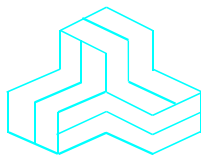


# ENGINEERING TEST REPORT



**BRS Transceiver**  
**Model No.: MT53H7A4604, MT53H7B4604, MT53H7P3E4604**  
**FCC ID: NUVMT53H74**

*Applicant:*

**Aearo Company**  
5457 West 79<sup>th</sup> Street  
Indianapolis, IN 46268-0940  
United States

*Tested in Accordance With*

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

**UltraTech's File No.: TLT-011F90**

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

Date: October 3, 2006



Report Prepared by: Mr. Dan Huynh

Tested by: Mr. Hung Trinh, EMI/RFI Technician

Issued Date: October 3, 2006

Test Dates: Aug. 15 & Sep. 26, 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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SL2-IN-E-1119R

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October 3, 2006

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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"><li>Exhibit 1: Submittal check lists</li><li>Exhibit 2: Introduction</li><li>Exhibit 3: Performance Assessment</li><li>Exhibit 4: EUT Operation and Configuration during Tests</li><li>Exhibit 5: Summary of test Results</li><li>Exhibit 6: Measurement Data</li><li>Exhibit 7: Measurement Uncertainty</li><li>Exhibit 8: Measurement Methods</li></ul>	OK
1	Test Setup Photos	Radiated Emissions Test Setup Photos	OK
2	External Photos of EUT	External EUT Photos	See Note (1)
3	Internal Photos of EUT	Internal EUT Photos	See Note (1)
4	Cover Letters	<ul style="list-style-type: none"><li>Cover Letter</li><li>Letter from the Applicant to Appoint Ultratech to Act as an Agent</li></ul>	OK
5	Attestation Statements	--	--
6	ID Label/Location Info	<ul style="list-style-type: none"><li>ID Label</li><li>Location of ID Label</li></ul>	See Note (1)
7	Block Diagrams	Block Diagram	See Note (1)
8	Schematic Diagrams	Schematics	See Note (1)
9	Parts List/Tune Up Info	<ul style="list-style-type: none"><li>Parts List</li><li>Tune Up Info</li></ul>	See Note (1)
10	Operational Description	Technical Description	See Note (1)
11	RF Exposure Info	SAR evaluation is not required since transmitter power is below FCC power thresholds	--
12	Users Manual	Instruction Manual	See Note (1)

Note (1): Refer to original filing.

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## EXHIBIT 2. INTRODUCTION

### 2.1. SCOPE

<b>Reference:</b>	FCC Parts 2 and 90
<b>Title:</b>	Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2 & 90
<b>Purpose of Test:</b>	Class II Permissive Change for BRS frequency band (464.5000- 467.9250 MHz), the device is electrically identical to original filing.
<b>Test Procedures:</b>	Both conducted and radiated emissions measurements were conducted in accordance with TIA Standard (ANSI/TIA-603-C-2004) – Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards.

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

None.

### 2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2005	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

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## EXHIBIT 3. PERFORMANCE ASSESSMENT

### 3.1. CLIENT INFORMATION

APPLICANT	
<b>Name:</b>	Aearo Company
<b>Address:</b>	5457 West 79 <sup>th</sup> Street Indianapolis, IN 46268-0940 United States
<b>Contact Person:</b>	Mike Cimino Phone #: 705-733-3404 Fax #: 705-733-3565 Email Address: mike_cimino@aearo.com

MANUFACTURER	
<b>Name:</b>	Peltor AB
<b>Address:</b>	Box 2341, Malmstensgatan 19 SE-331 02 Värnamo Sweden
<b>Contact Person:</b>	Lars Carlborg Phone #: +46 370 656535 Fax #: +46 470 694280 Email Address: lars.carlborg@peltor.se

### 3.2. 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>	Peltor
<b>Product Name:</b>	BRS Transceiver
<b>Model Name or Number:</b>	MT53H7A4604, MT53H7B4604, MT53H7P3E4604
<b>Serial Number:</b>	Test Sample
<b>Type of Equipment:</b>	Licensed Non-Broadcast Transmitter Held to Ear
<b>External Power Supply:</b>	N/A
<b>Transmitting/Receiving Antenna Type:</b>	Integral
<b>Primary User Functions of EUT:</b>	Two-way radio communications.

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### 3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Portable
Intended Operating Environment:	<ul style="list-style-type: none"><li>Residential</li><li>Commercial, Industrial or Business</li></ul>
Power Supply Requirement:	Two 1.5 V AA size batteries
RF Output Power Rating:	0.06 W (ERP)
Operating Frequency Range:	464.5000- 467.9250 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	25 KHz and 12.5 KHz
Occupied Bandwidth (99%):	<ul style="list-style-type: none"><li>12.144 kHz (for 25 KHz Channel Spacing)</li><li>7.695 kHz (for 12.5 KHz Channel Spacing)</li></ul>
*Emission Designation:	16K0F3E; 11K0F3E
Antenna Connector Type:	Integral

\* 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

### 3.4. LIST OF EUT'S PORTS

None.

## 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:	Two 1.5 V AA size batteries

### 4.2. 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>	Integral antenna.

Transmitter Test Signals	
<b>Frequency Band(s):</b>	464.5000- 467.9250 MHz
<b>Test Frequency(ies):</b>	464.500 MHz
<b>Transmitter Wanted Output Test Signals:</b>	
Transmitter Power (measured maximum output power):	17.08 dBm ERP (51 mW ERP)
Normal Test Modulation:	FM Voice
Modulating signal source:	External

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## 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.: IC2049-1). Last Date of Site Calibration: June 20, 2006.

### 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	Yes, See Note (1)
90.213 & 2.1055	Frequency Stability	Yes, See Note (2)
90.242(b)(8) & 2.1047(a)	Audio Frequency Response	Yes, See Note (2)
90.210 & 2.1047(b)	Modulation Limiting	Yes, See Note (2)
90.210 & 2.1049	Emission Limitation & Emission Mask	Yes, See Note (2)
90.210, 2.1057 & 2.1051	Emission Limits - Spurious Emissions at Antenna Terminal	Yes, See Note (2)
90.210, 2.1057 & 2.1053	Emission Limits - Field Strength of Spurious Emissions	Yes
90.214	Transient Frequency Behavior	Yes

Note (1): SAR evaluation is NOT required since Transmitter Power is below FCC power thresholds

Note (2): Compliance for this electrically identical device was demonstrated in the original filing. Therefore, it is not applicable for this Class II Permissive Change filing.

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

None.

### 5.4. DEVIATION OF STANDARD TEST PROCEDURES

None.

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## **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 Exhibit 8 of this report

### **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**

Two-way radio communications headsets.

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

### 6.5.1. Limits

Refer to FCC 47 CFR 90.205 for specification details.

### 6.5.2. Method of Measurements

Refer to Exhibit 8, Section 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

### 6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz to 40 GHz
RF Amplifier	Com-Power	PA-102		1 MHz to 1 GHz, 30 dB gain nominal
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
RF Signal Generator	Hewlett Packard	HP 83752B	3610A00457	0.01 – 20 GHz

### 6.5.4. Test Arrangement

See Section 8.2 of this test report for details.

### 6.5.5. Test Data

Fundamental Frequency (MHz)	ERP (dBm)
464.500	17.08

## 6.6. OCCUPIED BANDWIDTH & EMISSION MASK [§§ 2.1049, 90.209 & 90.210]

### 6.6.1. Limits

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

Frequency Range (MHz)	Maximum Authorized BW (KHz)	Channel Spacing (KHz)	Recommended Frequency Deviation (KHz)	FCC Applicable Mask
421-512	20.0	25	5.0	Mask B – Voice Mask C – Data
421-512	11.25	12.5	2.5	Mask D – Voice & Data

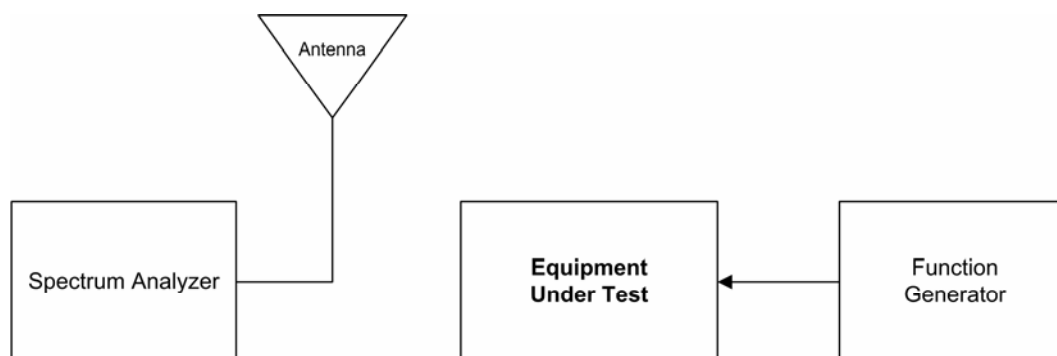
### 6.6.2. Method of Measurements

Refer to Exhibit 8, Section 8.3 of this report for measurement details.

### 6.6.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK20/B4/B21	834157/005	9 kHz- 40 GHz
Function Generator	Stanford Research Systems	DS345	34591	1 $\mu$ Hz – 30.2 MHz
Biconilog Antenna	EMCO	3142	10005	30 MHz to 2 GHz

### 6.6.4. Test Arrangement



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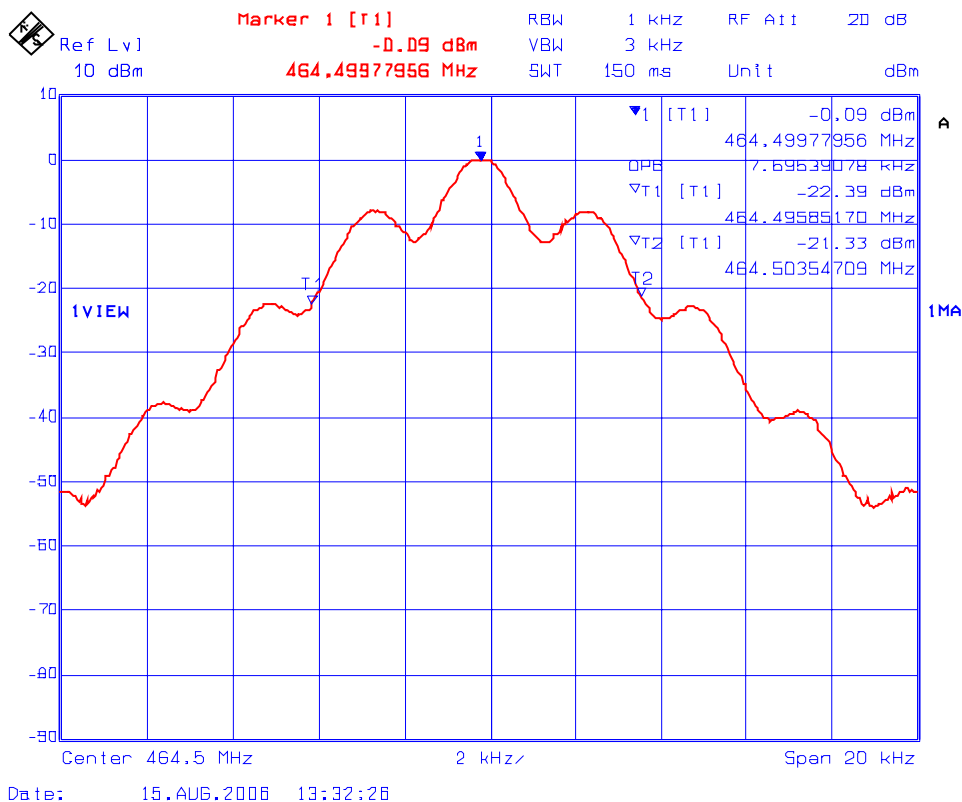
#### 6.6.5. Test Data

Frequency (MHz)	Channel Spacing (KHz)	*Measured 99% OBW at Maximum Freq. Deviation (KHz)	Maximum Authorized Bandwidth (KHz)
464.500	12.5	7.695	11.25
464.500	25	12.144	20.0

**Note:** 99% Occupied Bandwidth measurements were done using the built-in auto function of the analyzer.

Refer to the following test data plots for details.

**Plot 6.6.5.1 Occupied Bandwidth**  
Carrier Frequency: 464.5000 MHz  
Channel Spacing: 12.5 KHz



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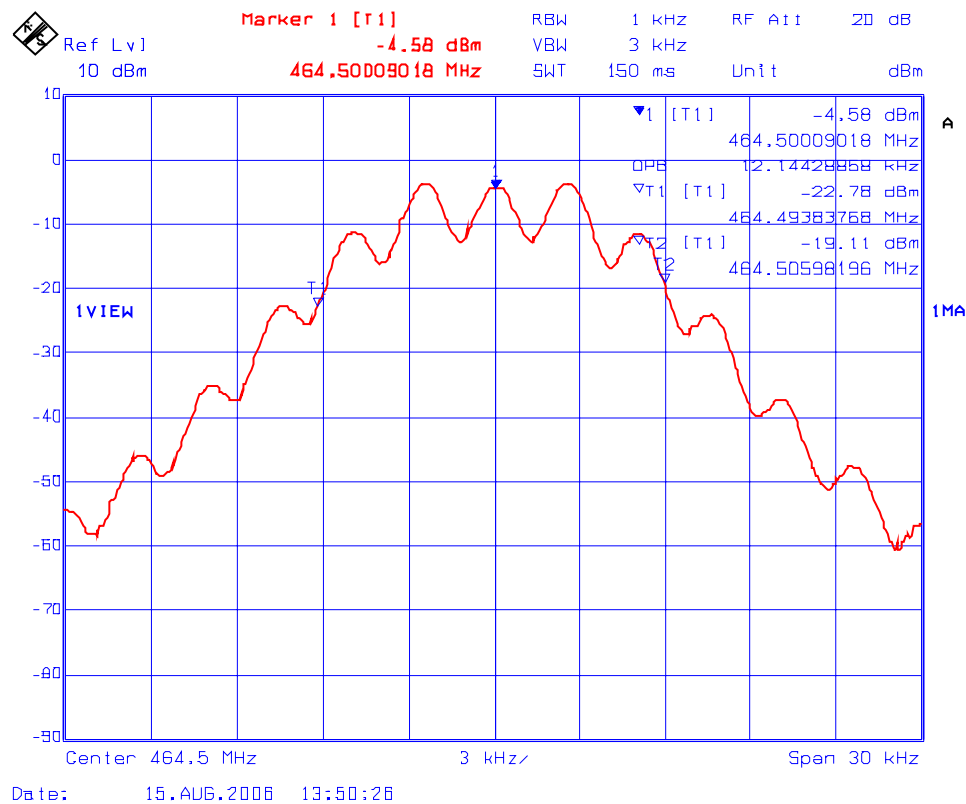
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**Plot 6.6.5.2 Occupied Bandwidth**  
Carrier Frequency: 464.5000 MHz  
Channel Spacing: 25 KHz



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## 6.7. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§ 90.210]

### 6.7.1. Limits

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

FCC Rules	Attenuation Limit (dBc)
90.210(b)	At least $43 + 10 \log(P)$ or -13 dBm
90.210(d)	At least $50 + 10 \log(P)$ dB or 70 dB, whichever is the lesser attenuation.

### 6.7.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Exhibit 8, Section 8.2 of this report and its value in dBc is calculated as follows:

- (1) If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.
- (2) If the transmitter's antenna is non-integral and diverse, the lowest ERP of the carrier with 0 dBi antenna gain is used for calculation of the spurious/harmonic emissions in dBc:  
Lowest ERP of the carrier =  $EIRP - 2.15 \text{ dB} = P_c + G - 2.15 \text{ dB} = P_c \text{ dBm (conducted)} + 0 \text{ dBi} - 2.15 \text{ dB}$
- (3) Spurious /harmonic emissions levels expressed in dBc (dB below carrier) are as follows:

$$\text{ERP of spurious/harmonic (dBc)} = \text{ERP of carrier (dBm)} - \text{ERP of spurious/harmonic emission (dBm)}$$

### 6.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 KHz to 40 GHz
RF Amplifier	Com-Power	PA-102		1 MHz to 1 GHz, 30 dB gain nominal
Microwave Amplifier	Hewlett Packard	HP 8449B	3008A00769	1 GHz to 26.5 GHz, 30 dB nominal
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
RF Signal Generator	Hewlett Packard	HP 83752B	3610A00457	0.01 – 20 GHz

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#### 6.7.4. Test Data

##### Remarks:

- The RF spurious/harmonic emission characteristics for different channel spacing are indistinguishable. Therefore, the following radiated emissions were performed at 12.5 KHz channel spacing setting and the results were compared with the more stringent limit of  $50+10\log(P \text{ in Watts})$  for the worst-case.
- The emissions were scanned from 30 MHz to 5 GHz; all emissions within 20 dB below the limits were recorded.

**Carrier Frequency (MHz):** 464.500

**Power (dBm):** 17.08

**Limit (dBc):** 37.08

Frequency (MHz)	E-Field (dB $\mu$ V/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured by Substitution Method		Limit (dBc)	Margin (dB)
				(dBm)	(dBc)		
2322.5	63.28	Peak	H	-38.68	55.8	37.08	-18.7
3716.0	68.51	Peak	H	-35.16	52.2	37.08	-15.2

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## 6.8. TRANSIENT FREQUENCY BEHAVIOR [§ 90.214]

### 6.8.1. Limits

Transient frequencies must be within the maximum frequency difference limits during the time intervals indicated:

Time intervals <sup>1, 2</sup>	Maximum frequency difference <sup>3</sup>	All equipment	
		150 to 174 MHz	421 to 512MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 KHz Channels			
t <sub>1</sub> <sup>4</sup> .....	± 25.0 KHz	5.0 ms	10.0 ms
t <sub>2</sub> .....	± 12.5 KHz	20.0 ms	25.0 ms
t <sub>3</sub> <sup>4</sup> .....	± 25.0 KHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 KHz Channels			
t <sub>1</sub> <sup>4</sup> .....	± 12.5 KHz	5.0 ms	10.0 ms
t <sub>2</sub> .....	± 6.25 KHz	20.0 ms	25.0 ms
t <sub>3</sub> <sup>4</sup> .....	± 12.5 KHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 KHz Channels			
t <sub>1</sub> <sup>4</sup> .....	±6.25 KHz	5.0 ms	10.0 ms
t <sub>2</sub> .....	±3.125 KHz	20.0 ms	25.0 ms
t <sub>3</sub> <sup>4</sup> .....	±6.25 KHz	5.0 ms	10.0 ms

- t<sub>on</sub> is the instant when a 1 KHz test signal is completely suppressed, including any capture time due to phasing.  
t<sub>1</sub> is the time period immediately following t<sub>on</sub>.  
t<sub>2</sub> is the time period immediately following t<sub>1</sub>.  
t<sub>3</sub> is the time period from the instant when the transmitter is turned off until t<sub>off</sub>.  
t<sub>off</sub> is the instant when the 1 KHz test signal starts to rise.
- During the time from the end of t<sub>2</sub> to the beginning of t<sub>3</sub>, the frequency difference must not exceed the limits specified in § 90.213.
- Difference between the actual transmitter frequency and the assigned transmitter frequency.
- If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

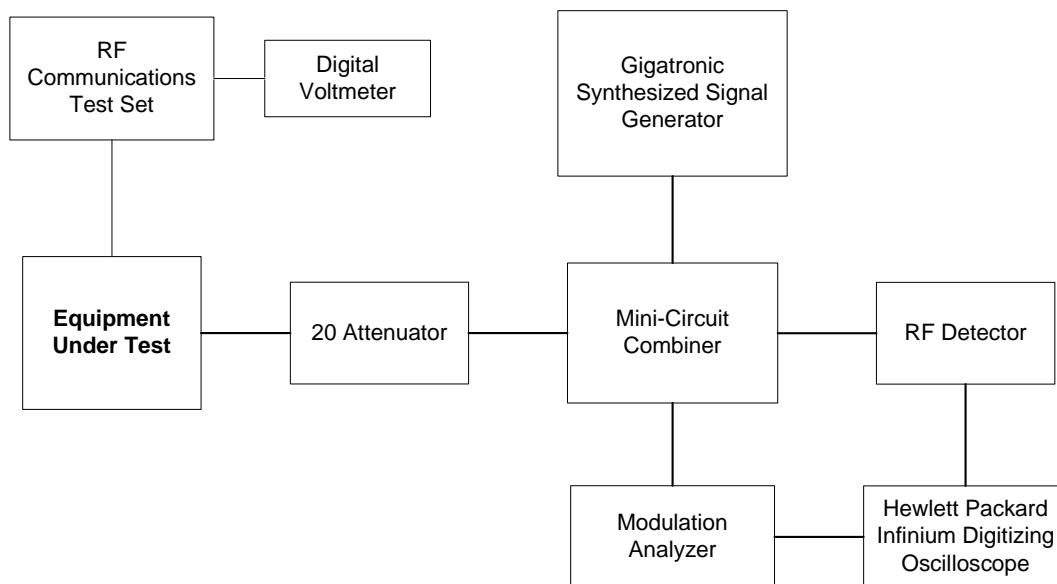
### 6.8.2. Method of Measurements

Refer to Exhibit 8, Section 8.4 of this test report and ANSI/TIA/EIA-603-C-2004, Section 2.2.19.

### 6.8.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
RF Communications Test Set	Hewlett Packard	8920B	US39064699	RF 30M-1G AF DC-25KHz
RF Synthesized Signal Generator	Gigatronic	6061A	5130408	10 KHz – 1050 MHz
Combiner	Mini-Circuit	ZFSC-3-4	15542	1 MHz – 1000 MHz
Infinium Digitizing Oscilloscope	Hewlett Packard	54810A	US38380192	DC - 500 MHz
RF Detector	Narda	503A-03	0105	10 MHz – 18 GHz
Attenuator	Weinschel Corp	23-20-34	BH7876	DC – 18 GHz
Modulation Analyzer	Hewlett Packard	8901B	3226A04606	150 KHz – 1300 MHz
Digital Voltmeter	Hewlett-Packard	3456A	2015A04523	DC-250 KHz

### 6.8.4. Test Arrangement



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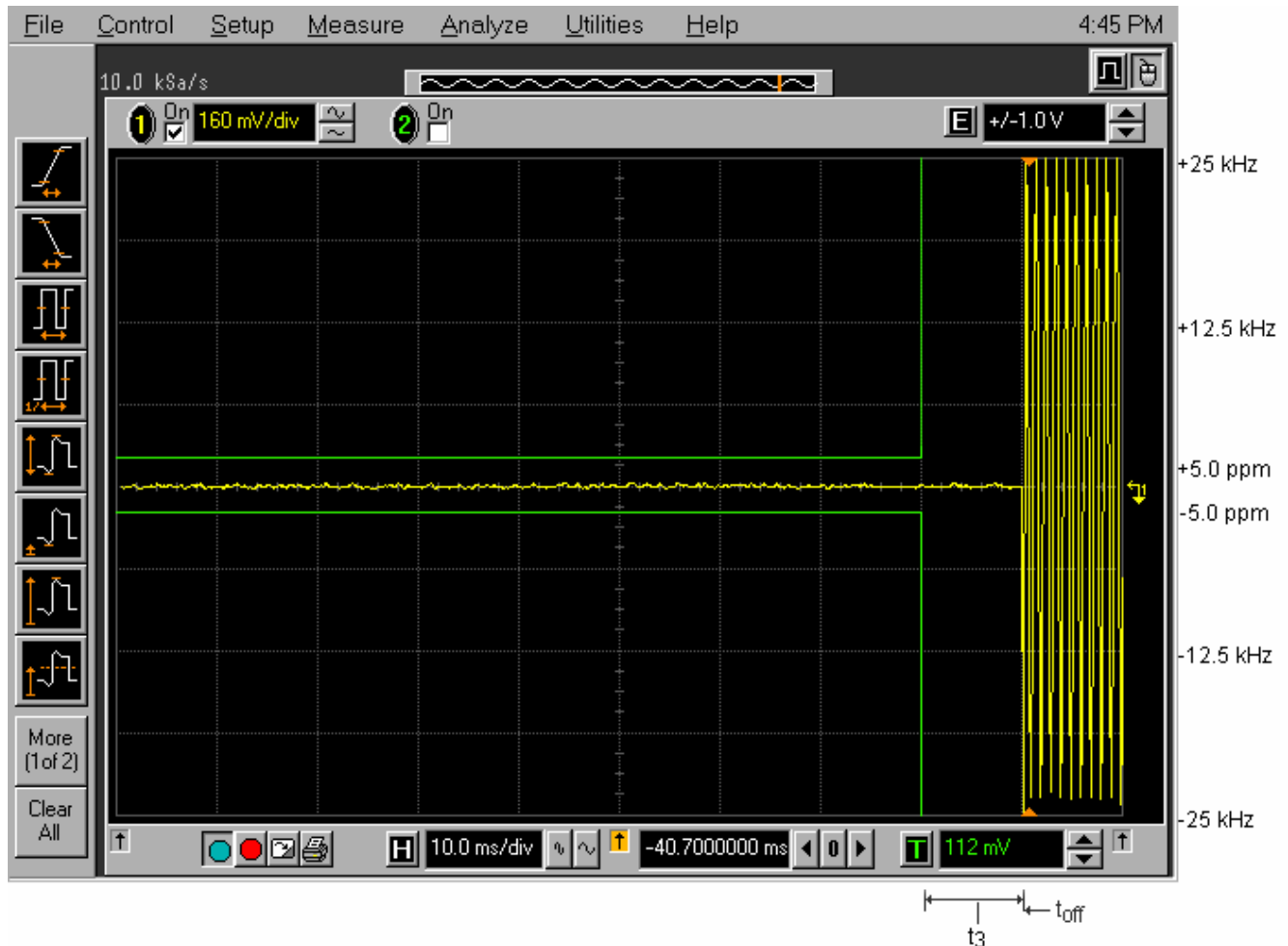
**Plot 6.8.5.2** Transient Frequency Behavior

Carrier Frequency: 464.5000 MHz

Channel Spacing: 25 KHz

Power: 51 mW ERP

Description: Switch off condition  $t_3$ ,  $t_{off}$



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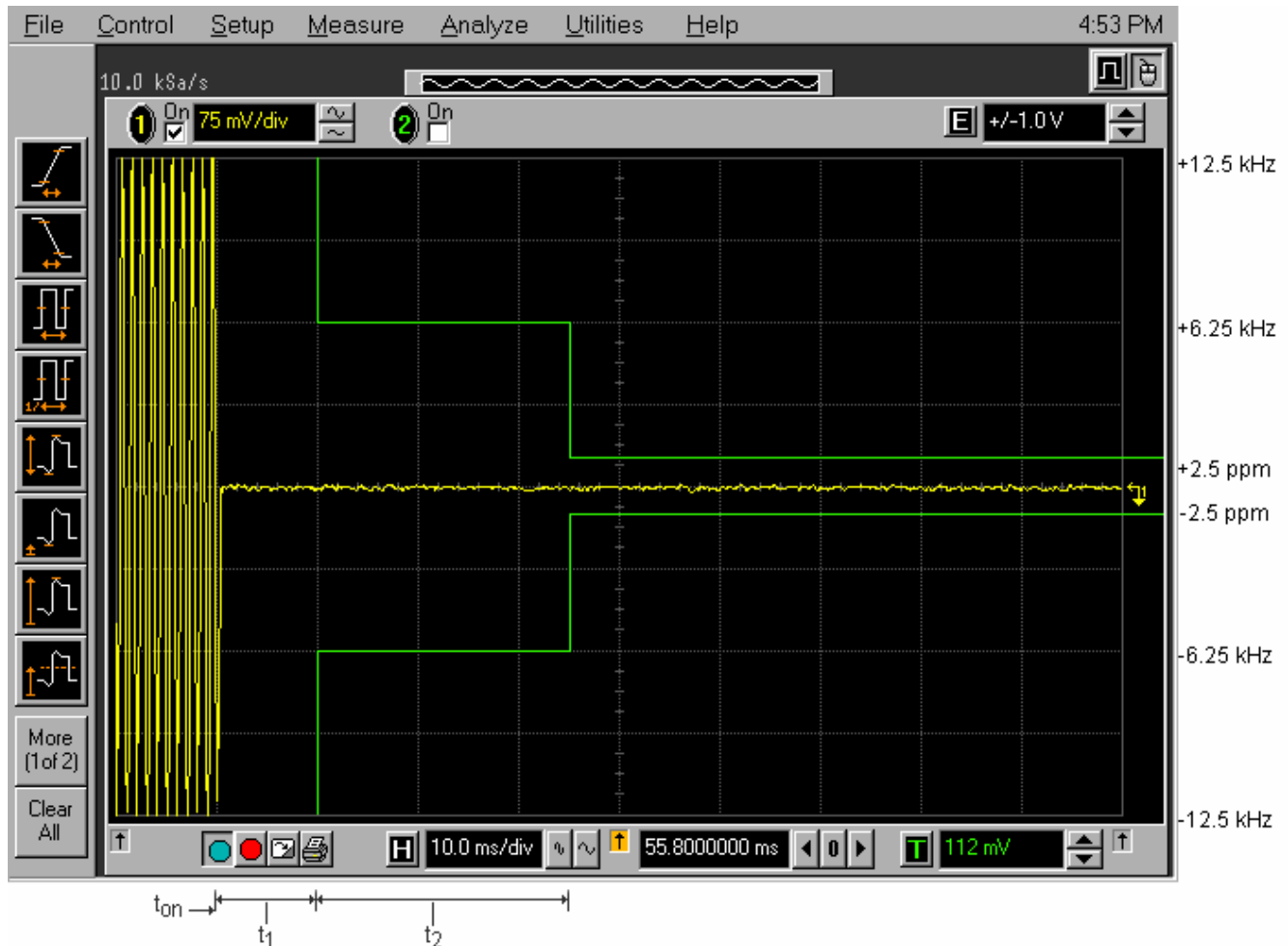
**Plot 6.8.5.3** Transient Frequency Behavior

Carrier Frequency: 464.5000 MHz

Channel Spacing: 12.5 KHz

Power: 51 mW ERP

Description: Switch on condition  $t_{on}$ ,  $t_1$ , and  $t_2$



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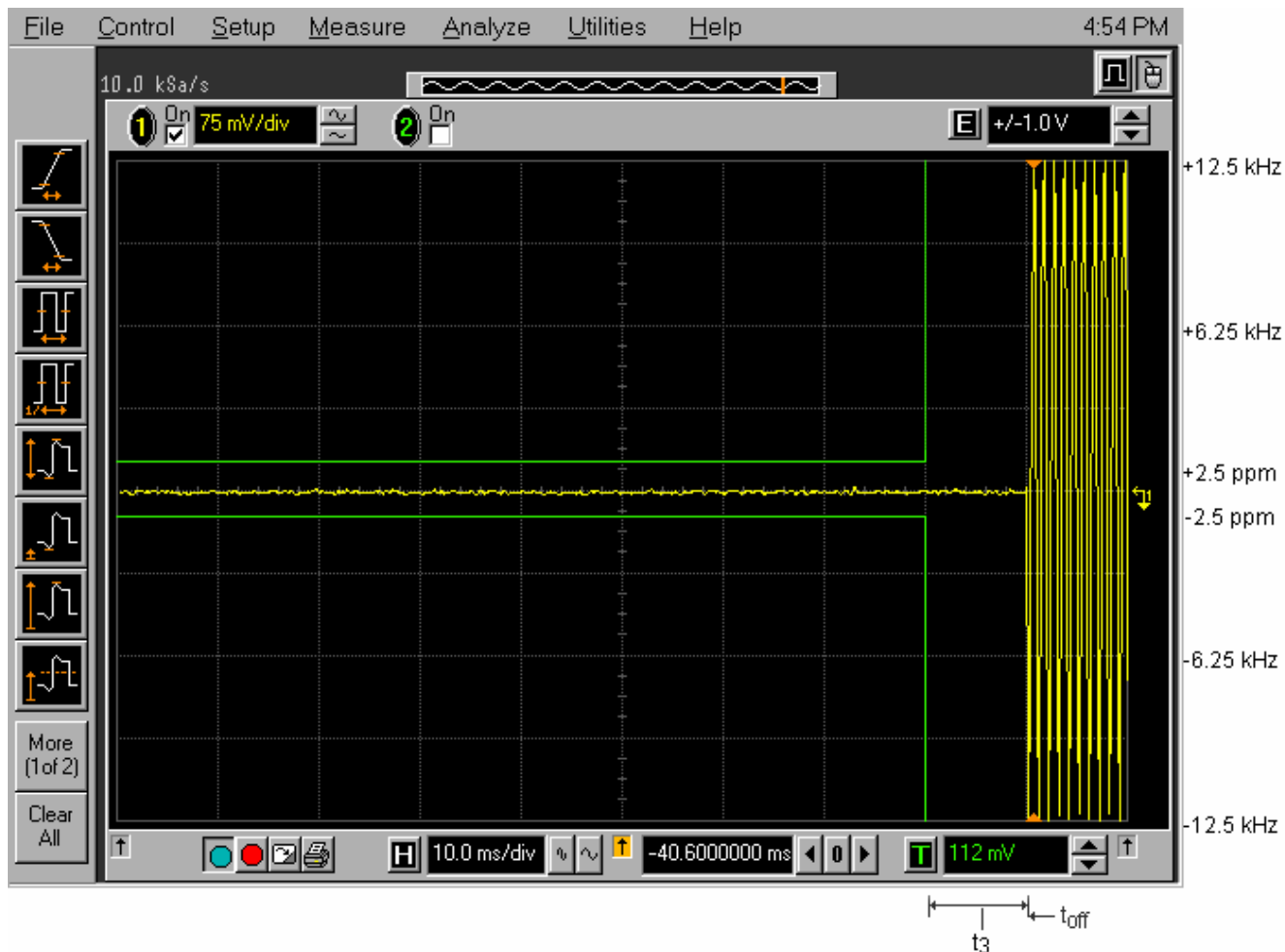
**Plot 6.8.5.4** Transient Frequency Behavior

Carrier Frequency: 464.5000 MHz

Channel Spacing: 12.5 KHz

Power: 51 mW ERP

Description: Switch off condition  $t_3$ ,  $t_{off}$



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## 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 (+ dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	$\pm 1.0$	$\pm 1.0$
Cable Loss Calibration	Normal (k=2)	$\pm 0.3$	$\pm 0.5$
EMI Receiver specification	Rectangular	$\pm 1.5$	$\pm 1.5$
Antenna Directivity	Rectangular	$\pm 0.5$	$\pm 0.5$
Antenna factor variation with height	Rectangular	$\pm 2.0$	$\pm 0.5$
Antenna phase center variation	Rectangular	0.0	$\pm 0.2$
Antenna factor frequency interpolation	Rectangular	$\pm 0.25$	$\pm 0.25$
Measurement distance variation	Rectangular	$\pm 0.6$	$\pm 0.4$
Site imperfections	Rectangular	$\pm 2.0$	$\pm 2.0$
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67(\text{Bi}) 0.3 (\text{Lp})$ Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$	U-Shaped	+1.1 -1.25	$\pm 0.5$
System repeatability	Std. Deviation	$\pm 0.5$	$\pm 0.5$
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:

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

## 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.

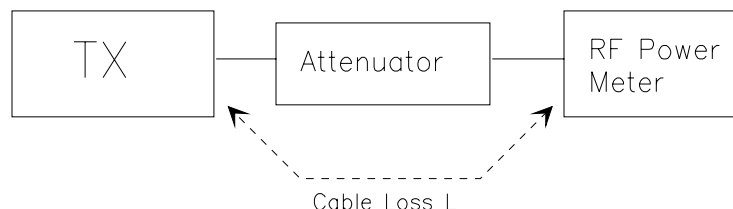
**Step 2:** Calculation of Average EIRP. See Figure 1

- 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.

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### 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: 10 KHz  
Video BW: same  
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

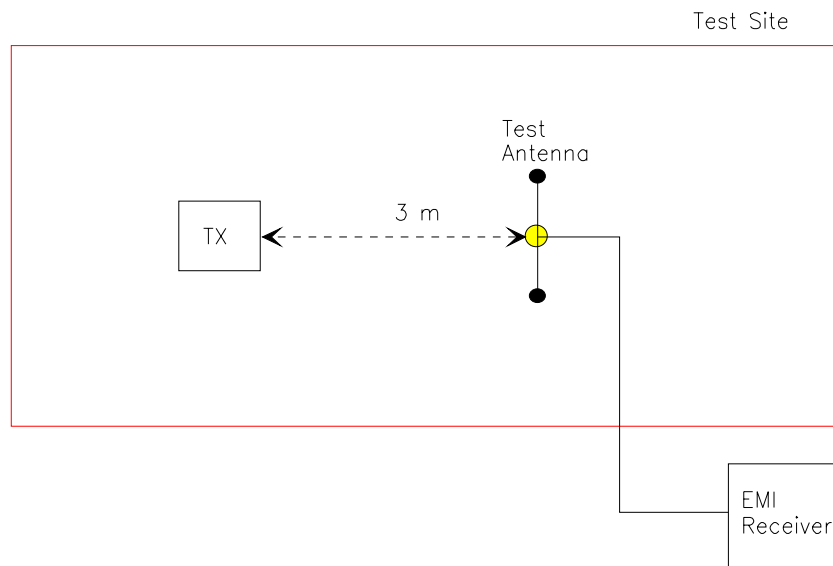
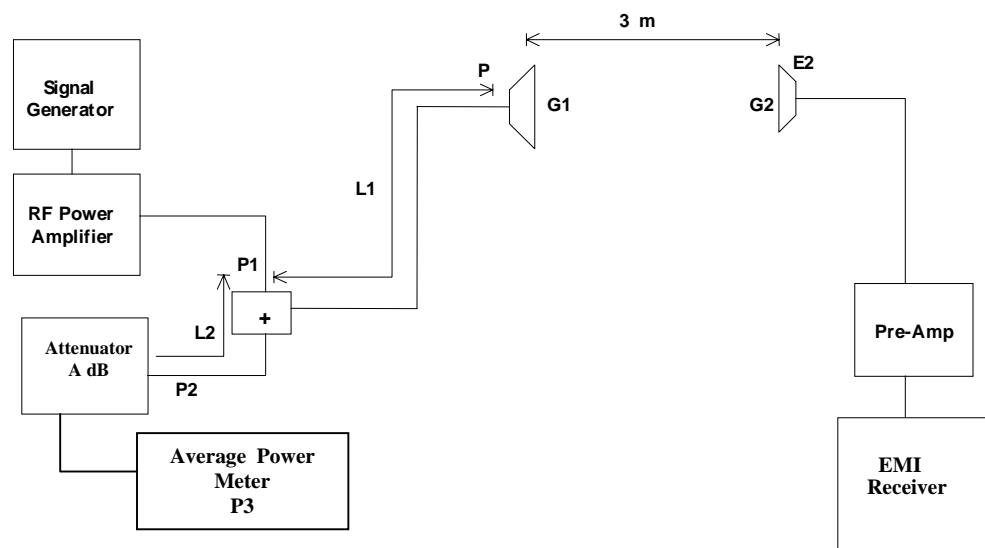


Figure 3



### 8.3. EMISSION MASK

**Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i):** The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.:  $\pm 2.5$  KHz peak deviation at 1 KHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

**Digital Modulation Through a Data Input Port @ 2.1049(h):** Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

- (1) For 25 KHz Channel Spacing: RBW = 300 Hz
- (2) For 12.5 KHz or 6.25 KHz Channel Spacings: RBW = 100 Hz

The all cases the Video Bandwidth shall be equal or greater than the measuring bandwidth.

### 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  $t_3$ .