

TEST REPORT

ACCORDING TO: FCC CFR 47 PART 15 Subpart C, sections 15.231(a), 15.231(e)

FOR:

Visonic Technologies Ltd.
ETC Equipment Tag
Model:P/N 5-ETC00433

This report is in conformity with ISO/ IEC 17025. The A2LA logo endorsement applies only to the test methods and the standards that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested.
This test report shall not be reproduced in any form except in full with the written approval of Hermon Laboratories Ltd.

Table of contents

1	Applicant information	3
2	Equipment under test attributes	3
3	Manufacturer information	3
4	Test details	3
5	Tests summary	4
6	EUT description	5
6.1	General information	5
6.2	Changes made in the EUT	5
6.3	Test configuration	5
7	Transmitter tests according to 47CFR part 15 subpart C requirements	6
7.1	Periodic operation requirements	6
7.2	Field strength of emissions	11
7.3	Occupied bandwidth test	25
7.4	Antenna requirements	27
7.5	Radiated emission measurements	28
8	APPENDIX A Test equipment and ancillaries used for tests	32
9	APPENDIX B Measurement uncertainties	33
10	APPENDIX C Test facility description	34
11	APPENDIX D Specification references	34
12	APPENDIX E Abbreviations and acronyms	35
13	APPENDIX F Test equipment correction factors	36

1 Applicant information

Client name: Visonic Technologies Ltd.
Address: Habarzel street 30, Tel Aviv, Israel, 69710
Telephone: +972 3768 1408
Fax: +972 3768 1415
E-mail: aelshtein@visonic.com
Contact name: Mr. Arick Elshtein

2 Equipment under test attributes

Product name: ETC Equipment Tag
Product type: Transmitter
Model(s): P/N 5-ETC00433
Serial number: 12432671
Receipt date 8/22/2005

3 Manufacturer information

Manufacturer name: Visonic Technologies Ltd.
Address: Habarzel street 30, Tel Aviv, Israel, 69710
Telephone: +972 3768 1408
Fax: +972 3768 1415
E-Mail: aelshtein@visonic.com
Contact name: Mr. Arick Elshtein

4 Test details

Project ID: 16644
Location: Hermon Laboratories Ltd. P.O.Box 23, Binyamina 30500, Israel
Test started: 8/22/2005
Test completed: 11/2/2005, 5/16/2006
Test specification(s): FCC Part 15, subpart C, §15.231(a), 15.231(e); subpart B, §15.109
Test suite: FCC_15.231(a) (5/9/2004 8:40:20 PM, modified)

5 Tests summary

Test	Status
Transmitter characteristics	
Section 15.231(a), 15.231(e), Periodic operation requirements	Pass
Section 15.231(e), Field strength of emissions	Pass
Section 15.231(c), Occupied bandwidth	Pass
Section 15.207(a), Conducted emission	Not required
Section 15.203, Antenna requirement	Pass
Unintentional emissions	
Section 15.107, Conducted emission at AC power port	Not required
Section 15.109, Radiated emission	Pass
Section 15.111, Conducted emission at receiver antenna port	Not required

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 replaces the previously issued test report identified by Doc ID: VISRAD_FCC.16644_rev1.

	Name and Title	Date	Signature
Tested by:	Mr. A. Adelberg, test engineer	November 2, 2005; May 16, 2006	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	May 16, 2006	
Approved by:	Mr. M. Nikishin, EMC group leader	May 17, 2006	

6 EUT description

6.1 General information

The ETC equipment tag is used for the purpose of locating, monitoring and protecting portable equipment in enclosed environments. It is capable of transmitting ID-coded IR beams as well as RF signals at 433.92 MHz, enabling constant and exact real time location, identification and status reporting. The device utilizes the integral antenna and is powered by 3 V internal lithium battery.

6.2 Changes made in the EUT

No changes were implemented.

6.3 Test configuration

Photograph 6.3.1 EUT general view



Test specification:	Sections 15.231(a), 15.231 (e), Periodic operation requirements		
Test procedure:	Supplier declaration		
Test mode:	Compliance	Verdict: PASS	
Date & Time:	11/3/2005 10:25:32 AM		
Temperature: 24 °C	Air Pressure: 1006 hPa	Relative Humidity: 37 %	Power Supply: 3 V DC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C requirements

7.1 Periodic operation requirements

7.1.1 General

The EUT was verified for compliance with periodic operation requirements listed below:

- Continuous transmissions such as voice, video and the radio control of toys are not permitted;
- Duration of each transmission shall not be greater than 1 second;
- Silent period between transmissions shall be at least 30 times the duration of the transmission;
- Silent period between transmissions shall be in no case less than 10 seconds;
- Polling or supervision transmissions, including data, to determine system integrity in security or safety applications shall not last longer than 2 seconds per hour (tamper, button pressed/released, LF entry signals).

The rationale for compliance with the above requirements was either test results or supplier declaration. The summary of results is provided in Table 7.1.1.

7.1.2 Test procedure for measurements of transmission duration

7.1.2.1 The EUT was set up as shown in Figure 7.1.1.

7.1.2.2 The spectrum analyzer center frequency was adjusted to the EUT carrier, span set to zero and video triggered for transmission.

7.1.2.3 The transmission time was captured and shown in the associated plots. The test results were recorded in Table 7.1.2.

Figure 7.1.1 Setup for transmitter shut down test

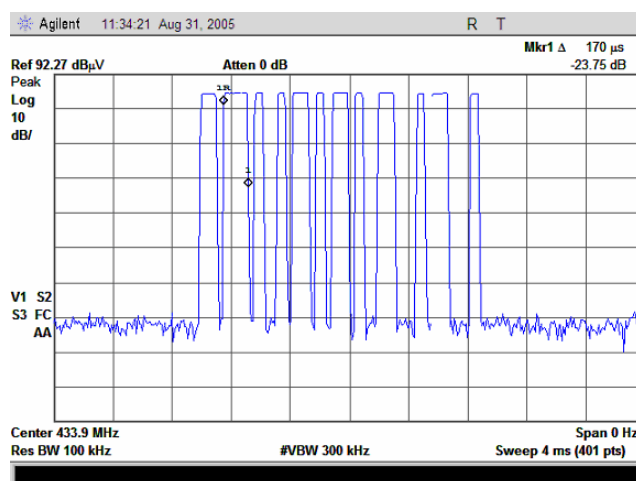


Test specification:	Sections 15.231(a), 15.231 (e), Periodic operation requirements		
Test procedure:	Supplier declaration		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	11/3/2005 10:25:32 AM		
Temperature: 24 °C	Air Pressure: 1006 hPa	Relative Humidity: 37 %	Power Supply: 3 V DC
Remarks:			

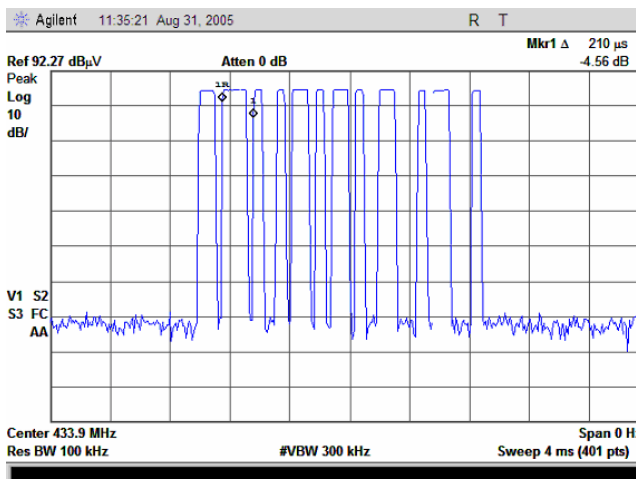
Table 7.1.1 Periodic operation requirements

Requirement	Rationale	Verdict
Continuous transmissions are not permitted	Supplier declaration	Comply
Duration of each transmission shall not be greater than 1 second	Plot 7.1.3	Comply
Silent period between transmissions shall be at least 30 times the duration of the transmission	Plot 7.1.4	Comply
Silent period between transmissions shall be in no case less than 10 seconds	Plot 7.1.4	Comply
Total duration of polling or supervision transmissions shall not exceed 2 seconds per hour	Plot 7.1.5	Comply

Plot 7.1.1 Transmission pulse duration

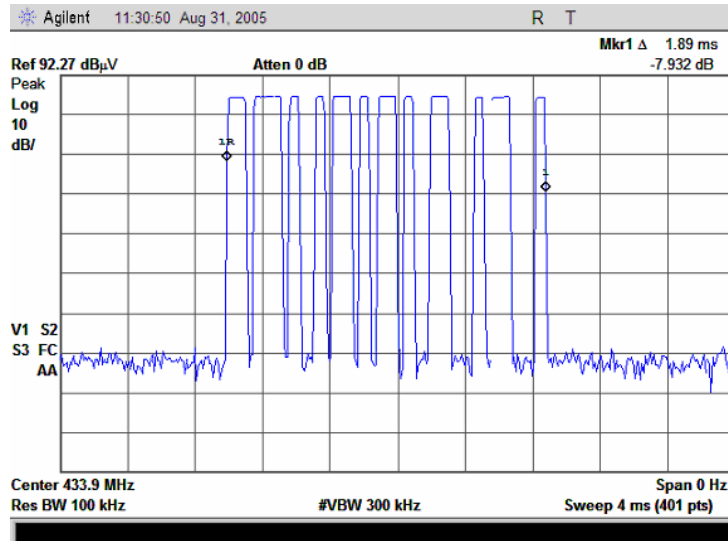


Plot 7.1.2 Transmission pulse period

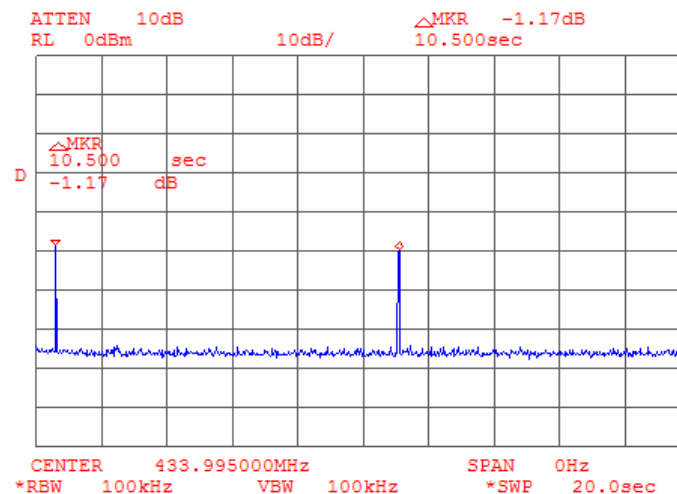


Test specification:	Sections 15.231(a), 15.231 (e), Periodic operation requirements		
Test procedure:	Supplier declaration		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	11/3/2005 10:25:32 AM		
Temperature: 24 °C	Air Pressure: 1006 hPa	Relative Humidity: 37 %	Power Supply: 3 V DC
Remarks:			

Plot 7.1.3 Transmission duration

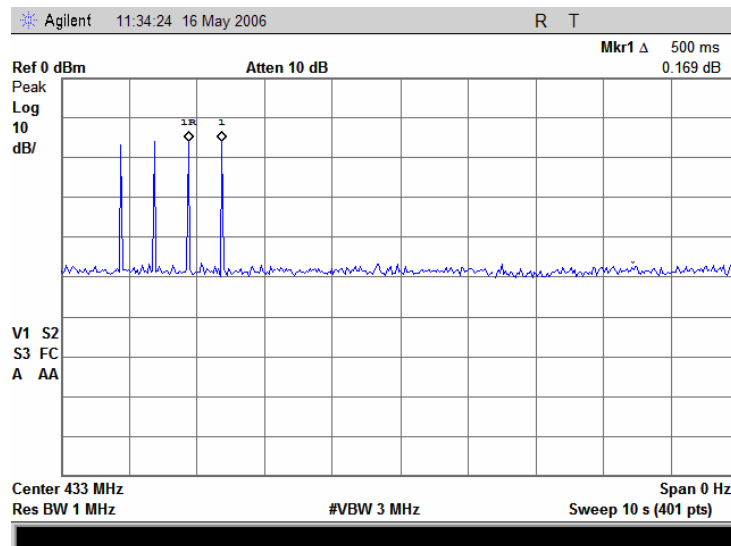


Plot 7.1.4 Silent period between two adjacent transmissions



Test specification:	Sections 15.231(a), 15.231 (e), Periodic operation requirements		
Test procedure:	Supplier declaration		
Test mode:	Compliance	Verdict: PASS	
Date & Time:	11/3/2005 10:25:32 AM		
Temperature: 24 °C	Air Pressure: 1006 hPa	Relative Humidity: 37 %	Power Supply: 3 V DC
Remarks:			

Plot 7.1.5 Four transmissions of tamper, button press/release and entry to LF area modes



Test specification:	Sections 15.231(a), 15.231 (e), Periodic operation requirements		
Test procedure:	Supplier declaration		
Test mode:	Compliance	Verdict: PASS	
Date & Time:	11/3/2005 10:25:32 AM		
Temperature: 24 °C	Air Pressure: 1006 hPa	Relative Humidity: 37 %	Power Supply: 3 V DC
Remarks:			

Table 7.1.2 Total duration of transmissions

Pulse duration*, ms	Pulse period, ms	Total burst duration*, ms	Silent period between transmissions, s	Silent period between transmissions limit, s	Margin, s	Verdict
0.17	0.21	1.53	10.5	10	0.5	Comply

* – Total burst duration = Transmission duration x pulse duration / pulse period

Reference numbers of test equipment used

HL 1424	HL 2780						
---------	---------	--	--	--	--	--	--

Full description is given in Appendix A.

Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

7.2 Field strength of emissions

7.2.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.2.1 and Table 7.2.2.

Table 7.2.1 Radiated fundamental emission limits

Fundamental frequency, MHz	Field strength at 3 m, dB(μV/m)	
	Peak	Average
433.9	92.87	72.87

Table 7.2.2 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m, dB(μV/m)				
	Within restricted bands			Outside restricted bands	
	Peak	Quasi Peak	Average	Peak	Average
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	72.87	52.87
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			
Above 1000	74.0	NA	54.0		

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

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

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

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

Note 1: The fundamental emission limit in dB(μV/m) was calculated as follows:

$$\text{Lim}_{AVR} = 20 \times \log(22.72727 \times F - 2545.545) \text{ - within } 130 - 174 \text{ MHz band;}$$

$$\text{Lim}_{AVR} = 20 \times \log(16.6667 \times F - 2833.3333) \text{ - within } 260 - 470 \text{ MHz band,}$$

where F is the carrier frequency in MHz.

The limit for spurious emissions was 20 dB lower than fundamental emission limit.

The above limits provided in terms of average values, peak limit was 20 dB above the average limit.

Note 2: 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.

Test specification:		Section 15.231(e), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Verdict: PASS	
Compliance			
Date & Time:		8/31/2005 9:36:12 AM	
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

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 measurements were performed in three EUT orthogonal positions.

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

7.2.2.4 The worst test results (the lowest margins) were found in the EUT horizontal (X) position, recorded in Table 7.2.3, Table 7.2.5 and shown in the associated plots.

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

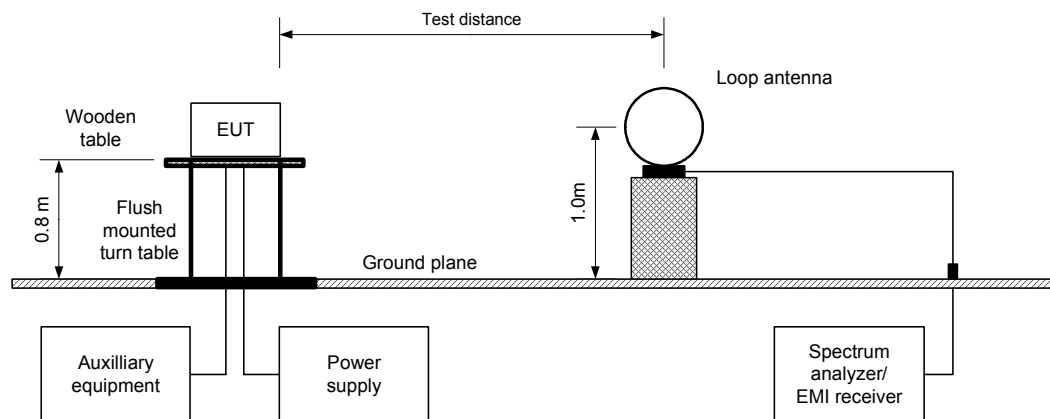
7.2.3.1 The EUT was set up as shown in Figure 7.2.2, energized and the performance check was conducted.

7.2.3.2 The measurements were performed in three EUT orthogonal positions.

7.2.3.3 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.

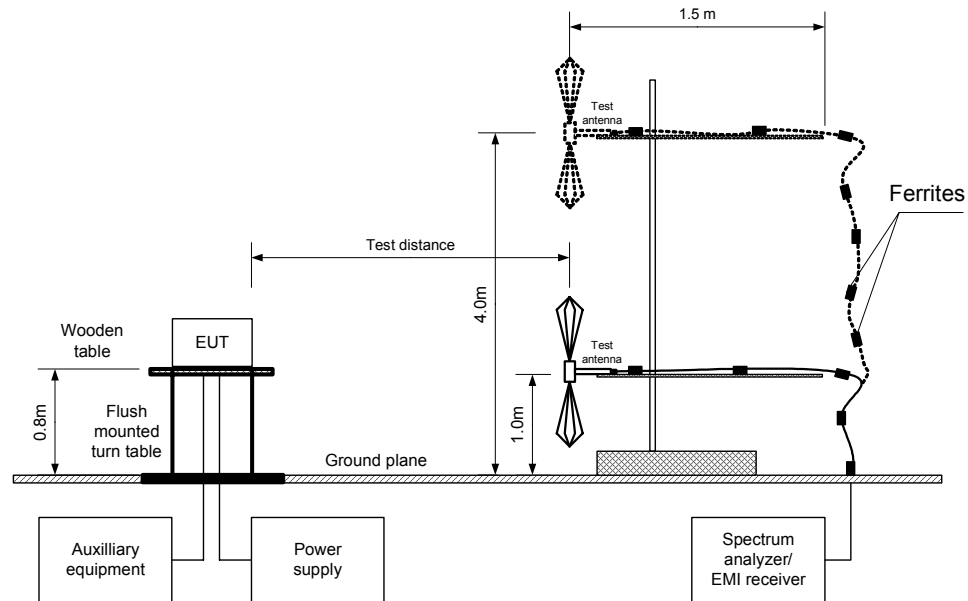
7.2.3.4 The worst test results (the lowest margins) were found in the EUT horizontal (X) position, recorded in Table 7.2.3, Table 7.2.5 and shown in the associated plots.

Figure 7.2.1 Setup for spurious emission field strength measurements below 30 MHz



Test specification:		Section 15.231(e), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Figure 7.2.2 Setup for spurious emission field strength measurements above 30 MHz



Test specification:		Section 15.231(e), Field strength of emissions			
Test procedure:		ANSI C63.4, Section 13.1.4			
Test mode:		Compliance		Verdict: PASS	
Date & Time:		8/31/2005 9:36:12 AM			
Temperature: 24 °C		Air Pressure: 1004 hPa		Relative Humidity: 39 %	
Remarks:		Power Supply: 3 V DC			

Table 7.2.3 Field strength of fundamental emission, spurious emissions outside restricted bands and within restricted bands at frequencies above 1 GHz

TEST SITE: Anechoic chamber /OATS
TEST DISTANCE: 3 m
EUT POSITION: X-axis
MODULATION: NRZ
MODULATING SIGNAL: ID code
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
INVESTIGATED FREQUENCY RANGE: 0.009 - 5000 MHz
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 1 kHz (9 kHz – 150 kHz)
9.0 kHz (150 kHz – 30 MHz)
120 kHz (30 MHz – 1000 MHz)
1.0 MHz (above 1000 MHz)
VIDEO BANDWIDTH: ≥ Resolution bandwidth
TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
Biconilog (30 MHz – 1000 MHz)
Double ridged guide (above 1000 MHz)

F, MHz	Antenna		Azimuth, degrees*	Peak field strength			Avr factor, dB	Average field strength			Verdict
	Pol.	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
Fundamental emission											
433.913	Hor	1.2	315	78.04	92.87	-14.83	-36.3	41.74	72.87	-31.13	Pass
Spurious emissions											
867.841	Hor	1.2	211	41.19	72.87	-31.00	-36.3	4.89	52.87	-47.98	Pass

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

**- Margin = dB below (negative if above) specification limit.

Table 7.2.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
0.17	0.21	1.89	10500	NA	-36.3

*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

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

for pulse train longer than 100 ms:

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

Reference numbers of test equipment used

HL 1425	HL 1553	HL 1566	HL 1567	HL 1941	HL 1984	HL 2697	HL 2780
---------	---------	---------	---------	---------	---------	---------	---------

Full description is given in Appendix A.

Test specification:		Section 15.231(e), Field strength of emissions			
Test procedure:		ANSI C63.4, Section 13.1.4			
Test mode:		Compliance		Verdict: PASS	
Date & Time:		8/31/2005 9:36:12 AM			
Temperature: 24 °C		Air Pressure: 1004 hPa		Relative Humidity: 39 %	
Remarks:		Power Supply: 3 V DC			

Table 7.2.5 Field strength of emissions below 1 GHz within restricted bands

TEST SITE: Anechoic chamber /OATS
TEST DISTANCE: 3 m
EUT POSITION: 3 orthogonal (X, Y, Z)
MODULATION: NRZ
MODULATING SIGNAL: ID code
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
TRANSMITTER OUTPUT POWER: W
INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 1 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: 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*				
No emissions were found								Pass

*- Margin = Measured emission - specification limit.

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

Table 7.2.6 Restricted bands

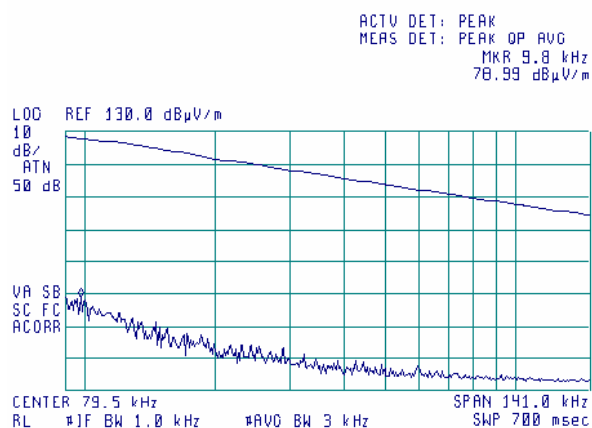
MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.37625 - 8.38675	73 - 74.6	399.9 - 410	2655 - 2900	10.6 - 12.7
0.495 - 0.505	8.41425 - 8.41475	74.8 - 75.2	608 - 614	3260 - 3267	13.25 - 13.4
2.1735 - 2.1905	12.29 - 12.293	108 - 121.94	960 - 1240	3332 - 3339	14.47 - 14.5
4.125 - 4.128	12.51975 - 12.52025	123 - 138	1300 - 1427	3345.8 - 3358	15.35 - 16.2
4.17725 - 4.17775	12.57675 - 12.57725	149.9 - 150.05	1435 - 1626.5	3600 - 4400	17.7 - 21.4
4.20725 - 4.20775	13.36 - 13.41	156.52475 - 156.52525	1645.5 - 1646.5	4500 - 5150	22.01 - 23.12
6.215 - 6.218	16.42 - 16.423	156.7 - 156.9	1660 - 1710	5350 - 5460	23.6 - 24
6.26775 - 6.26825	16.69475 - 16.69525	162.0125 - 167.17	1718.8 - 1722.2	7250 - 7750	31.2 - 31.8
6.31175 - 6.31225	16.80425 - 16.80475	167.72 - 173.2	2200 - 2300	8025 - 8500	36.43 - 36.5
8.291 - 8.294	25.5 - 25.67	240 - 285	2310 - 2390	9000 - 9200	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Plot 7.2.1 Radiated emission measurements from 9 to 150 kHz

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: X-axis

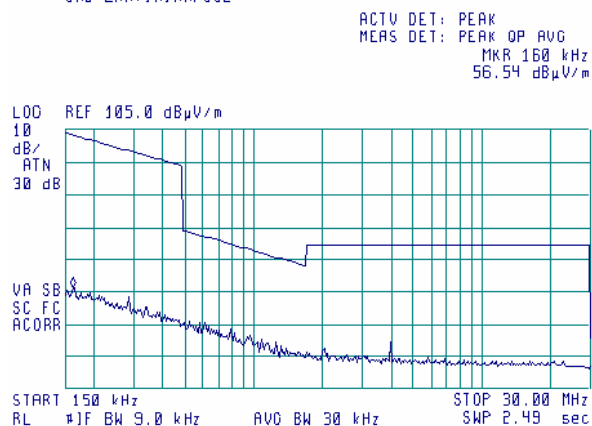
17:01:56 AUG 22, 2005



Plot 7.2.2 Radiated emission measurements from 0.15 to 30 MHz

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: X-axis

17:03:48 AUG 22, 2005
CMD ERR:1M1AMP5CL

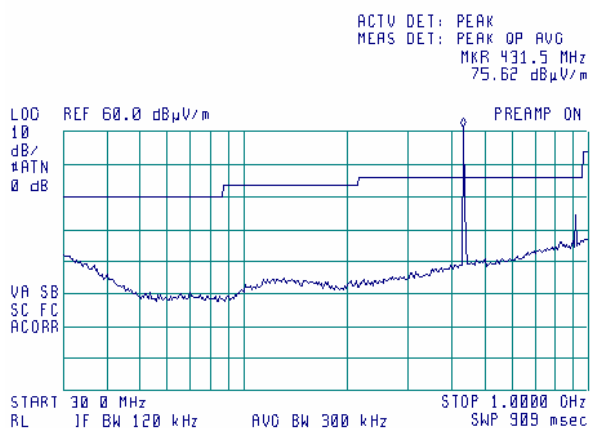


Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Plot 7.2.3 Radiated emission measurements from 30 to 1000 MHz

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X-axis

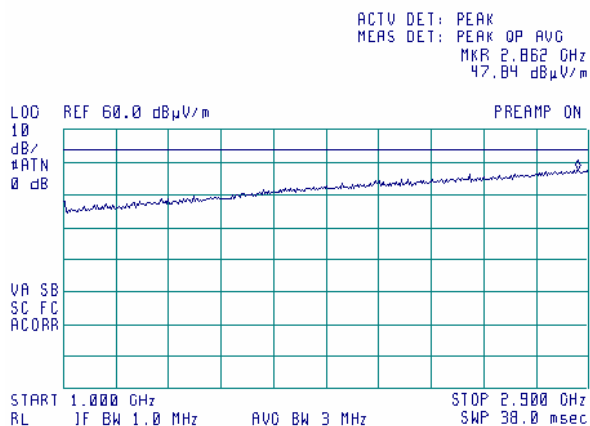
15:30:45 AUG 22, 2005



Plot 7.2.4 Radiated emission measurements from 1000 to 2900 MHz

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X-axis

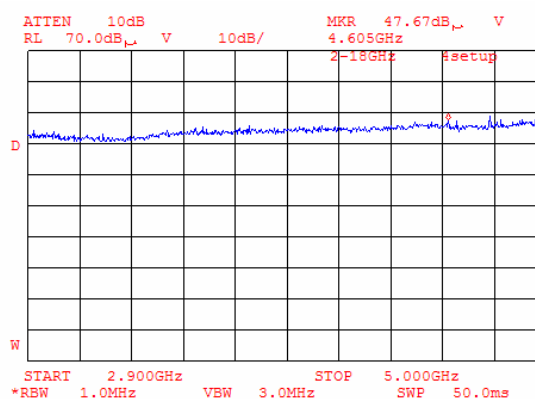
15:33:46 AUG 22, 2005



Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

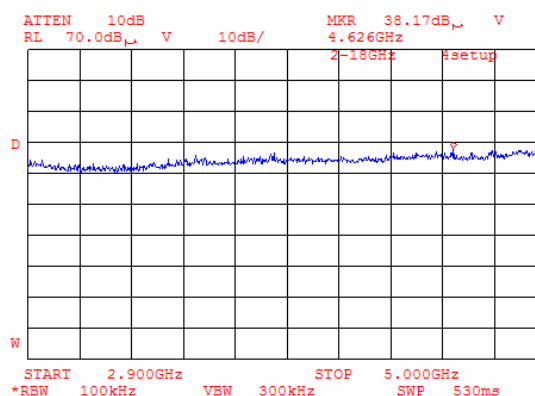
Plot 7.2.5 Radiated emission measurements from 2.9 to 5.0 GHz

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X-axis



Plot 7.2.6 Radiated emission measurements from 2.9 to 5.0 GHz

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X-axis

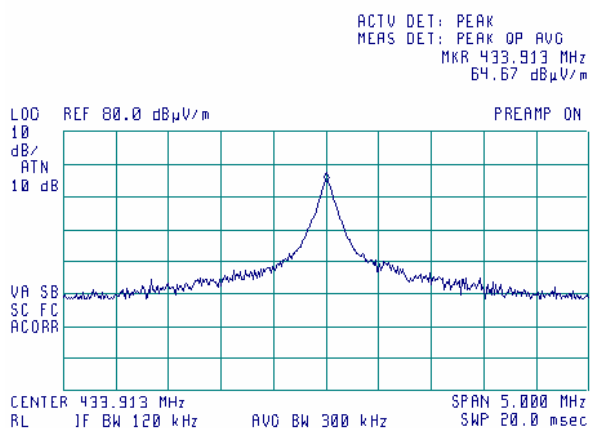


Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Plot 7.2.7 Radiated emission measurements at the fundamental frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: X-axis

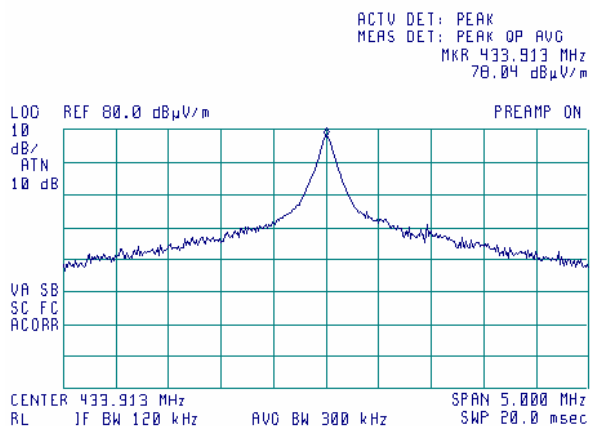
16:30:22 AUG 22, 2005



Plot 7.2.8 Radiated emission measurements at the fundamental frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: X-axis

16:10:00 AUG 22, 2005

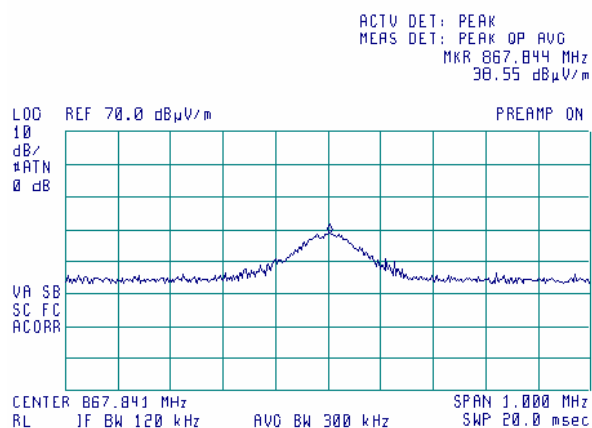


Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Plot 7.2.9 Radiated emission measurements at the second harmonic frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: X-axis

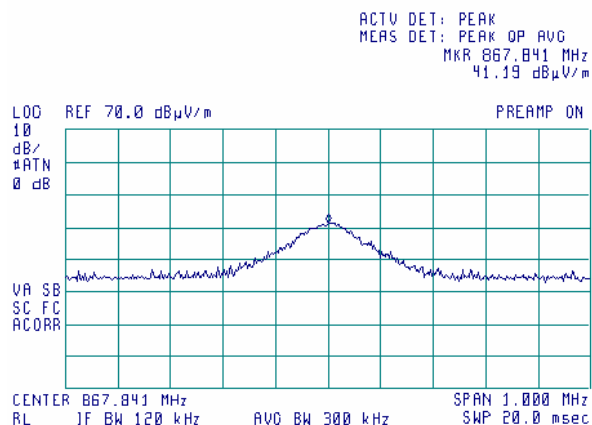
16:43:55 AUG 22, 2005



Plot 7.2.10 Radiated emission measurements at the second harmonic frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: X-axis

16:39:37 AUG 22, 2005

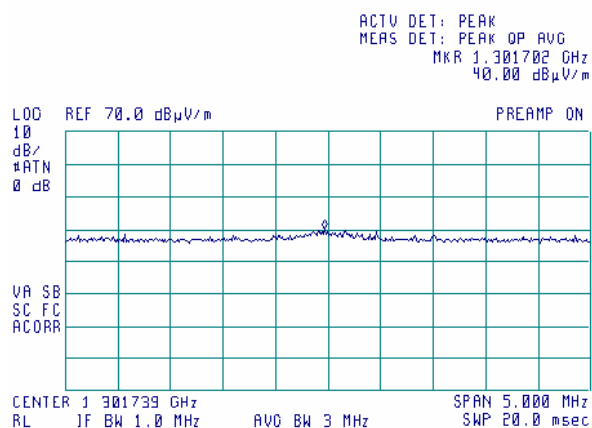


Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Plot 7.2.11 Radiated emission measurements at the third harmonic frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: X-axis

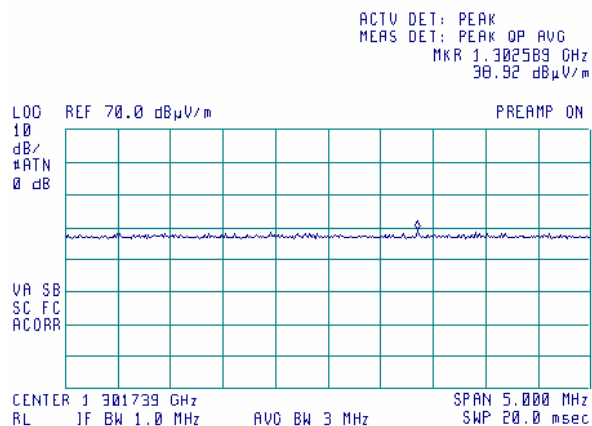
16:47:43 AUG 22, 2005



Plot 7.2.12 Radiated emission measurements at the third harmonic frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: X-axis

16:50:37 AUG 22, 2005

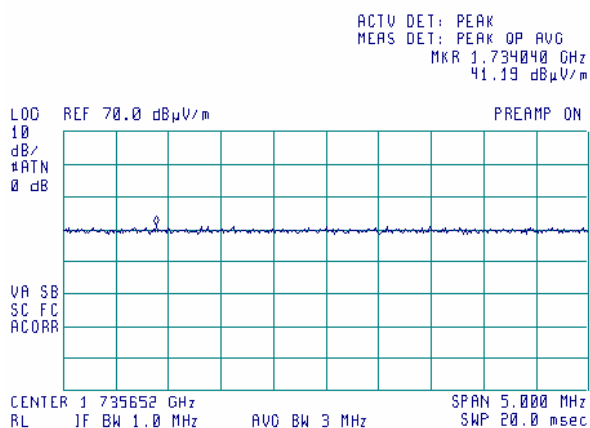


Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Plot 7.2.13 Radiated emission measurements at the forth harmonic frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: X-axis

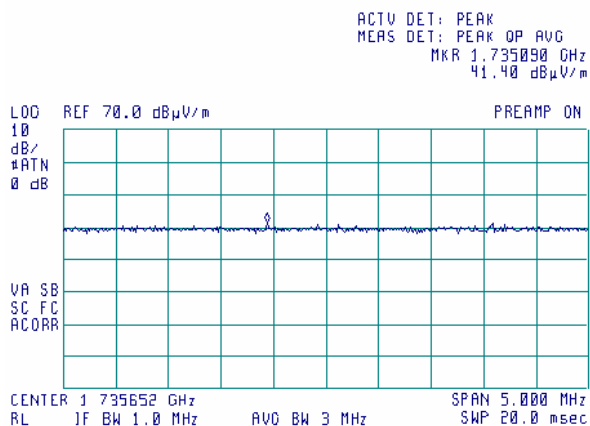
16:52:44 AUG 22, 2005



Plot 7.2.14 Radiated emission measurements at the forth harmonic frequency

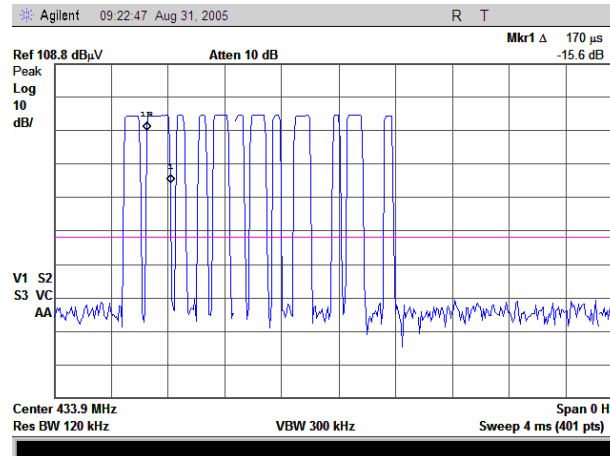
TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: X-axis

16:51:49 AUG 22, 2005

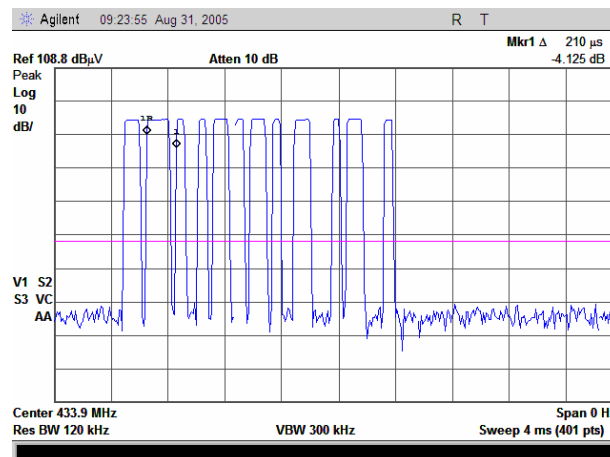


Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Plot 7.2.15 Transmission pulse duration

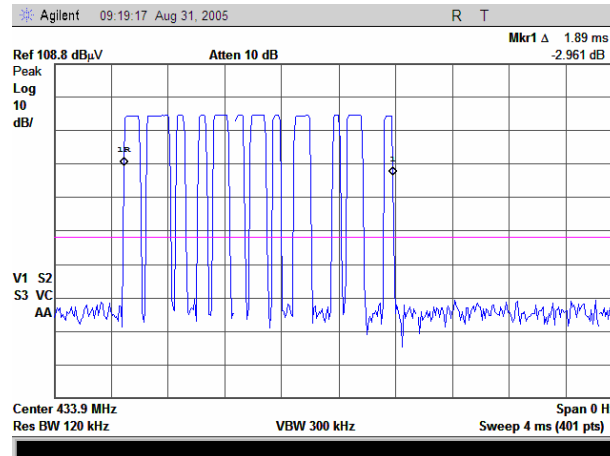


Plot 7.2.16 Transmission pulse period

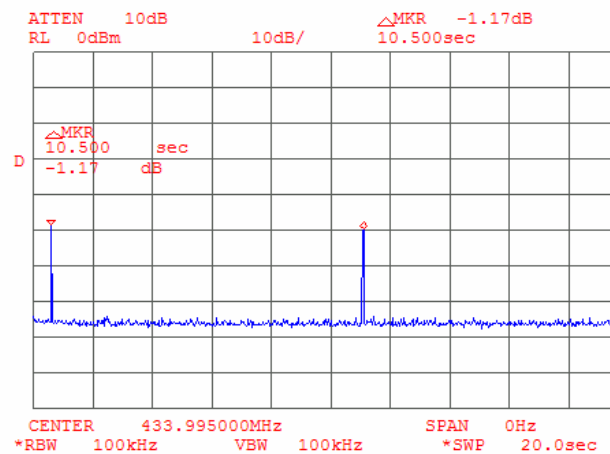


Test specification:	Section 15.231(e), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 9:36:12 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

Plot 7.2.17 Transmission burst duration



Plot 7.2.18 Transmission burst period



Test specification:		Section 15.231(c), Occupied bandwidth	
Test procedure:		ANSI C63.4, Section 13.1.7	
Test mode:		Compliance	Verdict: PASS
Date & Time:		8/31/2005 10:00:37 AM	
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

7.3 Occupied bandwidth test

7.3.1 General

This test was performed to measure transmitter occupied bandwidth. Specification test limits are given in Table 7.3.1. The test results are provided in Table 7.3.2 and associated plots.

Table 7.3.1 Occupied bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Maximum allowed bandwidth, % of the carrier frequency
70 - 900	20.0	0.25

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

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 was set to transmit modulated carrier.

7.3.2.3 The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.3.2 and associated plot.

Figure 7.3.1 Occupied bandwidth test setup



Test specification:		Section 15.231(c), Occupied bandwidth			
Test procedure:		ANSI C63.4, Section 13.1.7			
Test mode:		Compliance		Verdict: PASS	
Date & Time:		8/31/2005 10:00:37 AM			
Temperature: 24 °C		Air Pressure: 1004 hPa		Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:					

Table 7.3.2 Occupied bandwidth test results

DETECTOR USED: Peak hold
RESOLUTION BANDWIDTH: 100 kHz
VIDEO BANDWIDTH: 300 kHz
MODULATION ENVELOPE REFERENCE POINTS: 20 dBc
MODULATION: NRZ
MODULATING SIGNAL: ID code

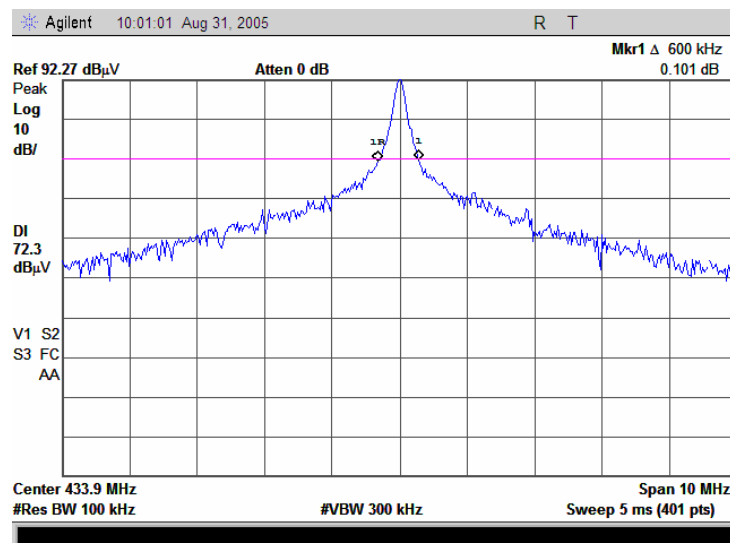
Carrier frequency, MHz	Occupied bandwidth, kHz	Limit		Margin, kHz	Verdict
		% of the carrier frequency	kHz		
433.9	600	0.25	1084.75	-484.75	Pass

Reference numbers of test equipment used

HL 0337	HL 1653							
---------	---------	--	--	--	--	--	--	--

Full description is given in Appendix A.

Plot 7.3.1 Occupied bandwidth test result



Test specification:	Section 15.203, Antenna requirement		
Test procedure:	Visual inspection / supplier declaration		
Test mode:	Compliance	Verdict:	PASS
Date & Time:	8/31/2005 10:56:08 AM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks:			

7.4 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 7.4.1.

Table 7.4.1 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 7.4.1 Antenna assembly



Test specification: Section 15.109, Radiated emission				
Test procedure: ANSI C63.4, Sections 11.6 and 12.1.4				
Test mode: Compliance		Verdict: PASS		
Date & Time: 11/2/2005 3:39:21 PM				
Temperature: 24 °C		Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks: SEE CFR 47 P 15 SEC 15,109				

7.5 Radiated emission measurements

7.5.1 General

This test was performed to measure radiated emissions from the EUT enclosure. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Radiated emission test limits

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

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

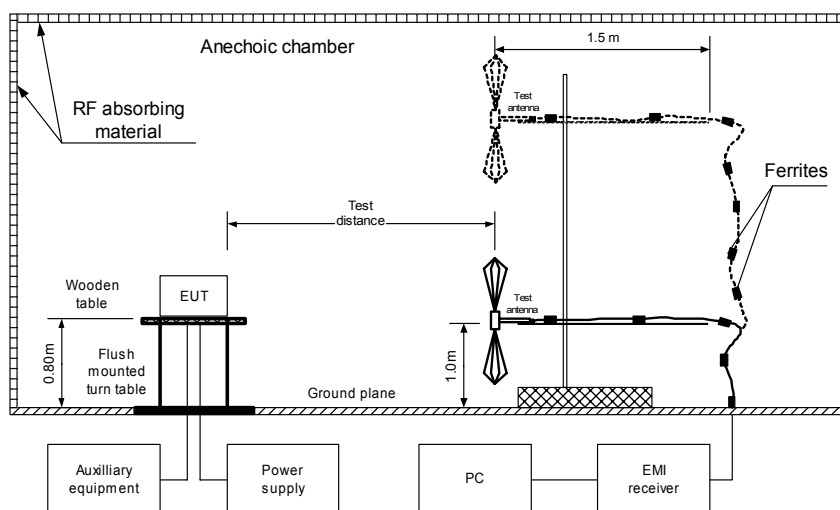
7.5.2 Test procedure for measurements in anechoic chamber

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

7.5.2.2 The specified frequency range was investigated with biconilog antenna connected to EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal and the EUT cables position was varied.

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

Figure 7.5.1 Setup for radiated emission measurements in anechoic chamber, table-top equipment



Test specification:		Section 15.109, Radiated emission	
Test procedure:		ANSI C63.4, Sections 11.6 and 12.1.4	
Test mode:	Compliance	Verdict:	PASS
Date & Time:	11/2/2005 3:39:21 PM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks: SEE CFR 47 P 15 SEC 15,109			

Table 7.5.2 Radiated emission test results

EUT SET UP: TABLE-TOP
LIMIT: Class B
EUT OPERATING MODE: Stand-by/receive
TEST SITE: ANECHOIC CHAMBER
TEST DISTANCE: 3 m

DETECTORS USED: PEAK / QUASI-PEAK
RESOLUTION BANDWIDTH: 120 kHz

RECESSION BANDWIDTH:				120 KHz				
Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
30 -1000	All found emissions were at least 20 dB below the specified limit							Pass

DETECTORS USED: PEAK / AVERAGE
RESOLUTION BANDWIDTH: 1000 kHz

Frequency, MHz	Peak emission, dB(μV/m)	Average			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
1000 - 2000	All found emissions were at least 20 dB below the specified limit							Pass

*- Margin = Measured emission – specification limit.

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

Reference numbers of test equipment used

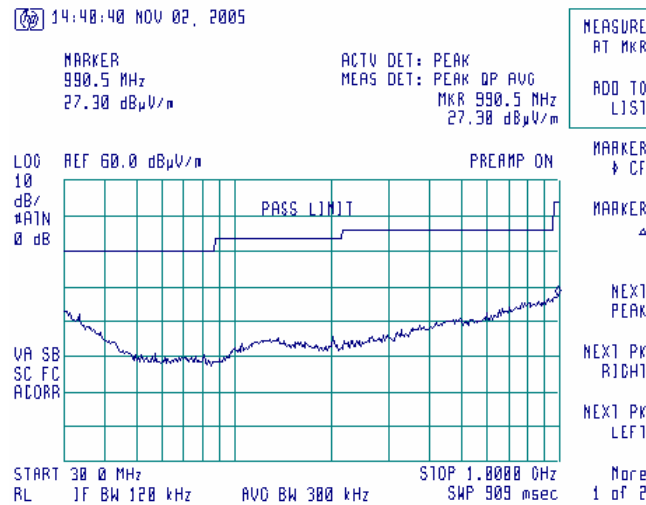
HL 1425	HL 1553	HL 1566	HL 1849	HL 1850	HL 2109	HL 2697	
---------	---------	---------	---------	---------	---------	---------	--

Full description is given in Appendix A.

Test specification:		Section 15.109, Radiated emission	
Test procedure:		ANSI C63.4, Sections 11.6 and 12.1.4	
Test mode:	Compliance	Verdict: PASS	
Date & Time:	11/2/2005 3:39:21 PM		
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks: SEE CFR 47 P 15 SEC 15.109			

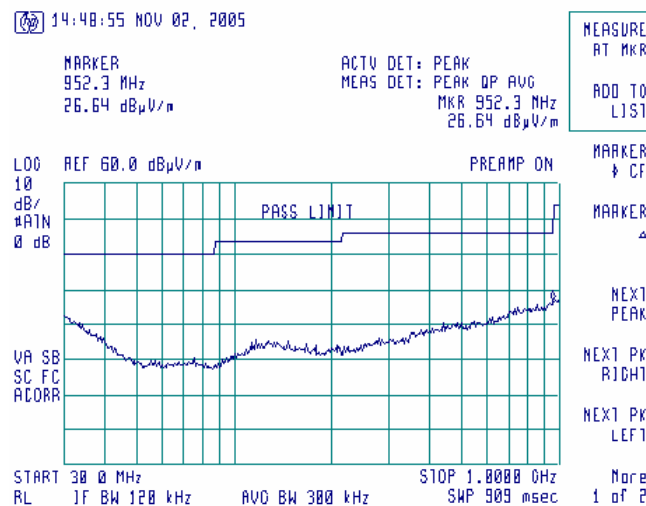
Plot 7.5.1 Radiated emission measurements in 30- 1000 MHz range, vertical antenna polarization

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m



Plot 7.5.2 Radiated emission measurements in 30- 1000 MHz range, horizontal antenna polarization

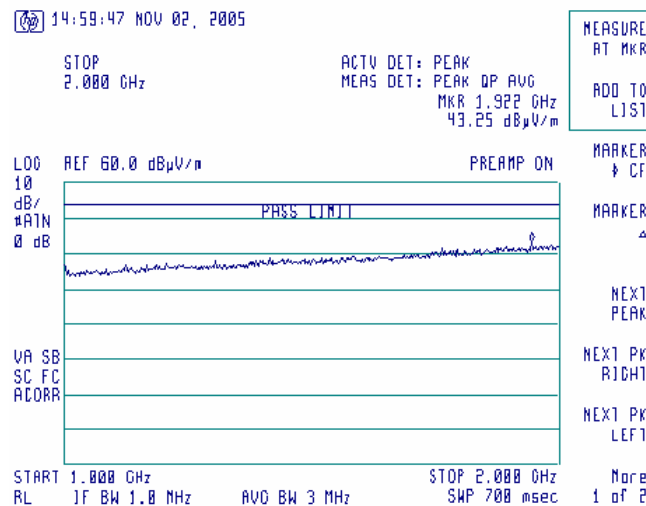
TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m



Test specification:		Section 15.109, Radiated emission	
Test procedure:		ANSI C63.4, Sections 11.6 and 12.1.4	
Test mode:		Compliance	Verdict: PASS
Date & Time:		11/2/2005 3:39:21 PM	
Temperature: 24 °C	Air Pressure: 1004 hPa	Relative Humidity: 39 %	Power Supply: 3 V DC
Remarks: SEE CFR 47 P 15 SEC 15.109			

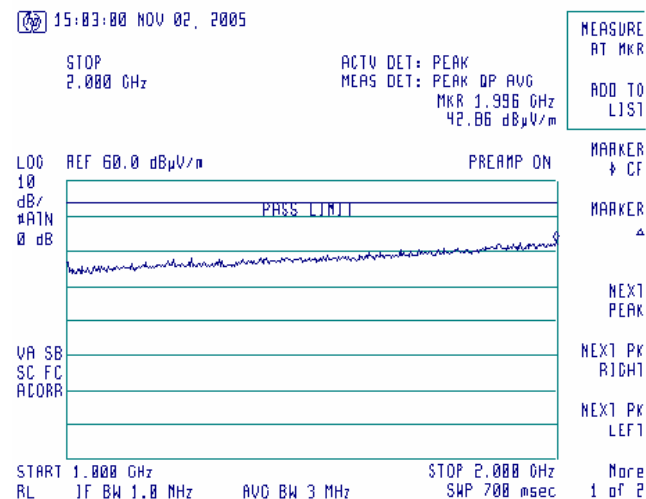
Plot 7.5.3 Radiated emission measurements above 1000 MHz, vertical antenna polarization

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m



Plot 7.5.4 Radiated emission measurements above 1000 MHz, horizontal antenna polarization

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m



8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal.	Due Cal.
0337	Probe set, hand held, 5 probes	Electro-Metrics	EHFP-30	238	6/05	6/06
0446	Shielded Room 3(L) x 3(W) x 2,4(H) m	HL	SR - 1	024	6/05	6/06
1424	Spectrum Analyzer, 30 Hz- 40 GHz	Agilent Technologies (HP)	8564EC	3946A002 19	1/06	1/07
1425	EMI Receiver, 9 kHz – 2.9 GHz, System: HL1426, HL1427	Agilent Technologies (HP)	8542E	3710A002 22, 3705A002 04	1/06	1/07
1553	Cable RF, 3.5 m	Alpha Wire	RG-214	1553	1/06	1/07
1566	Cable RF, 2 m	Huber-Suhner	Sucoflex 104PE	13094/4PE	1/06	1/07
1567	Cable RF, 2 m	Huber-Suhner	Sucoflex 104PE	13094/4P E	12/05	12/06
1653	Analyzer EMC, 9 KHz – 1.5 GHz	Agilent Technologies	E7401	US39440 281	2/06	2/07
1826	Antenna mast and turntable position controller	Sh. I. Mashines	CRL-4	1	5/06 check	5/07 check
1849	Antenna mast with polarity control	Sh. I. Mashines	AM-F4	NA	1/06 check	1/07 check
1850	Turntable	Sh. I. Mashines	TT-M-3	NA	1/06	1/07
1941	Cable 18 GHz, 4 m, green	Rhophase Microwave Ltd	SPS-1803A-4000-NPS	T4657	1/06	1/07
1984	Antenna, Double-Ridged Waveguide Horn, 1-18 GHz, 300 W, N-type	EMC Test Systems	3115	9911-5964	3/06	3/07
2109	Anechoic Chamber 6(L) x 5.5(W) x 2.95(H) m	HL	AC-2	2109	12/05	12/06
2697	Antenna, 30 MHz - 3.0 GHz	Sunol Sciences. Corp. Pleasanton, California USA	JB3	A022805	3/06	3/07
2780	EMS analyzer, 100 Hz to 26.5 GHz	Agilent Technologies (HP)	E7405A	MY451024	6/05	6/06

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	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB
Vertical polarization	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
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Occupied bandwidth	± 8.0 %

The test equipment has been calibrated according to its recommended procedures and is within the manufacturer's published limit of error. The standards and instruments used in the calibration system conform to the present requirements of ISO/IEC 17025 (or alternately ANSI/NCSL Z540-1).

The laboratory calibrates its measurement standards by a third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements. The Hermon Labs EMC measurements uncertainty is given in the table above.

10 APPENDIX C Test facility 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) and by Industry Canada for electromagnetic emissions (file numbers IC 2186-1 for OATS and IC 2186-2 for anechoic chamber), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, C-845 for conducted emissions site), assessed by TNO Certification EP&S (Netherlands) for a number of EMC, telecommunications, environmental, safety standards, and by AMTAC (UK) for safety of medical devices. 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).

Address: P.O. Box 23, Binyamina 30500, Israel.
Telephone: +972 4628 8001
Fax: +972 4628 8277
e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

Person for contact: Mr. Alex Usoskin, CEO.

11 APPENDIX D Specification references

47CFR part 15: 2005	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 Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
AVRG	average (detector)
BB	broad band
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μ V)	decibel referred to one microvolt
dB(μ V/m)	decibel referred to one microvolt per meter
dB(μ A)	decibel referred to one microampere
dB Ω	decibel referred to one Ohm
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
ITE	information technology equipment
k	kilo
kHz	kilohertz
LISN	line impedance stabilization network
LO	local oscillator
m	meter
MHz	megahertz
min	minute
mm	millimeter
ms	millisecond
μ s	microsecond
NA	not applicable
NB	narrow band
NT	not tested
OATS	open area test site
Ω	Ohm
PCB	printed circuit board
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
VA	volt-ampere
WB	wideband

13 APPENDIX F 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(μ V) to convert it into field intensity in dB(μ V/m).

Antenna factor
Double-ridged wave guide horn antenna
Model 3115, S/N 9911-5964, HL1984

Frequency, MHz	Antenna factor, dB(1/m)
1000.0	24.7
1500.0	25.7
2000.0	27.6
2500.0	28.9
3000.0	31.2
3500.0	32.0
4000.0	32.5
4500.0	32.7
5000.0	33.6
5500.0	35.1
6000.0	35.4
6500.0	34.9
7000.0	36.1
7500.0	37.8
8000.0	38.0
8500.0	38.1
9000.0	39.1
9500.0	38.3
10000.0	38.6
10500.0	38.2
11000.0	38.7
11500.0	39.5
12000.0	40.0
12500.0	40.4
13000.0	40.5
13500.0	41.1
14000.0	41.6
14500.0	41.7
15000.0	38.7
15500.0	38.2
16000.0	38.8
16500.0	40.5
17000.0	42.5
17500.0	45.9
18000.0	49.4

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

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

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	520	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	525	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	530	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	535	19.7	6.5	4.48	1230	25.2	6.8	4.82	1825	28.7	6.8	4.76	2420	31.0	6.8	4.82
45	11.3	-8.1	0.16	540	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	545	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	550	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	4.88
60	7.8	-2.1	0.62	555	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	2.0	8.5	0.63	560	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	565	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	570	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	575	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	0.8	1.20	580	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	4.96
90	8.2	1.1	1.29	585	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	590	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	595	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
105	11.7	-1.1	0.78	700	20.3	6.8	4.76	1295	25.3	7.2	5.22	1890	28.6	7.2	5.21	2485	31.1	7.0	5.00
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
115	13.3	-1.9	0.85	710	20.5	6.8	4.75	1305	25.3	7.2	5.21	1900	28.6	7.2	5.27	2495	31.2	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
135	13.8	-1.0	0.79	730	20.7	6.8	4.77	1325	25.5	7.2	5.21	1920	28.6	7.3	5.31	2515	31.0	7.2	5.26
140	13.4	-0.3	0.94	735	20.9	6.7	4.65	1330	25.6	7.0	5.08	1925	28.7	7.3	5.36	2520	31.2	7.0	5.05
145	13.1	0.3	1.08	740	21.0	6.8	4.83	1335	25.7	7.1	5.07	1930	28.6	7.3	5.39	2525	30.8	7.4	5.54
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	7.1	4.95	1955	28.5	7.5	5.57	2550	31.3	7.0	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	4.96	1965	28.7	7.4	5.47	2560	31.0	7.4	5.47
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	29.2	7.2	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	3.62	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	3.55	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	4.96	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	22.0	6.9	4.92	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	5.10	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	14.0	5.8	3.81	895	22.1	7.1	5.09	1490	26.5	7.1	5.17	2085	29.9	6.8	4.78	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	5.9	3.89	910	22.3	7.0	5.05	1505	26.5	7.2	5.27	2100	29.9	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	5.23	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	5.30	2110	29.9	6.8	4.78	2705	32.0	6.8	4.80
330	14.6	5.9	3.93	925	22.6	6.9	4.85	1520	26.5	7.3	5.36	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
360	15.6	5.8	3.78	955	23.0	6.8	4.81	1550	26.5	7.5	5.63	2145	29.9	6.9	4.92	2740	31.6	7.1	5.46
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	4.96
370	15.5	6.0	4.01	965	23.1	6.7	4.73	1560	26.9	7.1	5.16	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					

Cable loss
RF cable 3.5 m, Alpha Wire, model RG-214, S/N 149, HL 1553

No.	Frequency, MHz	Cable loss, dB	Measurement uncertainty, dB
1	1	0.01	±0.05
2	10	0.07	
3	30	0.12	
4	50	0.22	
5	100	0.26	
6	200	0.40	
7	300	0.52	
8	400	0.60	
9	500	0.70	
10	600	0.77	
11	700	0.84	
12	800	1.00	
13	900	1.00	
14	1000	1.05	
15	2000	1.70	

Cable loss
Cable RF, 2m, model: Sucoflex 104PE, S/N 13094/4PE, HL 1566

No.	Frequency, MHz	Cable loss, dB	Tolerance, dB	Measurement uncertainty, dB
1	30	0.10	≤ 5.0	±0.12
2	50	0.13		
3	100	0.20		
4	300	0.33		
5	500	0.45		
6	800	0.60		
7	1000	0.65		
8	1500	0.91		
9	2000	1.08		
10	2500	1.19		
11	3000	1.28		
12	3500	1.49		
13	4000	1.63		
14	4500	1.63	≤ 5.0	±0.17
15	5000	1.66		
16	5500	1.88		
17	6000	1.96		
18	6500	1.93		
19	7000	2.07		
20	7500	2.37		
21	8000	2.34		
22	8500	2.64		
23	9000	2.68		
24	9500	2.64		
25	10000	2.70		
26	10500	2.84		
27	11000	2.88		
28	11500	3.19		
29	12000	3.15		
30	12500	3.20	≤ 5.0	±0.26
31	13000	3.22		
32	13500	3.47		
33	14000	3.41		
34	14500	3.59		
35	15000	3.79		
36	15500	4.24		
37	16000	4.12		
38	16500	4.46		
39	17000	4.50		
40	17500	4.49		
41	18000	4.45		

Cable loss
Cable RF, 2 m, model: Sucoflex 104PE, s/n 13095/4PE, HL 1567

No.	Frequency, MHz	Cable loss, dB
1	30	0.09
2	50	0.15
3	100	0.23
4	300	0.31
5	500	0.46
6	800	0.63
7	1000	0.67
8	1500	0.89
9	2000	1.05
10	2500	1.18
11	300	1.26
12	5300	1.51
13	4000	1.66
14	4500	1.61
15	5000	1.67
16	5500	1.91
17	6000	1.98
18	6500	1.91
19	7000	2.04
20	7500	2.36
21	8000	2.36
22	8500	2.61
23	9000	2.69
24	9500	2.62
25	10000	2.73
26	10500	2.83
27	11000	2.84
28	11500	3.22
29	12000	3.17
30	12500	3.17
31	13000	3.18
32	13500	3.49
33	14000	3.43
34	14500	3.57
35	15000	3.76
36	15500	4.20
37	16000	4.10
38	16500	4.49
39	17000	4.53
40	17500	4.46
41	18000	4.47

Cable loss
Cable 18 GHz, 4 m, green, model: SPS-1803A-4000-NPS, S/N T4657, HL 1941

Frequency, GHz	Cable loss, dB
0.03	0.39
0.05	0.49
0.1	0.68
0.2	0.95
0.3	1.30
0.5	1.58
0.7	1.84
0.9	2.08
1.1	2.28
1.3	2.56
1.5	2.91
1.7	2.95
1.9	3.17
2.1	3.22
2.3	3.25
2.5	3.39
2.7	3.51
2.9	3.67
3.1	3.81
3.3	3.92
3.5	4.05
3.7	4.14
3.9	4.30
4.1	4.44
4.3	4.55
4.5	4.68
4.7	4.75
4.9	4.84
5.1	4.86
5.3	4.89
5.5	5.00
5.7	5.05
5.9	5.19
6.1	5.28
7.7	5.58

Frequency, GHz	Cable loss, dB
7.9	5.63
8.1	5.67
8.3	5.70
8.5	5.74
8.7	5.78
8.9	5.84
9.1	5.89
9.3	5.94
9.5	6.02
9.7	6.10
9.9	6.12
10.1	6.09
10.3	6.03
10.5	6.01
10.7	6.05
10.9	6.08
11.1	6.10
11.3	6.18
11.5	6.23
11.7	6.20
11.9	6.16
12.1	6.18
12.4	6.33
13.0	6.51
13.5	6.51
14.0	6.75
14.5	6.82
15.0	6.93
15.5	7.16
16.0	7.10
16.5	7.18
17.0	7.67
17.5	7.71
18.0	7.61