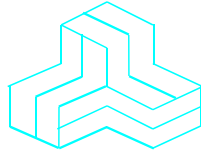


ENGINEERING TEST REPORT



Lemur Autovision (Sensor) Model No.: LS01

FCC ID: VVT-LS01

Applicant:
Root Four Imagination Inc.
80 Castors Dr.
Mount Pearl, NL
Canada A1N 5K5

In Accordance With

**FEDERAL COMMUNICATIONS COMMISSION (FCC)
Part 15, Subpart C, Section 15.231(e)
Momentarily Operation at 433.92 MHz**

UltraTech's File No.: ROFI-002_F15C231

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

Date: November 28, 2008



Report Prepared by: Dharmajit Solanki, RFI Engineer

Tested by: Hung Trinh, RFI Technician

Issued Date: November 28, 2008

Test Dates: November 3 to 8, 2008

- *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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0685



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200093-0



SL2-IN-E-1119R



2005-82 & 83

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File #: ROFI-002_F15C231

November 28, 2008

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	<ul style="list-style-type: none"> ▪ Exhibit 1: Submittal check lists ▪ Exhibit 2: Introduction ▪ Exhibit 3: Performance Assessment ▪ Exhibit 4: EUT Operation and Configuration during Tests ▪ Exhibit 5: Summary of test Results ▪ Exhibit 6: Measurement Data ▪ Exhibit 7: Measurement Uncertainty 	OK
1	Test Setup Photos	Radiated Emissions Test Setup Photos	OK
2	External Photos of EUT	External EUT Photos	OK
3	Internal Photos of EUT	Internal EUT Photos	OK
4	Cover Letters	<ul style="list-style-type: none"> ▪ Letter from Ultratech for Certification Request ▪ Letter from the Applicant to appoint Ultratech to act as an agent ▪ Letter from the Applicant to request for Confidentiality Filing 	OK
5	ID Label/Location Info	<ul style="list-style-type: none"> ▪ ID Label ▪ Location of ID Label 	OK
6	Block Diagrams	Block Diagram	OK
7	Schematic Diagrams	Schematics	OK
8	Parts List/Tune Up Info	Bill of Material	OK
9	Operational Description	Operational Description	OK
10	RF Exposure Info	--	n/a
11	Users Manual	User Manual	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.231(e)
Title:	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Section 15.231(e) - Momentarily Operation at 433.92 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:	Residential

2.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-15	2008	Code of Federal Regulations – Telecommunications
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
CISPR 22	2008	Information Technology Equipment - Radio Disturbance Characteristics – Limits and Methods of Measurement
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-2-1	2004	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Root Four Imagination Inc.
Address:	80 Castors Dr. Mount Pearl, NL Canada A1N 5K5
Contact Person:	Mr. Maurice Tuff Phone #: 709-747-7593 Fax #: 709-747-7594 Email Address: mtuff@rootfour.com

MANUFACTURER	
Name:	Root Four Imagination Inc.
Address:	80 Castors Dr. Mount Pearl, NL Canada A1N 5K5
Contact Person:	Mr. Maurice Tuff Phone #: 709-747-7593 Fax #: 709-747-7594 Email Address: mtuff@rootfour.com

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Product Name:	Lemur Autovision (Sensor)
Model Name or Number:	LS01
Serial Number:	Test Sample
Type of Equipment:	Low Power Transceiver
Input Power:	3.2V (derived from Car battery)
Primary User Functions of EUT:	Collect Driving Statistics

3.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Mobile
Intended Operating Environment:	Vehicle
RF Output Power Rating:	67.56 dBµV/m Avg E-field @ 3 meters
Operating Frequency Range:	433.92 MHz
Duty Cycle:	23.3 %
20 dB Bandwidth:	10.07 kHz
Modulation Type:	ASK
Antenna Connector Type:	Integral antenna, housed inside the enclosure.
Antenna Description:	Type: Trace Antenna etched into PCB Frequency Range: 433.92 MHz

3.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	OBD II	1	J1962 Male	Non-shielded

3.5. ANCILLARY EQUIPMENT

None

3.6. GENERAL TEST SETUP



EXHIBIT 4. EUT OPERATION CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	52%
Pressure:	102 kPa
Power Input Source:	3.2V (derived from Car battery)

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The EUT was set to transmit in burst mode continuously by means of special setting for testing purpose only.
Special Test Software:	None
Special Hardware Used:	None
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.

Transmitter Test Signal	
Frequency	433.92 MHz

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. 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.

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.: IC2049A-3). Calibration site expiry date for IC is May 17, 2009.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSIONS TEST RESULTS

FCC Sections	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirement (Permanently attached antenna used with this device)	Yes
15.231(c)	20 dB Bandwidth	Yes
15.231(d)	Frequency Tolerance for 40.66-40.70 MHz	N/A
15.231(e)	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
15.107(a)	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	N/A (battery operated device)
15.109(a)	Radiated Emissions for Receiver & Digital board	Yes
15.111(a)	Receiver Antenna Power Conducted Emissions Non-Integral Antenna Port	N/A (Integral Antenna)

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4.

6.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

6.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C64.3, FCC 15.209 and CISPR 16-1.

6.4. METHOD OF MEASUREMENTS

The measurements were performed in accordance with Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4.

6.5. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

The essential function of the EUT is to collect Driving Statistics and transmit to KeyFob.

6.6. AUTOMATIC TRANSMISSION REQUIREMENT [§15.231(e)]

6.6.1. FCC Provision

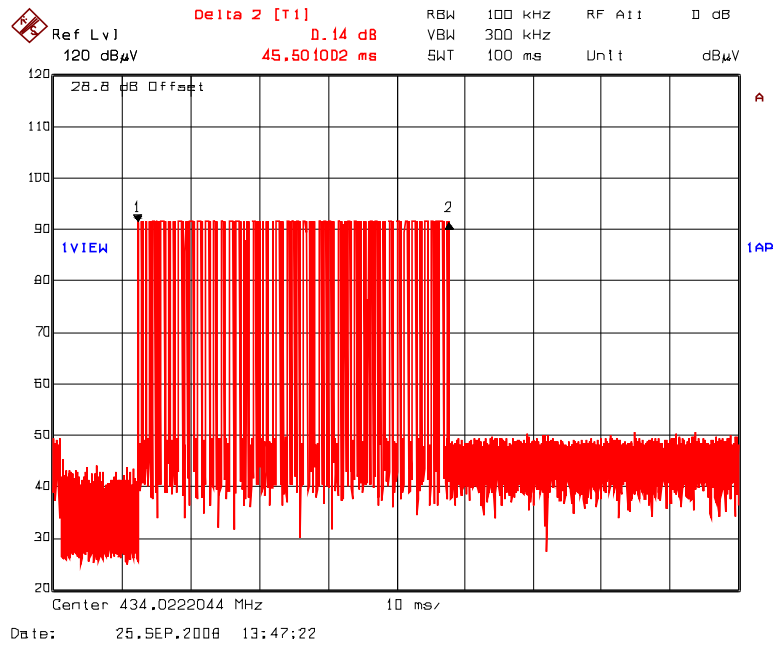
The devices operated under the provision of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

6.6.2. Test Data

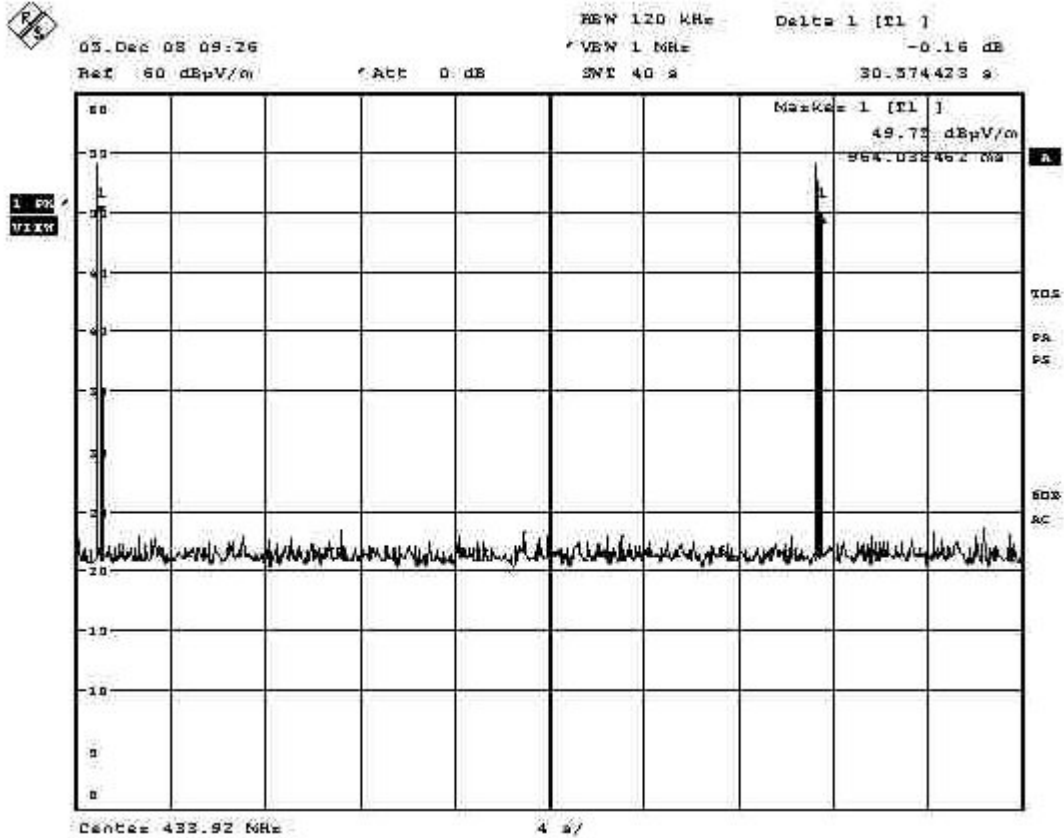
Kindly refer to the following plots for measurement details of transmission and silent period of this device.

- (1) Total Transmission Time (T_{on}) = 45.5mS; Which is less than 1 Sec., OK
- (2) $30 * T_{on} = 30 * 0.0455 = 1.36$ Sec.; Which is less than T silence = 30.57 Sec., OK
- (3) T silence = 30.57 Sec.; Which is greater than 10 Sec., OK

EUT complies with the above FCC provision.



(Transmission Time of a Pulse)



(Silent Period)

6.7. TRANSMITTER RADIATED EMISSIONS @ 3 METERS – FUNDAMENTAL, HARMONIC & SPURIOUS EMISSIONS [§15.231(e), 15.209 & 15.205]

6.7.1. Limits

The RF radiated emissions measured at 3 Meters distance shall not exceed the field strength below:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emission (microvolts/meter)
260 - 470	¹ 1500 to 5,000	¹ 150 to 500

¹ Linear interpolation.

Field Strength of Fundamental Limit @ 433.92 MHz = 72.87 dBµV/m at 3 meters
Field Strength of Spurious Limit (outside restricted bands) = 52.87 dBµV/m

Emissions within the restricted bands specified in §15.205(a) shall not exceed the general radiated emission limits specified in §15.209(a).

47 CFR 15.205(a) - Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

47 CFR 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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6.7.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and ANSI C63.4.

Note: Because the EUT employs pulsed operation, the unit was modified for continuous operation and the readings were corrected by subtraction the peak-average correction factor derived from the appropriate duty cycle calculation. See §15.35 (c).

6.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz
RF Amplifier	Hewlett Packard	8447F	2944A04098	0.1 MHz to 1300 MHz
RF Amplifier	Hewlett Packard	8449B	3008A00769	1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3142	10005	30 MHz to 2 GHz
Horn Antenna	EMCO	3115	6570	1 GHz – 18 GHz
High Pass Filter	Mini Circuit	SHP-800	10425	Cut off 433.92 MHz

6.7.4. Test Data

Frequency (MHz)	Peak E-Field @3m (dBµV/m)	Average E-Field @3m (dBµV/m)	Antenna Plane (V/H)	§15.231(e) Limits @ 3m (dBµV/m)	§15.209 (a) Limits @ 3m (dBµV/m)	Margin (dB)
433.92	80.20	67.56	V	72.87		-5.31
433.92	78.35	65.71	H	72.87		-7.16
867.84	46.73	34.09	V	52.87	46.00	-18.78
867.84	48.65	36.01	H	52.87	46.00	-16.86
1301.76*	61.71	49.07	V	52.87	54.00	-4.93
1301.76*	65.03	52.39	H	52.87	54.00	-1.61
1735.68	62.73	50.09	V	52.87	54.00	-3.91
1735.68	62.97	50.33	H	52.87	54.00	-3.67
2169.60	55.69	43.05	V	52.87	54.00	-10.95
2169.60	55.52	42.88	H	52.87	54.00	-11.12
2603.52	49.40	36.76	V	52.87	54.00	-17.24
2603.52	48.77	36.13	H	52.87	54.00	-17.87
3037.44	50.29	37.65	V	52.87	54.00	-16.35
3037.44	52.75	40.11	H	52.87	54.00	-13.89
3905.28*	51.87	39.23	V	52.87	54.00	-14.77
3905.28*	53.10	40.46	H	52.87	54.00	-13.54
4339.20*	49.14	36.50	V	52.87	54.00	-17.50
4339.20*	50.16	37.52	H	52.87	54.00	-16.48

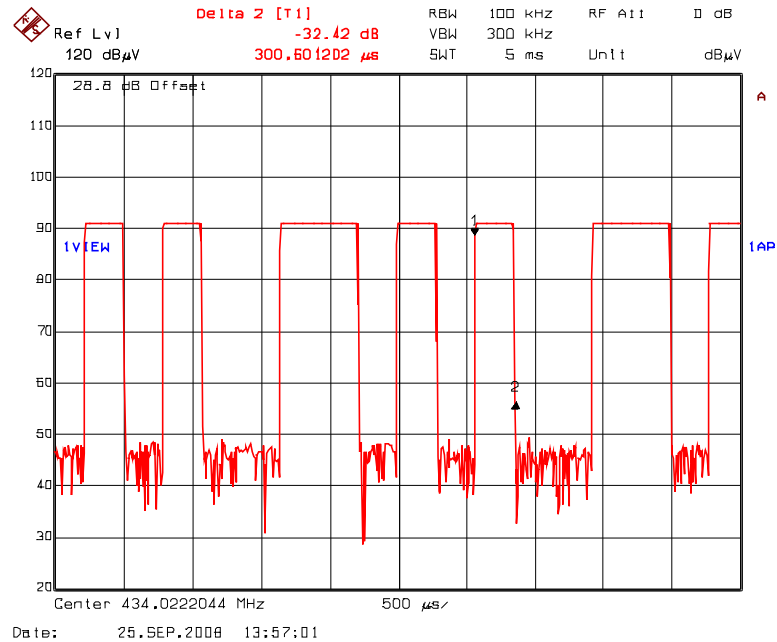
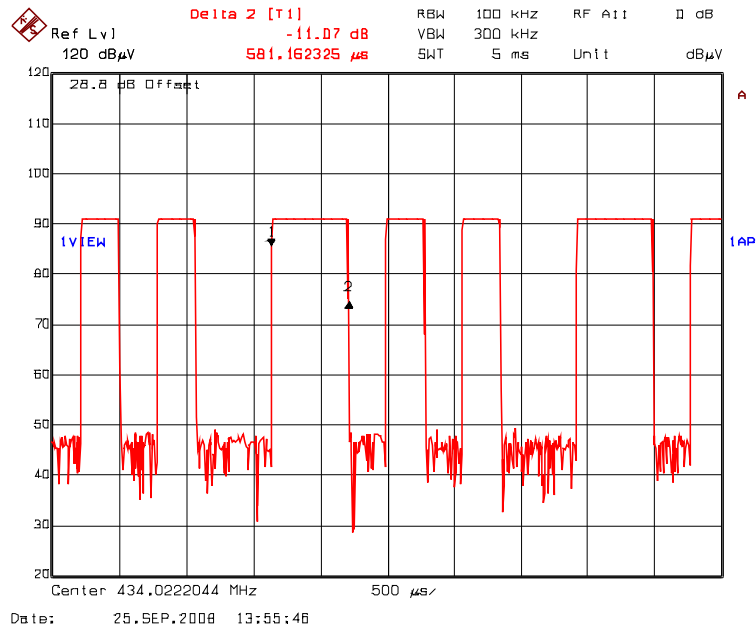
- The emissions were scanned from 30 MHz to 5 GHz at 3 meters distance and all spurious and harmonic emissions within 20 dB of the limit were recorded. The Average value of the measured emissions were compared with the limits as per Sec 15.231(b)(2).
- The transmitter was placed in three different orthogonal positions for searching maximum field strength level.
- The peak-average correction factor was obtained from the duty cycle calculation. See the Remarks below for details.

*Emissions within restricted band.

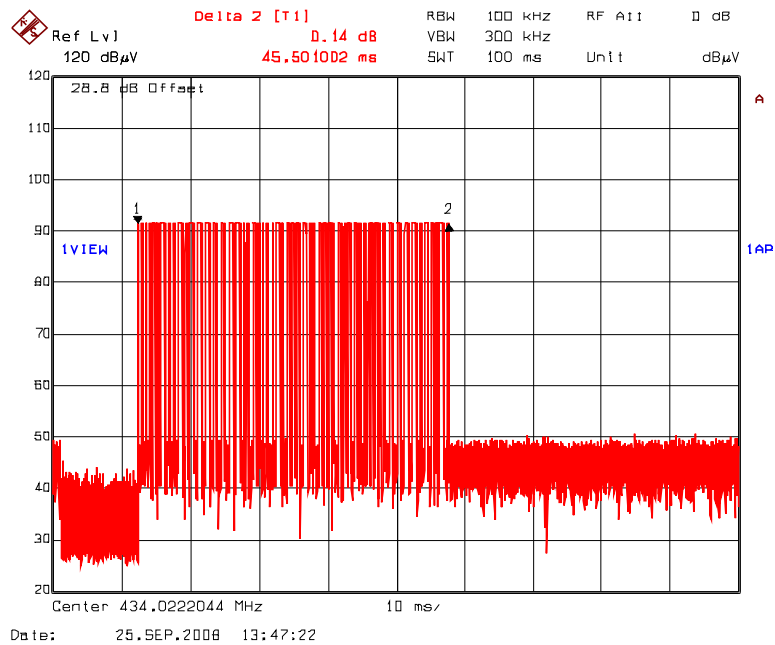
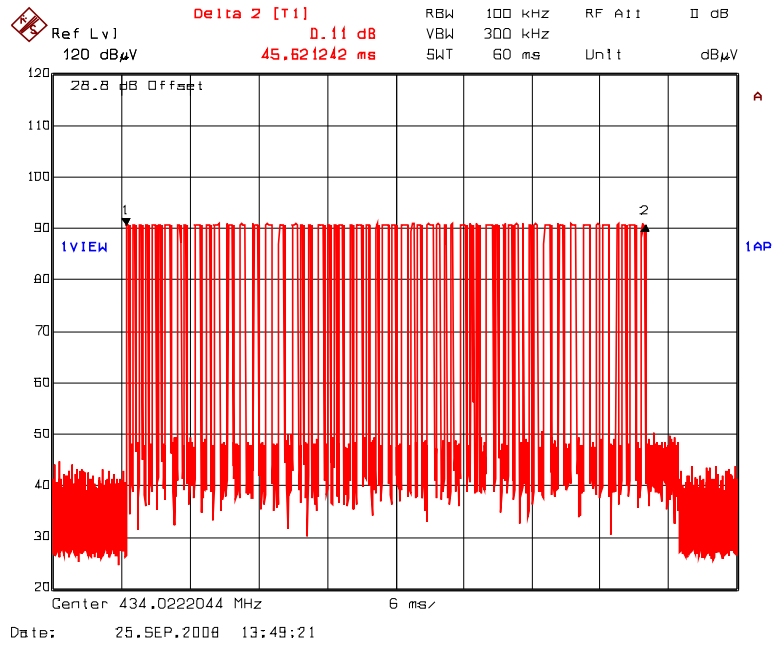
Remarks:

- Txon = 23.326 ms
- Duty cycle = Txon/100 = 0.233
- **Peak-to-Average Factor = 20*log (0.233) = -12.64dB**

Pulse Widths = 581.16µs & 300.60µs



Duty Cycle in 100ms: $(21 \times 581.16\mu s) + (37 \times 300.60\mu s) = 12.204 + 11.122\text{ms} = 23.326\text{ms}$
 Duty Cycle Factor = $20 \times \log(0.23326) = -12.64\text{dB}$



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6.8. EMISSION BANDWIDTH [§15.231(c)]

6.8.1. Limits

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

6.8.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004, §15.231(c) & ANSI C63.4.

The transmitter output was loosely coupled to the spectrum analyzer through a receiving antenna and the bandwidth of the fundamental frequency was measured with the spectrum analyzer with the resolution bandwidth of the spectrum analyzer set per ANSI C63.4.

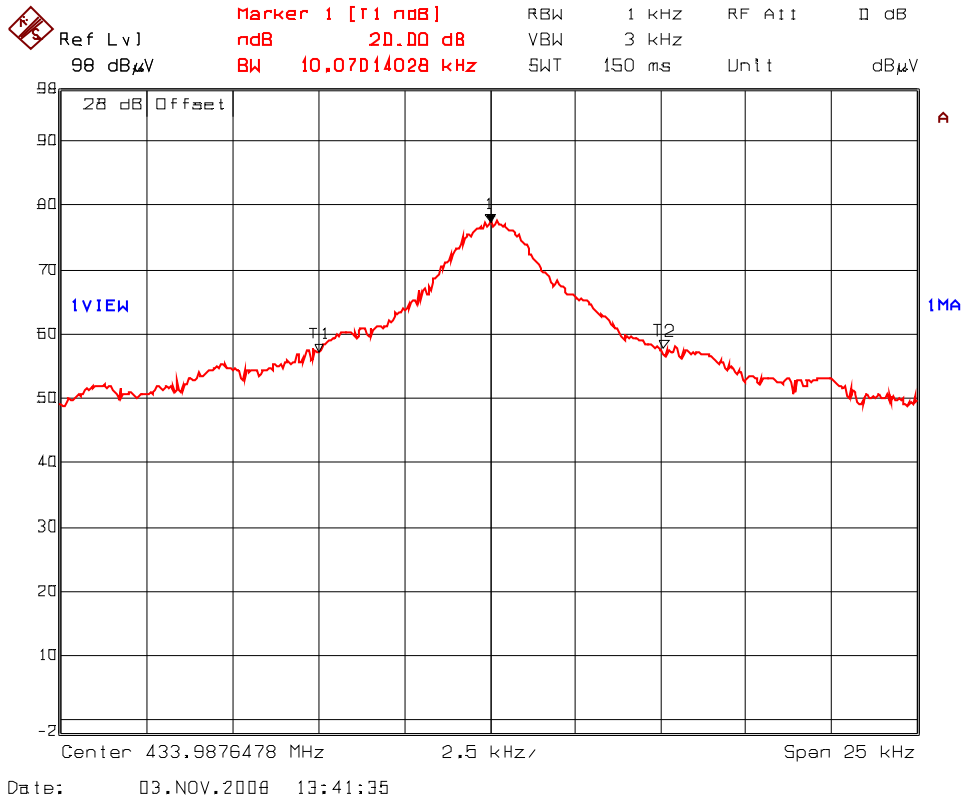
6.8.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz

6.8.4. Test Data

Frequency (MHz)	20 dB Bandwidth (kHz)	Maximum Limit (kHz)	Pass/Fail
433.92	10.07	1084	Pass

20 dB Bandwidth
Test Frequency: 433.92 MHz



6.9. RECEIVER & UNINTENTIONAL RADIATED SPURIOUS EMISSIONS [15.109(A)]

6.9.1. Limits

The equipment shall meet the limits of the following table:

Test Frequency Range (MHz)	Limits @3m (dBμV/m)	EMI Detector Used	Measuring Bandwidth (kHz)
30 – 88	40.0	Quasi-Peak	RBW = 120 kHz, VBW ≥ 120 kHz
88 – 216	43.5	Quasi-Peak	RBW = 120 kHz, VBW ≥ 120 kHz
216 – 960	46.0	Quasi-Peak	RBW = 120 kHz, VBW ≥ 120 kHz
Above 960	54.0	Average	RBW = 1 MHz, VBW ≥ 1MHz

6.9.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004, RSS-210, Issue 7 and ANSI C63.4.

The EUT shall be investigated from the lowest radio frequency signal generated or used in the device, without going below the lowest frequency for which a radiated emission limit is specified, up to the frequency shown in the following table:

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30
1.705 - 108	1000
108 – 500	2000
500 -1000	5000
Above 1000	5 th harmonic of the highest frequency or 40 GHz, whichever is lower

6.9.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz
RF Amplifier	Hewlett Packard	8447F	2944A04098	0.1 MHz to 1300 MHz
RF Amplifier	Hewlett Packard	8449B	3008A00769	1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3142	1005	30 MHz to 2 GHz
Horn Antenna	EMCO	3115	6570	1 GHz – 18 GHz
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz

6.9.4. Test Data

- The emissions were scanned from 30 MHz to 5 GHz of the receiver and all emissions are more than 20 dB below the limit.

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994).

7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (\pm 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 $\Gamma_R = 0.67$ (Bi) 0.3 (Lp) Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$	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:

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