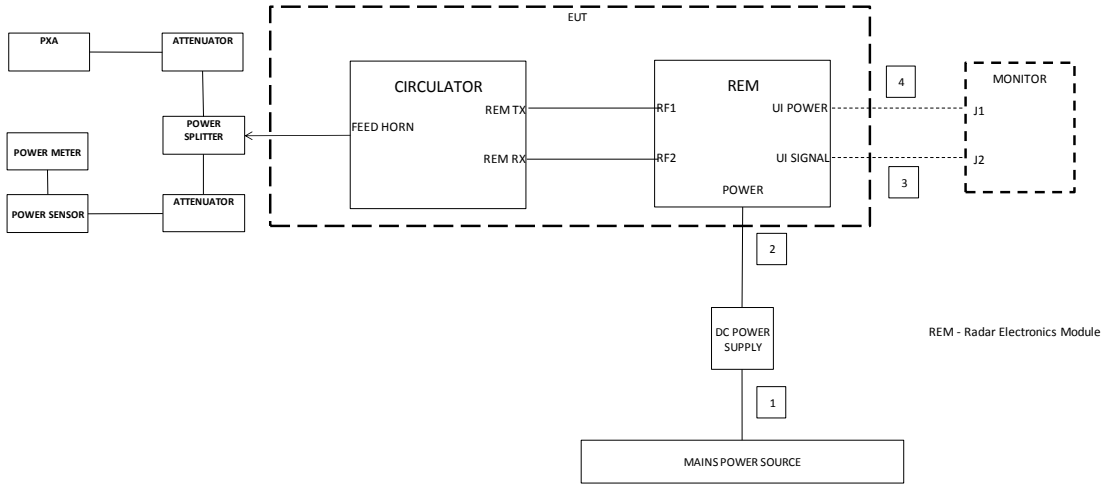
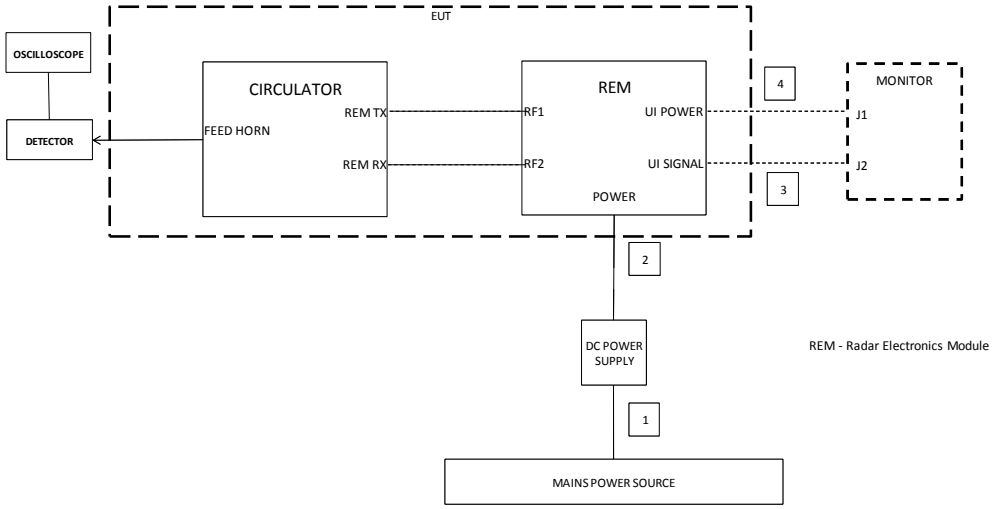
CONDUCTED SETUP DIAGRAM FOR TEST

Conducted - Bandwidth (PXA) & Average Power (Power Meter)



Conducted – Duty Cycle



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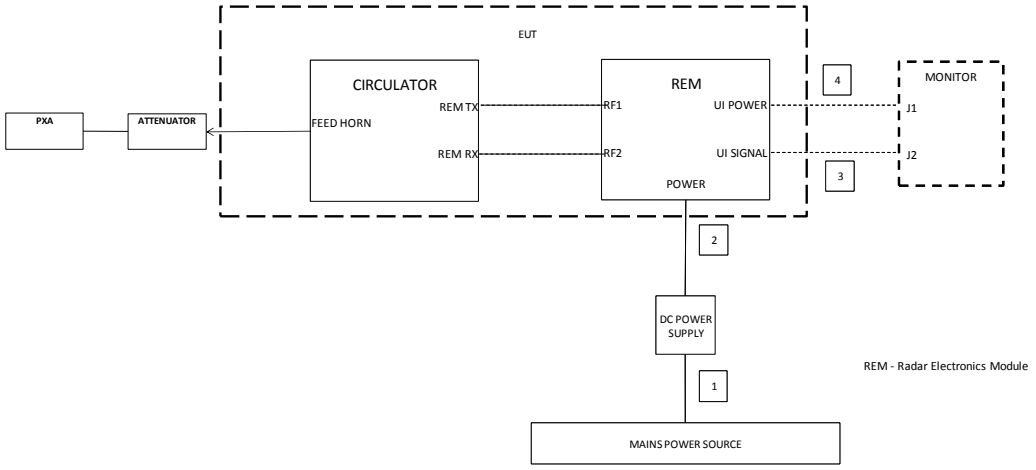
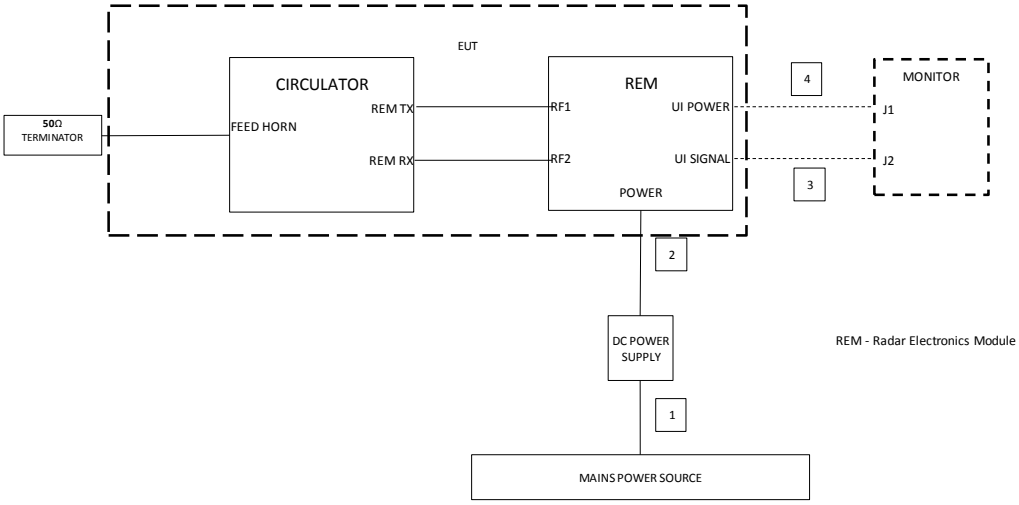
Conducted - Spurious



RADIATED SETUP DIAGRAM FOR TESTS



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6.6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment is utilized for the tests documented in this report:

Test Equipment List					
Description	**Manufacturer**	**Model**	**S/N**	**Local ID (T No.)**	**Cal Due**
N9030A PXA Signal Analyzer	Agilent	N9030A	MY52350427	313	8/7/2018
Analog Signal Generator, 40 GHz	Agilent	E8257D	MY48050681	181	8/3/2018
Power Meter	Agilent	N1911A	MY55196011	1265	12/14/2017
Power Sensor, 50MHz-18GHz	Agilent	N1921A	MY55200004	1226	8/30/2018
Detector , 0.01 to 33 GHz	Agilent	8474C	MY42240207	116	CNR
Power Splitter, DC-26.5 GHz	HP	11667B	--	--	CNR
Oscilloscope 1GHz 4 Ch DSO	Agilent	DSO9104A	MY51420139	946	8/10/2018
Attenuators, 10 dB, 0-40 GHz	Pasternak	PE7046-10	--	A1,A2,A3	CNR
Spectrum Analyzer, 44 GHz	Agilent	N9030A	MY5331I0593	907	1/23/2018
Antenna, Horn, 18 GHz	ETS Lindgren	3117	165319	863	6/9/2018
RF PreAmplifier, 1-18GHz	Miteq	AMF-4D-01000800-30-29P	--	493	6/23/2018
Antenna, Biconolog, 30MHz-1 GHz	Sunol Sciences	JB3	A051314-2	899	6/15/2018
RF PreAmplifier, 0.1-1300MHz	HP	8447D	C00580	10	2/15/2018
Spectrum Analyzer	Agilent	N9030A	MY55410147	1454	12/15/2017
Horn Antenna, 18 to 26.5GHz	ARA	MWH-1826/B	209338	449	6/12/1018
PreAmplifier, 1-26.5GHz	Agilent	8449B	3008A04710	404	7/23/2018
Preamplifier, 40 GHz	Miteq	NSP4000-SP2	924343	88	4/29/2018
Antenna, Horn, 40 GHz	ARA	MWH-2640/B	209340	446	6/12/2018
Chamber, Environmental	Espec	135568	3537942-A	#73	1/31/2018
True RMS Multimeter	Fluke	77IV	308600448	1747	4/15/2018
Power supply DC, 0-60VDC, 25A	Lambda	GEN1500W	OH87945V	--	CNR
Radiated Software	UL	UL EMC	Ver 9.5, October 19, 2016		

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7. APPLICABLE LIMITS AND TEST RESULTS

7.1. DUTY CYCLE

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The period of fundamental signal is measured in conducted setup with the signal feeding to a RF diode detector and measured by an oscilloscope, the duty cycle is then calculated.

RESULT

Modulation	ON Time (usec)	Period (usec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Corr Fac (dB)
ER_RPN_WAVEFORM	27.93	57.05	0.489	48.9%	3.1
SR_SYN_WAVEFORM	8.214	16.827	0.488	48.8%	3.1

Duty Cycle Correction Factor (dB) = 10 * Log (Duty Cycle)

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Duty Cycle – ER_RPN_WAVEFORM – ON TIME

Duty Cycle – ER_RPN_WAVEFORM - PERIOD

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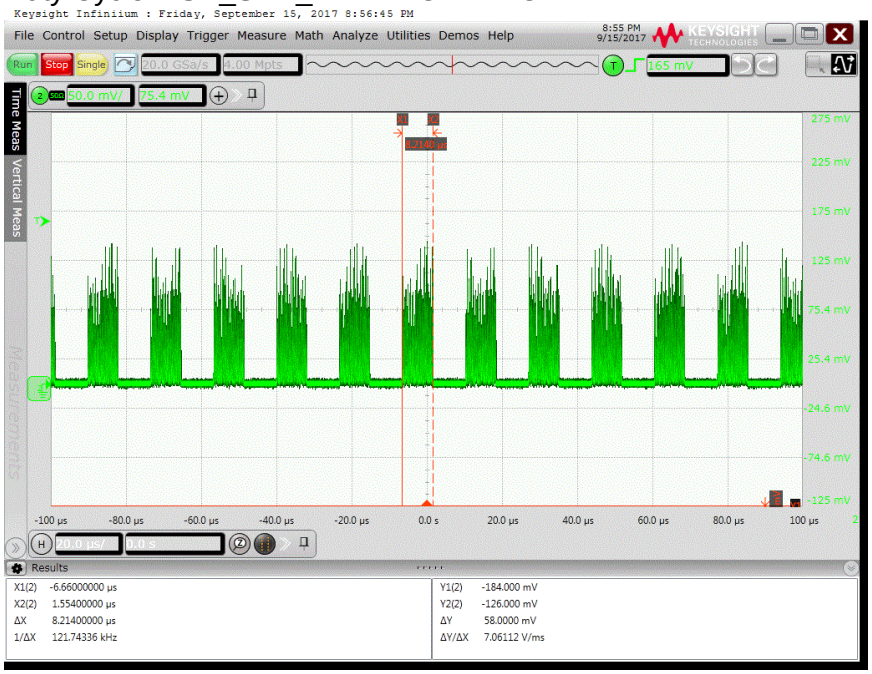
Duty Cycle – SR_SYN_WAVEFORM – ON TIME



Duty Cycle – SR_SYN__WAVEFORM - PERIOD

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7.2. MODULATION

APPLICABLE RULE

§2.1047

DECLARATION

The EUT employs Pulse Modulation, with AM modulation applied during the ON time of the pulse.

7.3. OCCUPIED BANDWIDTH

APPLICABLE RULE

§2.1049

TEST PROCEDURE

The occupied bandwidth (OBW) is measured using 99% bandwidth function of spectrum analyzer in a conducted setup.

The following spectrum analyzer settings were used.

Center Frequency:	9.5525 GHz actual setting (PXA shows 9.553 GHz)
Span:	200 MHz
RBW:	1 MHz
VBW:	3 MHz
Sweep Time:	Auto
Max Hold (Avg. 100)	

Note: Total power and -26dB Bandwidth are default PXA settings. Results on these items are not used.

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RESULT

ER_RPN_Waveform

Frequency vs. Temperatures & Voltages

Temp (ºC)	11.0 V_{DC} 99% OBW (MHz)	12.9 V_{DC} 99% OBW (MHz)	14.8 V_{DC} 99% OBW (MHz)
-30	43.976	44.121	44.043
-20	43.716	43.688	43.805
-10	43.355	43.39	43.351
0	43.261	43.23	43.179
10	43.215	43.132	43.093
20	43.082	43.039	43.034
30	43.015	42.849	42.993
40	42.974	42.968	42.969
50	42.943	42.952	42.942

SR_SYN_Waveform

Frequency vs. Temperatures & Voltages

Temp (ºC)	11.0 V_{DC} 99% OBW (MHz)	12.9 V_{DC} 99% OBW (MHz)	14.8 V_{DC} 99% OBW (MHz)
-30	95.84	95.82	95.772
-20	95.836	95.829	95.789
-10	95.788	95.77	95.717
0	95.802	95.81	95.798
10	95.711	95.777	95.785
20	95.765	95.8	95.766
30	95.741	95.775	95.746
40	95.782	95.76	95.788
50	95.79	95.762	95.797

Widest 99% Occupied Bandwidth using the highest power waveform is 44.121 MHz at -30 ^{o}C and 12.9 VDC.

Widest 99% Occupied Bandwidth using the widest bandwidth waveform is 95.84 MHz at -30 ^{o}C and 11 VDC.

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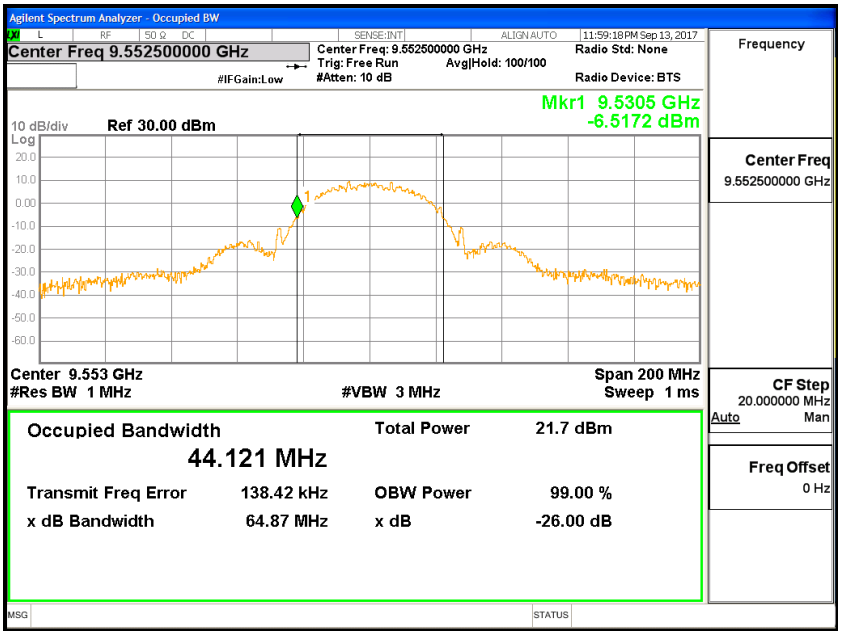
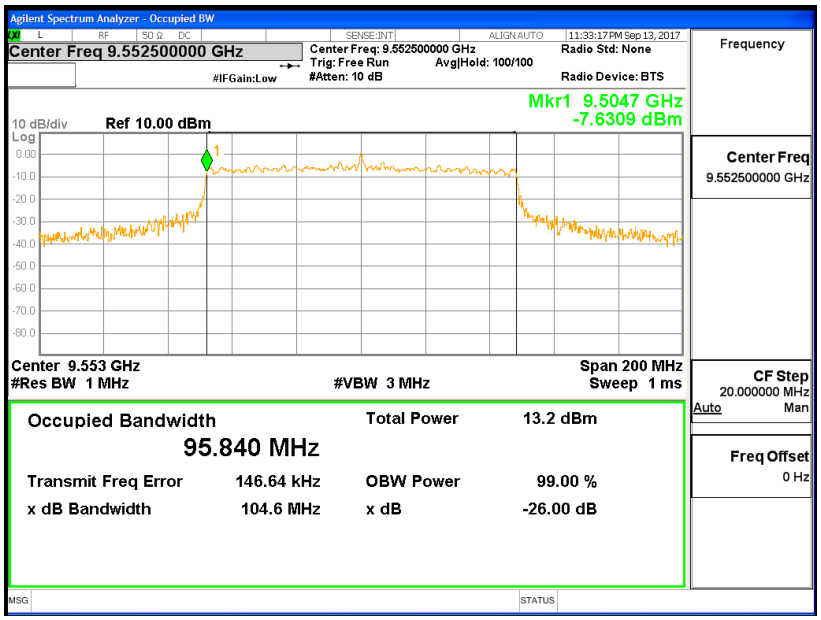
99% Occupied Bandwidth - ER_RPN_Waveform



99% Occupied Bandwidth - SR_SYN_Waveform



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7.4. RF OUTPUT POWER

APPLICABLE RULE

§2.1046

§90.205 (r) *All other frequency bands.* Requested transmitter power will be considered and authorized on a case by case basis.

LIMIT

Reporting requirement only for Equipment Authorization.

Authorized power is determined upon Station licensing.

TEST PROCEDURE

The maximum mean power is measured by a power sensor and power meter in a conducted setup.

Correction Factor = Measurement Cable Loss + Power Splitter Loss + Attenuator Loss

Where,

Measurement Cable Loss = Path Loss of cable @ 9.5525 GHz
Power Splitter Loss = Path Loss of Power Splitter @ 9.5525 GHz
Attenuator Loss = Path Loss of Attenuator @ 9.5525 GHz

A correction factor of 18 dB is applied to the reading of the power meter during test.

The average power sensor corrected measurement is then converted to average power during the ON time by adding the duty cycle factor = 3.1 dB, calculated above.

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RESULT

Duty Cycle Correction Factor = 3.1 dB

ER_RPN_Waveform

Mean Power vs. Temperatures & Voltages						
Temp	**Output Power (dBm)**					
(ºC)	**11 V_{DC}**		**12.9 V_{DC}**		**14.8 V_{DC}**	
	Measured	**During ON Time**	**Measured**	**During ON Time**	**Measured**	**During ON Time**
50	8.54	11.64	8.53	11.63	8.53	11.63
40	9.15	12.25	9.15	12.25	9.16	12.26
30	9.65	12.75	9.65	12.75	9.64	12.74
20	10.14	13.24	10.15	13.25	10.16	13.26
10	10.57	13.67	10.57	13.67	10.57	13.67
0	10.78	13.88	10.78	13.88	10.79	13.89
-10	11.16	14.26	11.16	14.26	11.17	14.27
-20	11.46	14.56	11.47	14.57	11.47	14.57
-30	11.86	14.96	11.87	14.97	11.88	14.98

SR_SYN_Waveform

Mean Power vs. Temperatures & Voltages						
Temp	**Output Power (dBm)**					
(ºC)	**11 V_{DC}**		**12.9 V_{DC}**		**14.8 V_{DC}**	
	Measured	**During ON Time**	**Measured**	**During ON Time**	**Measured**	**During ON Time**
50	0.45	3.55	0.44	3.54	0.44	3.54
40	0.96	4.06	0.96	4.06	0.97	4.07
30	1.71	4.81	1.72	4.82	1.71	4.81
20	1.98	5.08	1.98	5.08	1.99	5.09
10	2.49	5.59	2.48	5.58	2.49	5.59
0	2.75	5.85	2.76	5.86	2.75	5.85
-10	3.13	6.23	3.12	6.22	3.13	6.23
-20	3.52	6.62	3.51	6.61	3.51	6.61
-30	3.89	6.99	3.9	7	3.9	7

Highest mean output power during on time for ER_RPN waveform = 14.98 dBm @ -30°C and 14.8 V DC.

Highest mean output power during on time for SR_SYN waveform = 7.00 dBm @ -30°C and 14.8 V DC.

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7.5. FREQUENCY STABILITY

APPLICABLE RULES

§2.1055 (a) (1) The frequency stability shall be measured with variation of ambient temperature as follows: From −30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

§2.1055 (d) (1) The frequency stability shall be measured with variation of primary supply voltage as follows: Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

TEST PROCEDURE

The EUT is placed in an environmental chamber, with power furnished by an adjustable source. The carrier frequency is counted at each condition and compared with the reference condition.

The output power stability with variation of temperature and primary supply voltage is measured for determining the worst case (highest level) of output power.

The EUT requires a 12.9 V DC nominal supply voltage, this correlated to the DC supply voltage being varied from 11 V DC to 14.8 V DC at test.

The maximum peak to peak delta was calculated as follows:

Maximum Peak to Peak Delta = (Min F_L - Max F_L) + (Min F_H - Max F_H)

Min F_L=Minimum value from all F_L readings
Max F_L=Maximum value from all F_L readings
Min F_H=Minimum value from all F_H readings
Max F_H=Maximum value from all F_H readings

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RESULTS

ER_RPN_Waveform

Temp	11.0 V_{DC}		12.9 V_{DC}		14.8 V_{DC}	
	F_L	F_H	F_L	F_H	F_L	F_H
(ºC)	(GHz)	(GHz)	(GHz)	(GHz)	(GHz)	(GHz)
-30	9.5305	9.5745	9.5305	9.5745	9.5305	9.5745
-20	9.5301	9.5743	9.5305	9.5743	9.5305	9.5743
-10	9.5307	9.5741	9.5309	9.5739	9.5309	9.5739
0	9.5313	9.5741	9.5311	9.5741	9.5313	9.5739
10	9.5309	9.5741	9.5309	9.5743	9.5309	9.5741
20	9.5309	9.5743	9.5309	9.5741	9.5309	9.5741
30	9.5307	9.5739	9.5311	9.5739	9.5307	9.5741
40	9.5309	9.5739	9.5307	9.5741	9.5311	9.5741
50	9.5311	9.5739	9.5311	9.5739	9.5309	9.5739

Maximum Peak to Peak Delta **0.0018 GHz** (1.8 MHz)

SR_SYN_Waveform

Temp	11.0 V_{DC}		12.9 V_{DC}		14.8 V_{DC}	
	F_L	F_H	F_L	F_H	F_L	F_H
(ºC)	(GHz)	(GHz)	(GHz)	(GHz)	(GHz)	(GHz)
-30	9.5047	9.6003	9.5047	9.6005	9.5047	9.6003
-20	9.5045	9.6003	9.5047	9.6005	9.5049	9.6003
-10	9.5049	9.6003	9.5047	9.6003	9.5047	9.6003
0	9.5047	9.6003	9.5049	9.6003	9.5047	9.6005
10	9.5043	9.6001	9.5041	9.6003	9.5041	9.6003
20	9.5047	9.6001	9.5043	9.6003	9.5047	9.6001
30	9.5045	9.6005	9.5045	9.6003	9.5047	9.6003
40	9.5045	9.6003	9.5045	9.6003	9.5047	9.6003
50	9.5047	9.6003	9.5045	9.6003	9.5043	9.6003

Maximum Peak to Peak Delta **0.0012 GHz** (1.2 MHz)

Conclusion: The EUT remained within the 9.5 to 10 GHz authorized band over all specified temperature and voltage variations. The maximum variation (P-P) is1.8 MHz.

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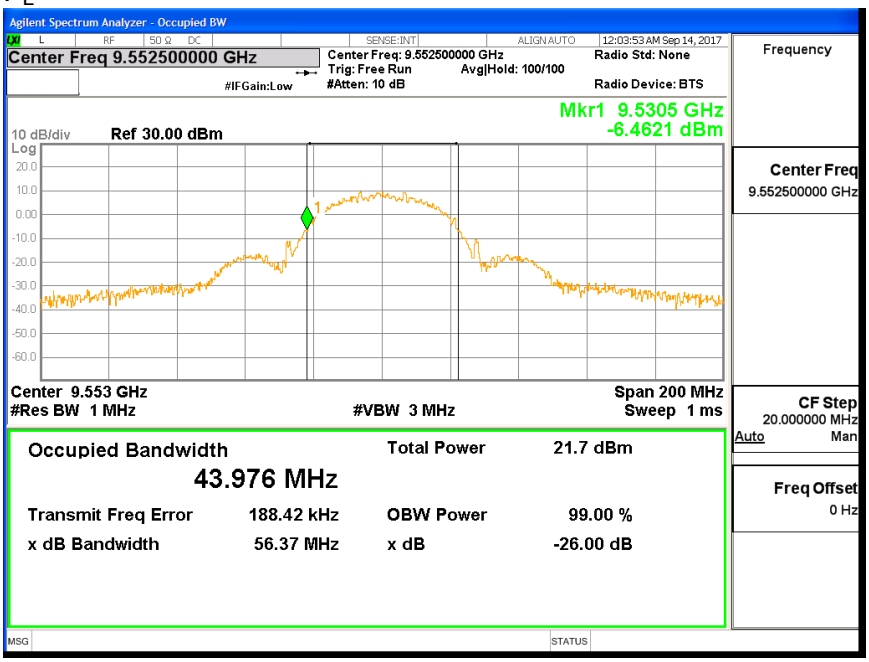
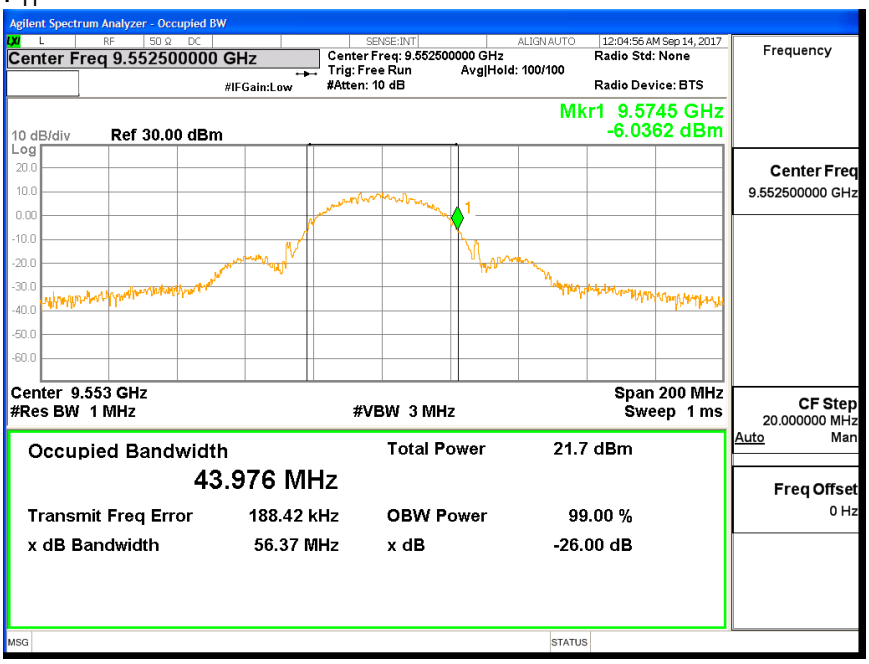
Occupied Bandwidth @ -30ºC & 11.0 V_{DC}
ER_RPN_Waveform

F_L



F_H



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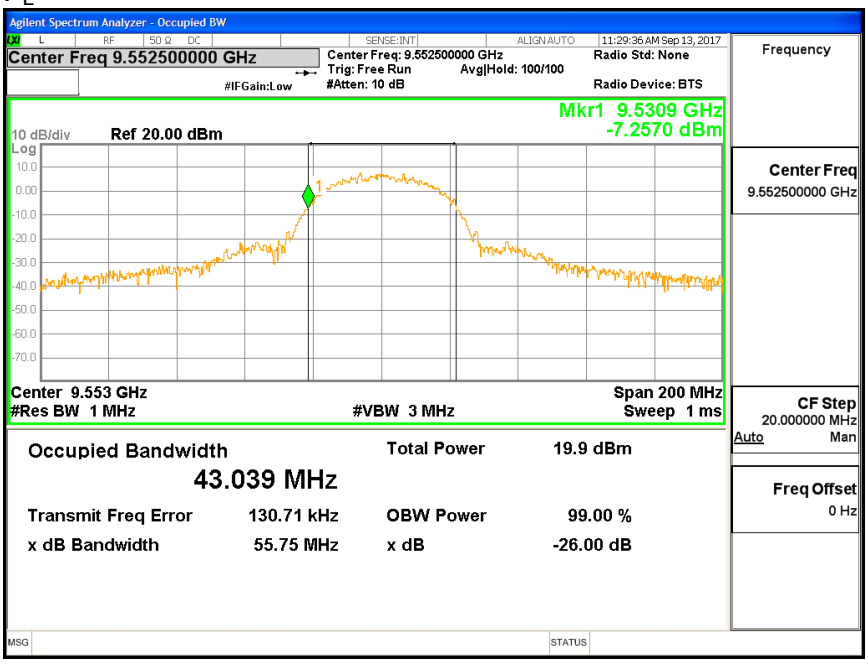
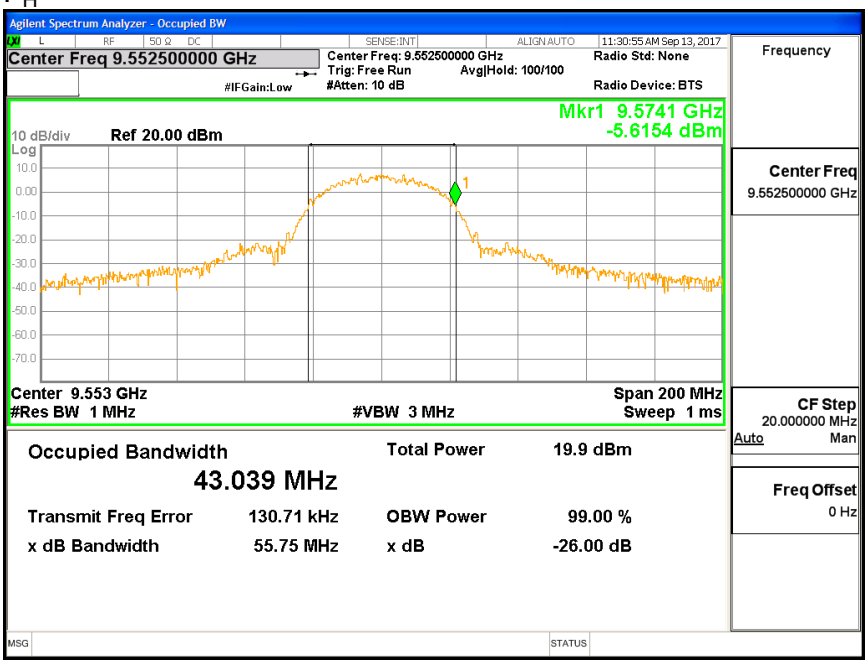
Occupied Bandwidth @ 20ºC & 12.9 V_{DC}
ER_RPN_Waveform

F_L



F_H



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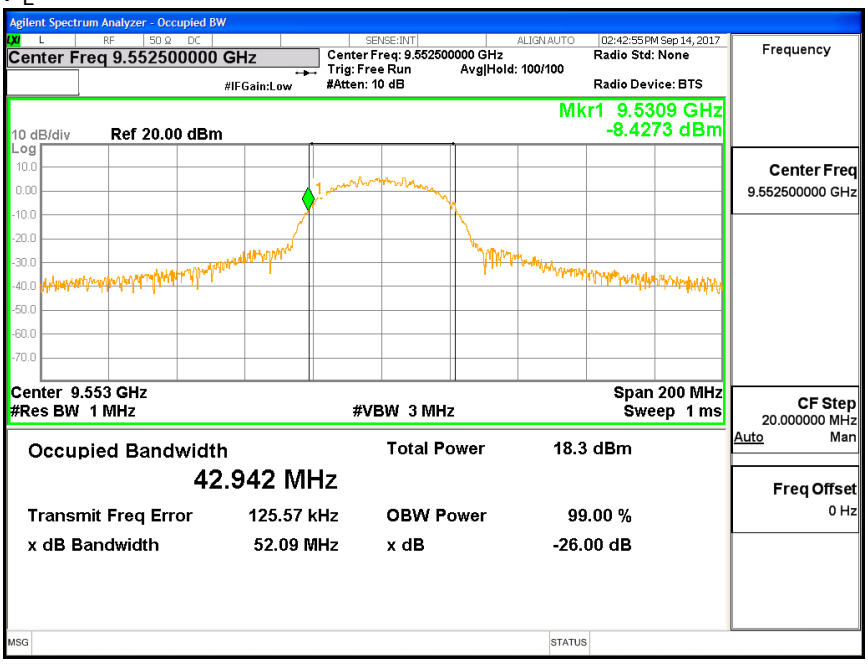
Occupied Bandwidth @ +50ºC & 14.8 V_{DC}
ER_RPN_Waveform

F_L



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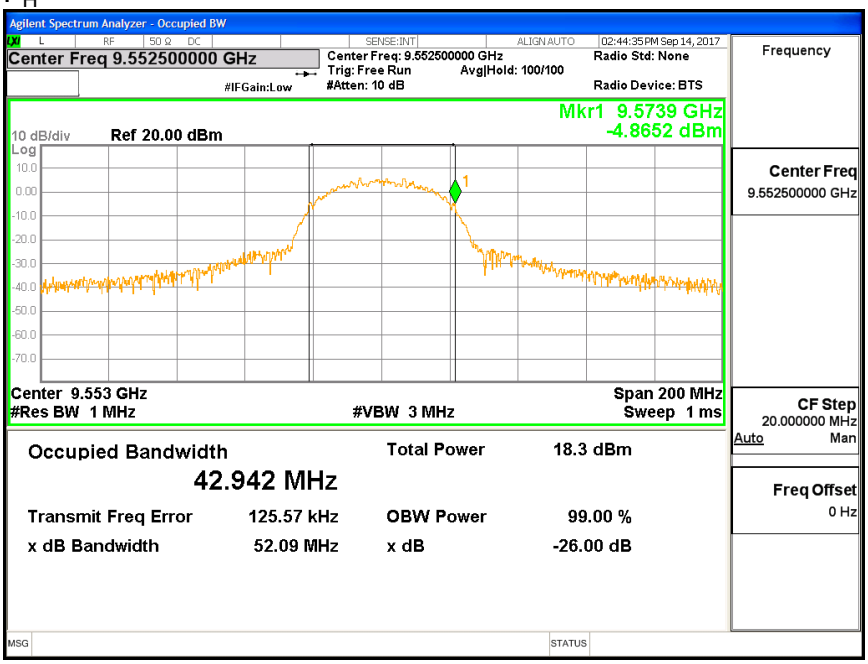

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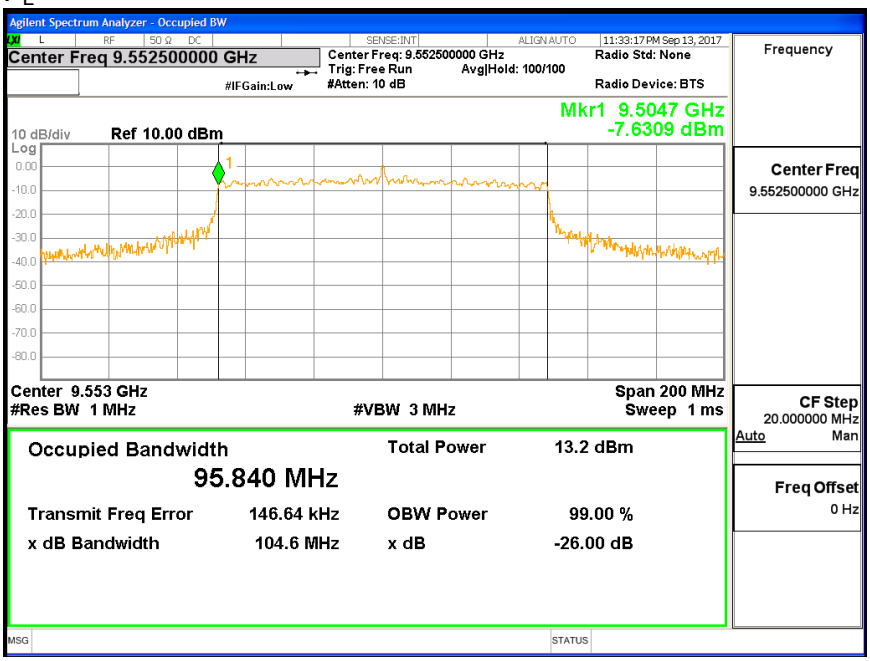
Occupied Bandwidth @ -30ºC & 11.0 V_{DC}
SR_SYN_Waveform

F_L



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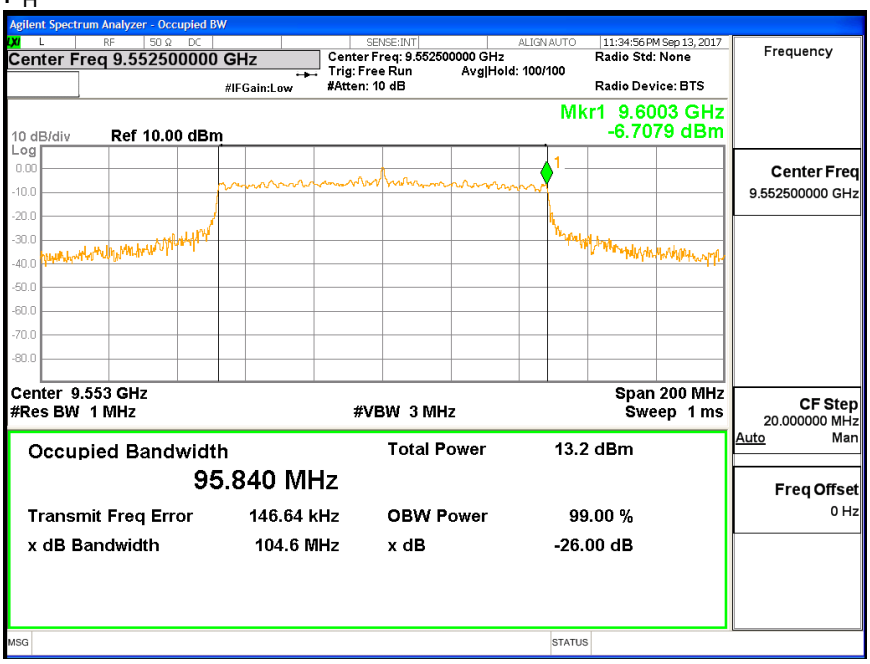

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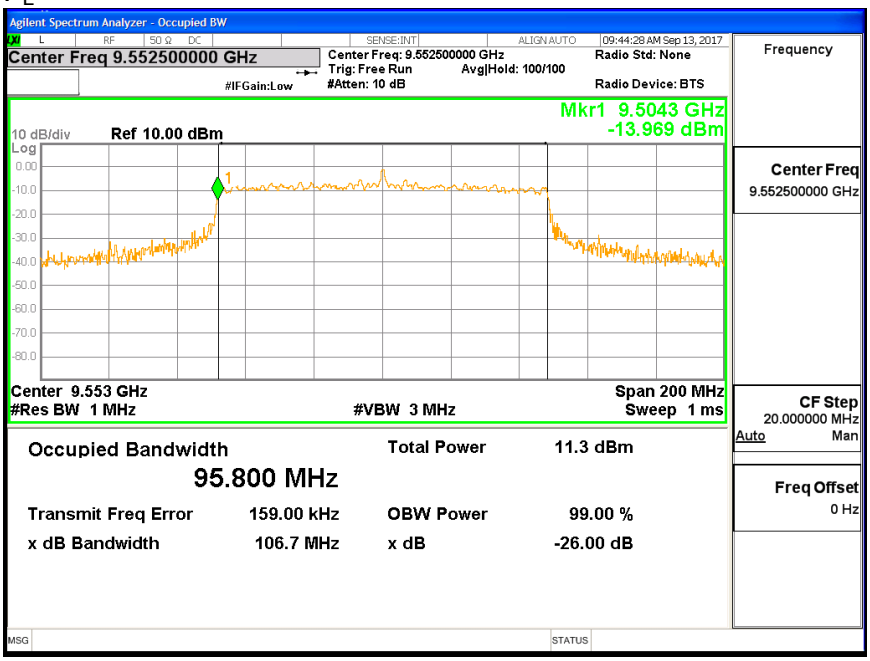
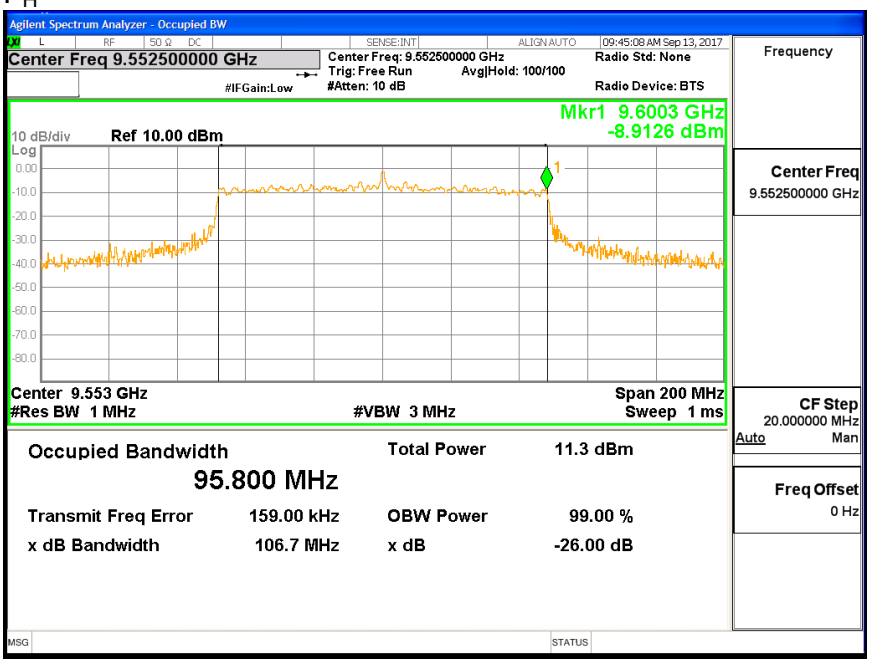
Occupied Bandwidth @ 20ºC & 12.9 V_{DC}
SR_SYN_Waveform

F_L



F_H



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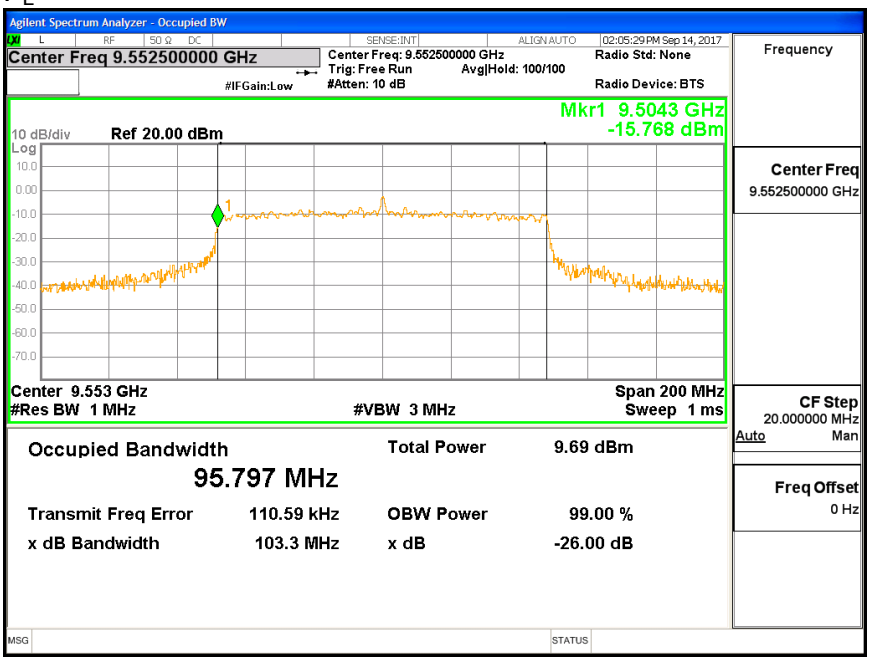
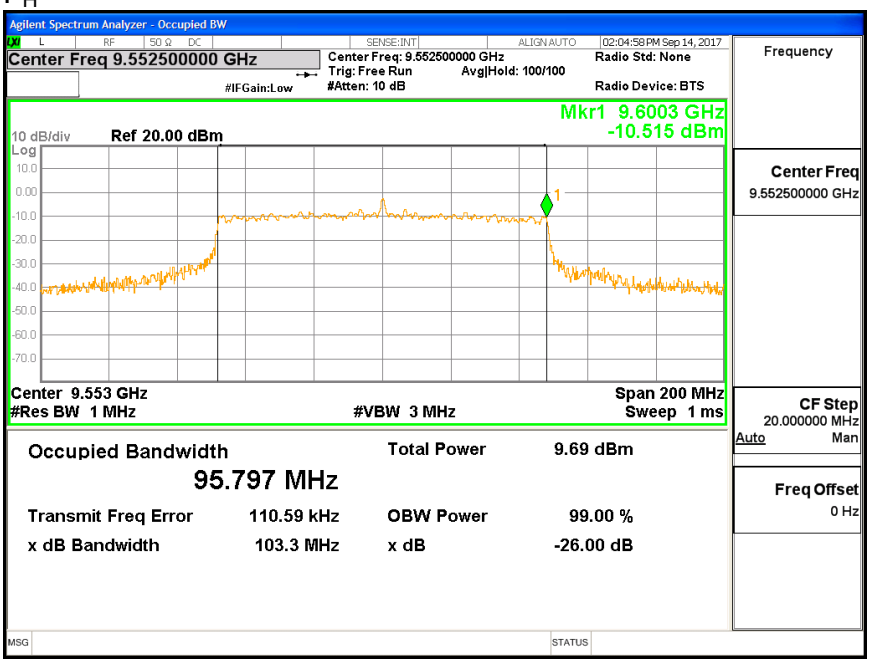
Occupied Bandwidth @ +50ºC & 14.8 V_{DC}
SR_SYN_Waveform

F_L



F_H



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7.6. CONDUCTED SPURIOUS EMISSIONS

APPLICABLE RULES

§2.1051 The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§2.1057 (a) (1) In all of the measurements set forth in §§2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below: If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

LIMIT

For frequencies outside the authorized band of 9500 to 10,000 MHz, the attenuation must be at least 43 + 10 log(Pm) dB. Pm is defined as the mean power of the radar in Watts. This equation will result in a -13 dBm limit line, regardless of the value of Pm: Pm (dBW) - attenuation = Pm (dBW) - (43 + 10 log(Pm)) = -43 dBW = -13 dBm.

TEST PROCEDURE

The conducted spurious emission is measured using spectrum analyzer. The EUT is programmed to its worst case pulse radar operation mode.

The highest power waveform is used for worst case conducted emissions.

The signal output is scanned using a peak detector. Any spur or harmonic within 6 dB of the limit is measured using average detectors.

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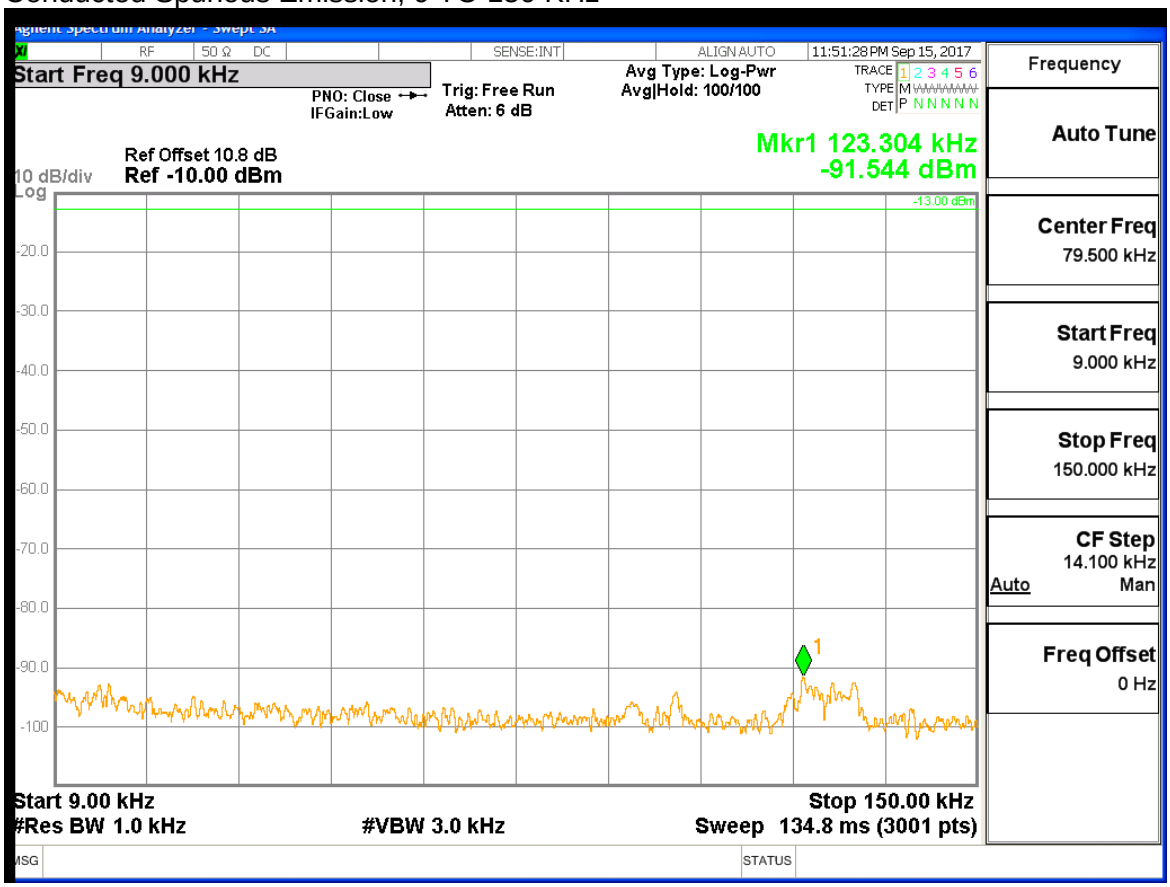
7.6.1. CONDUCTED SPURIOUS EMISSION, 9 KHz TO 40 GHz

7.6.1.1. 9 TO 150 KHz

Conducted Spurious Emission, 9 TO 150 KHz



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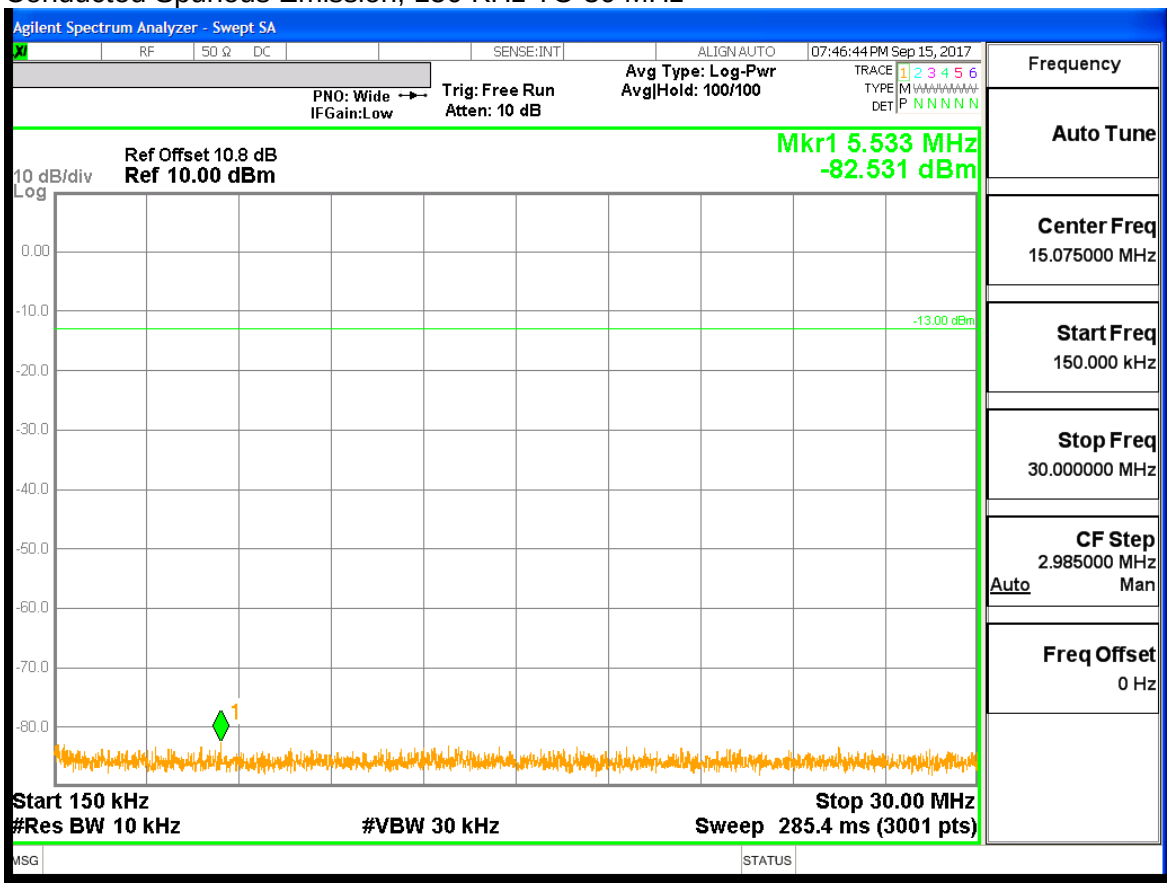
7.6.1.2. 150 KHz TO 30 MHz

Conducted Spurious Emission, 150 KHz TO 30 MHz



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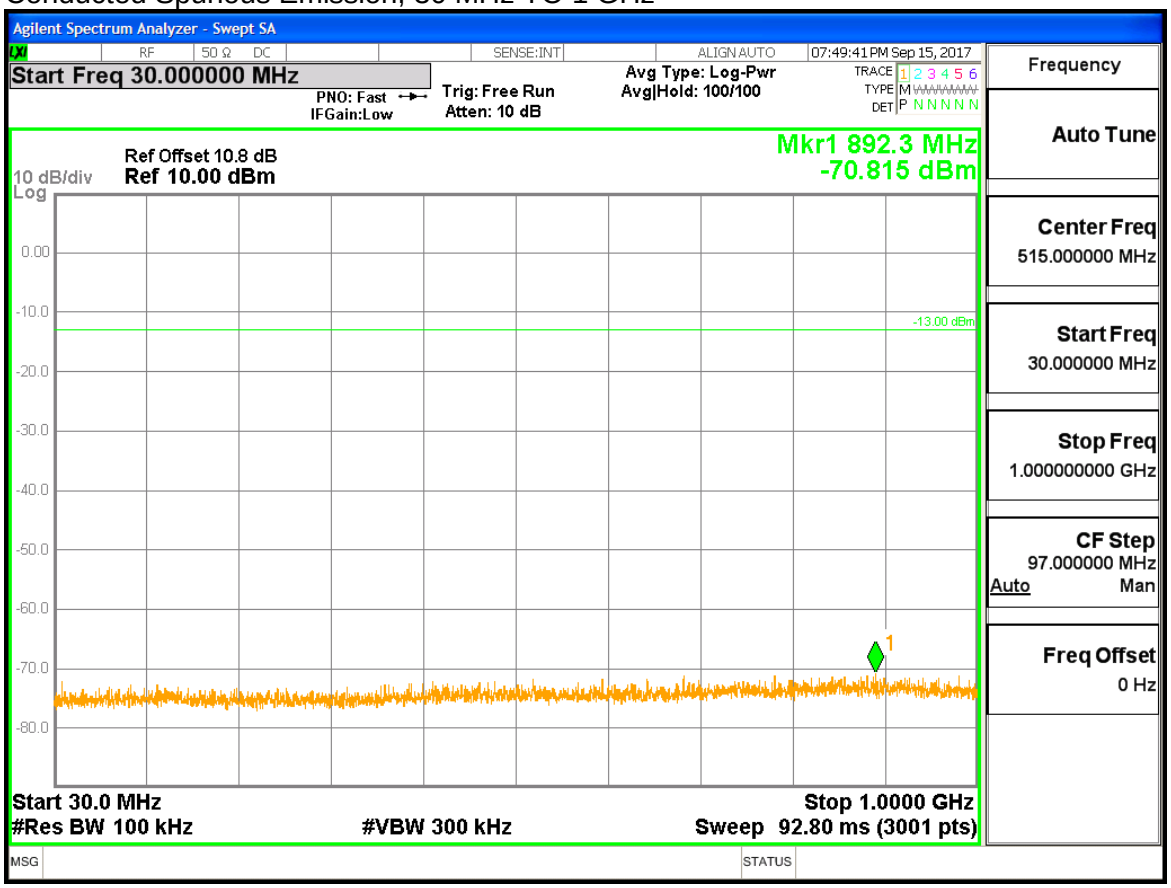
7.6.1.3. 30 MHz TO 1 GHz

Conducted Spurious Emission, 30 MHz TO 1 GHz



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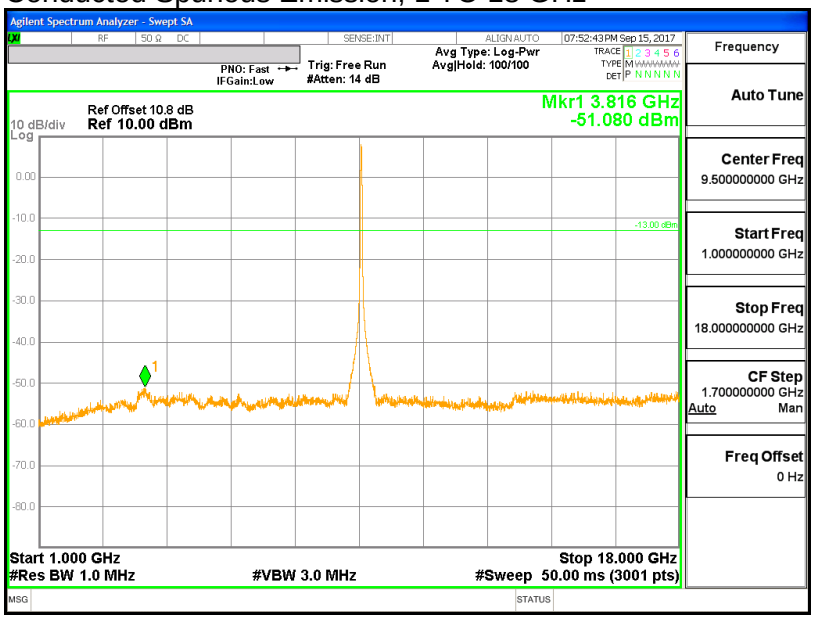
7.6.1.1. 1 TO 18 GHz

Conducted Spurious Emission, 1 TO 18 GHz



9.5525 GHz is the fundamental signal.

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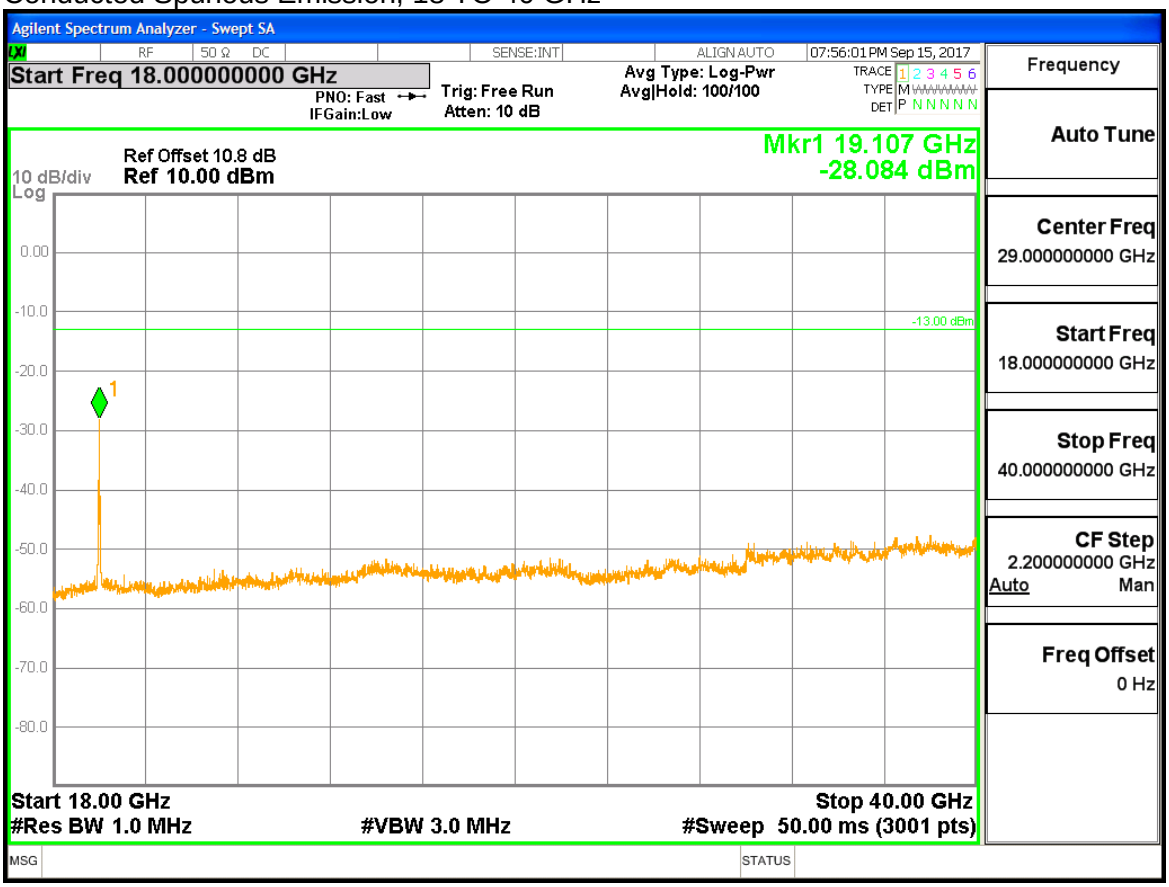
7.6.1.2. 18 TO 40 GHz

Conducted Spurious Emission, 18 TO 40 GHz



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7.7. RADIATED SPURIOUS EMISSIONS

APPLICABLE RULES

§2.1053 (a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate.

§2.1057 (a) (1) In all of the measurements set forth in §§2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below: If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

LIMIT

For frequencies outside the authorized band of 9500 to 10,000 MHz, the attenuation must be at least 43 + 10 log(Pm) dB. Pm is defined as the mean power of the radar in Watts. This equation will result in a -13 dBm limit line, regardless of the value of Pm: Pm (dBW) - attenuation = Pm (dBW) - (43 + 10 log(Pm)) = -43 dBW = -13 dBm.

TEST PROCEDURE

ANSI C63.26-2015

Radiated emissions are measured using the field strength method documented in clause 5.5.4.

The -13 dBm EIRP radiated power limit is equivalent to 82.2 dBuV/m at 3 m.

The signal output is scanned using a peak detector. Any spur or harmonic within 6 dB of the limit is measured using average detectors.

EUT is tested in the highest power mode (ER_RPN_WAVEFORM).

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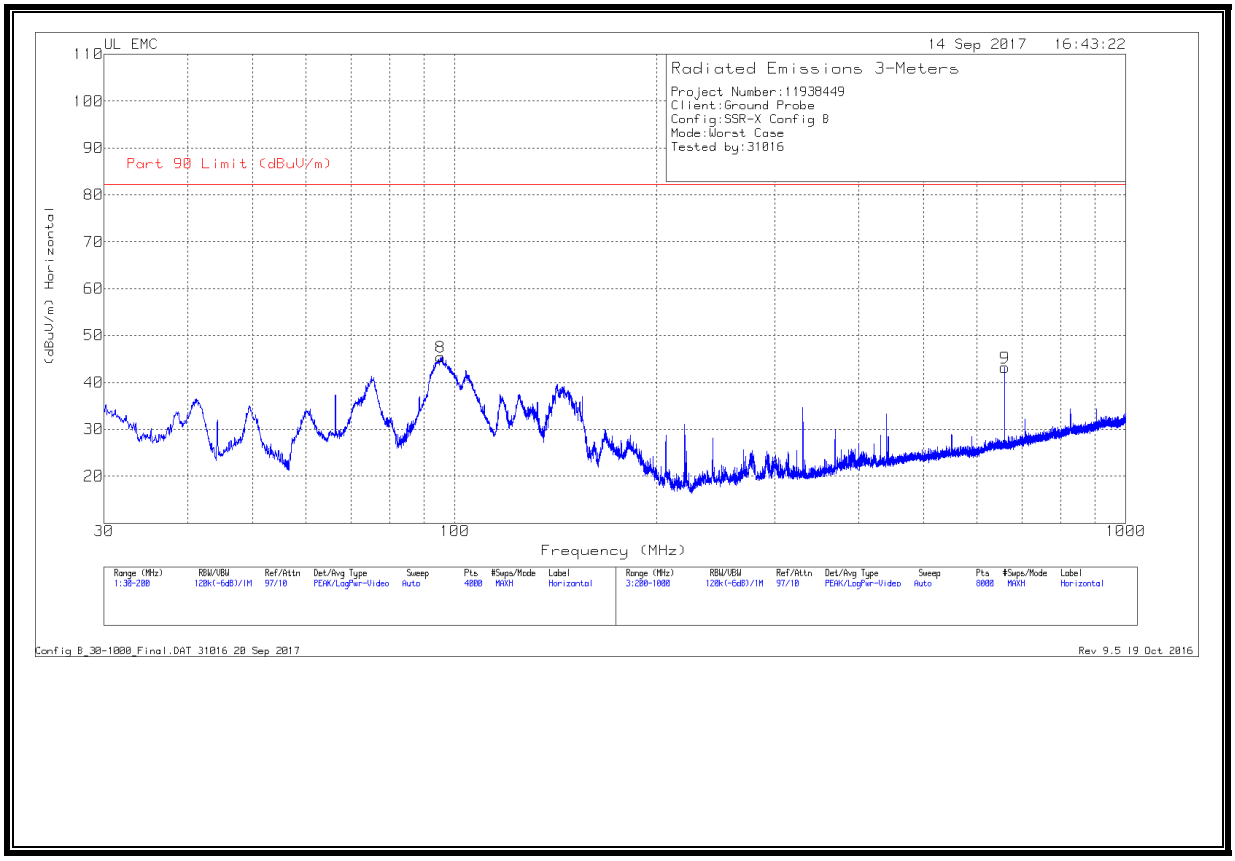
7.7.1. RADIATED SPURIOUS EMISSIONS, 30 MHz TO 40 GHz

7.7.1.1. 30 TO 1000 MHz

RADIATED SPURIOUS EMISSION, 30 - 1000 MHz (HORIZONTAL PLOT)



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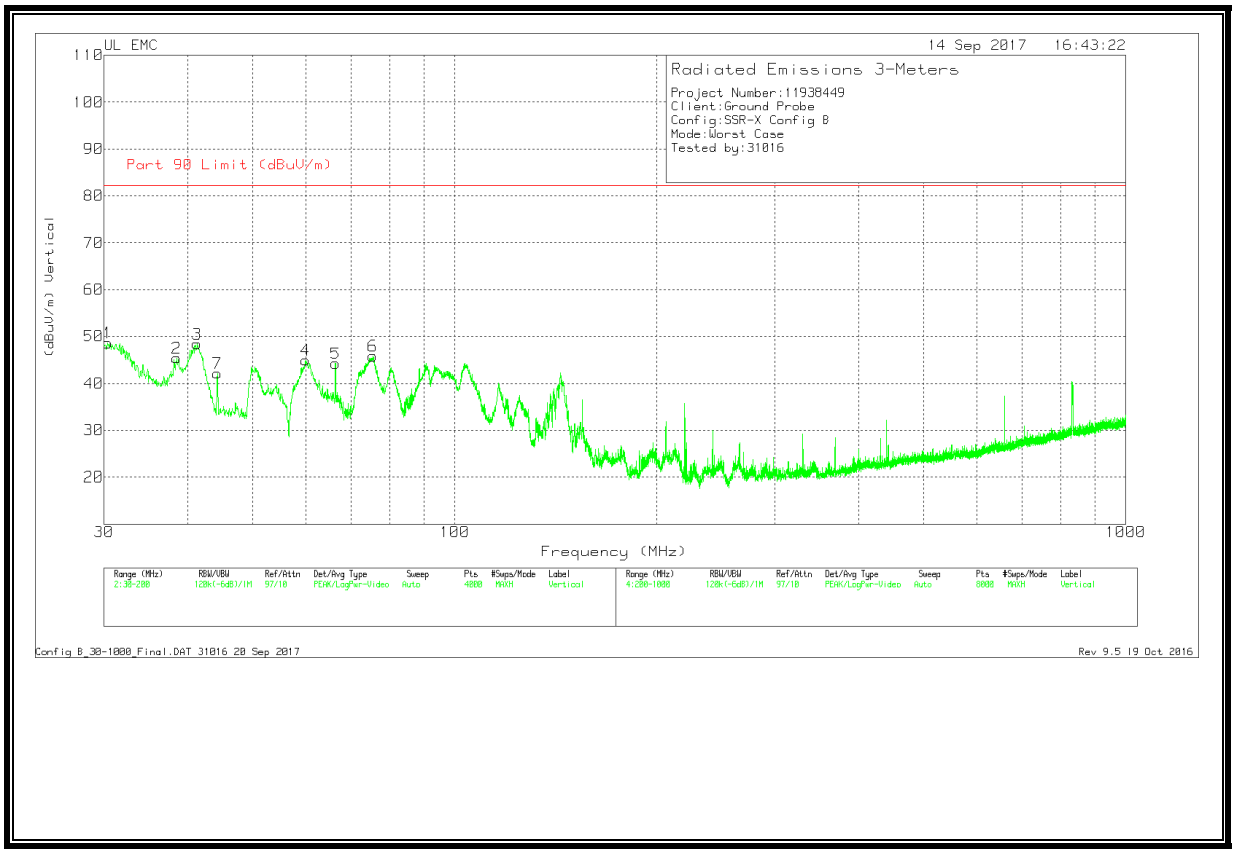
RADIATED SPURIOUS EMISSION, 30 - 1000 MHz (VERTICAL PLOT)



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RADIATED SPURIOUS EMISSION 30 - 1000 MHz

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	Part 90 Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	30.3826	52.23	Pk	25.2	-28.8	48.63	82.2	-33.57	0-360	100	V
2	38.5022	54.79	Pk	19.3	-28.7	45.39	82.2	-36.81	0-360	100	V
3	41.3079	59.93	Pk	17.2	-28.7	48.43	82.2	-33.77	0-360	100	V
4	59.9277	61.62	Pk	11.7	-28.4	44.92	82.2	-37.28	0-360	100	V
5	66.3894	60.47	Pk	12.1	-28.3	44.27	82.2	-37.93	0-360	100	V
6	75.4868	62.34	Pk	11.7	-28.2	45.84	82.2	-36.36	0-360	100	V
7	44.2412	55.83	Pk	14.9	-28.6	42.13	82.2	-40.07	0-360	100	V
8	95.2544	60.53	Pk	12.9	-28	45.43	82.2	-36.77	0-360	300	H
9	659.9598	44.77	Pk	23.6	-25.2	43.17	82.2	-39.03	0-360	100	H

Pk - Peak detector

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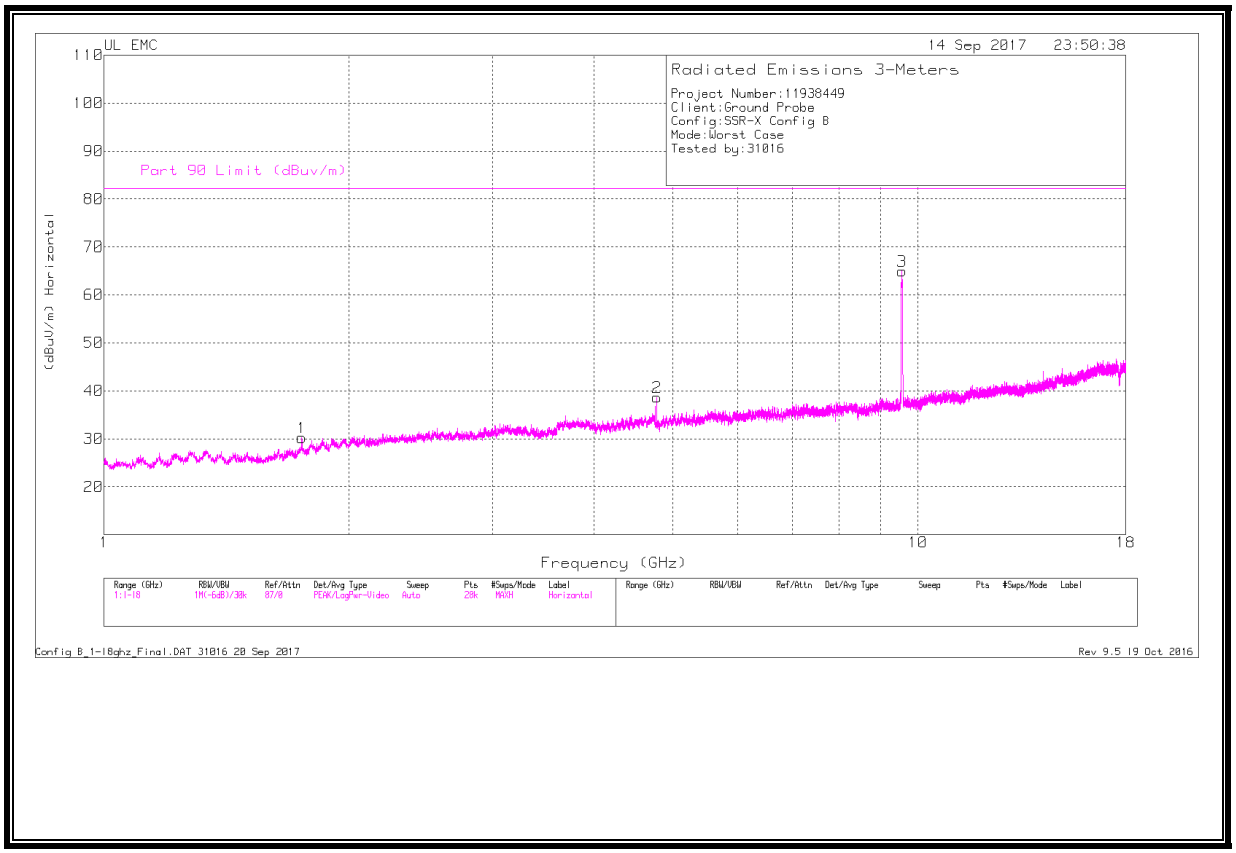
7.7.1.2. 1 TO 18 GHz

RADIATED SPURIOUS EMISSION, 1-18 GHz (HORIZONTAL PLOT)



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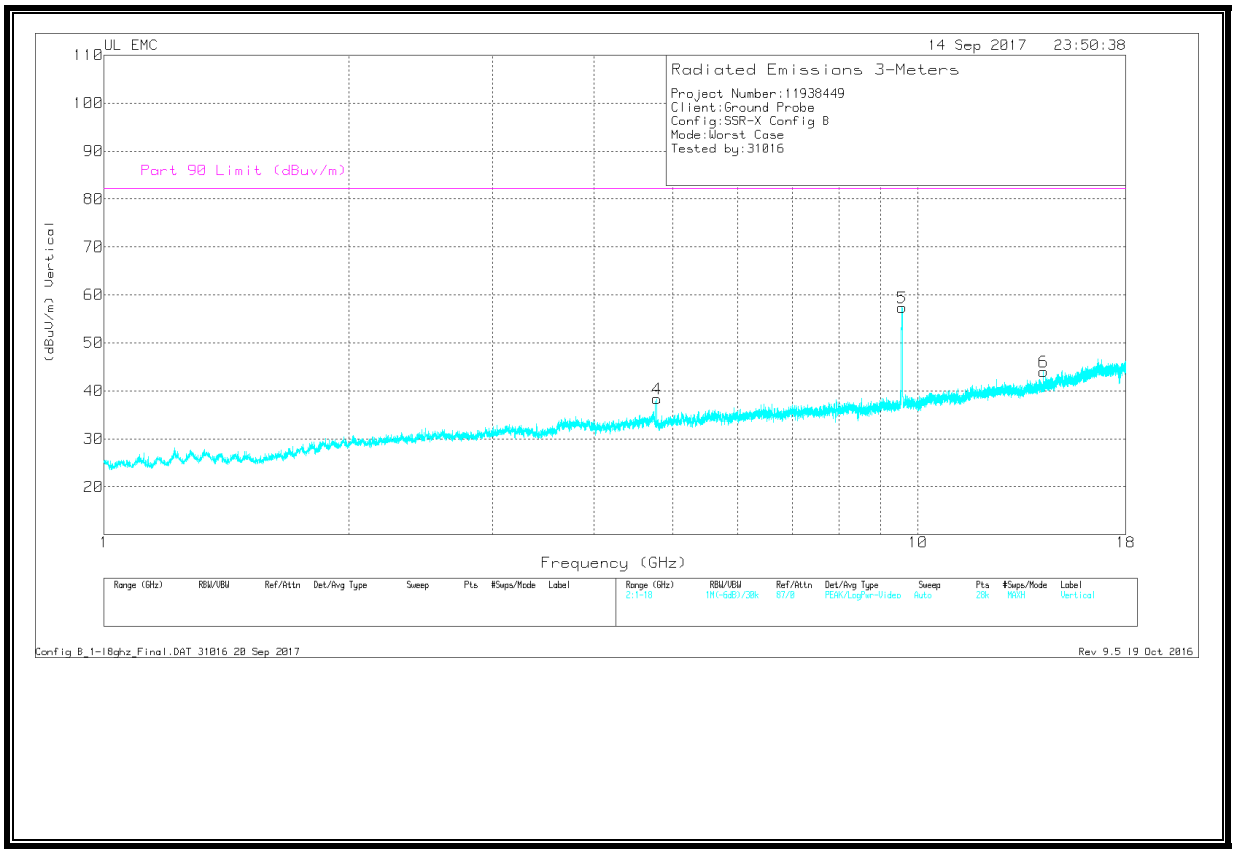
RADIATED SPURIOUS EMISSION, 1-18 GHz (VERTICAL PLOT)



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RADIATED SPURIOUS EMISSION 1 - 18 GHz

Radiated Emissions

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	Part 90 Limit (dBuV/m))	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1.749	40.81	Pk	29.7	-33	37.51	82.2	-44.69	351	271	H
2	4.776	40.4	Pk	34.3	-30.3	44.4	82.2	-37.8	235	113	H
4	4.776	39.68	Pk	34.3	-30.3	43.68	82.2	-38.52	211	143	V
6	14.256	34.48	Pk	39.5	-22.2	51.78	82.2	-30.42	220	106	V

Pk - Peak detector

Note: Markers 3 and 5 are the Fundamental Frequency of operation.

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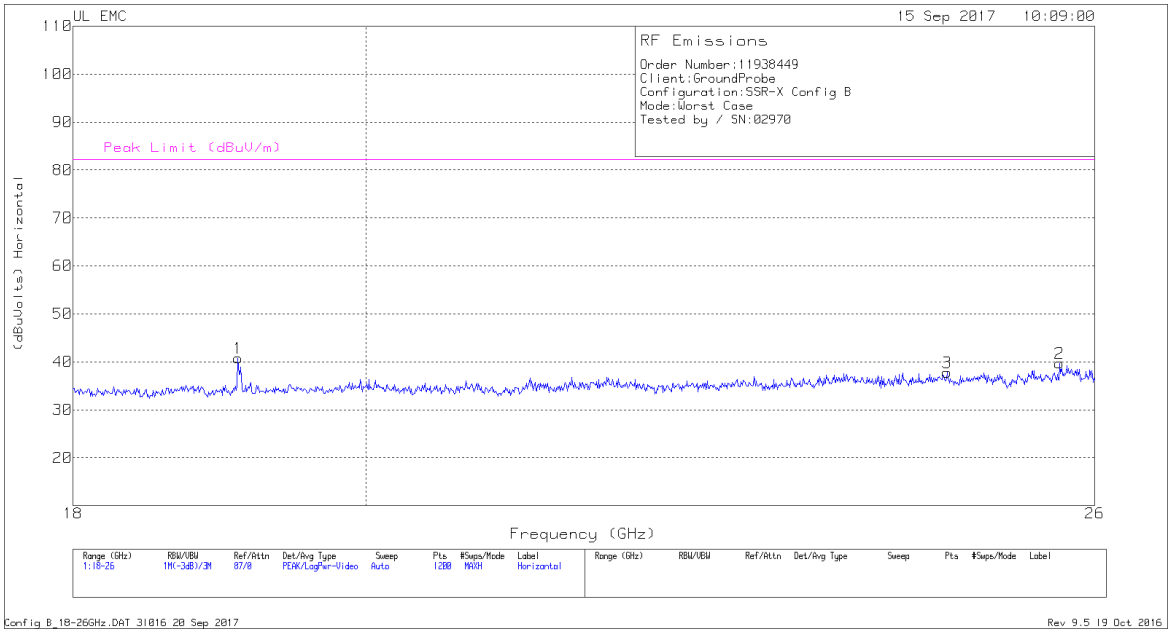
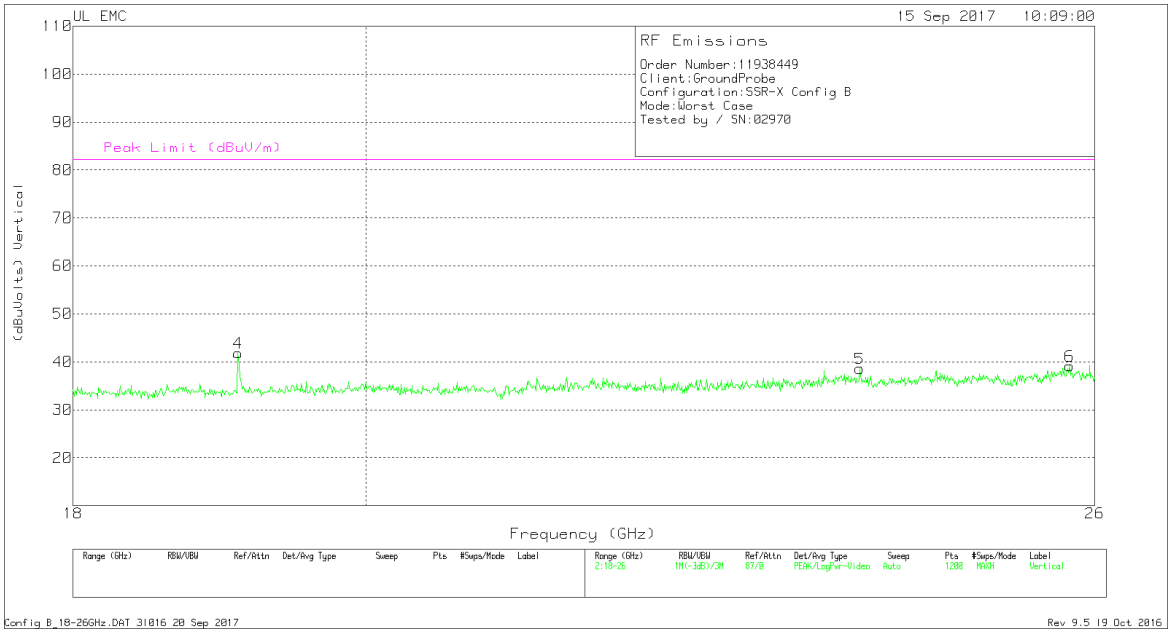
7.7.1.3. 18 TO 26 GHz

RADIATED SPURIOUS EMISSION 18 - 26 GHz (HORIZONTAL AND VERTICAL PLOT)

Horizontal



Vertical



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RADIATED SPURIOUS EMISSION 18 - 26 GHz

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Part 90 Limit (dBuV/m)	Margin (dB)
1	19.101	43.09	Pk	32.2	-25	-9.5	40.79	82.2	-41.41
2	25.673	40	Pk	34.1	-24.9	-9.5	39.7	82.2	-42.5
3	24.652	37.89	Pk	33.9	-24.5	-9.5	37.79	82.2	-44.41
4	19.101	44.11	Pk	32.2	-25	-9.5	41.81	82.2	-40.39
5	23.892	38.48	Pk	33.5	-23.9	-9.5	38.58	82.2	-43.62
6	25.766	39.23	Pk	34.1	-24.7	-9.5	39.13	82.2	-43.07

Pk - Peak detector

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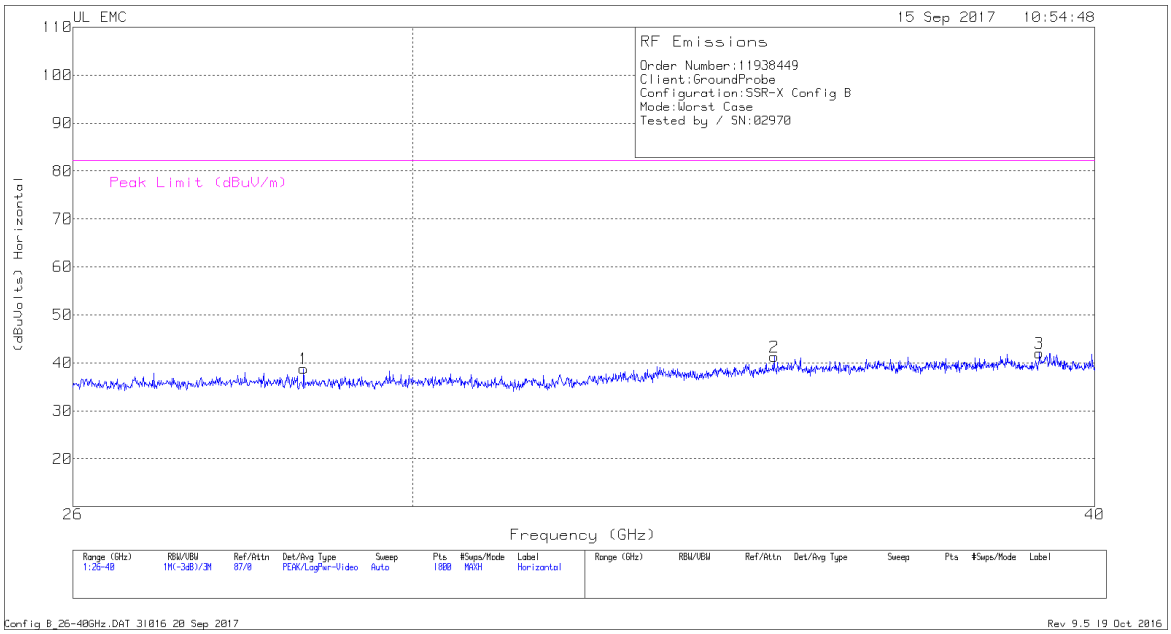
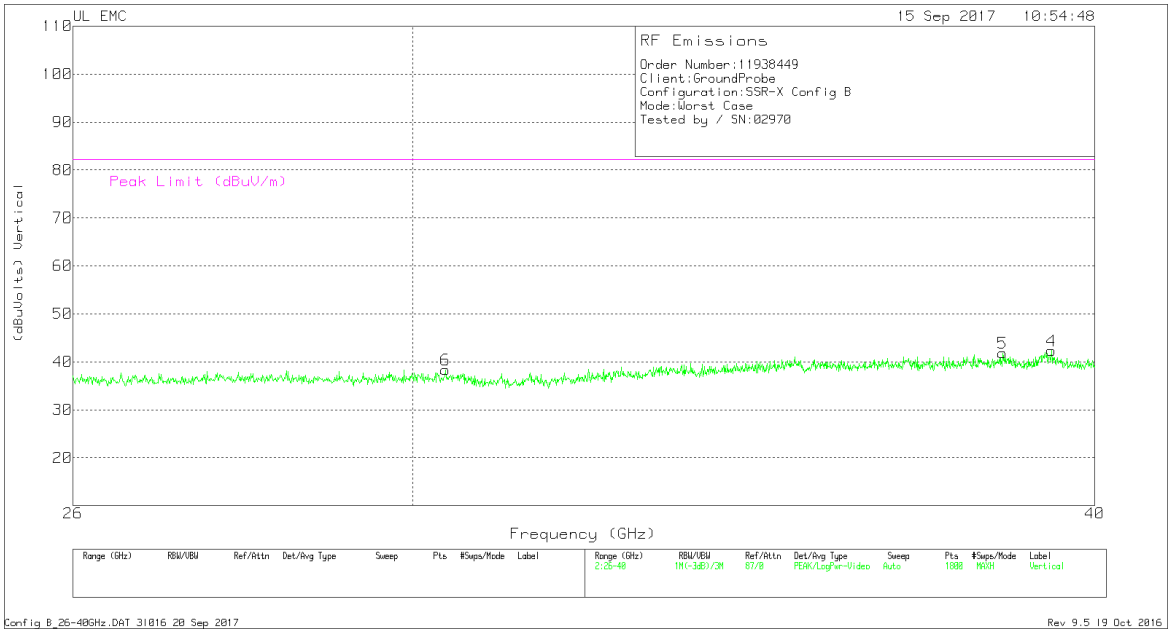
7.7.1.4. 26 TO 40 GHz

RADIATED SPURIOUS EMISSION 26 - 40 GHz (HORIZONTAL AND VERTICAL PLOT)

Horizontal



Vertical



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RADIATED SPURIOUS EMISSION 26 - 40 GHz

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Part 90 Limit (dBuV/m)	Margin (dB)
1	28.654	44.98	Pk	35.7	-32.4	-9.5	38.78	82.2	-43.42
2	34.942	46.79	Pk	37.2	-33.2	-9.5	41.29	82.2	-40.91
3	39.074	45.63	Pk	37.6	-31.7	-9.5	42.03	82.2	-40.17
4	39.276	45.85	Pk	38.5	-32.5	-9.5	42.35	82.2	-39.85
5	38.475	46.31	Pk	37	-32	-9.5	41.81	82.2	-40.39
6	30.42	44.53	Pk	36	-32.7	-9.5	38.33	82.2	-43.87

Pk - Peak detector

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7.8. RF EXPOSURE

LIMIT

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

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EQUATIONS

RF Exposure calculations are made in accordance with the equations given in FCC Bulletin 65 (Aperture antenna section).

POWER DENSITY AT ANTENNA SURFACE

The maximum power density at the surface of the antenna is given by Equation 11 as:

$S_{surface} = 4 * P / A$

where

P = Power fed to the Antenna
A = Area of antenna

NEAR-FIELD POWER DENSITY

The near-field boundary is given by Equation 12 as:

$R_{nf} = D^2 / (4 * \lambda)$

where

D = Largest Antenna Dimension
λ = Wavelength

The maximum near-field power density is given by Equation 13 as:

$S_{nf} = (16 * \eta * P) / (\pi * D^2)$

where

η = Aperture efficiency
P = Power fed to the Antenna
D = Antenna Diameter

For circular apertures, the aperture efficiency is given by Equation 14 as:

$\eta = [(G * \lambda^2) / (4 * \pi)] / [(\pi * D^2) /4]$

where

G = Power gain in the direction of interest
λ = Wavelength
D = Antenna Diameter

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TRANSITION REGION POWER DENSITY

The power density in the transition region is less than the maximum near-field power density.

FAR FIELD POWER DENSITY

The far-field boundary is given by Equation 16 as:

$$R_{ff} = (0.6 * D^2) / \lambda$$

where

D = Largest Antenna Dimension
λ = wavelength

Power density is given by Equation 18 as:

$$S_{ff} = (P * G) / (4 * \pi * R^2)$$

where

P = Power fed to the Antenna
G = Power gain in the direction of interest
R = Separation distance

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7.8.1. CALCULATIONS

From §1.1310 Table 1 (B), S = 1.0 mW/cm^2.

POWER DENSITY AT ANTENNA SURFACE

Power is average power over ON and OFF times, EUT has source-based duty cycle.

Frequency (GHz)	Output Power (dBm)	Output Power (mW)	Antenna Diameter (m)	Aperture Area (cm^2)	Power Density (mW/cm^2)	Limit (mW/cm^2)
9.5525	11.88	15.4	1.800	25434.0	0.002	1.0

NEAR-FIELD POWER DENSITY

Frequency (GHz)	Antenna Diameter (m)	Wavelength Lambda (m)	R (Near Field) (m)
9.5525	1.800	0.0314	25.79

Frequency (GHz)	Wavelength Lambda (m)	Antenna Gain (dBi)	Antenna Gain (Linear)	Antenna Diameter (m)	Aperture Efficiency (Linear)
9.5525	0.0314	46	39811	1.800	1.229

Frequency (GHz)	Output Power (dBm)	Output Power (mW)	Antenna Diameter (m)	Aperture Efficiency (Linear)	Power Density (mW/cm^2)	Limit (mW/cm^2)
9.5525	11.88	15.4	1.800	1.229	0.003	1.0

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FAR FIELD POWER DENSITY

The closest far-field boundary for a given antenna diameter is at the highest frequency in each applicable band.

Frequency (GHz)	Antenna Diameter (m)	Wavelength Lambda (m)	R (Far Field) (m)
9.5525	1.800	0.0314	61.90

The maximum far-field power density occurs at the far-field boundary:

Frequency (GHz)	Far-Field Distance (cm)	Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	Power Density (mW/cm^2)	Limit (mW/cm^2)
9.5525	6190	11.88	46	57.88	613762	0.00128	1.0

7.8.2. RESULTS AND CONCLUSIONS

The power density at the antenna surface, the maximum near-field power density and the maximum far-field power density are all less than the applicable limit.

For fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

7.8.3. MINIMUM SEPARATION DISTANCE

As a fixed location transmitter, the minimum separation distance is specified as 20 cm.

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