

# TEST REPORT

ACCORDING TO: FCC CFR 47 part 15 subpart C, section 15.225

FOR:

**Essence Security International Ltd.**  
**Tag Reader**  
**Model:ES700TR5-ES-M05**  
**FCC ID:YXG-ES700TR5-E**

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

**Client name:** Essence Security International Ltd.  
**Address:** 12 Abba Eban avenue, Ackerstein Tower Bldg. D, P.O.Box 2073, Herzliya 4612001, Israel  
**Telephone:** +972 7324 47735  
**Fax:** +972 9772 9962  
**E-mail:** israelgo@essence-grp.com  
**Contact name:** Mr. Israel Gottesman

## 2 Equipment under test attributes

**Product name:** Tag Reader  
**Product type:** Transceiver  
**Model(s):** ES700TR5-ES-M05  
**Serial number:** 9970993100558236  
**Hardware version:** 5  
**Software release:** 5.02  
**Receipt date** 17-Aug-16

## 3 Manufacturer information

**Manufacturer name:** Essence Security International Ltd.  
**Address:** 12 Abba Eban avenue, Ackerstein Tower Bldg. D, P.O.Box 2073, Herzliya 4612001, Israel  
**Telephone:** +972 7324 47735  
**Fax:** +972 9772 9962  
**E-Mail:** israelgo@essence-grp.com  
**Contact name:** Mr. Israel Gottesman

## 4 Test details

**Project ID:** 28531  
**Location:** Primary: Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel  
Satellite: Hermon Laboratories Ltd. Hefetz-Haim 10, Tel Aviv 6744124, Israel  
**Test started:** 17-Aug-16  
**Test completed:** 22-Aug-16  
**Test specification(s):** FCC CFR 47 part 15 subpart C, §15.225




## 5 Tests summary

Test	Status
<b>Transmitter characteristics</b>	
Sections 15.225(a) (b) (c), In band radiated emissions	Pass
Sections 15.225(d), Out of band radiated emissions	Pass
Section 15.225(e), Frequency stability	Pass
Section 15.207(a), Conducted emission	Not required
Section 15.215(c), Occupied bandwidth	Pass
Section 15.203, Antenna requirement	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:ESSRAD\_FCC.28531\_15.225.

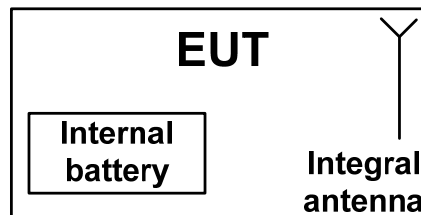
	Name and Title	Date	Signature
<b>Tested by:</b>	Mr.I. Zilberstein, test engineer	August 29, 2016	
<b>Reviewed by:</b>	Mrs. M. Cherniavsky, certification engineer	September 8, 2016	
<b>Approved by:</b>	Mr. M. Nikishin, EMC and Radio group manager	October 10, 2016	

## 6 EUT description

### 6.1 General information

The EUT, ES700TR5-ES-M05, is a wireless access control tag reader operating at 916.5 MHz. The EUT is equipped with an integral antenna and is powered by internal 4.5 V battery. The reader contains the RFID technology transmitter operating at 13.56 MHz.

### 6.2 Test configuration



### 6.3 Changes made in EUT

No changes were implemented in the EUT during testing.

## 6.4 Transmitter characteristics of RFID transmitter

<b>Type of equipment</b>					
Stand-alone (Equipment with or without its own control provisions)					
<b>V</b> 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)					
<b>Assigned frequency range</b>		13.110-14.010 MHz			
<b>Operating frequency range</b>		13.56 MHz			
<b>Maximum field strength</b>		73.26 dB(μV/m) at 3 m test distance			
<b>Is transmitter output power variable?</b>		<b>V</b>		No	
		Yes		continuous variable	
				stepped variable with stepsize	
				minimum RF power	
<b>Antenna connection</b>					
unique coupling		standard connector		<b>V</b> - integral	
				with temporary RF connector without temporary RF	
<b>Antenna/s technical characteristics</b>					
<b>Type</b>		<b>Manufacturer</b>		<b>Model number</b>	
Internal		Essence Security		Loop	
<b>Gain</b>		NA			
<b>Transmitter aggregate data rate/s</b>		106 kbps			
<b>Type of modulation</b>		AM			
<b>Transmitter duty cycle supplied for test</b>		100%			
<b>Transmitter power source</b>					
<b>V</b>	Battery	<b>Nominal rated voltage</b>	4.5 VDC	<b>Battery type</b>	alkaline
	DC	<b>Nominal rated voltage</b>			
	AC mains	<b>Nominal rated voltage</b>		<b>Frequency</b>	



<b>Test specification:</b> Sections 15.225(a) (b) (c), In band radiated emissions			
<b>Test procedure:</b> ANSI C63.10 section 6.5			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-16			
<b>Temperature:</b> 24.6 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

## 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:

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

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

#### 7.1.2 Test procedure

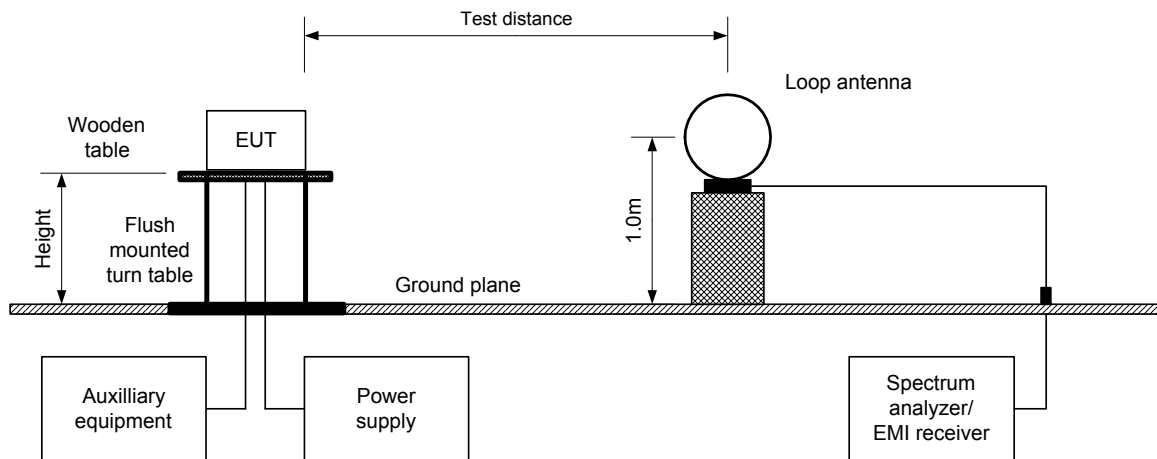
**7.1.2.1** The EUT was set up as shown in Figure 7.1.1 energized and the performance check was conducted.

**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°, 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.

<b>Test specification:</b> Sections 15.225(a) (b) (c), In band radiated emissions			
<b>Test procedure:</b> ANSI C63.10 section 6.5			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-16			
<b>Temperature:</b> 24.6 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

**Figure 7.1.1 Setup for in band radiated emission measurements**







<b>Test specification:</b> Sections 15.225(a) (b) (c), In band radiated emissions			
<b>Test procedure:</b> ANSI C63.10 section 6.5			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-16			
<b>Temperature:</b> 24.6 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

Table 7.1.2 In band radiated emission test results

TEST DISTANCE: 3 m  
 EUT POSITION: Typical (Vertical)  
 MODULATION: FSK  
 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*			
13.56005	73.99	73.26	124	-50.74	Vertical	290	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 1915	HL 3001	HL 4535	HL 4549	HL 4575		
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Full description is given in Appendix A.

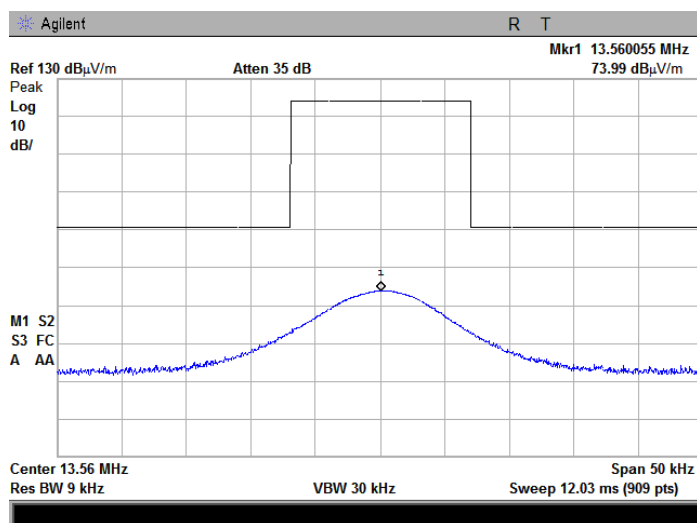


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Test specification: Sections 15.225(a) (b) (c), In band radiated emissions			
Test procedure: ANSI C63.10 section 6.5			
Test mode: Compliance		Verdict: PASS	
Date(s): 22-Aug-16			
Temperature: 24.6 °C	Relative Humidity: 48 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

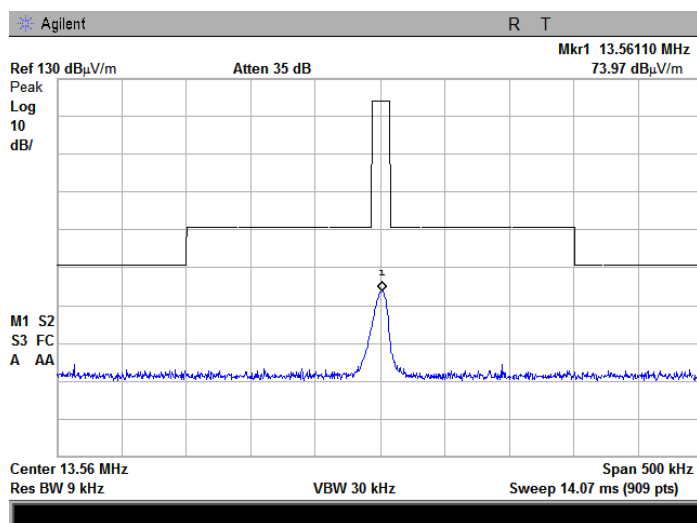
#### Plot 7.1.1 Fundamental emission test result

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



#### Plot 7.1.2 In band radiated emission test results

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





Test specification: Sections 15.225(d), Out of band radiated emissions			
Test procedure: ANSI C63.10 section 6.5			
Test mode: Compliance		Verdict: PASS	
Date(s): 22-Aug-16			
Temperature: 26.7 °C	Relative Humidity: 48 %	Air Pressure: 1008 hPa	Power: Battery
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:

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

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°, 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°, 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), Out of band radiated emissions			
Test procedure: ANSI C63.10 section 6.5			
Test mode: Compliance		Verdict: PASS	
Date(s): 22-Aug-16			
Temperature: 26.7 °C	Relative Humidity: 48 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Figure 7.2.1 Radiated emissions below 30 MHz test set up

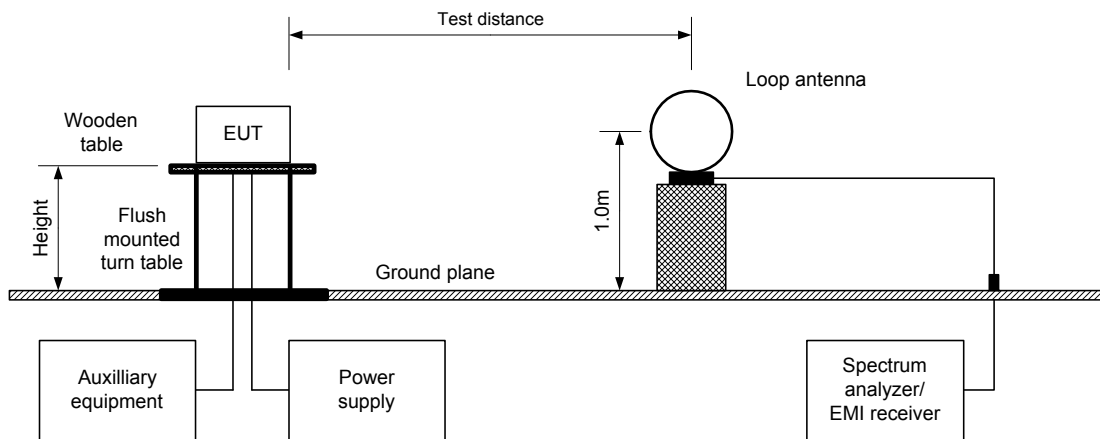
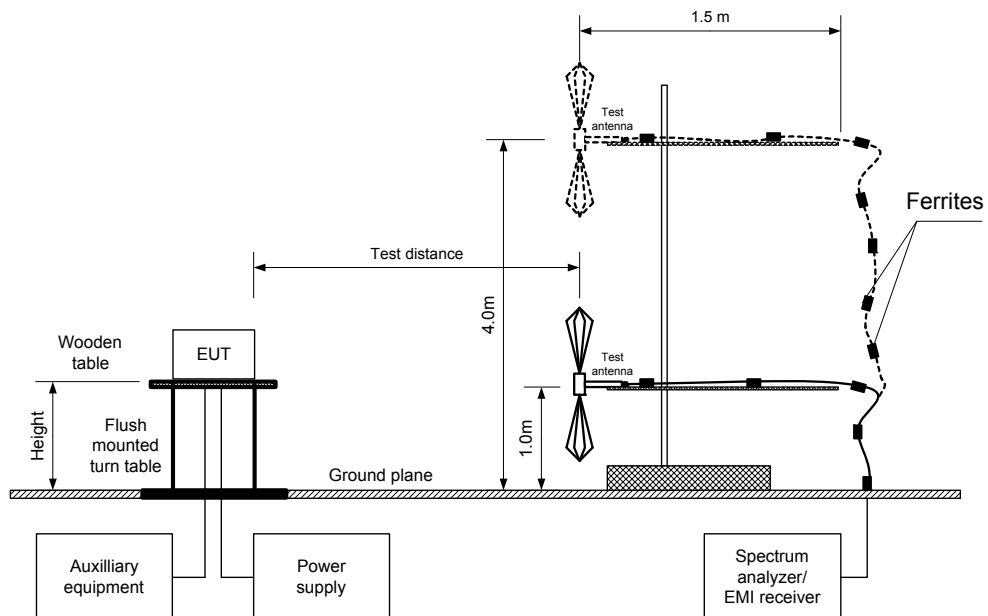


Figure 7.2.2 Radiated emissions above 30 MHz test set up





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<b>Test specification:</b> Sections 15.225(d), Out of band radiated emissions			
<b>Test procedure:</b> ANSI C63.10 section 6.5			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-16			
<b>Temperature:</b> 26.7 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

Table 7.2.2 Out of band radiated emissions test results

TEST DISTANCE: 3 m  
 EUT POSITION: Typical (Vertical)  
 MODULATION: FSK  
 MODULATING SIGNAL: ID code  
 INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 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

Frequency, MHz		Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
Peak emission, dB(μV/m)	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*					
No emission were found except carrier 13.56 MHz								Pass

\*- Margin = Measured emission - specification limit.

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

## Reference numbers of test equipment used

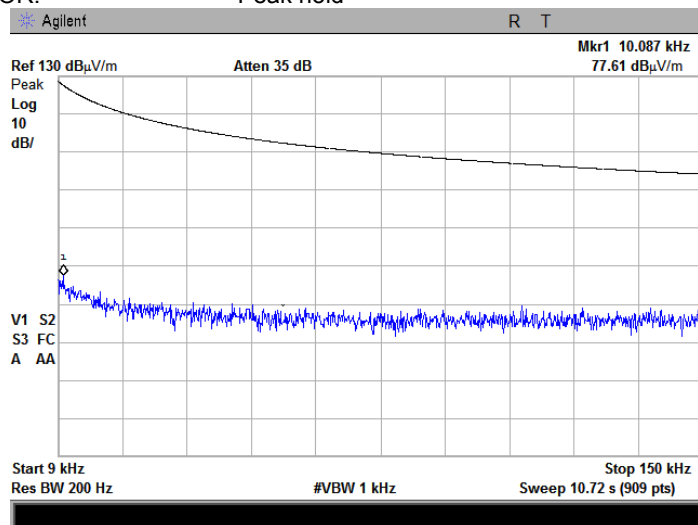
HL 0446	HL 2697	HL 3001	HL 4277	HL 5107			
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Full description is given in Appendix A.

<b>Test specification:</b> Sections 15.225(d), Out of band radiated emissions			
<b>Test procedure:</b> ANSI C63.10 section 6.5			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-16			
<b>Temperature:</b> 26.7 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

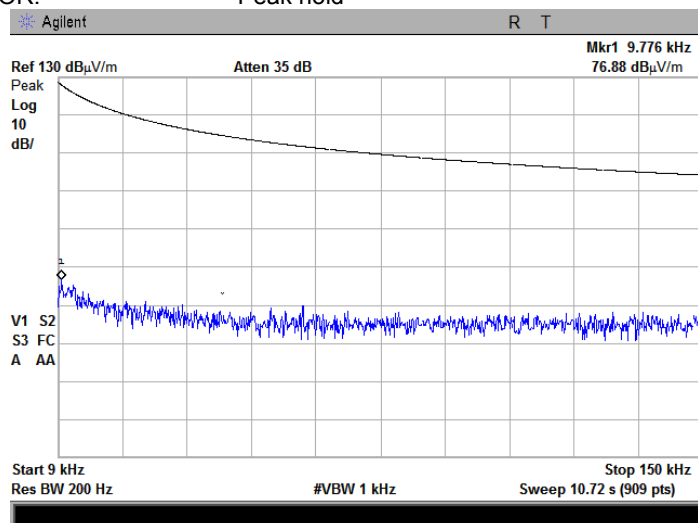
**Plot 7.2.1 Radiated emission measurements from 9 to 150 kHz**

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



**Plot 7.2.2 Radiated emission measurements from 9 to 150 kHz**

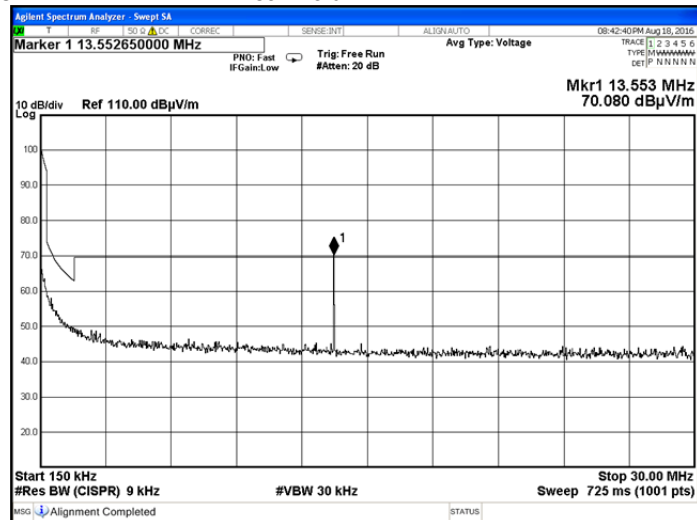
TEST SITE: Fully anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Horizontal  
DETECTOR: Peak hold



Test specification:		Sections 15.225(d), Out of band radiated emissions	
Test procedure:		ANSI C63.10 section 6.5	
Test mode:		Verdict: PASS	
Date(s):			
22-Aug-16			
Temperature: 26.7 °C	Relative Humidity: 48 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

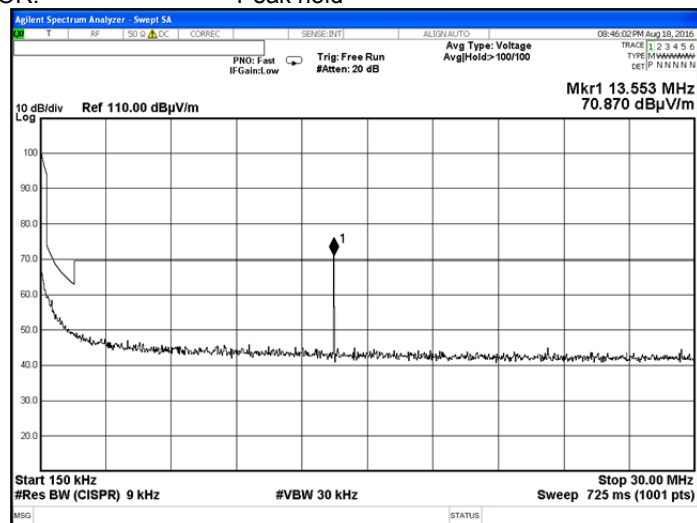
Plot 7.2.3 Radiated emission measurements from 0.15 to 30 MHz

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



Plot 7.2.4 Radiated emission measurements from 0.15 to 30 MHz

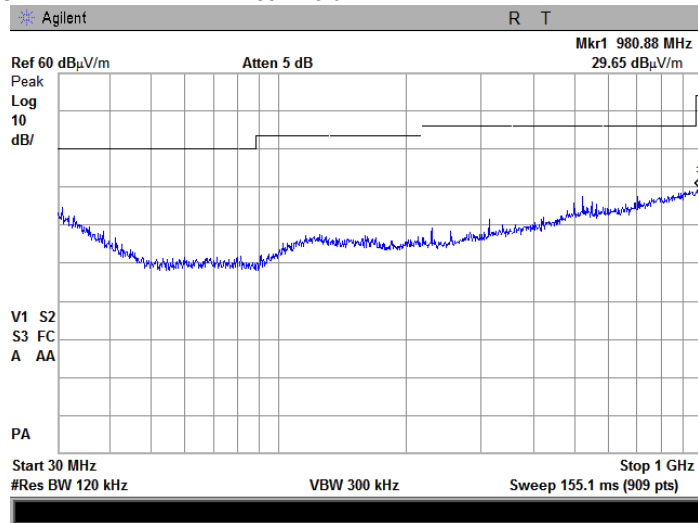
TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Horizontal  
DETECTOR: Peak hold



<b>Test specification:</b> Sections 15.225(d), Out of band radiated emissions			
<b>Test procedure:</b> ANSI C63.10 section 6.5			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-16			
<b>Temperature:</b> 26.7 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

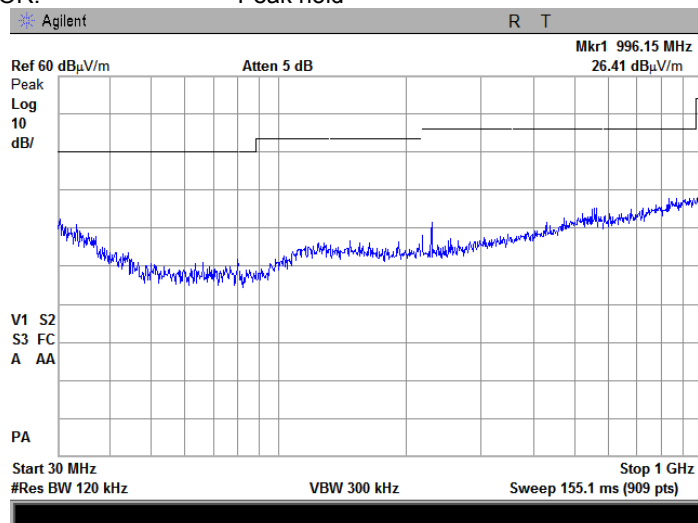
**Plot 7.2.5 Radiated emission measurements from 30 to 1000 MHz**

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



**Plot 7.2.6 Radiated emission measurements from 30 to 1000 MHz**

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





<b>Test specification:</b> <b>Section 15.225(e), Frequency stability</b>			
<b>Test procedure:</b> ANSI C63.10, Section 6.8			
<b>Test mode:</b> Compliance		<b>Verdict:</b> <b>PASS</b>	
<b>Date(s):</b> 9-Oct-16			
<b>Temperature:</b> 26°C	<b>Relative Humidity:</b> 52 %	<b>Air Pressure:</b> 1010 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

## 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.

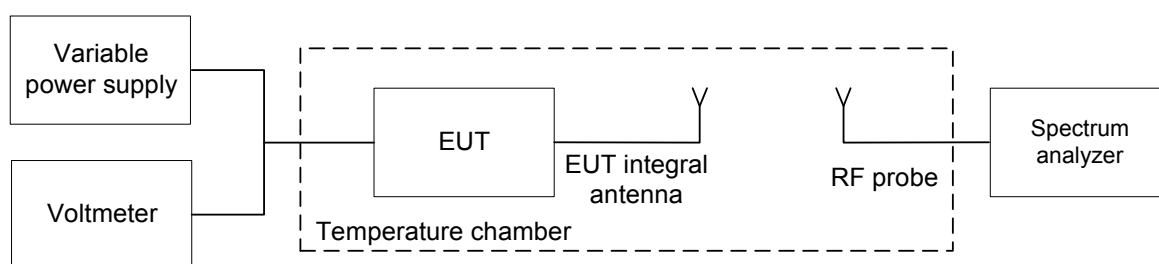
Table 7.3.1 Frequency stability limits

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 highest 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 chamber temperature was lowered by 10°C and a period of time sufficient to stabilize the temperature inside the chamber was allowed.
- 7.3.2.5 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.
- 7.3.2.6 The above procedure was repeated at the rest of the test temperatures and voltages as provided in Table 7.3.2.
- 7.3.2.7 Frequency displacement was calculated and compared with the limit as provided in Table 7.3.2.

Figure 7.3.1 Frequency stability test setup





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<b>Test specification:</b> <b>Section 15.225(e), Frequency stability</b>			
<b>Test procedure:</b> ANSI C63.10, Section 6.8			
<b>Test mode:</b> Compliance		<b>Verdict:</b> <b>PASS</b>	
<b>Date(s):</b> 9-Oct-16			
<b>Temperature:</b> 26°C	<b>Relative Humidity:</b> 52 %	<b>Air Pressure:</b> 1010 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

Table 7.3.2 Frequency stability test results

OPERATING FREQUENCY: 13.560 MHz  
 NOMINAL POWER VOLTAGE: 4.5 V  
 TEMPERATURE STABILIZATION PERIOD: 20 min  
 POWER DURING TEMPERATURE TRANSITION: Off  
 SPECTRUM ANALYZER MODE: Counter  
 RESOLUTION BANDWIDTH: 1 kHz  
 VIDEO BANDWIDTH: 1 kHz  
 MODULATION: Unmodulated

Temperature, °C	Voltage, V	Frequency, MHz				Max frequency drift, Hz		Limit, Hz	Margin, Hz	Verdict
		Start up	2 <sup>nd</sup> min	5 <sup>th</sup> min	10 <sup>th</sup> min	Positive	Negative			
-20	nominal	13.560043	13.560020	13.560010	13.560063	63	0	1356	1293	Pass
-10	nominal	13.560020	13.560025	13.560020	13.560030	30	0		1326	
0	nominal	13.560030	13.560025	13.560015	13.560020	30	0		1326	
10	nominal	13.560020	13.560015	13.560015	13.560020	20	0		1336	
20	nominal +15%	13.560033	13.559998	13.559988	13.560023	23	12		1333	
20	nominal	13.560038	13.560040	13.560010	13.560028	40	0		1316	
20	nominal -15%	13.560053	13.560018	13.560023	13.560033	53	0		1303	
30	nominal	13.560050	13.560025	13.560100	13.560100	100	0		1256	
40	nominal	13.560050	13.560150	13.560150	13.560050	150	0		1206	
50	nominal	13.560050	13.560050	13.560050	13.560050	50	0		1306	

\* - Reference frequency

## Reference numbers of test equipment used

HL 0758	HL 3001	HL 3286	HL 3901	HL 4164	HL 4778		
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Full description is given in Appendix A.

<b>Test specification:</b> <b>Section 15.215(c), Occupied bandwidth</b>			
<b>Test procedure:</b> ANSI C63.10 section 6.9.2			
<b>Test mode:</b> Compliance		<b>Verdict:</b> <b>PASS</b>	
<b>Date(s):</b> 22-Aug-16			
<b>Temperature:</b> 25.6 °C	<b>Relative Humidity:</b> 42 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

## 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**





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<b>Test specification:</b> <b>Section 15.215(c), Occupied bandwidth</b>			
<b>Test procedure:</b> ANSI C63.10 section 6.9.2			
<b>Test mode:</b> Compliance		<b>Verdict:</b> <b>PASS</b>	
<b>Date(s):</b> 22-Aug-16			
<b>Temperature:</b> 25.6 °C	<b>Relative Humidity:</b> 42 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> Battery
<b>Remarks:</b>			

Table 7.4.2 Occupied bandwidth test results

ASSIGNED FREQUENCY BAND 13.553 – 13.567 MHz  
 DETECTOR USED: Peak hold  
 RESOLUTION BANDWIDTH: 30 Hz  
 VIDEO BANDWIDTH: 1 kHz  
 MODULATION ENVELOPE REFERENCE POINTS: 20 dBc  
 MODULATING SIGNAL: enable

Band edge	Cross point frequency, MHz	Frequency drift, MHz		Modulation band edge, MHz	Assigned band edge, MHz	Verdict
		Negative	Positive			
Low	13.559824	0.000032	N/A	13.55979	13.553	Pass
High	13.560310	N/A	0.000063	13.56037	13.567	Pass

## Reference numbers of test equipment used

HL 3818								
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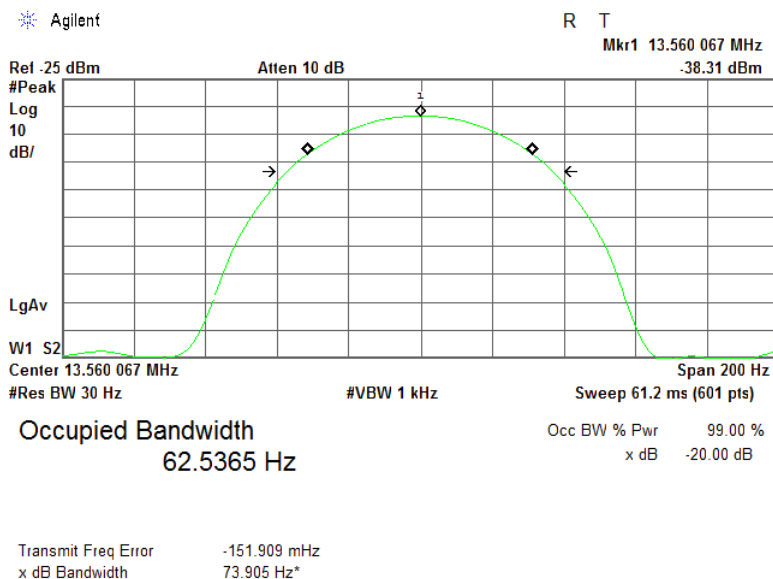
Full description is given in Appendix A.



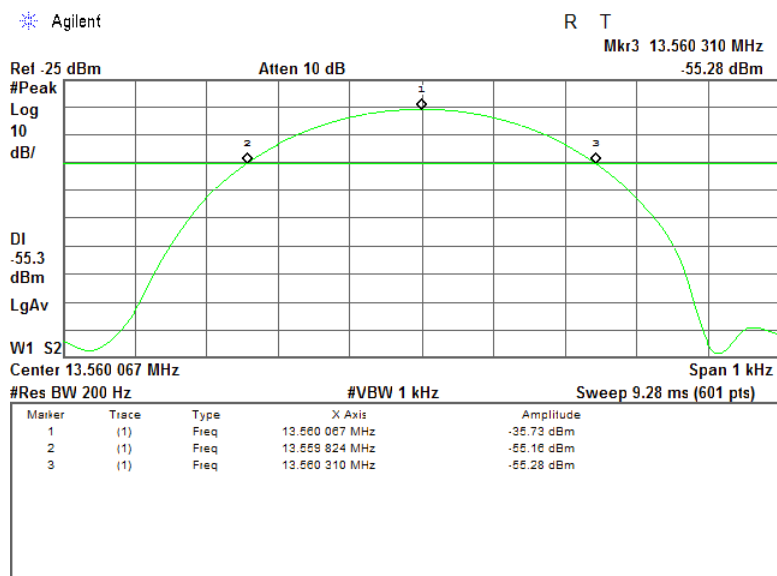
HERMON LABORATORIES

Test specification: Section 15.215(c), Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 22-Aug-16			
Temperature: 25.6 °C	Relative Humidity: 42 %	Air Pressure: 1005 hPa	Power: Battery
Remarks:			

Plot 7.4.1 Occupied bandwidth test result



Plot 7.4.2 Cross point frequencies test result



<b>Test specification:</b>		<b>Section 15.203, Antenna requirement</b>	
<b>Test procedure:</b>		Visual inspection / supplier declaration	
<b>Test mode:</b>		Compliance	<b>Verdict:</b> PASS
<b>Date(s):</b>		09-Mar-14	
<b>Temperature:</b> 22 °C	<b>Air Pressure:</b> 1015 hPa	<b>Relative Humidity:</b> 44 %	<b>Power Supply:</b> Battery
<b>Remarks:</b>			

## 7.5 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 7.5.1.

**Table 7.5.1 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 7.5.1 RFID antenna assembly**

Loop antenna



## 8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 kHz – 30 MHz	EMCO	6502	2857	18-Jan-16	18-Jan-17
0758	Power supply, dual, 36 V, 1 A	Horizon Electronics	DHR 36-1	5361231	07-Jul-16	07-Jul-17
1915	Antenna, Loop, Active Receiving, 1 kHz – 30 MHz	EMC Test Systems	6507	1457	18-Jan-16	18-Jan-17
2697	Antenna, 30 MHz – 3.0 GHz	Sunol Sciences. Corp. Pleasanton, California USA	JB3	A022805	10-May-16	10-May-17
3001	EMC Analyzer, 9 kHz to 3 GHz	Agilent Technologies	E7402A	US39440180	08-Jun-16	08-Jun-17
3286	Temperature Chamber, (-50 to +170) °C	Thermotron	EL-8-CH-1-1-CO2	21-9048	01-Oct-15	01-Oct-16
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY48250288	03-May-16	03-May-17
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1225/2A	15-Feb-16	15-Feb-17
4164	DC Power Supply, 60V, 5A	Standig	605D	NA	19-Jan-16	19-Jan-17
4277	Test Cable , DC-18 GHz, 3.05 m, N/M - N/M	Mini-Circuits	APC-10FT-NMM+	0748A	22-Nov-15	22-Nov-16
4295	Microwave Cable Assembly, 18.0 GHz, 3.4 m, SMA/SMA	Huber-Suhner	Sucoflex P103	NA	15-Dec-15	15-Dec-16
4535	Microwave Cable Assembly, 6.5 GHz, 5.0 m, N/M type-N/M type	Suhner Switzerland	214-U	NA	30-May-16	30-May-17
4541	Microwave Cable Assembly, 4.0 GHz, 1.0 m, N/M type-N/M type	Suhner Switzerland	214-U	NA	26-Aug-16	26-Aug-17
4542	Amplifier, 9 kHz to 1 GHz, 32 dB gain	Sonoma Instrument	310	0002A05639	10-Mar-16	10-Mar-17
4543	Broadband preamplifier, 0.5 to 18 GHz, 35 dB gain	Schwarzbeck mess-elektronik	BBV 9718	9718-134	03-Mar-16	03-Mar-17
4549	Cable RF, 6.8 m, N/N - type, up to 3 GHz	Suhner Switzerland	NA	07262	10-Mar-16	10-Mar-17
4551	Cable RF, 6.6 m, N/N - type, up to 18 GHz	Suhner Switzerland	Sucoflex 104E	22200/4E	10-Mar-16	10-Mar-17
4575	EXA Signal Analyzer, 9 kHz - 26.5 GHz	Agilent Technologies	N9010A	MY48030110	17-Feb-16	17-Mar-17
4659	EMC Anechoic Chamber (6.75 x 3.05 x 3.69) m	ETS Euroshield	Ft2000	NA	NA	NA
4778	EMI Receiver, 9 kHz - 2.9 GHz, System: HL1431, HL4777	Hewlett Packard	8542E	30807A00262, 3427A00123	05-Nov-15	05-Nov-16



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HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
5107	RF cable, 18 GHz, 4.5 m, N-type	Huber-Suhner	SF106A/1 1N/11N/4 500MM	500845/6 A	26-Jul-16	26-Jul-17



## 9 APPENDIX B Measurement uncertainties

### Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Radiated emissions at 10 m measuring distance Horizontal polarization  Vertical polarization	Biconilog antenna: $\pm 5.0$ dB Biconical antenna: $\pm 5.0$ dB Log periodic antenna: $\pm 5.1$ dB Double ridged horn antenna: $\pm 5.3$ dB Biconilog antenna: $\pm 5.5$ dB Biconical antenna: $\pm 5.5$ dB Log periodic antenna: $\pm 5.6$ dB Double ridged horn antenna: $\pm 5.8$ dB
Radiated emissions at 3 m measuring distance Horizontal polarization  Vertical polarization	Biconilog antenna: $\pm 5.3$ dB Biconical antenna: $\pm 5.0$ dB Log periodic antenna: $\pm 5.3$ dB Double ridged horn antenna: $\pm 5.3$ dB Biconilog antenna: $\pm 6.0$ dB Biconical antenna: $\pm 5.7$ dB Log periodic antenna: $\pm 6.0$ dB Double ridged horn antenna: $\pm 6.0$ dB
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: $\pm 2.6$ dB 2.9 GHz to 6.46 GHz: $\pm 3.5$ dB 6.46 GHz to 13.2 GHz: $\pm 4.3$ dB 13.2 GHz to 22.0 GHz: $\pm 5.0$ dB 22.0 GHz to 26.8 GHz: $\pm 5.5$ dB 26.8 GHz to 40.0 GHz: $\pm 4.8$ 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, 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, 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 and environmental simulation (for exact scope please refer to Certificate No. 839.01).

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## 11 APPENDIX D Specification references

47CFR part 15: 2015	Radio Frequency Devices.
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.2: 1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications.
ANSI C63.4: 2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

## 12 APPENDIX E Test equipment correction factors

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( $\mu$ V) to convert it into field intensity in dB( $\mu$ V/m).

**Antenna factor**  
**Active loop antenna**  
**EMC Test Systems**  
**Model 6507, S/N 1457, HL 1915**

Frequency, kHz	Measured antenna factor, dBS/m
10	-22.7
20	-27.6
50	-31.3
75	-31.8
100	-32.2
150	-32.3
250	-32.6
500	-32.8
750	-33.0
1000	-33.1
2000	-33.4
3000	-33.7
4000	-34.0
5000	-34.3
10000	-34.9
15000	-35.6
20000	-35.9
25000	-36.1
30000	-36.7

The antenna factor shall be added to receiver reading in dB $\mu$ V to obtain field strength in dB $\mu$ A/m.

Antenna calibration  
Sunol Sciences Inc., model JB3, serial number A022805, HL 2697

Frequency, MHz	ACF, dB	Gain, dBi	Num gain	Frequency, MHz	ACF, dB	Gain, dBi	Num gain	Frequency, MHz	ACF, dB	Gain, dBi	Num gain	Frequency, MHz	ACF, dB	Gain, dBi	Num gain	Frequency, MHz	ACF, dB	Gain, dBi	Num gain
30	22.2	-22.5	0.01	620	19.7	6.3	4.27	1215	24.9	7.0	5.05	1810	28.3	7.1	5.08	2405	30.9	6.9	4.93
35	18.5	-17.4	0.02	625	19.7	6.5	4.42	1220	24.9	7.0	4.99	1815	28.5	6.9	4.91	2410	30.9	6.9	4.89
40	14.7	-12.5	0.06	630	19.6	6.6	4.57	1225	25.1	6.9	4.91	1820	28.6	6.8	4.74	2415	31.0	6.9	4.85
45	11.3	-8.1	0.16	635	19.7	6.5	4.48	1230	25.2	6.8	4.82	1825	28.7	6.8	4.75	2420	31.0	6.8	4.82
45	11.3	-8.1	0.16	640	19.9	6.4	4.40	1235	25.1	7.0	4.96	1830	28.7	6.8	4.76	2425	31.1	6.8	4.81
50	8.9	-4.7	0.34	645	19.9	6.5	4.45	1240	25.0	7.1	5.09	1835	28.7	6.7	4.72	2430	31.0	6.9	4.87
55	7.9	-2.8	0.52	650	19.9	6.5	4.51	1245	25.0	7.1	5.12	1840	28.8	6.7	4.69	2435	31.0	6.9	4.86
60	7.5	-2.1	0.62	655	19.9	6.6	4.60	1250	25.0	7.1	5.15	1845	28.6	6.9	4.90	2440	31.2	6.8	4.74
65	8.5	-2.0	0.63	660	19.9	6.7	4.69	1255	25.0	7.2	5.25	1850	28.4	7.1	5.12	2445	31.1	6.9	4.91
70	9.0	-1.9	0.64	665	19.9	6.7	4.70	1260	24.9	7.3	5.36	1855	28.5	7.0	5.07	2450	31.0	7.0	4.96
75	8.8	-1.1	0.78	670	20.0	6.7	4.71	1265	25.0	7.3	5.31	1860	28.6	7.0	5.01	2455	31.0	7.0	5.01
80	8.4	-0.2	0.97	675	20.1	6.7	4.71	1270	25.1	7.2	5.26	1865	28.5	7.1	5.17	2460	30.9	7.2	5.19
85	8.0	0.6	1.20	680	20.1	6.7	4.71	1275	25.3	7.0	5.05	1870	28.4	7.3	5.33	2465	31.1	6.9	4.95
90	8.2	1.1	1.29	685	20.1	6.8	4.79	1280	25.5	6.8	4.94	1875	28.4	7.2	5.28	2470	31.3	6.8	4.76
95	9.2	0.5	1.13	690	20.1	6.9	4.88	1285	25.4	7.0	4.97	1880	28.5	7.2	5.22	2475	31.4	6.7	4.69
100	10.6	-0.4	0.92	695	20.2	6.8	4.82	1290	25.3	7.1	5.10	1885	28.5	7.2	5.22	2480	31.3	6.8	4.79
110	12.6	-1.6	0.70	705	20.4	6.8	4.75	1300	25.2	7.3	5.33	1895	28.6	7.2	5.24	2490	31.1	7.0	4.99
120	13.9	-2.1	0.62	715	20.5	6.8	4.80	1310	25.5	7.1	5.09	1905	28.5	7.3	5.36	2500	30.9	7.2	5.27
125	14.2	-2.0	0.63	720	20.5	6.9	4.85	1315	25.4	7.2	5.23	1910	28.5	7.4	5.45	2505	31.1	7.1	5.15
130	14.2	-1.7	0.68	725	20.6	6.8	4.81	1320	25.3	7.3	5.36	1915	28.5	7.3	5.38	2510	31.0	7.2	5.22
140	13.4	0.3	0.94	735	20.9	6.7	4.55	1330	25.6	7.0	4.98	1925	28.6	7.3	5.39	2520	31.2	7.0	5.05
150	12.9	0.8	1.21	745	21.0	6.6	4.59	1340	25.7	7.1	5.09	1935	28.5	7.4	5.54	2530	31.0	7.3	5.37
160	12.7	1.6	1.44	755	21.0	6.8	4.74	1350	25.7	7.1	5.17	1945	28.5	7.5	5.59	2540	31.2	7.1	5.09
165	12.5	2.0	1.59	760	21.0	6.8	4.83	1355	25.8	7.0	5.06	1950	28.6	7.4	5.48	2545	31.0	7.3	5.43
170	12.2	2.6	1.83	765	21.1	6.8	4.73	1360	25.9	6.9	4.95	1955	28.6	7.5	5.57	2550	31.0	7.3	5.39
175	11.8	3.3	2.13	770	21.3	6.7	4.64	1365	26.0	6.9	4.95	1960	28.6	7.5	5.65	2555	31.1	7.2	5.30
180	11.6	3.7	2.36	775	21.3	6.7	4.68	1370	26.0	7.0	4.98	1965	28.7	7.4	5.47	2560	31.0	7.4	5.47
185	11.5	4.0	2.54	780	21.3	6.7	4.72	1375	26.0	7.0	5.01	1970	28.5	7.2	5.29	2565	30.8	7.6	5.70
190	11.6	4.2	2.61	785	21.3	6.8	4.77	1380	26.0	7.0	5.06	1975	28.9	7.2	5.22	2570	31.1	7.3	5.37
200	13.1	3.2	2.07	795	21.4	6.8	4.79	1390	26.1	6.9	4.92	1985	29.1	7.1	5.11	2580	31.6	6.9	4.87
205	12.0	4.4	2.76	800	21.5	6.8	4.77	1395	26.2	6.9	4.94	1990	29.1	7.0	5.06	2585	31.6	6.8	4.79
210	11.0	5.6	3.66	805	21.6	6.7	4.71	1400	26.2	7.0	4.96	1995	29.1	7.1	5.09	2590	31.6	6.9	4.88
215	11.3	5.6	3.59	810	21.7	6.7	4.65	1405	26.1	7.0	5.02	2000	29.1	7.1	5.11	2595	31.5	7.0	4.97
220	11.6	5.5	3.52	815	21.7	6.7	4.72	1410	26.1	7.1	5.09	2005	29.1	7.1	5.16	2600	31.6	6.9	4.86
225	11.7	5.5	3.45	820	21.7	6.8	4.80	1415	26.2	7.0	5.02	2010	29.1	7.1	5.15	2605	31.3	7.2	5.30
230	11.9	5.5	3.57	825	21.7	6.8	4.82	1420	26.3	7.0	5.06	2015	29.2	7.1	5.13	2610	31.4	7.1	5.15
235	12.1	5.5	3.56	830	21.7	6.9	4.85	1425	26.2	7.1	5.10	2020	29.2	7.1	5.18	2615	31.7	6.9	4.88
240	12.3	5.5	3.54	835	21.8	6.8	4.82	1430	26.1	7.2	5.25	2025	29.3	7.1	5.08	2620	31.6	7.0	4.97
245	12.3	5.7	3.71	840	21.9	6.8	4.80	1435	26.1	7.2	5.24	2030	29.3	7.0	5.05	2625	31.4	7.1	5.17
250	12.3	5.9	3.88	845	21.9	6.8	4.83	1440	26.2	7.2	5.24	2035	29.3	7.1	5.07	2630	31.6	7.0	5.00
255	12.5	5.9	3.85	850	21.9	6.9	4.86	1445	26.3	1	5.11	2040	29.3	7.1	5.13	2635	31.8	6.8	4.82
260	12.7	5.8	3.83	855	22.0	6.8	4.80	1450	26.5	7.0	4.98	2045	29.2	7.2	5.23	2640	31.7	7.0	4.98
265	13.2	5.5	3.54	860	22.1	6.8	4.74	1455	26.4	7.1	5.07	2050	29.2	7.2	5.27	2645	31.7	6.9	4.93
270	13.7	5.2	3.27	865	22.1	6.9	4.82	1460	26.4	7.1	5.17	2055	29.3	7.2	5.21	2650	31.8	6.9	4.85
275	13.7	5.3	3.39	870	21.9	7.1	5.11	1465	26.4	7.2	5.19	2060	29.5	7.0	5.02	2655	31.8	6.9	4.85
280	13.7	5.4	3.50	875	22.0	7.1	5.08	1470	26.4	7.2	5.22	2065	29.4	7.1	5.08	2660	31.7	7.0	5.02
285	13.7	5.6	3.61	880	22.1	7.0	5.05	1475	26.4	7.1	5.17	2070	29.4	7.1	5.01	2665	32.0	6.7	4.71
290	13.7	5.7	3.72	885	22.1	7.0	5.06	1480	26.5	7.1	5.12	2075	29.5	7.0	5.01	2670	32.0	6.7	4.67
295	13.8	5.8	3.77	890	22.1	7.0	5.06	1485	26.5	7.1	5.14	2080	29.8	6.8	4.76	2675	31.9	6.8	4.81
300	13.9	5.8	3.81	895	22.2	7.1	5.09	1490	26.5	7.1	5.17	2085	29.7	6.9	4.89	2680	31.7	7.0	5.04
305	14.0	5.9	3.85	900	22.2	7.1	5.12	1495	26.5	7.2	5.24	2090	29.7	6.9	4.86	2685	31.9	6.8	4.83
310	14.1	5.9	3.88	905	22.3	7.1	5.09	1500	26.5	7.2	5.31	2095	29.8	6.8	4.78	2690	32.1	6.7	4.72
315	14.3	5.8	3.88	910	22.3	7.0	5.05	1505	26.5	7.2	5.27	2100	29.8	6.8	4.75	2695	32.1	6.7	4.71
320	14.4	5.9	3.90	915	22.4	7.0	4.99	1510	26.6	7.2	5.30	2105	29.8	6.8	4.81	2700	32.0	6.8	4.81
325	14.5	5.9	3.92	920	22.6	6.9	4.92	1515	26.6	7.2	5.37	2110	29.9	6.8	4.78	2705	32.0	6.8	4.80
330	14.6	5.9	3.93	925	22.7	6.9	4.85	1520	26.5	7.3	5.38	2115	29.9	6.8	4.76	2710	32.1	6.8	4.79
335	14.7	6.0	4.02	930	22.8	6.8	4.77	1525	26.6	7.3	5.37	2120	29.9	6.8	4.84	2715	32.1	6.7	4.71
340	14.7	6.2	4.12	935	22.8	6.8	4.83	1530	26.6	7.3	5.36	2125	29.9	6.9	4.89	2720	32.4	6.5	4.47
345	14.9	6.1	4.06	940	22.8	6.9	4.89	1535	26.6	7.4	5.44	2130	29.9	6.9	4.90	2725	32.2	6.7	4.63
350	15.1	6.0	3.99	945	22.8	6.9	4.87	1540	26.5	7.4	5.53	2135	29.8	6.9	4.94	2730	31.9	7.0	5.05
355	15.3	5.9	3.88	950	22.9	6.9	4.85	1545	26.5	7.5	5.58	2140	29.8	7.1	5.08	2735	31.6	7.4	5.44
360	15.8	5.8	3.78	955	23.0	6.8	4.81	1550	26.6	7.5	5.63	2145	29.8	6.9	4.92	2740	31.8	7.1	5.40
365	15.5	5.9	3.89	960	23.1	6.8	4.77	1555	26.7	7.3	5.39	2150	29.9	7.0	4.98	2745	31.9	7.0	5.06
370	15.5	6.0	4.01	965	23.1	6.7	4.73	1560	26.9	7.1	5.18	2155	29.8	7.1	5.10	2750	32.0	6.9	4.94
375	15.6	6.1	4.03	970	23.2	6.7	4.69	1565	26.9	7.2	5.23	2160	29.8	7.1	5.09	2755	32.0	7.0	4.98
380	15.7	6.1	4.05	975	23.3	6.6	4.62	1570	26.9	7.2	5.30	2165	29.9	7.0	5.00	2760	32.0	7.0	5.06
385	15.7	6.2	4.15	980	23.5	6.6	4.54	1575	27.0	7.2	5.23	2170	29.9	7.1	5.07	2765	32.2	6.8	4.80
390	15.7	6.3	4.25	985	23.5	6.6	4.52	1580	27.0	7.1	5.17	2175	29.8	7.2	5.20	2770	32.3	6.8	



**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



HERMON LABORATORIES

**Cable loss**  
**Test cable, Mini-Circuits, S/N 0748A, 18 GHz, 3.05 m, N/M - N/M**  
**APC-10FT-NMNM+, HL 4277**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.12	4400	3.19	9000	4.82	13600	5.97
30	0.21	4500	3.24	9100	4.87	13700	6.01
50	0.28	4600	3.29	9200	4.90	13800	6.04
100	0.40	4700	3.34	9300	4.96	13900	6.09
200	0.59	4800	3.37	9400	4.99	14000	6.12
300	0.73	4900	3.41	9500	5.03	14100	6.16
400	0.86	5000	3.45	9600	5.07	14200	6.20
500	0.97	5100	3.48	9700	5.11	14300	6.22
600	1.07	5200	3.52	9800	5.13	14400	6.26
700	1.15	5300	3.56	9900	5.15	14500	6.29
800	1.23	5400	3.58	10000	5.17	14600	6.33
900	1.31	5500	3.62	10100	5.19	14700	6.33
1000	1.39	5600	3.65	10200	5.19	14800	6.35
1100	1.46	5700	3.69	10300	5.21	14900	6.38
1200	1.54	5800	3.72	10400	5.22	15000	6.38
1300	1.60	5900	3.76	10500	5.22	15100	6.40
1400	1.67	6000	3.80	10600	5.22	15200	6.42
1500	1.74	6100	3.84	10700	5.25	15300	6.46
1600	1.79	6200	3.89	10800	5.25	15400	6.51
1700	1.86	6300	3.92	10900	5.26	15500	6.55
1800	1.92	6400	3.96	11000	5.29	15600	6.56
1900	1.98	6500	4.00	11100	5.30	15700	6.59
2000	2.04	6600	4.04	11200	5.31	15800	6.60
2100	2.09	6700	4.07	11300	5.35	15900	6.64
2200	2.14	6800	4.11	11400	5.36	16000	6.65
2300	2.20	6900	4.14	11500	5.39	16100	6.65
2400	2.25	7000	4.17	11600	5.41	16200	6.67
2500	2.31	7100	4.21	11700	5.45	16300	6.69
2600	2.36	7200	4.23	11800	5.48	16400	6.71
2700	2.42	7300	4.27	11900	5.51	16500	6.72
2800	2.46	7400	4.30	12000	5.53	16600	6.73
2900	2.51	7500	4.34	12100	5.56	16700	6.75
3000	2.56	7600	4.37	12200	5.59	16800	6.80
3100	2.60	7700	4.40	12300	5.61	16900	6.82
3200	2.65	7800	4.44	12400	5.62	17000	6.85
3300	2.70	7900	4.47	12500	5.65	17100	6.90
3400	2.75	8000	4.49	12600	5.68	17200	6.96
3500	2.80	8100	4.53	12700	5.71	17300	7.02
3600	2.85	8200	4.57	12800	5.73	17400	7.07
3700	2.90	8300	4.60	12900	5.76	17500	7.06
3800	2.95	8400	4.63	13000	5.80	17600	7.06
3900	2.98	8500	4.67	13100	5.83	17700	7.08
4000	3.02	8600	4.69	13200	5.86	17800	7.09
4100	3.07	8700	4.73	13300	5.88	17900	7.07
4200	3.10	8800	4.76	13400	5.91	18000	7.08
4300	3.14	8900	4.79	13500	5.94		

**Cable loss**  
**Microwave Cable Assembly, 18.0 GHz, 3.4 m, SMA/SMA, Huber-Suhner, S/N 4295,**  
**Sucoflex P103, HL 4295**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.11	5000	2.09	10200	2.97	15400	3.63
30	0.18	5100	2.12	10300	3.01	15500	3.65
50	0.23	5200	2.13	10400	3.00	15600	3.63
100	0.31	5300	2.16	10500	3.05	15700	3.64
200	0.38	5400	2.19	10600	3.09	15800	3.64
300	0.43	5500	2.21	10700	3.05	15900	3.66
400	0.52	5600	2.21	10800	3.09	16000	3.71
500	0.60	5700	2.24	10900	3.10	16100	3.67
600	0.67	5800	2.24	11000	3.08	16200	3.71
700	0.72	5900	2.25	11100	3.11	16300	3.70
800	0.78	6000	2.27	11200	3.12	16400	3.71
900	0.83	6100	2.25	11300	3.12	16500	3.72
1000	0.89	6200	2.29	11400	3.20	16600	3.84
1100	0.94	6300	2.34	11500	3.16	16700	3.78
1200	0.98	6400	2.37	11600	3.16	16800	3.85
1300	1.03	6500	2.33	11700	3.20	16900	3.88
1400	1.06	6600	2.34	11800	3.19	17000	3.85
1500	1.11	6700	2.39	11900	3.21	17100	3.88
1600	1.14	6800	2.46	12000	3.28	17200	3.92
1700	1.19	6900	2.45	12100	3.23	17300	3.90
1800	1.22	7000	2.44	12200	3.26	17400	4.00
1900	1.26	7100	2.43	12300	3.30	17500	4.02
2000	1.30	7200	2.44	12400	3.25	17600	4.00
2100	1.34	7300	2.51	12500	3.26	17700	3.96
2200	1.37	7400	2.54	12600	3.30	17800	4.01
2300	1.40	7500	2.49	12700	3.26	17900	4.02
2400	1.44	7600	2.52	12800	3.34	18000	4.08
2500	1.47	7700	2.59	12900	3.37		
2600	1.50	7800	2.57	13000	3.30		
2700	1.55	7900	2.55	13100	3.35		
2800	1.58	8000	2.57	13200	3.31		
2900	1.60	8100	2.58	13300	3.33		
3000	1.63	8200	2.64	13400	3.42		
3100	1.64	8300	2.70	13500	3.43		
3200	1.67	8400	2.65	13600	3.40		
3300	1.69	8500	2.66	13700	3.47		
3400	1.73	8600	2.68	13800	3.45		
3500	1.74	8700	2.70	13900	3.43		
3600	1.76	8800	2.74	14000	3.52		
3700	1.79	8900	2.74	14100	3.51		
3800	1.82	9000	2.76	14200	3.54		
3900	1.85	9100	2.82	14300	3.55		
4000	1.87	9200	2.79	14400	3.52		
4100	1.90	9300	2.82	14500	3.52		
4200	1.92	9400	2.83	14600	3.56		
4300	1.93	9500	2.83	14700	3.55		
4400	1.94	9600	2.86	14800	3.55		
4500	1.97	9700	2.93	14900	3.59		
4600	1.99	9800	2.89	15000	3.56		
4700	2.01	9900	2.91	15100	3.59		
4800	2.02	10000	2.94	15200	3.59		
4900	2.04	10100	2.94	15300	3.59		



**Cable loss**  
**Microwave Cable Assembly, 6.5 GHz, 5.0 m, N/M type-N/M type**  
**Suhner Switzerland, HL 4535**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.10	1700	1.79	4400	3.53
15	0.13	1800	1.86	4500	3.60
20	0.15	1900	1.93	4600	3.72
30	0.18	2000	2.00	4700	3.80
40	0.21	2100	2.06	4800	3.87
50	0.24	2200	2.13	4900	3.94
60	0.26	2300	2.19	5000	3.99
70	0.29	2400	2.25	5100	4.06
80	0.31	2500	2.32	5200	4.12
90	0.33	2600	2.38	5300	4.17
100	0.35	2700	2.45	5400	4.25
150	0.43	2800	2.51	5500	4.31
200	0.50	2900	2.57	5600	4.40
300	0.63	3000	2.64	5700	4.47
400	0.74	3100	2.73	5800	4.54
500	0.85	3200	2.79	5900	4.64
600	0.94	3300	2.86	6000	4.73
700	1.03	3400	2.91	6100	4.79
800	1.12	3500	2.97	6200	4.89
900	1.20	3600	3.02	6300	5.00
1000	1.28	3700	3.07	6400	5.06
1100	1.35	3800	3.14	6500	5.13
1200	1.43	3900	3.20		
1300	1.50	4000	3.25		
1400	1.58	4100	3.32		
1500	1.65	4200	3.38		
1600	1.72	4300	3.46		

**Cable loss**  
**Microwave Cable Assembly, 4.0 GHz, 1.0 m, N/M type-N/M type**  
**Suhner Switzerland, HL 4541**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.02	1700	0.45
15	0.03	1800	0.46
20	0.03	1900	0.48
30	0.04	2000	0.49
40	0.04	2100	0.52
50	0.05	2200	0.54
60	0.06	2300	0.55
70	0.06	2400	0.56
80	0.07	2500	0.58
90	0.07	2600	0.59
100	0.08	2700	0.61
150	0.10	2800	0.63
200	0.12	2900	0.64
300	0.15	3000	0.67
400	0.18	3100	0.70
500	0.20	3200	0.74
600	0.23	3300	0.77
700	0.25	3400	0.80
800	0.28	3500	0.82
900	0.30	3600	0.86
1000	0.31	3700	0.88
1100	0.33	3800	0.94
1200	0.35	3900	0.95
1300	0.37	4000	0.99
1400	0.39		
1500	0.41		
1600	0.43		

**Cable loss**  
**RF Cable, Huber-Suhner, 18 GHz, 6 m, N- type,**  
**SF106A/11N/11N/4500MM, S/N 500845/6A**  
**HL 5107**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.01	5500	1.75
50	0.16	6000	1.84
100	0.22	6500	1.92
200	0.31	7000	2.00
300	0.38	7500	2.07
400	0.44	8000	2.15
500	0.49	8500	2.23
600	0.54	9000	2.29
700	0.58	9500	2.38
800	0.63	10000	2.43
900	0.67	10500	2.50
1000	0.71	11000	2.57
1100	0.74	11500	2.63
1200	0.77	12000	2.69
1300	0.81	12500	2.76
1400	0.84	13000	2.82
1500	0.87	13500	2.87
1600	0.91	14000	2.93
1700	0.93	14500	3.00
1800	0.96	15000	3.06
1900	0.99	15500	3.12
2000	1.01	16000	3.18
2500	1.14	16500	3.22
3000	1.26	17000	3.28
3500	1.37	17500	3.36
4000	1.47	18000	3.43
4500	1.57		
5000	1.66		

## 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( $\mu$ V)	decibel referred to one microvolt
dB( $\mu$ V/m)	decibel referred to one microvolt per meter
dB( $\mu$ A)	decibel referred to one microampere
DC	direct current
EIRP	equivalent isotropically radiated power
ERP	effective radiated power
EUT	equipment under test
F	frequency
GHz	gigahertz
GND	ground
H	height
HL	Hermon laboratories
Hz	hertz
k	kilo
kHz	kilohertz
LO	local oscillator
m	meter
MHz	megahertz
min	minute
mm	millimeter
ms	millisecond
$\mu$ s	microsecond
NA	not applicable
NB	narrow band
OATS	open area test site
$\Omega$	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

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