HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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EST REPORT

ACCORDING TO: FCC CFR 47 part 15 subpart C, section 15.225;
RSS-210 issue9 Annex B section B.6

FOR:

On Track Innovations Ltd.

Ultra-compact, multi-purpose NFC reader

Models: SATURN 8700 USB
SATURN 8700 Plus USB

FCC ID:JNX-OTI-SAT8700P

IC:10533A-OTISAT8700P

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1 Applicant information

Client name:	On Track Innovations Ltd.
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Telephone:	+972 4686 8003
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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):	SATURN 8700 Plus USB
Hardware version:	Main Board: V1.1.2 Antenna board: V1.1.0 Display: V4.0
Software release:	S8_V05
Receipt date	09-Jul-17

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
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Contact name:	Mr. Hemy Itay

4 Test details

Project ID:	29404
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	09-Jul-17
Test completed:	09-Aug-17
Test specification(s):	FCC CFR 47 part 15 subpart C, §15.225; RSS-210 issue 9 Annex B section B.6, RSS-Gen issue 4

5 Tests summary

Test	Status
Transmitter characteristics	
FCC Sections 15.225(a) (b) (c) / RSS-210, Section B.6(a), (b), (c), In band radiated emissions	Pass
FCC Sections 15.225(d) / RSS-210, Section B.6(d), Out of band radiated emissions	Pass
FCC Section 15.225(e) / RSS-210, Section B.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

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.29404_DXT.

	Name and Title	Date	Signature
Tested by:	Mr. S. Samokha, test engineer Mr. A. Morozov, test engineer	August 9, 2017	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	September 4 , 2017	
Approved by:	Mr. K. Zushchyk, project manager	November 7, 2017	

6 EUT description

6.1 General information

The EUT is an ultra-compact, multi-purpose NFC reader with a proximity transceiver operating at 13.56 MHz and with a Bluetooth module operating in 2400 - 2483.5 MHz range. The EUT is powered from 5 VDC obtained from auxiliary laptop via USB and supports USB communication.

According to manufacturer's declaration provided in Appendix G of the test report, both EUT models, SATURN 8700 USB and SATURN 8700 Plus USB, have the same PCB and RF part; the only difference is that SATURN 8700 Plus USB is equipped with LCD display. That is why only SATURN 8700 Plus USB was tested.

6.2 Ports and lines

Port type	Port description	Connected from	Connected to	Qty.	Cable type	Cable length	Indoor / outdoor
Power + signal	USB	EUT	Laptop	1	Shielded	1.5 m*	Indoor

* Always shorter than 3 m

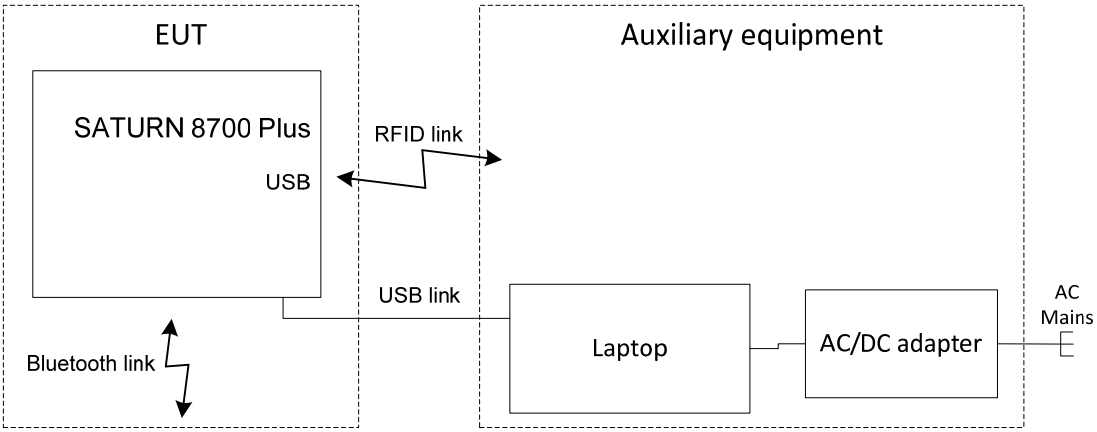
6.3 Auxiliary equipment

Description	Manufacturer	Model number	Serial number
Laptop	Lenovo	T420	R8-Y7NMP 11/08
AC/DC adapter for laptop	Lenovo	92P1103	11S92P1103Z1ZBEF6CB1LK
NFC tag	NXP	NA	NA
NFC tag	AUSTRIACARD	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)	

Assigned frequency range	13.110-14.010 MHz
Operating frequency	13.56 MHz
Maximum field strength of carrier	72.97 dB(µV/m) at 3 m diatance

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
Internal	On Track Innovations	Loop	NA

Type of modulation			ASK				
Transmitter duty cycle supplied for test			100%				
Transmitter power source							
	Battery	**Nominal rated voltage**		Battery type			
X	DC	**Nominal rated voltage**	5 VDC				
	AC mains	**Nominal rated voltage**		Frequency			

Test specification:	Sections 15.225(a) (b) (c) / RSS-210, Section B.6(a), (b), (c), In band radiated emissions		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	12-Jul-17		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C 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

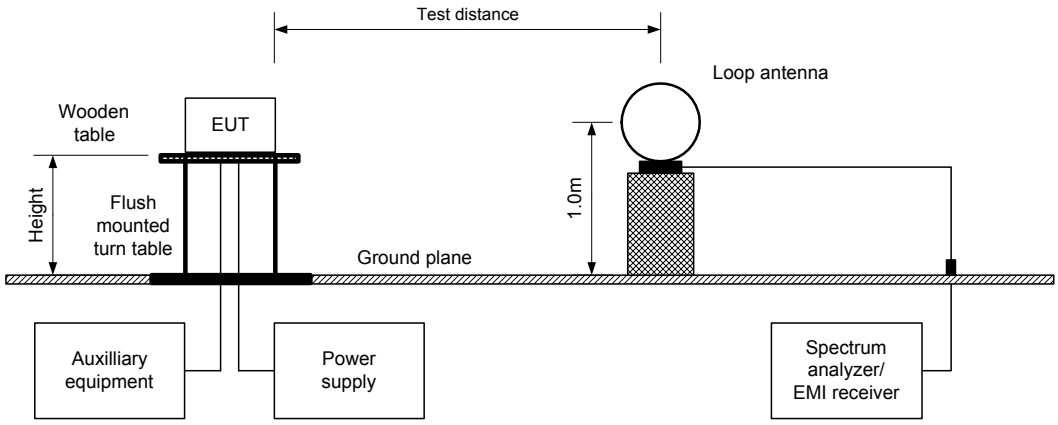
7.1.2.1 The EUT was set up as shown in Figure 7.1.1 energized and the performance check was conducted.

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 B.6(a), (b), (c), In band radiated emissions**		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	12-Jul-17		
Temperature: 23 ºC	**Relative Humidity:** 55 %	**Air Pressure:** 1007 hPa	**Power:** 5 VDC
Remarks:			

Figure 7.1.1 Setup for in band radiated emission measurements



Test specification:	**Sections 15.225(a) (b) (c) / RSS-210, Section B.6(a), (b), (c), In band radiated emissions**		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	12-Jul-17		
Temperature: 23 ºC	**Relative Humidity:** 55 %	**Air Pressure:** 1007 hPa	**Power:** 5 VDC
Remarks:			

Table 7.1.2 In band radiated emission test results

TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
MODULATION: ASK
MODULATING SIGNAL: ID code
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
INVESTIGATED FREQUENCY RANGE: 13.110 – 14.010 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*			
13.5590	72.97	72.97	124.0	-51.03	Vertical	0	Pass

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

Reference numbers of test equipment used

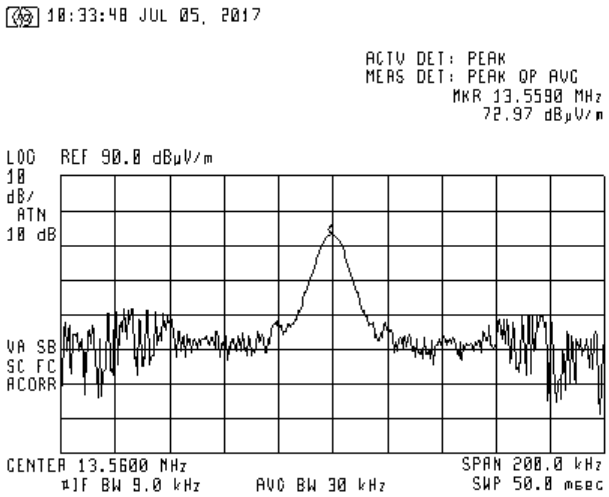
HL 0446	HL 0521	HL 4278	HL 4353				

Full description is given in Appendix A.

Test specification:	**Sections 15.225(a) (b) (c) / RSS-210, Section B.6(a), (b), (c), In band radiated emissions**		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	12-Jul-17		
Temperature: 23 ºC	**Relative Humidity:** 55 %	**Air Pressure:** 1007 hPa	**Power:** 5 VDC
Remarks:			

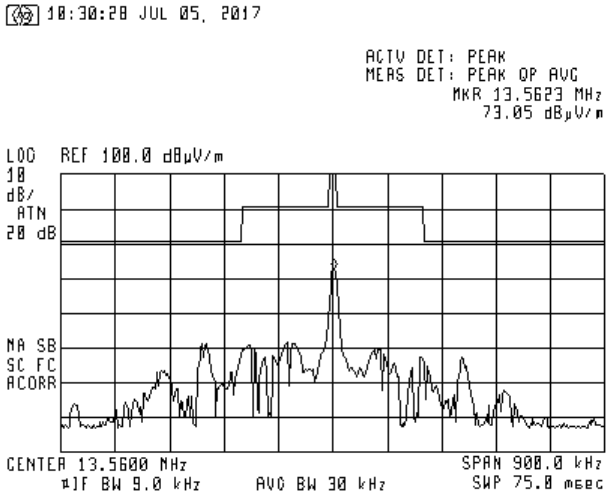
Plot 7.1.1 Fundamental emission test result

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
DETECTOR: Peak hold
EUT POSITION Typical (Vertical)



Plot 7.1.2 In band radiated emission test results

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
DETECTOR: Peak hold
EUT POSITION Typical (Vertical)



Test specification:	Sections 15.225(d) / RSS-210, Section B.6(d), Out of band radiated emissions		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	12-Jul-17		
Temperature: 26 ºC	Relative Humidity: 49 %	Air Pressure: hPa	Power: 5 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 B.6(d), Out of band radiated emissions**		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	12-Jul-17		
Temperature: 26 ºC	**Relative Humidity:** 49 %	**Air Pressure:** hPa	**Power:** 5 VDC
Remarks:			

Figure 7.2.1 Radiated emissions below 30 MHz test set up

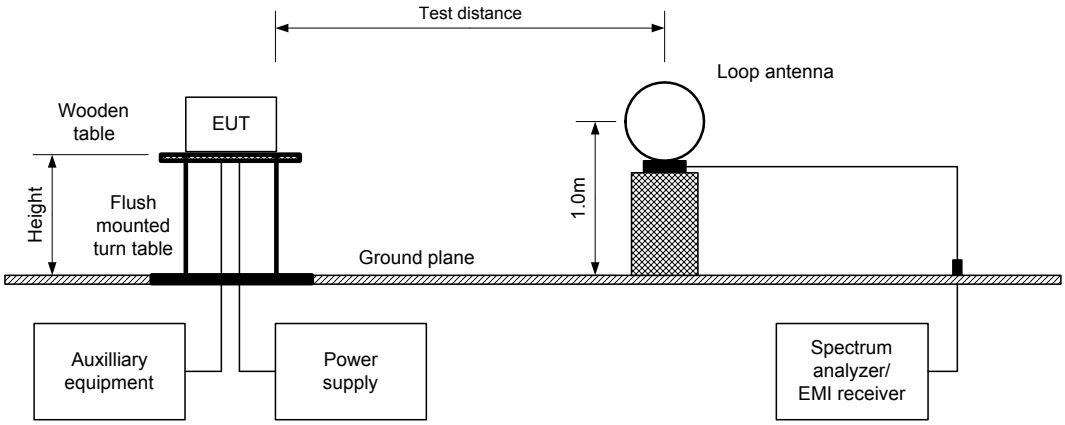
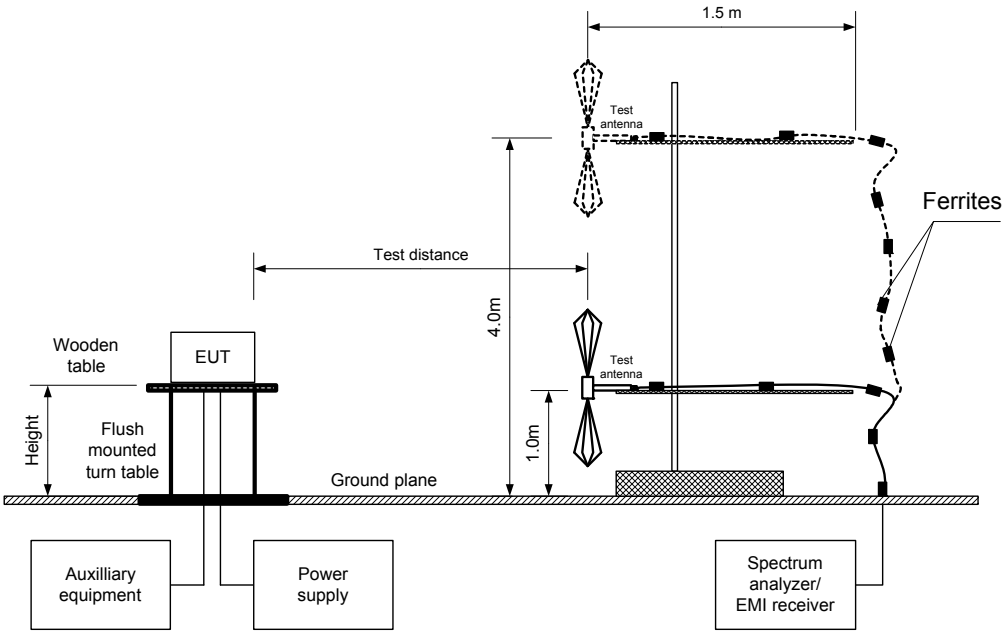


Figure 7.2.2 Radiated emissions above 30 MHz test set up



Test specification:	**Sections 15.225(d) / RSS-210, Section B.6(d), Out of band radiated emissions**		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	12-Jul-17		
Temperature: 26 ºC	**Relative Humidity:** 49 %	**Air Pressure:** hPa	**Power:** 5 VDC
Remarks:			

Table 7.2.2 Out of band radiated emissions test results

TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
MODULATING SIGNAL: ID code
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
INVESTIGATED FREQUENCY RANGE: 0.009 – 30.0 MHz
RESOLUTION BANDWIDTH: 0.2 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***				
40.68	24.4	23.1	40	-16.9	Vertical	1.0	260	Pass
47.60	27.1	22.3	40	-17.7	Vertical	1.0	220	
240.00	31.7	26.2	46	-19.8	Horizontal	1.2	154	
255.00	31.5	29.2	46	-16.8	Horizontal	1.2	160	
269.50	28.6	24.8	46	-21.2	Horizontal	1.2	160	

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

Reference numbers of test equipment used

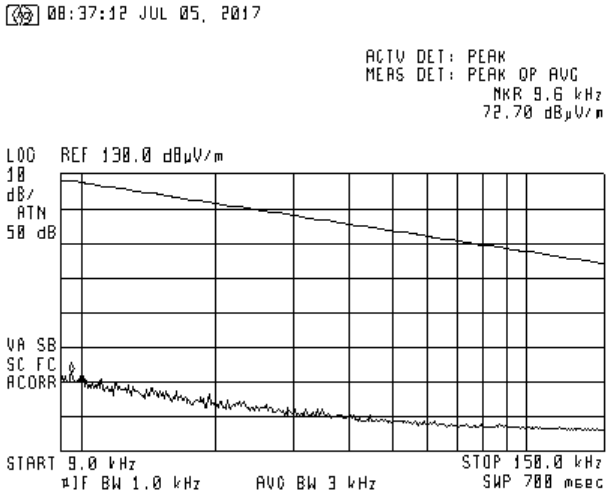
HL 0446	HL 0521	HL 0604	HL 4278	HL 4353			

Full description is given in Appendix A.

Test specification:	**Sections 15.225(d) / RSS-210, Section B.6(d), Out of band radiated emissions**		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	12-Jul-17		
Temperature: 26 ºC	**Relative Humidity:** 49 %	**Air Pressure:** hPa	**Power:** 5 VDC
Remarks:			

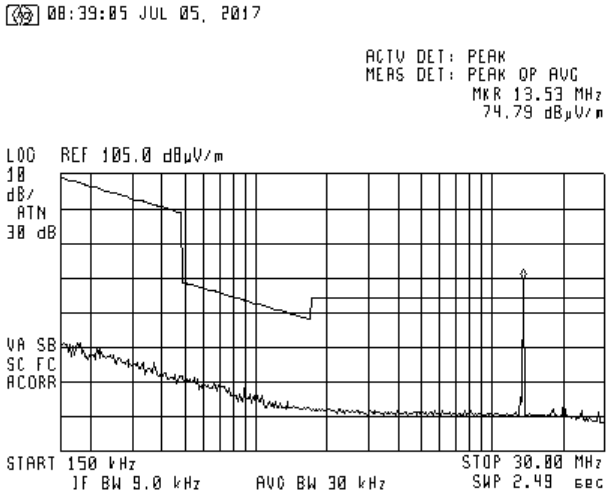
Plot 7.2.1 Radiated emission measurements from 9 to 150 kHz

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



Plot 7.2.2 Radiated emission measurements from 0.15 to 30 MHz

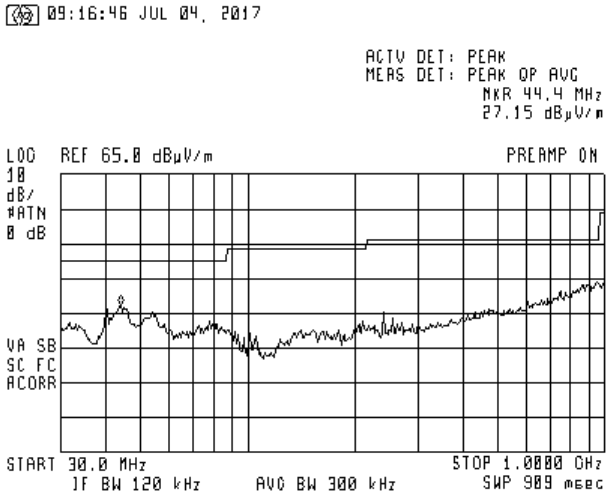
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical&Horizontal
DETECTOR: Peak hold



Test specification:	Sections 15.225(d) / RSS-210, Section B.6(d), Out of band radiated emissions		
Test procedure:	ANSI C63.10 sections 6.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	12-Jul-17		
Temperature: 26 ºC	Relative Humidity: 49 %	Air Pressure: hPa	Power: 5 VDC
Remarks:			

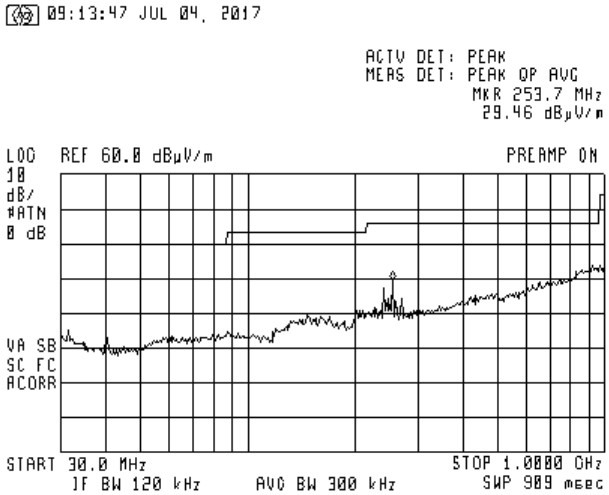
Plot 7.2.3 Radiated emission measurements from 30 to 1000 MHz

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 B.6, Frequency stability		
Test procedure:	ANSI C63.10 sections 6.8		
Test mode:	Compliance	Verdict:	PASS
Date(s):	02-Aug-17		
Temperature: 28 ºC	Relative Humidity: 48 %	Air Pressure: 1009 hPa	Power: 5 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.

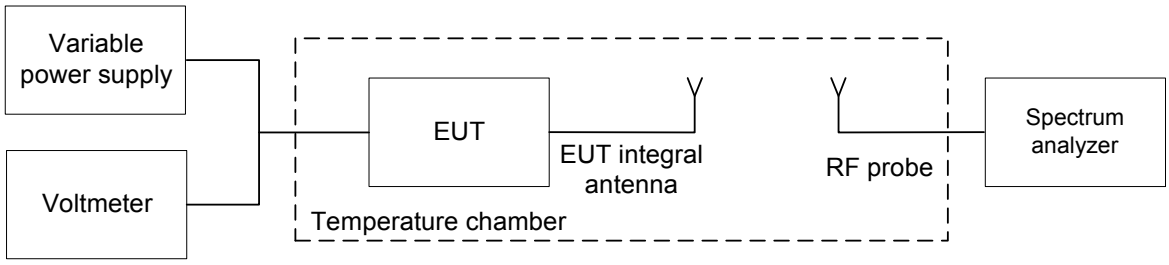
7.3.2.2 The EUT power was turned off. Temperature within test chamber was set to the required one and a period of time sufficient to stabilize all of the oscillator circuit components was allowed.

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 B.6, Frequency stability**		
Test procedure:	ANSI C63.10 sections 6.8		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	02-Aug-17		
Temperature: 28 ºC	**Relative Humidity:** 48 %	**Air Pressure:** 1009 hPa	**Power:** 5 VDC
Remarks:			

Table 7.3.2 Frequency stability test results

OPERATING FREQUENCY: 13.560 MHz
NOMINAL POWER VOLTAGE: 5 VDC
TEMPERATURE STABILIZATION PERIOD: 20 min
POWER DURING TEMPERATURE TRANSITION: Off
RESOLUTION BANDWIDTH: 10 Hz
VIDEO BANDWIDTH: 30 Hz
MODULATION: ASK

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	13.56005	13.56005	13.56002	13.56002	300	0	1356	-1056	Pass
20	nominal	13.56000	13.56000	13.55975	13.55975*	0	250		-1106	
+60	nominal	13.55975	13.55974	13.55974	13.55974	0	10		-1346	

* - Reference frequency

Reference numbers of test equipment used

HL 2909	HL 3286						

Full description is given in Appendix A.

Test specification:	Section 15.207(a) / RSS-Gen, Section 8.8, Conducted emission		
Test procedure:	ANSI C63.10 sections 6.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Jul-17		
Temperature: 24 ºC	Relative Humidity: 51 %	Air Pressure: 1003 hPa	Power: 110 VAC, 60 Hz
Remarks:			

7.4 Conducted emissions at AC mains input port

7.4.1 General

This test was performed to measure common mode conducted emissions at the EUT power port. The specification test limits are given in Table 7.4.1.

Table 7.4.1 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.

7.4.2 Test procedure

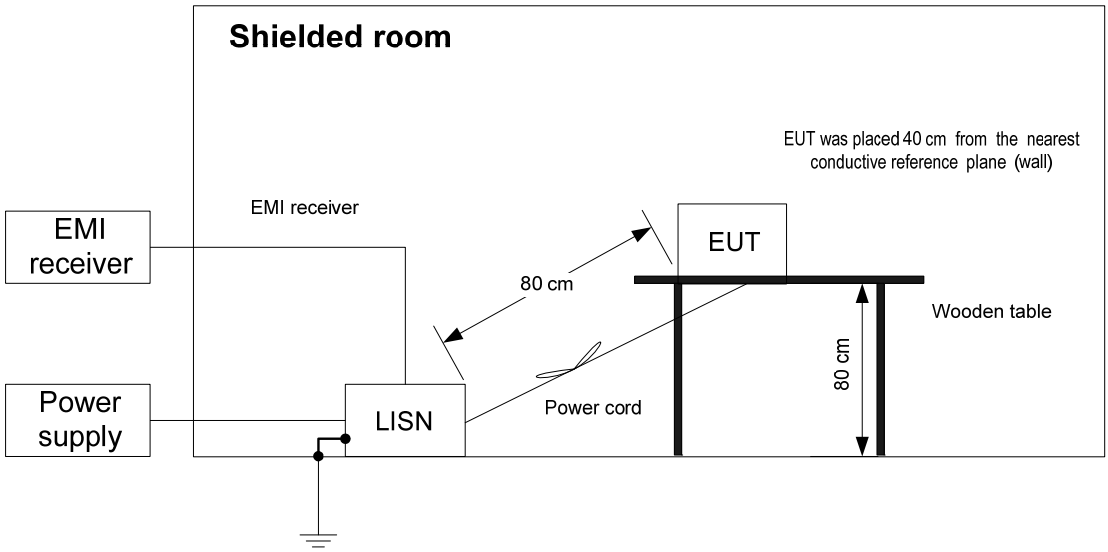
7.4.2.1 The EUT was set up as shown in Figure 7.4.1 and the associated photographs, energized and the EUT performance was checked.

7.4.2.2 The measurements were performed at the EUT mains terminals with the LISN, connected to the EMI receiver in the frequency range referred to in Table 7.4.2. The unused coaxial connector of the LISN was terminated with 50 Ohm.

7.4.2.3 The position of the EUT cables was varied to find the highest emission.

7.4.2.4 The worst test results with respect to the limits were recorded in Table 7.4.2 and shown in the associated plots.

Figure 7.4.1 Setup for conducted emission measurements, table-top EUT



Test specification:	**Section 15.207(a) / RSS-Gen, Section 8.8, Conducted emission**		
Test procedure:	ANSI C63.10 sections 6.2		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	13-Jul-17		
Temperature: 24 ºC	**Relative Humidity:** 51 %	**Air Pressure:** 1003 hPa	**Power:** 110 VAC, 60 Hz
Remarks:			

Table 7.4.2 Conducted emission test results

LINE: AC mains
EUT OPERATING MODE: Transmit
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*		
0.189286	42.01	35.25	64.08	-28.83	25.09	54.08	-28.99	L1	Pass
0.392700	49.51	47.25	58.01	-10.76	32.19	48.01	-15.82		
0.477000	41.38	37.15	56.43	-19.28	24.78	46.43	-21.65		
0.602238	41.86	35.04	56.00	-20.96	22.89	46.00	-23.11		
23.299130	40.89	35.81	60.00	-24.19	29.03	50.00	-20.97		
0.189286	42.02	40.46	64.08	-23.62	31.02	54.08	-23.06	L2	Pass
0.302360	41.92	36.42	60.20	-23.78	25.17	50.20	-25.03		
0.408730	48.90	46.03	57.71	-11.68	30.83	47.71	-16.88		
0.502500	42.16	37.35	56.00	-18.65	26.65	46.00	-19.35		
0.713240	39.52	35.10	56.00	-20.90	19.38	46.00	-26.62		
24.400790	36.91	30.87	60.00	-29.13	23.78	50.00	-26.22		

*****- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

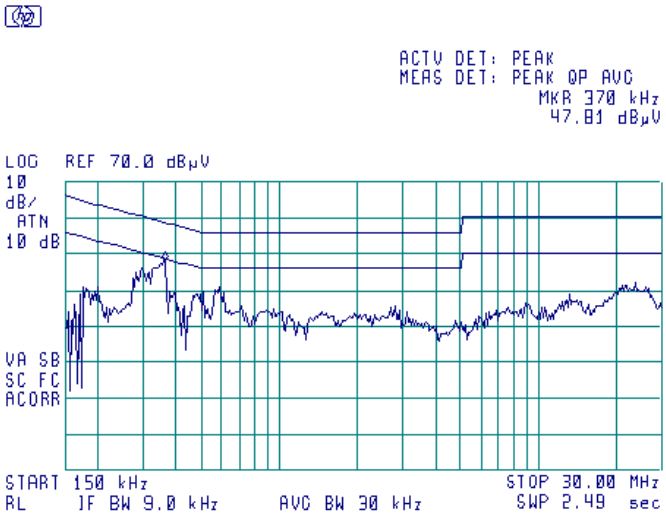
HL 0447	HL 0495	HL 0813	HL 1513	HL 4527			

Full description is given in Appendix A.

Test specification:	**Section 15.207(a) / RSS-Gen, Section 8.8, Conducted emission**		
Test procedure:	ANSI C63.10 sections 6.2		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	13-Jul-17		
Temperature: 24 ºC	**Relative Humidity:** 51 %	**Air Pressure:** 1003 hPa	**Power:** 110 VAC, 60 Hz
Remarks:			

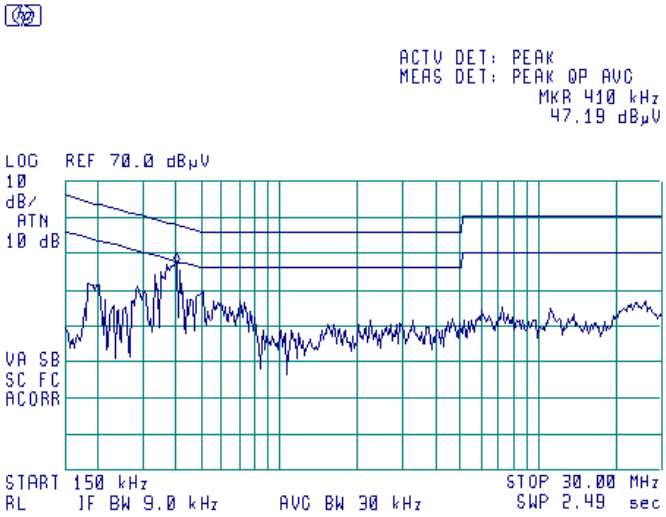
Plot 7.4.1 Conducted emission measurements

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



Plot 7.4.2 Conducted emission measurements

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



Test specification:	Section 15.215(c) / RSS-Gen, section 6.6, Occupied bandwidth		
Test procedure:	ANSI C63.10 section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	09-Jul-17		
Temperature: 28 ºC	Relative Humidity: 48 %	Air Pressure: 1006 hPa	Power: 230 VAC, 50 Hz
Remarks:			

7.5 Occupied bandwidth test

7.5.1 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 7.5.1.

Table 7.5.1 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.

7.5.2 Test procedure

7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.

7.5.2.2 The 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.

7.5.2.3 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 7.5.2 and the associated plot.

7.5.2.4 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 7.5.1 Occupied bandwidth test setup

Test specification:	**Section 15.215(c) / RSS-Gen, section 6.6, Occupied bandwidth**		
Test procedure:	ANSI C63.10 section 6.9.2		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	09-Jul-17		
Temperature: 28 ºC	**Relative Humidity:** 48 %	**Air Pressure:** 1006 hPa	**Power:** 230 VAC, 50 Hz
Remarks:			

Table 7.5.2 Occupied bandwidth test results

ASSIGNED FREQUENCY BAND 13.11 – 14.01 MHz
DETECTOR USED: Peak hold
RESOLUTION BANDWIDTH: 1 kHz
VIDEO BANDWIDTH: 10 kHz
MODULATION ENVELOPE REFERENCE POINTS: 20 dBc
MODULATION: Unmodulated
MODULATING SIGNAL: Unmodulated

Band edge	Cross point frequency, MHz	Frequency drift, kHz		Modulation band edge, MHz	Assigned band edge, MHz	Verdict
		Negative	Positive			
Low	13.3426	0.25	NA	13.3424	13.110	Pass
High	13.7761	NA	0.3	13.7764	14.010	Pass

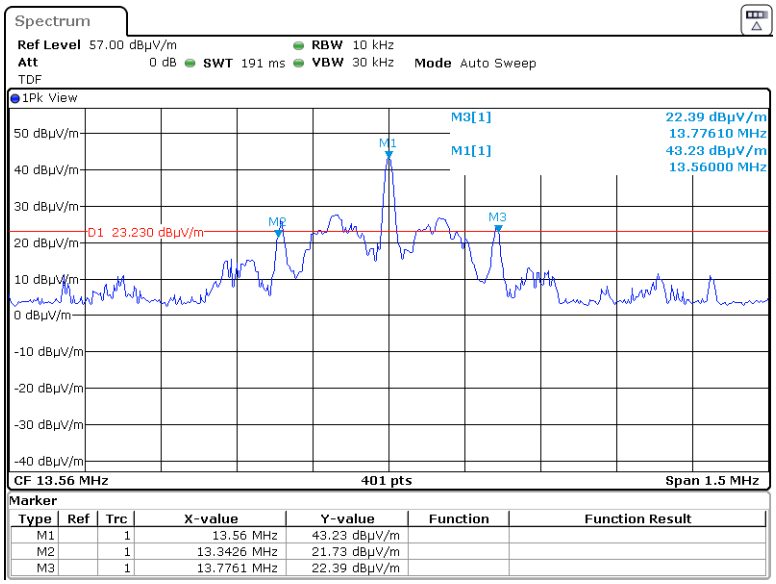
Reference numbers of test equipment used

HL 2909	HL 3901	HL 4135						

Full description is given in Appendix A.

Test specification:	Section 15.215(c) / RSS-Gen, section 6.6, Occupied bandwidth		
Test procedure:	ANSI C63.10 section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	09-Jul-17		
Temperature: 28 ºC	Relative Humidity: 48 %	Air Pressure: 1006 hPa	Power: 230 VAC, 50 Hz
Remarks:			

Plot 7.5.1 Occupied bandwidth test result



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):	9-Aug-17		
Temperature: 22 ºC	Air Pressure: 1011 hPa	Relative Humidity: 54 %	Power Supply: 5 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	

8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 kHz - 30 MHz	EMCO	6502	2857	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
0813	Cable Coax, 12 m, N-type, up to 3.0 GHz	Hermon Laboratories	C214-12	149	18-Dec-16	18-Dec-17
1513	Cable RF, 8 m, BNC/BNC	Belden	M17/167 MIL-C-17	1513	20-Sep-16	20-Sep-17
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY414447 62	09-Mar-17	09-Mar-18
3286	Temperature Chamber, (-50 to +170) °C	Thermotron	EL-8-CH-1-1-CO2	21-9048	06-Oct-16	06-Oct-17
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFLE X 102A	1225/2A	20-Feb-17	20-Feb-18
4135	Shield Box	TESCOM CO., LTD	TC-5916A	5916A000 136	06-Apr-17	06-Apr-18
4278	Test Cable , DC-18 GHz, 4.6 m, N/M - N/M	Mini-Circuits	APC-15FT-NMNM+	0755A	24-Aug-17	24-Aug-18
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
4527	DC block , 50 Ohm, 10 MHz to 6 GHz	Mini-Circuits	BLK-6-N+	NA	16-Jan-17	16-Jan-18

9 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

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

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.
Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.
In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

10 APPENDIX C Test 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 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-869 for RE measurements above 1 GHz, C-845 for conducted emissions site and T-1606 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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Telephone: +972 4628 8001
Fax: +972 4628 8277
e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

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

11 APPENDIX D Specification references

FCC 47CFR part 15: 2016	Radio Frequency Devices
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
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-210 Issue 9: 2016	Licence- Exempt Radio Apparatus: Category I Equipment
RSS-Gen Issue 4: 2014	General Requirements and Information for the Certification of Radiocommunication Equipment
ICES-003 issue 6:2016	Information Technology Equipment (ITE) – Limits and methods of measurement

12 APPENDIX E Test equipment correction factors

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

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

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

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

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

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(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).

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

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

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

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

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

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

13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
AVRG	average (detector)
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 TEST REPORT

14 APPENDIX G Manufacturer's declaration

oti	**Confidential**	**OTI Ltd.** Z.H.R. Industrial zone, POB 32 Rosh Pina 12000, Israel Tel. 972-4-6868000, Fax.972-4-6938887

SATURN8700 Plus USB versus SATURN8700 USB
Declaration of Differences

I hereby declare that the SATURN8700 Plus USB hardware is the same as the SATURN8700 USB hardware except for the following:

- Addition of a display and its interconnecting flat cable.
- Larger box to accommodate also the display.

Notes:

- The SATURN8700 USB contains two boards, main board and antenna board, which are sandwiched one above the other by means two connectors.
- The SATURN8700 Plus USB uses identical **two boards sandwich** with the addition of a display which is physically mounted outside the perimeter of the rest of the HW. This way it does not affect the RFID and BLE transmission characteristics.
- All the HW associated with the display is assembled on the main board regardless of it uses – SATURN8700 USB and SATURN8700 Plus USB.
- The section of the housing which holds the two bards sandwich is the same as the SATURN8700 USB housing.
- The display power consumption is very low compared with the overall power consumption so no side effects in this regard.

Hemy Itay
VP HW Eng.
OTI

ON TRACK INNOVATIONS LTD

END OF DOCUMENT