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839.01
Electrical

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TEST REPORT

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

FOR:

On Track Innovations Ltd.

RF Nozzle reader (NID transmitter)

Model: EFP-RFN 900

Table of contents

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1 Applicant information

Client name:	On Track Innovations Ltd.
Address:	P.O.B. 32, ZHR Industrial Zone, Rosh Pina, Index 12000, Israel
Telephone:	+972 4686 8000
Fax:	+972 4693 8887
E-mail:	h_itay@otiglobal.com
Contact name:	Mr. Hemy Itay

2 Equipment under test attributes

Product name:	RF Nozzle reader
Product type:	NID transmitter
Model(s):	EFP-RFN 900
Serial number:	0015
Receipt date	3/10/2010

3 Manufacturer information

Manufacturer name:	On Track Innovations Ltd.
Address:	P.O.B. 32, ZHR Industrial Zone, Rosh Pina, Index 12000, Israel
Telephone:	+972 4686 8000
Fax:	+972 4693 8887
E-Mail:	h_itay@otiglobal.com
Contact name:	Mr. Hemy Itay

4 Test details

Project ID:	20581
Location:	Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel
Test started:	3/10/2010
Test completed:	3/25/2010
Test specification(s):	FCC Part 15, subpart C, §15.225

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5 Tests summary

Test	Status
Transmitter characteristics	
Sections 15.225(a) (b) (c), In band radiated emissions	Pass
Section 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 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.

	Name and Title	Date	Signature
Tested by:	Mrs. E. Pitt, test engineer	March 25, 2010	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	March 31, 2010	
Approved by:	Mr. M. Nikishin, EMC and radio group manager	March 31, 2010	

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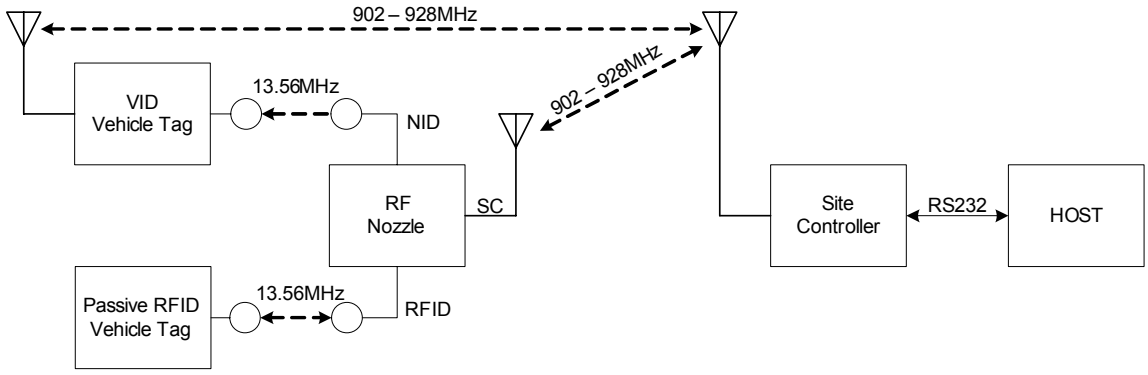
6 EUT description

6.1 General information

The EUT, "RF Nozzle" reader, is designed to serve as an interface between the refueled vehicle and the pump/station SC (Site Controller) to facilitate controlled and secured refueling. It is mounted on the refueling nozzle.

The RF Nozzle is a battery powered unit, comprising three different RF sections: a RFID 13.56 MHz transceiver, a NID (Nozzle ID) 13.56 MHz transmitter and a SC (Site Controller) 902-928 MHz transceiver, all operating under the control of a local microprocessor.

The principle of the EUT operation is shown in the diagram below.



6.2 Changes made in EUT

No changes were performed in the EUT.

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6.3 EUT positions during testing

Photograph 6.3.1 EUT vertical position (X-axis)

Photograph 6.3.2 EUT typical position (Y-axis)

Photograph 6.3.3 EUT horizontal position (Z-axis)

6.4 Transmitter characteristics of NID transmitter

Type of equipment								
	Stand-alone (Equipment with or without its own control provisions)							
V	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
	mobile	Always at a distance more than 20 cm from all people
V	portable	May operate at a distance closer than 20 cm to human body

Assigned frequency range	13.56 MHz
Operating frequency range	13.56 MHz
Maximum field strength	41.8 dB(µV/m) at 3 m test distance

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

Antenna connection				
V unique coupling	standard connector	Integral	with temporary RF connector	
			without temporary RF connector	

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

Transmitter aggregate data rate/s	106 kbps
Type of modulation	AM
Transmitter duty cycle supplied for test	100%

Transmitter power source					
V	Battery	**Nominal rated voltage**	3.6 V	Battery type	Lithium
	DC	**Nominal rated voltage**			
	AC mains	**Nominal rated voltage**		Frequency	

Test specification:	Sections 15.225(a) (b) (c), In band radiated emissions		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/15/2010 2:17:52 PM		
Temperature: 24.7 ºC	Air Pressure: 1006 hPa	Relative Humidity: 45 %	Power Supply: 3.6 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.

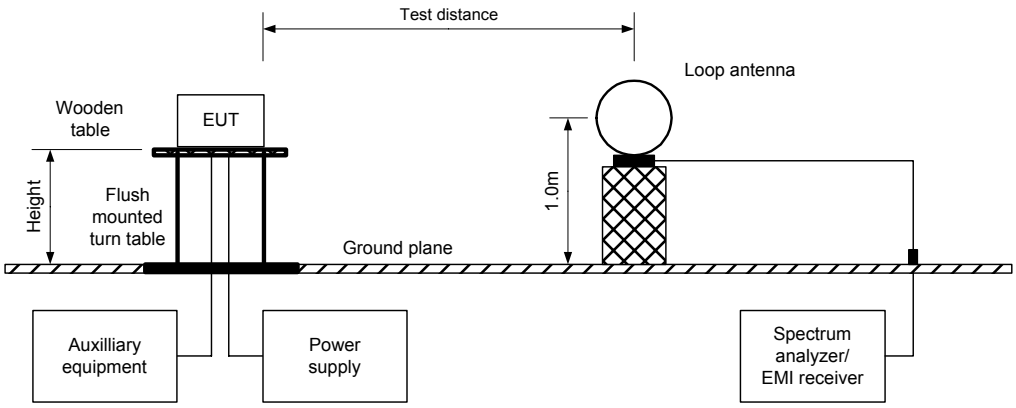
7.1.2.2 The measurements were performed in 3 orthogonal positions of the EUT.

7.1.2.3 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.

7.1.2.4 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), In band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date & Time:	3/15/2010 2:17:52 PM		
Temperature: 24.7 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 45 %	**Power Supply:** 3.6 VDC
Remarks:			

Figure 7.1.1 Setup for in band radiated emission measurements



Test specification:	**Sections 15.225(a) (b) (c), In band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date & Time:	3/15/2010 2:17:52 PM		
Temperature: 24.7 ºC	**Air Pressure:** 1006 hPa	**Relative Humidity:** 45 %	**Power Supply:** 3.6 VDC
Remarks:			

Table 7.1.2 In band radiated emission test results

TEST DISTANCE:	3 m
EUT POSITION:	3 orthogonal (X / Y / Z)
MODULATION:	AM
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*			
13.56	41.8	NA	124.0	-82.2	Vertical	0	Pass

The recorded test result was obtained in the EUT typical position.

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

Reference numbers of test equipment used

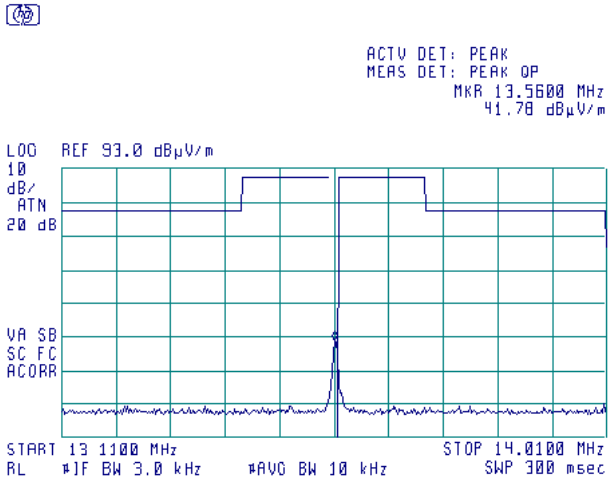
HL 0446	HL 0521	HL 2871	HL 3616				

Full description is given in Appendix A.

Test specification:	Sections 15.225(a) (b) (c), In band radiated emissions		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/15/2010 2:17:52 PM		
Temperature: 24.7 ºC	Air Pressure: 1006 hPa	Relative Humidity: 45 %	Power Supply: 3.6 VDC
Remarks:			

Plot 7.1.1 Fundamental emission test result

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 C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/17/2010 1:38:55 PM		
Temperature: 24.7 ºC	Air Pressure: 1014 hPa	Relative Humidity: 42 %	Power Supply: 3.6 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) found in the EUT 3 orthogonal positions, 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 7.2.1, 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) found in the EUT 3 orthogonal positions, 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 C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/17/2010 1:38:55 PM		
Temperature: 24.7 ºC	Air Pressure: 1014 hPa	Relative Humidity: 42 %	Power Supply: 3.6 VDC
Remarks:			

Figure 7.2.1 Radiated emissions below 30 MHz test set up

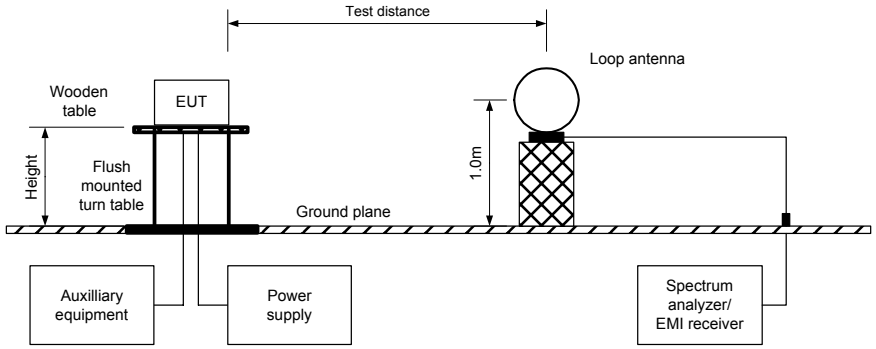
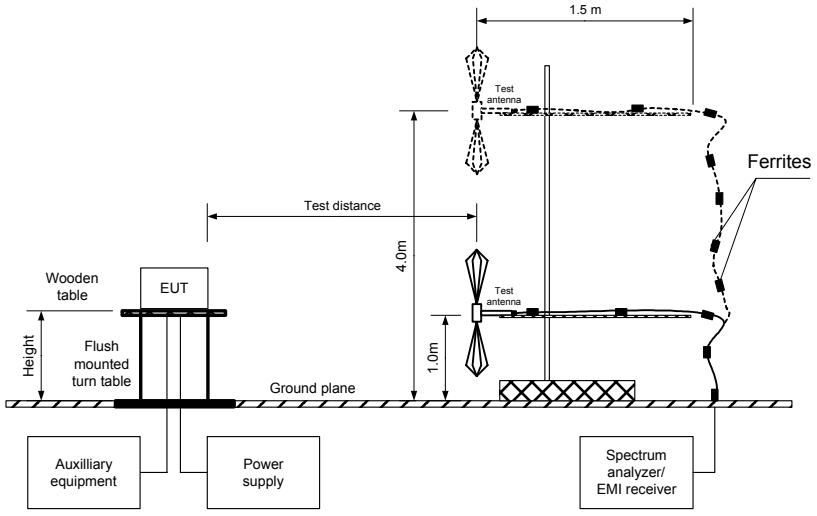


Figure 7.2.2 Radiated emissions above 30 MHz test set up



Test specification:	**Sections 15.225(d), Out of band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date & Time:	3/17/2010 1:38:55 PM		
Temperature: 24.7 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 42 %	**Power Supply:** 3.6 VDC
Remarks:			

Table 7.2.2 Out of band radiated emissions test results

TEST DISTANCE:	3 m
EUT POSITION:	3 orthogonal (X / Y / Z)
MODULATION:	AM
MODULATING SIGNAL:	ID code
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
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
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***				
216.95	42.6	41.8	46.0	-4.2	H	1.0	147	Pass
339.00	41.8	40.7	46.0	-5.3	H	1.0	165	
420.35	41.5	40.2	46.0	-5.8	V	1.0	221	
447.48	43.5	42.4	46.0	-3.6	V	1.0	208	
474.58	44.8	43.8	46.0	-2.2	V	1.0	172	
501.70	41.0	39.4	46.0	-6.6	V	1.0	224	

The recorded test results were found in the EUT different orthogonal positions.

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

Reference numbers of test equipment used

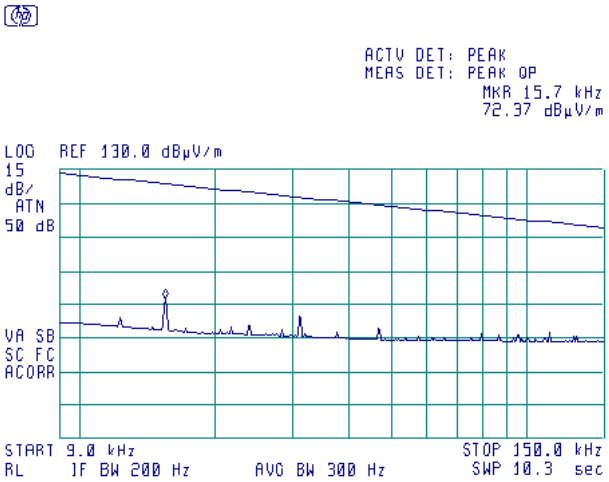
HL 0446	HL 0521	HL 0604	HL 2871	HL 3616			

Full description is given in Appendix A.

Test specification:	**Sections 15.225(d), Out of band radiated emissions**		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date & Time:	3/17/2010 1:38:55 PM		
Temperature: 24.7 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 42 %	**Power Supply:** 3.6 VDC
Remarks:			

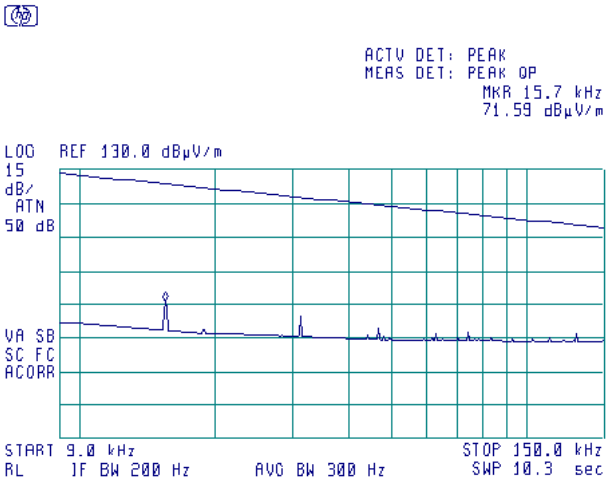
Plot 7.2.1 Radiated emission measurements from 9 to 150 kHz

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



Plot 7.2.2 Radiated emission measurements from 9 to 150 kHz

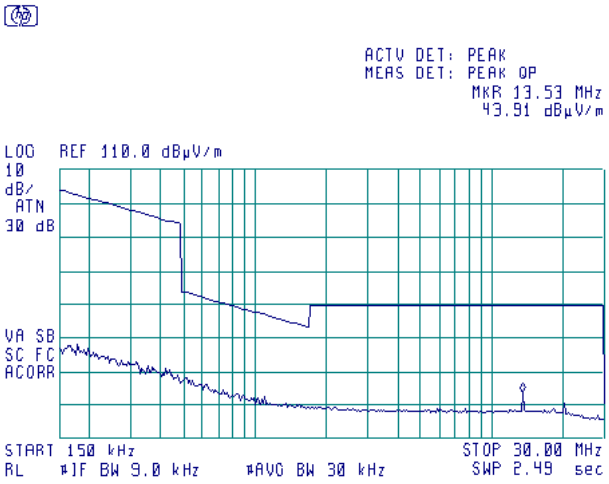
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
DETECTOR: Peak hold



Test specification:	Sections 15.225(d), Out of band radiated emissions		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/17/2010 1:38:55 PM		
Temperature: 24.7 ºC	Air Pressure: 1014 hPa	Relative Humidity: 42 %	Power Supply: 3.6 VDC
Remarks:			

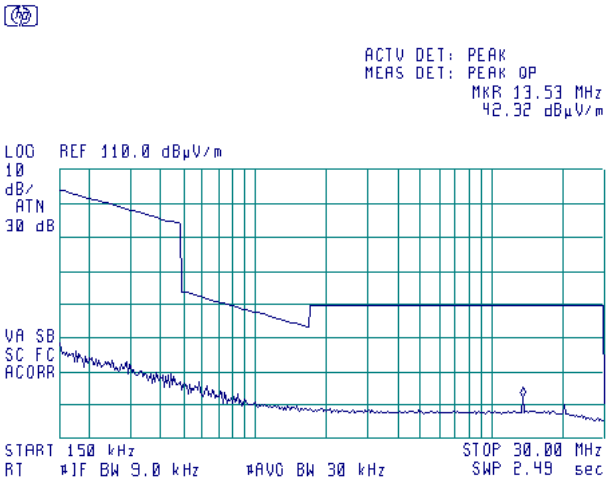
Plot 7.2.3 Radiated emission measurements from 0.15 to 30 MHz

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

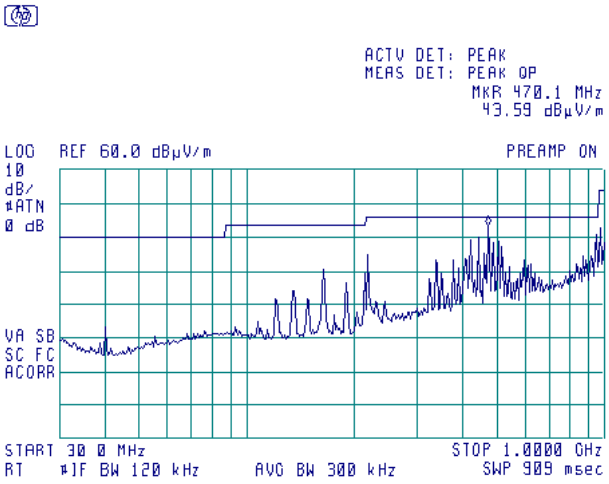
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
DETECTOR: Peak hold



Test specification:	Sections 15.225(d), Out of band radiated emissions		
Test procedure:	ANSI C63.4, Sections 5.3 and 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/17/2010 1:38:55 PM		
Temperature: 24.7 ºC	Air Pressure: 1014 hPa	Relative Humidity: 42 %	Power Supply: 3.6 VDC
Remarks:			

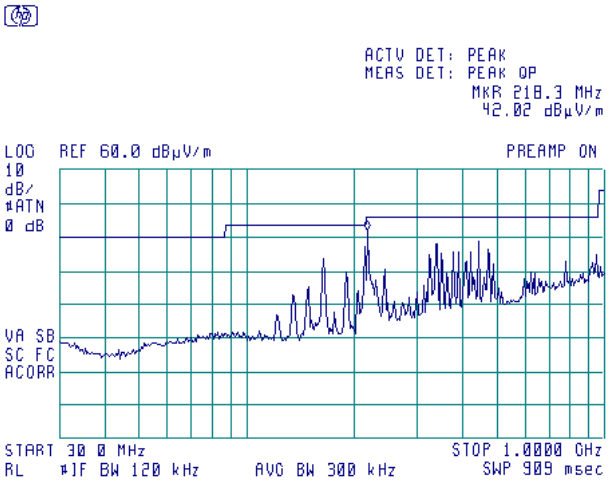
Plot 7.2.5 Radiated emission measurements from 30 to 1000 MHz

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



Plot 7.2.6 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), Frequency stability		
Test procedure:	ANSI C63.4, Section 13.1.6		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/17/2010 12:13:42 PM		
Temperature: 24 ºC	Air Pressure: 1014 hPa	Relative Humidity: 42 %	Power Supply: 3.6 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.

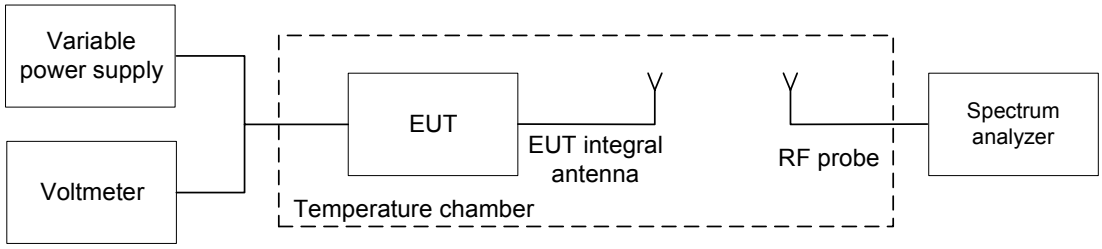
7.3.2.2 The EUT power was turned off. Temperature within test chamber was set to the required one and a period of time sufficient to stabilize all of the oscillator circuit components was allowed.

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), Frequency stability**		
Test procedure:	ANSI C63.4, Section 13.1.6		
Test mode:	Compliance	**Verdict:**	PASS
Date & Time:	3/17/2010 12:13:42 PM		
Temperature: 24 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 42 %	**Power Supply:** 3.6 VDC
Remarks:			

Table 7.3.2 Frequency stability test results

OPERATING FREQUENCY: 13.560 MHz
NOMINAL POWER VOLTAGE: 3.6 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, 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	13.5598	13.5598	13.5598	13.5598	NA	200	1356	-1156	Pass
20	nominal	13.55970	13.55970	13.55970	13.55970	NA	300		-1056	
50	nominal	13.55955	13.55955	13.55955	13.55955	NA	450		-906	

* - Reference frequency

Reference numbers of test equipment used

HL 0493	HL 2909						

Full description is given in Appendix A.

Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.4, Section 13.1.7		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/17/2010 1:45:11 PM		
Temperature: 24 ºC	Air Pressure: 1014 hPa	Relative Humidity: 42 %	Power Supply: 3.6 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

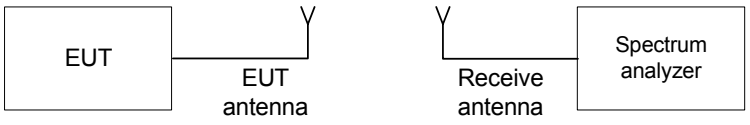
7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized and its proper operation was checked.

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 plot.

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), Occupied bandwidth**		
Test procedure:	ANSI C63.4, Section 13.1.7		
Test mode:	Compliance	**Verdict:**	PASS
Date & Time:	3/17/2010 1:45:11 PM		
Temperature: 24 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 42 %	**Power Supply:** 3.6 VDC
Remarks:			

Table 7.4.2 Occupied bandwidth test results

ASSIGNED FREQUENCY BAND	13.11 – 14.01 MHz
DETECTOR USED:	Peak hold
RESOLUTION BANDWIDTH:	3 kHz
VIDEO BANDWIDTH:	10 kHz
MODULATION ENVELOPE REFERENCE POINTS:	20 dBc
MODULATION:	AM
MODULATING SIGNAL:	enable

Band edge	Cross point frequency, MHz	Frequency drift, kHz		Modulation band edge, MHz	Assigned band edge, MHz	Verdict
		Negative	Positive			
Low	13.5465	0.45	NA	13.54605	13.11	Pass
High	13.5753	NA	0	13.57530	14.01	Pass

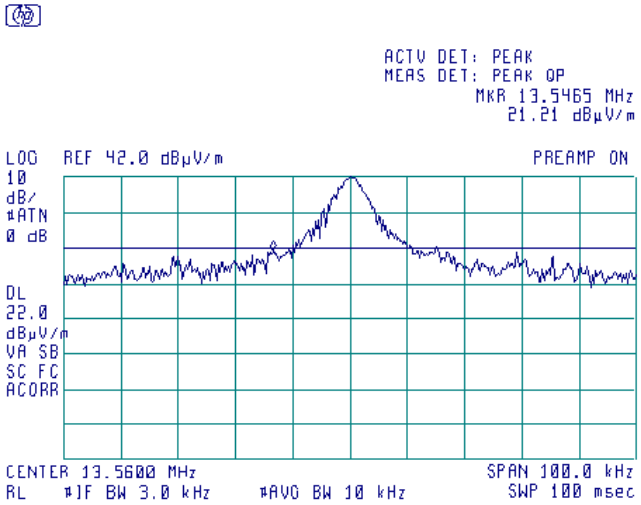
Reference numbers of test equipment used

HL 0446	HL 0521	HL 2871	HL 3616					

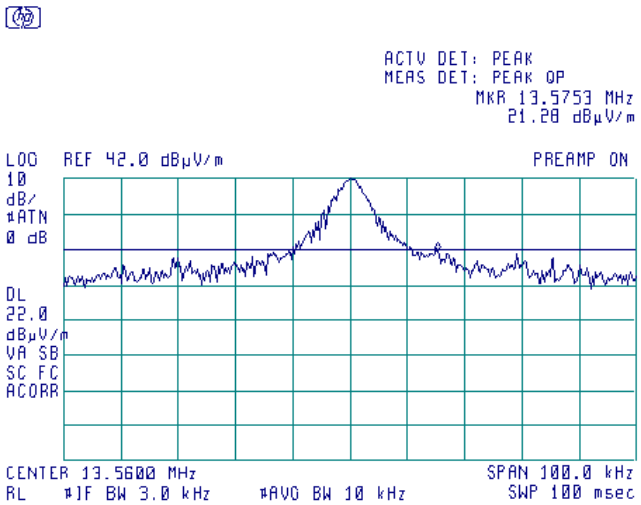
Full description is given in Appendix A.

Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.4, Section 13.1.7		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	3/17/2010 1:45:11 PM		
Temperature: 24 °C	Air Pressure: 1014 hPa	Relative Humidity: 42 %	Power Supply: 3.6 VDC
Remarks:			

Plot 7.4.1 Occupied bandwidth test result, low band frequency



Plot 7.4.2 Occupied bandwidth test result, high band frequency



Test specification:	**Section 15.203, Antenna requirement**		
Test procedure:	Visual inspection / supplier declaration		
Test mode:	Compliance	**Verdict:**	PASS
Date & Time:	3/17/2010 2:40:03 PM		
Temperature: 24 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 42 %	**Power Supply:** 3.6 VDC
Remarks:			

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	

8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal.	Due Cal.
0446	Antenna, Loop, Active, 10 kHz - 30 MHz	EMCO	6502	2857	29-Jun-09	29-Jun-10
0493	Temperature Chamber -45…175 deg C	Thermotron	S-1.2 Mini-Max	14016	20-May-09	20-May-10
0521	EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz	Hewlett Packard	8546A	3617A 00319, 3448A00253	27-Aug-09	27-Aug-10
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	11-Jan-10	11-Jan-11
2871	Microwave Cable Assembly, 18 GHz, 6.4 m, SMA - SMA	Huber-Suhner	198-8155-00	2871	16-Sep-09	16-Sep-10
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY41444762	07-May-09	07-May-10
3616	Cable RF, 6.5 m, N type-N type, DC-6.5 GHz	Suhner Switzerland	Rg 214/U	NA	02-Dec-09	02-Dec-10

9 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
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, 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 numbers IC 2186A-1 for OATS, IC 2186A-2 for anechoic chamber, IC 2186A-3 for full-anechoic chamber for RE measurements above 1 GHz), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-27 for full-anechoic chamber for RE measurements above 1 GHz, C-845 for conducted emissions site, T-1606 for conducted emissions at telecommunication ports), has a status of a Telefication - Listed Testing Laboratory, Certificate No. L138/00. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing and environmental simulation (for exact scope please refer to Certificate No. 839.01).

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e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

Person for contact: Mr. Alex Usoskin, CEO.

11 APPENDIX D Specification references

47CFR part 15: 2009	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: 2003	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(μV) to convert it into field intensity 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)
26	7.8	940	24.0
28	7.8	960	24.1
30	7.8	980	24.5
40	7.2	1000	24.9
60	7.1	1020	25.0
70	8.5	1040	25.2
80	9.4	1060	25.4
90	9.8	1080	25.6
100	9.7	1100	25.7
110	9.3	1120	26.0
120	8.8	1140	26.4
130	8.7	1160	27.0
140	9.2	1180	27.0
150	9.8	1200	26.7
160	10.2	1220	26.5
170	10.4	1240	26.5
180	10.4	1260	26.5
190	10.3	1280	26.6
200	10.6	1300	27.0
220	11.6	1320	27.8
240	12.4	1340	28.3
260	12.8	1360	28.2
280	13.7	1380	27.9
300	14.7	1400	27.9
320	15.2	1420	27.9
340	15.4	1440	27.8
360	16.1	1460	27.8
380	16.4	1480	28.0
400	16.6	1500	28.5
420	16.7	1520	28.9
440	17.0	1540	29.6
460	17.7	1560	29.8
480	18.1	1580	29.6
500	18.5	1600	29.5
520	19.1	1620	29.3
540	19.5	1640	29.2
560	19.8	1660	29.4
580	20.6	1680	29.6
600	21.3	1700	29.8
620	21.5	1720	30.3
640	21.2	1740	30.8
660	21.4	1760	31.1
680	21.9	1780	31.0
700	22.2	1800	30.9
720	22.2	1820	30.7
740	22.1	1840	30.6
760	22.3	1860	30.6
780	22.6	1880	30.6
800	22.7	1900	30.6
820	22.9	1920	30.7
840	23.1	1940	30.9
860	23.4	1960	31.2
880	23.8	1980	31.6
900	24.1	2000	32.0
920	24.1		

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

Cable loss
Cable coaxial, Huber-Suhner, 18 GHz, 6.4 m, SMA - SMA, model 198-8155-00, HL 2871

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.12	5750	2.34	12000	3.55
30	0.14	6000	2.39	12250	3.61
100	0.27	6250	2.46	12500	3.67
250	0.45	6500	2.52	12750	3.74
500	0.63	6750	2.58	13000	3.79
750	0.76	7000	2.64	13250	3.82
1000	0.89	7250	2.68	13500	3.83
1250	1.01	7500	2.73	13750	3.83
1500	1.12	7750	2.78	14000	3.88
1750	1.23	8000	2.83	14250	3.93
2000	1.32	8250	2.88	14500	3.96
2250	1.41	8500	2.94	14750	4.01
2500	1.49	8750	2.97	15000	4.00
2750	1.58	9000	3.02	15250	4.01
3000	1.66	9250	3.07	15500	4.00
3250	1.73	9500	3.13	15750	4.13
3500	1.80	9750	3.18	16000	4.22
3750	1.87	10000	3.21	16250	4.29
4000	1.93	10250	3.26	16500	4.29
4250	2.01	10500	3.30	16750	4.32
4500	2.06	10750	3.36	17000	4.37
4750	2.12	11000	3.39	17250	4.45
5000	2.17	11250	3.44	17500	4.49
5250	2.24	11500	3.48	17750	4.53
5500	2.29	11750	3.52	18000	4.55

Cable loss
Cable coaxial, RG-214/U, N type-N type, 6.5 m
Suhner Switzerland, HL 3616

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.13	1750	2.66	3550	4.44	5350	6.08
30	0.25	1800	2.72	3600	4.46	5400	6.12
50	0.32	1850	2.78	3650	4.59	5450	6.17
100	0.48	1900	2.81	3700	4.60	5500	6.25
150	0.60	1950	2.86	3750	4.72	5550	6.31
200	0.71	2000	2.94	3800	4.72	5600	6.35
250	0.81	2050	2.97	3850	4.86	5650	6.41
300	0.91	2100	3.01	3900	4.85	5700	6.50
350	1.00	2150	3.06	3950	4.99	5750	6.52
400	1.07	2200	3.11	4000	4.90	5800	6.57
450	1.14	2250	3.16	4050	5.04	5850	6.61
500	1.23	2300	3.21	4100	5.01	5900	6.71
550	1.30	2350	3.26	4150	5.10	5950	6.70
600	1.37	2400	3.31	4200	5.08	6000	6.75
650	1.44	2450	3.35	4250	5.18	6050	6.74
700	1.50	2500	3.39	4300	5.14	6100	6.84
750	1.58	2550	3.46	4350	5.22	6150	6.87
800	1.64	2600	3.48	4400	5.21	6200	6.93
850	1.69	2650	3.55	4450	5.29	6250	6.96
900	1.77	2700	3.59	4500	5.31	6300	7.02
950	1.79	2750	3.66	4550	5.39	6350	7.04
1000	1.87	2800	3.68	4600	5.41	6400	7.10
1050	1.92	2850	3.75	4650	5.49	6450	7.11
1100	1.98	2900	3.79	4700	5.52	6500	7.19
1150	2.05	2950	3.86	4750	5.60		
1200	2.09	3000	3.89	4800	5.64		
1250	2.15	3050	3.94	4850	5.73		
1300	2.21	3100	3.98	4900	5.70		
1350	2.27	3150	4.03	4950	5.73		
1400	2.33	3200	4.06	5000	5.75		
1450	2.38	3250	4.12	5050	5.83		
1500	2.44	3300	4.14	5100	5.82		
1550	2.48	3350	4.22	5150	5.91		
1600	2.52	3400	4.24	5200	5.92		
1650	2.56	3450	4.31	5250	5.98		
1700	2.62	3500	4.35	5300	6.01		

13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
AM	amplitude modulation
AVRG	average (detector)
BB	broad band
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(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
PCB	printed circuit board
PM	pulse modulation
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
VA	volt-ampere
WB	wideband

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