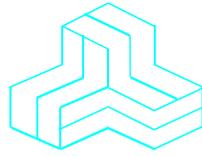


ENGINEERING TEST REPORT



UHF FM REPEATER (400-430 MHz)
Model No.: IC-FR4000-1
FCC ID: AFJ236801

Applicant:

ICOM Incorporated
1-1-32, Kamiminami, Hirano-ku
Osaka
Japan, 547-0003

Tested in Accordance With

Federal Communications Commission (FCC)
47 CFR Parts 2 and 90 (Subpart I)

UltraTech's File No.: ICOM-154FCC90

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



Date: September 19, 2007

Report Prepared by: Tri M. Luu, P.Eng.

Tested by: Hung Trinh, RFI Technician

Issued Date: September 19, 2007

Test Dates: September 9 & 18, 2007

- *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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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 Photos	OK
2	External Photos of EUT	--	--
3	Internal Photos of EUT	Photos of the new PA circuit	OK
4	Cover Letters	Cover Letter	OK
5	Attestation Statements	<ul style="list-style-type: none"> • Letter from the Applicant to appoint Ultratech to act as an agent • Letter from the Applicant to request for Confidentiality Filing 	OK
6	ID Label/Location Info	--	--
7	Block Diagrams	Block diagram	OK
8	Schematic Diagrams	Schematic diagram	OK
9	Parts List/Tune Up Info	Parts List	OK
10	Operational Description	--	--
11	RF Exposure Info	--	--
12	Users Manual	--	--

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 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: ICOM-154FCC90
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Parts 2 and 90
Title:	Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2 & 90
Purpose of Test:	Class II Permissive Change: The 2SC72SC3012 (Q2) and SC-1322 (IC1) on the P50 PA unit is out of production. A new PA board with new power module IC, RA60H4047M1 is created in place of the 50PA board and VARISTOR board.
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.

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

None

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2006	Code of Federal Regulations – Telecommunication
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 16-1-1	2004	Specification for Radio Disturbance and Immunity measuring apparatus and methods
TIA/EIA 603, Edition C	2004	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	ICOM Incorporated
Address:	1-1-32, Kamiminami, Hirano-ku Osaka Japan, 547-0003
Contact Person:	Mr. Yoshiteru Yano Phone #: 06 6793 5302 Fax #: 06 6793 0013 Email Address: world_support@icom.co.jp

MANUFACTURER	
Name:	ICOM Incorporated
Address:	1-1-32, Kamiminami, Hirano-ku Osaka Japan, 547-0003
Contact Person:	Mr. Yoshiteru Yano Phone #: 06 6793 5302 Fax #: 06 6793 0013 Email Address: world_support@icom.co.jp

3.2. Equipment under Test (EUT) INFORMATION

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

Brand Name:	ICOM Incorporated
Product Name:	UHF FM Repeater
Model Name or Number:	IC-FR4000-1
Serial Number:	Test sample
Type of Equipment:	Non-broadcast Radio Communication Equipment
External Power Supply:	N/A
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	Fixed, base voice radio communication

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Fixed, base station UHF Repeater
Intended Operating Environment:	Commercial, Light Industry & Heavy Industry
Power Supply Requirement:	120 V 60 Hz / 13.6 Vdc
RF Output Power Rating:	50 Watts Hi and 10 Watts Lo
Operating Frequency Range:	400-430 MHz
Number of Channels:	32
Output Impedance (RF):	50 Ohms
Channel Spacing:	12.5 kHz and 25 kHz
Occupied Bandwidth (99%):	<ul style="list-style-type: none"> • 9.3 kHz (for 12.5 kHz Channel Spacing) • 13.7 kHz (for 25 kHz Channel Spacing)
Emission Designation*:	11K0F3E and 16K0F3E
Input Impedance (MIC)	600 Ohms
Antenna Connector Type:	BNC (female)

* For an average case of commercial telephony, the Necessary Bandwidth is calculated as follows:

1. For FM Voice Modulation:

Channel Spacing = 12.5 KHz, D = 2.5 KHz max., K = 1, M = 3 KHz
 $B_n = 2M + 2DK = 2(3) + 2(2.5)(1) = 11 \text{ kHz}$
 emission designation: 11K0F3E

Channel Spacing = 25 KHz, D = 5 KHz max., K = 1, M = 3 KHz
 $B_n = 2M + 2DK = 2(3) + 2(5)(1) = 16 \text{ kHz}$
 emission designation: 16K0F3E

RECEIVER	
Power Supply Requirement:	120 V 60 Hz / 13.6 Vdc
Operating Frequency Range:	400-430 MHz
Number of Channels	32
RF Output Impedance (RF):	50 Ohms
Input Impedance (SP):	600 Ohms
Audio Output Power (Resistive Load):	2.5 W (4 ohms)

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	Transmit Antenna Port (TX/TX-RX)	1	N	Shielded
2	RF Receive Antenna RX Port (50 ohms)	1	N	Shielded
3	External Speaker (EXT SP) Port	1	Jack	Non-shielded
4	Remote Port	1	RJ-45	Non-shielded
5	ACC (Accessory/Remote Control))	1	DB25	Shielded
6	Microphone/Speaker [MIC/SP] Port	1	RJ-11	Non-shielded
7	Telco Line	1	RS-11	Non-shielded

3.5. ANCILLARY EQUIPMENT

2 x Microphones.

EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	120 VAC 60 Hz / 13.6V DC

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	N/A
Special Hardware Used:	N/A
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load.

Transmitter Test Signals	
Frequency Band(s):	400-430 MHz
Test Frequencies: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	400.10, 415.50 and 429.90 MHz
Transmitter Wanted Output Test Signals:	
<ul style="list-style-type: none"> ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation: ▪ Modulating signal source: 	50 Watts Hi and 10 Watts Lo FM Voice external

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.

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(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 Site No.: 2049A-2, Expiry Date: July 4, 2008).

5.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
90.205 & 2.1046	RF Power Output	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	See Note 1
90.213 & 2.1055	Frequency Stability	See Note 2
90.242(b)(8) & 2.1047(a)	Audio Frequency Response	See Note 2
90.210 & 2.1047(b)	Modulation Limiting	See Note 2
90.210 & 2.1049	Emission Limitation & Emission Mask	See Note 2
90.210, 2.1057 & 2.1051	Emission Limits - Spurious Emissions at Antenna Terminal	Yes
90.210, 2.1057 & 2.1053	Emission Limits - Field Strength of Spurious Emissions	Yes
90.214	Transient Frequency Behavior	See Note 2
UHF FM REPEATER, Model No.: IC-FR4000-1, by ICOM Incorporated has also been tested and found to comply with FCC Part 15, Subpart B - Radio Receivers and Class B Digital Devices . The engineering test report has been documented and kept in file and it is available upon FCC request.		

Note 1: RF exposure compliance is addressed at the time of licensing.

Note 2: Refer to original filing.

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

5.4. DEVIATION OF STANDARD TEST PROCEDURES

None.

ULTRATECH GROUP OF LABS

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File #: ICOM-154FCC90
 September 19, 2007

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

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

6.1. TEST PROCEDURES

Refer to Ultratech Test Procedures, File # ULTR P001-2004, ANSI C63.4, TIA-603-C.

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 C63.4 and CISPR 16-1-1.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

The essential function of the EUT is to correctly communicate data to and from radios over RF link.

6.5. RF POWER OUTPUT [§§ 2.1046 & 90.205]

6.5.1. Limits

See FCC 47 CFR 90.205 for specification details.

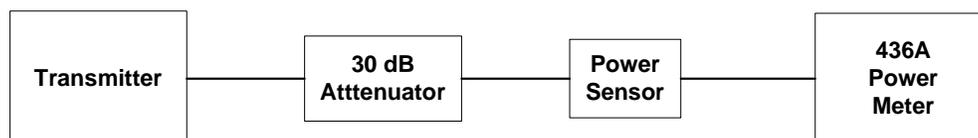
6.5.2. Method of Measurements

ULTRATECH Test Procedures, File # ULTR P001-2004 and TIA-603-C.

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Power Meter	Hewlett Packard	436A	1725A02249	10 kHz – 50 GHz, sensor dependent
Power Sensor	Hewlett Packard	8481A	2702A68983	10 MHz – 18 GHz
Attenuator	Weinschel	48-30-34	BM5354	DC – 18 GHz

6.5.4. Test Arrangement



6.5.5. Test Data

Channel	Frequency (MHz)	Bandwidth (Wide/Narrow)	Power Rating		Measured Power	
			dBm	Watts	dBm	Watts
Power Source: 120 VAC 60 Hz						
01 L	400.5	Narrow	40	10	40.19	10.45
02 L	415.5	Narrow	40	10	40.03	10.07
03 L	429.5	Narrow	40	10	39.90	9.77
04 H	400.5	Narrow	47	50	47.06	50.82
05 H	415.5	Narrow	47	50	46.90	48.98
06 H	429.5	Narrow	47	50	46.73	47.10
01 L	400.5	Wide	40	10	40.21	10.50
02 L	415.5	Wide	40	10	40.06	10.14
03 L	429.5	Wide	40	10	39.87	9.71
04 H	400.5	Wide	47	50	47.01	50.23
05 H	415.5	Wide	47	50	46.88	48.75
06 H	429.5	Wide	47	50	46.76	47.42
Power Source: 13.6 VDC						
01 L	400.5	Narrow	40	10	40.19	10.45
02 L	415.5	Narrow	40	10	40.04	10.09
03 L	429.5	Narrow	40	10	39.88	9.73
04 H	400.5	Narrow	47	50	47.05	50.70
05 H	415.5	Narrow	47	50	46.90	48.98
06 H	429.5	Narrow	47	50	46.72	46.99
01 L	400.5	Wide	40	10	40.22	10.52
02 L	415.5	Wide	40	10	40.05	10.12
03 L	429.5	Wide	40	10	39.88	9.73
04 H	400.5	Wide	47	50	47.00	50.12
05 H	415.5	Wide	47	50	46.89	48.87
06 H	429.5	Wide	47	50	46.74	47.21

Remark(s): Since there is no change in RF output powers with either AC or DC supplies, the following tests will be conducted with 120 V 60 Hz

6.6. SPURIOUS EMISSIONS AT ANTENNA TERMINALS [§§ 2.1051 & 90.210]

6.6.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
90.210(b)&(c) – Voice & data	10 MHz to Lowest frequency of the radio to 10 th harmonic of the highest frequency of the radio	43+10*log(P) or -13 dBm
90.210(d) – Voice & data	10 MHz to Lowest frequency of the radio to 10 th harmonic of the highest frequency of the radio	50+10*log(P) or -20 dBm or 70 dBc whichever is less

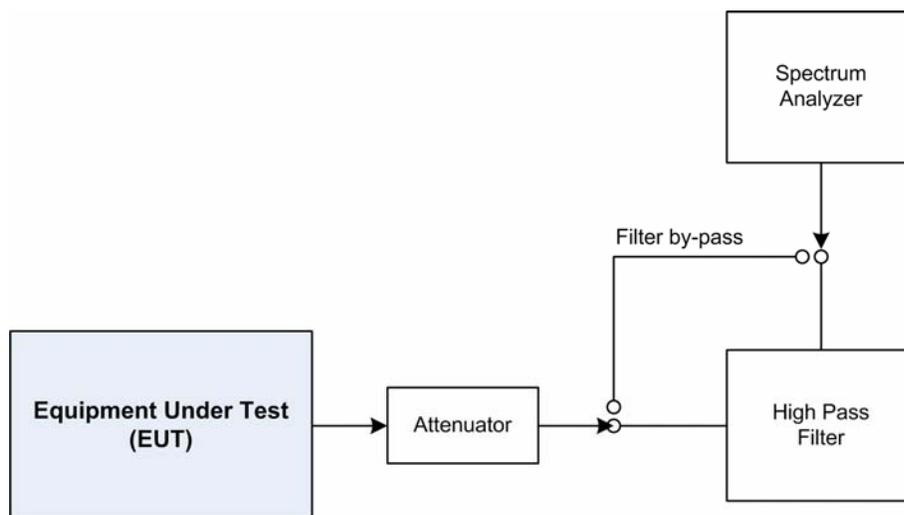
6.6.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and TIA-603-C.

6.6.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK30	100077	20 Hz – 40 GHz
High pass Filter	Mini Circuits	SHP-800	10425	Cut Off at 400 MHz
Attenuator	Weinschel	48-30-34	BM5354	DC – 18 GHz

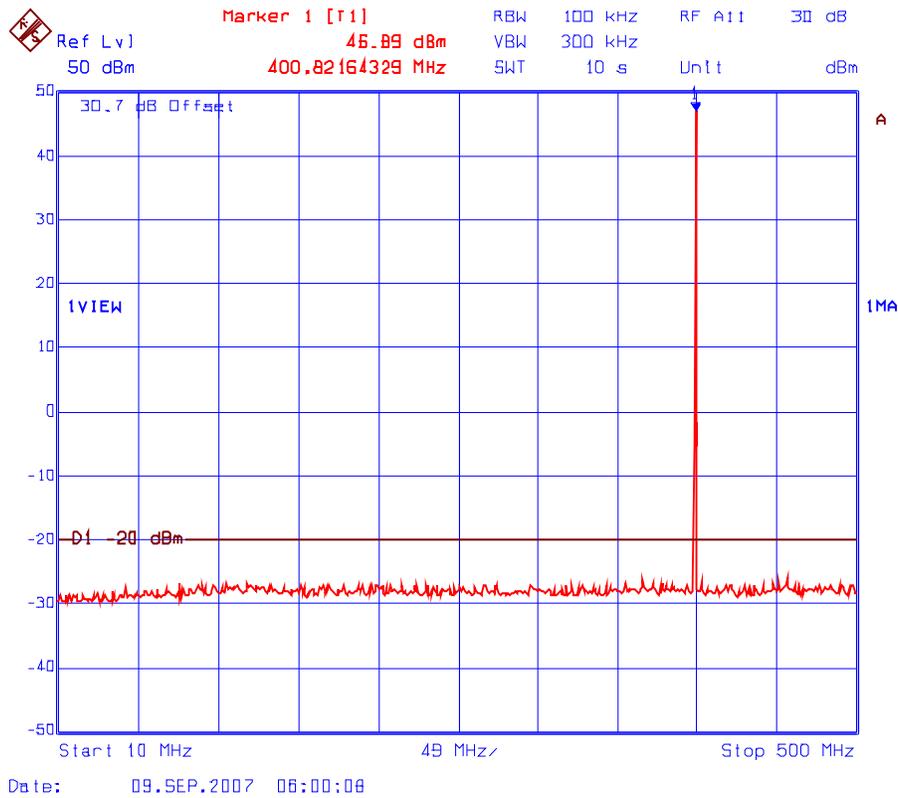
6.6.4. Test Arrangement



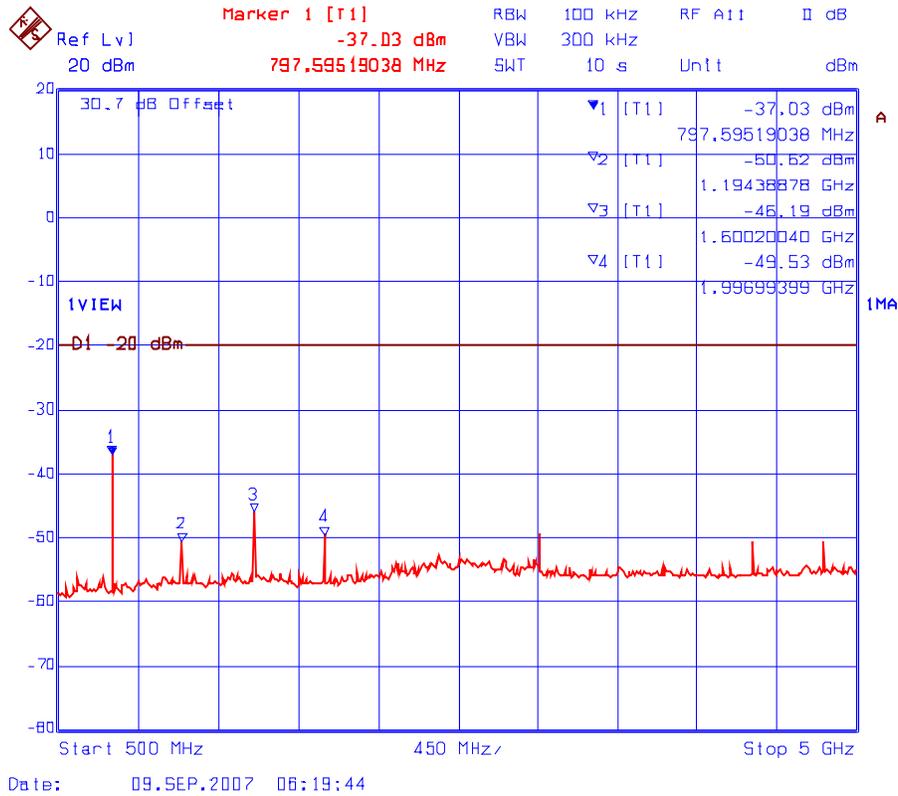
6.6.5. Test Data

Note: Since there was no difference in spurious/harmonic emissions based on our prescans, the rf spurious/harmonic emissions in this section would be performed for 12.5 kHz Channel Spacing and the lower Limit of $50 + 10 \cdot \log(P)$ would be applied for worst case.

Plot 6.6.5.1(a) Transmitter Antenna Power Conducted Emissions
Tx Frequency: 400.10 MHz
Channel Spacing: 12.5 kHz
Output Power: 47 dBm



Plot 6.6.5.1(b) Transmitter Antenna Power Conducted Emissions
 Tx Frequency: 400.10 MHz
 Channel Spacing: 12.5 kHz
 Output Power: 47 dBm



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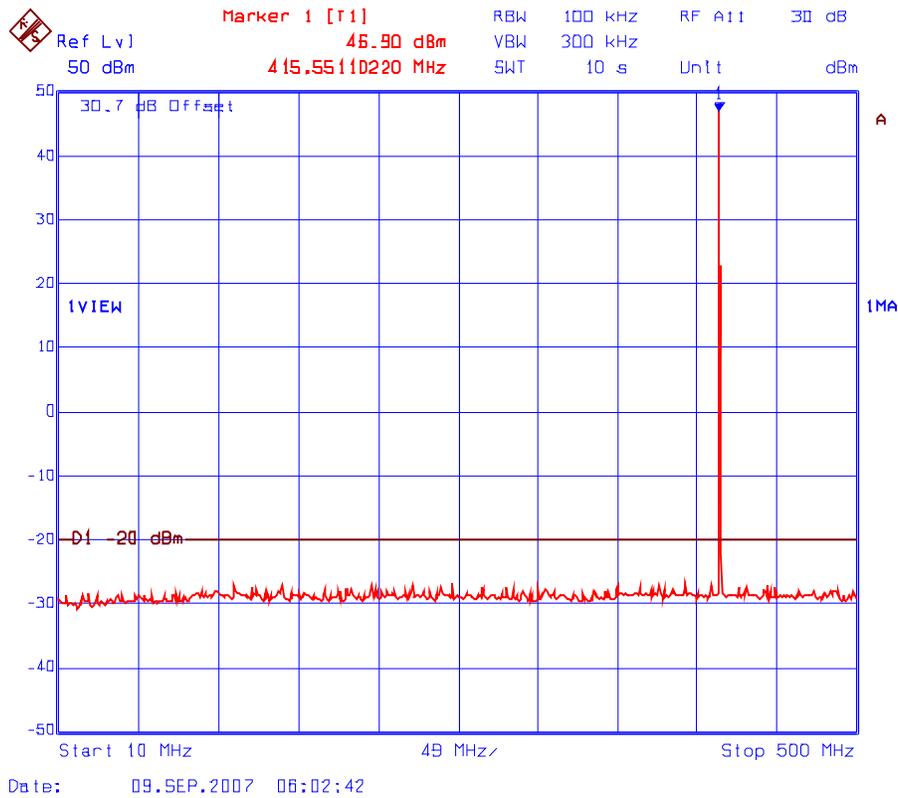
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 6.6.5.2(a) Transmitter Antenna Power Conducted Emissions
Tx Frequency: 415.5 MHz
Channel Spacing: 12.5 kHz
Output Power: 47 dBm



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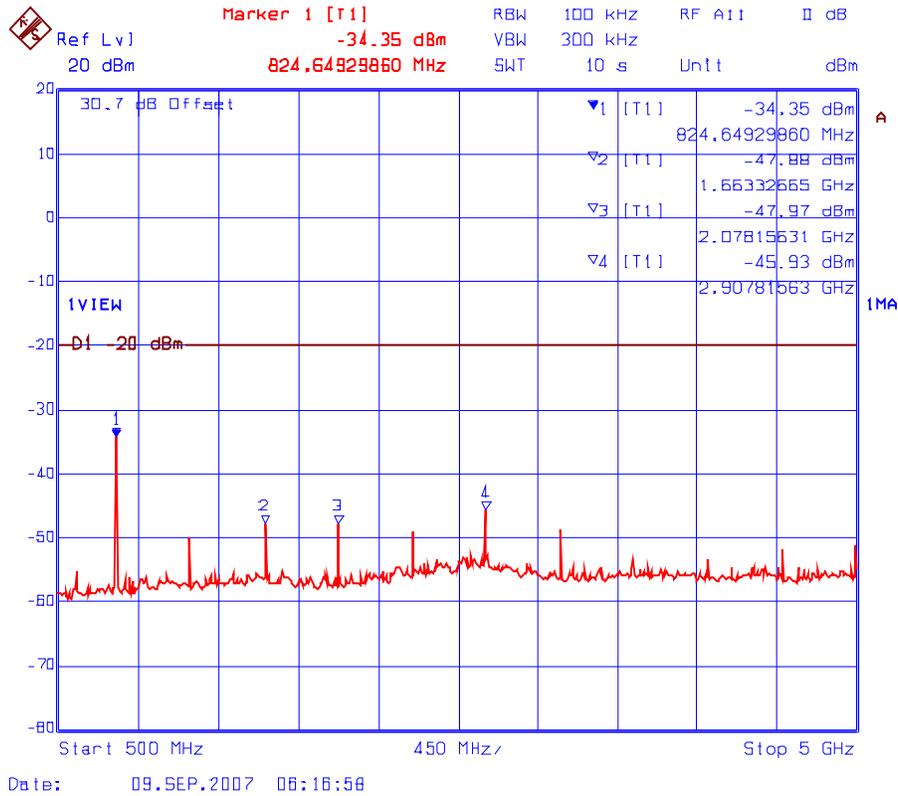
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Plot 6.6.5.2(b) Transmitter Antenna Power Conducted Emissions
 Tx Frequency: 415.5 MHz
 Channel Spacing: 12.5 kHz
 Output Power: 47 dBm



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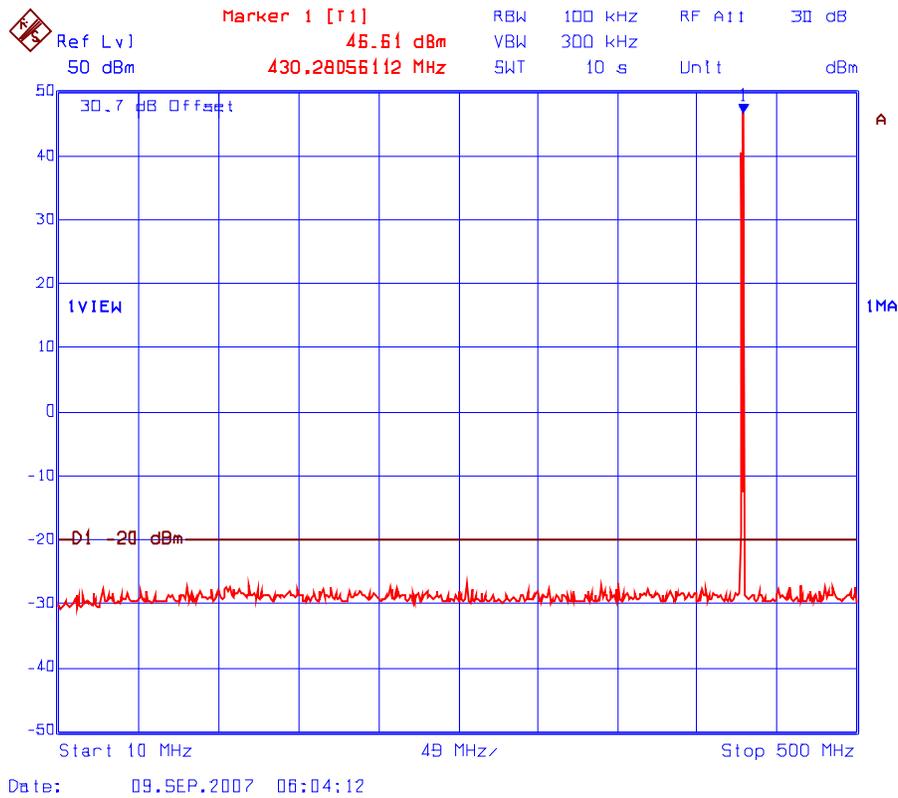
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Plot 6.6.5.3(a) Transmitter Antenna Power Conducted Emissions
Tx Frequency: 429.5 MHz
Channel Spacing: 12.5 kHz
Output Power: 47 dBm



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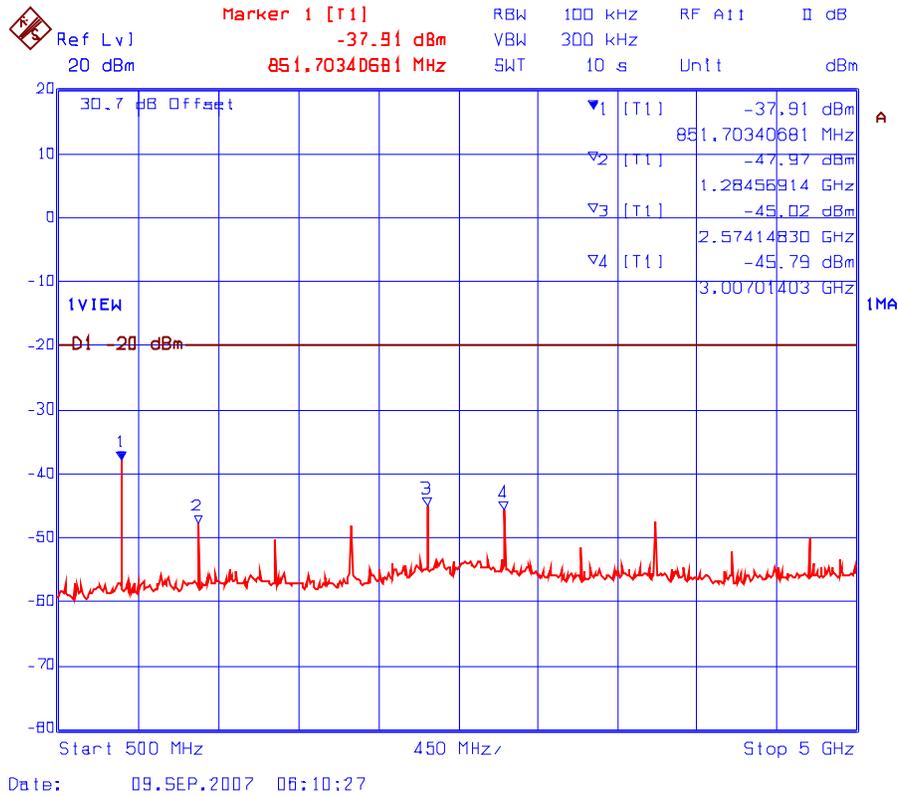
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Plot 6.6.5.3(b) Transmitter Antenna Power Conducted Emissions
 Tx Frequency: 429.5 MHz
 Channel Spacing: 12.5 kHz
 Output Power: 47 dBm



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File #: ICOM-154FCC90

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

6.7. FIELD STRENGTH OF SPURIOUS RADIATION [§§ 2.1053 & 90.210]

6.7.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
90.210(b)&(c) – Voice & data	10 MHz to Lowest frequency of the radio to 10 th harmonic of the highest frequency of the radio	43+10*log(P) or -13 dBm
90.210(d) – Voice & data	10 MHz to Lowest frequency of the radio to 10 th harmonic of the highest frequency of the radio	50+10*log(P) or -20 dBm or 70 dBc whichever is less

6.7.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and TIA-603-C

6.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK30	100077	20 Hz – 40 GHz
RF Amplifier	Com-Power	PA-102		1 MHz to 1 GHz, 30 dB gain nominal
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz, 30 dB nominal
RF Signal Generator	Hewlett Packard	HP 83752B	3610A00457	0.01 – 20 GHz
Biconilog Antenna	EMCO	3142	10005	30 MHz to 2 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 GHz – 1 GHz
Dipole Antenna	EMCO	3121C	8907-440	30 GHz – 1 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3155	9911-5955	1 GHz – 18 GHz

6.7.4. Test Data

Remarks:

- The RF spurious/harmonic emission characteristics between 2 different channel spacing operations are similar. Therefore, the following radiated emissions were performed with 12.5 kHz channel spacing operation, and the results were compared with the lowest limit of $50+10\log(P \text{ in Watts})$ for the worst case.
- The radiated emissions with high power settings were measured at 3 meters distance and represented the worst case.

Carrier Frequency:	400.5 MHz						
Transmitter Conducted Power	50 W (47.0 dBm)						
Limit:	$50+10\log(P_{\text{in watt}}) = 50+10\log(50) = 67.0 \text{ dBc}$						
Test Frequency Range:	30 MHz to the tenth harmonic						
Frequency (MHz)	E-Field (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured by Substitution Method (dBm) (dBc)		Limit (dBc)	Margin (dB)
No significant emissions found, all emissions are more than 20 dB below the specified limit.							

Carrier Frequency:	415.5 MHz						
Transmitter Conducted Power	50 W (47.0 dBm)						
Limit:	$50+10\log(P_{\text{in watt}}) = 50+10\log(50) = 67.0 \text{ dBc}$						
Test Frequency Range:	30 MHz to the tenth harmonic						
Frequency (MHz)	E-Field (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured by Substitution Method (dBm) (dBc)		Limit (dBc)	Margin (dB)
No significant emissions found, all emissions are more than 20 dB below the specified limit.							

Carrier Frequency:	429.5 MHz						
Transmitter Conducted Power	50 W (47.0 dBm)						
Limit:	$50+10\log(P_{\text{in watt}}) = 50+10\log(50) = 67.0 \text{ dBc}$						
Test Frequency Range:	30 MHz to the tenth harmonic						
Frequency (MHz)	E-Field (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured by Substitution Method (dBm) (dBc)		Limit (dBc)	Margin (dB)
No significant emissions found, all emissions are more than 20 dB below the specified 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 3 m biconical antenna including a factor of k = 2 is used:

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