

ENGINEERING TEST REPORT



V-Smart, A,R
Model No.: V-Smrt, A,R

FCC ID: QC4-VSMRTAR

Applicant: **Bioscrypt Inc.**
505 Cochrane Drive
Markham, Ontario
Ontario, L3R 8E3

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SEC. 15.225
Unlicensed Low Power Transmitters
Operating in the frequency band 13.11-14.01 MHz

UltraTech's File No.: MYT-088FCC15C

This Test report is Issued under the Authority of
Tri M. Luu, Professional Engineer,
Vice President of Engineering
UltraTech Group of Labs



Date: July 17, 2006

Report Prepared by: Dharmajit Solanki

Tested by: Mr. Hung Trinh

Issued Date: July 17, 2006

Test Dates: May 16 - June 22, 2006

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech

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TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION	3
1.1. SCOPE	3
1.2. RELATED SUBMITAL(S)/GRANT(S).....	3
1.3. NORMATIVE REFERENCES	3
EXHIBIT 2. PERFORMANCE ASSESSMENT	4
2.1. CLIENT INFORMATION.....	4
2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION	4
2.3. EUT'S TECHNICAL SPECIFICATIONS	5
2.4. LIST OF EUT'S PORTS.....	5
2.5. ANCILLARY EQUIPMENT.....	5
2.6. GENERAL TEST SETUP.....	6
EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS.....	7
3.1. CLIMATE TEST CONDITIONS	7
3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS	7
EXHIBIT 4. SUMMARY OF TEST RESULTS.....	8
4.1. LOCATION OF TESTS.....	8
4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS	8
4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES.....	8
EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS	9
5.1. TEST PROCEDURES	9
5.2. MEASUREMENT UNCERTAINTIES	9
5.3. MEASUREMENT EQUIPMENT USED:	9
5.4. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPARTS B & C, PARA.15.107(A) & 15.207	10
5.5. 26 DB & 20 DB BANDWIDTH @ FCC 15.215(C).....	13
5.6. FREQUENCY STABILITY @ FCC §15.225(E).....	15
5.7. TRANSMITTER SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.225 & 15.205	17
EXHIBIT 6. MEASUREMENT UNCERTAINTY	20
6.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY	20
6.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY	21

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.225
Title	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Unlicensed Low Power Transmitters operating in the Frequency Band 13.11-14.01 MHz .
Test Procedures	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - 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.
Environmental Classification:	• Light-industry, Commercial • Industry

1.2. RELATED SUBMITAL(S)/GRANT(S)

None

1.3. NORMATIVE REFERENCES

FCC CFR Parts 0-19	Feb. 16 - 2006	Code of Federal Regulations – Telecommunication
ANSI C63.4	2004	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
CISPR 22 +A1 EN 55022	2003-04-10 2004-10-14 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement
CISPR 16-2-3	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-3: Radiated disturbance measurement

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT:	
Name:	Bioscrypt Inc.
Address:	505 Cochrane Drive Markham, Ontario Ontario, L3R 8E3
Contact Person:	Mr. Vladimir Lazic Phone #: 905-940-7787 Fax #: 905-940-7642 Email Address: vladimir.lazic@bioscrypt.com

MANUFACTURER:	
Name:	Bioscrypt Inc.
Address:	505 Cochrane Drive Markham, Ontario Ontario, L3R 8E3
Contact Person:	Mr. Vladimir Lazic Phone #: 905-940-7787 Fax #: 905-940-7642 Email Address: vladimir.lazic@bioscrypt.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name	Bioscrypt Inc.
Product Name	V-Smart, A,R
Model Name or Number	V-Smrt, A,R
Serial Number	Test Sample
Type of Equipment	Unlicensed Low Power Transmitters
Input Power Supply Type	9-12 V DC using a generic external power supply
Primary User Functions of EUT:	finger print reader

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2.3. EUT'S TECHNICAL SPECIFICATIONS

V-Smart, A,R employs Gemplus make 13.553-13.567 MHz Radio Transmitter Module (GemProx-C2).

TRANSMITTER	
Equipment Type:	▪ Base station (fixed use)
Intended Operating Environment:	▪ Commercial, light industry & heavy industry
Power Supply Requirement:	12 VDC, 120mA
E-Field of the Carrier Signal:	39.2 dBuV/m at 10 meters
Operating Frequency:	13.56 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	N/A
Duty Cycle:	100%
20 dB Bandwidth:	6.61 kHz
Modulation Type:	ASK, Modified Miller, 106 kbit/s
Antenna Connector Type:	Manufacturer: Gemplus Type: PCB Loop Antenna Model: Integral Frequency Range: 13.56 MHz

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	RS-232	1x 2 wires	DB-15 (all ports)	Non shielded
2	RS-485	1x 2 wires	DB-15	Non shielded
3	Wiegand Input	1x 2 wires	DB-15	Non shielded
4	Wiegand Output	1x 2 wires	DB-15	Non shielded
5	Signal GND	1	DB-15	Non shielded
6	Wiegand GND	1	DB-15	Non shielded
7	Power	1	DB-15	Non shielded
8	Power Return	1	DB-15	Non shielded
9	Line Trigger (GPO)	1	DB-15	Non shielded
10	Earth GND	1	DB-15	Non shielded
11	USB Service Port	1	Min USB	

2.5. ANCILLARY EQUIPMENT

N/A

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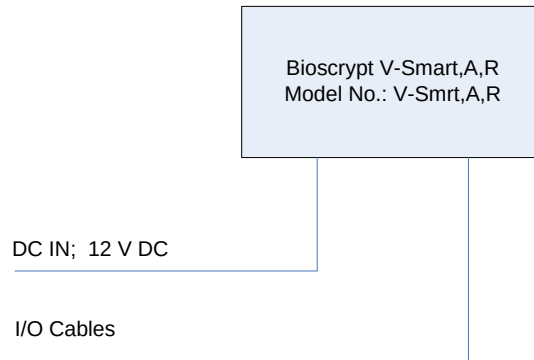
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2.6. GENERAL TEST SETUP



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EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	12 Vdc

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

The Model V-Smrt, A,R was set to transmit continuously during tests.

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EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).
- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049-1). Last Date of Site Calibration: June. 20, 2005.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.203	Antenna Requirement	Yes. Integral antenna
15.225 (e)	Frequency Stability	Yes
15.225 & 15.205/209	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
15.215(c)	26 & 20 dB Bandwidths	Yes
15.107(a)	Power Line Conducted Emissions Measurements (Transmit & Receive)	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices. The engineering test report can be provided upon FCC requests.		

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

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EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in ANSI C63.4 and ULTR-P001-2004.

5.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document LAB 34 with a confidence level of 95%. Please refer to Exhibit 6 for Measurement Uncertainties.

5.3. MEASUREMENT EQUIPMENT USED:

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1.

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5.4. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPARTS B & C, PARA.15.107(A) & 15.207

5.4.1. Limits

The equipment shall meet the limits of the following table:

Test Frequency Range (MHz)	CLASS B LIMITS		Measuring Bandwidth
	Quasi-Peak (dB μ V)	Average* (dB μ V)	
0.15 to 0.5	66 to 56*	56 to 46*	RBW = 9 kHz VBW $\geq$ 9 kHz for QP VBW = 1 Hz for Average
0.5 to 5	56	46	RBW = 9 kHz VBW $\geq$ 9 kHz for QP VBW = 1 Hz for Average
5 to 30	60	50	RBW = 9 kHz VBW $\geq$ 9 kHz for QP VBW = 1 Hz for Average

* Decreasing linearly with logarithm of frequency

5.4.2. Method of Measurements

Refer to Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4 for measurement methods

5.4.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
EMI Receiver System/Spectrum Analyzer with built-in Amplifier	Hewlett Packard	HP 8546A	3520A00248	9KHz-5.6GHz, 50 Ohms
Transient Limiter	Hewlett Packard	11947A	310701998	9 kHz – 200 MHz 10 dB attenuation
L.I.S.N.	EMCO	3825/2	89071531	9 kHz – 200 MHz 50 Ohms / 50 μ H
12'x16'x12' RF Shielded Chamber	RF Shielding	...	..	...

5.4.4. Photographs of Test Setup

Refer to the Photographs #1 & #2 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

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5.4.5. Test data

Conforms. Refer to Plots # 1 to 2 for details of measurements

Plot #1: DC POWER LINE CONDUCTED EMISSION MEASUREMENTS

Detector: [X] PEAK [] QUASI-PEAK [] AVERAGE		Temp: 23C°	Humidity: 12%	File#: MYT-088Q
Line Tested: 1	Line Voltage: 12 V DC	Test Tech: CAROLYN	Test Date: June 8, 06	
Standard: FCC 15B	Comments: Pass, OEM 150 50 OHM ANTENNA LOAD			

177

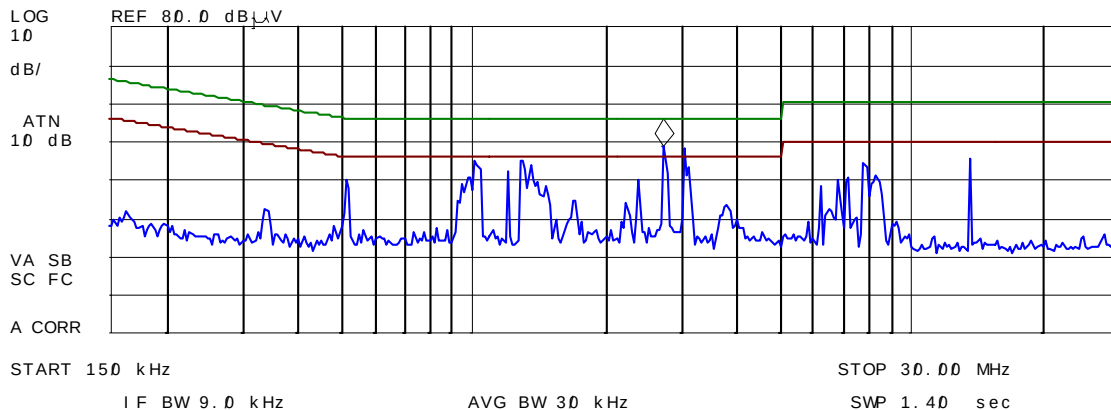
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV Δ L2
1	1.292570	49.0	42.0	23.6	-22.4
2	2.744100	50.4	48.6	43.5	-2.5
3	3.083750	51.0	48.1	43.4	-2.6
4	7.676250	50.0	40.1	21.5	-28.5
5	13.561050	49.9	47.6	34.5	-15.5

ACTV DET: PEAK

MEAS DET: PEAK QP AVG

MKR 2.73 MHz

48.47 dB μ V



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Plot #2: DC POWER LINE CONDUCTED EMISSIONS MEASUREMENTS

Detector: ☒ PEAK ☐ QUASI-PEAK ☐ AVERAGE		Temp: 23C°	Humidity: 12%	File#: MYT-088Q
Line Tested: 2	Line Voltage: 12 Vdc	Test Tech: CAROLYN	Test Date: June 8, 06	
Standard: FCC 15B	Comments: Pass, OEM 150 50 OHM ANTENNA LOAD			

HP

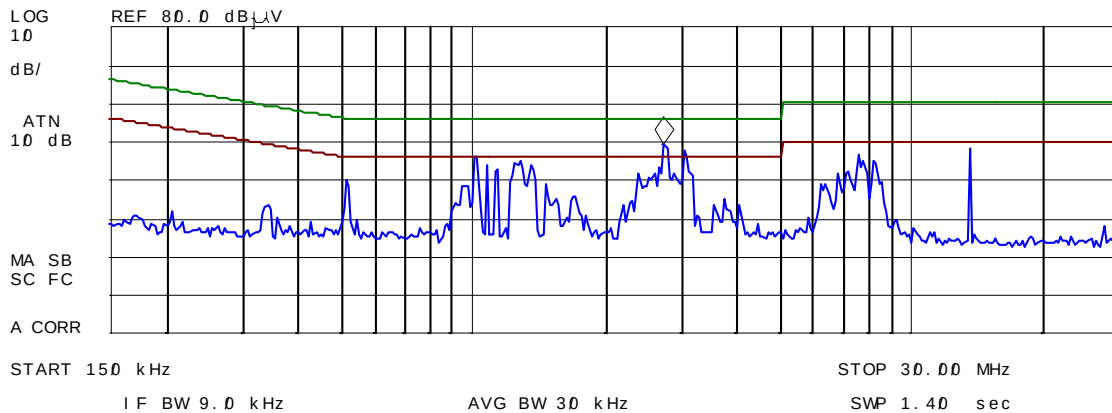
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV Δ L2
1	1.292125	47.5	41.6	23.4	-22.6
2	2.738900	51.2	50.0	45.6	-0.4
3	3.082438	52.0	48.5	43.6	-2.4
4	13.561550	50.4	48.1	34.9	-15.1

ACTV DET: PEAK

MEAS DET: PEAK QP AVG

MKR 2.73 MHz

49.28 dB μ V



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5.5. 26 DB & 20 DB BANDWIDTH @ FCC 15.215(C)

5.5.1. Limits

The rf spectrum shall not stay in the restricted band specified in FCC 15.205

5.5.2. Method of Measurements

Refer to ANSI C63.4

The transmitter output was connected to the spectrum analyzer through an attenuator. the bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 1% of approximate 26dB BW, VBW > RBW, Span = approx. 3x26dB BW. The 26 dB Bandwidth was measured and recorded.

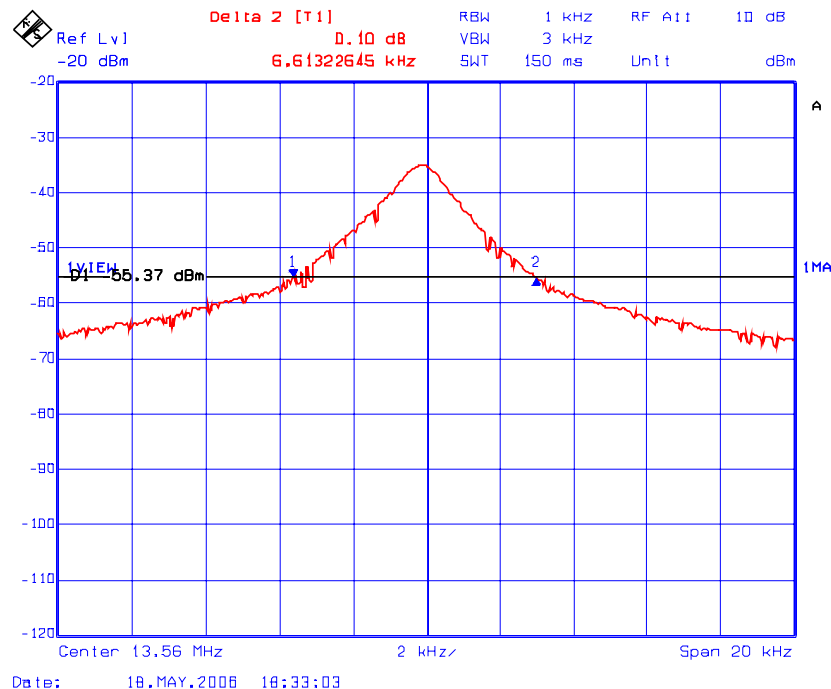
5.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer

5.5.4. Test Data

CHANNEL FREQUENCY (MHz)	20 dB Bandwidth (KHz)	26 dB Bandwidth (KHz)
13.56	6.61	11.70

20 dB Occupied Bandwidth:-



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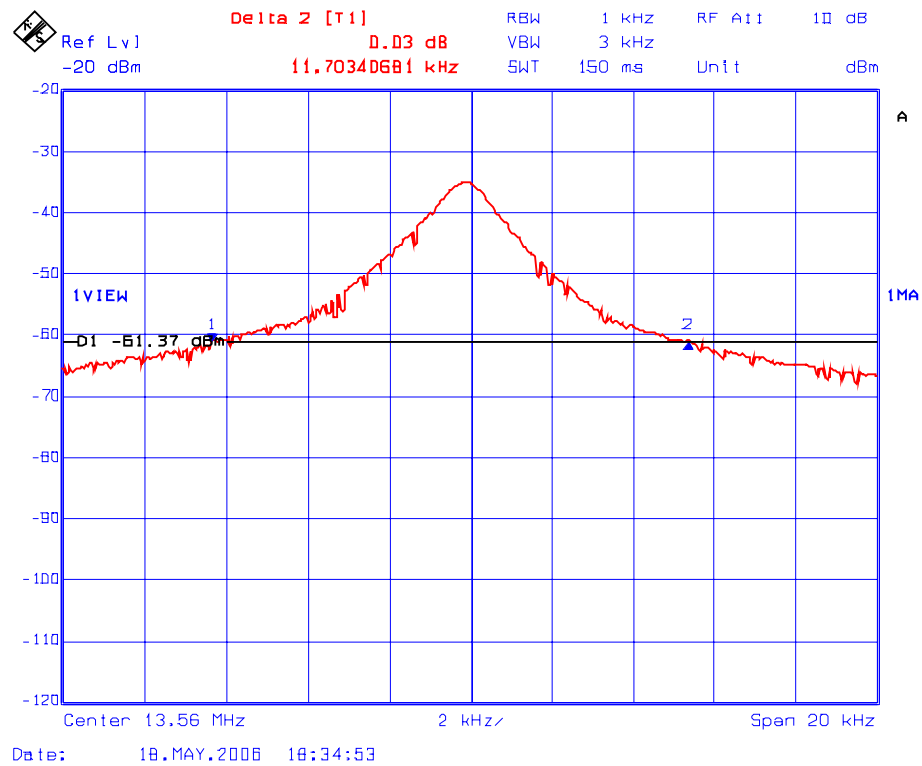
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26 dB Occupied Bandwidth:-



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5.6. FREQUENCY STABILITY @ FCC §15.225(E)

5.6.1. Limits

The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

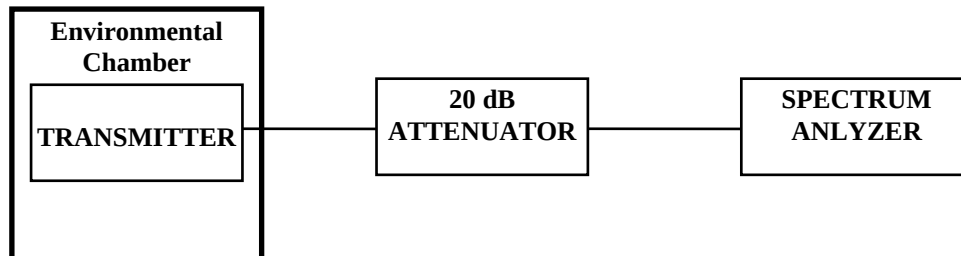
5.6.2. Method of Measurements

Refer to Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4 for measurement methods

5.6.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Attenuator(s)	Bird	..	...	DC – 22 GHz
Temperature & Humidity Chamber	Tenney	T5	9723B	-40° to +60 ° C range

5.6.4. Test Arrangement



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5.6.5. Test Data

Frequency Band:	13.553-13.567 MHz
Center Frequency:	13.56 MHz
Frequency Tolerance Limit:	$\pm 0.01\%$ or 1356 Hz
Max. Frequency Tolerance Measured:	100 Hz
Input Voltage Rating:	12 V DC Nominal

Ambient Temperature (°C)	Center Frequency & RF Power Output Variation		
	Supply Voltage (Nominal) 12 Volts	Supply Voltage (85 % of Nominal) 9 Volts	Supply Voltage (115% of Nominal) 12 Volts
	Hz	Hz	Hz
-30	100	N/A	N/A
-20	100	N/A	N/A
-10	60	N/A	N/A
0	60	N/A	N/A
+10	20	N/A	N/A
+20	00	-20	20
+30	100	N/A	N/A
+40	60	N/A	N/A
+50	20	N/A	N/A
+55	20	N/A	N/A

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5.7. TRANSMITTER SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.225, 15.209 & 15.205

5.7.1. Limits

- The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.
- Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
- Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.
- The field strength of any emissions appearing outside of the 13.110 – 14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.

Remarks:

FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) - Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	162.0125 - 167.17	2310 - 2390	9.3 - 9.5
0.49 - 0.51	167.72 - 173.2	2483.5 - 2500	10.6 - 12.7
2.1735 - 2.1905	240 - 285	2655 - 2900	13.25 - 13.4
8.362 - 8.366	322 - 335.4	3260 - 3267	14.47 - 14.5
13.36 - 13.41	399.9 - 410	3332 - 3339	14.35 - 16.2
25.5 - 25.67	608 - 614	3345.8 - 3358	17.7 - 21.4
37.5 - 38.25	960 - 1240	3600 - 4400	22.01 - 23.12
73 - 75.4	1300 - 1427	4500 - 5250	23.6 - 24.0
108 - 121.94	1435 - 1626.5	5350 - 5460	31.2 - 31.8
123 - 138	1660 - 1710	7250 - 7750	36.43 - 36.5
149.9 - 150.05	1718.8 - 1722.2	8025 - 8500	Above 38.6
156.7 - 156.9	2200 - 2300	9000 - 9200	

FCC CFR 47, Part 15, Subpart C, Para. 15.209(a) -- Field Strength Limits within Restricted Frequency Bands --

FREQUENCY (MHz)	FIELD STRENGTH LIMITS (microvolts/m)	DISTANCE (Meters)
0.009 - 0.490	2,400 / F (KHz)	300
0.490 - 1.705	24,000 / F (KHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

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5.7.2. Method of Measurements

Refer to Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4 for measurement methods

Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.

- For measurements from 9 KHz to 150 KHz, set RBW = 200 Hz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurements from 150 KHz to 30 MHz, set RBW = 10 KHz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurements from 30 MHz to 1 GHz, set RBW = 100 KHz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz, SWEEP=AUTO.

If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

5.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Peak Power Meter & Peak Power Sensor	Hewlett Packard	8900 8481A	2131A00124 2551A01965	0.1-18 GHz 50 Ohms Input
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Active Loop Antenna	EMCO	6507	8906-1167	1 kHz – 30 MHz
Log Periodic/Bow-Tie Antenna	EMCO	3143	1029	20 - 1000 MHz

5.7.4. Photographs of Test Setup

Refer to photos in Annex 1 for test setup photos.

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File #: MYT-088FCC15C

July 17, 2006

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5.7.5. Test Data

5.7.5.1. Radiated emissions from 9 KHz to 30 MHz at 10 Meters Distance using an Active Loop Antenna

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (Degree)	LIMIT @ 10m 15.209 (dBuV/m)	LIMIT MARGIN (dB)	PASS/ FAIL	Distance (m)
13.559	33.71	Peak	0	93.5	-59.8	PASS	10
13.559	39.15	Peak	90	93.5	-54.4	PASS	10
The emissions were scanned from 10 kHz to 30 MHz and all emissions within 40 dB below the limits were recorded.							

5.7.5.2. Radiated emissions from 30 MHz to 1 GHz at 10 Meters Distance using Biconilog Antenna

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	EMI DETECTOR (Peak/QP)	ANTENNA PLANE (V/H)	LIMIT @ 10m 15.225/15.209 (dBuV/m)	LIMIT MARGIN (dB)	PASS/ FAIL	Distance (m)
40.677	25.60	Peak	V	29.5	-3.9	PASS	10
40.677	16.40	Peak	H	29.5	-13.1	PASS	10
67.795	22.40	Peak	V	29.5	-7.1	PASS	10
67.795	16.57	Peak	H	29.5	-12.9	PASS	10
81.354	14.23	Peak	V	29.5	-15.3	PASS	10
108.472	16.05	Peak	V	33.0	-16.9	PASS	10
122.031	15.46	Peak	V	33.0	-17.5	PASS	10
135.590	23.34	Peak	V	33.0	-9.7	PASS	10
135.590	18.78	Peak	H	33.0	-14.2	PASS	10
The emissions were scanned from 30 MHz to 1000 GHz and all emissions within 20 dB below the limits were recorded.							

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File #: MYT-088FCC15C

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EXHIBIT 6. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and LAB 34

6.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Line Conducted)	PROBABILITY DISTRIBUTION	UNCERTAINTY (dB)	
		9-150 kHz	0.15-30 MHz
EMI Receiver specification	Rectangular	+1.5	+1.5
LISN coupling specification	Rectangular	+1.5	+1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	+0.3	+0.5
Mismatch: Receiver VRC $\Gamma_1 = 0.03$ LISN VRC $\Gamma_R = 0.8(9 \text{ kHz}) 0.2 (30 \text{ MHz})$ Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$	U-Shaped	± 0.2	± 0.3
System repeatability	Std. deviation	± 0.2	± 0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	+1.25	+1.30
Expanded uncertainty U	Normal (k=2)	+2.50	+2.60

Sample Calculation for Measurement Accuracy in 450 kHz to 30 MHz Band:

$$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30 \text{ dB}$$

$$U = 2u_c(y) = \pm 2.6 \text{ dB}$$

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File #: MYT-088FCC15C

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6.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (+ dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	+1.0	+1.0
Cable Loss Calibration	Normal (k=2)	+0.3	+0.5
EMI Receiver specification	Rectangular	+1.5	+1.5
Antenna Directivity	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	+2.0	+0.5
Antenna phase center variation	Rectangular	0.0	+0.2
Antenna factor frequency interpolation	Rectangular	+0.25	+0.25
Measurement distance variation	Rectangular	+0.6	+0.4
Site imperfections	Rectangular	+2.0	+2.0
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67(\text{Bi}) 0.3 (\text{Lp})$ Uncertainty limits $20\text{Log}(1+\Gamma_1\Gamma_R)$	U-Shaped	+1.1 -1.25	± 0.5
System repeatability	Std. Deviation	+0.5	+0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k=2 is used:

$$U = 2u_c(y) = 2x(+2.19) = +4.38 \text{ dB} \quad \text{And} \quad U = 2u_c(y) = 2x(-2.21) = -4.42 \text{ dB}$$

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