

TEST REPORT

ACCORDING TO: FCC CFR 47 Part 90, subpart I, and RSS-119 Issue 12:2015

FOR:

Telematics Wireless Ltd.
Repeater of automatic water
meter reading system
Model: Allegro Repeater
FCC ID:NTA2WREP2
IC: 4732A-2WREP2

This report is in conformity with ISO/ IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested.
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1 Applicant information

Client name: Telematics WirelessLtd.
Address: 26 Hamelacha street, POB 1911, Holon, 58117, Israel
Telephone: +972 3557 5829
Fax: +972 3557 5783
E-mail: slavas@telematics-wireless.com
Contact name: Mr. Slava Snitkovsky

2 Equipment under test attributes

Product name: Repeater of automatic water meter reading system
Product type: Transceiver
Model(s): Allegro Repeater
Serial number: 20610
Hardware version: B
Software release: 1.02
Receipt date 14-Dec-15

3 Manufacturer information

Manufacturer name: Telematics WirelessLtd.
Address: 26 Hamelacha street, POB 1911, Holon, 58117, Israel
Telephone: +972 3557 5829
Fax: +972 3557 5783
E-Mail: slavas@telematics-wireless.com
Contact name: Mr. Slava Snitkovsky

4 Test details

Project ID: 27753
Location: Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel
Test started: 14-Dec-15
Test completed: 24-Jan-16
Test specification(s): FCC part 90, subpart I; RSS-119 issue 12

5 Tests summary

Test	Status
Transmitter characteristics	
FCC Section 90.205 / RSS-119 Section 5.4, Maximum output power	Pass
FCC Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth	Pass
FCC Section 90.210 / RSS-119 Section 5.8.4, Emission mask	Pass
FCC Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	Pass
FCC Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	Pass
FCC Section 90.213 / RSS-119 Section 5.3, Frequency stability	Pass
FCC Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	Pass
FCC Section 2.1091 / RSS-102 section 2.5, RF radiation exposure evaluation	Pass, Exhibit in application for certification provided

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

This test report supersedes the previously issued test report identified by Doc ID: TELRAD_FCC.27753.

	Name and Title	Date	Signature
Tested by:	Mrs. E. Pitt, test engineer	January 24, 2016	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	February 3, 2016	
Approved by:	Mr. M. Nikishin, EMC and Radio group manager	March 29, 2016	

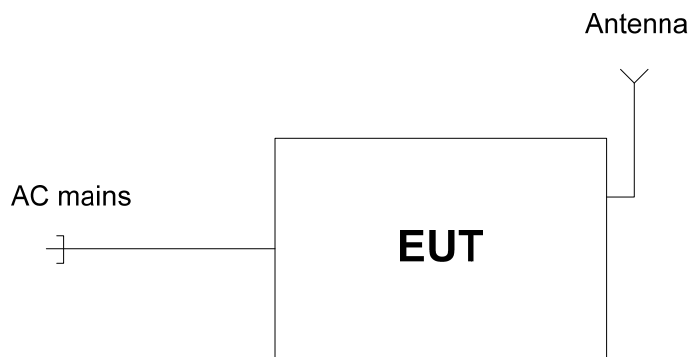
6 EUT description

6.1 General information

The EUT, a two-way repeater of an automatic water meter reading system, is a plug and play multi-channel/ frequency RF transceiver unit, operating in 450-470 MHz ISM band. The unit is designated to transceiver / collect wireless transmissions of water meter.

The EUT sends the collected data through external antenna.

6.2 Test configuration



6.3 Changes made in EUT

No changes were implemented in the EUT during the testing.

6.4 Transmitter characteristics

Type of equipment							
X	Stand-alone (Equipment with or without its own control provisions)						
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)						
	Plug-in card (Equipment intended for a variety of host systems)						
Intended use		Condition of use					
	fixed	Always at a distance more than 2 m from all people					
X	mobile	Always at a distance more than 20 cm from all people					
	portable	May operate at a distance closer than 20 cm to human body					
Assigned frequency range		450- 470 MHz					
Maximum rated output power		At transmitter 50 Ω RF output connector				34.95 dBm	
Is transmitter output power variable?		No					
		X	Yes	continuous variable			
				stepped variable with stepsize			
				0.5 dB			
				minimum RF power			
33 dBm							
maximum RF power							
35.2 dBm							
Antenna connection							
unique coupling	X	standard connector	integral	with temporary RF connector			
			without temporary RF connector				
Antenna/s technical characteristics							
Type	Manufacturer		Model number		Gain		
External	Kathrein		721388		7 dBi		
Transmitter 99% power bandwidth		6 kHz					
Transmitter aggregate data rate/s		4.8 kbps					
Type of modulation		4GFSK					
Modulating test signal (baseband)		PRBS					
Maximum transmitter duty cycle in normal use		23 %	Tx ON time	320 ms	Period	20 s	
Transmitter duty cycle supplied for test		25 %	Tx ON time	1 s	Period	4 s	
Transmitter power source							
	Battery	Nominal rated voltage	VDC	Battery type			
	DC	Nominal rated voltage	VDC				
X	AC mains	Nominal rated voltage	120 VAC	Frequency	60 Hz		
Common power source for transmitter and receiver				X	yes	no	

Test specification:		Section 90.205 / RSS-119 Section 5.4, Maximum output power	
Test procedure:		47 CFR, Section 2.1046; TIA/EIA-603-D, Section 2.2.1	
Test mode:	Compliance	Verdict:	PASS
Date(s):	14-Dec-15		
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

7 Transmitter tests according to 47CFR part 90 and RSS-119 requirements

7.1 Peak output power test

7.1.1 General

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

Table 7.1.1 Peak output power limits

Assigned frequency range, MHz	Maximum peak output power	
	W	dBm
450.0 –470.0	4	36

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 to the end user RF output power.

7.1.2.3 The peak output power was measured with spectrum analyzer as provided in Table 7.1.2 and the associated plots.

Figure 7.1.1 Peak output power test setup





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Test specification:		Section 90.205 / RSS-119 Section 5.4, Maximum output power	
Test procedure:		47 CFR, Section 2.1046; TIA/EIA-603-D, Section 2.2.1	
Test mode:	Compliance	Verdict:	PASS
Date(s):	14-Dec-15		
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Table 7.1.2 Peak output power test results

OPERATING FREQUENCY RANGE: 450 – 470 MHz
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 120 kHz
 VIDEO BANDWIDTH: 300 kHz
 MODULATION: 4GFSK
 MODULATING SIGNAL: PRBS
 BIT RATE: 4.8 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Carrier frequency, MHz	Spectrum analyzer reading, dBm	External attenuation, dB	Cable loss, dB	RF output power, dBm	Limit, dBm	Margin, dB	Verdict
450	34.95	included	included	34.95	36	-1.05	Pass
460	34.81	included	included	34.81	36	-1.19	Pass
470	34.31	included	included	34.31	36	-1.69	Pass

Note: The manufacturer's rated power is 35.2 dBm. The measured output power is within ± 1 dB required by the standard.

Reference numbers of test equipment used

HL 3440	HL 3455	HL 3818	HL 3903				
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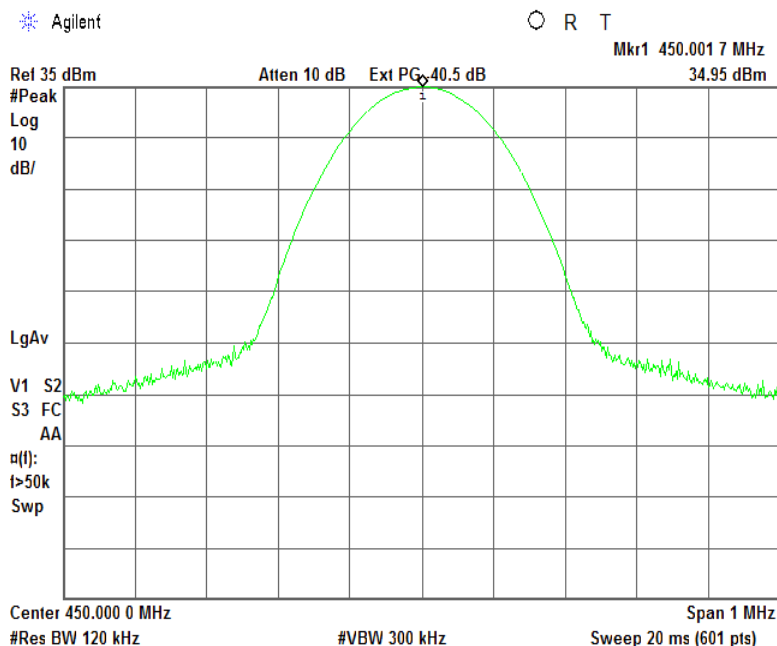
Full description is given in Appendix A.



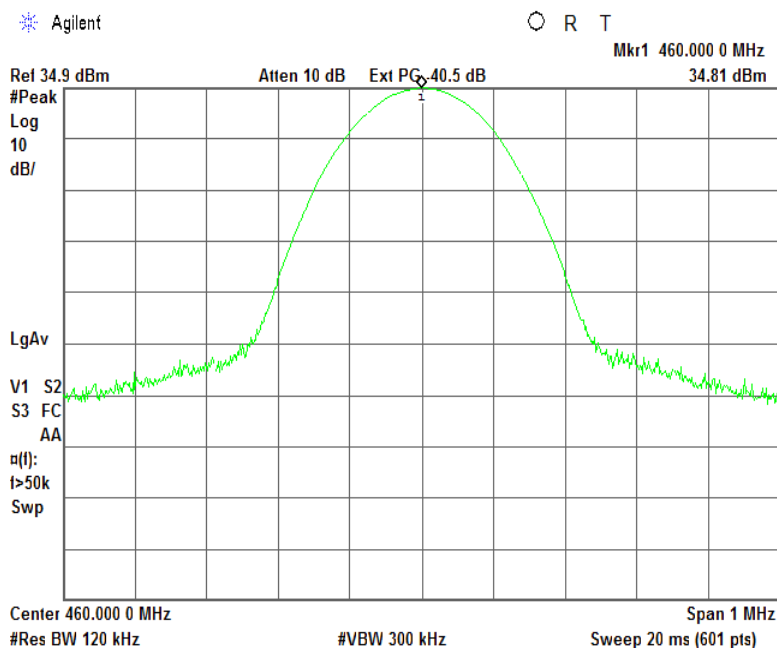
HERMON LABORATORIES

Test specification:	Section 90.205 / RSS-119 Section 5.4, Maximum output power		
Test procedure:	47 CFR, Section 2.1046; TIA/EIA-603-D, Section 2.2.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	14-Dec-15		
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.1.1 Peak output power test results at low frequency



Plot 7.1.2 Peak output power test results at mid frequency

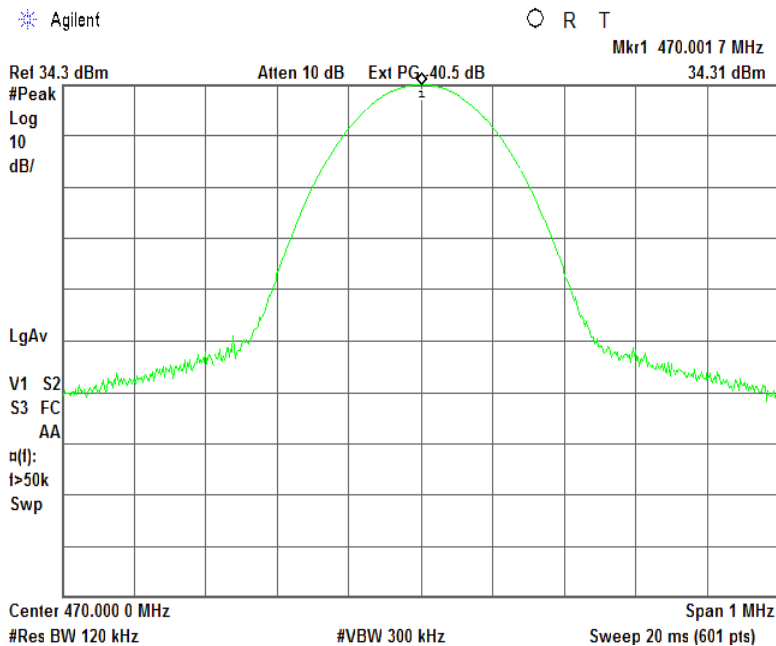




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Test specification:		Section 90.205 / RSS-119 Section 5.4, Maximum output power	
Test procedure:		47 CFR, Section 2.1046; TIA/EIA-603-D, Section 2.2.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.1.3 Peak output power test results at high frequency



Test specification:		Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth	
Test procedure:		47 CFR, Section 2.1049	
Test mode:		Compliance	Verdict: PASS
Date(s):		15-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
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, MHz	Modulation envelope reference points*, dBc	Maximum allowed bandwidth, kHz
450-470	26	6

* - Modulation envelope reference points are provided in terms of attenuation below the unmodulated carrier.

7.2.2 Test procedure

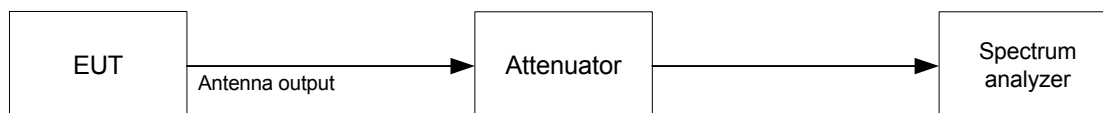
7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and its proper operation was checked.

7.2.2.2 The EUT was set to transmit the unmodulated carrier and the reference peak power level was measured.

7.2.2.3 The EUT was set to transmit the normally modulated carrier.

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

Figure 7.2.1 Occupied bandwidth test setup





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Test specification:		Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth	
Test procedure:		47 CFR, Section 2.1049	
Test mode:	Compliance	Verdict:	PASS
Date(s):	15-Dec-15		
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Table 7.2.2 Occupied bandwidth test results

DETECTOR USED: Peak hold
 RESOLUTION BANDWIDTH: 300 Hz
 VIDEO BANDWIDTH: 3 kHz
 MODULATION ENVELOPE REFERENCE POINTS: 26 dBc
 MODULATION: 4GFSK
 MODULATING SIGNAL: PRBS
 BIT RATE: 4.8 kbps

Carrier frequency, MHz	Occupied bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
450	4.541	6	-1.459	Pass
460	4.375	6	-1.625	Pass
470	4.532	6	-1.468	Pass

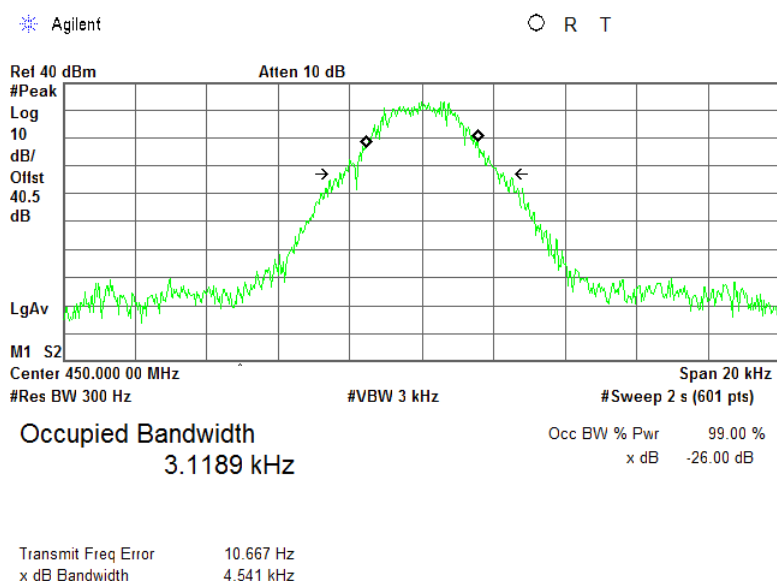
Reference numbers of test equipment used

HL 3440	HL 3455	HL 3818	HL 3903				
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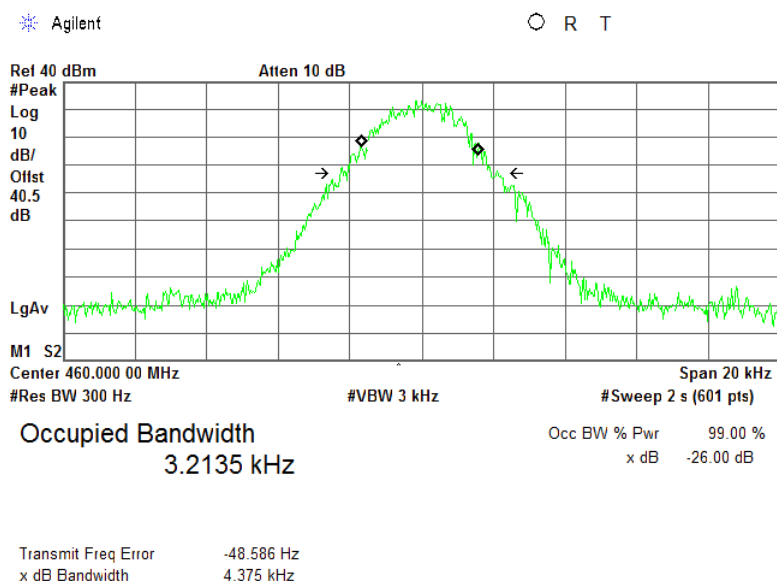
Full description is given in Appendix A.

Test specification:		Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth	
Test procedure:		47 CFR, Section 2.1049	
Test mode:		Compliance	Verdict: PASS
Date(s):		15-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.2.1 Occupied bandwidth test result at low frequency



Plot 7.2.2 Occupied bandwidth test result at mid frequency

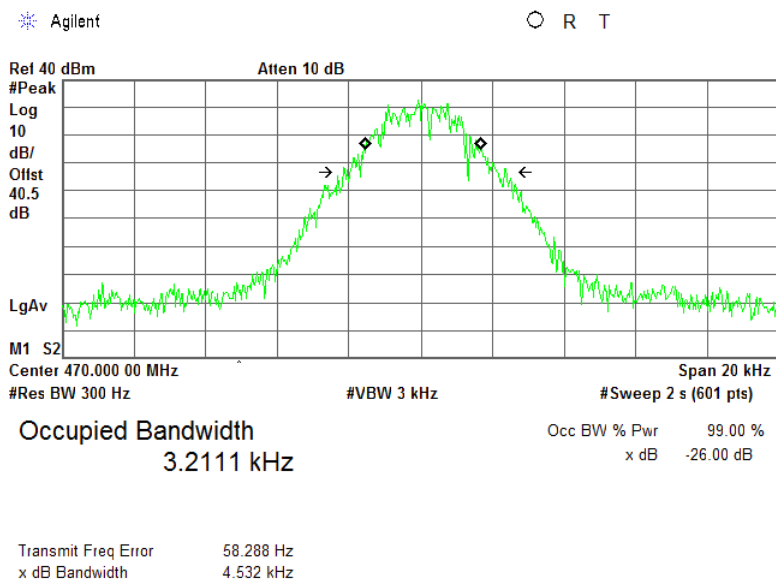




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Test specification:		Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth	
Test procedure:		47 CFR, Section 2.1049	
Test mode:		Compliance	Verdict: PASS
Date(s):		15-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.2.3 Occupied bandwidth test result at high frequency



Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Emission mask	
Test procedure:		47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

7.3 Emission mask test

7.3.1 General

This test was performed to measure emission mask at RF antenna connector. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Emission mask limits

Frequency displacement from carrier	Attenuation below carrier, dBc
Emission mask E (Channel bandwidth 6.25 kHz, authorized bandwidth 6 kHz)	
0 – 3.0 kHz	0
3.0 – 4.6 kHz	30 + 16.67 (fd - 3kHz)
More than 4.6 kHz	55 + 10log(P)

* - linearly increase with frequency

** - emission mask includes carrier modulation envelope within ± 250 % of the authorized bandwidth; the frequency range removed beyond ± 250 % of the authorized bandwidth from carrier was investigated as spurious emission

7.3.2 Test procedure

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and its proper operation was checked.

7.3.2.2 The emission mask was measured with spectrum analyzer as provided in the associated plots. The test results are provided in Table 7.3.2 and the the associated plots.

Figure 7.3.1 Emission mask test setup





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Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Emission mask	
Test procedure:		47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Table 7.3.2 Emission mask test results

Carrier frequency, MHz	Limit	Verdict
450	Emission mask E	Pass
460		
470		

Reference numbers of test equipment used

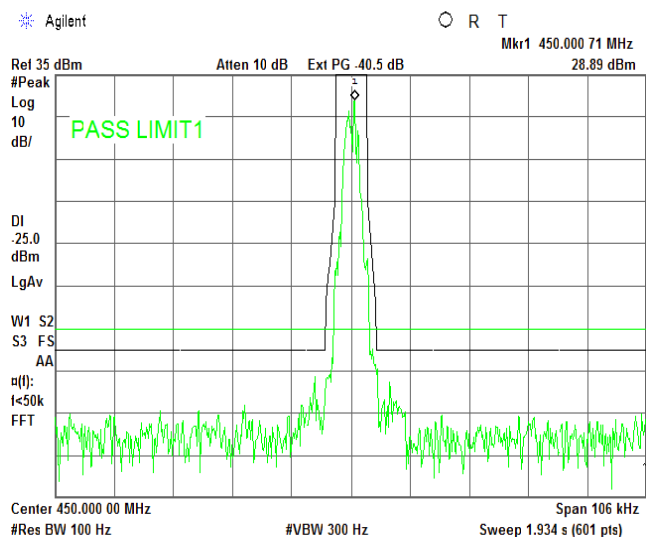
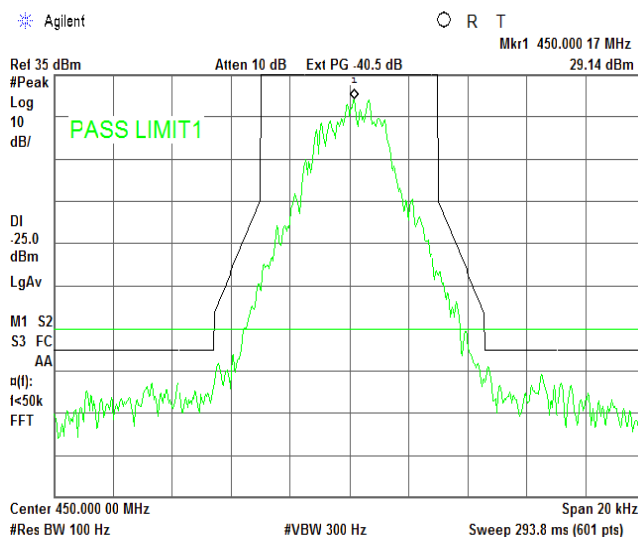
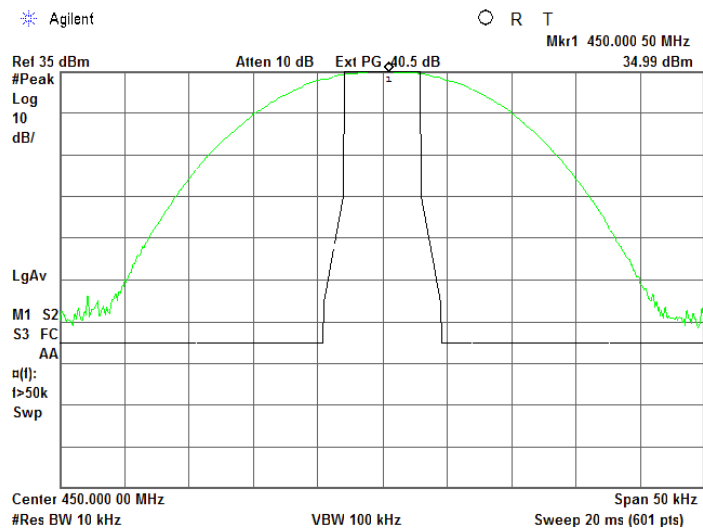
HL 2780	HL 3435	HL 3440	HL 3455	HL 4275
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Full description is given in Appendix A.

Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Emission mask	
Test procedure:		47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.3.1 Emission mask test results at low carrier frequency

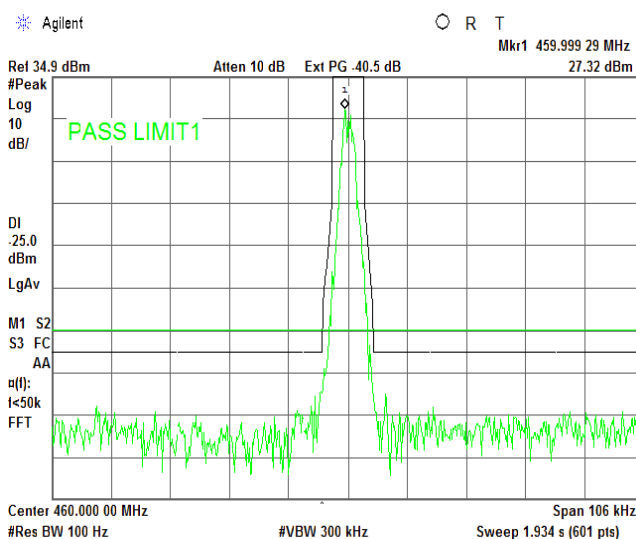
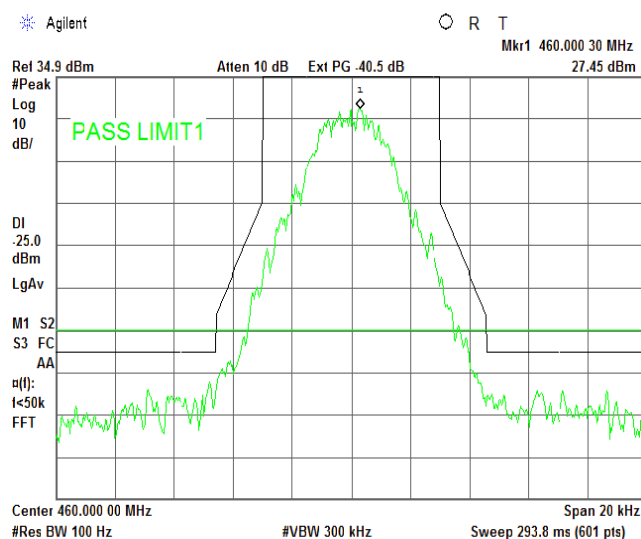
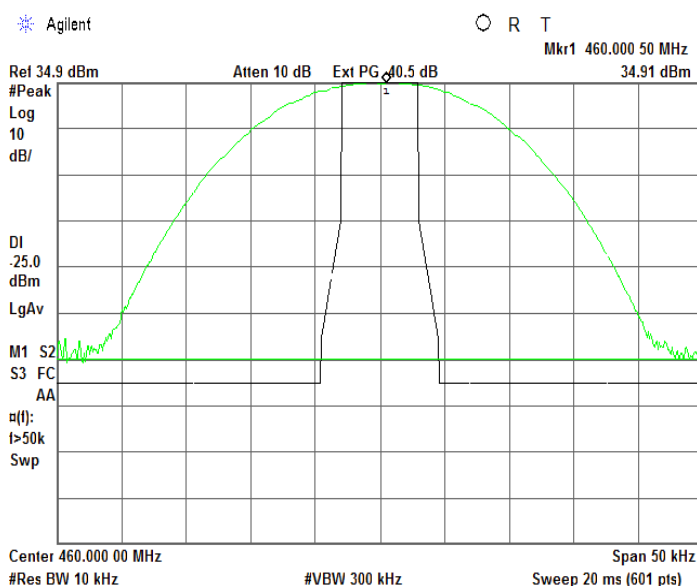
OPERATING FREQUENCY RANGE: 450-470 MHz
DETECTOR USED: Peak
MODULATION: 4GFSK
MODULATING SIGNAL: PRBS
BIT RATE: 4.8 kbps
TRANSMITTER OUTPUT POWER SETTINGS: Maximum



Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Emission mask	
Test procedure:		47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.3.2 Emission mask test results at mid carrier frequency

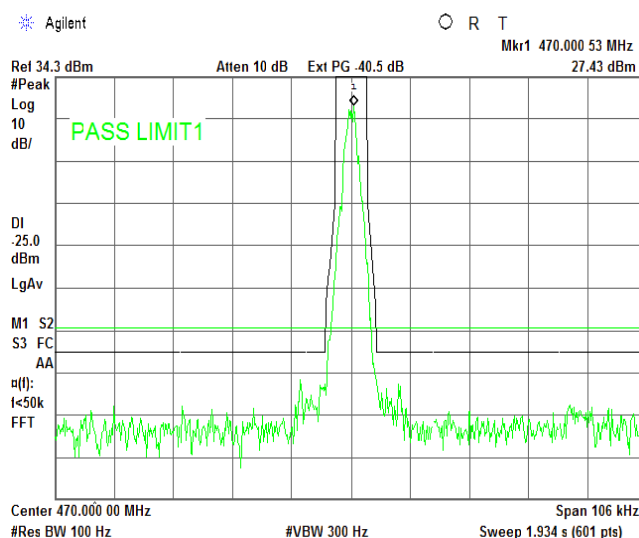
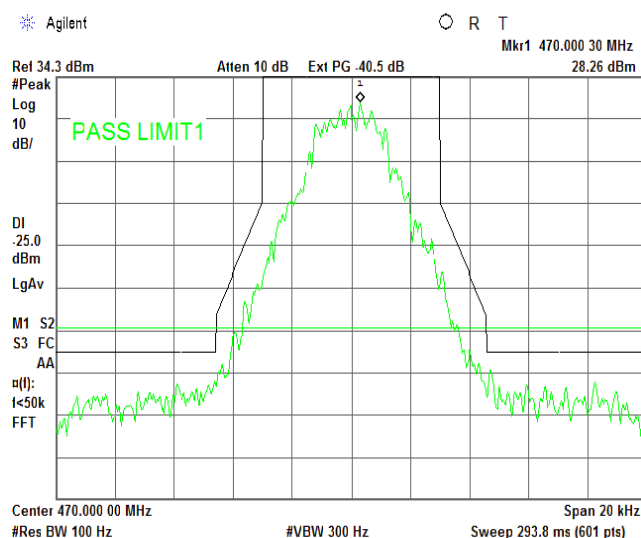
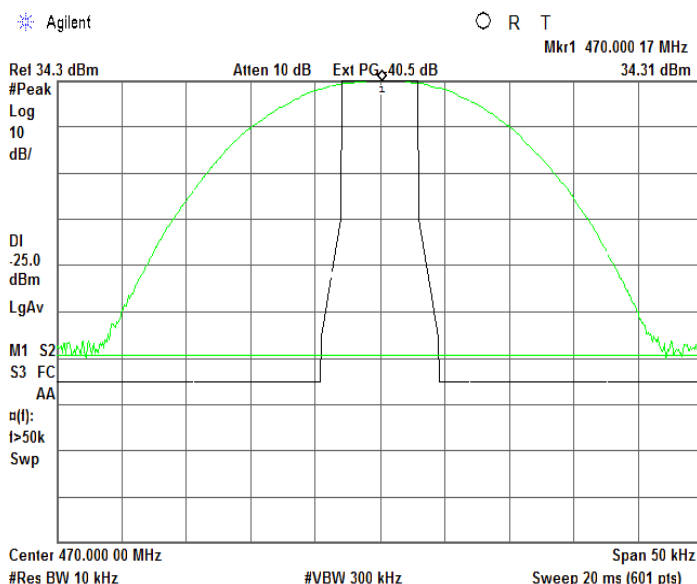
OPERATING FREQUENCY RANGE: 450-470 MHz
DETECTOR USED: Peak
MODULATION: 4GFSK
MODULATING SIGNAL: PRBS
BIT RATE: 4.8 kbps
TRANSMITTER OUTPUT POWER SETTINGS: Maximum



Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Emission mask	
Test procedure:		47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.3.3 Emission mask test results at high carrier frequency

OPERATING FREQUENCY RANGE: 450-470 MHz
DETECTOR USED: Peak
MODULATION: 4GFSK
MODULATING SIGNAL: PRBS
BIT RATE: 4.8 kbps
TRANSMITTER OUTPUT POWER SETTINGS: Maximum



Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	
Test procedure:		47 CFR, Sections 2.1053 and 90.210(e); TIA/EIA-603-D, Section 2.2.12	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Dec-15	
Temperature: 22 °C	Air Pressure: 1014 hPa	Relative Humidity: 51 %	Power Supply: 120 VAC
Remarks:			

7.4 Radiated spurious emission measurements

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 Radiated spurious emission test limits

Frequency, MHz	Attenuation below carrier, dBc	ERP of spurious, dBm	Equivalent field strength limit @ 3m, dB(μV/m)***
0.009 – 10th harmonic*	55+10logP**	-25	72.4

* - Excluding the in band emission within ± 250 % of the authorized bandwidth from the carrier

** - P is transmitter output power in Watts

*** - Equivalent field strength limit was calculated from maximum allowed ERP of spurious as follows:
 $E = \sqrt{30 \times P \times 1.64} / r$, where P is ERP in Watts, 1.64 is numeric gain of ideal dipole and r is antenna to EUT distance in meters

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

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. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.4.2.3 The worst test results (the lowest margins) were recorded in Table 7.4.2 and shown in the associated plots.

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

7.4.3.1 The EUT was set up as shown in Figure 7.4.2, energized and the performance check was conducted.

7.4.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept from 1 to 4 m in both, vertical and horizontal, polarizations.

7.4.3.3 The worst test results (the lowest margins) were recorded in Table 7.4.2 and shown in the associated plots.

7.4.4 Test procedure for substitution ERP measurements of spurious

7.4.4.1 The test equipment was set up as shown in Figure 7.4.3 and energized.

7.4.4.2 RF signal generator was set to the frequency of investigated spurious emission and the RF output level was preliminary adjusted to produce the same field strength as it was measured from the EUT.

7.4.4.3 The test antenna height was swept from 1 to 4 m to find maximum emission from substitution antenna and RF signal generator output was fine adjusted to produce the same field strength as it was measured from the EUT.

7.4.4.4 The above procedure was performed in both, horizontal and vertical, polarizations of the test and substitution antennas.

7.4.4.5 The ERP of spurious emissions was calculated as a sum of signal generator output power in dBm and antenna gain in dBd reduced by cable loss in dB.

7.4.4.6 The above procedure was repeated at the rest of investigated frequencies.

7.4.4.7 The worst test results (the lowest margins) were recorded in Table 7.4.3 and shown in the associated plots.

Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	
Test procedure:		47 CFR, Sections 2.1053 and 90.210(e); TIA/EIA-603-D, Section 2.2.12	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Dec-15	
Temperature: 22 °C	Air Pressure: 1014 hPa	Relative Humidity: 51 %	Power Supply: 120 VAC
Remarks:			

Figure 7.4.1 Setup for spurious emission field strength measurements in 9 kHz to 30 MHz band

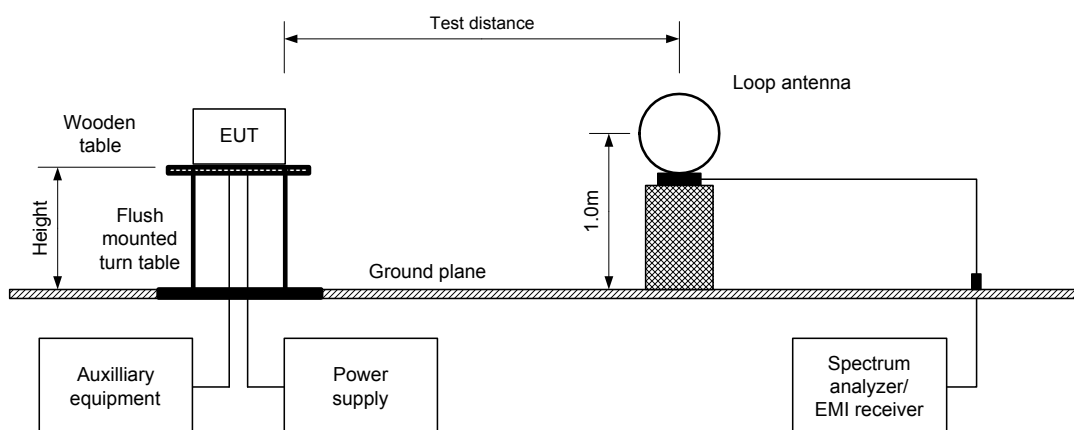
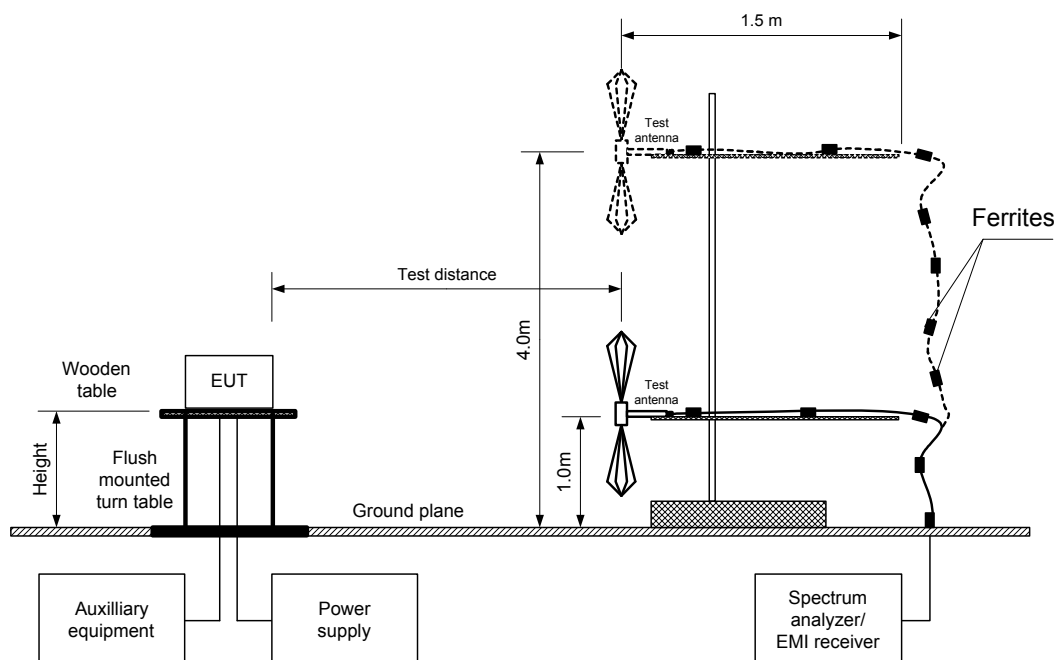
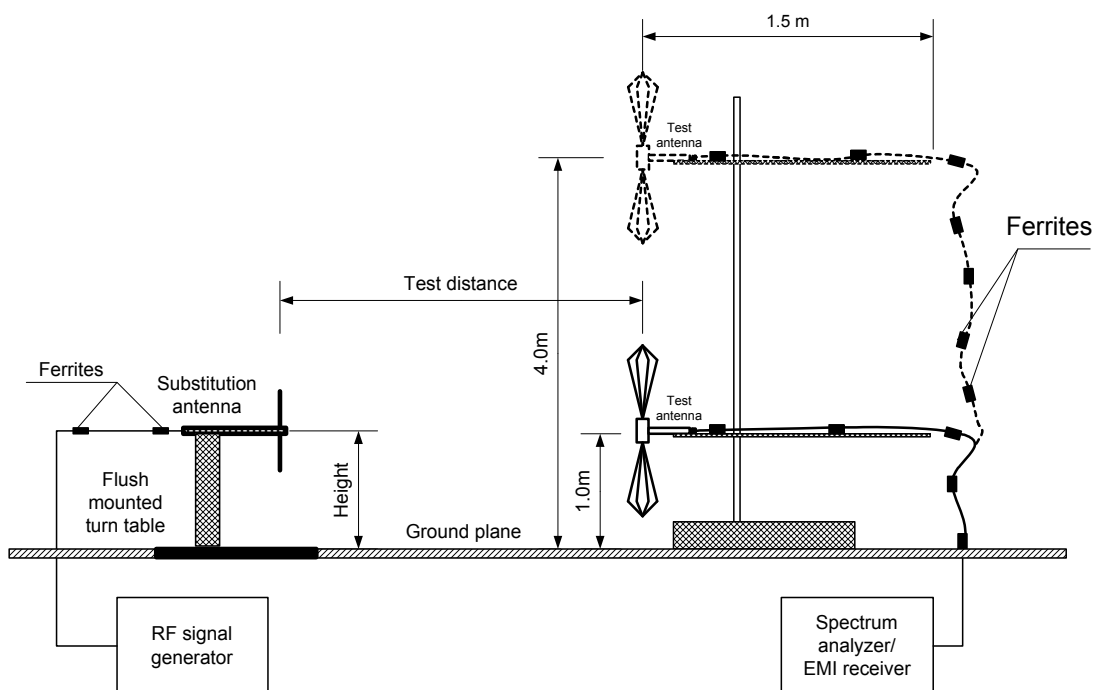


Figure 7.4.2 Setup for spurious emission field strength measurements above 30 MHz



Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	
Test procedure:		47 CFR, Sections 2.1053 and 90.210(e); TIA/EIA-603-D, Section 2.2.12	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Dec-15	
Temperature: 22 °C	Air Pressure: 1014 hPa	Relative Humidity: 51 %	Power Supply: 120 VAC
Remarks:			

Figure 7.4.3 Setup for substitution ERP measurements of spurious



Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	
Test procedure:		47 CFR, Sections 2.1053 and 90.210(e); TIA/EIA-603-D, Section 2.2.12	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Dec-15	
Temperature: 22 °C	Air Pressure: 1014 hPa	Relative Humidity: 51 %	Power Supply: 120 VAC
Remarks:			

Table 7.4.2 Spurious emission field strength test results

ASSIGNED FREQUENCY RANGE: 450-470 MHz
 TEST DISTANCE: 3 m
 TEST SITE: Semi anechoic chamber
 EUT HEIGHT: 0.8 m
 INVESTIGATED FREQUENCY RANGE: 0.009 – 5000 MHz
 DETECTOR USED: Peak
 VIDEO BANDWIDTH: > Resolution bandwidth
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 Double ridged guide (above 1000 MHz)
 MODULATION: 4GFSK
 BIT RATE: 4.8 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Frequency, MHz	Field strength, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	RBW, kHz	Antenna polarization	Antenna height, m	Turn-table position**, degrees
900	55.4	72.4	-17.0	120	Vertical	1.0	40
920	53.4	72.4	-19.0	120	Vertical	1.0	47
940	54.2	72.4	-18.2	120	Vertical	1.0	40

Table 7.4.3 Substitution ERP of spurious test results

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 SUBSTITUTION ANTENNA HEIGHT: 0.8 m
 DETECTOR USED: Peak
 VIDEO BANDWIDTH: > Resolution bandwidth
 SUBSTITUTION ANTENNA TYPE: Tunable dipole (30 MHz – 1000 MHz)
 Double ridged guide (above 1000 MHz)

Frequency, MHz	Field strength, dB(μV/m)	RBW, kHz	Antenna polarization	RF generator output, dBm	Ant gain, dBd	Cable loss, dB	ERP, dBm	Limit, dBm	Margin, dB*	Verdict
900	55.4	120	Vertical	-49.0	6.6	2.7	-45.1	-25	-20.1	Pass
920	53.4	120	Vertical	-51.0	6.6	2.7	-47.1	-25	-22.1	Pass
940	54.2	120	Vertical	-50.0	6.6	2.7	-46.1	-25	-21.1	Pass

Reference numbers of test equipment used

HL 0446	HL 0521	HL 0539	HL 0604	HL 1984	HL 2432	HL 4273	HL 4280
HL 4353							

Full description is given in Appendix A.



HERMON LABORATORIES

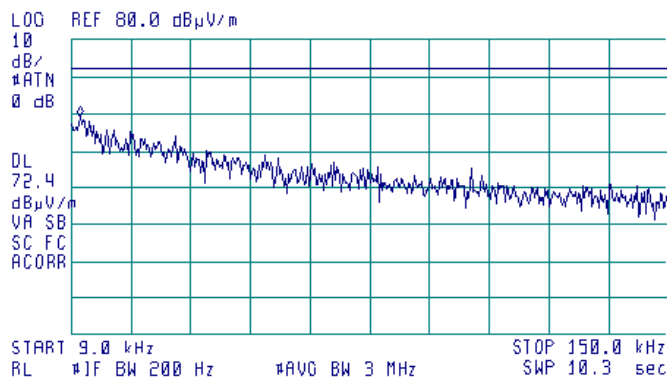
Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	
Test procedure:		47 CFR, Sections 2.1053 and 90.210(e); TIA/EIA-603-D, Section 2.2.12	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Dec-15	
Temperature: 22 °C	Air Pressure: 1014 hPa	Relative Humidity: 51 %	Power Supply: 120 VAC
Remarks:			

Plot 7.4.1 Radiated emission measurements in 9 - 150 kHz range

TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: Low, mid; high
TEST DISTANCE: 3 m



ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 11.1 kHz
59.27 dBμV/m

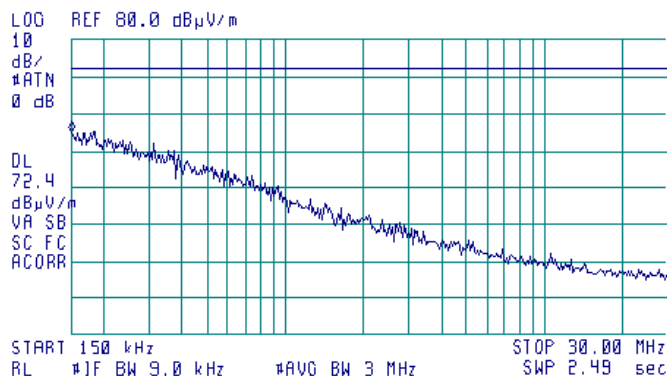


Plot 7.4.2 Radiated emission measurements in 0.15 - 30 MHz range

TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: Low, mid; high
TEST DISTANCE: 3 m



ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 150 kHz
55.04 dBμV/m



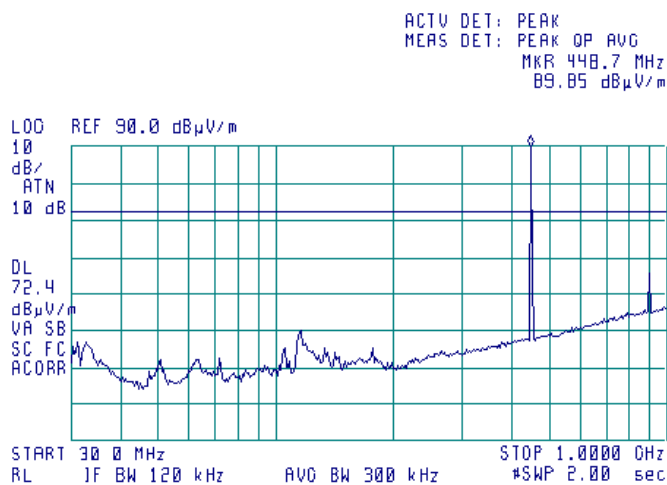


HERMON LABORATORIES

Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	
Test procedure:		47 CFR, Sections 2.1053 and 90.210(e); TIA/EIA-603-D, Section 2.2.12	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Dec-15	
Temperature: 22 °C	Air Pressure: 1014 hPa	Relative Humidity: 51 %	Power Supply: 120 VAC
Remarks:			

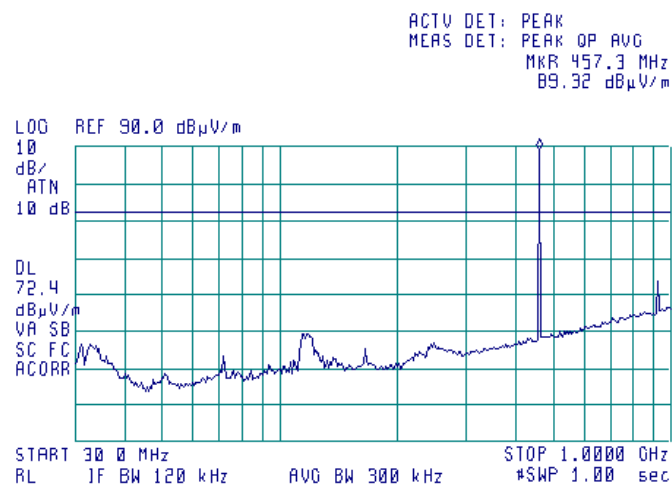
Plot 7.4.3 Radiated emission measurements in 30 - 1000 MHz range

TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: Low
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m



Plot 7.4.4 Radiated emission measurements in 30 - 1000 MHz range

TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: Mid
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m



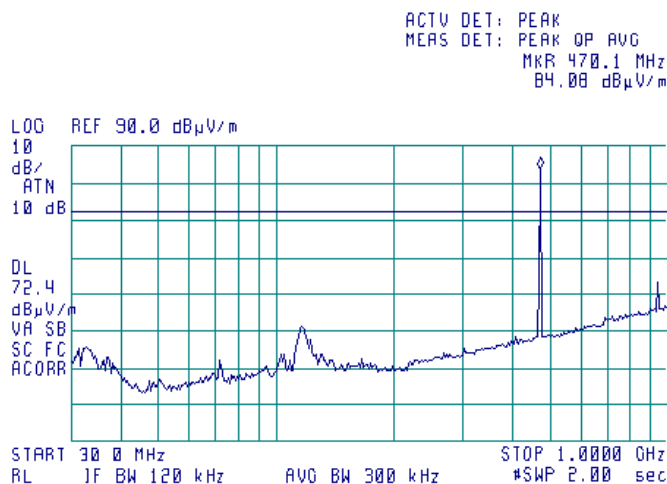


HERMON LABORATORIES

Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	
Test procedure:		47 CFR, Sections 2.1053 and 90.210(e); TIA/EIA-603-D, Section 2.2.12	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Dec-15	
Temperature: 22 °C	Air Pressure: 1014 hPa	Relative Humidity: 51 %	Power Supply: 120 VAC
Remarks:			

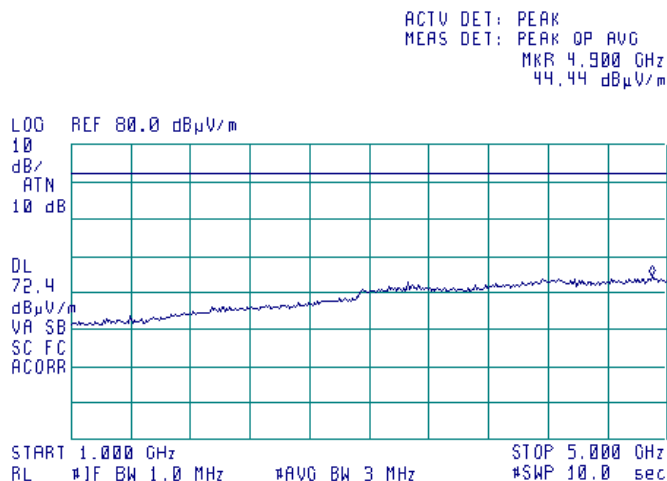
Plot 7.4.5 Radiated emission measurements in 30 - 1000 MHz range

TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: High
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m



Plot 7.4.6 Radiated emission measurements in 1000 – 5000 MHz range

TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: Low, mid, high
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m



Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

7.5 Spurious emissions at RF antenna connector test

7.5.1 General

This test was performed to measure spurious emissions at RF antenna connector. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Spurious emission limits

Frequency, MHz	Attenuation below carrier, dBc	ERP of spurious, dBm
0.009 – 10th harmonic*	55+10log(P) (mask E)	-25.0

* - spurious emission limits do not apply to the in band emission within ± 250 % of the authorized bandwidth from the carrier; investigated in course of emission mask testing

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

7.5.2.3 The spurious emission was measured with spectrum analyzer as provided in Table 7.5.2 and the associated plots.

7.5.2.4 The test results are provided in Table 7.5.2 and the associated plots.

Figure 7.5.1 Spurious emission test setup





Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Table 7.5.2 Spurious emission test results

ASSIGNED FREQUENCY RANGE: 450 - 470 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 – 5000 MHz
 DETECTOR USED: Peak
 VIDEO BANDWIDTH: ≥ Resolution bandwidth
 MODULATION: 4GFSK
 MODULATING SIGNAL: PRBS
 BIT RATE: 4.8 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Frequency, MHz	SA reading, dBm	Attenuator, dB	Cable loss, dB	RBW, kHz	Spurious emission, dBm	Limit, dBm	Margin, dB*	Verdict
Low carrier frequency 450 MHz								
430.00	-36.22	included	included	100	-36.22	-25	-11.22	Pass
470.00	-35.28	included	included	100	-35.28	-25	-15.28	Pass
900.00	-29.31	included	included	100	-29.31	-25	-4.31	Pass
1350.0	-27.76	included	included	1000	-27.76	-25	-2.76	Pass
Mid carrier frequency 460 MHz								
420.0	-34.91	included	included	100	-34.91	-25	-9.91	Pass
500.0	-35.49	included	included	100	-35.49	-25	-15.49	Pass
920.0	-28.60	included	included	100	-28.60	-25	-23.60	Pass
1380.0	-28.14	included	included	1000	-28.14	-25	-23.14	Pass
High carrier frequency 470 MHz								
450.00	-34.20	included	included	100	-34.20	-25	-9.20	Pass
490.00	-35.51	included	included	100	-35.51	-25	-15.51	Pass
940.00	-30.50	included	included	100	-30.50	-25	-5.50	Pass
1410.00	-29.31	included	included	1000	-29.31	-25	-4.31	Pass

*- Margin = Spurious emission – specification limit.

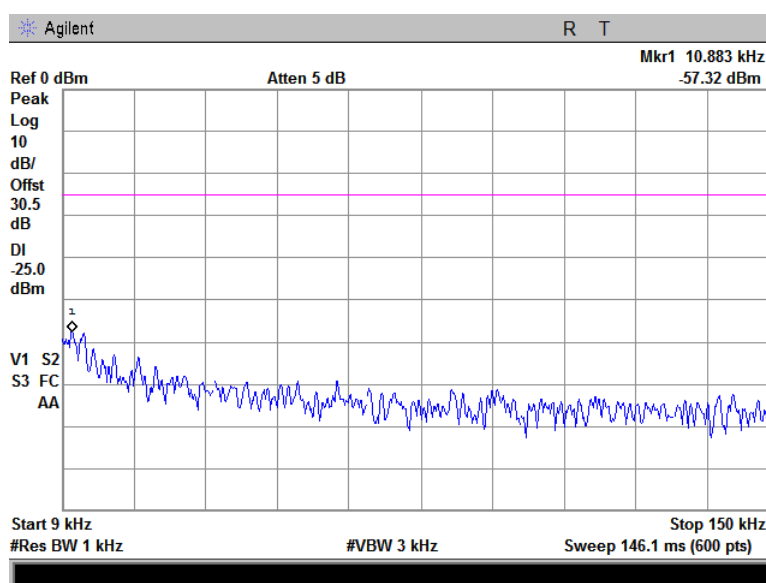
Reference numbers of test equipment used

HL 2780	HL 3435	HL 3440	HL 3455	HL 3818	HL 3903		
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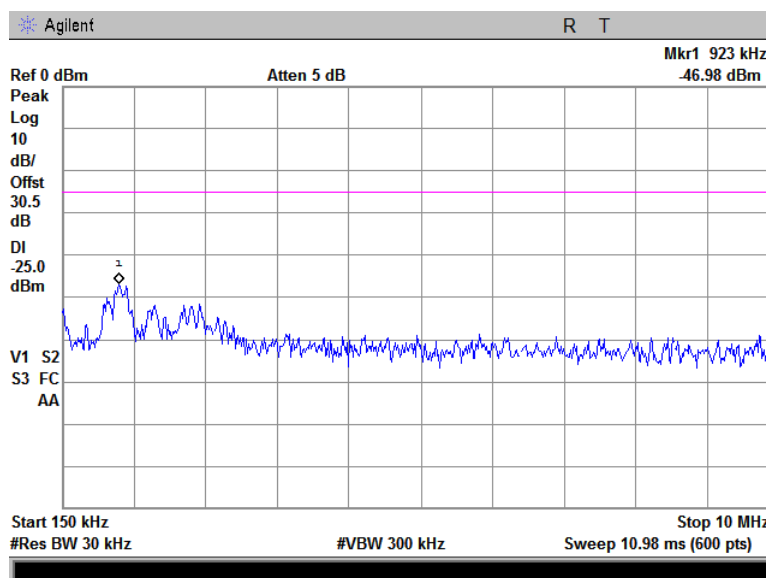
Full description is given in Appendix A.

Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.1 Spurious emission measurements in 9 - 100 kHz range at low carrier frequency

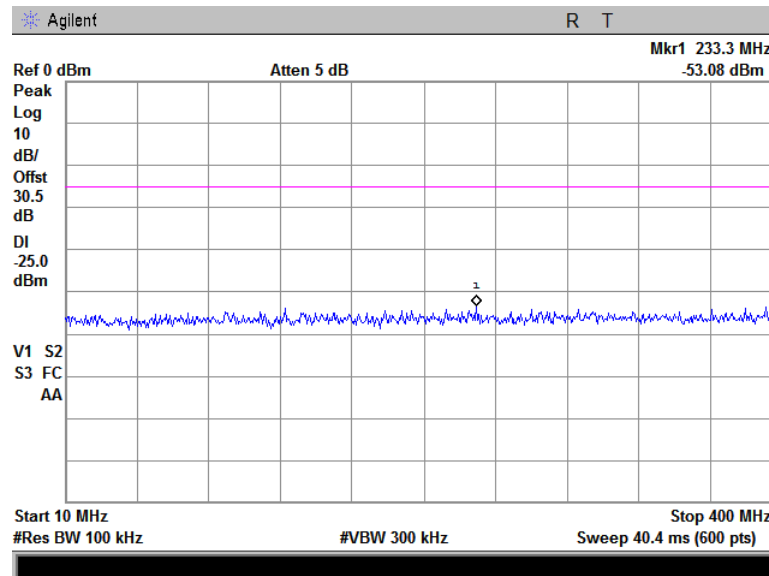


Plot 7.5.2 Spurious emission measurements in 0.15 - 10 MHz range at low carrier frequency

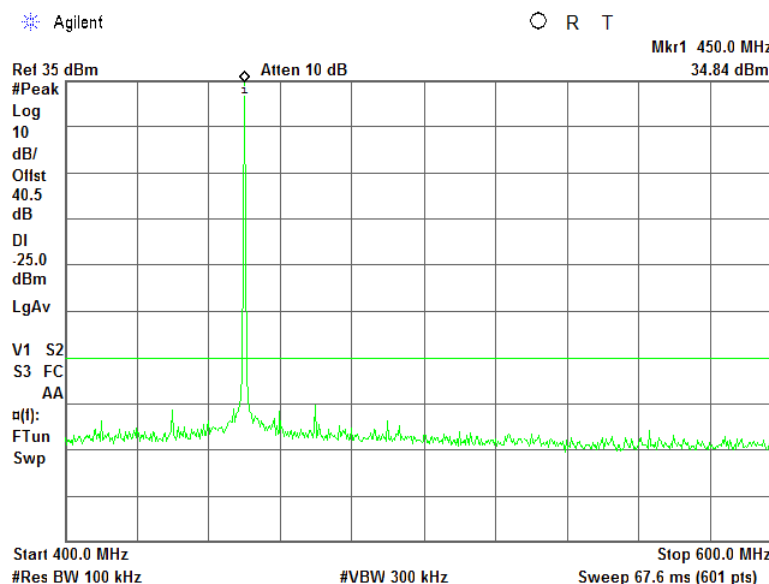


Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.3 Spurious emission measurements in 10 - 400 MHz range at low carrier frequency

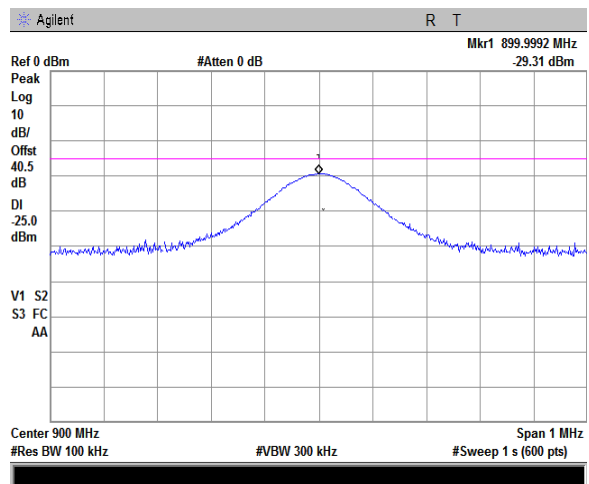
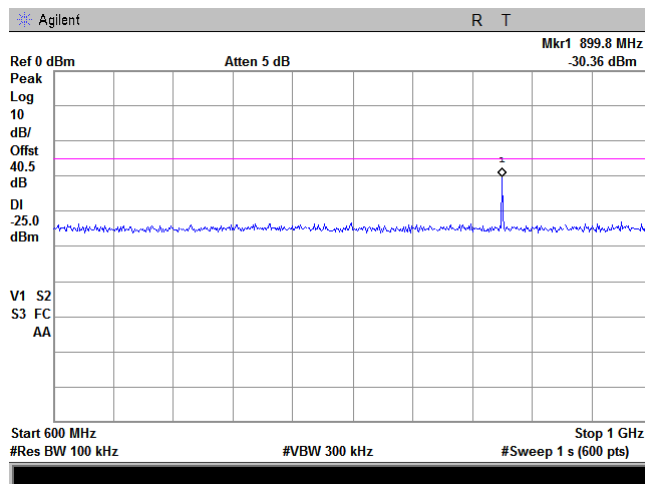


Plot 7.5.4 Spurious emission measurements in 400 - 600 MHz range at low carrier frequency

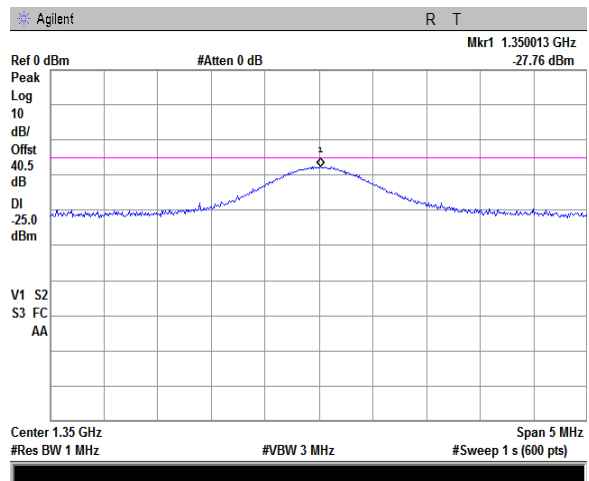
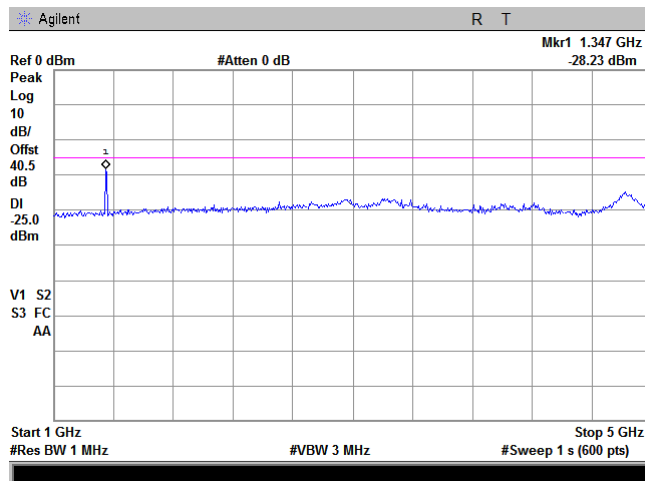


Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.5 Spurious emission measurements in 600 - 1000 MHz range at low carrier frequency

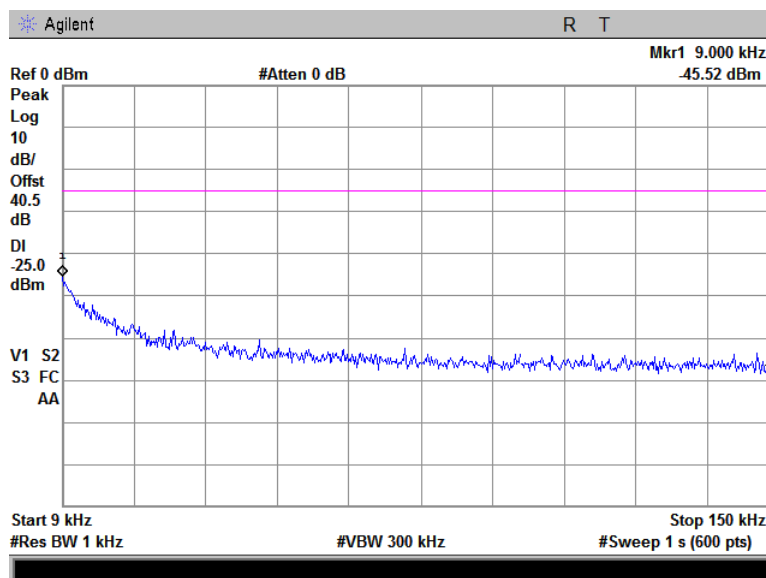


Plot 7.5.6 Spurious emission measurements in 1000 – 5000 MHz at low carrier frequency

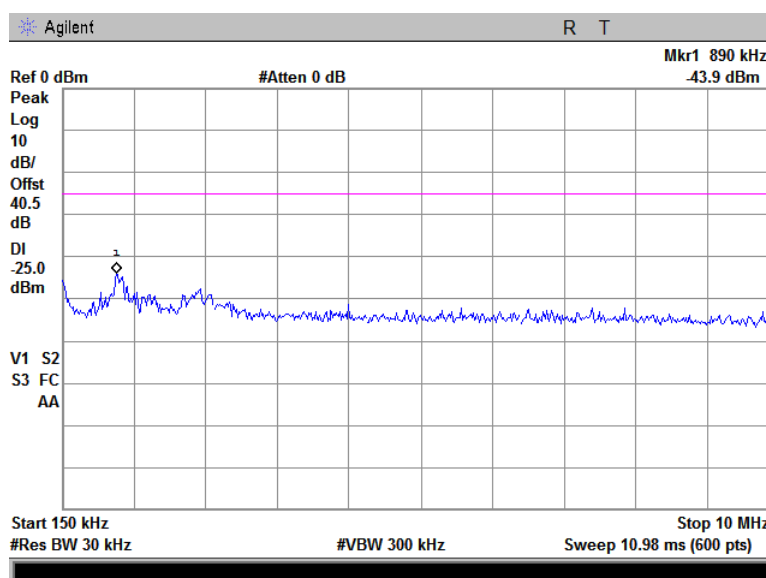


Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.7 Spurious emission measurements in 9 - 150 kHz range at mid carrier frequency

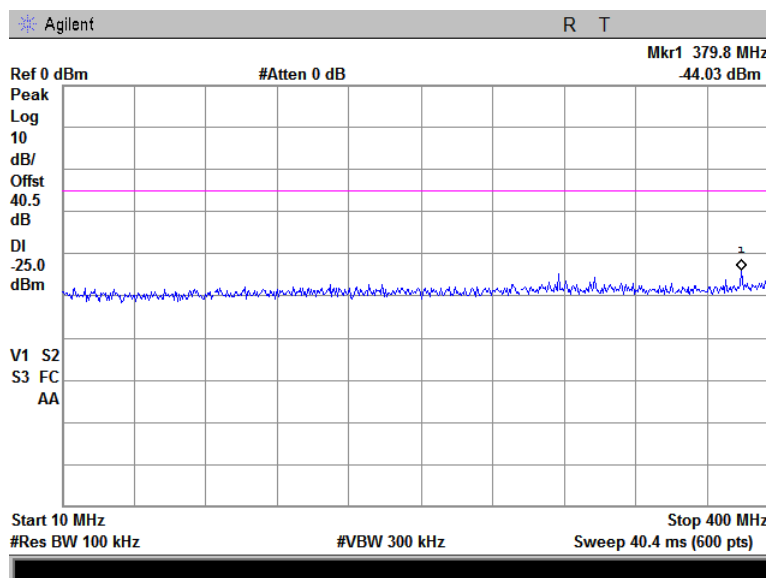


Plot 7.5.8 Spurious emission measurements in 0.15 - 10 MHz range at mid carrier frequency

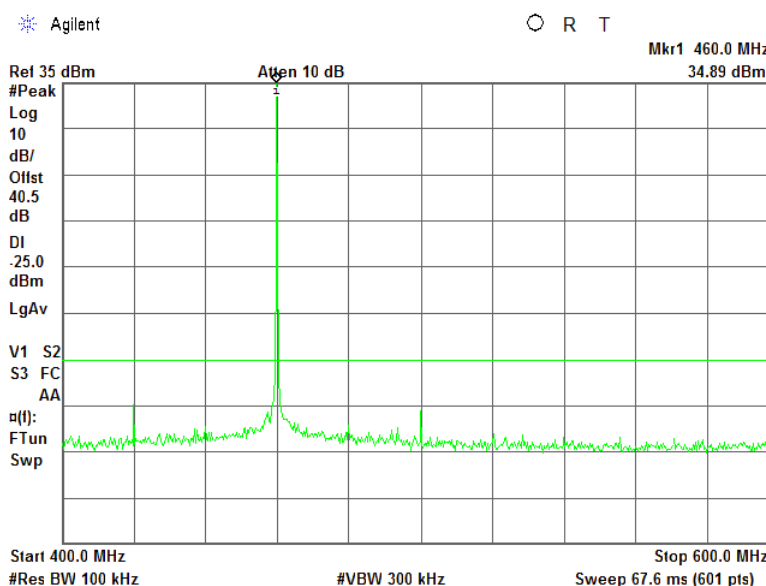


Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.9 Spurious emission measurements in 10 - 400 MHz range at mid carrier frequency

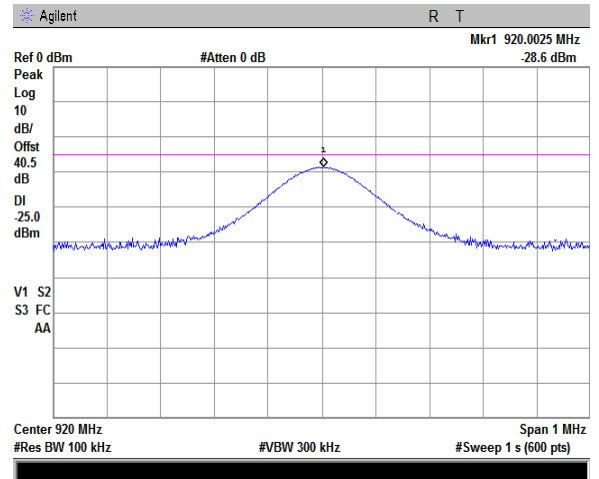
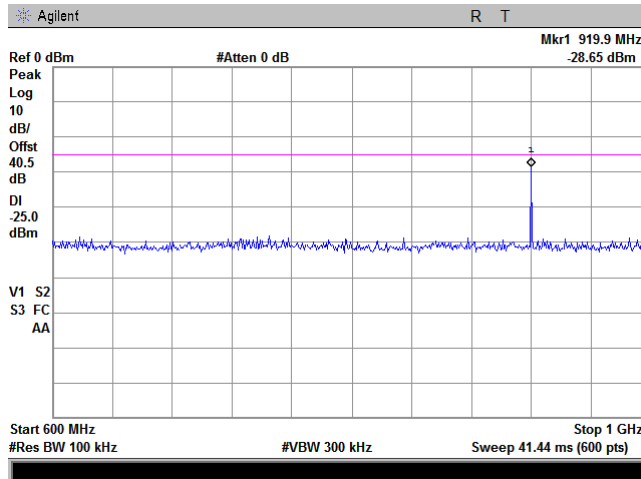


Plot 7.5.10 Spurious emission measurements in 400 -600 MHz range at mid carrier frequency

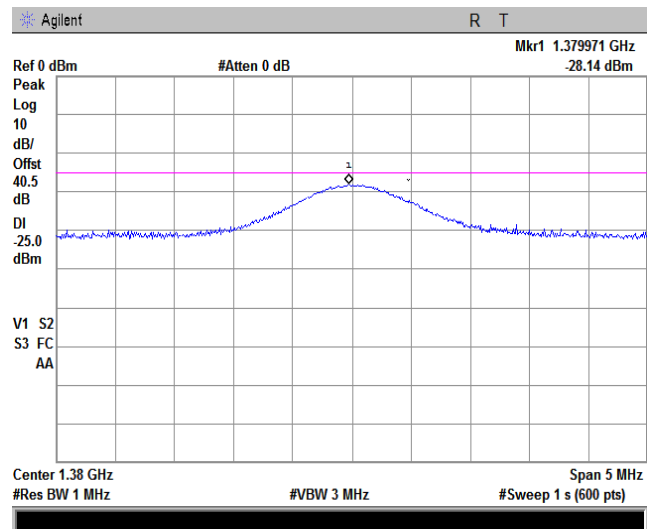
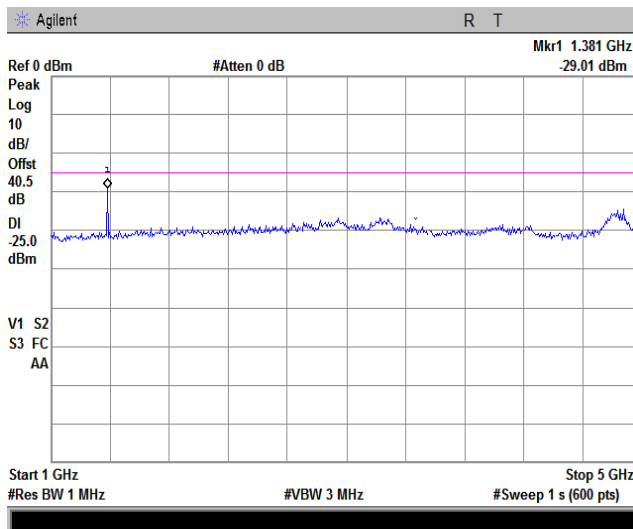


Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.11 Spurious emission measurements in 600 - 1000 MHz range at mid carrier frequency

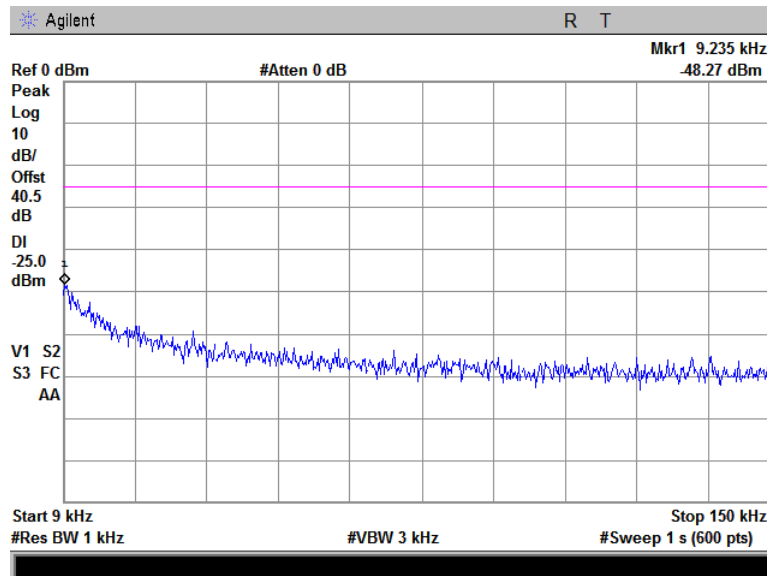


Plot 7.5.12 Spurious emission measurements in 1000 – 5000 MHz at mid carrier frequency

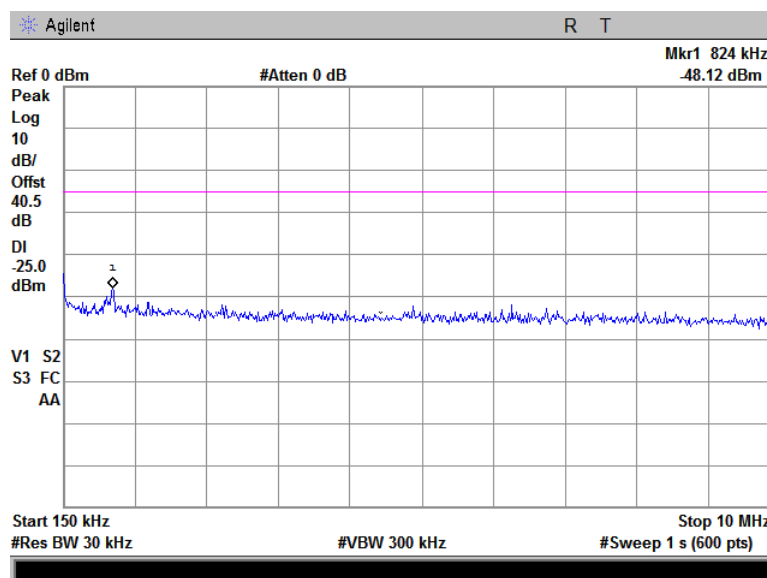


Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.13 Spurious emission measurements in 9 - 150 kHz range at high carrier frequency

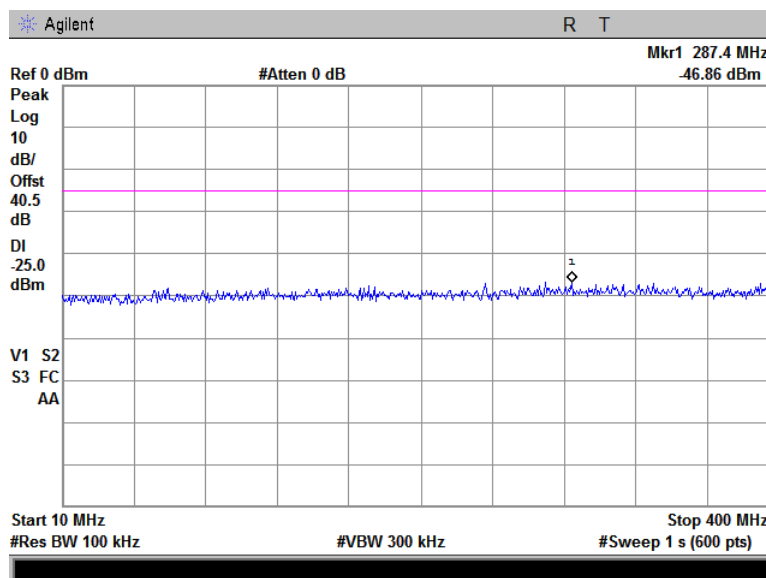


Plot 7.5.14 Spurious emission measurements in 0.15 - 10 MHz range at high carrier frequency

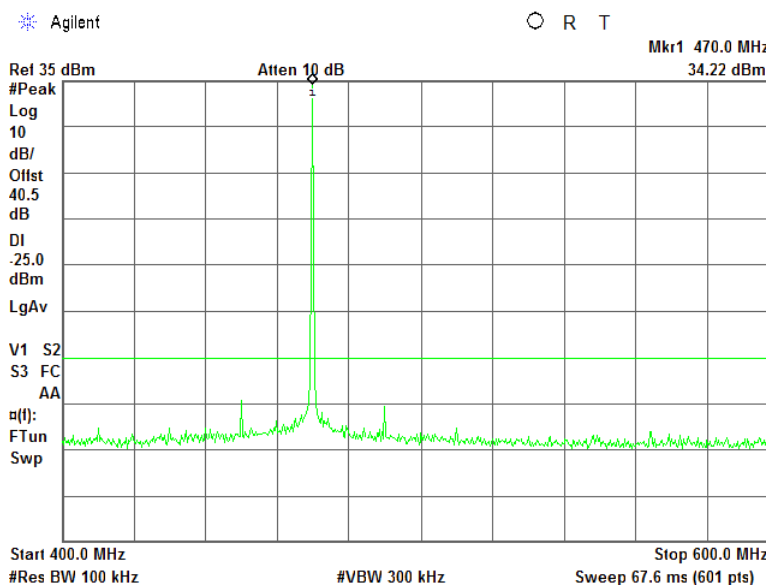


Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.15 Spurious emission measurements in 10 - 400 MHz range at high carrier frequency

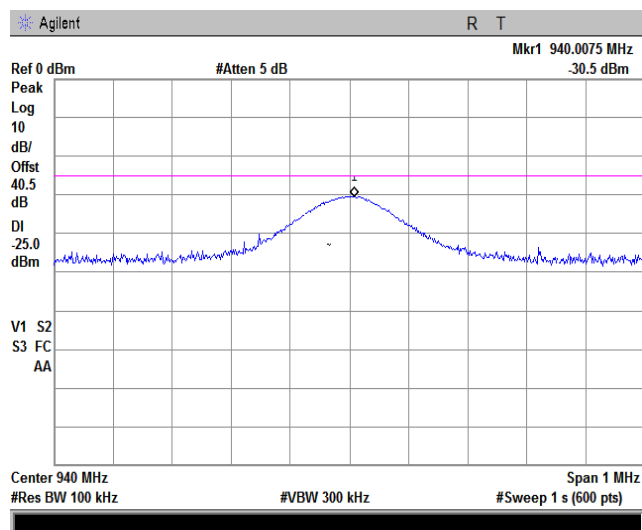
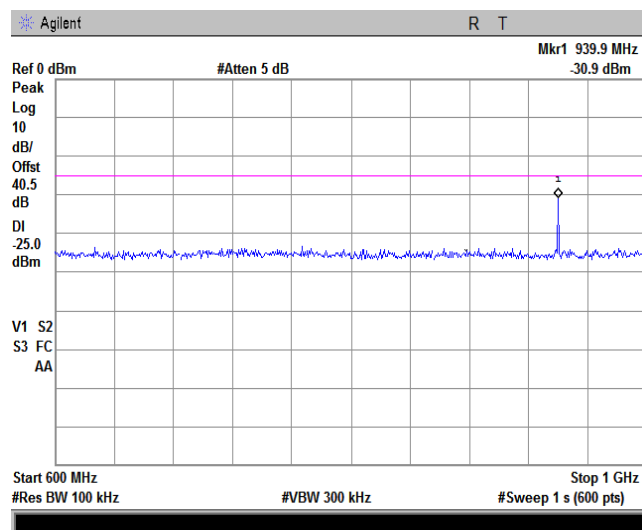


Plot 7.5.16 Spurious emission measurements in 400 -600 MHz range at high carrier frequency

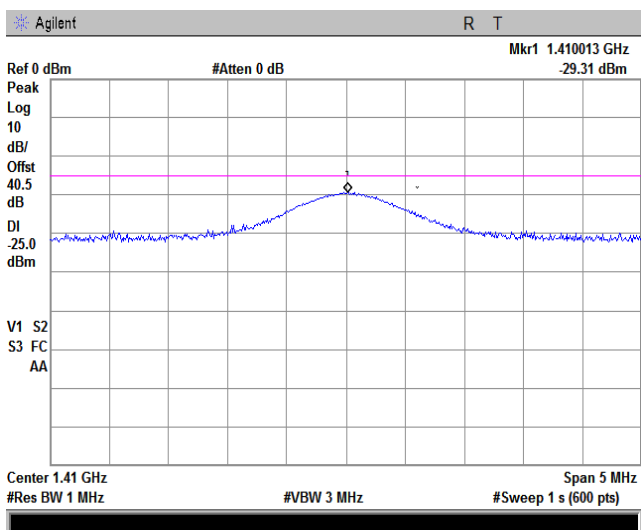
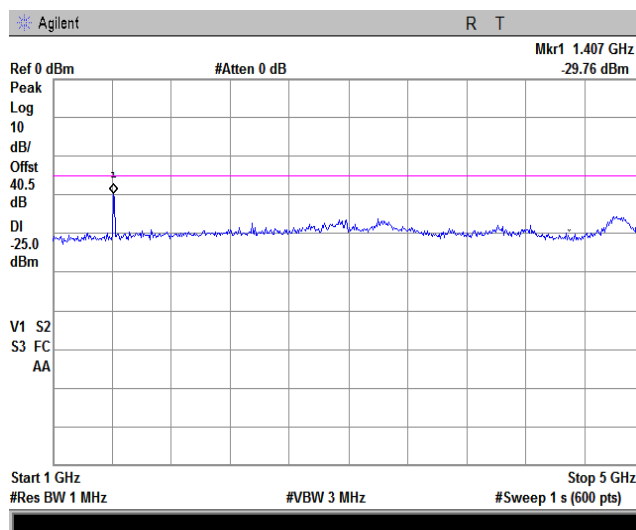


Test specification:		Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	
Test procedure:		47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-D, Section 2.2.13	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Dec-15 - 16-Dec-15	
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.17 Spurious emission measurements in 600 - 1000 MHz range at high carrier frequency



Plot 7.5.18 Spurious emission measurements in 1000 – 5000 MHz at high carrier frequency



Test specification:		Section 90.213 / RSS-119 Section 5.3, Frequency stability	
Test procedure:		47 CFR, Section 2.1055; TIA/EIA-603-D, Section 2.2.2	
Test mode:	Compliance	Verdict:	PASS
Date(s):	16-Dec-15		
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

7.6 Frequency stability test

7.6.1 General

This test was performed to measure frequency stability of transmitter RF carrier. Specification test limits are given in Table 7.6.1.

Table 7.6.1 Frequency stability limits

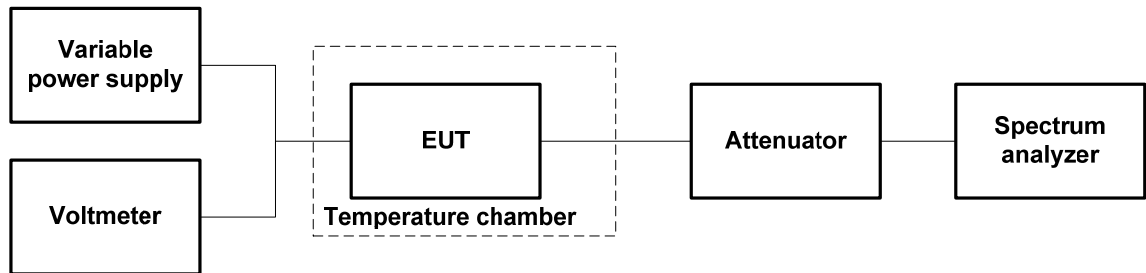
Assigned frequency, MHz	Maximum allowed frequency displacement	
	ppm	Hz
450	1.0	450
460		460
470		470

7.6.2 Test procedure

- 7.6.2.1 The EUT was set up as shown in Figure 7.6.1, energized and its proper operation was checked.
- 7.6.2.2 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.
- 7.6.2.3 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.
- 7.6.2.4 The above procedure was repeated at 0°C and at the lowest test temperature.
- 7.6.2.5 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.
- 7.6.2.6 Frequency displacement was calculated and compared with the limit as provided in Table 7.6.2.

Test specification:		Section 90.213 / RSS-119 Section 5.3, Frequency stability	
Test procedure:		47 CFR, Section 2.1055; TIA/EIA-603-D, Section 2.2.2	
Test mode:	Compliance	Verdict:	PASS
Date(s):	16-Dec-15		
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Figure 7.6.1 Frequency stability test setup





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Test specification:		Section 90.213 / RSS-119 Section 5.3, Frequency stability			
Test procedure:		47 CFR, Section 2.1055; TIA/EIA-603-D, Section 2.2.2			
Test mode:		Compliance	Verdict: PASS		
Date(s):		16-Dec-15			
Temperature: 23 °C		Air Pressure: 1016 hPa	Relative Humidity: 56 %		Power Supply: 120 VAC
Remarks:					

Table 7.6.2 Frequency stability test results

OPERATING FREQUENCY: 450-470 MHz
 NOMINAL POWER VOLTAGE: 120 V
 TEMPERATURE STABILIZATION PERIOD: 20 min
 POWER DURING TEMPERATURE TRANSITION: Off
 SPECTRUM ANALYZER MODE: Counter
 RESOLUTION BANDWIDTH: 10 Hz
 VIDEO BANDWIDTH: 10 Hz
 MODULATION: Unmodulated

T, °C	Voltage, V	Frequency, MHz							Max frequency drift, Hz		Limit, Hz	Margin, Hz	Verdict
		Start up	1 st min	2 nd min	3 rd min	4 th min	5 th min	10 th min	Positive	Negative			
Low frequency 450 MHz													
-30	nominal	449.999960	449.999960	449.999957	449.999960	449.999963	449.999963	449.999967	0	42	450	-408	Pass
-20	nominal	449.999983	NA	NA	NA	NA	NA	449.999980	0	19		-431	Pass
-10	nominal	449.999930	NA	NA	NA	NA	NA	449.999931	0	69		-381	Pass
0	nominal	449.999940	449.999940	449.999940	449.999941	449.999942	449.999940	449.999940	0	59		-391	Pass
10	nominal	449.999947	NA	NA	NA	NA	NA	449.999943	0	56		-394	Pass
20	+15%	450.000000	NA	NA	NA	NA	NA	450.000000	1	0		-449	Pass
20	nominal	450.000000	NA	NA	NA	NA	NA	499.999999*	1	0		-449	Pass
20	-15%	499.999999	NA	NA	NA	NA	NA	450.000000	1	0		-449	Pass
30	nominal	450.000002	450.000002	450.000002	450.000002	450.000003	450.000003	450.000003	4	0		-446	Pass
40	nominal	450.000028	NA	NA	NA	NA	NA	450.000032	33	0		-417	Pass
50	nominal	450.000047	NA	NA	NA	NA	NA	450.000054	55	0		-395	Pass
60	nominal	450.000067	NA	NA	NA	NA	NA	450.000073	74	0		-376	Pass
70	nominal	450.000087	NA	NA	NA	NA	NA	450.000091	92	0	-358	Pass	
Mid frequency													
-30	nominal	459.999957	459.999957	459.999955	459.999953	459.999955	459.999957	459.999957	0	42	460	-418	Pass
-20	nominal	459.999980	NA	NA	NA	NA	NA	459.999981	0	15		-445	Pass
-10	nominal	459.999933	NA	NA	NA	NA	NA	459.999933	0	62		-398	Pass
0	nominal	459.999943	459.999943	459.999940	459.999943	459.999943	459.999940	459.999940	0	55		-405	Pass
10	nominal	459.999949	NA	NA	NA	NA	NA	459.999940	0	55		-405	Pass
20	+15%	459.999995	NA	NA	NA	NA	NA	459.999998	3	0		-457	Pass
20	nominal	459.999993	NA	NA	NA	NA	NA	459.999995*	0	2		-458	Pass
20	-15%	459.999996	NA	NA	NA	NA	NA	459.999998	3	0		-457	Pass
30	nominal	460.000016	470.000015	470.000016	470.000016	470.000016	470.000016	470.000016	21	0		-439	Pass
40	nominal	460.000023	NA	NA	NA	NA	NA	460.000032	37	0		-423	Pass
50	nominal	460.000047	NA	NA	NA	NA	NA	460.000050	55	0		-405	Pass
60	nominal	460.000070	NA	NA	NA	NA	NA	460.000077	82	0		-378	Pass
70	nominal	460.000081	NA	NA	NA	NA	NA	460.000087	92	0	-368	Pass	



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Test specification:	Section 90.213 / RSS-119 Section 5.3, Frequency stability				
Test procedure:	47 CFR, Section 2.1055; TIA/EIA-603-D, Section 2.2.2				
Test mode:	Compliance	Verdict:			PASS
Date(s):	16-Dec-15				
Temperature: 23 °C	Air Pressure: 1016 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC		
Remarks:					

Table 7.6.2 Frequency stability test results (continued)

T, °C	Voltage, V	Frequency, MHz							Max frequency drift, Hz		Limit, Hz	Margin, Hz	Verdict
		Start up	1 st min	2 nd min	3 rd min	4 th min	5 th min	10 th min	Positive	Negative			
High frequency													
-30	nominal	469.999953	469.999953	469.999953	469.999957	469.999955	469.999953	469.999957	0	44	470	-426	Pass
-20	nominal	469.999983	NA	NA	NA	NA	NA	469.999987	0	14		-456	Pass
-10	nominal	469.999933	NA	NA	NA	NA	NA	469.999933	0	64		-406	Pass
0	nominal	469.999943	469.999943	469.999943	469.999943	469.999940	469.999941	469.999940	0	58		-412	Pass
10	nominal	469.999951	NA	NA	NA	NA	NA	469.999940	0	57		-413	Pass
20	+15%	469.999998	NA	NA	NA	NA	NA	469.999998	1	0		-469	Pass
20	nominal	469.999997	NA	NA	NA	NA	NA	469.999997*	0	0		-470	Pass
20	-15%	469.999999	NA	NA	NA	NA	NA	470.000000	3	0		-467	Pass
30	nominal	470.000012	470.000014	470.000014	470.000012	470.000013	470.000012	470.000012	15	0		-455	Pass
40	nominal	470.000028	NA	NA	NA	NA	NA	470.000037	40	0		-430	Pass
50	nominal	470.000043	NA	NA	NA	NA	NA	470.000051	54	0		-416	Pass
60	nominal	470.000072	NA	NA	NA	NA	NA	470.000077	80	0		-390	Pass
70	nominal	470.000080	NA	NA	NA	NA	NA	470.000084	87	0		-383	Pass

* - Reference frequency

Reference numbers of test equipment used

HL 0495	HL 1457	HL 1876	HL 3203	HL 3286	HL 3310	HL 3390	HL 3768
HL 3776	HL 3818						

Full description is given in Appendix A.

Test specification:		Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	
Test procedure:		TIA/EIA-603-D, Section 2.2.19	
Test mode:		Compliance	Verdict: PASS
Date(s):		27-Dec-15 - 24-Jan-16	
Temperature: 23 °C	Air Pressure: 1024 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

7.7 Transient frequency behaviour test

7.7.1 General

This test was performed to measure carrier frequency drift as function of time during transmitter start up and shut down. Specification test limits are given in Table 7.7.1.

Table 7.7.1 Transient frequency limits

Channel bandwidth, kHz	Carrier frequency tolerance, kHz	Duration, ms	Time interval*
421.0 – 512.0 MHz band			
6.25	± 6.25	10.0	t ₁
	± 3.125	25.0	t ₂
	± 6.25	10.0	t ₃

* - t_{on} is the instant when a 1 kHz test signal is completely suppressed;

t₁ is the time period immediately following t_{on};

t₂ is the time period immediately following t₁;

t₃ is the time period from the instant when the transmitter is turned off until t_{off};

t_{off} is the instant when the 1 kHz test signal starts to rise.

7.7.2 Test procedure

7.7.2.1 The EUT was set up as shown in Figure 7.7.1, energized and its proper operation was checked. Variable attenuator was adjusted to provide signal level approximately 40 dB below the FM receiver maximum allowed level as measured with RF power meter. The EUT was turned off.

7.7.2.2 The signal generator was set to the assigned transmitter frequency modulated with 1 kHz tone at 25 kHz deviation and the output power was adjusted to provide the same as the EUT signal level at the FM receiver input as measured with power meter.

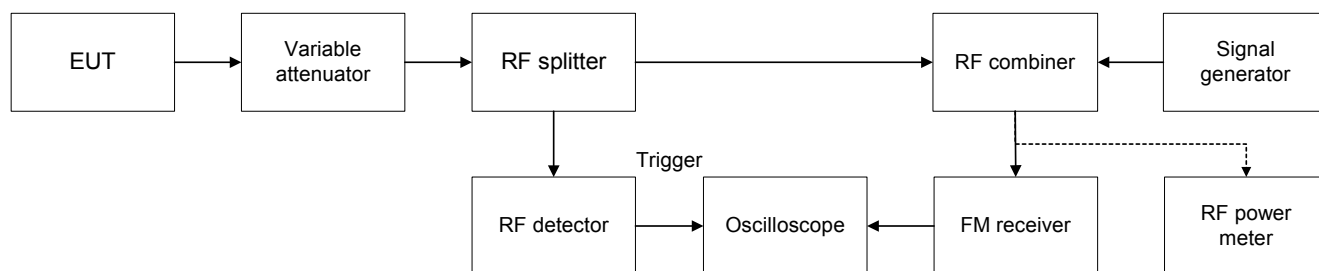
7.7.2.3 The storage oscilloscope was set to provide horizontal sweep rate 10 milliseconds per division. Amplitude control of the storage oscilloscope was adjusted to obtain 1 kHz sinusoidal signal vertically centered with ± 4 divisions amplitude.

7.7.2.4 The variable attenuator was adjusted to increase RF level supplied to splitter by 30 dB and the EUT was consequently turned on and off. Transient frequency during power switching was captured and shown in the associated plots.

7.7.2.5 The test results are provided in Table 7.7.2 and the associated plots.

Test specification:		Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	
Test procedure:		TIA/EIA-603-D, Section 2.2.19	
Test mode:		Compliance	Verdict: PASS
Date(s):		27-Dec-15 - 24-Jan-16	
Temperature: 23 °C	Air Pressure: 1024 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Figure 7.7.1 Transient frequency test setup





Test specification:		Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	
Test procedure:		TIA/EIA-603-D, Section 2.2.19	
Test mode:		Compliance	Verdict: PASS
Date(s):		27-Dec-15 - 24-Jan-16	
Temperature: 23 °C	Air Pressure: 1024 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Table 7.7.2 Transient frequency behaviour test results

Carrier frequency, MHz	Time interval	Duration, ms	Frequency tolerance, kHz	Limit, kHz	Margin, kHz	Verdict
Channel bandwidth 6.25 kHz						
450	t ₁	5.0	1.34	± 6.25	-4.91	Pass
	t ₂	20.0	0	± 3.125	-3.125	
	t ₃	5.0	0	± 6.25	-6.25	
460	t ₁	5.0	1.80	± 6.25	-4.45	Pass
	t ₂	20.0	0	± 3.125	-3.125	
	t ₃	5.0	0	± 6.25	-6.25	
470	t ₁	5.0	2.65	± 6.25	-3.60	Pass
	t ₂	20.0	0	± 3.125	-3.125	
	t ₃	5.0	0	± 6.25	-6.25	

Reference numbers of test equipment used

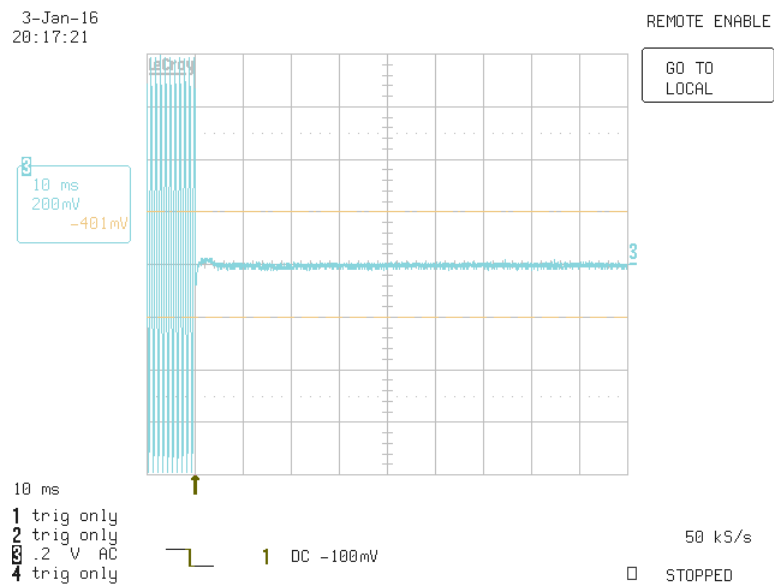
HL 0539	HL 0911	HL 2227	HL 3300	HL 3310	HL 3727	HL 4413	
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Full description is given in Appendix A.

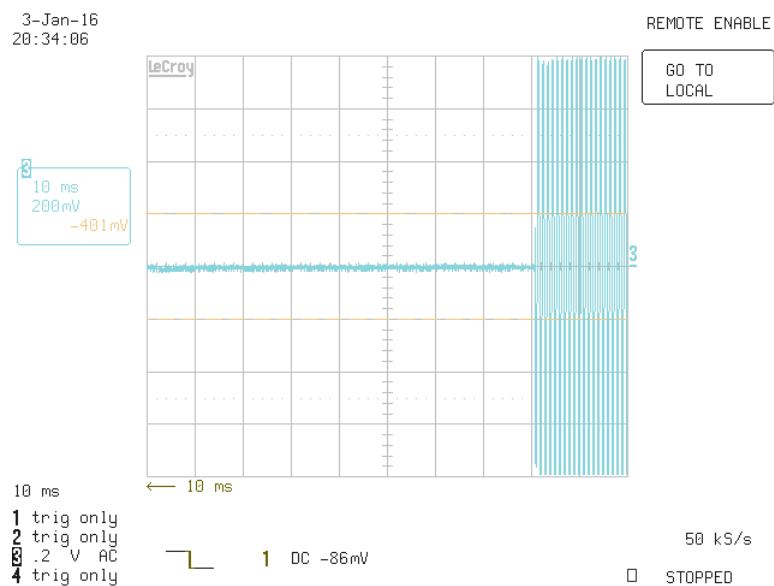
Test specification:		Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	
Test procedure:		TIA/EIA-603-D, Section 2.2.19	
Test mode:		Compliance	Verdict: PASS
Date(s):		27-Dec-15 - 24-Jan-16	
Temperature: 23 °C	Air Pressure: 1024 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.7.1 Transient frequency during power ON test results at low carrier frequency

4 divisions vertically centered on the display=12.5 kHz deviation of the FM modulation
1 div=3.125 kHz

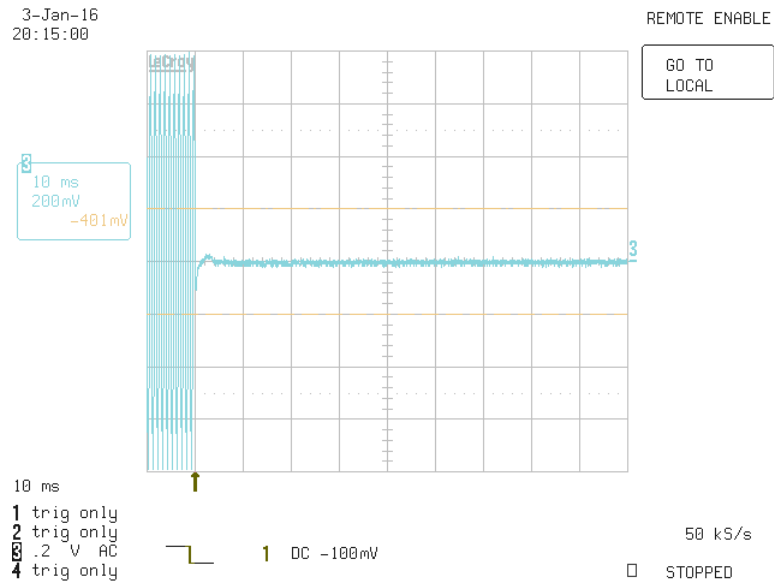


Plot 7.7.2 Transient frequency during power OFF test results at low carrier frequency

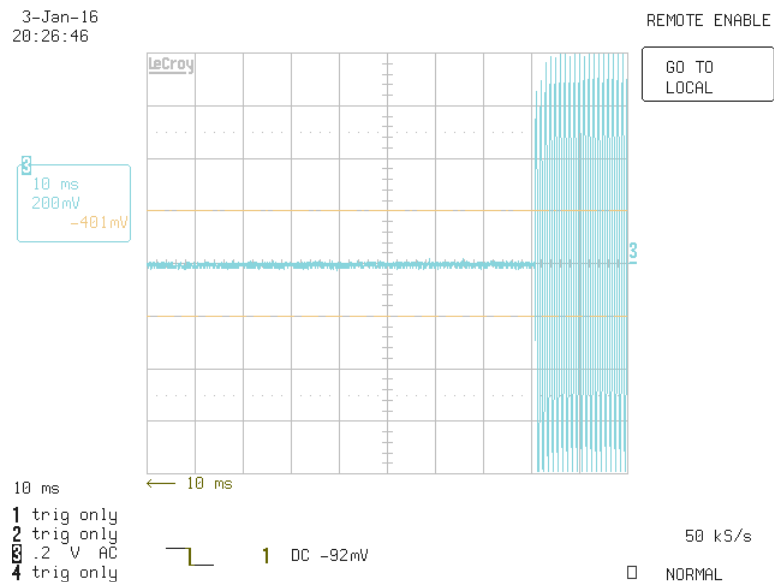


Test specification:		Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	
Test procedure:		TIA/EIA-603-D, Section 2.2.19	
Test mode:		Compliance	Verdict: PASS
Date(s):		27-Dec-15 - 24-Jan-16	
Temperature: 23 °C	Air Pressure: 1024 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.7.3 Transient frequency during power ON test results at mid carrier frequency

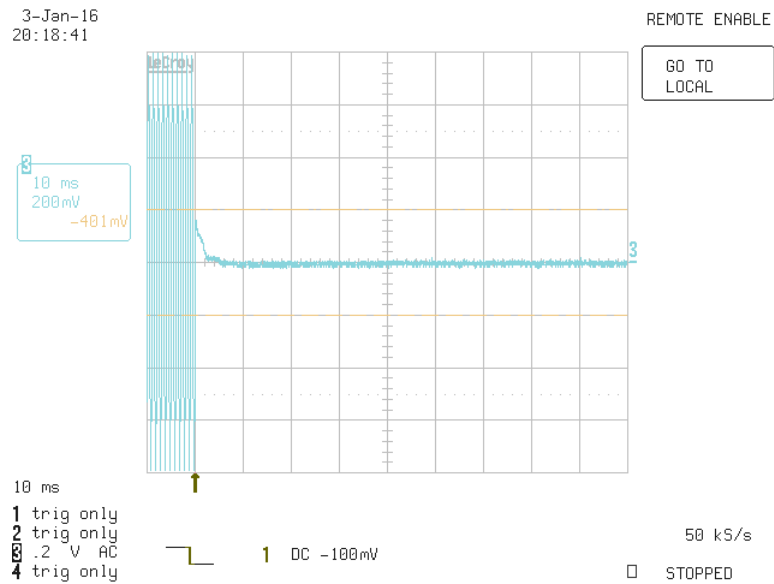


Plot 7.7.4 Transient frequency during power OFF test results at mid carrier frequency

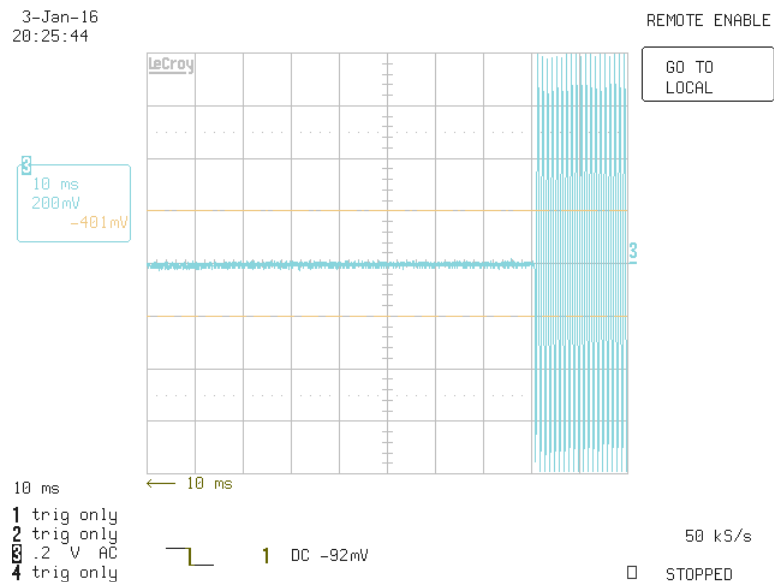


Test specification:		Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	
Test procedure:		TIA/EIA-603-D, Section 2.2.19	
Test mode:		Compliance	Verdict: PASS
Date(s):		27-Dec-15 - 24-Jan-16	
Temperature: 23 °C	Air Pressure: 1024 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.7.5 Transient frequency during power ON test results at high carrier frequency



Plot 7.7.6 Transient frequency during power OFF test results at high carrier frequency



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	18-Jan-16	18-Jan-17
0447	LISN, 16/2, 300V RMS, 50 Ohm/50 uH + 5 Ohm, STD CISPR 16-1	Hermon Laboratories	LISN 16 - 1	066	13-Oct-15	13-Oct-16
0495	Autotransformer 0-255V, 10A	Variac	EMPL01	495	02-Jun-15	02-Jun-16
0521	EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz	Hewlett Packard	8546A	3617A 00319, 3448A002 53	27-Oct-15	27-Oct-16
0539	Generator Signal, 10 kHz - 1.2 GHz	Marconi Instruments	2023	112121/04 1	31-Aug-15	31-Aug-16
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	15-May-15	15-May-16
0787	Transient Limiter 9 kHz-200 MHz	Hewlett Packard	11947A	3107A018 77	12-Oct-15	12-Oct-16
0911	Coupler Dual Directional, 20 dB, 0.1 - 2.0 GHz	Hewlett Packard	778D	1144A078 27	14-Feb-13	14-Feb-16
1457	Cable, 1 m	Harbour Industries	MIL 17/60- RG142	1457	03-Sep-15	03-Sep-16
1513	Cable RF, 8 m, BNC/BNC	Belden	M17/167 MIL-C-17	1513	08-Sep-15	08-Sep-16
1876	Attenuator, 50 Ohm, 100 W, 20 dB	Bird Electronic Corp.	8343-200	2200	01-Feb-15	01-Feb-16
1984	Antenna, Double-Ridged Waveguide Horn, 1 to 18 GHz, 300 W	EMC Test Systems	3115	9911-5964	17-Apr-15	17-Apr-16
2227	Crystal Detector 0.01-18 GHz, 100 mW	Hewlett Packard Co	8472A	NA	27-Oct-15	27-Oct-17
2432	Antenna, Double-Ridged Waveguide Horn 1 to 18 GHz	EMC Test Systems	3115	00027177	17-Apr-15	17-Apr-16
2780	EMC analyzer, 100 Hz to 26.5 GHz	Agilent Technologies	E7405A	MY451024 62	08-Sep-15	08-Sep-16
3203	Climatic chamber, -35 to 180°C	Angelantoni	HYGROS 15	5675	13-Mar-15	13-Mar-16
3286	Temperature Chamber, (-50 to +170) °C	Thermotron	EL-8-CH- 1-1-CO2	21-9048	01-Oct-15	01-Oct-16
3300	Attenuator set, 0 to 81 dB, 1 dB step, DC-18 GHz	Agilent Technologies	8494B/84 95B	MY421469 11/MY421 43939	16-Aug-15	16-Aug-16
3310	Multimeter	Fluke	115C	94321810	13-Jul-15	13-Jul-16
3390	Microwave Cable Assembly, 26.5 GHz, 1.0 m, N type/N type	Suhner Sucoflex	104EA	3390	04-Feb-16	04-Feb-17
3435	Precision Fixed Attenuator, 50 Ohm, 5 W, 10 dB, DC to 18 GHz	Mini-Circuits	BW-S10W5+	NA	10-Mar-15	10-Mar-16
3440	Precision Fixed Attenuator, 50 Ohm, 5 W, 20 dB, DC to 18 GHz	Mini-Circuits	BW-S20W5+	NA	01-Dec-15	01-Dec-16
3455	Medium Power Fixed Coaxial Attenuator DC to 40 GHz, 20 dB, 5 W	Aeroflex / Weinschel	75A-20-12	1182	11-Mar-15	11-Mar-16
3612	Cable RF, 17.5 m, N type-N type	Teldor	RG-214/U	NA	07-Dec-15	07-Dec-16
3727	Oscilloscope, 1 GHz, 4 channels	LeCroy Corporation	LC584AL	10449	28-Jun-15	28-Jun-16
3768	Attenuator, N-type, 20 dB, DC to 18 GHz, 5 W	Mini-Circuits	BW-N20W5+	NA	18-Aug-15	18-Aug-16
3776	Attenuator, N-type, 10 dB, DC to 18 GHz, 5 W	Mini-Circuits	BW-N10W5+	NA	01-Jan-16	01-Jan-17



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HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY48250288	29-Apr-15	29-Apr-16
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	10-Feb-15	10-Feb-16
4068	Attenuator, SMA, 30 dB, DC to 12.4 GHz	Midwest Microwave	ATT-0527-30-SMA-07	NA	13-Jul-15	13-Jul-16
4273	Test Cable , DC-18 GHz, 1.8 m, SMA/M - N/M	Mini-Circuits	CBL-6FT-SMNM+	70045	28-May-15	28-May-16
4275	Test Cable , DC-18 GHz, 1.8 m, SMA/M - N/M	Mini-Circuits	CBL-6FT-SMNM+	70050	22-Nov-15	22-Nov-16
4280	Test Cable , DC-18 GHz, 4.6 m, N/M - N/M	Mini-Circuits	APC-15FT-NMNM+	0763A	22-Nov-15	22-Nov-16
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-15	15-Mar-16
4413	Resistive divider, DC to 1.5 GHz, 2 W	Microlab	DA-3FN	NA	15-Jul-14	15-Jul-16
4722	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	51228701001	01-Jan-16	01-Jan-17
4932	Microwave preamplifier, 500 MHz to 18 GHz, 40 dB Gain	Com-Power Corporation	PAM-118A	551029	19-Nov-15	19-Nov-16

9 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Transmitter tests	
Carrier power conducted at antenna connector	± 1.7 dB
Carrier power radiated (substitution method)	± 4.5 dB
Occupied bandwidth	$\pm 8\%$
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
Spurious emissions radiated 30 MHz – 40 GHz (substitution method)	± 4.5 dB
Frequency error	30 – 300 MHz: ± 50.5 Hz (1.68 ppm) 300 – 1000 MHz: ± 168 Hz (0.56 ppm)
Transient frequency behaviour	187 Hz $\pm 13.9\%$
Duty cycle, timing (Tx ON / OFF) and average factor measurements	$\pm 1.0\%$

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

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

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

10 APPENDIX C Test facility description

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

Hermon Laboratories is listed by the Federal Communications Commission (USA) for all parts of Code of Federal Regulations 47 (CFR 47), Registration Numbers 90624 for OATS and 90623 for the anechoic chamber; by Industry Canada for electromagnetic emissions (file number IC 2186A-1 for OATS), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-27 for full-anechoic chamber for RE measurements above 1 GHz, C-845 for conducted emissions site, T-1606 for conducted emissions at telecommunication ports), has a status of a Telefication - Listed Testing Laboratory, Certificate No. L138/00. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing and environmental simulation (for exact scope please refer to Certificate No. 839.01). The FCC Designation Number is IL1001.

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Person for contact: Mr. Alex Usoskin, CEO.

11 APPENDIX D Specification references

FCC 47CFR part 90: 2015	Private land mobile radio services
FCC 47CFR part 2: 2015	Frequency allocations and radio treaty matters; general rules and regulations
ANSI C63.2: 1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications.
ANSI C63.4: 2009	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.
ANSI/TIA/EIA-603-D:2010	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
RSS-119 Issue 12: 2015	Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz

12 APPENDIX E Test equipment correction factors

Correction factor
Line impedance stabilization network
Model LISN 16 - 1
Hermon Laboratories, HL 0447

Frequency, kHz	Correction factor, dB
10	4.9
15	2.86
20	1.83
25	1.25
30	0.91
35	0.69
40	0.53
50	0.35
60	0.25
70	0.18
80	0.14
90	0.11
100	0.09
125	0.06
150	0.04

The correction factor in dB is to be added to meter readings of an interference analyzer or a spectrum analyzer.

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

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

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

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

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

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

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

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

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

Antenna factor
Double-ridged guide horn antenna
Model 3115, serial number: 00027177, HL 2432

Frequency, MHz	Antenna factor. dB(1/m)
1000.0	24.7
1500.0	25.7
2000.0	27.8
2500.0	28.9
3000.0	30.7
3500.0	31.8
4000.0	33.0
4500.0	32.8
5000.0	34.2
5500.0	34.9
6000.0	35.2
6500.0	35.4
7000.0	36.3
7500.0	37.3
8000.0	37.5
8500.0	38.0
9000.0	38.3
9500.0	38.3
10000.0	38.7
10500.0	38.7
11000.0	38.9
11500.0	39.5
12000.0	39.5
12500.0	39.4
13000.0	40.5
13500.0	40.8
14000.0	41.5
14500.0	41.3
15000.0	40.2
15500.0	38.7
16000.0	38.5
16500.0	39.8
17000.0	41.9
17500.0	45.8
18000.0	49.1

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

Cable loss
Cable coaxial, Microwave Cable Assembly, 104EA, 18 GHz, 1.0 m
Suhner Sucoflex, HL 3390

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.03	4800	0.55	9800	0.89	14900	1.07
30	0.04	4900	0.56	9900	0.89	15000	1.07
50	0.05	5000	0.57	10000	0.86	15100	1.08
100	0.07	5100	0.58	10100	0.86	15200	1.07
200	0.10	5200	0.58	10200	0.88	15300	1.09
300	0.12	5300	0.59	10300	0.92	15400	1.10
400	0.14	5400	0.59	10400	0.94	15500	1.10
500	0.16	5500	0.60	10500	0.96	15600	1.12
600	0.17	5600	0.61	10600	0.93	15700	1.15
700	0.18	5700	0.61	10700	0.89	15800	1.15
800	0.20	5800	0.63	10800	0.89	15900	1.17
900	0.21	5900	0.63	10900	0.88	16000	1.14
1000	0.23	6000	0.64	11000	0.92	16100	1.14
1100	0.24	6100	0.64	11100	0.91	16200	1.15
1200	0.25	6200	0.64	11200	0.89	16300	1.14
1300	0.27	6300	0.65	11300	0.88	16400	1.13
1400	0.28	6400	0.65	11400	0.88	16500	1.13
1500	0.28	6500	0.66	11500	0.90	16600	1.13
1600	0.30	6600	0.67	11600	0.94	16700	1.14
1700	0.31	6700	0.67	11700	0.96	16800	1.14
1800	0.32	6800	0.67	11800	0.92	16900	1.14
1900	0.33	6900	0.68	11900	0.92	17000	1.14
2000	0.34	7000	0.67	12000	0.91	17100	1.15
2100	0.35	7100	0.68	12100	0.92	17200	1.14
2200	0.35	7200	0.69	12200	0.95	17300	1.15
2300	0.36	7300	0.69	12300	0.98	17400	1.15
2400	0.37	7400	0.68	12400	0.96	17500	1.16
2500	0.39	7500	0.69	12500	0.99	17600	1.16
2600	0.40	7600	0.70	12600	0.96	17700	1.16
2700	0.41	7700	0.71	12700	0.93	17800	1.19
2800	0.42	7800	0.72	12800	0.94	17900	1.21
2900	0.42	7900	0.72	12900	0.98	18000	1.25
3000	0.43	8000	0.72	13000	0.99		
3100	0.44	8100	0.73	13100	0.99		
3200	0.45	8200	0.74	13200	0.99		
3300	0.46	8300	0.75	13300	0.99		
3400	0.46	8400	0.74	13400	1.00		
3500	0.47	8500	0.73	13500	1.02		
3600	0.47	8600	0.73	13600	1.05		
3700	0.47	8700	0.75	13700	1.03		
3800	0.49	8800	0.77	13800	1.02		
3900	0.49	8900	0.77	13900	1.03		
4000	0.50	9000	0.77	14000	1.03		
4100	0.51	9100	0.77	14100	1.05		
4200	0.52	9200	0.78	14200	1.05		
4300	0.52	9300	0.80	14300	1.04		
4400	0.53	9400	0.82	14400	1.03		
4500	0.53	9500	0.82	14600	1.06		
4600	0.54	9600	0.83	14700	1.07		
4700	0.56	9700	0.89	14800	1.08		

Cable loss
Cable coaxial, RG-214/U, N type-N type, 17 m
Teldor, HL 3612

Frequency, MHz	Cable loss, dB
0.1	0.05
0.5	0.07
1	0.10
3	0.22
5	0.29
10	0.39
30	0.68
50	0.90
100	1.27
150	1.58
200	1.80
250	2.12
300	2.36
350	2.60
400	2.82
450	2.99
500	3.23
550	3.40
600	3.56
650	3.71
700	3.90
750	4.04
800	4.23
850	4.39
900	4.55
950	4.65
1000	4.79

Cable loss
Microwave Cable Assembly, Huber-Suhner, 40 GHz, 1.5 m, SMA-SMA, S/N 1226/2A
HL 3903

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	-0.02	9500	1.84	21000	2.98
100	0.15	10000	1.86	22000	3.07
500	0.38	10500	1.93	23000	3.13
1000	0.56	11000	1.99	24000	3.21
1500	0.69	11500	2.04	25000	3.26
2000	0.82	12000	2.10	26000	3.48
2500	0.90	12500	2.15	27000	3.44
3000	0.98	13000	2.21	28000	3.53
3500	1.06	13500	2.25	29000	3.59
4000	1.11	14000	2.29	30000	3.66
4500	1.17	14500	2.34	31000	3.70
5000	1.24	15000	2.36	32000	3.79
5500	1.32	15500	2.40	33000	3.88
6000	1.40	16000	2.45	34000	3.94
6500	1.50	16500	2.48	35000	3.91
7000	1.56	17000	2.56	36000	4.05
7500	1.62	17500	2.58	37000	4.22
8000	1.68	18000	2.60	38000	4.25
8500	1.74	19000	2.84	39000	4.27
9000	1.78	20000	2.88	40000	4.33

Cable loss
Test cable, Mini-Circuits, S/N 70045, 18 GHz, 1.8 m, SMA/M - N/M
CBL-6FT-SMNM+, HL 4273

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.09	4800	1.76	9800	2.70	14800	3.59
30	0.11	4900	1.78	9900	2.71	14900	3.59
50	0.14	5000	1.81	10000	2.73	15000	3.60
100	0.20	5100	1.82	10100	2.75	15100	3.63
200	0.30	5200	1.86	10200	2.76	15200	3.67
300	0.38	5300	1.89	10300	2.79	15300	3.70
400	0.45	5400	1.92	10400	2.81	15400	3.68
500	0.50	5500	1.96	10500	2.82	15500	3.70
600	0.55	5600	2.00	10600	2.83	15600	3.71
700	0.60	5700	2.03	10700	2.87	15700	3.77
800	0.65	5800	2.04	10800	2.87	15800	3.75
900	0.69	5900	2.07	10900	2.88	15900	3.77
1000	0.73	6000	2.10	11000	2.89	16000	3.79
1100	0.77	6100	2.10	11100	2.91	16100	3.85
1200	0.80	6200	2.11	11200	2.92	16200	3.82
1300	0.84	6300	2.11	11300	2.94	16300	3.83
1400	0.88	6400	2.14	11400	2.95	16400	3.88
1500	0.92	6500	2.15	11500	2.98	16500	3.89
1600	0.95	6600	2.15	11600	3.00	16600	3.92
1700	0.98	6700	2.16	11700	3.02	16700	3.88
1800	1.01	6800	2.19	11800	3.04	16800	3.95
1900	1.04	6900	2.22	11900	3.08	16900	3.91
2000	1.07	7000	2.24	12000	3.09	17000	3.97
2100	1.09	7100	2.26	12100	3.12	17100	3.92
2200	1.13	7200	2.29	12200	3.13	17200	3.94
2300	1.15	7300	2.32	12300	3.16	17300	3.94
2400	1.18	7400	2.36	12400	3.17	17400	3.98
2500	1.21	7500	2.39	12500	3.19	17500	3.93
2600	1.24	7600	2.41	12600	3.20	17600	3.95
2700	1.27	7700	2.43	12700	3.21	17700	3.96
2800	1.30	7800	2.46	12800	3.21	17800	3.97
2900	1.34	7900	2.49	12900	3.22	17900	3.96
3000	1.36	8000	2.52	13000	3.22	18000	3.97
3100	1.38	8100	2.52	13100	3.24		
3200	1.41	8200	2.54	13200	3.24		
3300	1.45	8300	2.59	13300	3.27		
3400	1.46	8400	2.61	13400	3.28		
3500	1.49	8500	2.60	13500	3.31		
3600	1.51	8600	2.63	13600	3.31		
3700	1.55	8700	2.65	13700	3.35		
3800	1.34	8800	2.65	13800	3.37		
3900	1.36	8900	2.65	13900	3.40		
4000	1.38	9000	2.66	14000	3.43		
4100	1.41	9100	2.66	14100	3.45		
4200	1.45	9200	2.67	14200	3.46		
4300	1.46	9300	2.67	14300	3.46		
4400	1.49	9400	2.67	14400	3.49		
4500	1.51	9500	2.68	14500	3.50		
4600	1.55	9600	2.69	14600	3.50		
4700	1.34	9700	2.69	14700	3.52		

Cable loss
Test cable, Mini-Circuits, S/N 70050, 18 GHz, 1.8 m, SMA/M - N/M
CBL-6FT-SMNM+, HL 4275

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.08	5000	1.71	10200	2.64	15400	3.46
30	0.11	5100	1.73	10300	2.65	15500	3.47
50	0.14	5200	1.75	10400	2.66	15600	3.52
100	0.21	5300	1.76	10500	2.67	15700	3.55
200	0.30	5400	1.77	10600	2.70	15800	3.55
300	0.37	5500	1.82	10700	2.71	15900	3.55
400	0.43	5600	1.84	10800	2.72	16000	3.61
500	0.49	5700	1.86	10900	2.73	16100	3.62
600	0.54	5800	1.86	11000	2.75	16200	3.63
700	0.58	5900	1.89	11100	2.77	16300	3.62
800	0.62	6000	1.94	11200	2.78	16400	3.66
900	0.66	6100	1.95	11300	2.80	16500	3.71
1000	0.70	6200	1.96	11400	2.82	16600	3.71
1100	0.74	6300	1.97	11500	2.83	16700	3.67
1200	0.78	6400	2.01	11600	2.84	16800	3.69
1300	0.81	6500	2.03	11700	2.86	16900	3.74
1400	0.84	6600	2.02	11800	2.88	17000	3.73
1500	0.88	6700	2.02	11900	2.89	17100	3.71
1600	0.91	6800	2.05	12000	2.90	17200	3.73
1700	0.94	6900	2.06	12100	2.92	17300	3.77
1800	0.97	7000	2.07	12200	2.93	17400	3.77
1900	1.00	7100	2.07	12300	2.94	17500	3.76
2000	1.02	7200	2.08	12400	2.96	17600	3.76
2100	1.05	7300	2.11	12500	2.98	17700	3.78
2200	1.07	7400	2.13	12600	2.99	17800	3.80
2300	1.10	7500	2.15	12700	3.01	17900	3.79
2400	1.13	7600	2.16	12800	3.03	18000	3.78
2500	1.15	7700	2.18	12900	3.05		
2600	1.18	7800	2.21	13000	3.07		
2700	1.20	7900	2.24	13100	3.09		
2800	1.24	8000	2.25	13200	3.12		
2900	1.26	8100	2.26	13300	3.13		
3000	1.28	8200	2.29	13400	3.14		
3100	1.30	8300	2.31	13500	3.16		
3200	1.33	8400	2.33	13600	3.18		
3300	1.36	8500	2.33	13700	3.19		
3400	1.37	8600	2.34	13800	3.21		
3500	1.39	8700	2.36	13900	3.23		
3600	1.42	8800	2.38	14000	3.25		
3700	1.45	8900	2.39	14100	3.26		
3800	1.46	9000	2.40	14200	3.27		
3900	1.48	9100	2.42	14300	3.30		
4000	1.50	9200	2.45	14400	3.32		
4100	1.53	9300	2.46	14500	3.33		
4200	1.55	9400	2.48	14600	3.34		
4300	1.57	9500	2.50	14700	3.36		
4400	1.59	9600	2.52	14800	3.39		
4500	1.61	9700	2.54	14900	3.40		
4600	1.64	9800	2.56	15000	3.41		
4700	1.66	9900	2.58	15100	3.41		
4800	1.67	10000	2.60	15200	3.44		
4900	1.69	10100	2.61	15300	3.46		

Cable loss
Test cable, Mini-Circuits, S/N 0763A, 18 GHz, 4.6 m, N/M - N/M
APC-15FT-NMNM+, HL 4280

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.21	5000	4.27	10200	6.50	15400	8.49
30	0.26	5100	4.32	10300	6.55	15500	8.50
50	0.34	5200	4.35	10400	6.59	15600	8.55
100	0.51	5300	4.41	10500	6.62	15700	8.58
200	0.63	5400	4.43	10600	6.65	15800	8.61
300	0.73	5500	4.49	10700	6.66	15900	8.64
400	0.91	5600	4.54	10800	6.68	16000	8.68
500	1.07	5700	4.58	10900	6.70	16100	8.72
600	1.21	5800	4.63	11000	6.71	16200	8.73
700	1.33	5900	4.67	11100	6.72	16300	8.75
800	1.45	6000	4.73	11200	6.74	16400	8.77
900	1.55	6100	4.76	11300	6.77	16500	8.80
1000	1.65	6200	4.81	11400	6.81	16600	8.80
1100	1.75	6300	4.86	11500	6.84	16700	8.82
1200	1.85	6400	4.89	11600	6.87	16800	8.83
1300	1.94	6500	4.94	11700	6.89	16900	8.87
1400	2.03	6600	4.95	11800	6.94	17000	8.92
1500	2.11	6700	4.99	11900	7.00	17100	8.96
1600	2.19	6800	5.04	12000	7.05	17200	9.01
1700	2.27	6900	5.04	12100	7.10	17300	9.07
1800	2.34	7000	5.09	12200	7.17	17400	9.09
1900	2.42	7100	5.15	12300	7.23	17500	9.14
2000	2.49	7200	5.19	12400	7.29	17600	9.17
2100	2.56	7300	5.25	12500	7.34	17700	9.21
2200	2.63	7400	5.33	12600	7.38	17800	9.24
2300	2.69	7500	5.39	12700	7.44	17900	9.28
2400	2.76	7600	5.42	12800	7.48	18000	9.31
2500	2.83	7700	5.51	12900	7.55		
2600	2.89	7800	5.58	13000	7.58		
2700	2.95	7900	5.62	13100	7.63		
2800	3.02	8000	5.68	13200	7.67		
2900	3.08	8100	5.73	13300	7.72		
3000	3.15	8200	5.78	13400	7.76		
3100	3.21	8300	5.83	13500	7.81		
3200	3.27	8400	5.87	13600	7.85		
3300	3.33	8500	5.92	13700	7.88		
3400	3.38	8600	5.96	13800	7.93		
3500	3.44	8700	6.00	13900	7.97		
3600	3.49	8800	6.04	14000	8.01		
3700	3.55	8900	6.10	14100	8.05		
3800	3.60	9000	6.13	14200	8.09		
3900	3.65	9100	6.17	14300	8.12		
4000	3.71	9200	6.22	14400	8.15		
4100	3.75	9300	6.25	14500	8.19		
4200	3.81	9400	6.28	14600	8.22		
4300	3.86	9500	6.32	14700	8.26		
4400	3.93	9600	6.36	14800	8.29		
4500	3.98	9700	6.37	14900	8.32		
4600	4.03	9800	6.41	15000	8.36		
4700	4.08	9900	6.42	15100	8.40		
4800	4.13	10000	6.45	15200	8.43		
4900	4.18	10100	6.48	15300	8.44		

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

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

Cable loss
Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,
NC29-N1N1-244, S/N 51228701001
HL 4722

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
50	0.22	9000	2.93
100	0.30	9500	3.06
300	0.52	10000	3.16
500	0.66	10500	3.20
1000	0.93	11000	3.34
1500	1.15	11500	3.39
2000	1.33	12000	3.48
2500	1.49	12500	3.55
3000	1.64	13000	3.66
3500	1.77	13500	3.75
4000	1.90	14000	3.76
4500	2.03	14500	3.87
5000	2.17	15000	3.98
5500	2.30	15500	4.01
6000	2.39	16000	4.14
6500	2.51	16500	4.15
7000	2.59	17000	4.32
7500	2.67	17500	4.36
8000	2.76	18000	4.38
8500	2.84		

13 APPENDIX F Abbreviations and acronyms

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

END OF DOCUMENT