HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO: FCC CFR 47 part 15 subpart C, section 15.225 and subpart B; RSS-210 issue 8 Annex 2 section A2.6, ICES-003 Issue 5:2012

FOR:

On Track Innovations Ltd.

Ultra-compact, multi-purpose NFC reader

Models:

UNO-SATURN 6700

UNO-SATURN 6700 USB

FCC ID:JNX-OTI-SAT6700

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1 Applicant information

Client name:	On Track Innovations Ltd.
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Telephone:	+972 4686 8003
Fax:	+972 4693 8887
E-mail:	h_itay@otiglobal.com
Contact name:	Mr. Hemy Itay

2 Equipment under test attributes

Product name:	Ultra-compact, multi-purpose NFC reader
Product type:	RFID transceiver
Model(s):	UNO-SATURN 6700
Serial number:	T2
Hardware version:	V1
Software release:	040507
Receipt date	19-Jul-15

3 Manufacturer information

Manufacturer name:	On Track Innovations Ltd.
Address:	Z.H.R. Industrial zone, P.O. Box 32, Rosh Pina, 12000, Israel
Telephone:	+972 4686 8003
Fax:	+972 4693 8887
E-Mail:	h_itay@otiglobal.com
Contact name:	Mr. Hemy Itay

4 Test details

Project ID:	27289
Location:	Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel
Test started:	28-Jul-15
Test completed:	20-Sep-15
Test specification(s):	FCC CFR 47 part 15 subpart C, §15.225 and subpart B class B; RSS-210 issue 8 Annex 2 section A2.6, RSS-Gen issue 4, ICES-003 issue 5:2012

5 Tests summary

Test	Status
Transmitter characteristics	
FCC Sections 15.225(a) (b) (c) / RSS-210, Section A2.6, In band radiated emissions	Pass
FCC Sections 15.225(d) / RSS-210, Section A2.6, Out of band radiated emissions	Pass
FCC Section 15.225(e) / RSS-210, Section A2.6, Frequency stability	Pass
FCC Section 15.207(a) / RSS-Gen, Section 8.8, Conducted emission	Pass
FCC Section 15.215(c) / RSS-Gen, Section 6.6, Occupied bandwidth	Pass
FCC Section 15.203/ RSS-Gen, Section 8.3, Antenna requirements	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 7.1.2/ 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.

This test report supersedes the previously issued test report identified by Doc ID:OTIRAD_FCC.27289.

	Name and Title	Date	Signature
Tested by:	Mrs. E. Pitt, test engineer	September 20, 2015	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	May 16, 2016	
Approved by:	Mr. M. Nikishin, EMC and Radio group manager	May 17, 2016	

6 EUT description

6.1 General information

The EUT is an outdoor ultra-compact, multi-purpose NFC reader with proximity transceiver operating at 13.56 MHz.

The EUT has two models: UNO-SATURN 6700 and UNO-SATURN 6700 USB. The RFID transmitter is the same for the both models. The USB model supports USB communication with the host and is energized by the 5V supply via the USB mini connector.

The RS232 model supports RS-232 communication with the host and uses different connector, carrying both the communication and the 8-40VDC supply. And on board SMPS regulate the input DC supply down to 5VDC.

The combination of the both models was tested.

6.2 Ports and lines

Port type	Port description	Connected from	Connected to	Qty.	Cable type	Cable length
Signal	USB	EUT	Host Simulator	1	Shielded	1 m
Power + signal	DC power + RS-232	EUT	Host Simulator & AC/DC adaptor	1	Unshielded	1.5 m

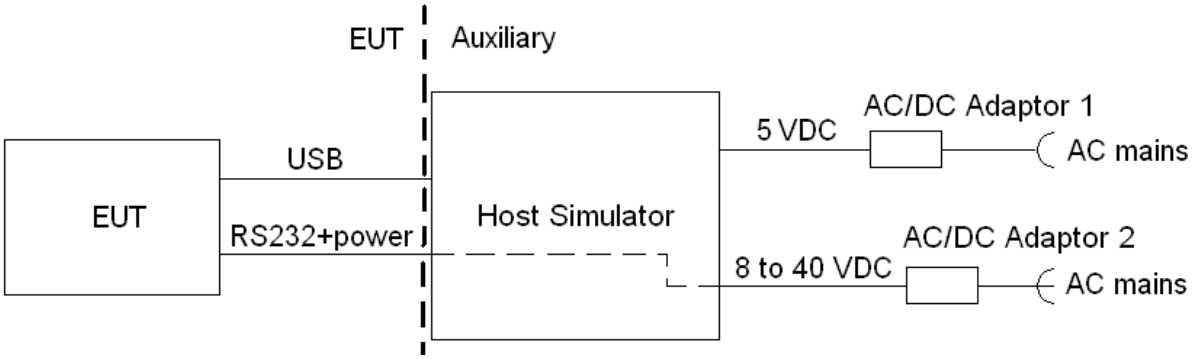
6.3 Auxiliary equipment

Description	Manufacturer	Model number	Serial number
AC/DC Adaptor 1 (AC / 5VDC)	Huawei	NA	NA
AC/DC Adaptor 2 (120 VAC / 8-40 VDC)	EMTC	MD242-120070-ADC	NA
Host Simulator	OTI	NA	NA

6.4 Changes made in EUT

No changes were implemented in the EUT during testing.

6.5 Test configuration



6.6 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	13.110-14.010 MHz
Operating frequency	13.56 MHz

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

Antenna connection				
unique coupling	standard connector	X	integral	with temporary RF connector
				X without temporary RF connector

Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
Loop	On Track Innovations	NA	NA

Type of modulation	AM				
Transmitter duty cycle supplied for test	100%				

Transmitter power source					
	Battery	**Nominal rated voltage**		Battery type	
X	DC	**Nominal rated voltage**	12 VDC from 120 VAC/8- 40 VDC adapter		
	AC mains	**Nominal rated voltage**		Frequency	

Test specification:	**Sections 15.225(a) (b) (c) / RSS-210, Section A2.6, In band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C and RSS-210 Annex 2 requirements

7.1 In band radiated emissions

7.1.1 General

This test was performed to measure field strength of fundamental emission and modulation products from the EUT within the assigned band. Specification test limits are given in Table 7.1.1.

Table 7.1.1 Radiated emission limits

Frequency, MHz	Field strength at 30 m distance*		Field strength at 3 m distance*	
	μV/m	dB(μV/m)	μV/m	dB(μV/m)**
13.110 – 13.410	106	40.5	10600	80.5
13.410 – 13.553	334	50.5	33400	90.5
13.553 – 13.567	**15848**	**84.0**	**1584800**	**124.0**
13.567 – 13.710	334	50.5	33400	90.5
13.710 – 14.010	106	40.5	10600	80.5

*- The limit is provided in quasi peak values.

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

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

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

7.1.2 Test procedure

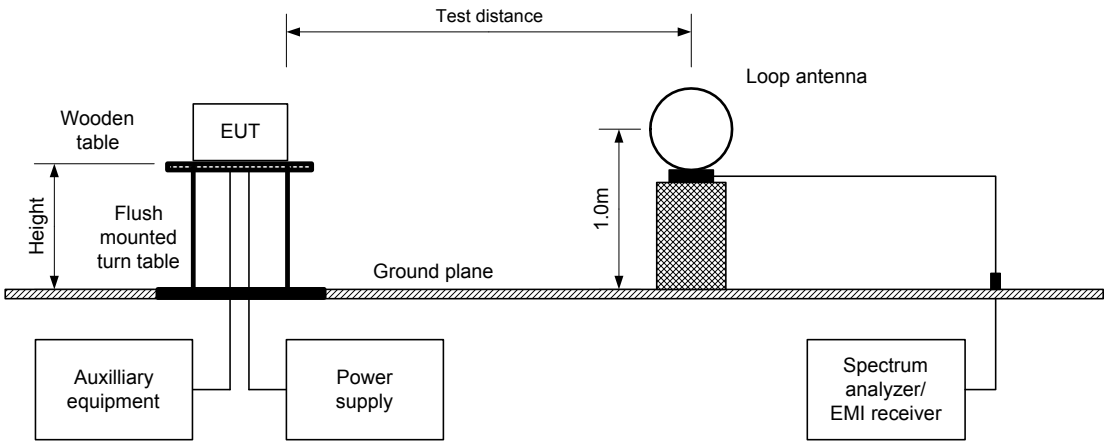
7.1.2.1 The EUT was set up as shown in Figure 7.1.1 energized and the performance check was conducted.

7.1.2.2 The specified frequency range was investigated with loop antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna was rotated around its vertical axis and the measuring antenna polarization was switched from vertical to horizontal.

7.1.2.3 The worst test results (the lowest margins) were recorded in Table 7.1.2 and shown in the associated plots.

Test specification:	**Sections 15.225(a) (b) (c) / RSS-210, Section A2.6, In band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Figure 7.1.1 Setup for in band radiated emission measurements



Test specification:	**Sections 15.225(a) (b) (c) / RSS-210, Section A2.6, In band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Table 7.1.2 In band radiated emission test results

TEST DISTANCE: 3 m
EUT POSITION: Typical
MODULATION: AM
MODULATING SIGNAL: PRBS
INVESTIGATED FREQUENCY RANGE: 13.553 – 13.567 MHz
RESOLUTION BANDWIDTH: 9.0 kHz
VIDEO BANDWIDTH: 30.0 kHz

Carrier frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Azimuth**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*			
Unom							Pass
13.563	78.33	77.9	124.0	-46.1	Vertical	270	
115%Unom							
13.563	78.26	78.0	124.0	-46.0	Vertical	270	
85%Unom							
13.563	78.17	77.9	124.0	-46.1	Vertical	270	

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

Reference numbers of test equipment used

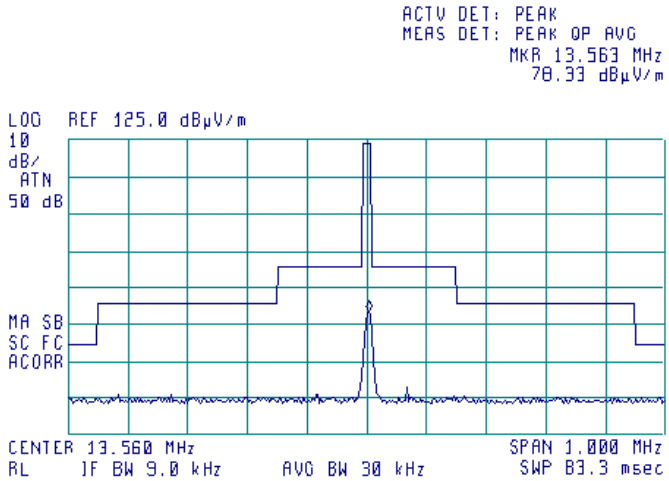
HL 0446	HL 0521	HL 4353	HL 4722				

Full description is given in Appendix A.

Test specification:	**Sections 15.225(a) (b) (c) / RSS-210, Section A2.6, In band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

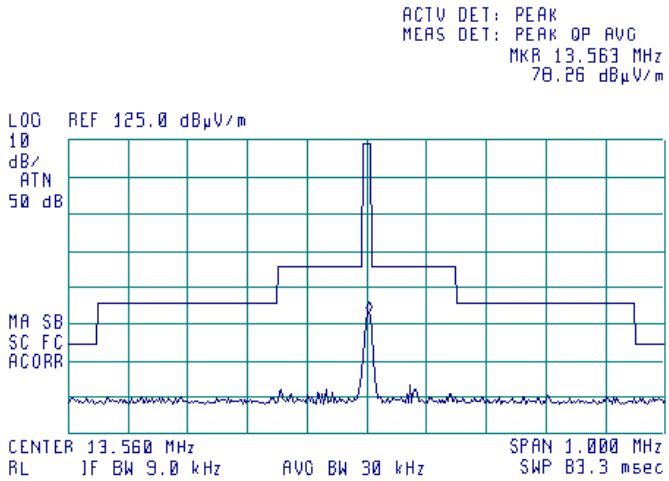
Plot 7.1.1 Fundamental emission test result at U_{nom} input voltage

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
DETECTOR: Peak hold
EUT POSITION Typical installation



Plot 7.1.2 Fundamental emission test result at 115%U_{nom} input voltage

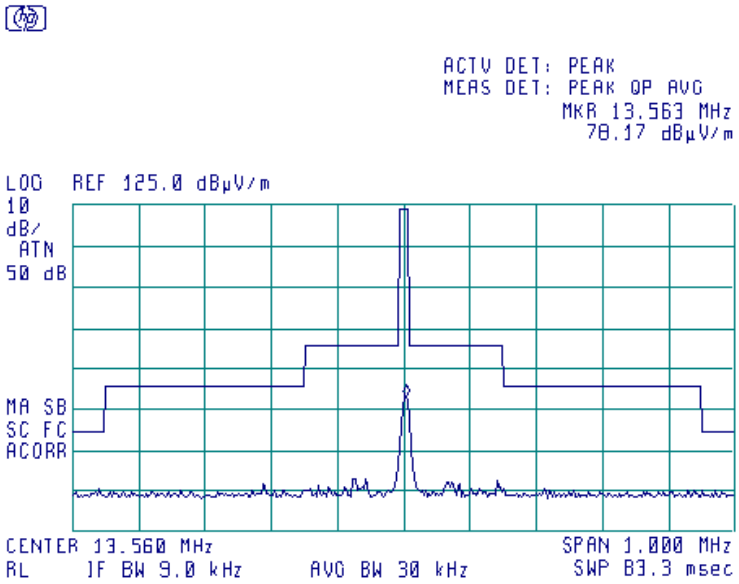
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
DETECTOR: Peak hold
EUT POSITION Typical installation



Test specification:	**Sections 15.225(a) (b) (c) / RSS-210, Section A2.6, In band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Plot 7.1.3 Fundamental emission test result at 85%U_{nom} input voltage

TEST SITE:	Semi anechoic chamber
TEST DISTANCE:	3 m
DETECTOR:	Peak hold
EUT POSITION	Typical installation



Test specification:	Sections 15.225(d) / RSS-210, Section A2.6, Out of band radiated emissions		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	Air Pressure: 1006 hPa	Relative Humidity: 49 %	Power Supply: 12 VDC
Remarks:			

7.2 Out of band radiated emissions

7.2.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Radiated emission limits

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

*- The above field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.
**- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

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

where S_1 and S_2 – standard defined and test distance respectively in meters.
***- The limit decreases linearly with the logarithm of frequency.

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

7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and the performance check was conducted.

7.2.2.2 The specified frequency range was investigated with loop antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna was rotated around its vertical axis and the measuring antenna polarization was switched from vertical to horizontal.

7.2.2.3 The worst test results (the lowest margins) were recorded in Table 7.2.2 and shown in the associated plots.

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

7.2.3.1 The EUT was set up as shown in Figure 7.2.2, energized and the performance check was conducted.

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

7.2.3.3 The worst test results (the lowest margins) were recorded in Table 7.2.2 and shown in the associated plots.

Test specification:	**Sections 15.225(d) / RSS-210, Section A2.6, Out of band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Figure 7.2.1 Radiated emissions below 30 MHz test set up

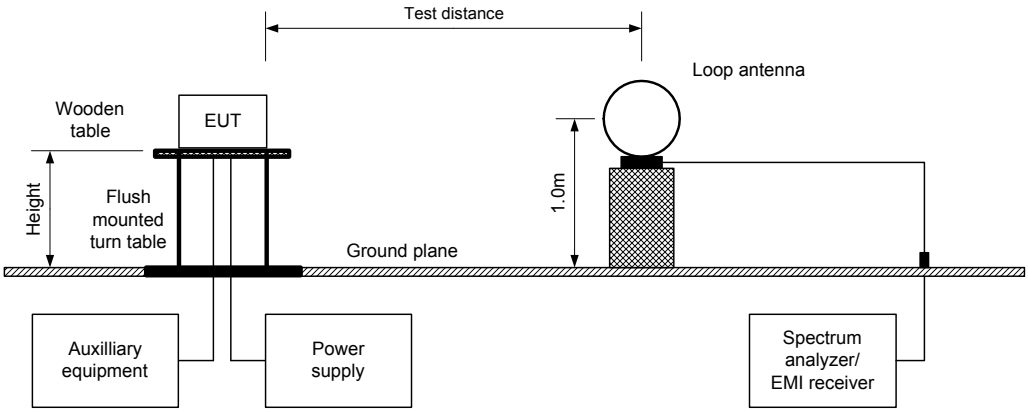
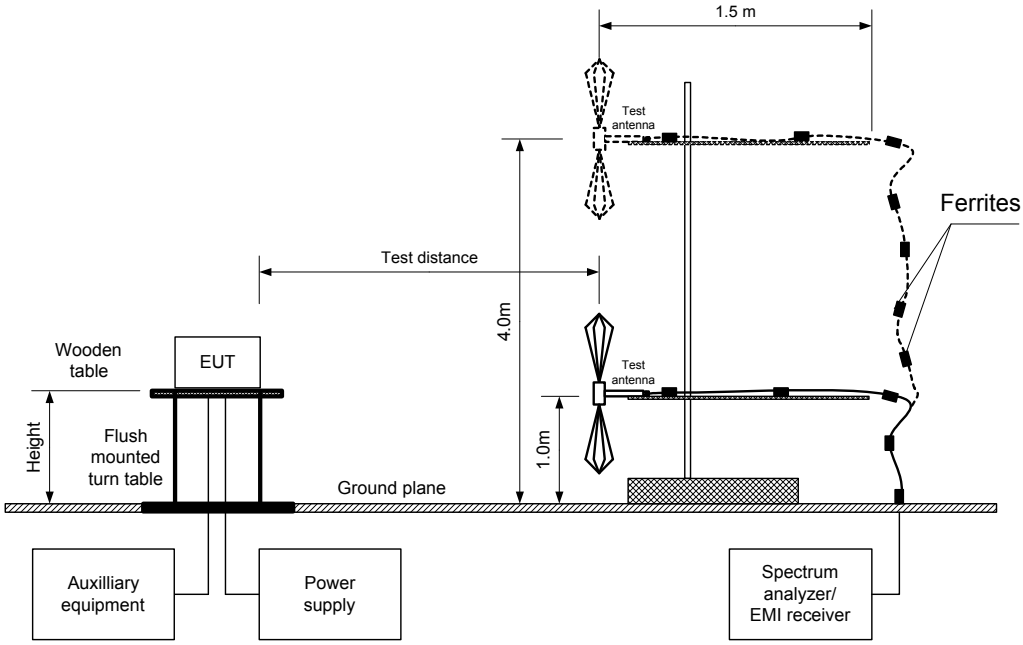


Figure 7.2.2 Radiated emissions above 30 MHz test set up



Test specification:	**Sections 15.225(d) / RSS-210, Section A2.6, Out of band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Table 7.2.2 Out of band radiated emissions test results

TEST DISTANCE: 3 m
EUT POSITION: Typical
MODULATION: AM
INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
RESOLUTION BANDWIDTH: 1.0 kHz (9 kHz – 150 kHz)
9.0 kHz (150 kHz – 30 MHz)
120 kHz (30 MHz – 1000 MHz)
VIDEO BANDWIDTH: ≥ Resolution bandwidth
TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
Biconilog (30 MHz – 1000 MHz)

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
27.119	46.99	45.2	69.5	-24.3	Vertical	0.8	300	Pass
37.338	43.85	36.04	40.0	-4.0	Vertical	1.2	0	
81.361	27.8	25.60	40.0	-14.4	Vertical	1.3	300	
189.128	34.7	33.43	43.5	-10.1	Vertical	1.5	30	
216.963	31..89	29.47	46.0	-16.5	Vertical	1.0	15	
37.800	34.21	28.16	40.0	-11.8	Horizontal	1.2	350	
189.868	31.63	30.41	43.5	-13.1	Horizontal	1.3	180	
230.525	28.07	24.32	46.0	-21.7	Horizontal	1.2	25	

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

Reference numbers of test equipment used

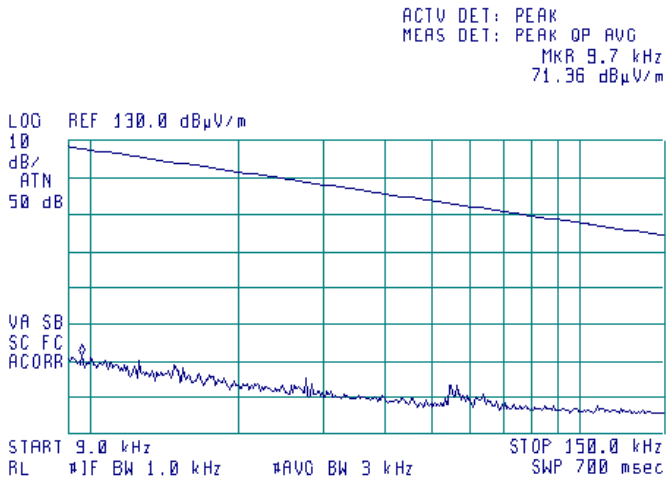
HL 0446	HL 0521	HL 0604	HL 4353	HL 4722			

Full description is given in Appendix A.

Test specification:	**Sections 15.225(d) / RSS-210, Section A2.6, Out of band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

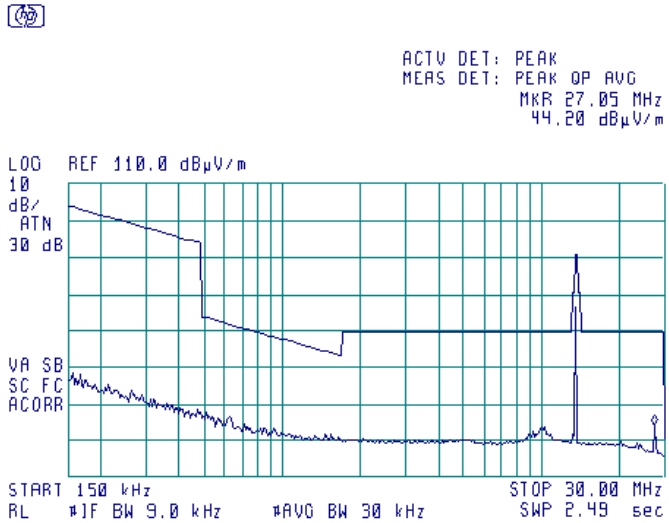
Plot 7.2.1 Radiated emission measurements from 9 to 150 kHz

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



Plot 7.2.2 Radiated emission measurements from 0.15 to 30 MHz

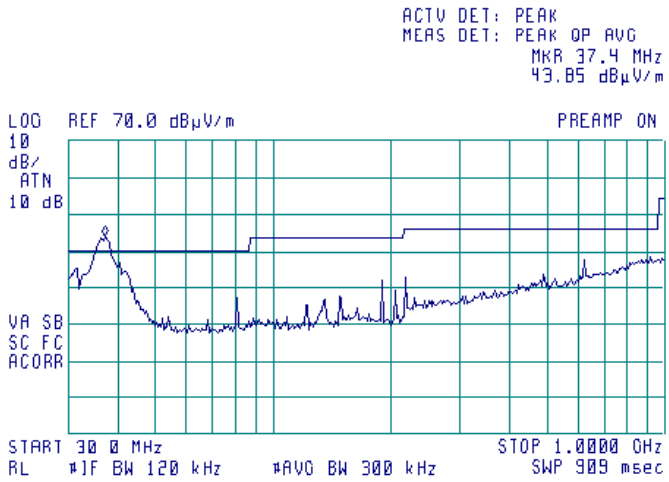
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
DETECTOR: Peak hold



Test specification:	**Sections 15.225(d) / RSS-210, Section A2.6, Out of band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

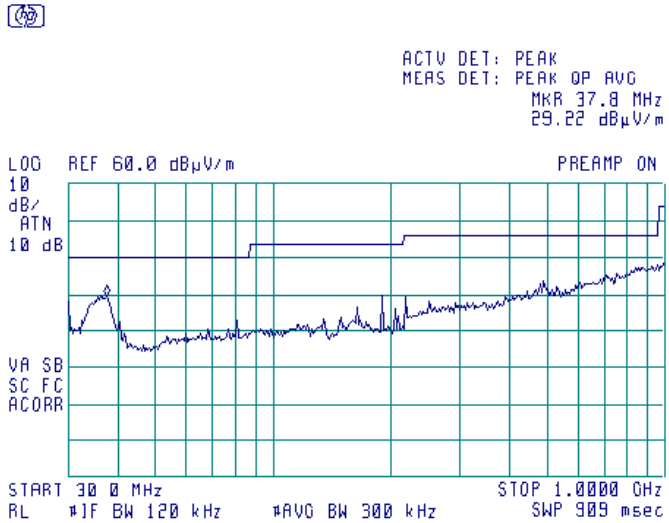
Plot 7.2.3 Radiated emission measurements from 30 to 1000 MHz

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



Plot 7.2.4 Radiated emission measurements from 30 to 1000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
DETECTOR: Peak hold



Test specification:	Section 15.225(e) / RSS-210, Section A2.6, Frequency stability		
Test procedure:	ANSI C63.4, Section 13.1.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Aug-15		
Temperature: 23 ºC	Air Pressure: 1009 hPa	Relative Humidity: 49 %	Power Supply: 12 VDC
Remarks:			

7.3 Frequency stability test

7.3.1 General

This test was performed to measure frequency stability of transmitter RF carrier. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Frequency stability limits

Assigned frequency, MHz	Maximum allowed frequency displacement	
	%	Hz
13.560	± 0.01 %	1356

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.

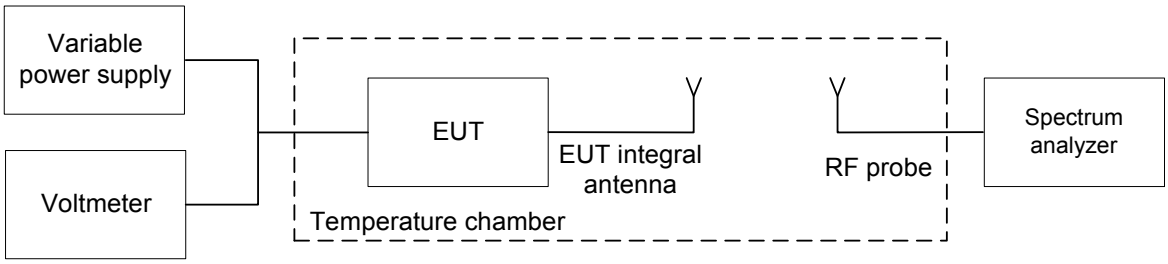
7.3.2.2 The EUT power was turned off. Temperature within test chamber was set to the required one and a period of time sufficient to stabilize all of the oscillator circuit components was allowed.

7.3.2.3 The EUT was powered on and carrier frequency was measured at start up moment and then after 2, 5 and 10 minutes. The EUT was powered off.

7.3.2.4 The above procedure was repeated at the rest of the test temperatures and voltages as provided in Table 7.3.2.

7.3.2.5 Frequency displacement was calculated and compared with the limit as provided in Table 7.3.2.

Figure 7.3.1 Frequency stability test setup



Test specification:	**Section 15.225(e) / RSS-210, Section A2.6, Frequency stability**		
Test procedure:	ANSI C63.4, Section 13.1.6		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1009 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Table 7.3.2 Frequency stability test results

OPERATING FREQUENCY: 13.560 MHz
NOMINAL POWER VOLTAGE: 12.0 VDC
TEMPERATURE STABILIZATION PERIOD: 20 min
POWER DURING TEMPERATURE TRANSITION: Off
SPECTRUM ANALYZER MODE: Counter
RESOLUTION BANDWIDTH: 1 kHz
VIDEO BANDWIDTH: 3 kHz
MODULATION: AM

Temperature, ºC	Voltage, V	Frequency, MHz				Max frequency drift, Hz		Limit, Hz	Margin, Hz	Verdict
		Start up	2nd min	5th min	10th min	Positive	Negative			
-20	nominal	13.55997	13.55993	13.55993	13.55993	140	100	1356	-1216	Pass
20	nominal +15%	13.55983	13.55993	13.55993	13.55990	100	0		-1256	
20	nominal	13.55983	13.55990	13.55990	13.55983	NA	NA		NA	
20	nominal -15%	13.55893	13.55980	13.55980	13.55980	-30	-900		-456	
50	nominal	13.55993	13.55987	13.55987	13.55983	100	0		-1256	

* - Reference frequency

Reference numbers of test equipment used

HL 0493	HL 1424	HL 3810					

Full description is given in Appendix A.

Test specification:	**Section 15.215(c) / RSS-Gen, section 6.6, Occupied bandwidth**		
Test procedure:	ANSI C63.4, Section 13.1.7		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	06-Aug-15		
Temperature: 24.4 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 46 %	**Power Supply:** 12 VDC
Remarks:			

7.4 Occupied bandwidth test

7.4.1 General

This test was performed to verify that the 20 dB bandwidth of the emissions was contained within the standard specified frequency band according to FCC §15.215 requirements. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Occupied bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc
13.110 – 13.410	20.0
13.410 – 13.553	
13.553 – 13.567	
13.567 – 13.710	
13.710 – 14.010	

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

7.4.2 Test procedure

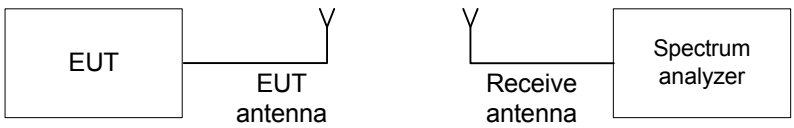
7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized and its proper operation was checked.

7.4.2.2 The spectrum analyzer sweep time and bandwidth were set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.

7.4.2.3 The peak of emission was measured. The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.4.2 and associated plots.

7.4.2.4 Modulation bandwidth was calculated by adding of the negative frequency drift to the lower measured frequency and the positive frequency drift to the higher measured frequency. The obtained modulation bandwidth was verified to be within the allowed frequency range.

Figure 7.4.1 Occupied bandwidth test setup



Test specification:	**Section 15.215(c) / RSS-Gen, section 6.6, Occupied bandwidth**		
Test procedure:	ANSI C63.4, Section 13.1.7		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	06-Aug-15		
Temperature: 24.4 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 46 %	**Power Supply:** 12 VDC
Remarks:			

Table 7.4.2 Occupied bandwidth test results

ASSIGNED FREQUENCY BAND	13.110 – 14.010 MHz
DETECTOR USED:	Peak hold
RESOLUTION BANDWIDTH:	1 kHz
VIDEO BANDWIDTH:	10 kHz
MODULATION ENVELOPE REFERENCE POINTS:	20 dBc
MODULATION:	AM
MODULATING SIGNAL:	enable

Band edge	Cross point frequency, MHz	Frequency drift, Hz		Modulation band edge, MHz	Assigned band edge, MHz	Verdict
		Negative	Positive			
Low	13.55793	-900	NA	13.55703	13.553	Pass
High	13.56158	NA	140	13.56172	13.567	Pass

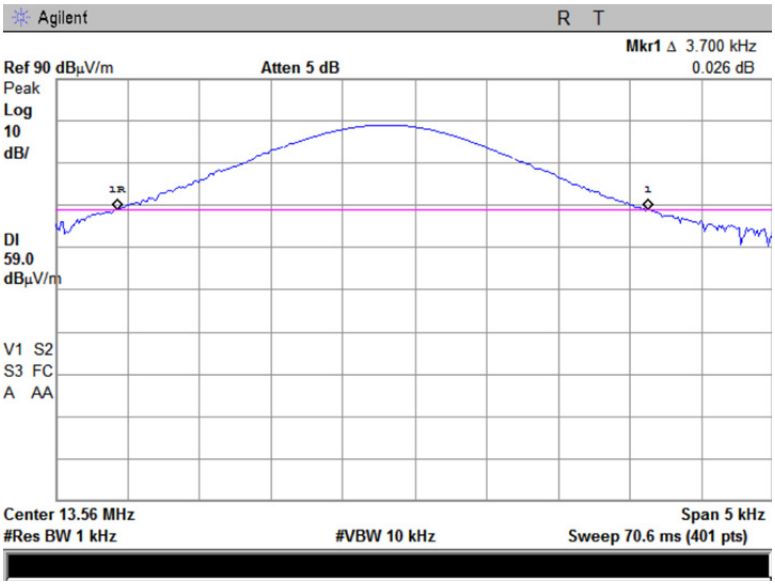
Reference numbers of test equipment used

HL 0446	HL 2780	HL 4721	HL 4347					

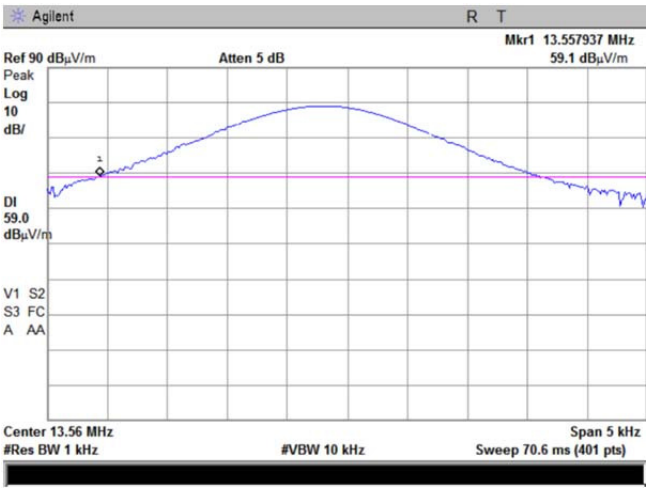
Full description is given in Appendix A.

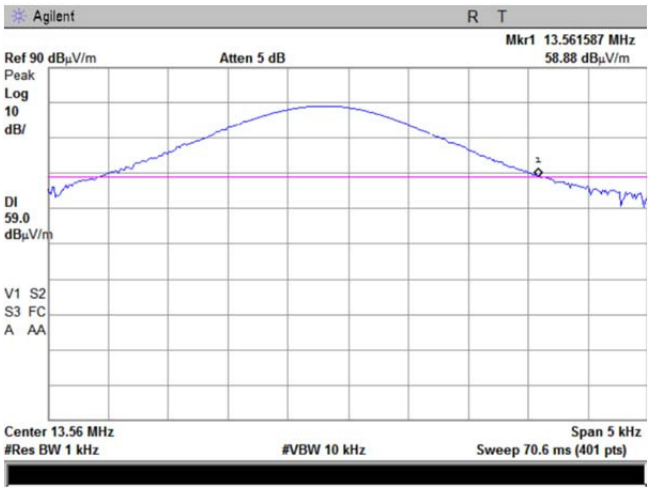
Test specification:	**Section 15.215(c) / RSS-Gen, section 6.6, Occupied bandwidth**		
Test procedure:	ANSI C63.4, Section 13.1.7		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	06-Aug-15		
Temperature: 24.4 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 46 %	**Power Supply:** 12 VDC
Remarks:			

Plot 7.4.1 Occupied bandwidth test result



Plot 7.4.2 Occupied bandwidth test result, low and high band frequencies





Test specification:	**FCC Part 15, Section 207 / RSS-Gen, Section 8.8, Conducted emission**		
Test procedure:	ANSI C63.4, Section 13.1.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	17-Sep-15		
Temperature: 24 ºC	**Air Pressure:** 1008 hPa	**Relative Humidity:** 55 %	**Power Supply:** 120 VAC
Remarks: Controller/Repeater			

7.5 Conducted emissions

7.5.1 General

This test was performed to measure common mode conducted emissions at the power port. Specification test limits are given in Table 7.5.1.

Table 7.5.1 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.

7.5.2 Test procedure

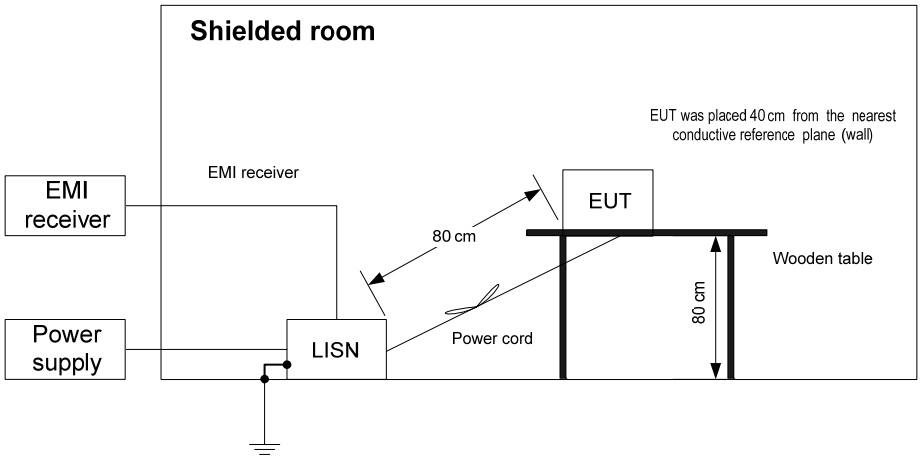
7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and the performance check was conducted.

7.5.2.2 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.

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

7.5.2.4 The worst test results (the lowest margins) were recorded in Table 7.5.2 and shown in the associated plots.

Figure 7.5.1 Setup for conducted emission measurements, table-top equipment



Test specification:	**FCC Part 15, Section 207 / RSS-Gen, Section 8.8, Conducted emission**		
Test procedure:	ANSI C63.4, Section 13.1.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	17-Sep-15		
Temperature: 24 ºC	**Air Pressure:** 1008 hPa	**Relative Humidity:** 55 %	**Power Supply:** 120 VAC
Remarks: Controller/Repeater			

Table 7.5.2 Conducted emission test results

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*		
0.460	53.28	50.29	56.74	-6.45	40.09	46.74	-6.65	L1	Pass
1.150	50.30	46.41	56.00	-9.59	36.03	46.00	-9.97		
1.931	53.21	49.63	56.00	-6.37	39.90	46.00	-6.10		
2.649	53.01	48.87	56.00	-7.13	39.56	46.00	-6.44		
3.250	45.22	41.02	56.00	-14.98	31.74	46.00	-14.26		
0.457	54.00	50.85	56.79	-5.94	41.22	46.79	-5.57	L2	Pass
1.131	51.41	46.64	56.00	-9.36	37.08	46.00	-8.92		
1.950	54.31	50.47	56.00	-5.53	40.32	46.00	-5.68		
2.595	54.39	50.45	56.00	-5.55	40.77	46.00	-5.23		
3.139	46.85	41.91	56.00	-14.09	32.32	46.00	-13.68		

*- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

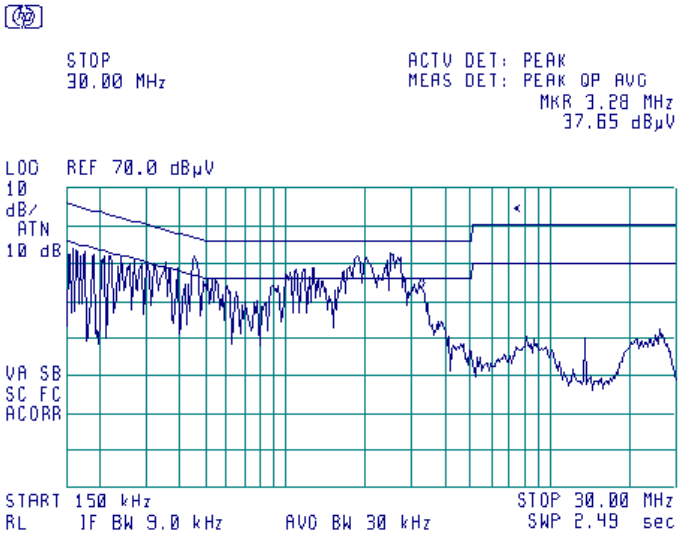
HL 0447	HL 0787	HL 1425	HL 1513	HL 3612			

Full description is given in Appendix A.

Test specification:	FCC Part 15, Section 207 / RSS-Gen, Section 8.8, Conducted emission		
Test procedure:	ANSI C63.4, Section 13.1.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Sep-15		
Temperature: 24 ºC	Air Pressure: 1008 hPa	Relative Humidity: 55 %	Power Supply: 120 VAC
Remarks: Controller/Repeater			

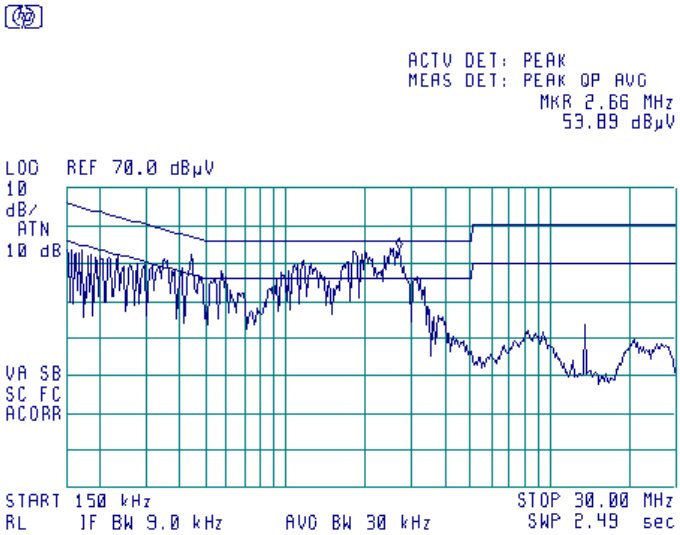
Plot 7.5.1 Conducted emission measurements

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



Plot 7.5.2 Conducted emission measurements

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



Test specification:	**FCC Section 15.203/ RSS-Gen, Section 7.1.4, Antenna requirement**		
Test procedure:	Visual inspection / supplier declaration		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	08-Sep-15		
Temperature: 23 ºC	**Air Pressure:** 1009 hPa	**Relative Humidity:** 46 %	**Power Supply:** 12 VDC
Remarks:			

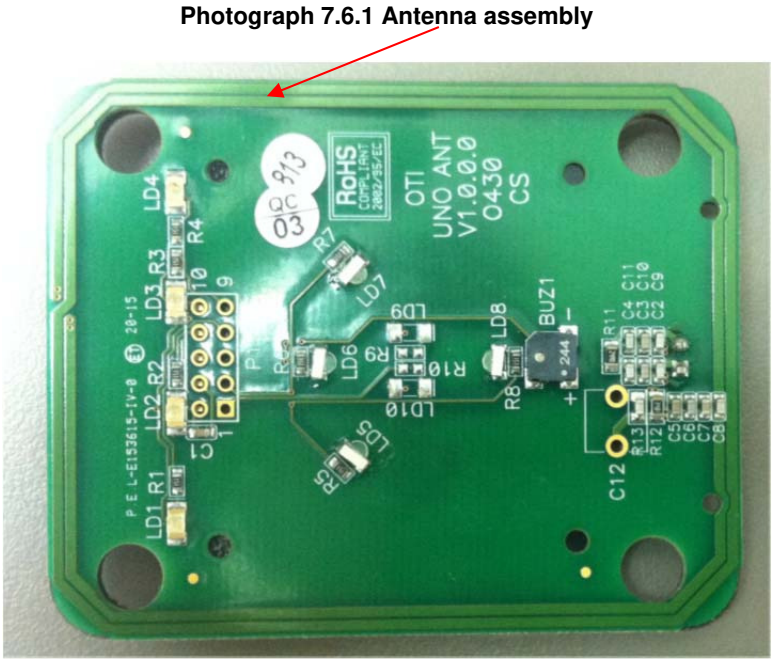
7.6 Antenna requirements

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 7.6.1.

Table 7.6.1 Antenna requirements

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

Photograph 7.6.1 Antenna assembly



Test specification:	**FCC Part 15, Section 107 / ICES-003, Section 6.1, Class B, Conducted emission at AC power port**		
Test procedure:	ANSI C63.4, Sections 11.5 and 12.1.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-Jul-15		
Temperature: 24 ºC	**Air Pressure:** 1004 hPa	**Relative Humidity:** 45 %	**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 photograph, energized and the performance check was conducted.

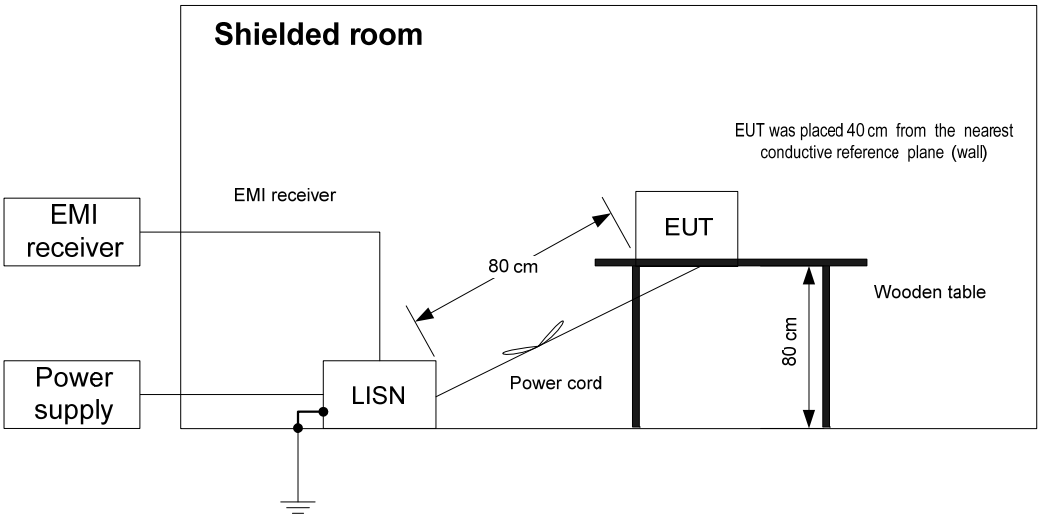
8.1.2.2 The measurements were performed at power terminals with the LISN, connected to a spectrum analyzer in the frequency range referred to in Table 8.1.2. Unused coaxial connector of the LISN was terminated with 50 Ohm. Quasi-peak and average detectors were used throughout the testing.

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.

Test specification:	**FCC Part 15, Section 107 / ICES-003, Section 6.1, Class B, Conducted emission at AC power port**		
Test procedure:	ANSI C63.4, Sections 11.5 and 12.1.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-Jul-15		
Temperature: 24 ºC	**Air Pressure:** 1004 hPa	**Relative Humidity:** 45 %	**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

Test specification:	**FCC Part 15, Section 107 / ICES-003, Section 6.1, Class B, Conducted emission at AC power port**		
Test procedure:	ANSI C63.4, Sections 11.5 and 12.1.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-Jul-15		
Temperature: 24 ºC	**Air Pressure:** 1004 hPa	**Relative Humidity:** 45 %	**Power Supply:** 120 VAC
Remarks:			

Table 8.1.2 Conducted emission test results

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

Frequency, MHz	Peak emission, dB(μV)	Quasi-peak			Average			Line ID	Verdict
		Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*	Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*		
0.460	53.28	50.29	56.74	-6.45	40.09	46.74	-6.65	L1	Pass
1.150	50.30	46.41	56.00	-9.59	36.03	46.00	-9.97		
1.931	53.21	49.63	56.00	-6.37	39.90	46.00	-6.10		
2.649	53.01	48.87	56.00	-7.13	39.56	46.00	-6.44		
3.250	45.22	41.02	56.00	-14.98	31.74	46.00	-14.26		
0.457	54.00	50.85	56.79	-5.94	41.22	46.79	-5.57	L2	Pass
1.131	51.41	46.64	56.00	-9.36	37.08	46.00	-8.92		
1.950	54.31	50.47	56.00	-5.53	40.32	46.00	-5.68		
2.595	54.39	50.45	56.00	-5.55	40.77	46.00	-5.23		
3.139	46.85	41.91	56.00	-14.09	32.32	46.00	-13.68		

*- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

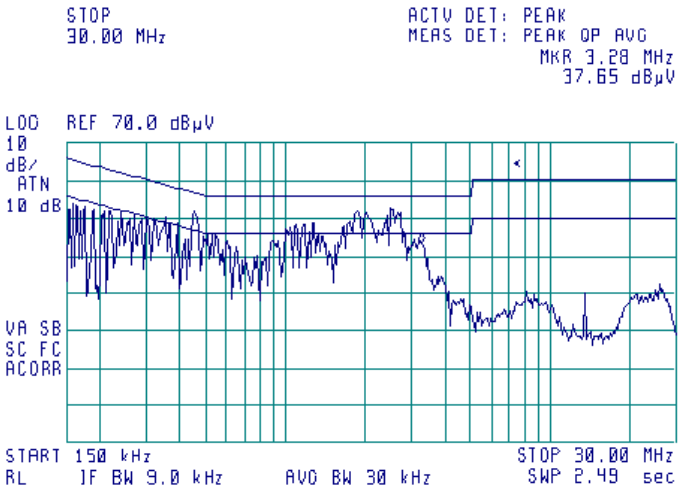
HL 0447	HL 0787	HL 1425	HL 1513	HL 3612			

Full description is given in Appendix A.

Test specification:	**FCC Part 15, Section 107 / ICES-003, Section 6.1, Class B, Conducted emission at AC power port**		
Test procedure:	ANSI C63.4, Sections 11.5 and 12.1.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-Jul-15		
Temperature: 24 ºC	**Air Pressure:** 1004 hPa	**Relative Humidity:** 45 %	**Power Supply:** 120 VAC
Remarks:			

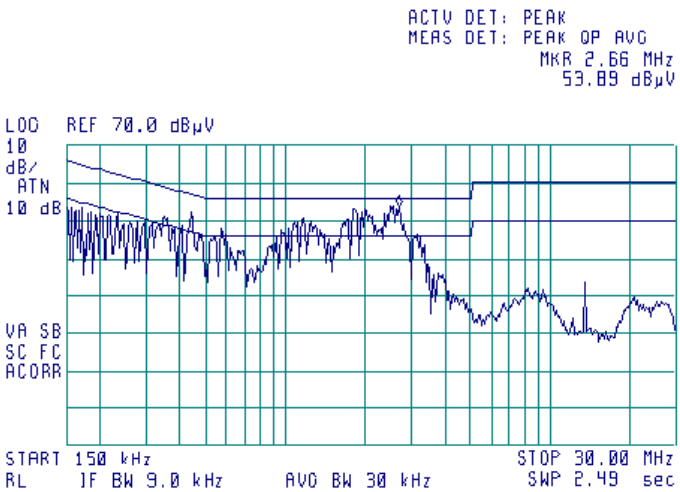
Plot 8.1.1 Conducted emission measurements

LINE: L1
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Plot 8.1.2 Conducted emission measurements

LINE: L2
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Test specification:	FCC Part 15, Section 109 / RSS-Gen, Section 7.1.2 / ICES-003, Radiated emission		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	Air Pressure: 1006 hPa	Relative Humidity: 49 %	Power Supply: 12 VDC
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, 8.2.2.

Table 8.2.1 Radiated emission limits according to FCC Part 15, Section 109 and ICES-003, Section 6.2

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 - 5th 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: $Lim_{S2} = Lim_{S1} + 20 \log (S_1/S_2)$,
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 7.1.2

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 - 5th 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 and associated photographs, energized and the performance check was conducted.

8.2.2.2 Preliminary measurements were performed in the anechoic chamber at 3 m test distance. The specified frequency range was investigated with biconical and log periodic antennas connected to EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed, its polarization was switched from vertical to horizontal and the EUT cables position was varied.

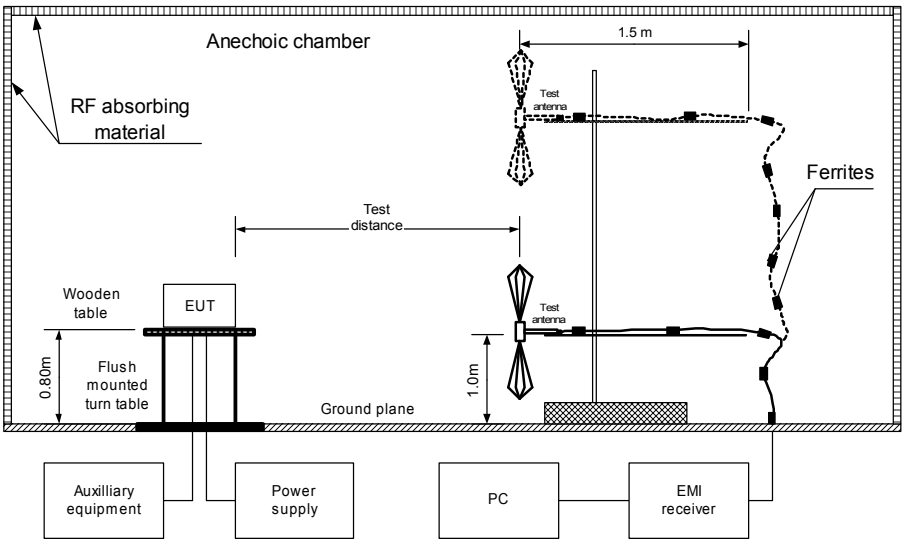
8.2.2.3 The EUT was set up as shown in Figure 8.2.2, energized and the performance check was conducted.

8.2.2.4 Final measurements were performed at the open area test site at 10 m test distance. The EUT wires and cables were arranged to produce maximum emission as it was found during preliminary measurements. The frequencies yield the worst test results (the lowest margins) during preliminary testing were investigated with biconilog antenna connected to EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed from 1 to 4 m and its polarization was changed from vertical to horizontal.

8.2.2.5 The worst test results (the lowest margins) were recorded in Table 8.2.3 and shown in the associated plots.

Test specification:	**FCC Part 15, Section 109 / RSS-Gen, Section 7.1.2 / ICES-003, Radiated emission**		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

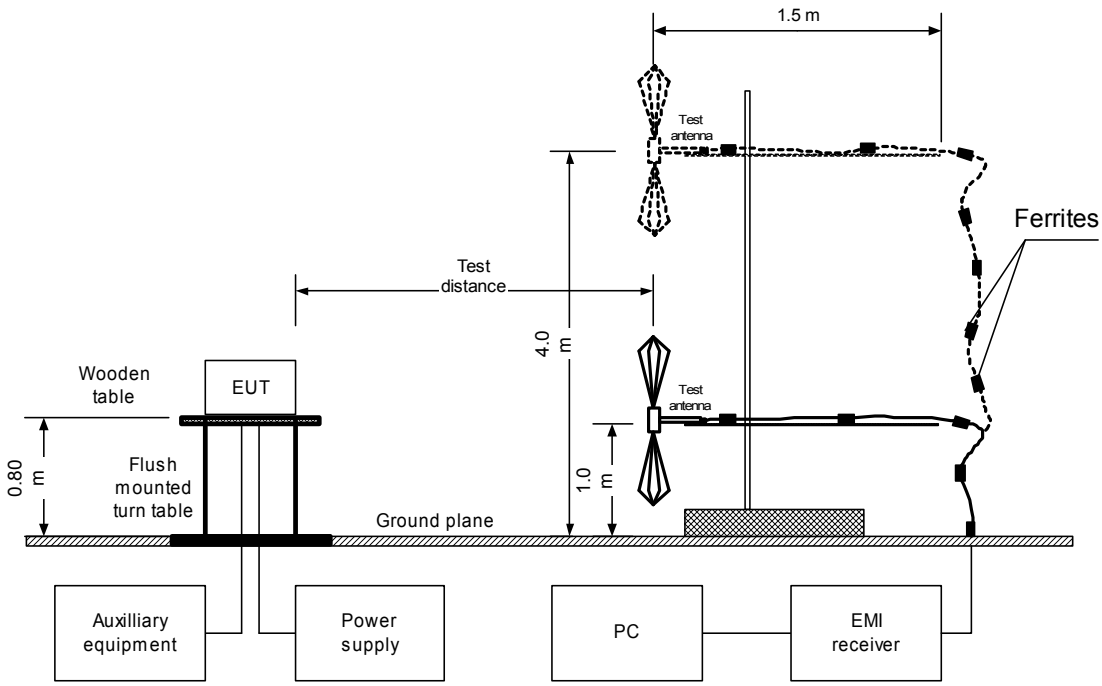
Figure 8.2.1 Setup for radiated emission measurements in anechoic chamber, table-top equipment



Photograph 8.2.1 Setup for preliminary radiated emission measurements

Test specification:	**FCC Part 15, Section 109 / RSS-Gen, Section 7.1.2 / ICES-003, Radiated emission**		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Figure 8.2.2 Setup for radiated emission measurements at OATS, table-top equipment



Test specification:	**FCC Part 15, Section 109 / RSS-Gen, Section 7.1.2 / ICES-003, Radiated emission**		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Photograph 8.2.2 Setup for final radiated emission measurements, general view

Photograph 8.2.3 Setup for final radiated emission measurements, EUT cabling

Test specification:	**FCC Part 15, Section 109 / RSS-Gen, Section 7.1.2 / ICES-003, Radiated emission**		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

Table 8.2.3 Radiated emission test results

EUT SET UP:	TABLE-TOP
LIMIT:	Class B
EUT OPERATING MODE:	Receive / Stand-by
TEST SITE:	OATS
TEST DISTANCE:	10 m
DETECTORS USED:	PEAK / QUASI-PEAK
FREQUENCY RANGE:	30 MHz – 1000 MHz
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*				
37.338	32.1	26.3	29.5	-3.2	Vertical	1.1	200	Pass
81.361	27.8	23.4	29.5	-6.1	Vertical	1.1	100	
189.128	28.3	25.3	33.0	-7.7	Vertical	1.3	335	
216.963	28.0	24.2	43.5	-19.3	Vertical	1.4	180	

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

Reference numbers of test equipment used

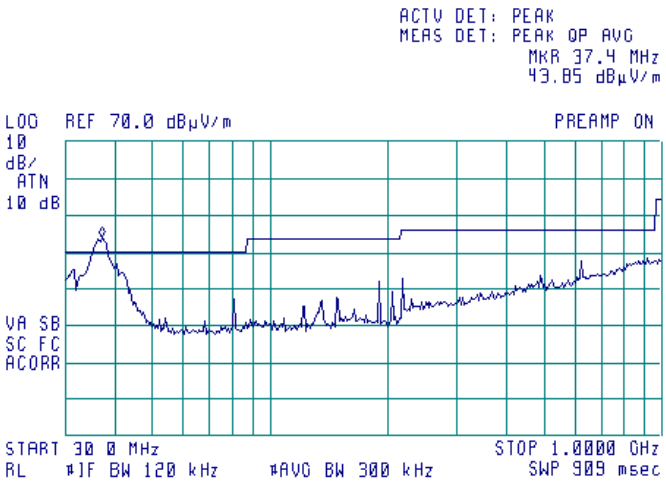
HL 0521	HL 0604	HL 0784	HL 0813	HL 1552	HL 4278	HL 4353	HL 4778

Full description is given in Appendix A.

Test specification:	**FCC Part 15, Section 109 / RSS-Gen, Section 7.1.2 / ICES-003, Radiated emission**		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	05-Aug-15		
Temperature: 23 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 49 %	**Power Supply:** 12 VDC
Remarks:			

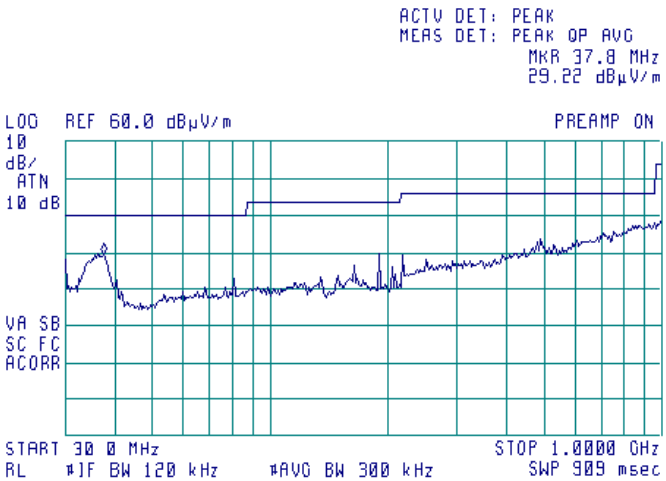
Plot 8.2.1 Radiated emission measurements in 30 - 1000 MHz range, vertical antenna polarization

TEST SITE: Semi anechoic chamber
LIMIT: Class B
TEST DISTANCE: 3 m
EUT OPERATING MODE: Receive / Stand-by



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

TEST SITE: Semi anechoic chamber
LIMIT: Class B
TEST DISTANCE: 3 m
EUT OPERATING MODE: Receive / Stand-by



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	13-Jan-15	13-Jan-16
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
0493	Temperature Chamber -45…175 deg C	Thermotron	S-1.2 Mini-Max	14016	25-May-15	25-May-16
0521	EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz	Hewlett Packard	8546A	3617A 00319, 3448A002 53	22-Oct-14	22-Oct-15
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	15-May-15	15-May-16
0784	Antenna X-WING BILOG, 20 MHz - 2 GHz	Schaffner-Chase EMC	CBL6140 A	1120	15-May-15	15-May-16
0787	Transient Limiter 9 kHz-200 MHz	Hewlett Packard	11947A	3107A018 77	12-Oct-15	12-Oct-16
0813	Cable Coax, 12 m, N-type, up to 3.0 GHz	Hermon Laboratories	C214-12	149	07-Dec-14	07-Dec-15
1424	Spectrum Analyzer, 30 Hz- 40 GHz	Agilent Technologies	8564EC	3946A002 19	12-Apr-15	12-Apr-16
1425	EMI Receiver, 9 kHz - 2.9 GHz, System: HL1426, HL1427	Agilent Technologies	8542E	3710A002 22, 3705A002 04	24-Dec-14	24-Dec-15
1513	Cable RF, 8 m, BNC/BNC	Belden	M17/167 MIL-C-17	1513	08-Sep-15	08-Sep-16
1552	Cable RF, 8 m	Alpha Wire	RG-214	1552	07-Dec-14	07-Dec-15
2780	EMC analyzer, 100 Hz to 26.5 GHz	Agilent Technologies	E7405A	MY451024 62	08-Sep-15	08-Sep-16
3612	Cable RF, 17.5 m, N type-N type	Teldor	RG-214/U	NA	07-Dec-14	07-Dec-15
3810	Near-Field Probe Set, Hand held, 6 probes	EMC Test Systems	7405	9706-3927	01-Jan-15	01-Jan-16
4278	Test Cable , DC-18 GHz, 4.6 m, N/M - N/M	Mini-Circuits	APC-15FT-NMNM+	0755A	20-Nov-14	20-Nov-15
4347	Low Loss Armored Test Cable, DC - 18 GHz, 2.0 m, N type-M/N type-M	MegaPhase	NC29-N1N1-79	12025103 001	08-Jan-15	08-Jan-16
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-15	15-Mar-16
4721	Low Loss Armored Test Cable, DC - 18 GHz, 4.5 m, N type-M/N type-M	MegaPhase	NC29-N1N1-177	51300101 001	12-Jul-15	12-Jul-16
4722	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	51228701 001	31-Aug-15	31-Aug-16
4778	EMI Receiver, 9 kHz - 2.9 GHz, System: HL1431, HL4777	Hewlett Packard	8542E	30807A00 262, 3427A001 23	06-Nov-14	06-Nov-15

10 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted emissions with LISN	9 kHz to 150 kHz: ± 3.9 dB 150 kHz to 30 MHz: ± 3.8 dB
Radiated emissions at 10 m measuring distance Horizontal polarization Vertical polarization	 Biconilog antenna: ± 5.0 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.1 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 5.5 dB Biconical antenna: ± 5.5 dB Log periodic antenna: ± 5.6 dB Double ridged horn antenna: ± 5.8 dB
Radiated emissions at 3 m measuring distance Horizontal polarization Vertical polarization	 Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 6.0 dB Biconical antenna: ± 5.7 dB Log periodic antenna: ± 6.0 dB Double ridged horn antenna: ± 6.0 dB
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: ± 2.6 dB 2.9 GHz to 6.46 GHz: ± 3.5 dB 6.46 GHz to 13.2 GHz: ± 4.3 dB 13.2 GHz to 22.0 GHz: ± 5.0 dB 22.0 GHz to 26.8 GHz: ± 5.5 dB 26.8 GHz to 40.0 GHz: ± 4.8 dB

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

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

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

11 APPENDIX C Test laboratory 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, 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 US1003.

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website: www.hermonlabs.com

Person for contact: Mr. Alex Usoskin, CEO.

12 APPENDIX D Specification references

FCC 47CFR part 15: 2014	Radio Frequency Devices
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
RSS-210 Issue 8: 2010	Low Power Licence- Exempt Radiocommunication Devices
RSS-Gen Issue 4: 2014	General Requirements and Information for the Certification of Radiocommunication Equipment
ICES-003 issue 5:2012	Information Technology Equipment (ITE) – 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.

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

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

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

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

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

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

Antenna factor
Biconilog antenna
CHASE Model CBL6140A
Serial no: 1120, HL 0784

Frequency, MHz	Antenna factor, dB
30.0	4.3
35.0	7.3
40.0	8.8
45.0	9.3
50.0	9.6
60.0	9.9
70.0	9.2
80.0	7.6
90.0	7.6
100.0	8.8
120.0	7.2
125.0	7.5
140.0	7.7
150.0	7.9
160.0	11.4
175.0	8.6
180.0	8.8
200.0	9.8
250.0	12.5
300.0	12.2
350.0	14.8
400.0	16.1
450.0	16.5
500.0	17.6
550.0	18.3
600.0	18.5
650.0	19.8
700.0	20.1
750.0	20.8
800.0	21.2
850.0	22.0
900.0	22.2
950.0	23.2
1000.0	23.8

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

Cable loss
Cable coax, RG-214, 12 m, s/n 149, HL 0813

No.	Frequency, MHz	Cable loss, dB	Measured uncertainty, dB
1	10	0.27	±0.12
2	30	0.51	±0.12
3	50	0.70	±0.12
4	100	1.05	±0.12
5	150	1.30	±0.13
6	200	1.52	±0.13
7	250	1.71	±0.13
8	300	1.91	±0.13
9	400	2.27	±0.13
10	500	2.56	±0.13
11	600	2.85	±0.14
12	700	3.11	±0.14
13	800	3.37	±0.14
14	900	3.64	±0.14
15	1000	3.90	±0.14

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
Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,
NC29-N1N1-79 S/N 12025103 001,
HL 4347

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
50	0.08	9000	0.92
100	0.11	9500	1.00
300	0.18	10000	1.05
500	0.23	10500	1.04
1000	0.32	11000	1.05
1500	0.39	11500	1.09
2000	0.45	12000	1.13
2500	0.50	12500	1.15
3000	0.54	13000	1.19
3500	0.59	13500	1.19
4000	0.62	14000	1.22
4500	0.65	14500	1.26
5000	0.69	15000	1.32
5500	0.71	15500	1.38
6000	0.77	16000	1.34
6500	0.82	16500	1.36
7000	0.84	17000	1.46
7500	0.85	17500	1.49
8000	0.88	18000	1.46
8500	0.90		

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, 4.5 m, N type-M/N type-M, NC29-N1N1-177, S/N 51300101 001
HL 4721

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
50	0.15	9000	2.13
100	0.21	9500	2.15
300	0.35	10000	2.21
500	0.45	10500	2.28
1000	0.65	11000	2.47
1500	0.79	11500	2.47
2000	0.91	12000	2.51
2500	1.03	12500	2.57
3000	1.13	13000	2.59
3500	1.23	13500	2.66
4000	1.32	14000	2.68
4500	1.40	14500	2.81
5000	1.48	15000	2.90
5500	1.56	15500	3.16
6000	1.65	16000	3.04
6500	1.72	16500	3.12
7000	1.81	17000	3.03
7500	1.89	17500	3.15
8000	1.99	18000	3.33
8500	2.06		

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		

14 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
AVRG	average (detector)
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
dB(μA)	decibel referred to one microampere
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
μs	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