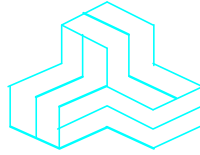


# ENGINEERING TEST REPORT



**VHF Transceivers**  
**Model No.: IC-F3161S/T/DS/DT**  
**FCC ID: AFJ289300**

*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, 22, 74, 80 and 90 (Subpart I)**

**UltraTech's File No.: ICOM-349Q\_FCC90**

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

Date: December 10, 2013

Report Prepared by: Dharmajit Solanki

Tested by: Wayne Wu, RFI/EMI Technician

Issued Date: December 10, 2013

Test Dates: December 4 - 6, 2013

- 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.

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NVLAP LAB  
CODE 200093-0



SL2-IN-E-1119R



CA2049



TL363\_B



TPTDP  
DA1300

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## EXHIBIT 1. INTRODUCTION

### 1.1. SCOPE

<b>Reference:</b>	FCC Parts 2, 22, 74, 80 and 90 (Subpart I)
<b>Title:</b>	Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2, 22, 74, 80 and 90
<b>Purpose of Test:</b>	To obtain FCC Class II Permissive Change Authorization for Radio operating in the Frequency Band 136-174 MHz (25 kHz and 12.5 kHz Channel Spacing).
<b>Test Procedures:</b>	Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard TIA/EIA-603 D – Land Mobile FM or PM Communications Equipment Measurement and performance Standard.

### 1.2. RELATED SUBMITTAL(S)/GRANT(S)

None

### 1.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2013	Code of Federal Regulations – Telecommunication
ANSI C63.4	2009	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
TIA/EIA 603, Edition D	2010	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

## EXHIBIT 2. PERFORMANCE ASSESSMENT

### 2.1. CLIENT INFORMATION

APPLICANT	
<b>Name:</b>	Icom Incorporated
<b>Address:</b>	1-1-32, Kamiminami, Hirano-ku, Osaka Japan, 547-0003
<b>Contact Person:</b>	Mr. Takayuki Watanabe Phone #: +81-66-793-5302 Fax #: +81-66-793-0013 Email Address: <a href="mailto:export@icom.co.jp">export@icom.co.jp</a>

MANUFACTURER	
<b>Name:</b>	Icom Incorporated
<b>Address:</b>	1-1-32, Kamiminami,d Hirano-ku, Osaka Japan, 547-0003
<b>Contact Person:</b>	Mr. Takayuki Watanabe Phone #: +81-66-793-5302 Fax #: +81-66-793-0013 Email Address: <a href="mailto:export@icom.co.jp">export@icom.co.jp</a>

### 2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

<b>Brand Name:</b>	ICOM Incorporated
<b>Product Name:</b>	VHF Transceivers
<b>Model Name or Number:</b>	IC-F3161DS
<b>Serial Number:</b>	Test Sample
<b>Type of Equipment:</b>	Licensed Non-Broadcast VHF Transceiver
<b>Power Supply Requirement:</b>	7.5 VDC nominal
<b>Transmitting/Receiving Antenna Type:</b>	Non-integral
<b>Primary User Functions of EUT:</b>	Voice and data communication in occupational environment over VHF frequencies.

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## 2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Portable
Intended Operating Environment:	Commercial, Industrial or Business
Power Supply Requirement:	7.5 VDC nominal
RF Output Power Rating:	5 W (High) and 1 W (Low)
Operating Frequency Range:	136-174 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	25 KHz, 12.5 KHz, 6.25 KHz
Occupied Bandwidth (99%):	<ul style="list-style-type: none"> <li>15.57 KHz (for 25 KHz Channel Spacing)</li> <li>5.73 KHz (for 12.5 KHz Channel Spacing)</li> <li>3.72 KHz (for 6.25 KHz Channel Spacing)</li> </ul>
Emission Designation*:	16K0F3E, 11K0F3E, 11K0F7E, 11K0F7D, 8K10F1E, 8K10F1D, 4K00F1E, 4K00F1D
Antenna Connector Type:	J Type Connector
Antenna Description	Manufacturer: ICOM Inc. Antenna Type: Helical antenna Model Number: FA-SC55V Gain: -4.5 dBi

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

For FM Voice Modulation:

Channel Spacing = 25 KHz, D = 5 KHz max, K = 1, M = 3 KHz

$B_n = 2M + 2DK = 2(3) + 2(5)(1) = \underline{16 \text{ KHz}}$

Emission designation: 16K0F3E

Channel Spacing = 12.5 KHz, D = 2.5 KHz max, K = 1, M = 3 KHz

$B_n = 2M + 2DK = 2(3) + 2(2.5)(1) = \underline{11 \text{ KHz}}$

Emission designation: 11K0F3E

## 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	Antenna Connector	1	J Type	Shield
2	SP/MIC Jack	1	Plug-in Jack	N/A

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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:

<b>Temperature:</b>	21 to 23°C
<b>Humidity:</b>	40 to 51%
<b>Pressure:</b>	102 kPa
<b>Power Input Source:</b>	7.5 VDC Nominal

### 3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

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

Transmitter Test Signals	
<b>Frequency Band(s):</b>	136-174 MHz
<b>Test Frequencies:</b> (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	138.1 MHz, 151.1 MHz, 161.8 MHz, 173.3 MHz
<b>Transmitter Wanted Output Test Signals:</b>  Transmitter Power (measured maximum output power):  Normal Test Modulation:  Modulating signal source:	  5 Watts High and 1 Watt Low  FM Voice and Digital  External

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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.

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.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2014-04-04.

### 4.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes*
2.1046, 22.565, 74.461, 80.215 & 90.205	RF Power Output	Yes
2.1047(a), 80.213(e) & 90.242(b)(8)	Audio Frequency Response	Not applicable to new standard. However, tests are conducted under FCC's recommendation*
2.1047(b), 74.463, 80.213 & 90.210	Modulation Limiting	Yes*
2.1049, 74.462, 80.211(f), 90.209 & 90.210	Emission Limitation & Emission Mask	Yes*
2.1051, 2.1057, 80.211(f)(3) & 90.210	Emission Limits - Spurious Emissions at Antenna Terminal	Yes*
2.1053, 2.1057, 22.359, 74.462, 80.211(f)(3) & 90.210	Emission Limits - Field Strength of Spurious Emissions	Yes
2.1055, 22.355, 74.464, 80.209 & 90.213	Frequency Stability	Yes
74.462(c) & 90.214	Transient Frequency Behavior	Yes*

\* Refer to the Original filing, this modification doesn't affect these test results. The limits for the part 22, 74 & 80 are either same or lower than part 90 hence this device complies with the requirements.

### 4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

### 4.4. DEVIATION OF STANDARD TEST PROCEDURES

None

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## EXHIBIT 5. TEST DATA

### 5.1. RF POWER OUTPUT [§2.1046, 22.565, 74.461, 80.215 & 90.205]

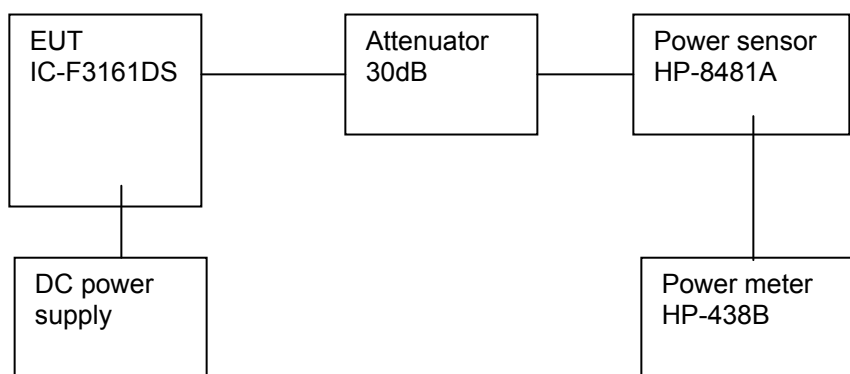
#### 5.1.1. Limits

Please refer to FCC 47 CFR 90.205, 74.461, 80.215 & 22.565 for specification details.

#### 5.1.2. Method of Measurements

Refer to Section 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

#### 5.1.3. Test Arrangement



#### 5.1.4. Test Equipment List

Refer to Exhibit 7.

#### 5.1.5. Test Data

Fundamental Frequency (MHz)	Measured (Average) Power (W)	Power Rating (W)
High Power Level, 5 Watts		
138.1	5.60	5.0
151.1	5.13	5.0
161.8	4.88	5.0
173.3	4.74	5.0
Low Power Level, 1 Watt		
138.1	1.07	1.0
151.1	1.07	1.0
161.8	1.02	1.0
173.3	1.00	1.0



## 5.2. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§ 22.1053, 2.1057, 22.359, 74.462, 80.211(f)(3) & 90.210]

### 5.2.1. Limits

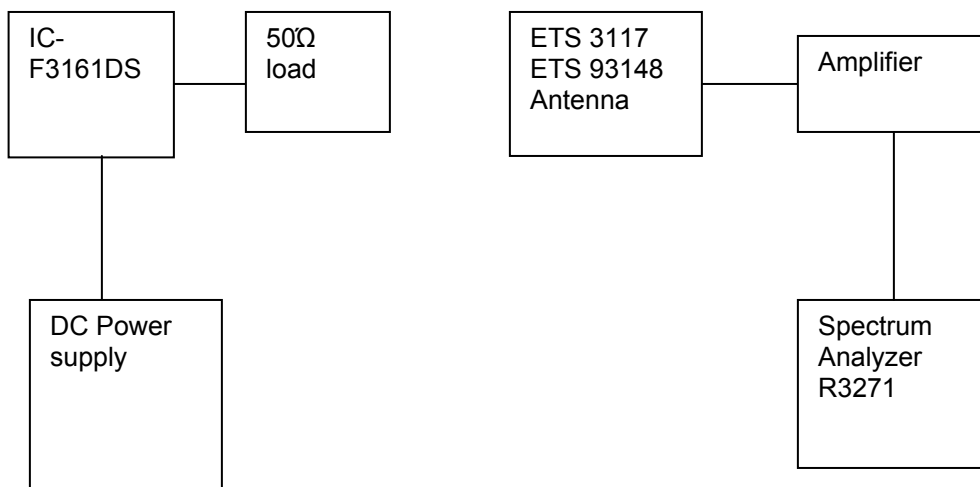
Emissions shall be attenuated below the mean output power of the transmitter as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
§ 90.210(b)	10 MHz to Lowest frequency of the radio to 10 <sup>th</sup> harmonic of the highest frequency of the radio	At least 43 + 10 log(P) or -13 dBm
§ 90.210(d)	10 MHz to Lowest frequency of the radio to 10 <sup>th</sup> harmonic of the highest frequency of the radio	At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.
§ 90.210(e)	10 MHz to Lowest frequency of the radio to 10 <sup>th</sup> harmonic of the highest frequency of the radio	At least 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.
§ 22.359, 74.462 § 80.211(f)(3)	The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of	At least 43 + 10 log (P) dB.

### 5.2.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Section 8.2 of this report.

### 5.2.3. Test Arrangement



### 5.2.4. Test Equipment List

Refer to Exhibit 7

### 5.2.5. Test Data

#### Remarks:

- The RF spurious/harmonic emission characteristics for different channel spacing are indistinguishable. Therefore, the following radiated emissions were performed at 6.25 KHz channel spacing operation, and the results were compared with the more stringent limit of  $55+10*\log(P \text{ in Watts})$  for the worst-case.
- The radiated emissions were performed with high power setting (**5 Watts**) at 3 meters distance to represents the worst-case test configuration.
- The emissions were scanned from 30 MHz to 2 GHz; all emissions within 20 dB below the limits were recorded.

#### 5.2.5.1. Near Lowest Frequency (138.1 MHz)

Carrier Frequency (MHz): 138.1  
Power<sub>conducted</sub> (dBm): 37.48  
Limit (dBm): -25

Frequency (MHz)	E-Field (dBμV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured (dBm)	Limit (dBm)	Margin (dB)
No significant Tx spurious emissions were found between 30 MHz to 2 GHz. All emissions found were more than 20 dB below the worst case limit of -25 dBm.						

#### 5.2.5.2. Near Middle Frequency #1 (151.1 MHz)

Carrier Frequency (MHz): 151.1  
Power<sub>conducted</sub> (dBm): 37.10  
Limit (dBm): -25

Frequency (MHz)	E-Field (dBμV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured (dBm)	Limit (dBm)	Margin (dB)
No significant Tx spurious emissions were found between 30 MHz to 2 GHz. All emissions found were more than 20 dB below the worst case limit of -25 dBm.						

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#### 5.2.5.3. Near Middle Frequency #2 (161.8 MHz)

Carrier Frequency (MHz): 161.8  
Power<sub>conducted</sub> (dBm): 36.88  
Limit (dBm): -25

Frequency (MHz)	E-Field (dB $\mu$ V/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured (dBm)	Limit (dBm)	Margin (dB)
No significant Tx spurious emissions were found between 30 MHz to 2 GHz. All emissions found were more than 20 dB below the worst case limit of -25 dBm.						

#### 5.2.5.4. Near Highest Frequency (173.3 MHz)

Carrier Frequency (MHz): 173.3  
Power<sub>conducted</sub> (dBm): 36.76  
Limit (dBm): -25

Frequency (MHz)	E-Field (dB $\mu$ V/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured (dBm)	Limit (dBm)	Margin (dB)
No significant Tx spurious emissions were found between 30 MHz to 2 GHz. All emissions found were more than 20 dB below the worst case limit of -25 dBm.						

### 5.3. FREQUENCY STABILITY [§2.1055, 22.355, 74.464, 80.209 & 90.213]

#### 5.3.1. Limits

§ 90.213 Transmitters used must have minimum frequency stability as specified in the following table.

Frequency Range (MHz)	Channel Bandwidth (KHz)	Frequency Tolerance (ppm)		
		Fixed and Base Stations	Mobile Stations	
			> 2 W	≤ 2 W
150-174 MHz	6.25	1.0	2.0	2.0
	12.5	2.5	5.0	5.0
	25	5.0	5.0	50.0*
421-512 MHz	6.25	0.5	1.0	1.0
	12.5	1.5	2.5	2.5
	25	2.5	5.0	5.0

- Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands must have a frequency stability of 5 ppm.
- Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

§ 22.355 Transmitters used must have minimum frequency stability as specified in the following table.

TABLE C-1—FREQUENCY TOLERANCE FOR TRANSMITTERS IN THE PUBLIC MOBILE SERVICES

Frequency range (MHz)	Base, fixed (ppm)	Mobile ≤3 watts (ppm)	Mobile ≤3 watts (ppm)
25 to 50 .....	20.0	20.0	50.0
50 to 450 .....	5.0	5.0	50.0
450 to 512 .....	2.5	5.0	5.0
821 to 896 .....	1.5	2.5	2.5
928 to 929 .....	5.0	n/a	n/a
929 to 960 .....	1.5	n/a	n/a
2110 to 2220 .....	10.0	n/a	n/a

§ 74.464 - For operations on frequencies above 25 MHz using authorized bandwidths up to 30 kHz, the licensee of a remote pickup broadcast station or system shall maintain the operating frequency of each station in compliance with the frequency tolerance requirements of §90.213 of this chapter. For all other operations, the licensee of a remote pickup broadcast station or system shall maintain the operating frequency of each station in accordance with the following:

Frequency range	Tolerance (percent)	
	Base station	Mobile station
25 to 30 MHz:		
3 W or less .....	.002	.005
Over 3 W .....	.002	.002
30 to 300 MHz:		
3 W or less .....	.0005	.005
Over 3 W .....	.0005	.0005
300 to 500 MHz, all powers .....	.00025	.0005

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§ 80.209 Transmitters used must have minimum frequency stability as specified in the following table.

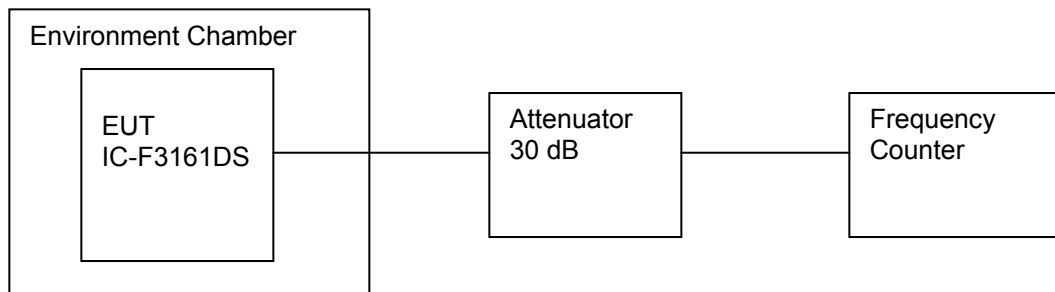
(5) Band 156–162 MHz:	
(i) Coast stations:	
For carriers licensed to operate with a carrier power:	
Below 3 watts .....	10.
3 to 100 watts .....	5. <sup>7</sup>
(ii) Ship stations .....	10. <sup>4</sup>
(iii) Survival craft stations operating on 121.500 MHz .....	50.
(iv) EPIRBs:	
Operating on 121.500 and 243.000 MHz .....	50.
Operating on 156.750 and 156.800 MHz. <sup>6</sup> .....	10.

<sup>7</sup> For transmitters operated at private coast stations with antenna heights less than 6 meters (20 feet) above ground and output power of 25 watts or less the frequency tolerance is 10 parts in 10<sup>6</sup>.

### 5.3.2. Method of Measurements

Refer to Section 8.3 of this report for measurement details

### 5.3.3. Test Arrangement



### 5.3.4. Test Equipment List

Refer to Exhibit 7

### 5.3.5. Test Data

<b>Product Name:</b>	<b>VHF Transceivers</b>
<b>Model No.:</b>	<b>IC-F3161DS</b>
<b>Center Frequency:</b>	138.1 MHz
<b>Full Power Level:</b>	37.48 dBm
<b>Frequency Tolerance Limit:</b>	$\pm 1$ ppm or $\pm 138$ Hz
<b>Max. Frequency Tolerance Measured:</b>	-52 Hz or -0.38 ppm
<b>Input Voltage Rating:</b>	7.5 VDC (nominal)

Ambient Temperature (°C)	CENTER FREQUENCY & RF POWER OUTPUT VARIATION		
	Supply Voltage (Nominal) 7.5 VDC	Supply Voltage (85% of Nominal) 6.3 Vdc	Supply Voltage (115% of Nominal) 8.63 Vdc
	Hz	Hz	Hz
-30	-47	N/A	N/A
-20	-52	N/A	N/A
-10	-39	N/A	N/A
0	-43	N/A	N/A
+10	-22	N/A	N/A
+20	13	-11	24
+30	13	N/A	N/A
+40	30	N/A	N/A
+50	37	N/A	N/A
+60	48	N/A	N/A

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## EXHIBIT 6. MEASUREMENT UNCERTAINTY (K=2, 95% CONFIDENCE LEVEL)

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

### Radiated Emission Measurement Uncertainty

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	Measured	Limit
$u_c$	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	$\pm 2.15$	$\pm 2.6$
$U$	Expanded uncertainty U: $U = 2u_c(y)$	$\pm 4.30$	$\pm 5.2$

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	Measured	Limit
$u_c$	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	$\pm 2.39$	$\pm 2.6$
$U$	Expanded uncertainty U: $U = 2u_c(y)$	$\pm 4.78$	$\pm 5.2$

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	Measured	Limit
$u_c$	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	$\pm 1.87$	Under consideration
$U$	Expanded uncertainty U: $U = 2u_c(y)$	$\pm 3.75$	Under consideration

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File #: ICOM-349Q\_FCC90  
December 10, 2013

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

## EXHIBIT 7. TEST EQUIPMENTS LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Operating Range	Calibration Due Date
Spectrum Analyzer	R/S	FSP	100646/007	9 KHz – 7 GHz	25-Sep-14
Attenuator (30dB)	Aeroflex/Weinschel	53-40-34	MN917	DC-1 GHz	Note 1*
High Pass Filter	Mini Circuit	SHP 250	--	Cut off 250 MHz	Note 1*
Power Meter	Hewlett Packard	438A	3008A06729	100K--50G sensor dependant	25-Mar-14
Power Sensor	Hewlett Packard	8482A	US37295944	100KHz-4.2GHZ	26-Feb-14
Modulation Analyzer	Hewlett Packard	8901B	3226A04606	150KHz-1300MHz	29-Jan-14
Frequency Counter	EIP	545A	2683	10Hz - 18 GHz	25-Mar-14
combiner	Mini Circuit	ZFSC-3-4	15542	1MHz - 1GHz	Note 1*
RF Detector	Pasternack	PE8000-50		10M--1G Hz	Note 1*
Environment Chamber	Envirotronics	SSH32C	11994847-S-11059	-60 to 177 degree C	16-Apr-14
RF Synthesized signal Generator	HP	8648C	3343U00391	100K-3200M Hz AM/ FM/ PM	03-Jan-14
Horn antenna	ETS-LINDGREN	3117	119425	1-18GHz	25-Apr-14
Preamplifier	Hewlett Packard	8449B	3008A00769	1-26.5GHz	06-Aug-14
Power supply	XANTREX	XKW 60-50	26509	0-60V 0-50A DC	Note 1*
Antenna	ETS	93148	1101	200-2000 MHz	22-Mar-14
Antenna	EMCO	93110B	9906-3319	20-200MHz	30-Mar-14
EMI Receiver	R/S	ESU 40	100037	20 Hz-40 GHz	07-Mar-14
Preamplifier	AH System	PAM-0118	225	20MHz-18GHz	25-Mar-14

\*Note 1: In-house calibrated/verified before the test.

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## EXHIBIT 8. MEASUREMENT METHODS

### 8.1. CONDUCTED POWER MEASUREMENTS

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- If the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

**Step 1:** Duty Cycle measurements if the transmitter's transmission is transient

- Using a EMI Receiver with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter,  $x = T_x \text{ on} / (T_x \text{ on} + T_x \text{ off})$  with  $0 < x < 1$ , is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

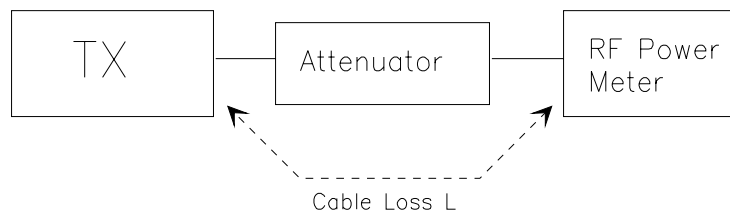
**Step 2:** Calculation of Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);
- The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in dBi, according to the formula:

$$\text{EIRP} = A + G + 10\log(1/x)$$

{X = 1 for continuous transmission =>  $10\log(1/x) = 0 \text{ dB}$ }

**Figure 1.**



## 8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

### 8.2.1. MAXIMIZING RF EMISSION LEVEL (E-FIELD)

- (a) The measurements were performed with full rf output power and modulation.
- (b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
- (c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
- (d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
- (e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor  
 $E \text{ (dB}\mu\text{V/m)} = \text{Reading (dB}\mu\text{V)} + \text{Total Correction Factor (dB/m)}$

- (f) Set the EMI Receiver and #2 as follows:

Center Frequency: test frequency  
Resolution BW: 100 KHz  
Video BW: same  
Detector Mode: positive  
Average: off  
Span: 3 x the signal bandwidth

- (g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (h) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
- (i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
- (k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
- (l) Repeat for all different test signal frequencies.

### 8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

- (a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

Center Frequency: equal to the signal source  
Resolution BW: 100 KHz  
Video BW: VBW > RBW  
Detector Mode: positive  
Average: off  
Span: 3 x the signal bandwidth

- (b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor  
 $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

- (c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.  
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
  - ◆ DIPOLE antenna for frequency from 30-1000 MHz or
  - ◆ HORN antenna for frequency above 1 GHz }.(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.  
(f) Use one of the following antenna as a receiving antenna:
  - ◆ DIPOLE antenna for frequency from 30-1000 MHz or
  - ◆ HORN antenna for frequency above 1 GHz }.(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.  
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.  
(i) Tune the EMI Receivers to the test frequency.  
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.  
(k) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.  
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.  
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.  
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

$$P = P1 - L1 = (P2 + L2) - L1 = P3 + A + L2 - L1$$

$$\text{EIRP} = P + G1 = P3 + L2 - L1 + A + G1$$

$$\text{ERP} = \text{EIRP} - 2.15 \text{ dB}$$

$$\text{Total Correction factor in EMI Receiver \# 2} = L2 - L1 + G1$$

Where:

P:	Actual RF Power fed into the substitution antenna port after corrected.
P1:	Power output from the signal generator
P2:	Power measured at attenuator A input
P3:	Power reading on the Average Power Meter
EIRP:	EIRP after correction
ERP:	ERP after correction

- (o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)  
(p) Repeat step (d) to (o) for different test frequency  
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.  
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

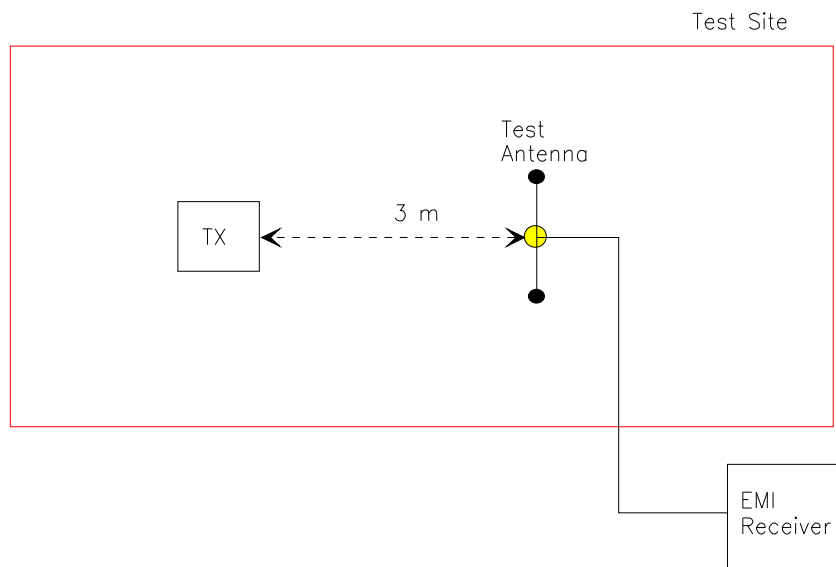
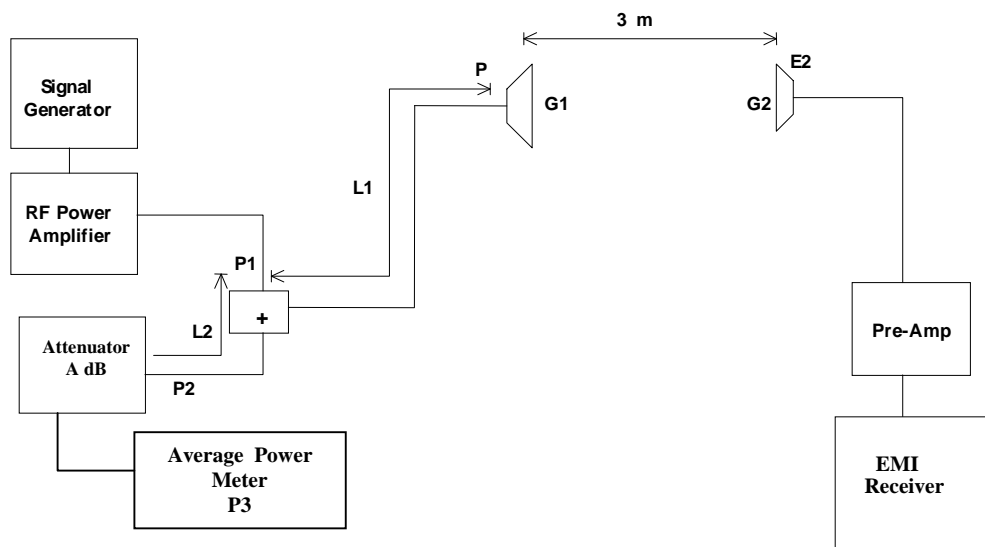


Figure 3



### 8.3. FREQUENCY STABILITY

Refer to FCC @ 2.1055.

- (a) The frequency stability shall be measured with variation of ambient temperature as follows: From -30 to +50 centigrade except that specified in subparagraph (2) & (3) of this paragraph.
- (b) Frequency measurements shall be made at extremes of the specified temperature range and at intervals of not more than 10 centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short-term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stability circuitry need be subjected to the temperature variation test.
- (d) The frequency stability supply shall be measured with variation of primary supply voltage as follows:
  - (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
  - (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
  - (3) The supply voltage shall be measured at the input to the cable normally provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.
- (e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c) and (d) of this section. (For example, measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment).

## 8.4. TRANSIENT FREQUENCY BEHAVIOR

1. Connect the transmitter under tests as shown in the above block diagram
2. Set the signal generator to the assigned frequency and modulate with a 1 KHz tone at  $\pm 12.5$  KHz deviation and its output level to be 50 dB below the transmitter rf output at the test receiver end.
3. Set the horizontal sweep rate on the storage scope to 10 milliseconds per division and adjust the display to continuously view the 1000 Hz tone from the Demodulator Output Port (DOP) of the Test Receiver. Adjust the vertical scale amplitude control of the scope to display the 1000 Hz at  $\pm 4$  divisions vertical Center at the display.
4. Adjust the scope so it will trigger on an increasing magnitude from the RF trigger signal of the transmitter under test when the transmitter was turned on. Set the controls to store the display.
5. The output at the DOP, due to the change in the ratio of the power between the signal generator input power and transmitter output power will, because of the capture effect of the test receiver, produce a change in display: For the first part of the sweep it will show the 1 KHz test signal. Then once the receiver's demodulator has been captured by the transmitter power, the display will show the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The instant when the 1 KHz test signal is completely suppressed (including any capture time due to phasing) is considered to be  $t_{on}$ . The trace should be maintained within the allowed divisions during the period  $t_1$  and  $t_2$ .
6. During the time from the end of  $t_2$  to the beginning of  $t_3$  the frequency difference should not exceed the limits set by the FCC in Part 90.214 and the outlined in the Carrier Frequency Stability sections. The allowed limit is equal to FCC frequency tolerance limits specified in FCC 90.213.
7. Repeat the above steps when the transmitter was turned off for measuring  $t_3$ .