

TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C § 15.247 (DTS) and subpart B,
RSS-247 issue 2, RSS-Gen issue 5, ICES-003 Issue 6

FOR:

ST Engineering Telematics Wireless Ltd.
Water Meter Reader
Model: MMR3
FCC ID:NTAMMR31
IC:4732A-MMR31

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1 Applicant information

Client name: ST Engineering Telematics Wireless Ltd.
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Telephone: +972 3557 5700
Fax: +972 3557 5703
E-mail: ItsikK@telematics-wireless.com
Contact name: Mr. Itsik Kanner

2 Equipment under test attributes

Product name: Water Meter Reader
Product type: Transceiver
Model(s): MMR3
Serial number: 723726
Hardware version: C
Software release: V01.01
Receipt date 10-Apr-16

3 Manufacturer information

Manufacturer name: ST Engineering Telematics Wireless Ltd.
Address: 26 Hamelacha street, POB 1911, Holon, 5811801, Israel
Telephone: +972 3557 5700
Fax: +972 3557 5703
E-Mail: ItsikK@telematics-wireless.com
Contact name: Mr. Itsik Kanner

4 Test details

Project ID: 28136
Location: Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel
Test started: 10-Apr-16
Test completed: 17-Apr-16
Test specification(s): FCC 47CFR part 15 subpart C § 15.247 (DTS), subpart B;
RSS-247 issue 2, RSS-Gen issue 5, ICES-003 Issue 6: 2019 (updated)

5 Tests summary

Test	Status
Transmitter characteristics	
FCC section 15.247(a)(2) / RSS-247 section 5.2(a), 6 dB bandwidth	Pass
FCC section 15.247(b)(3) / RSS-247 section 5.4(d), Peak output power	Pass
FCC section 15.247(i) / RSS-102 section 2.5.2, RF exposure	Pass, the exhibit to the application of certification is provided
FCC section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	Pass
FCC section 15.247(d) / RSS-247 section 5.5, Emissions at band edges	Pass
FCC section 15.247(e) / RSS-247 section 5.2(b), Peak power density	Pass
FCC section 15.203 / RSS-Gen section 6.8, Antenna requirement	Pass
FCC section 15.207(a) / RSS-Gen section 8.8, Conducted emission	Pass
Unintentional emissions	
FCC section 15.107 / ICES-003, Section 6.1, Class B, Conducted emission at AC power port	Pass
FCC section 15.109 / RSS-Gen section 7.3 / ICES-003, Section 6.2, Class B, Radiated emission	Pass

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.

The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mrs. E. Pitt, test engineer	April 17, 2016	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	June 10, 2020	
Approved by:	Mr. S. Samokha, Technical Manager, EMC and Radio	July 1, 2020	

6 EUT description

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

6.1 General information

The EUT, MMR3 is a compact RF Receiver/Transmitter unit operating at 916.3 MHz. The MMR3 is used for wireless data collection, transmitted from water meters. Following the data collection, the collected data is transmitted via the RF transmitter to another transceiver.

The MMR3 receiver is enabled and collects data transmitted by water meters. The received data is decoded and saved in the internal memory or transmitted via the RS232/USB to external PC/Laptop/Pocket PC.

6.2 Ports and lines

Port type	Port description	Connected from	Connected to	Qty.	Cable type	Cable length, m
Power	DC input	EUT	AC/DC adapter	1	Unshielded	1.7
Power	AC	AC/DC adapter	AC mains	1	NA	NA
Signal	USB	EUT	Laptop	1	Shielded	1.0
Power	DC	Laptop	AC/DC adapter	1	Unshielded	1.9
Power	AC	AC/DC adapter	AC mains	1	Unshielded	1.0
Power	DC output	not in use				
Signal	RS-232	not in use				

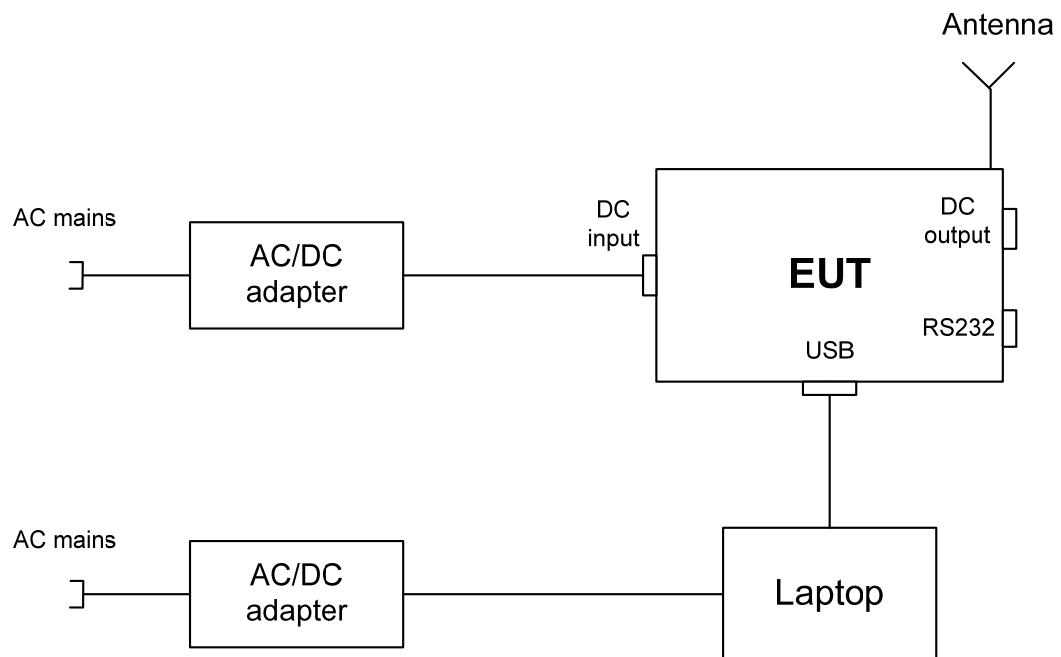
6.3 Support and test equipment

Description	Manufacturer	Model number	Serial number
Laptop	IBM	Type 2525-64G	L3-GH596
AC/DC adapter (to laptop)	IBM	P/N 93P5022	R2589789
AC/DC adapter	TRG	25120-E-11E03	25120-0001151

6.4 Changes made in EUT

No changes were implemented in the EUT during the testing.

6.5 Test configuration



6.6 Transmitter characteristics

Type of equipment						
	Stand-alone (Equipment with or without its own control provisions)					
X	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		902-928 MHz				
Operating frequency range		916.3 MHz				
Maximum rated output power		At transmitter 50 Ω RF output connector		NA		
		Peak output power		14.13 dBm		
Is transmitter output power variable?		X	No			
		Yes		continuous variable		
				stepped variable with stepsize	dB	
				minimum RF power	dBm	
				maximum RF power	dBm	
Antenna connection						
X	unique coupling	standard connector	integral	with temporary RF connector without temporary RF connector		
Antenna/s technical characteristics						
Type	Manufacturer	Model number		Gain		
External short monopole	Panorama	PCX-TNC-C3G		2 dBi		
Transmitter aggregate data rate/s		60 kbps				
Type of modulation		FSK				
Modulating test signal (baseband)		PRBS				
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 15.247(a)(2) / RSS-247 section 5.2(a), 6 dB bandwidth	
Test procedure:		ANSI C63.10 section 11.8.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		10-Apr-16 - 13-Apr-16	
Temperature: 23 °C	Air Pressure: 1009 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C and RSS-247 requirements

7.1 Minimum 6 dB bandwidth

7.1.1 General

This test was performed to measure the 6 dB bandwidth of the EUT carrier frequency. Specification test limits are given in Table 7.1.1, Table 7.1.2.

Table 7.1.1 The 6 dB bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Minimum bandwidth, kHz
902.0 – 928.0	6.0	500.0
2400.0 – 2483.5		
5725.0 – 5850.0		

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

Table 7.1.2 The 99% bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points	Limit, kHz
902.0 – 928.0	99%	NA
2400.0 – 2483.5		
5725.0 – 5850.0		

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 set to transmit modulated carrier.

7.1.2.3 The transmitter minimum 6 dB bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.1.3 and the associated plots.

Figure 7.1.1 The 6 dB bandwidth test setup





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Test specification:		Section 15.247(a)(2) / RSS-247 section 5.2(a), 6 dB bandwidth	
Test procedure:		ANSI C63.10 section 11.8.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		10-Apr-16 - 13-Apr-16	
Temperature: 23 °C	Air Pressure: 1009 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Table 7.1.3 The 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 902-928 MHz
 DETECTOR USED: Peak
 SWEEP MODE: Max hold
 SWEEP TIME: Auto
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 MODULATION: FSK
 BIT RATE: 60 kbps

Carrier frequency, MHz	6 dB bandwidth, kHz	99% bandwidth, MHz	Limit, kHz	Verdict
916.3	712.785	1.0006	500	Pass

Reference numbers of test equipment used

HL 2909								
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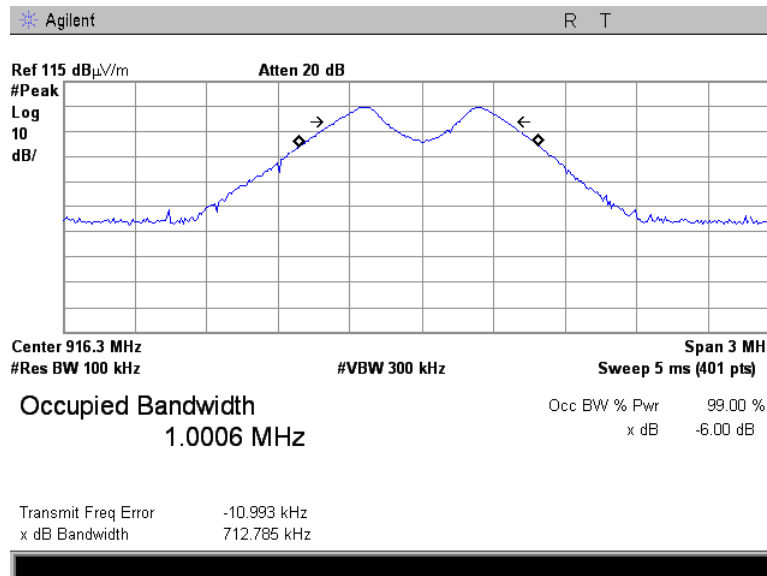
Full description is given in Appendix A.



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Test specification:		Section 15.247(a)(2) / RSS-247 section 5.2(a), 6 dB bandwidth	
Test procedure:		ANSI C63.10 section 11.8.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		10-Apr-16 - 13-Apr-16	
Temperature: 23 °C	Air Pressure: 1009 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.1.1 The 6 dB bandwidth test result





Test specification:		Section 15.247(b)(3) / RSS-247 section 5.4(d), Maximum output power	
Test procedure:		ANSI C63.10 section 11.9.2.2.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		13-Apr-16 - 14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

7.2 Maximum output power

7.2.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Peak output power limits

Assigned frequency range, MHz	Maximum antenna gain, dBi	Peak output power*		Equivalent field strength limit @ 3m, dB(μV/m)**
		W	dBm	
902.0 – 928.0	6.0	1.0	30.0	131.2
2400.0 – 2483.5				
5725.0 – 5850.0				

*- The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

**- Equivalent field strength limit was calculated from the peak output power as follows: $E = \sqrt{30 \times P \times G} / r$, where P is peak output power in Watts, r is antenna to EUT distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator.

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

7.2.2.3 The resolution bandwidth of spectrum analyzer was set to the nearest available value greater than 5 % of the EUT occupied bandwidth as it represents the absolute worst case, VBW ≥ 3 RBW, and the power of the EUT carrier frequency was measured with antenna connected to spectrum analyzer.

7.2.2.4 The average power was measured using the instrument's band power measurement function and the trace average was at least 100 traces in power averaging mode as recorded in Table 7.2.2 and associated plots. The power was computed by integrating the spectrum across the OBW of the signal.

7.2.2.5 To compute the average power during the actual transmission time the duty cycle correction factor was added to the measured power.

7.2.2.6 The maximum output power was calculated using the equation for field strength of carrier as follows:

$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

$$P = \text{SA reading, dBm} + 107 \text{ dB} + \text{AF, dB/m} + \text{CL, dB} - \text{Transmitter antenna gain, dBi} - 95.2 \text{ dB} + 10 \log(1/D) \text{ dB},$$

where 107 dB is a SA conversion factor

AF – measuring antenna factor

CL – cable loss

D is a duty cycle.

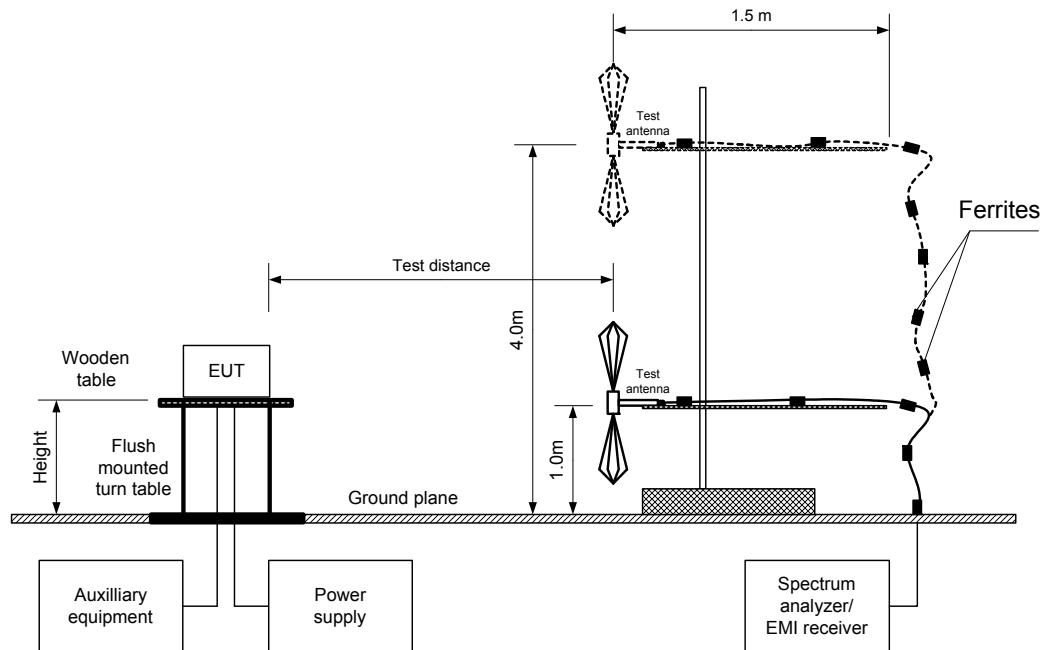
7.2.2.7 The worst test results (the lowest margins) were recorded in Table 7.2.2.



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Test specification:		Section 15.247(b)(3) / RSS-247 section 5.4(d), Maximum output power	
Test procedure:		ANSI C63.10 section 11.9.2.2.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		13-Apr-16 - 14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Figure 7.2.1 Setup for carrier field strength measurements





Test specification:		Section 15.247(b)(3) / RSS-247 section 5.4(d), Maximum output power	
Test procedure:		ANSI C63.10 section 11.9.2.2.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		13-Apr-16 - 14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Table 7.2.2 Peak output power test results

ASSIGNED FREQUENCY RANGE: 902 - 928 MHz
 TEST DISTANCE: 3 m
 TEST SITE: Semi anechoic chamber
 EUT HEIGHT: 0.8 m
 DETECTOR USED: AVR
 TEST ANTENNA TYPE: Biconilog (30 MHz – 1000 MHz)
 MODULATION: FSK
 BIT RATE: 60 kbps
 EUT 6 dB BANDWIDTH: 713 kHz

Frequency, MHz	SA reading, dBm	Antenna factor, dB	Cable loss, dB	EUT antenna gain, dBi	Average output power, dBm*	Limit, dBm	Margin, dB**	Verdict
916.30	-36.87	24.4	2.5	2	14.13	30.0	-15.87	Pass

*- Average output power was calculated as follows:

SA reading, dBm + 107 dB + AF, dB/m + CL, dB - Transmitter antenna gain, dBi - 95.2 dB + 10 log(1/D), dB.

** - Margin = Output power – specification limit.

Reference numbers of test equipment used

HL 0521	HL 0604	HL 3818	HL 4278	HL 4353			
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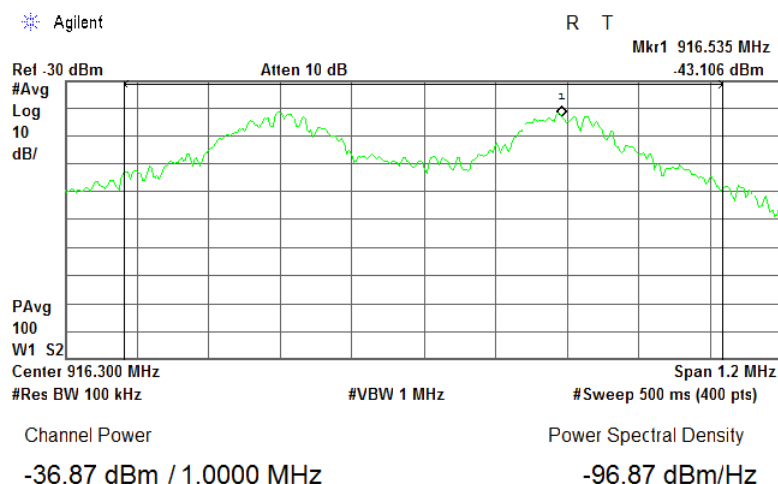
Full description is given in Appendix A.



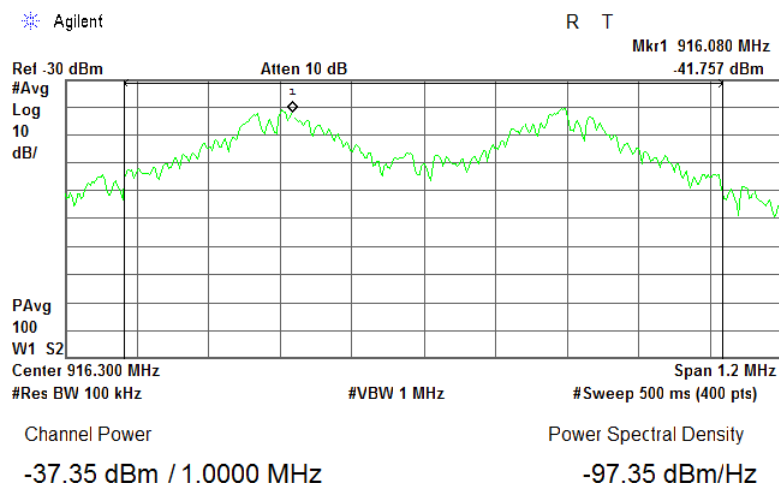
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Test specification:		Section 15.247(b)(3) / RSS-247 section 5.4(d), Maximum output power	
Test procedure:		ANSI C63.10 section 11.9.2.2.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		13-Apr-16 - 14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.2.1 Power of carrier at Unom



Plot 7.2.2 Power of carrier at 115%Unom





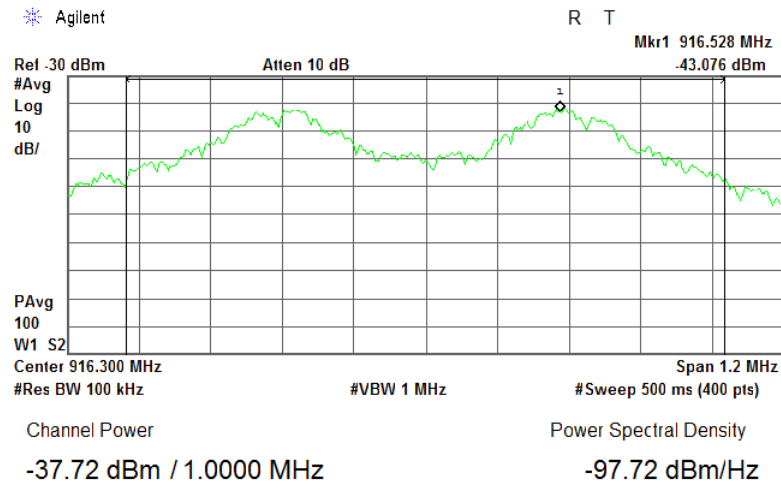
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Report ID: TELRAD_FCC.28136_rev1.docx

Date of Issue: 1-Jul-20

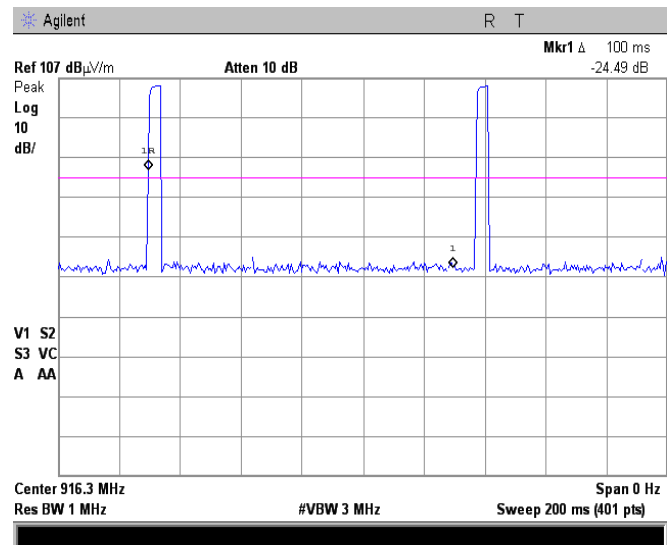
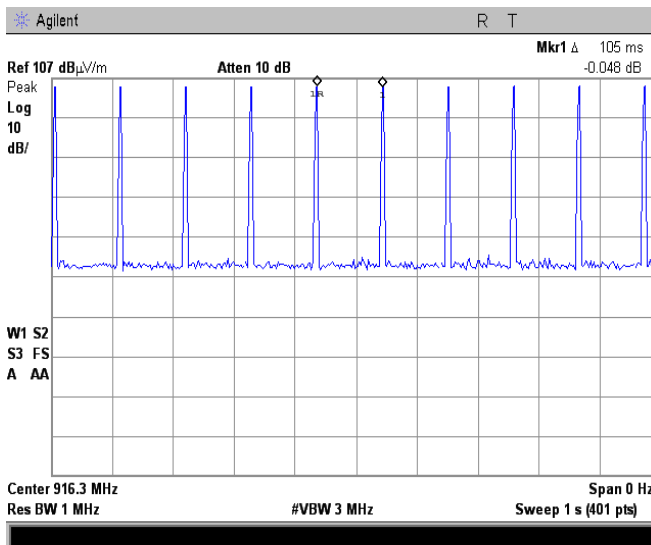
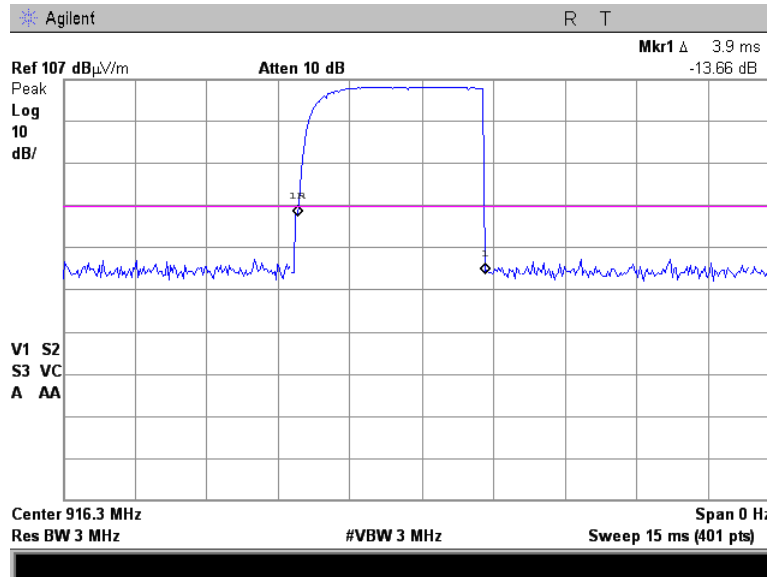
Test specification:		Section 15.247(b)(3) / RSS-247 section 5.4(d), Maximum output power	
Test procedure:		ANSI C63.10 section 11.9.2.2.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		13-Apr-16 - 14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.2.3 Power of carrier at 85%Unom



Test specification:		Section 15.247(b)(3) / RSS-247 section 5.4(d), Maximum output power	
Test procedure:		ANSI C63.10 section 11.9.2.2.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		13-Apr-16 - 14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.2.4 Pulse duration and period measurements for duty cycle calculation, FSK modulation



Duty cycle=3.9/105= 0.037; 10Log 1/DC=14.3 dB

Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

7.3 Field strength of spurious emissions

7.3.1 General

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

Table 7.3.1 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m within restricted bands, dB(μV/m)*			Attenuation of field strength of spurious versus carrier outside restricted bands, dBc***
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	30.0
0.090 – 0.110	NA	108.5 – 106.8**	NA	
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**	
0.490 – 1.705	NA	73.8 – 63.0**	NA	
1.705 – 30.0*		69.5		
30 – 88		40.0		
88 – 216		43.5		
216 – 960		46.0		
960 - 1000		54.0		
1000 – 10 th harmonic	74.0	NA	54.0	

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

$$\text{Lim}_{S_2} = \text{Lim}_{S_1} + 40 \log (S_1/S_2),$$

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

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

*** - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

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

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

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

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

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

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

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

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

Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

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

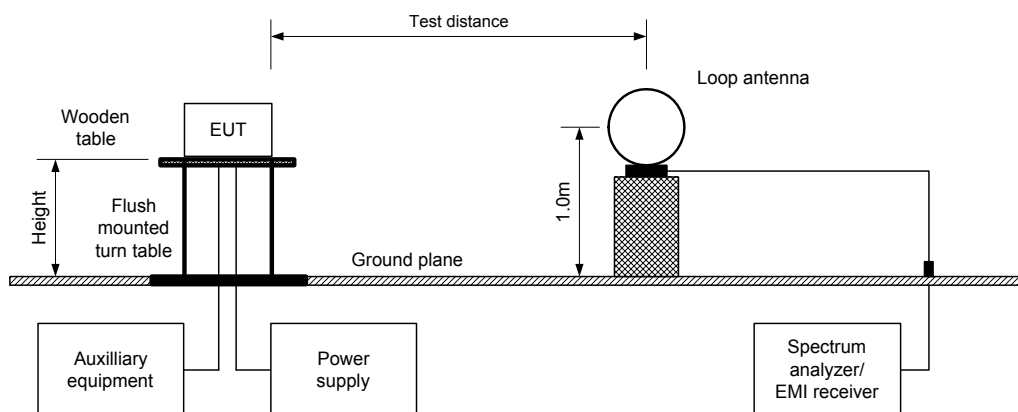
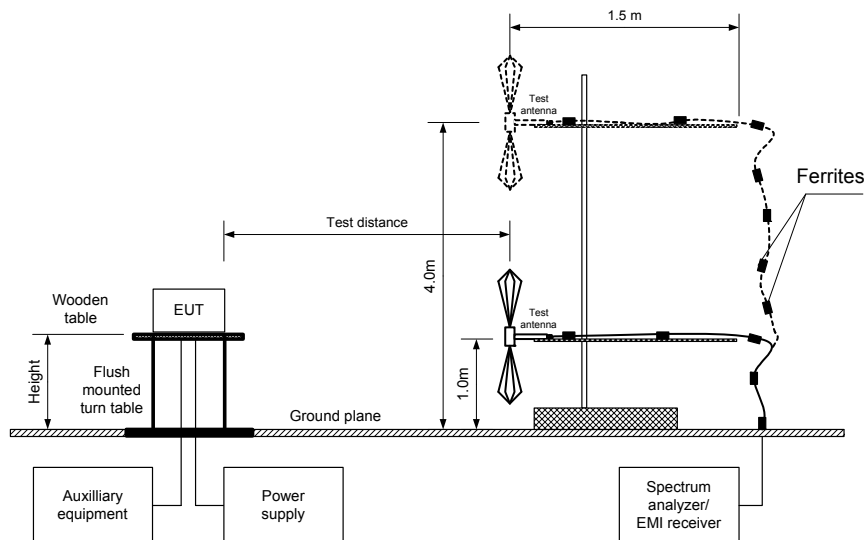


Figure 7.3.2 Setup for spurious emission field strength measurements above 30 MHz



Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Table 7.3.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY: 902-928 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 - 9500 MHz
 TEST DISTANCE: 3 m
 MODULATION: FSK
 BIT RATE: 60 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 Double ridged guide (above 1000 MHz)

Frequency, MHz	Field strength of spurious, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(μV/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
33.4	44.13	Vertical	1.1	20	111.35	67.22	30	37.22	Pass
1832.1	33.20	Vertical	1.4	60		78.15		48.15	

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

**- Margin = Attenuation below carrier – specification limit.

Table 7.3.3 Field strength of spurious emissions above 1 GHz within restricted bands

ASSIGNED FREQUENCY: 902-928 MHz
 INVESTIGATED FREQUENCY RANGE: 1000 – 9500 MHz
 TEST DISTANCE: 3 m
 MODULATION: FSK
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 1000 kHz
 TEST ANTENNA TYPE: Double ridged guide

TEST ANTENNA TYPE:			Basic field guide								Verdict
Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength(VBW=3 MHz)			Average field strength(VBW=10 Hz)				
	Polarization	Height, m		Measured, dB(µV/m)	Limit, dB(µV/m)	Margin, dB**	Measured, dB(µV/m)	Calculated, dB(µV/m)	Limit, dB(µV/m)	Margin, dB***	
No signals were found											Pass

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

**- Margin = Measured field strength - specification limit.

***- Margin = Calculated field strength - specification limit,

where Calculated field strength = Measured field strength + average factor.

Table 7.3.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
3.9	105	NA	NA	NA	-28.6 (not used)

*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

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

for pulse train longer than 100 ms:

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



HERMON LABORATORIES

Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Table 7.3.5 Field strength of spurious emissions below 1 GHz within restricted bands

ASSIGNED FREQUENCY: 902-928 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
 TEST DISTANCE: 3 m
 MODULATION: FSK
 RESOLUTION BANDWIDTH: 1.0 kHz (9 kHz – 150 kHz)
 9.0 kHz (150 kHz – 30 MHz)
 120 kHz (30 MHz – 1000 MHz)
 VIDEO BANDWIDTH: > Resolution bandwidth
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
117.5	33.7	29.2	43.5	-14.3	Vertical	1.2	230	Pass

*- Margin = Measured emission - specification limit.

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

Reference numbers of test equipment used

HL 0446	HL 0521	HL 0604	HL 1984	HL 3346	HL 3440	HL 4278	HL 4353
HL 4909	HL 4933						

Full description is given in Appendix A.



Test specification:	Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict: PASS	
Date(s):	14-Apr-16		
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Table 7.3.6 Restricted bands according to FCC section 15.205

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.37625 - 8.38675	73 - 74.6	399.9 - 410	2690 - 2900	10.6 - 12.7
0.495 - 0.505	8.41425 - 8.41475	74.8 - 75.2	608 - 614	3260 - 3267	13.25 - 13.4
2.1735 - 2.1905	12.29 - 12.293	108 - 121.94	960 - 1240	3332 - 3339	14.47 - 14.5
4.125 - 4.128	12.51975 - 12.52025	123 - 138	1300 - 1427	3345.8 - 3358	15.35 - 16.2
4.17725 - 4.17775	12.57675 - 12.57725	149.9 - 150.05	1435 - 1626.5	3600 - 4400	17.7 - 21.4
4.20725 - 4.20775	13.36 - 13.41	156.52475 - 156.52525	1645.5 - 1646.5	4500 - 5150	22.01 - 23.12
6.215 - 6.218	16.42 - 16.423	156.7 - 156.9	1660 - 1710	5350 - 5460	23.6 - 24
6.26775 - 6.26825	16.69475 - 16.69525	162.0125 - 167.17	1718.8 - 1722.2	7250 - 7750	31.2 - 31.8
6.31175 - 6.31225	16.80425 - 16.80475	167.72 - 173.2	2200 - 2300	8025 - 8500	36.43 - 36.5
8.291 - 8.294	25.5 - 25.67	240 - 285	2310 - 2390	9000 - 9200	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

Table 7.3.7 Restricted bands according to RSS-Gen

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.291 - 8.294	16.80425 - 16.80475	399.9 - 410	3260 - 3267	10.6 - 12.7
2.1735 - 2.1905	8.362 - 8.366	25.5 - 25.67	608 - 614	3332 - 3339	13.25 - 13.4
3.020 - 3.026	8.37625 - 8.38675	37.5 - 38.25	960 - 1427	3345.8 - 3358	14.47 - 14.5
4.125 - 4.128	8.41425 - 8.41475	73 - 74.6	1435 - 1626.5	3500 - 4400	15.35 - 16.2
4.17725 - 4.17775	12.29 - 12.293	74.8 - 75.2	1645.5 - 1646.5	4500 - 5150	17.7 - 21.4
4.20725 - 4.20775	12.51975 - 12.52025	108 - 138	1660 - 1710	5350 - 5460	22.01 - 23.12
5.677 - 5.683	12.57675 - 12.57725	156.52475 - 156.52525	1718.8 - 1722.2	7250 - 7750	23.6 - 24
6.215 - 6.218	13.36 - 13.41	156.7 - 156.9	2200 - 2300	8025 - 8500	31.2 - 31.8
6.26775 - 6.26825	16.42 - 16.423	240 - 285	2310 - 2390	9000 - 9200	36.43 - 36.5
6.31175 - 6.31225	16.69475 - 16.69525	322 - 335.4	2655 - 2900	9300 - 9500	Above 38.6

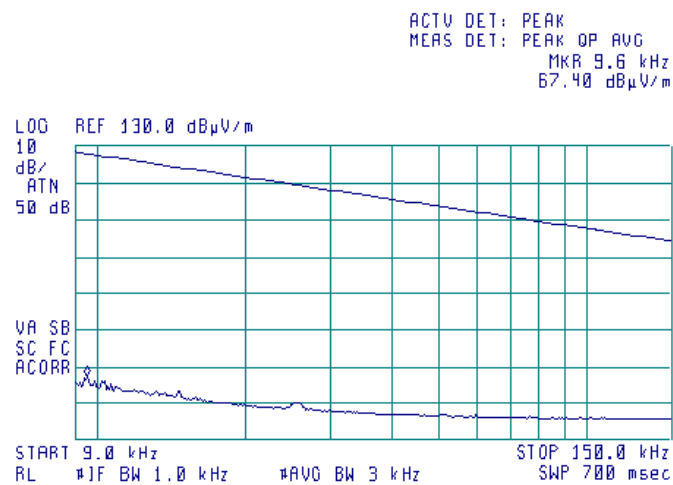


HERMON LABORATORIES

Test specification:	Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	14-Apr-16		
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

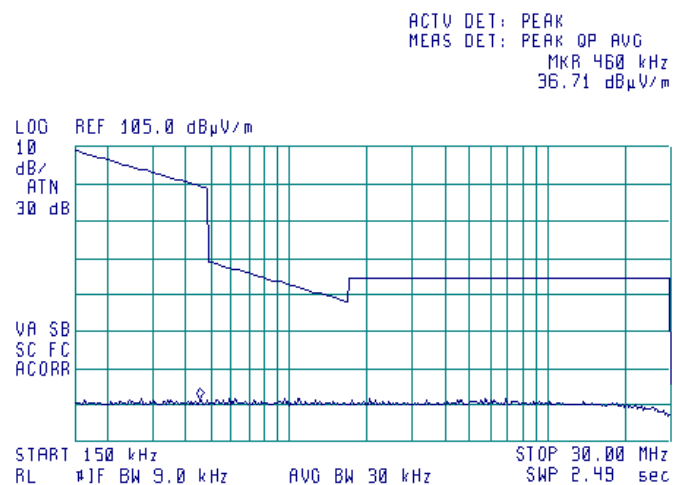
Plot 7.3.1 Radiated emission measurements from 9 to 150 kHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Plot 7.3.2 Radiated emission measurements from 0.15 to 30 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



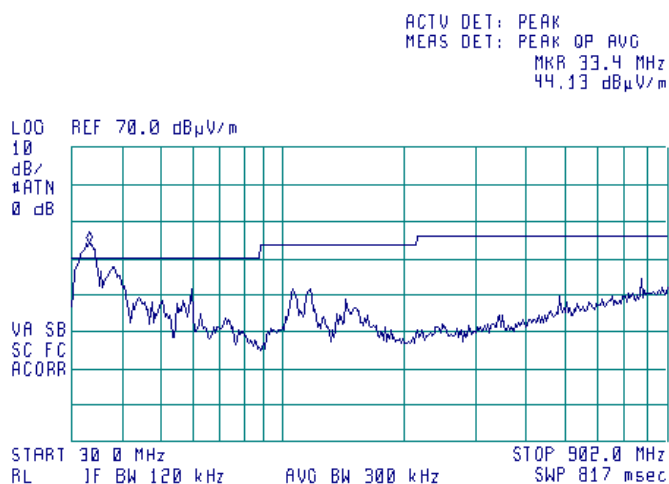


HERMON LABORATORIES

Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

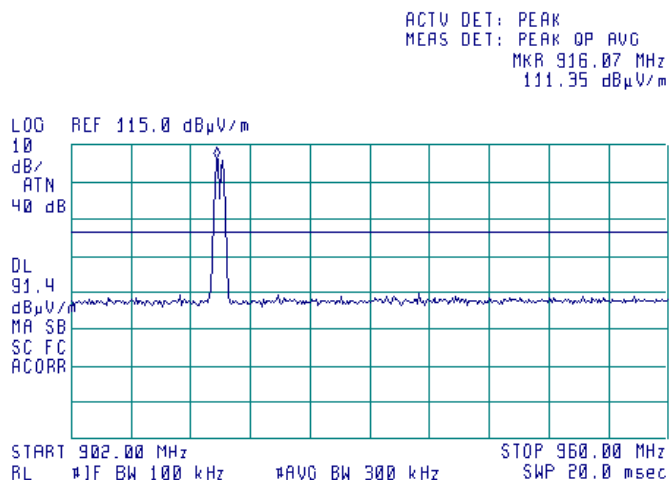
Plot 7.3.3 Radiated emission measurements from 30 to 902 MHz

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



Plot 7.3.4 Radiated emission measurements from 902 to 960 MHz

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



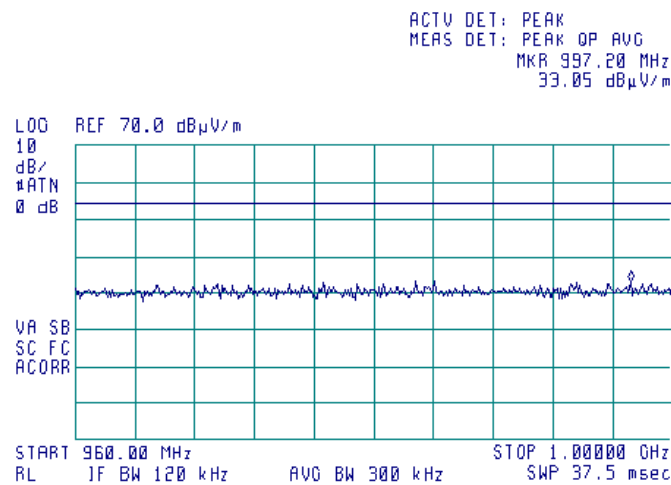


HERMON LABORATORIES

Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

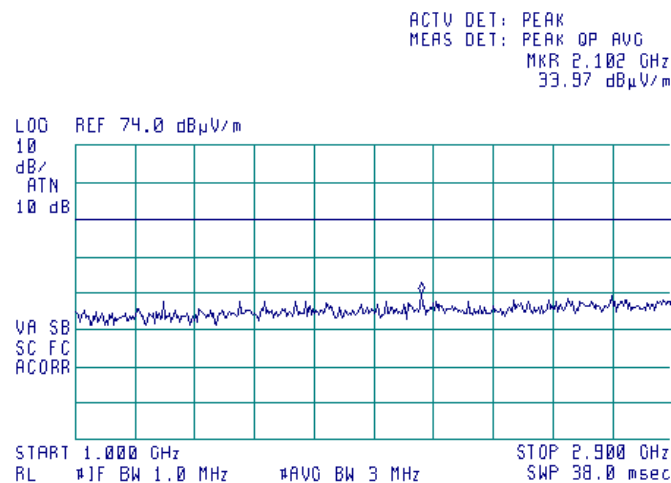
Plot 7.3.5 Radiated emission measurements from 960 to 1000 MHz

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



Plot 7.3.6 Radiated emission measurements from 1000 to 2900 MHz

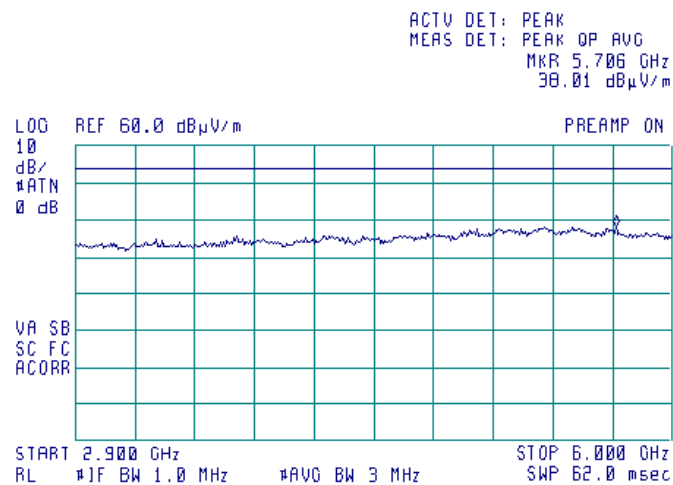
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.3.7 Radiated emission measurements from 2900 to 6000 MHz

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

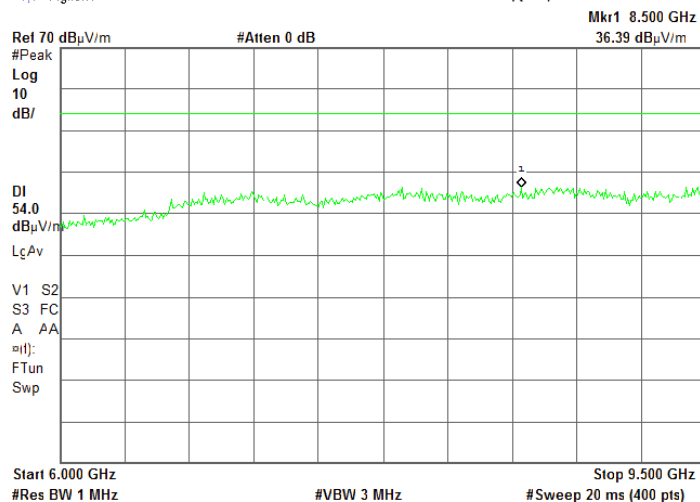


Plot 7.3.8 Radiated emission measurements from 6000 to 9500 MHz

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

Agilent

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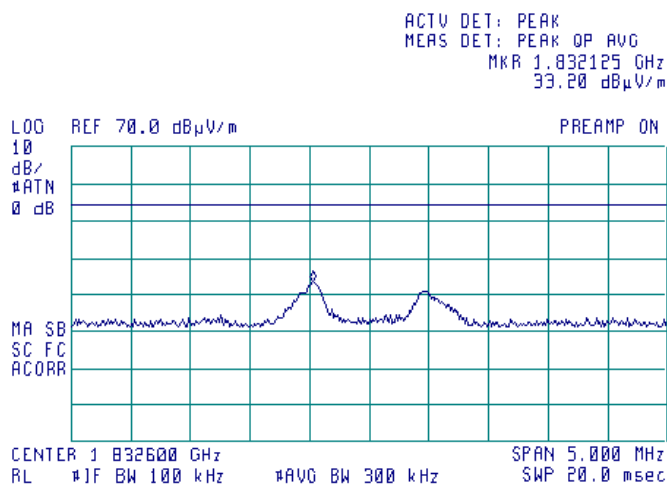


HERMON LABORATORIES

Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

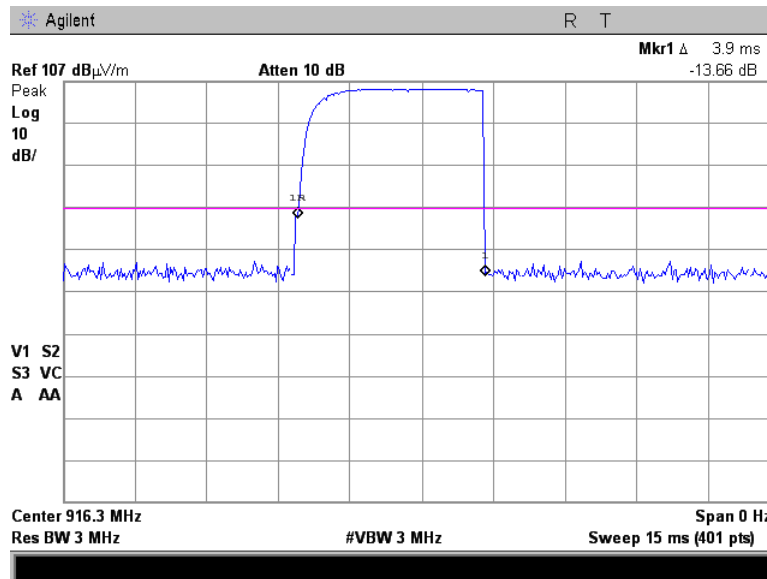
Plot 7.3.9 Radiated emission measurements at 2nd harmonic

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

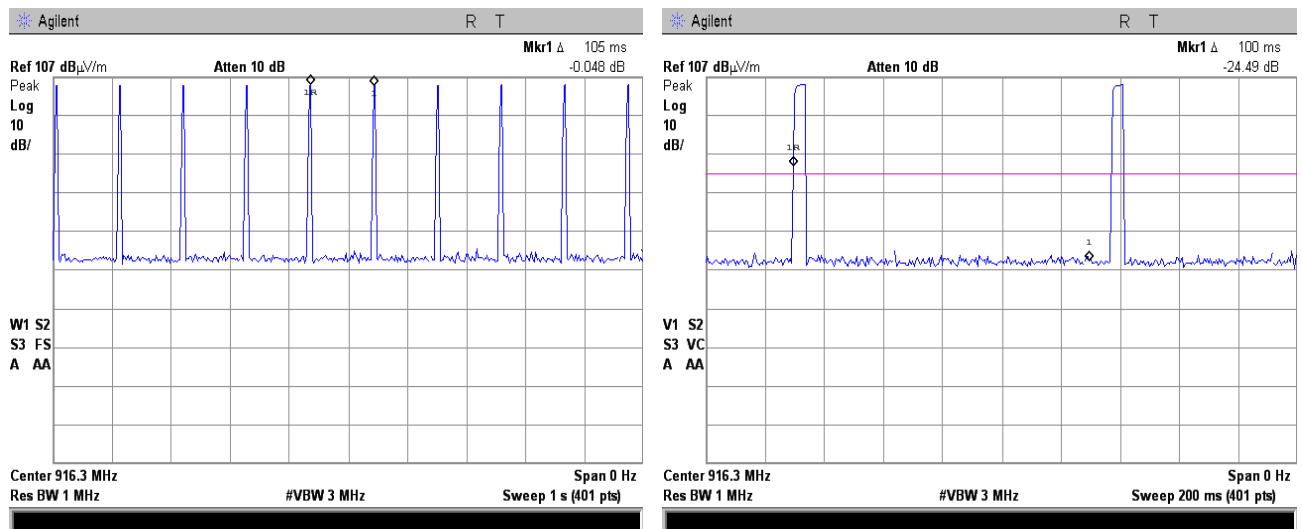


Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.3.10 Transmission pulse duration



Plot 7.3.11 Transmission pulse period



Test specification:		Section 15.247(d) / RSS-247 section 5.5, Band edge emissions	
Test procedure:		ANSI C63.10 section 11.13.2	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

7.4 Band edge radiated emissions

7.4.1 General

This test was performed to measure emissions, radiated from the EUT at the assigned frequency band edges. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Band edge emission limits

Output power	Assigned frequency, MHz	Attenuation below carrier*, dBc
Averaged over a time interval	902.0 – 928.0	30.0
	2400.0 – 2483.5	
	5725.0 – 5850.0	

* - Band edge emission limit is provided in terms of attenuation below the peak of modulated carrier measured with the same resolution bandwidth.

7.4.2 Test procedure

- 7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized normally modulated at the maximum data rate and its proper operation was checked.
- 7.4.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.
- 7.4.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.4.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.
- 7.4.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.4.2 and associated plots and referenced to the highest emission level measured within the authorized band.
- 7.4.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.

Figure 7.4.1 Band edge emission test setup





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Test specification:		Section 15.247(d) / RSS-247 section 5.5, Band edge emissions	
Test procedure:		ANSI C63.10 section 11.13.2	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Table 7.4.2 Band edge emission test results

ASSIGNED FREQUENCY RANGE: 902-928 MHz
 DETECTOR USED: Peak
 MODULATION: FSK
 BIT RATE: 60 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz

Frequency, MHz	Band edge emission, dBuV/m	Emission at carrier, dBuV/m	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
902	60.45	111.8	51.35	30.0	21.35	Pass
928	60.84		50.96		20.96	

*- Margin = Measured emission – specification limit.

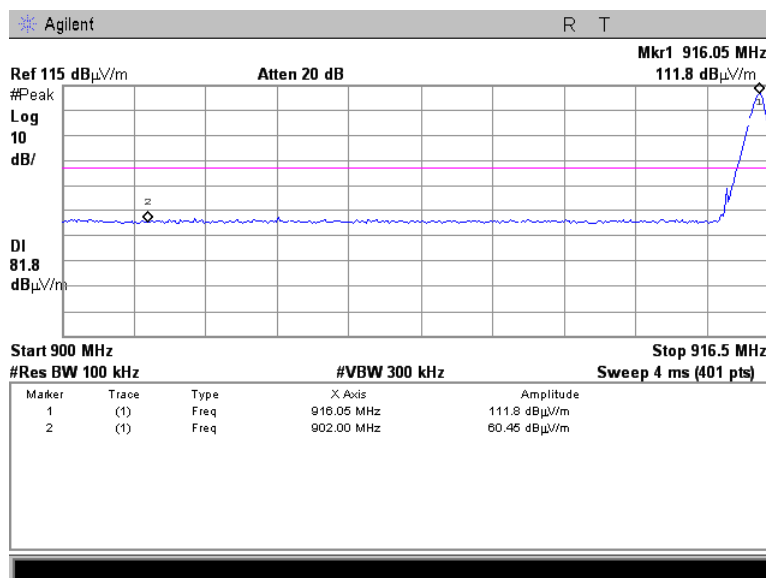
Reference numbers of test equipment used

HL 0604	HL 2909	HL 4278	HL 4353				
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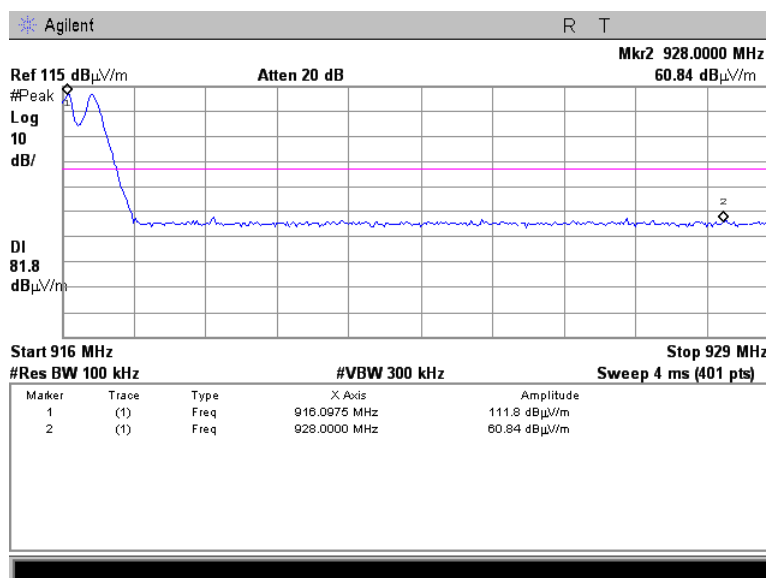
Full description is given in Appendix A.

Test specification:		Section 15.247(d) / RSS-247 section 5.5, Band edge emissions	
Test procedure:		ANSI C63.10 section 11.13.2	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.4.1 The low band edge emission at carrier frequency



Plot 7.4.2 The high band edge emission at carrier frequency





Test specification:		Section 15.247(e) / RSS-247 section 5.2(b), Maximum power spectral density	
Test procedure:		ANSI C63.10 section 11.10.5	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

7.5 Maximum power spectral density (PSD)

7.5.1 General

This test was performed to measure the peak power spectral density radiated by the transmitter RF antenna. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Power spectral density limits

Assigned frequency range, MHz	Measurement bandwidth, kHz	Peak spectral power density, dBm	Equivalent field strength limit @ 3m, dB(μV/m)*
902.0 – 928.0	3.0	8.0	103.2
2400.0 – 2483.5			
5725.0 – 5850.0			

* - Equivalent field strength limit was calculated from the peak spectral power density as follows: $E = \sqrt{30 \times P} / r$, where P is peak spectral power density and r is antenna to EUT distance in meters.

7.5.2 Test procedure for field strength measurements

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 to end user RF output power.

7.5.2.3 The field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

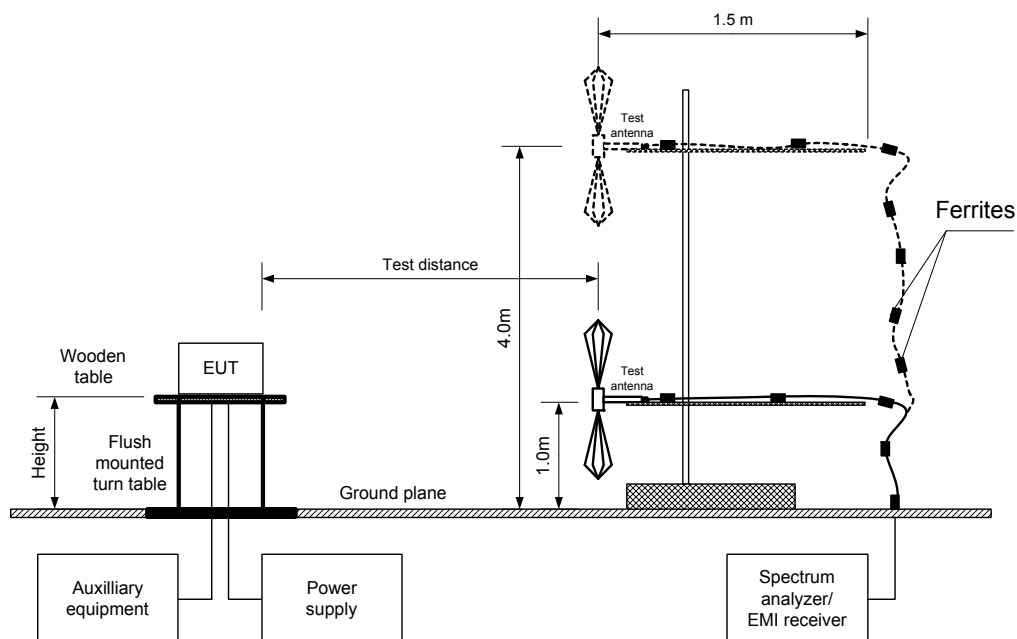
7.5.2.4 The average power spectral density was measured in power averaging mode with resolution bandwidth set to 3 kHz, video bandwidth $VBW \geq 3$ RBW over a minimum of 100 traces to find the highest level.

7.5.2.5 To compute the average power spectral density during the actual transmission time the duty cycle correction factor was added to the measured PSD.

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

Test specification:		Section 15.247(e) / RSS-247 section 5.2(b), Maximum power spectral density	
Test procedure:		ANSI C63.10 section 11.10.5	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Figure 7.5.1 Setup for carrier field strength measurements





Test specification:		Section 15.247(e) / RSS-247 section 5.2(b), Maximum power spectral density	
Test procedure:		ANSI C63.10 section 11.10.5	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Table 7.5.2 Field strength measurement of peak spectral power density

ASSIGNED FREQUENCY: 902 - 928 MHz
 TEST DISTANCE: 3 m
 TEST SITE: Semi anechoic chamber
 EUT HEIGHT: 0.8 m
 DETECTOR USED: Average
 TEST ANTENNA TYPE: Biconilog (30 MHz – 1000 MHz)
 MODULATION: FSK
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 BIT RATE: 60 kbps

Frequency, MHz	Field strength, dB(μV/m)	Calculated PSD* dBm	Limit, dBm	Margin, dB**	Antenna polarization	Antenna height, m	Turn-table position***, degrees	Verdict
916.3	83.46	0.56	8	-7.44	Vertical	1.3	45	Pass

* - Calculated PSD = Field strength, dB(μV/m) – EUT antenna gain, dBi – 95.2 dB + 10log(1/DC) dB

** - Margin = Calculated PSD - Limit

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

Reference numbers of test equipment used

HL 0521	HL 0604	HL 4278	HL 4353				
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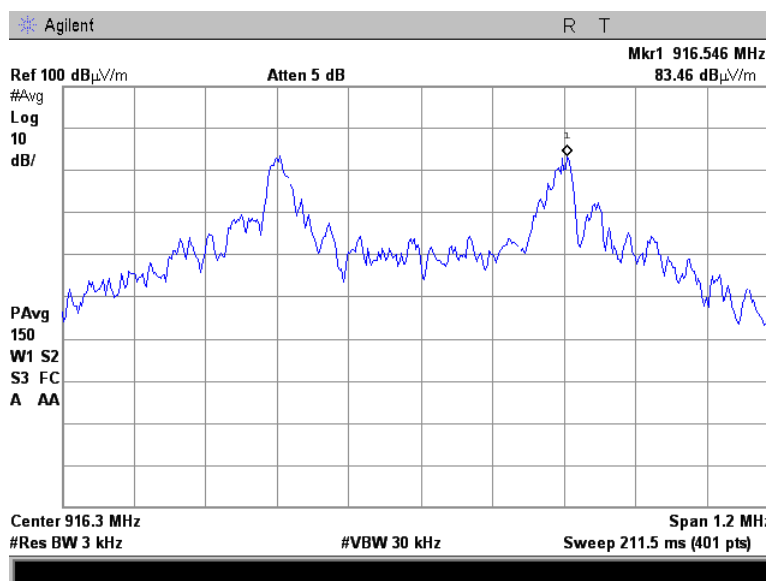
Full description is given in Appendix A.



HERMON LABORATORIES

Test specification:		Section 15.247(e) / RSS-247 section 5.2(b), Maximum power spectral density	
Test procedure:		ANSI C63.10 section 11.10.5	
Test mode:		Compliance	Verdict: PASS
Date(s):		14-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

Plot 7.5.1 Peak spectral power density





Test specification: FCC section 15.207(a), RSS-Gen section 8.8, Conducted emission			
Test procedure: ANSI C63.10 section 6.2			
Test mode:	Compliance	Verdict: PASS	
Date(s):	13-Apr-16		
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

7.6 Conducted emissions

7.6.1 General

This test was performed to measure common mode conducted emissions at the power port. Specification test limits are given in Table 7.6.1.

Table 7.6.1 Limits for conducted emissions

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

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

7.6.2 Test procedure

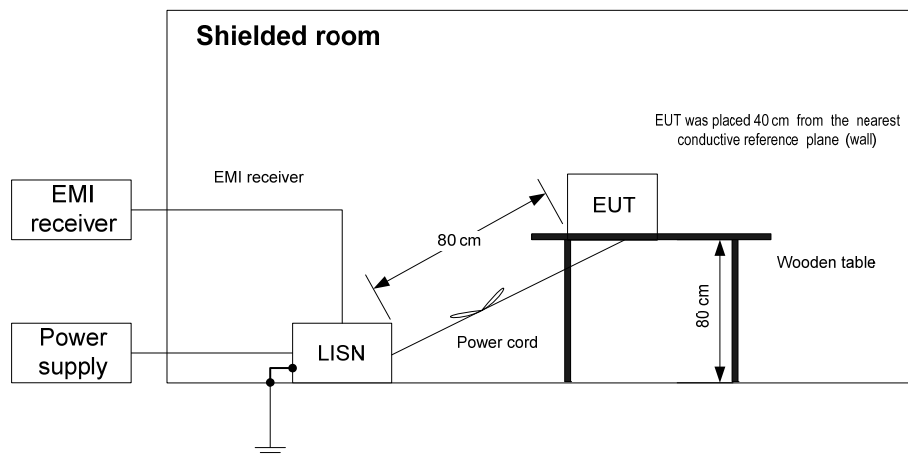
7.6.2.1 The EUT was set up as shown in Figure 7.6.1 and associated photographs, energized and the performance check was conducted.

7.6.2.2 The measurements were performed at power terminals with the LISN, connected to a spectrum analyzer while unused coaxial connector of the LISN was terminated with 50 Ohm.

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

7.6.2.4 The worst test results (the lowest margins) were recorded in Table 7.6.2 and shown in the associated plots.

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





HERMON LABORATORIES

Test specification:	FCC section 15.207(a), RSS-Gen section 8.8, Conducted emission		
Test procedure:	ANSI C63.10 section 6.2		
Test mode:	Compliance	Verdict: PASS	
Date(s):	13-Apr-16		
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

Table 7.6.2 Conducted emission test results

EUT LINE: AC mains
EUT OPERATING MODE: Transmit
EUT SET UP: TABLE-TOP
TEST SITE: SHIELDED ROOM
FREQUENCY RANGE: 150 kHz - 30 MHz
RESOLUTION BANDWIDTH: 9 kHz

Frequency, MHz	Peak emission, dB(μV)	Quasi-peak			Average			Line ID	Verdict
		Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*	Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*		
0.170	39.990	38.540	65.020	-26.480	29.690	55.020	-25.330	L1	Pass
0.339	45.410	43.650	59.280	-15.630	40.000	49.280	-9.280		
9.295	40.390	37.090	60.000	-22.910	31.820	50.000	-18.180		
25.964	49.830	46.220	60.000	-13.780	41.300	50.000	-8.700		
0.171	40.500	38.900	64.990	-26.090	30.420	54.990	-24.570	L2	Pass
0.339	45.350	43.540	59.290	-15.750	39.960	49.290	-9.330		
9.375	41.650	37.250	60.000	-22.750	30.300	50.000	-19.700		
25.965	48.740	46.230	60.000	-13.770	40.020	50.000	-9.980		

*- Margin = Measured emission - specification limit.

LAPTOP LINE: AC mains
EUT OPERATING MODE: Transmit
EUT SET UP: TABLE-TOP
TEST SITE: SHIELDED ROOM
FREQUENCY RANGE: 150 kHz - 30 MHz
RESOLUTION BANDWIDTH: 9 kHz

Frequency, MHz	Peak emission, dB(μV)	Quasi-peak			Average			Line ID	Verdict
		Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*	Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*		
0.194	57.030	55.620	63.870	-8.250	49.550	53.870	-4.320	L1	Pass
0.259	47.760	46.630	61.520	-14.890	40.830	51.520	-10.690		
0.519	39.890	38.620	56.000	-17.380	35.760	46.000	-10.240		
21.560	37.570	31.780	60.000	-28.220	25.380	50.000	-24.620		
0.196	57.720	55.810	63.830	-8.020	49.600	53.830	-4.230	L2	Pass
0.260	49.400	48.090	61.500	-13.410	42.010	51.500	-9.490		
0.519	39.210	38.140	56.000	-17.860	36.440	46.000	-9.560		
21.559	36.600	31.490	60.000	-28.510	24.500	50.000	-25.500		

*- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

HL 0447	HL 0495	HL 0787	HL 1501	HL 2832	HL 3016	HL 3612	HL 3836
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Full description is given in Appendix A.

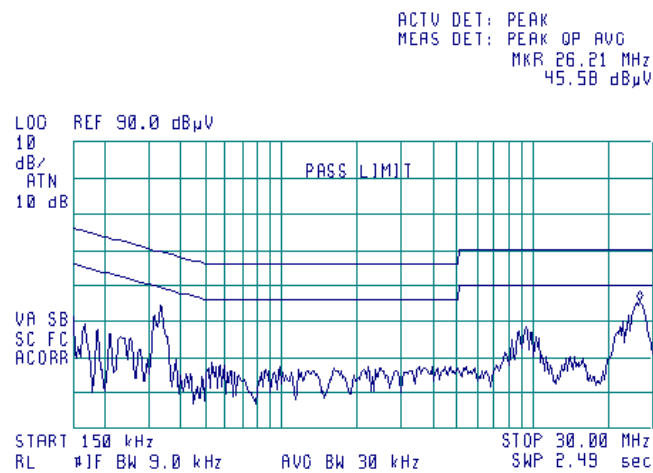


HERMON LABORATORIES

Test specification: FCC section 15.207(a), RSS-Gen section 8.8, Conducted emission			
Test procedure: ANSI C63.10 section 6.2			
Test mode:	Compliance	Verdict: PASS	
Date(s):	13-Apr-16		
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

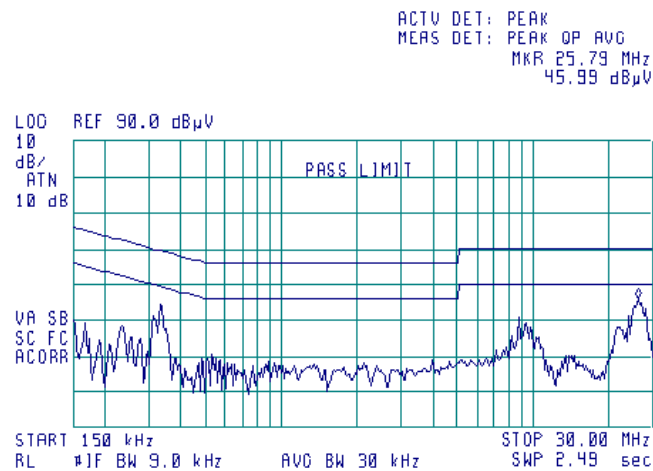
Plot 7.6.1 Conducted emission measurements

EUT LINE: L1
EUT OPERATING MODE: Transmit
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Plot 7.6.2 Conducted emission measurements

EUT LINE: L2
EUT OPERATING MODE: Transmit
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



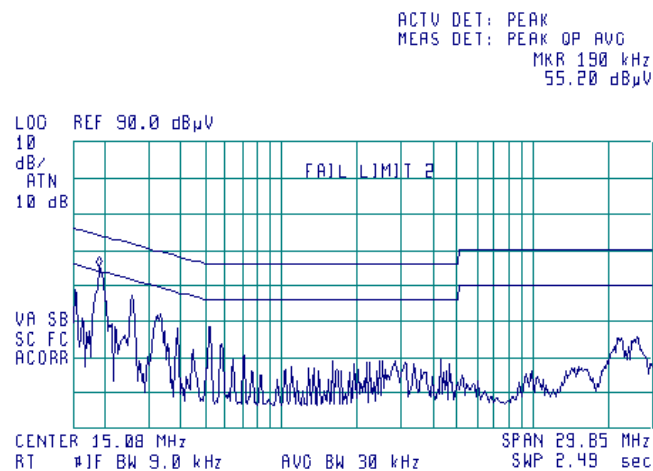


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Test specification:		FCC section 15.207(a), RSS-Gen section 8.8, Conducted emission	
Test procedure:		ANSI C63.10 section 6.2	
Test mode:		Verdict: PASS	
Date(s):			
13-Apr-16			
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

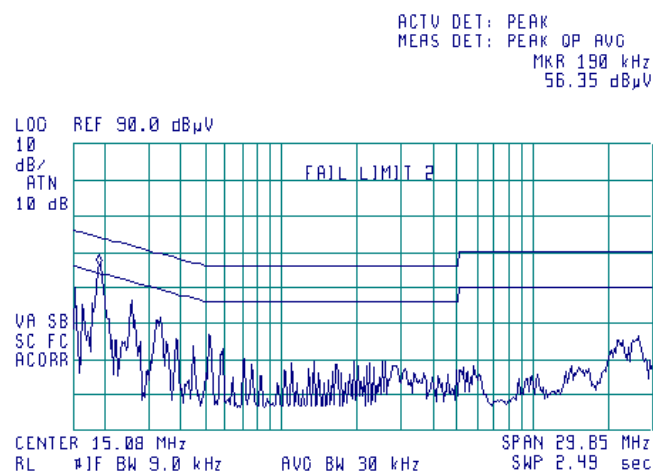
Plot 7.6.3 Conducted emission measurements

LAPTOP LINE: L1
EUT OPERATING MODE: Transmit
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Plot 7.6.4 Conducted emission measurements

LAPTOP LINE: L2
EUT OPERATING MODE: Transmit
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Test specification:		FCC section 15.203, RSS-Gen section 6.8, Antenna requirement	
Test procedure:		Visual inspection	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Apr-16	
Temperature: 23 °C	Air Pressure: 1007 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks:			

7.7 Antenna requirements

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

The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.7.1.

Table 7.7.1 Antenna requirements

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

Photograph 7.7.1 Antenna assembly





Test specification:	FCC Part 15, Section 107 / ICES-003 section 6.1, Conducted emission at AC power port		
Test procedure:	ANSI C63.4, Section 12.2.4		
Test mode:	Compliance	Verdict: PASS	
Date(s):	13-Apr-16		
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

8 Unintentional emissions

8.1 Conducted emissions

8.1.1 General

This test was performed to measure common mode conducted emissions at the mains power port. Specification test limits are given in Table 8.1.1.

Table 8.1.1 Limits for conducted emissions

Frequency, MHz	Class B limit, dB(μV)		Class A limit, dB(μV)	
	QP	AVRG	QP	AVRG
0.15 - 0.5	66 - 56*	56 - 46*	79	66
0.5 - 5.0	56	46	73	60
5.0 - 30	60	50	73	60

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

8.1.2 Test procedure

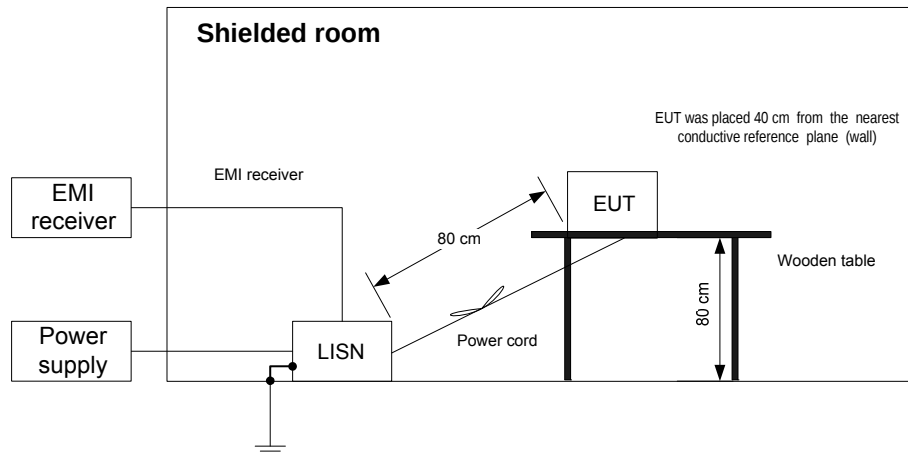
- 8.1.2.1** The EUT was set up as shown in Figure 8.1.1 and associated photographs, energized and the performance check was conducted.
- 8.1.2.2** The measurements were performed at power terminals with the LISN, connected to a spectrum analyzer while unused coaxial connector of the LISN was terminated with 50 Ohm.
- 8.1.2.3** The position of the device cables was varied to determine maximum emission level.
- 8.1.2.4** The worst test results (the lowest margins) were recorded in Table 8.1.2 and shown in the associated plots.



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Test specification:	FCC Part 15, Section 107 / ICES-003 section 6.1, Conducted emission at AC power port		
Test procedure:	ANSI C63.4, Section 12.2.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Apr-16		
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

Figure 8.1.1 Setup for conducted emission measurements, table-top equipment



Photograph 8.1.1 Setup for conducted emission measurements





HERMON LABORATORIES

Test specification:	FCC Part 15, Section 107 / ICES-003 section 6.1, Conducted emission at AC power port		
Test procedure:	ANSI C63.4, Section 12.2.4		
Test mode:	Compliance	Verdict: PASS	
Date(s):	13-Apr-16		
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

Table 8.1.2 Conducted emission test results

EUT LINE: AC mains
EUT OPERATING MODE: Stand-by and receive
EUT SET UP: TABLE-TOP
TEST SITE: SHIELDED ROOM
FREQUENCY RANGE: 150 kHz - 30 MHz
RESOLUTION BANDWIDTH: 9 kHz

Frequency, MHz	Peak emission, dB(μV)	Quasi-peak			Average			Line ID	Verdict
		Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*	Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*		
0.170	39.990	38.540	65.020	-26.480	29.690	55.020	-25.330	L1	Pass
0.339	45.410	43.650	59.280	-15.630	40.000	49.280	-9.280		
9.295	40.390	37.090	60.000	-22.910	31.820	50.000	-18.180		
25.964	49.830	46.220	60.000	-13.780	41.300	50.000	-8.700		
0.171	40.500	38.900	64.990	-26.090	30.420	54.990	-24.570	L2	Pass
0.339	45.350	43.540	59.290	-15.750	39.960	49.290	-9.330		
9.375	41.650	37.250	60.000	-22.750	30.300	50.000	-19.700		
25.965	48.740	46.230	60.000	-13.770	40.020	50.000	-9.980		

*- Margin = Measured emission - specification limit.

LAPTOP LINE: AC mains
EUT OPERATING MODE: Stand-by and receive
EUT SET UP: TABLE-TOP
TEST SITE: SHIELDED ROOM
FREQUENCY RANGE: 150 kHz - 30 MHz
RESOLUTION BANDWIDTH: 9 kHz

Frequency, MHz	Peak emission, dB(μV)	Quasi-peak			Average			Line ID	Verdict
		Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*	Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*		
0.194	57.030	55.620	63.870	-8.250	49.550	53.870	-4.320	L1	Pass
0.259	47.760	46.630	61.520	-14.890	40.830	51.520	-10.690		
0.519	39.890	38.620	56.000	-17.380	35.760	46.000	-10.240		
21.560	37.570	31.780	60.000	-28.220	25.380	50.000	-24.620		
0.196	57.720	55.810	63.830	-8.020	49.600	53.830	-4.230	L2	Pass
0.260	49.400	48.090	61.500	-13.410	42.010	51.500	-9.490		
0.519	39.210	38.140	56.000	-17.860	36.440	46.000	-9.560		
21.559	36.600	31.490	60.000	-28.510	24.500	50.000	-25.500		

*- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

HL 0447	HL 0495	HL 0787	HL 1501	HL 2832	HL 3016	HL 3612	HL 3836
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Full description is given in Appendix A.

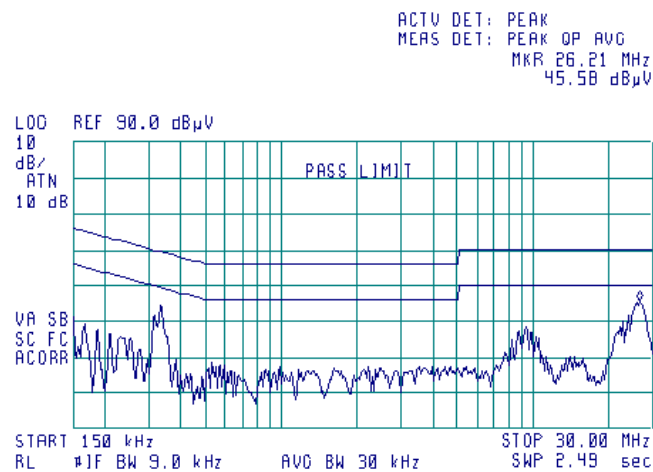


HERMON LABORATORIES

Test specification:	FCC Part 15, Section 107 / ICES-003 section 6.1, Conducted emission at AC power port		
Test procedure:	ANSI C63.4, Section 12.2.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Apr-16		
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

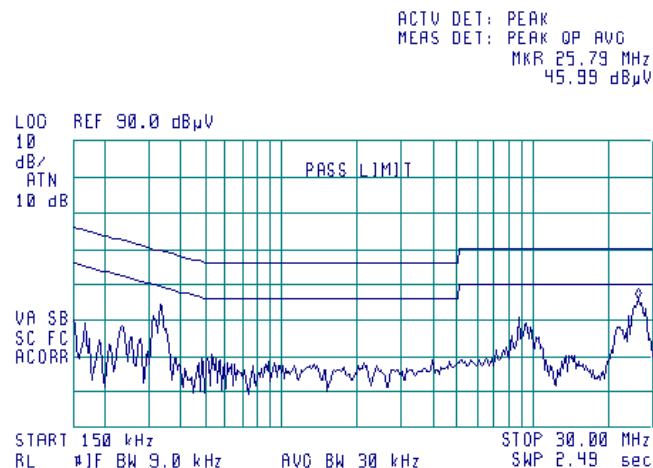
Plot 8.1.1 Conducted emission measurements

EUT LINE: L1
LIMIT: Class B
EUT OPERATING MODE: Stand-by and receive
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Plot 8.1.2 Conducted emission measurements

EUT LINE: L2
LIMIT: Class B
EUT OPERATING MODE: Stand-by and receive
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK





HERMON LABORATORIES

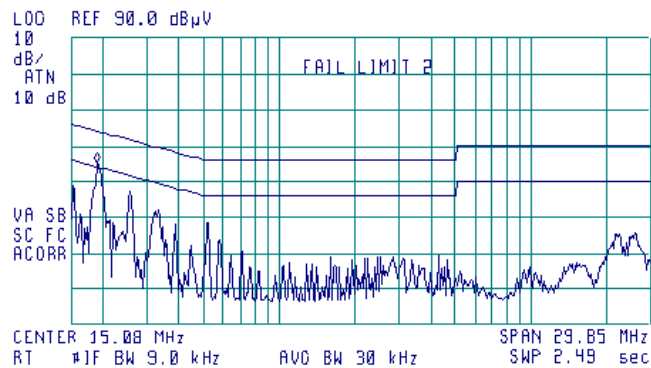
Test specification:	FCC Part 15, Section 107 / ICES-003 section 6.1, Conducted emission at AC power port		
Test procedure:	ANSI C63.4, Section 12.2.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Apr-16		
Temperature: 24.1 °C	Air Pressure: 1007 hPa	Relative Humidity: 49 %	Power Supply: 120 VAC
Remarks:			

Plot 8.1.3 Conducted emission measurements

LAPTOP LINE: L1
LIMIT: Class B
EUT OPERATING MODE: Stand-by and receive
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 190 kHz
55.20 dBμV

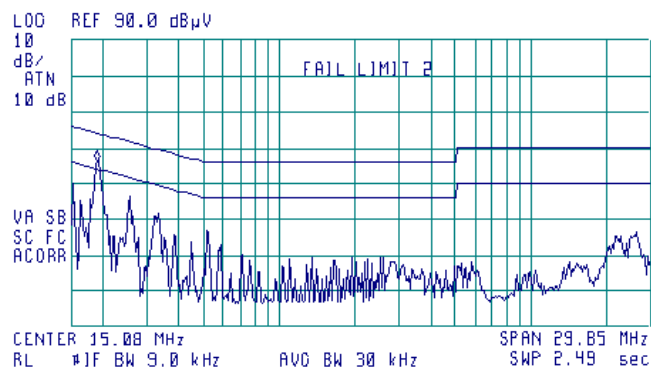


Plot 8.1.4 Conducted emission measurements

LAPTOP LINE: L2
LIMIT: Class B
EUT OPERATING MODE: Stand-by and receive
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 190 kHz
56.35 dBμV





Test specification:		FCC Part 15, Section 109 / RSS-Gen, Section 7.3 / ICES-003 section 6.2, Class B, Radiated emission	
Test procedure:		ANSI C63.4, Section 12.2.5	
Test mode:		Compliance	Verdict: PASS
Date(s):		17-Apr-16	
Temperature: 22 °C	Air Pressure: 1007 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

8.2 Radiated emission measurements

8.2.1 General

This test was performed to measure radiated emissions from the EUT enclosure. Specification test limits are given in Table 8.2.1, Table 8.2.2.

Table 8.2.1 Radiated emission limits according to FCC Part 15, Section 109

Frequency, MHz	Class B limit, dB(μV/m)		Class A limit, dB(μV/m)	
	10 m distance	3 m distance	10 m distance	3 m distance
30 - 88	29.5*	40.0	39.0	49.5*
88 - 216	33.0*	43.5	43.5	54.0*
216 - 960	35.5*	46.0	46.4	56.9*
960 - 5 th harmonic**	43.5*	54.0	49.5	60.0*

* - The limit for test distance other than specified was calculated using the inverse linear distance extrapolation factor as follows: $\text{Lim}_{S_2} = \text{Lim}_{S_1} + 20 \log(S_1/S_2)$, where S_1 and S_2 – standard defined and test distance respectively in meters.

Table 8.2.2 Radiated emission limits according to RSS-Gen, Section 7.3

Frequency, MHz	Field strength limit at 3 m test distance, dB(μV/m)
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
960 - 5 th harmonic**	54.0

** - harmonic of the highest frequency the EUT generates, uses, operates or tunes to.

8.2.2 Test procedure

8.2.2.1 The EUT was set up as shown in Figure 8.2.1, energized and the performance check was conducted.

8.2.2.2 The measurements were performed in the semi anechoic chamber at 3 m test distance. The specified frequency range was investigated with biconilog antenna connected to EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal and the EUT cables position was varied.

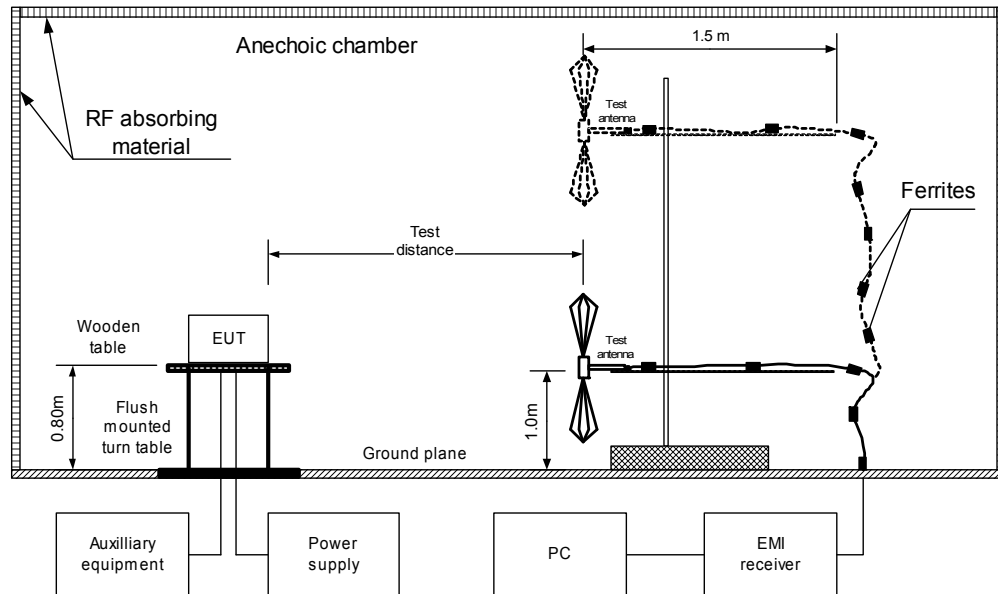
8.2.2.3 The worst test results (the lowest margins) were provided in the associated tables and plots.



HERMON LABORATORIES

Test specification:		FCC Part 15, Section 109 / RSS-Gen, Section 7.3 / ICES-003 section 6.2, Class B, Radiated emission	
Test procedure:		ANSI C63.4, Section 12.2.5	
Test mode:		Verdict: PASS	
Date(s):			
Temperature: 22 °C		Air Pressure: 1007 hPa	Relative Humidity: 56 %
		Power Supply: 120 VAC	
Remarks:			

Figure 8.2.1 Setup for radiated emission measurements in anechoic chamber, table-top equipment





HERMON LABORATORIES

Test specification:		FCC Part 15, Section 109 / RSS-Gen, Section 7.3 / ICES-003 section 6.2, Class B, Radiated emission	
Test procedure:		ANSI C63.4, Section 12.2.5	
Test mode:		Verdict: PASS	
Date(s):		17-Apr-16	
Temperature: 22 °C	Air Pressure: 1007 hPa	Relative Humidity: 56 %	Power Supply: 120 VAC
Remarks:			

Table 8.2.3 Radiated emission test results

EUT SET UP: TABLE-TOP
LIMIT: Class B
EUT OPERATING MODE: Stand-by and Receive
TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
FREQUENCY RANGE: 30 MHz – 1000 MHz
DETECTORS USED: PEAK / QUASI-PEAK
RESOLUTION BANDWIDTH: 120 kHz

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
33.5	43.8	37.4	40.0	-2.6	Vertical	1.3	80	Pass
44.8	36.5	29.6	40.0	-10.4	Vertical	1.3	210	
117.5	33.7	29.2	43.5	-14.3	Vertical	1.2	230	
729.0	41.7	40.1	46.0	-5.9	Vertical	1.4	170	
776.3	41.6	39.4	46.0	-6.6	Horizontal	1.3	110	

DETECTORS USED: PEAK / AVERAGE
FREQUENCY RANGE: 1000 MHz – 5000 MHz
RESOLUTION BANDWIDTH: 1000 kHz

Peak				Average			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
Frequency, MHz	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
No signals were found										Pass

*- Margin = Measured emission - specification limit.

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

Reference numbers of test equipment used

HL 0521	HL 0604	HL 4278	HL 4353	HL 4933			
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Full description is given in Appendix A.

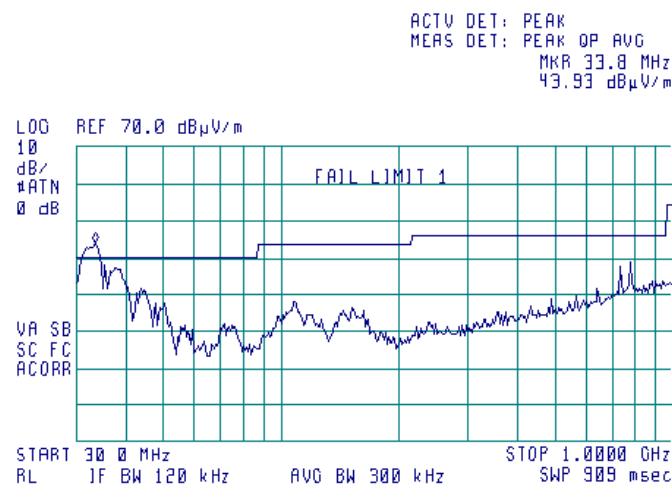


HERMON LABORATORIES

Test specification:		FCC Part 15, Section 109 / RSS-Gen, Section 7.3 / ICES-003 section 6.2, Class B, Radiated emission			
Test procedure:		ANSI C63.4, Section 12.2.5			
Test mode:		Compliance		Verdict: PASS	
Date(s):		17-Apr-16			
Temperature: 22 °C		Air Pressure: 1007 hPa		Relative Humidity: 56 %	
				Power Supply: 120 VAC	
Remarks:					

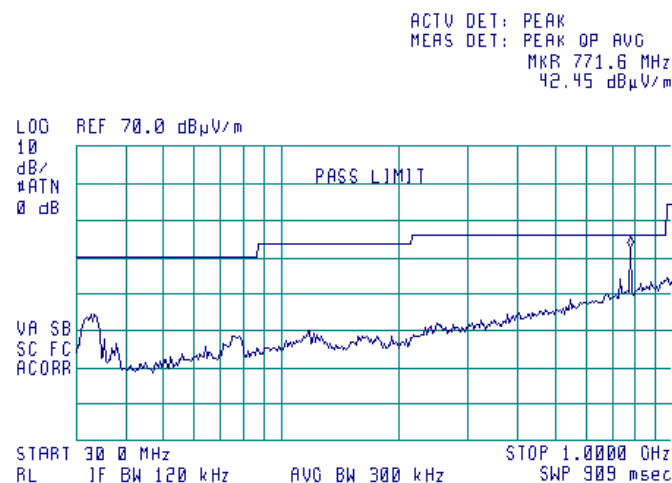
Plot 8.2.1 Radiated emission measurements in 30 - 1000 MHz range, vertical antenna polarization

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT OPERATING MODE: Stand-by



Plot 8.2.2 Radiated emission measurements in 30 - 1000 MHz range, horizontal antenna polarization

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT OPERATING MODE: Stand-by



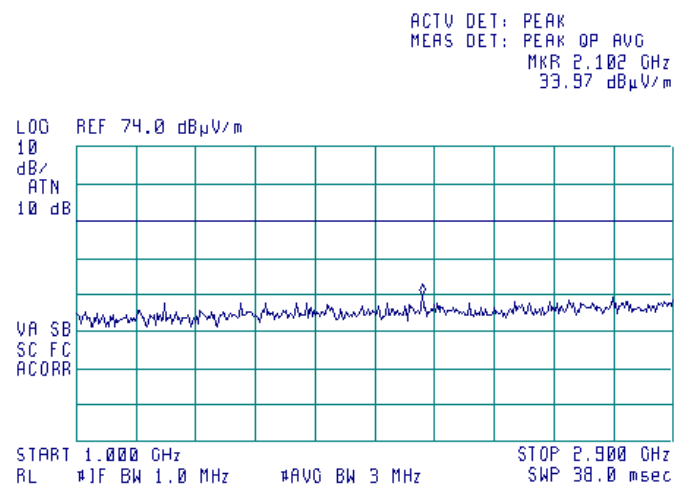


HERMON LABORATORIES

Test specification:		FCC Part 15, Section 109 / RSS-Gen, Section 7.3 / ICES-003 section 6.2, Class B, Radiated emission	
Test procedure:		ANSI C63.4, Section 12.2.5	
Test mode:		Compliance	
Date(s):		17-Apr-16	
Temperature: 22 °C		Air Pressure: 1007 hPa	
Remarks:		Relative Humidity: 56 %	Power Supply: 120 VAC

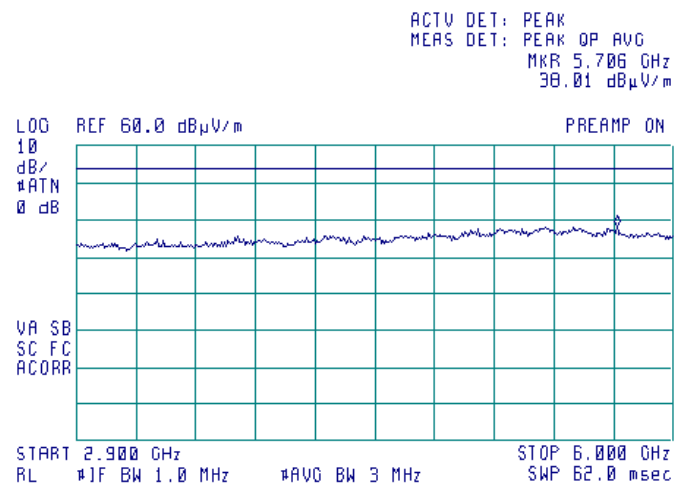
Plot 8.2.3 Radiated emission measurements from 1000 to 2900 MHz

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



Plot 8.2.4 Radiated emission measurements from 2900 to 6000 MHz

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



9 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check*	Due Cal./ Check*
0446	Antenna, Loop, Active, 10 kHz - 30 MHz	EMCO	6502	2857	19-Jan-17	19-Jan-18
0447	LISN, 16/2, 300V RMS, 50 Ohm/50 uH + 5 Ohm, STD CISPR 16-1	Hermon Laboratories	LISN 16 - 1	066	01-Nov-16	01-Nov-17
0495	Autotransformer 0-255V, 10A	Variac	EMPL01	495	01-Jun-17	01-Jun-18
0521	EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz	Hewlett Packard	8546A	3617A 00319, 3448A002 53	27-Oct-16	27-Oct-17
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	12-May-17	12-May-18
0787	Transient Limiter 9 kHz-200 MHz	Hewlett Packard	11947A	3107A018 77	26-Oct-16	26-Oct-17
1501	Cable RF, 6 m, BNC/BNC	Belden	M17/167 MIL-C-17	1501	15-Dec-16	15-Dec-17
1984	Antenna, Double-Ridged Waveguide Horn, 1 to 18 GHz, 300 W	EMC Test Systems	3115	9911-5964	13-Nov-16	13-Nov-17
2832	Load Termination, BNC, 50 Ohm	Hermon Laboratories	TBNC-50	2832	08-Nov-16	08-Nov-17
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY414447 62	09-Mar-17	09-Mar-18
3016	LISN, Two-line V-network, 9 kHz to 30 MHz, (50 uH+5 Ohm), CISPR16-1, MIL-461E	Rohde & Schwarz	ESH 3-Z5	892239/00 2	11-Jan-17	11-Jan-18
3346	High Pass Filter, 50 Ohm, 5000 to 11000 MHz.	Mini-Circuits	VHF-4600+	NA	01-Oct-15	01-Oct-17
3440	Precision Fixed Attenuator, 50 Ohm, 5 W, 20 dB, DC to 18 GHz	Mini-Circuits	BW-S20W5+	NA	07-Dec-16	07-Dec-17
3612	Cable RF, 17.5 m, N type-N type	Teldor	RG-214/U	NA	18-Dec-16	18-Dec-17
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY482502 88	07-May-17	07-May-18
3836	Load Termination 50 Ohm, 0.5 W, DC-1GHz	RELM	LT-50	NA	06-Nov-16	06-Nov-17
4278	Test Cable , DC-18 GHz, 4.6 m, N/M - N/M	Mini-Circuits	APC-15FT-NMNM+	0755A	26-Sep-16	26-Sep-17
4353	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	12025101 003	15-Mar-17	15-Mar-18
4909	High Pass Filter, 50 Ohm, 2640 to 6230 MHz., SMA-FM / SMA-M	Mini-Circuits	VHF-2275+	NA	01-Oct-15	01-Oct-17
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	14-Oct-16	14-Oct-17

*The calibration was valid at the testing time.

10 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted carrier power at RF antenna connector	Below 12.4 GHz: ± 1.7 dB 12.4 GHz to 40 GHz: ± 2.3 dB
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: ± 2.6 dB 2.9 GHz to 6.46 GHz: ± 3.5 dB 6.46 GHz to 13.2 GHz: ± 4.3 dB 13.2 GHz to 22.0 GHz: ± 5.0 dB 22.0 GHz to 26.8 GHz: ± 5.5 dB 26.8 GHz to 40.0 GHz: ± 4.8 dB
Occupied bandwidth	± 8.0 %
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Conducted emissions with LISN	9 kHz to 150 kHz: ± 3.9 dB 150 kHz to 30 MHz: ± 3.8 dB
Radiated emissions at 3 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 6.0 dB Biconical antenna: ± 5.7 dB Log periodic antenna: ± 6.0 dB Double ridged horn antenna: ± 6.0 dB

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

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

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

11 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, Radio, Safety, Environmental and Telecommunication testing facility.

Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for relevant parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; Recognized by Innovation, Science and Economic Development Canada for wireless and terminal testing (ISED), ISED #2186A, CAB identifier is IL1001; Certified by VCCI, Japan (the registration numbers are R-10808 for OATS, R-11082 for anechoic chamber, G-10869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-11606 for conducted emissions at telecommunication ports).

The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

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Person for contact: Mr. Michael Nikishin, EMC&Radio group manager

12 APPENDIX D Specification references

FCC 47CFR part 15: 2019	Radio Frequency Devices
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.2: 2016	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications
ANSI C63.4: 2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
RSS-247 Issue 2: 2017	Digital Transmission Systems (DTs), Frequency Hopping Systems (FHSs) and Licence- Exempt Local Area Network (LE-LAN) Devices
RSS-Gen Issue 5 with Am.1: 2019	General Requirements for Compliance of Radio Apparatus
ICES-003 Issue 6: 2019 (updated)	Information Technology Equipment (Including Digital Apparatus)— Limits and Methods of Measurement

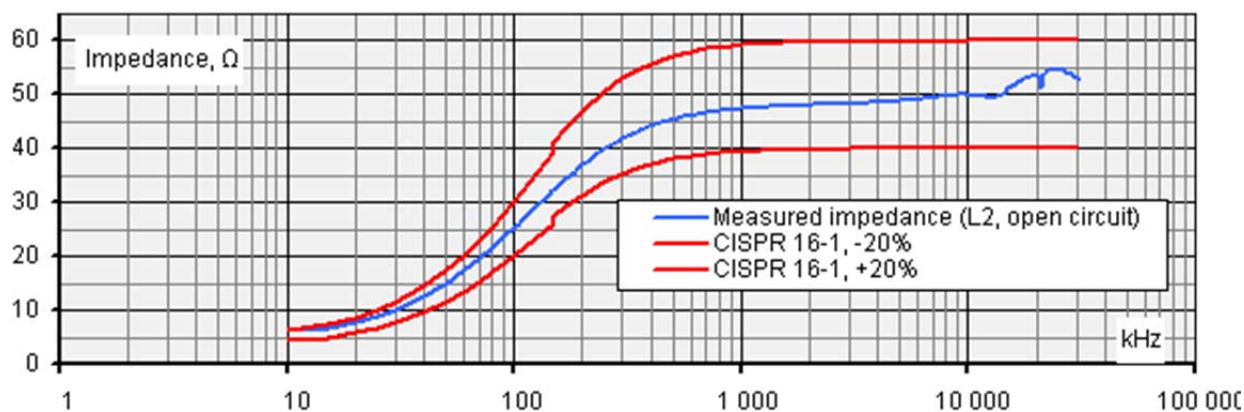
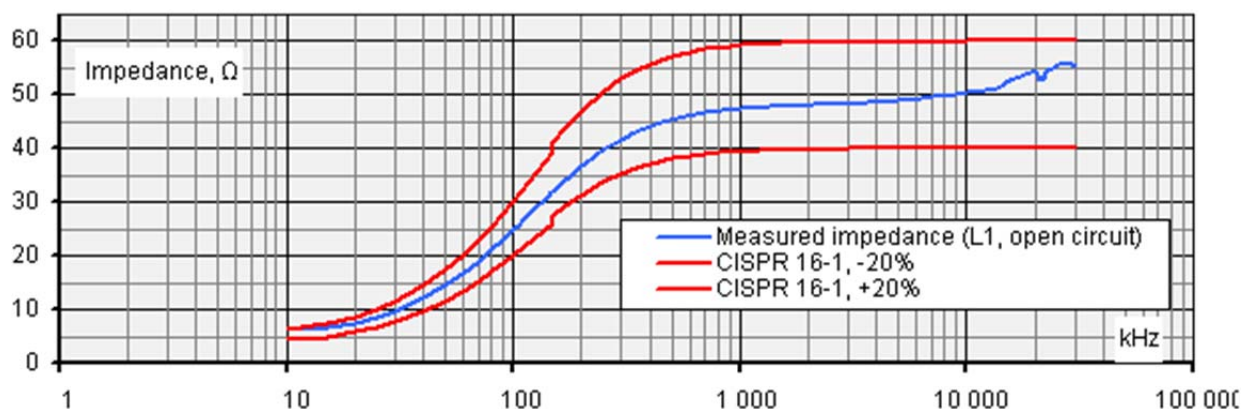
13 APPENDIX E Test equipment correction factors

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.

Correction factor
Line impedance stabilization network
Model ESH 3-Z5, Rhode&Schwarz, HL 3016



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).



HERMON LABORATORIES

Antenna factor, HL 4933

**Active Horn Antenna Factor Calibration**

1 GHz to 18 GHz

Equipment:			ACTIVE HORN ANTENNA		
Model:			AHA-118		
Serial Number:			701046		
Calibration Distance:			3 Meter		
Polarization:			Horizontal		
Calibration Date:			11/12/2014		
Frequency (GHz)	Preamplifier Gain (dB)	Antenna Factor with pre-amp (dB/m)	Frequency (GHz)	Preamplifier Gain (dB)	Antenna Factor with pre-amp (dB/m)
1	40.96	-16.47	10	40.94	-1.97
1.5	41.21	-14.53	10.5	40.63	-1.06
2	41.44	-13.30	11	40.74	-1.50
2.5	41.71	-12.87	11.5	40.65	-0.52
3	41.96	-12.26	12	40.76	-0.15
3.5	42.14	-11.77	12.5	41.03	-0.85
4	42.13	-10.91	13	41.37	-0.81
4.5	41.79	-9.41	13.5	41.18	0.05
5	41.44	-7.54	14	40.98	0.36
5.5	40.91	-6.47	14.5	40.81	1.26
6	40.69	-5.48	15	40.65	0.25
6.5	40.64	-5.53	15.5	40.93	-1.05
7	40.76	-4.12	16	41.31	-1.44
7.5	40.94	-3.12	16.5	40.96	-0.80
8	40.68	-1.69	17	40.64	-0.02
8.5	40.08	-1.71	17.5	40.57	1.81
9	40.41	-1.86	18	40.08	3.63
9.5	41.21	-2.73			
Calibration according to ARP 958					
Antenna Factor to be added to receiver reading:					
Meter Reading (dBuV) + Antenna Factor (dB/m) = Corrected Reading (dBuV/m)					

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

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

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

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

14 APPENDIX F Abbreviations and acronyms

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

END OF DOCUMENT