ENGINEERING TEST REPORT

FRS UHF FM Transceiver
Model No.: IC-4088A
FCC ID: AFJ262700

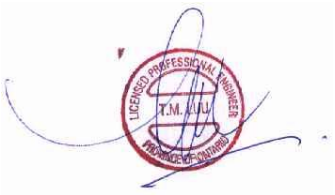
Applicant:

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 95 (Subpart B)

UltraTech's File No.: ICOM-056F95B

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: June 2, 2003	
Report Prepared by: Dan Huynh Issued Date: June 2, 2003	Tested by: Wayne Wu, RFI/EMI Technician Test Dates: April 1 – May 13, 2003

- *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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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	▪ 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 ▪ Exhibit 8: Measurement Methods	OK
1	Test Setup Photos	Radiated Emission Test Setup Photos	OK
2	External EUT Photos	External EUT Photos	OK
3	Internal EUT Photos	Internal EUT Photos	OK
4	Cover Letters	▪ 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	Attestation Statements	--	--
6	ID Label/Location Info	▪ ID Label ▪ Location of ID Label	OK
7	Block Diagrams	IC-4088A Block Diagram	OK
8	Schematic Diagrams	▪ Main Unit Schematic Diagram ▪ RF Unit Schematic Diagram	OK
9	Parts List/Tune Up Info	IC-4088A Adjustment Procedures	OK
10	Operational Description	IC-4088A Circuit Description	OK
11	RF Exposure Info	See SAR Declaration of Conformity	OK
12	Users Manual	IC-4088A Instruction Manual	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	47 CFR, Parts 2 and 95
Title:	Telecommunication – 47 Code of Federal Regulations (CFR), Parts 2 & 95
Purpose of Test:	To gain FCC Certification Authorization for Radio operating 462.5625 – 467.7125 MHz band.
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 Title 47 CFR Parts 0-19, 80-End	2002	Code of Federal Regulations Title 47 – Telecommunication
ANSI C63.4	1992	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 & EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1	1999	Specification for Radio Disturbance and Immunity measuring apparatus and methods

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. Takashi Aoki Phone #: +81 6 6793 5302 Fax #: +81 6 6793 0013 Email Address: export@icom.co.jp

MANUFACTURER	
Name:	Icom Incorporated
Address:	1-1-32, Kamiminami, Hirano-ku Osaka, Japan 547-0003
Contact Person:	Mr. Takashi Aoki Phone #: +81 6 6793 5302 Fax #: +81 6 6793 0013 Email Address: export@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:	FRS UHF FM Transceiver
Model Name or Number:	IC-4088A
Serial Number:	Test Sample
Type of Equipment:	Non-broadcast Radio Communication Equipment
Input Power Supply Type:	• Internal Battery: 3 AA (R6) alkaline BP-202 Ni-Cd Battery Pack • External DC Sources: Icom Inc. BC-149A AC Adapter Input: 120V AC 60Hz 0.3A Output: 6V DC 1000mA Icom Inc. CP-18A Cigarette Lighter Adapter Input: DC 12V – 16V Output: DC 6V 1.5A
Transmitting/Receiving Antenna Type:	Integral
Primary User Functions of EUT:	Family Radio Service FM Transceiver

3.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Portable
Intended Operating Environment:	Residential
Power Supply Requirement:	3 AA (R6) alkaline, DC 6V via AC / Cigarette Lighter Adapter
RF Output Power Rating:	26.88 dBm (0.488 W), conducted power 24.14 dBm (0.259 W), ERP
Operating Frequency Range:	462.5625 MHz to 467.7125 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	25 kHz
Occupied Bandwidth (99%):	8.85 kHz
Emission Designator*:	11K0F3E
Antenna Connector Type:	Integral
Antenna Description:	**Type 1 Antenna:** Manufacturer: Icom Type: Helical Model: n/a Frequency Range: 462.5625 - 467.7125MHz In/Out Impedance: 50 Ohms Gain: 2.22dBi **Type 2 Antenna:** Manufacturer: Icom Type: Helical Model: n/a Frequency Range: 462.5625 - 467.7125MHz In/Out Impedance: 50 Ohms Gain: 1.13dBi **Note:** The unit with the highest antenna gain was used for testing to represent the worst case.

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

For FM Voice Modulation:

D = 2.5 kHz max., K = 1, M = 3 KHz

B_n = 2M + 2DK
B_n = 2M + 2DK = 2(3) + 2(2.5)(1) = 11 kHz
Emission designator: 11K0F3E

◇ Channel frequency list

CH	Freq.(MHz)
1	462.5625
2	462.5875
3	462.6125
4	462.6375
5	462.6625
6	462.6875
7	462.7125
8	467.5625
9	467.5875
10	467.6125
11	467.6375
12	467.6625
13	467.6875
14	467.7125

◇ CTCSS code table

CH	Freq.	CH	Freq.	CH	Freq.	CH	Freq.
01	67.0	11	97.4	21	136.5	31	192.8
02	71.9	12	100.0	22	141.3	32	203.5
03	74.4	13	103.5	23	146.2	33	210.7
04	77.0	14	107.2	24	151.4	34	218.1
05	79.7	15	110.9	25	156.7	35	225.7
06	82.5	16	114.8	26	162.2	36	233.6
07	85.4	17	118.8	27	167.9	37	241.8
08	88.5	18	123.0	28	173.8	38	250.3
09	91.5	19	127.3	29	179.9	---	OFF
10	94.8	20	131.8	30	186.2		

(unit: Hz)

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	DC Power	1	2-prong plug	Non-shielded
2	Speaker /Microphone	1	Sp/Mic Jack	Non-shielded

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:	51%
1.13dBi Pressure:	102 kPa
Power input source:	DC 6V via AC Adaptor

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:	None.
Special Hardware Used:	None.
Transmitter Test Antenna:	The EUT is tested with an integral transmitter antenna.

Transmitter Test Signals	
Frequency Band(s):	462.5625 - 467.7125 MHz
Frequencies Tested:	Lowest: 462.5625 MHz Highest: 467.7125 MHz
RF Power Output (measured maximum output power):	26.88 dBm (0.488 W), conducted power 24.14 dBm (0.259 W), ERP
Normal Test Modulation:	F3E
Modulating Signal Source:	External: FM with 2.5 kHz sine wave Internal: CTCSS (Continuous Tone Coded Squelch System) Voice scrambler function

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 Powerline 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 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have 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 Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: August 10, 2002.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC 47 CFR Section(s)	Test Requirements	Applicability (Yes/No)
2.1046(a), 95.639(d)	RF Power Output	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
2.1047(a), 95.637(a)	Audio Frequency Response	Yes
2.1047(b), 95.637(a)	Modulation Limiting	Yes
2.1049(c)(1), 95.635(a)(b)	Occupied Bandwidth	Yes
2.1051, 2.1057 & 95.635(a)(b)	Spurious Emissions at Antenna Terminals	Yes
2.1053, 2.1057 & 95.635(a)(b)	Field Strength of Spurious Radiation	Yes
2.1055, 95.627(b)	Frequency Stability	Yes

FRS UHF FM Transceiver, **Model No.: IC-4088A**, 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.

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

5.4. DEVIATION OF STANDARD TEST PROCEDURES

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 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 C63.4:1992 and CISPR 16-1.

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(a) & 95.639(d)]

6.5.1. Limits

§95639(d): No FRS unit, under any condition of modulation, shall exceed 0.500 W effective radiated power (ERP).

6.5.2. Method of Measurements

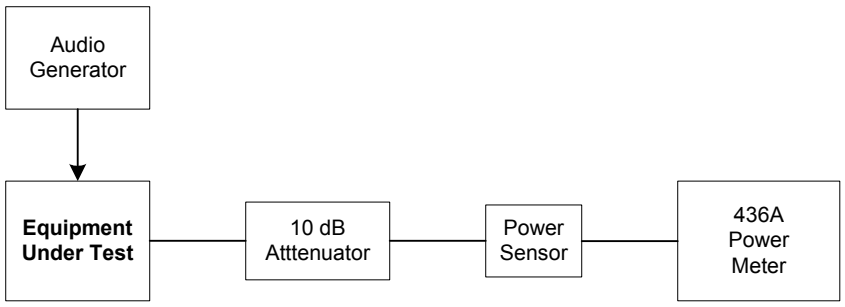
Refer to Exhibit 8, section 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Power Meter	Hewlett Packard	436A	1725A02249	10 kHz – 50 GHz, sensor dependent
Power Sensor	Hewlett Packard	8481A	2702A68983	10 MHz – 18 GHz
EMI Receiver/ Spectrum Analyzer	Advantest	R3271	15050203	100 Hz – 26.5 GHz
Attenuator	Weinschel Corp	24-10-34	BJ0039	DC – 8.5 GHz
Dipole Antenna	EMCO	3121C	8907-440	30 MHz – 1 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 MHz – 1 GHz
Synthesized RF Signal Generator	Gigatronic	6061A	5130408	10kHz – 1050 MHz
Audio Generator	Stanford Research Systems	DS345	34591	1μHz – 30.2 MHz

6.5.4. Test Arrangement

- Power at RF Power Output Terminals



- For ERP test arrangement, refer to section 8.2 of this test report for details

6.5.5. Test Data

Conducted Power

Transmitter Channel Output	Fundamental Frequency (MHz)	Measured Power (W)
Lowest (CH01)	462.5625	0.488
Highest (CH14)	467.7125	0.480

ERP Using Substitution Method

Frequency (MHz)	Peak E-Field @ 3m (dBµV/m)	Antenna Polarization (V/H)	Peak Power From Signal GEN. Ps (dBm)	Substitution Antenna Gain Gd (dBi)	Measured Peak EIRP = Ps + Gd (dBm)	Measured Peak ERP = EIRP - 2.15 (dBm)
462.5625	126.33	V	24.99	1.30	26.29	24.14
462.5625	127.96	H	24.08	1.30	25.38	23.23
467.7125	124.36	V	23.81	1.30	25.11	22.96
467.7125	128.05	H	23.78	1.30	25.08	22.93

The maximum measured ERP is 24.14 dBm (0.259 W), as indicated in the above table.

6.6. AUDIO FREQUENCY RESPONSE [§§ 2.1047(a) & 95.637(a)]

6.6.1. Limits

Recommended audio filter attenuation characteristics are given below:

RF Band	Audio band	Minimum Attenuation Rel. to 1 kHz Attenuation
406.1 – 960 MHz	3 –20 kHz above 20 kHz	60 $\log_{10}$(f/3) dB where f is in kHz 50dB

§ 95.637(a): A FRS unit that transmits emission type F3E, the audio frequency response must not exceed 3.125 kHz.

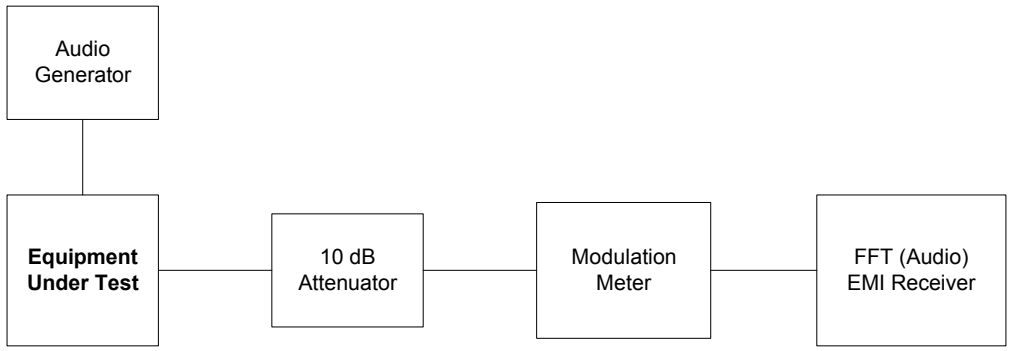
6.6.2. Method of Measurements

The rated audio input signal was applied to the input of the audio lowpass filter (or of all modulation stages) using an audio oscillator, this input signal level and its corresponding output signal were then measured and recorded using the FFT (Audio) EMI Receiver. Tests were repeated at different audio signal frequencies from 0 to 50 kHz.

6.6.3. Test Equipment List

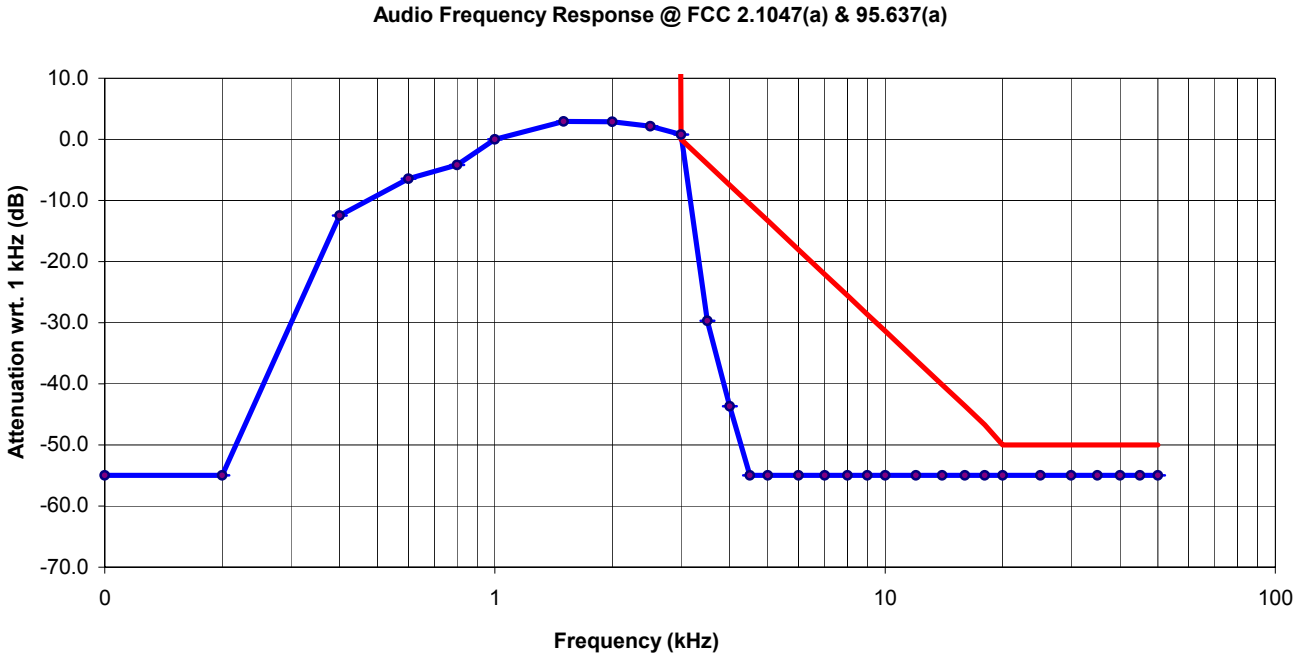
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
FFT (audio) EMI Receiver	Advantest	R9211E	82020336	10 mHz – 100 kHz, 1 MHz Input Impedance
Audio Generator	Stanford Research Systems	DS345	34591	1µHz – 30.2 MHz
Modulation Meter	Hewlett Packard	HP-8901B	3226A04606	150 kHz – 1.3 GHz
Attenuator	Weinschel Corp	24-10-34	BJ0039	DC – 8.5 GHz

6.6.4. Test Arrangement



6.6.5. Test Data

Frequency (kHz)	Audio In (dBV)	Audio Out (dBV)	Attenuation (Out - In) (dB)	Attenuation wrt. 1 kHz (dB)	FCC Recommend Limit (dB)
0.1	-42.16	<55.00	<-12.8	<-55.0	--
0.2	-42.16	<55.00	<-12.8	<-55.0	--
0.4	-42.16	-12.50	29.7	-12.5	--
0.6	-42.16	-6.48	35.7	-6.4	--
0.8	-42.16	-4.21	38.0	-4.2	--
1.0	-42.16	-0.04	42.1	0.0	--
1.5	-42.16	2.89	45.1	2.9	--
2.0	-42.16	2.86	45.0	2.9	--
2.5	-42.16	2.13	44.3	2.2	--
3.0	-42.16	0.73	42.9	0.8	0
3.5	-42.16	-29.72	12.4	-29.7	-4
4.0	-42.16	-43.69	-1.5	-43.7	-7
4.5	-42.16	<-55.00	<-12.8	<-55.0	-11
5.0	-42.16	<-55.00	<-12.8	<-55.0	-13
6.0	-42.16	<-55.00	<-12.8	<-55.0	-18
7.0	-42.16	<-55.00	<-12.8	<-55.0	-22
8.0	-42.16	<-55.00	<-12.8	<-55.0	-26
9.0	-42.16	<-55.00	<-12.8	<-55.0	-29
10.0	-42.16	<-55.00	<-12.8	<-55.0	-31
12.0	-42.16	<-55.00	<-12.8	<-55.0	-36
14.0	-42.16	<-55.00	<-12.8	<-55.0	-40
16.0	-42.16	<-55.00	<-12.8	<-55.0	-44
18.0	-42.16	<-55.00	<-12.8	<-55.0	-47
20.0	-42.16	<-55.00	<-12.8	<-55.0	-50
25.0	-42.16	<-55.00	<-12.8	<-55.0	-50
30.0	-42.16	<-55.00	<-12.8	<-55.0	-50
35.0	-42.16	<-55.00	<-12.8	<-55.0	-50
40.0	-42.16	<-55.00	<-12.8	<-55.0	-50
45.0	-42.16	<-55.00	<-12.8	<-55.0	-50
50.0	-42.16	<-55.00	<-12.8	<-55.0	-50



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

6.7. MODULATION LIMITING [§§ 2.1047(b) & 95.637(a)]

6.7.1. Limits

§ 95.637(a): - A FRS unit that transmits emission type F3E must not exceed a peak frequency deviation of plus or minus 2.5 kHz.

6.7.2. Method of Measurements

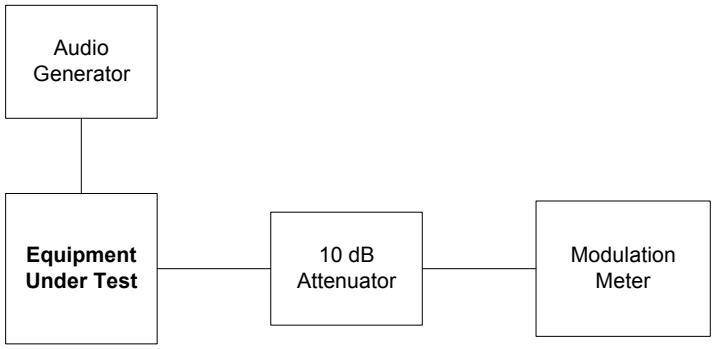
For Audio Transmitter: The carrier frequency deviation was measured with the tone input signal level varied from 0 Vp to audio input rating level plus 16 dB at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.

For Data Transmitter with Maximum Frequency Deviation set by Factory: The EUT was set at maximum frequency deviation, and its peak frequency deviation was then measured using EUT's internal random data source.

6.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Audio Generator	Stanford Research Systems	DS345	34591	1μHz – 30.2 MHz
Modulation Meter	Hewlett Packard	HP-8901B	3226A04606	150 kHz – 1.3 GHz
Attenuator	Weinschel Corp	24-10-34	BJ0039	DC – 8.5 GHz

6.7.4. Test Arrangement



6.7.5. Test Data

Voice Modulation Limiting:

Modulating Signal Level	Peak Frequency Deviation (kHz) at the following modulating frequency:					Limit
(mVrms)	0.1 kHz	0.5 kHz	1.0 kHz	3.0 kHz	5.0 kHz	(kHz)
2.0	0.08	0.20	0.44	0.84	0.09	2.5
4.0	0.08	0.34	0.81	1.45	0.08	2.5
6.0	0.08	0.46	1.15	1.58	0.09	2.5
8.0	0.09	0.59	1.53	1.64	0.09	2.5
10.0	0.08	0.71	1.88	1.64	0.08	2.5
12.0	0.08	0.85	1.93	1.65	0.08	2.5
14.0	0.08	0.96	1.95	1.64	0.09	2.5
16.0	0.08	1.12	1.98	1.64	0.08	2.5
18.0	0.08	1.22	1.99	1.65	0.08	2.5
20.0	0.07	1.37	2.02	1.65	0.08	2.5
25.0	0.07	1.68	2.03	1.65	0.08	2.5
30.0	0.08	1.94	2.06	1.65	0.08	2.5
35.0	0.08	1.95	2.06	1.66	0.09	2.5
40.0	0.08	1.96	2.07	1.64	0.08	2.5
45.0	0.09	1.98	2.07	1.65	0.09	2.5
50.0	0.09	1.99	2.07	1.65	0.10	2.5

Voice Signal Input Level = STD MOD Level + 16 dB = 17.84 dBVrms + 16 = 33.84 dBVrms

Modulating Frequency (kHz)	Peak Frequency Deviation (kHz)	Maximum Limit (kHz)
0.1	0.08	2.5
0.2	0.08	2.5
0.4	1.97	2.5
0.6	2.00	2.5
0.8	2.06	2.5
1.0	2.07	2.5
1.2	2.06	2.5
1.4	2.07	2.5
1.6	2.06	2.5
1.8	2.06	2.5
2.0	2.05	2.5
2.5	1.93	2.5
3.0	1.65	2.5
3.5	0.28	2.5
4.0	0.12	2.5
4.5	0.11	2.5
5.0	0.11	2.5
6.0	0.14	2.5
7.0	0.08	2.5
8.0	0.08	2.5
9.0	0.07	2.5
10.0	0.08	2.5

6.8. OCCUPIED BANDWIDTH & EMISSION LIMITATION [§§ 2.1049(c)(1) & 95.635(a)(b)]

6.8.1. Limits

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

(1) At least 25 dB (decibels) on any frequency removed from the center of the authorized bandwidth by more than 50% up to and including 100% of the authorized bandwidth.

(2) At least 35 dB on any frequency removed from the center of the authorized bandwidth by more than 100% up to and including 250% of the authorized bandwidth.

(3) At least 43 + 10 log10 (TP) dB on any frequency removed from the center of the authorized bandwidth by more than 250%.

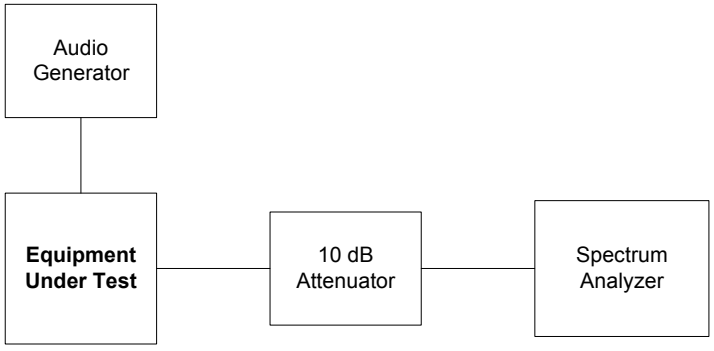
6.8.2. Method of Measurements

Refer to Exhibit 8, section 8.4 of this report for measurement details

6.8.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3710A00223	9 kHz – 22 GHz
Audio Generator	Stanford Research Systems	DS345	34591	1μHz – 30.2 MHz
Attenuator	Weinschel Corp	24-10-34	BJ0039	DC – 8.5 GHz

6.8.4. Test Arrangement



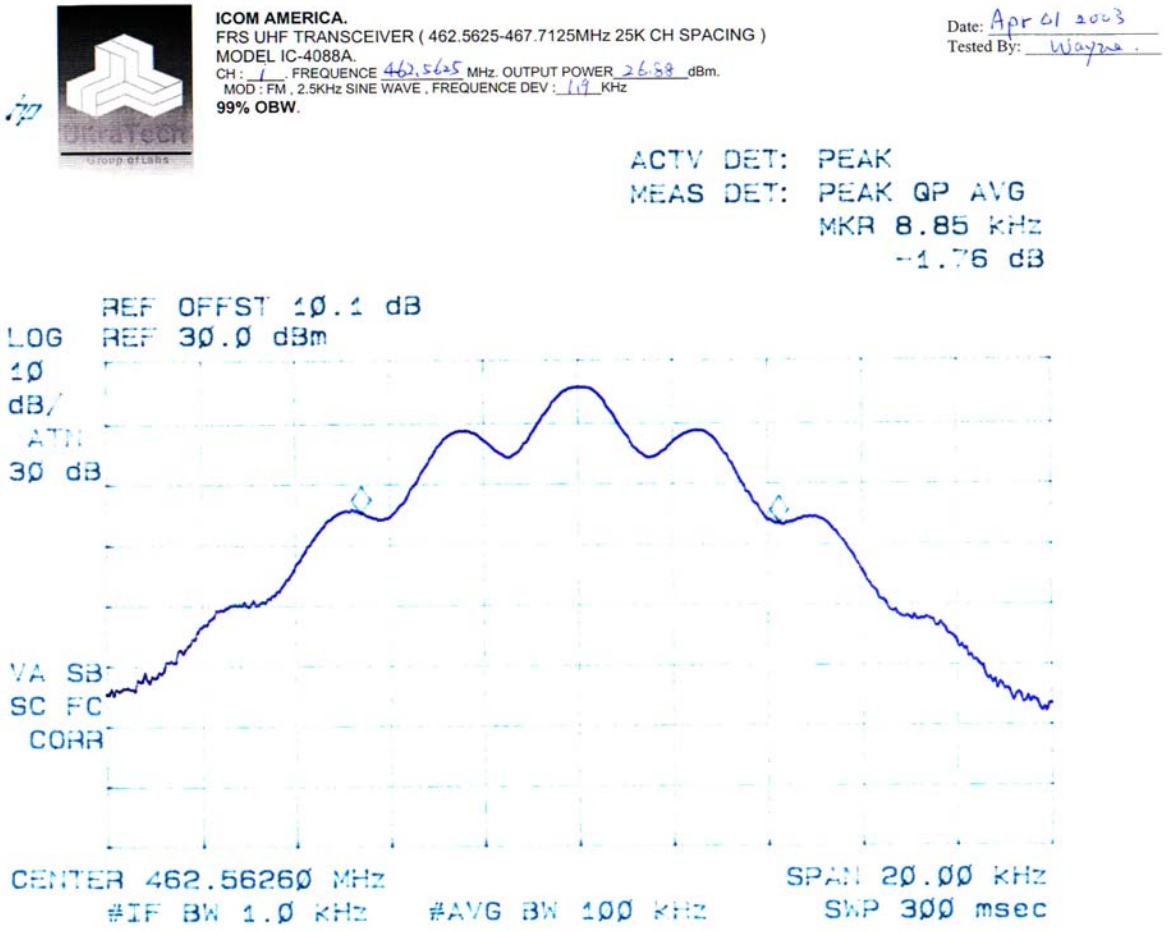
6.8.5. Test Data

6.8.6. 99% Occupied Bandwidth

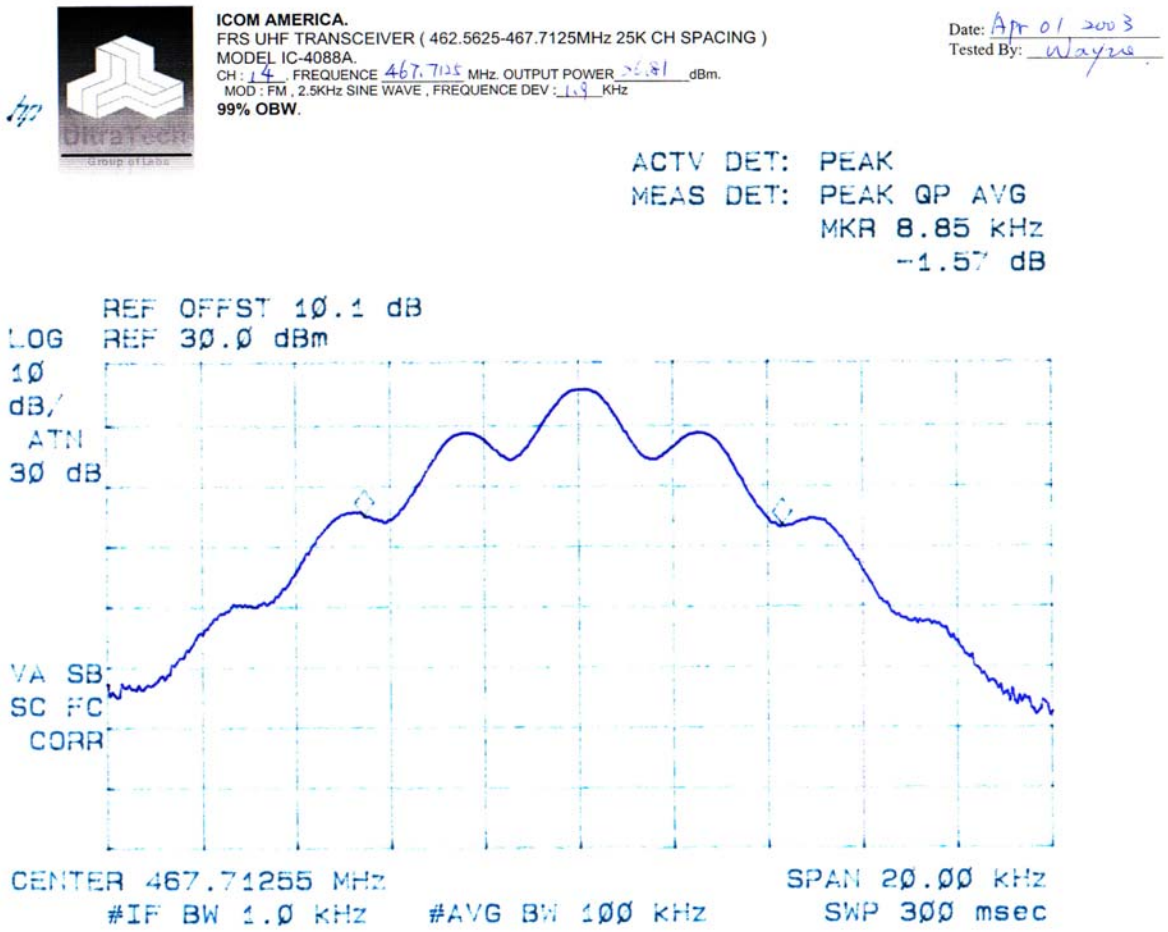
Channel	Frequency (MHz)	*Measured 99% Occupied Bandwidth (kHz)	Authorized Bandwidth (kHz)
01	462.5625	8.85	12.5
14	467.7125	8.85	12.5

*See plots 1 and 2 for measurement details.

Plot 1:
99 % Occupied Bandwidth
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave



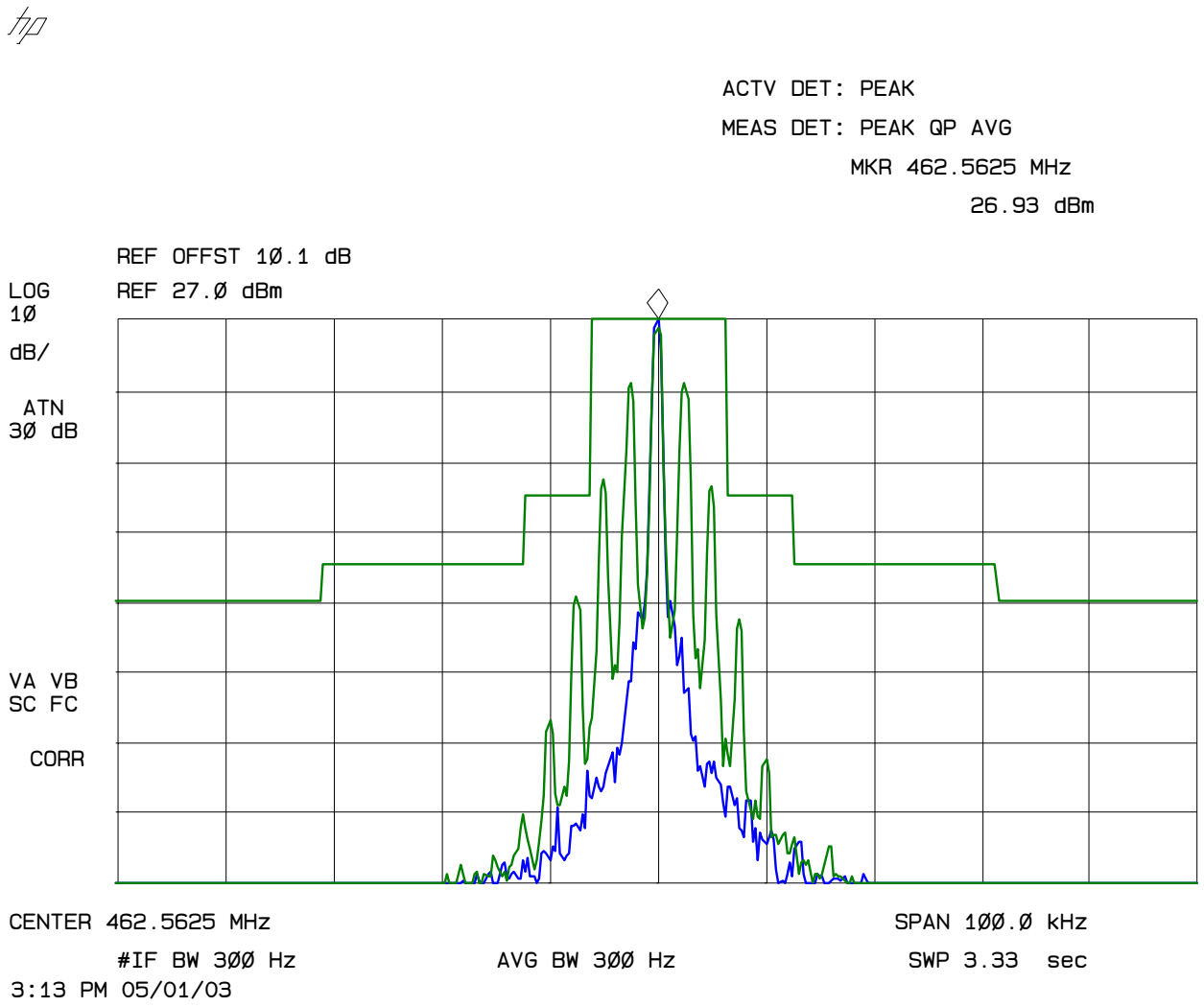
Plot 2:
99 % Occupied Bandwidth
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave



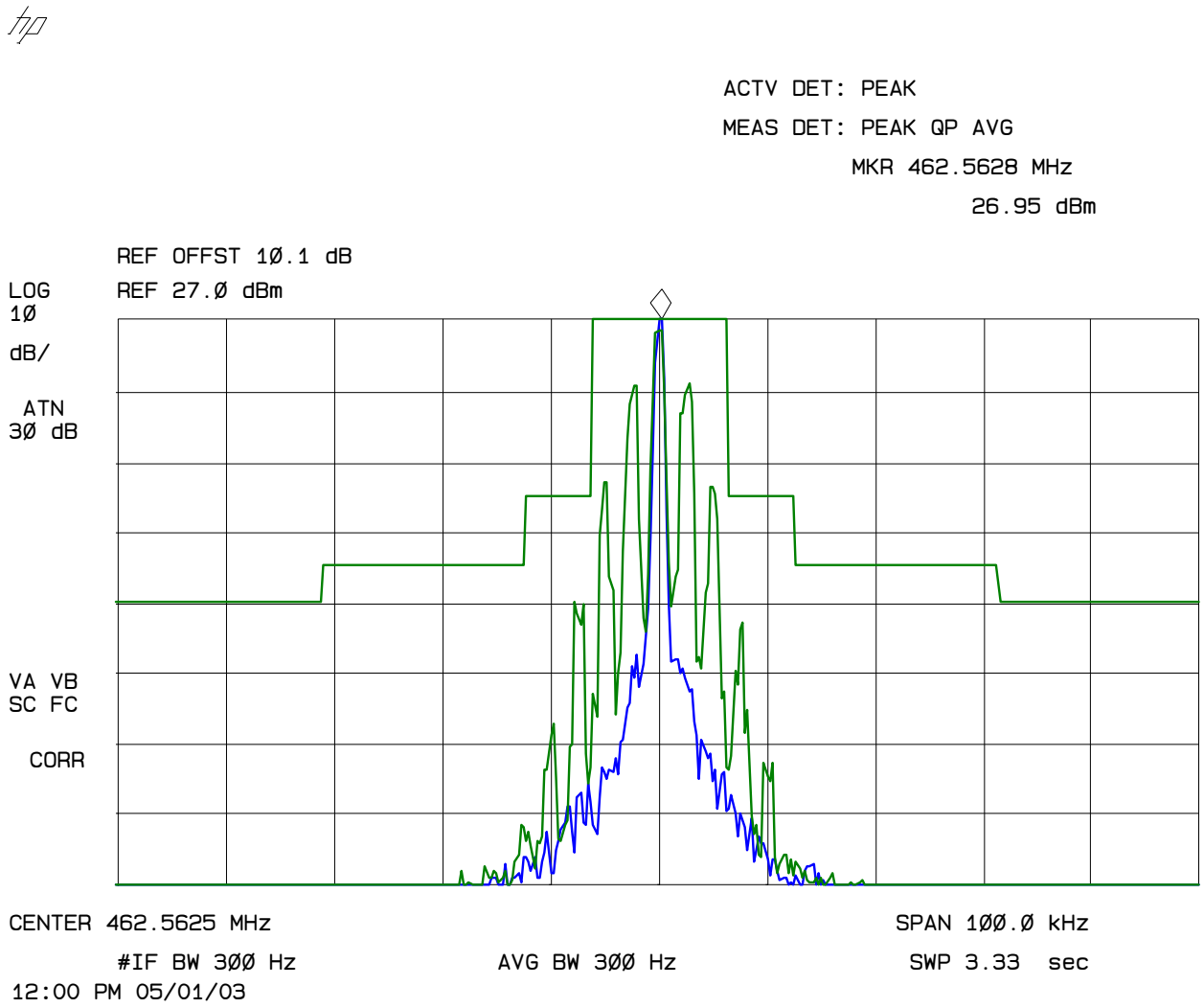
6.8.7. Emission Limitation

See the following test data plots (3 to 14) for measurement results.

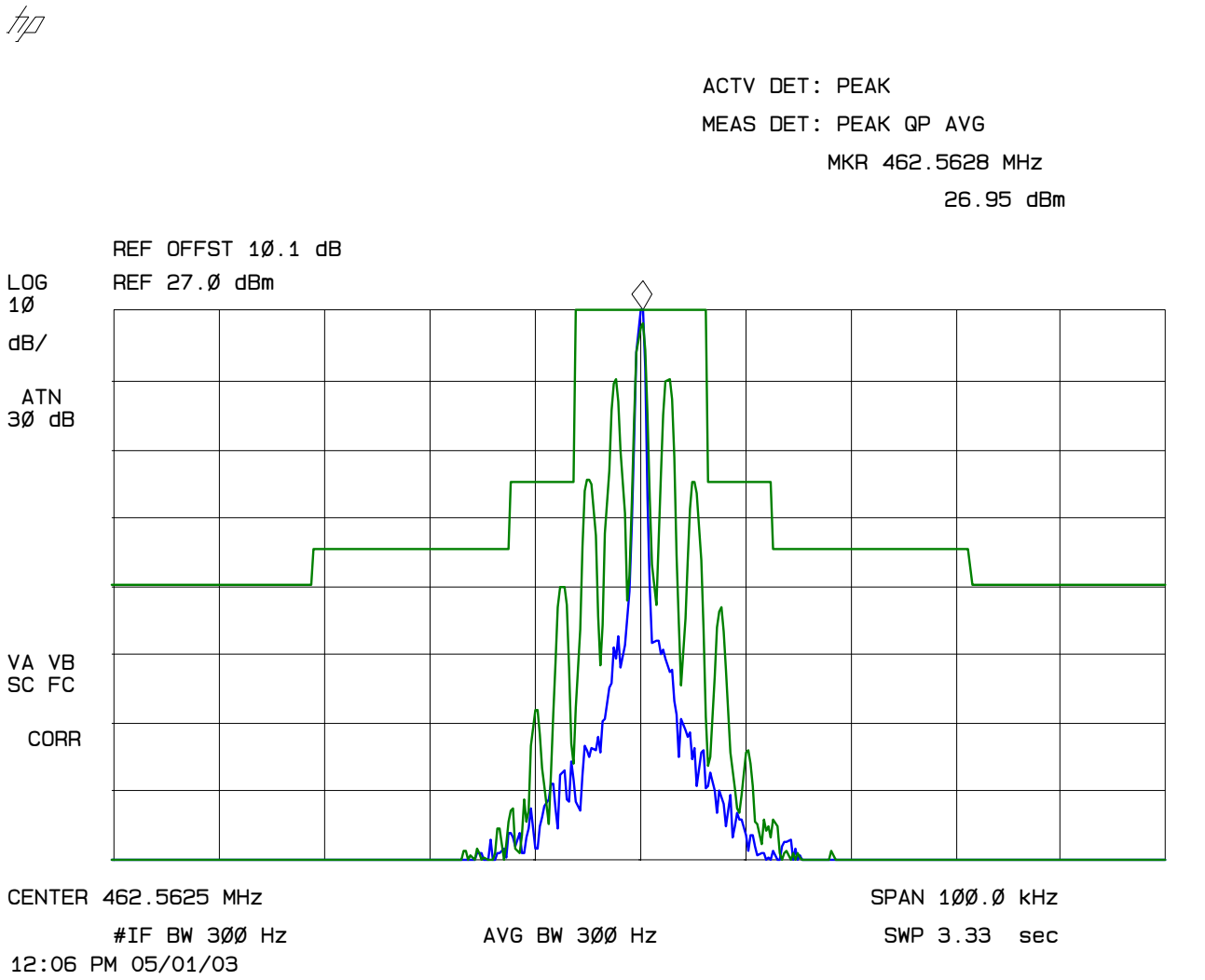
Plot 3:
Emission Limitation
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: OFF
CTCSS Code: OFF



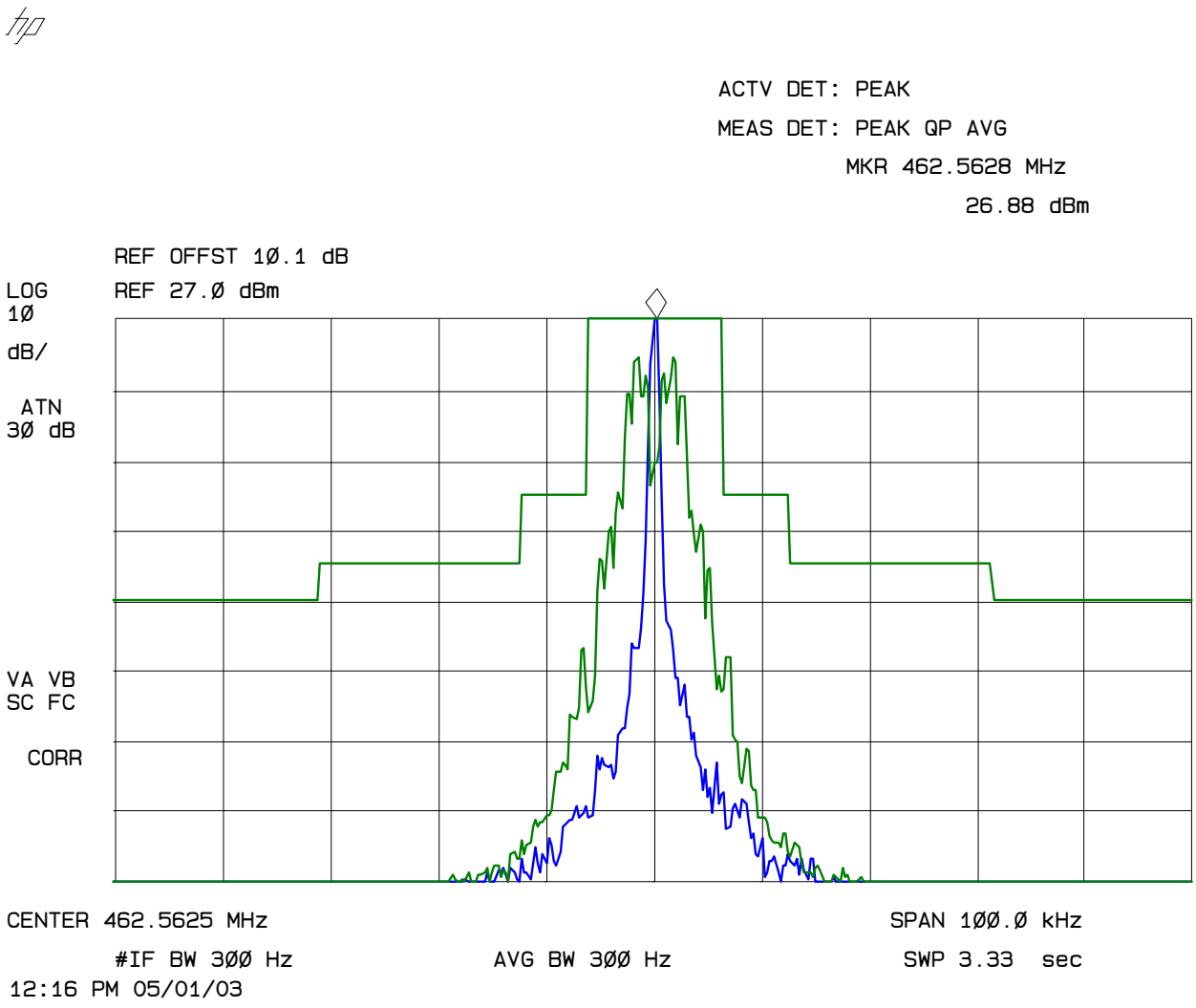
Plot 4:
Emission Limitation
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: OFF
CTCSS Code: CH 01 (67.0 Hz)



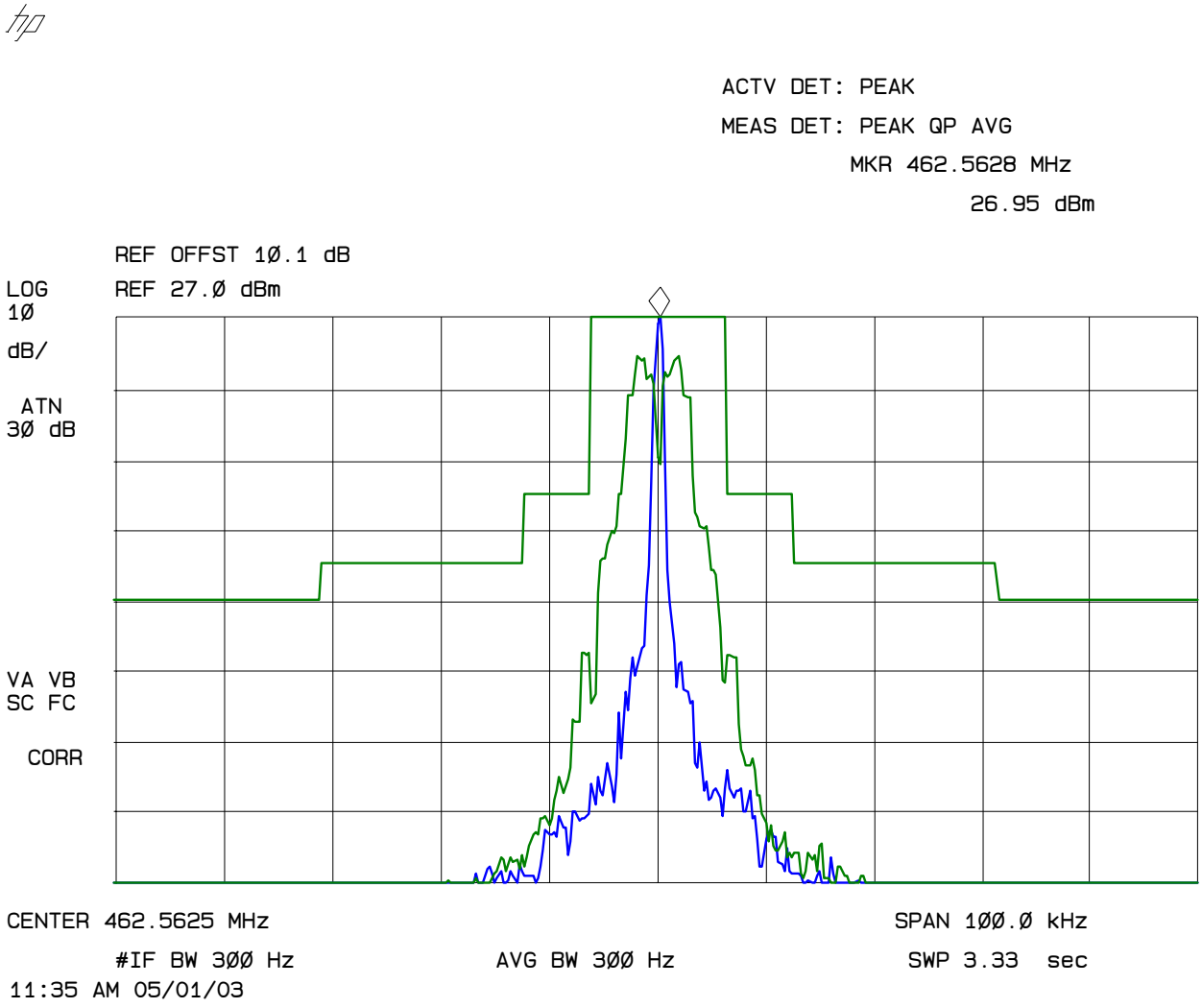
Plot 5:
Emission Limitation
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: OFF
CTCSS Code: CH 38 (250.3 Hz)



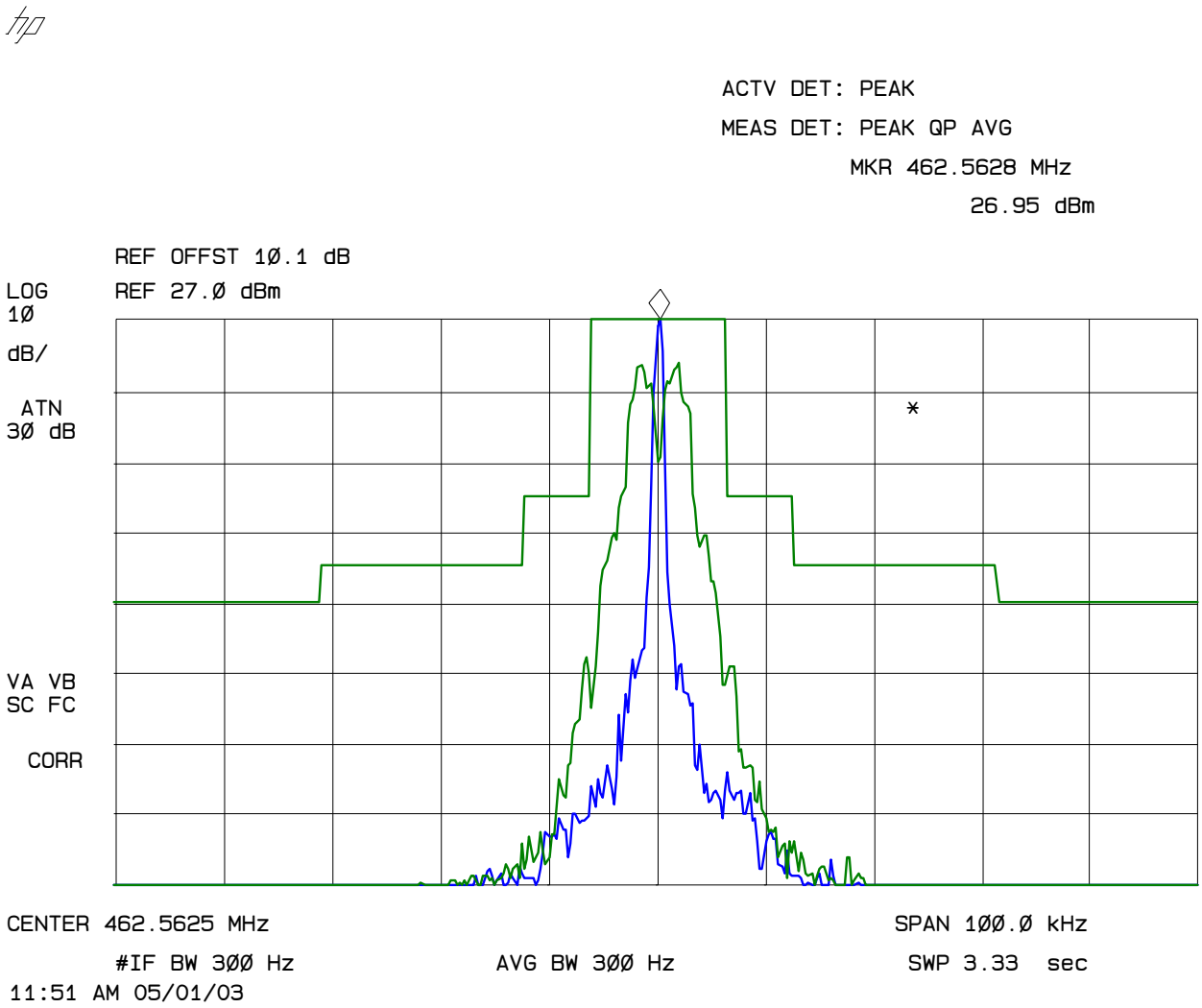
Plot 6:
Emission Limitation
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: ON
CTCSS Code: OFF



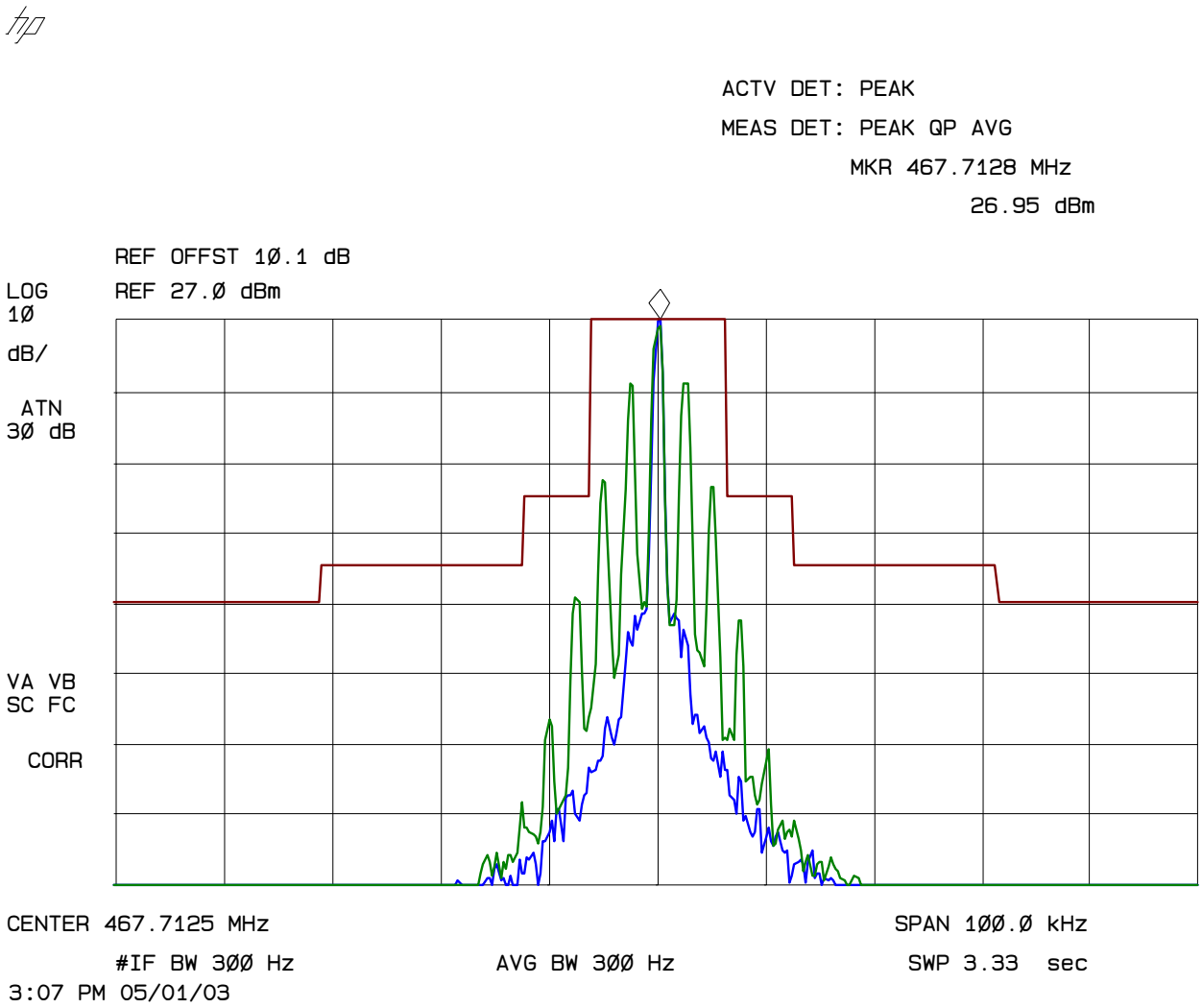
Plot 7:
Emission Limitation
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: ON
CTCSS Code: CH 01 (67.0 Hz)



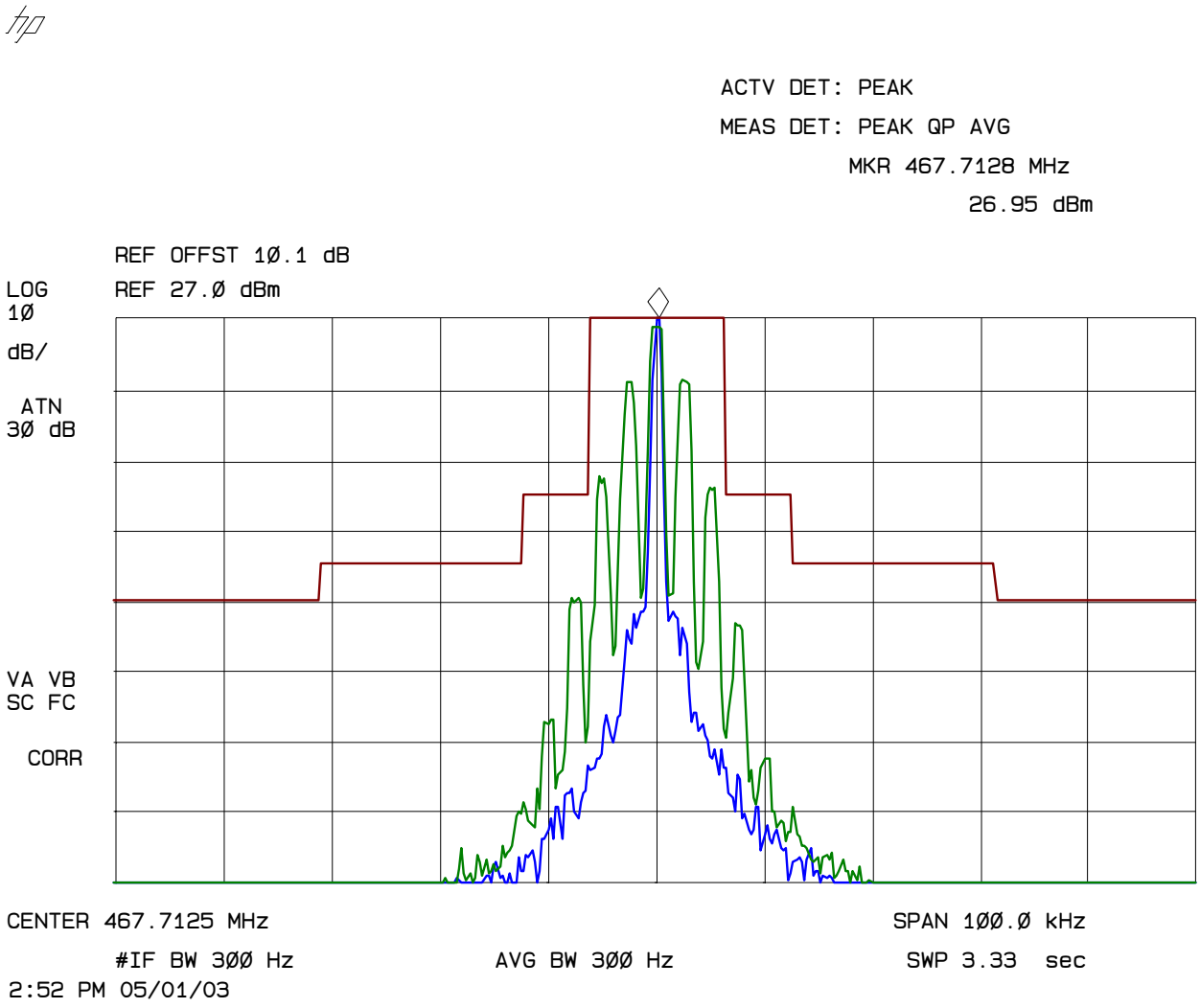
Plot 8:
Emission Limitation
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: ON
CTCSS Code: CH 38 (250.3 Hz)



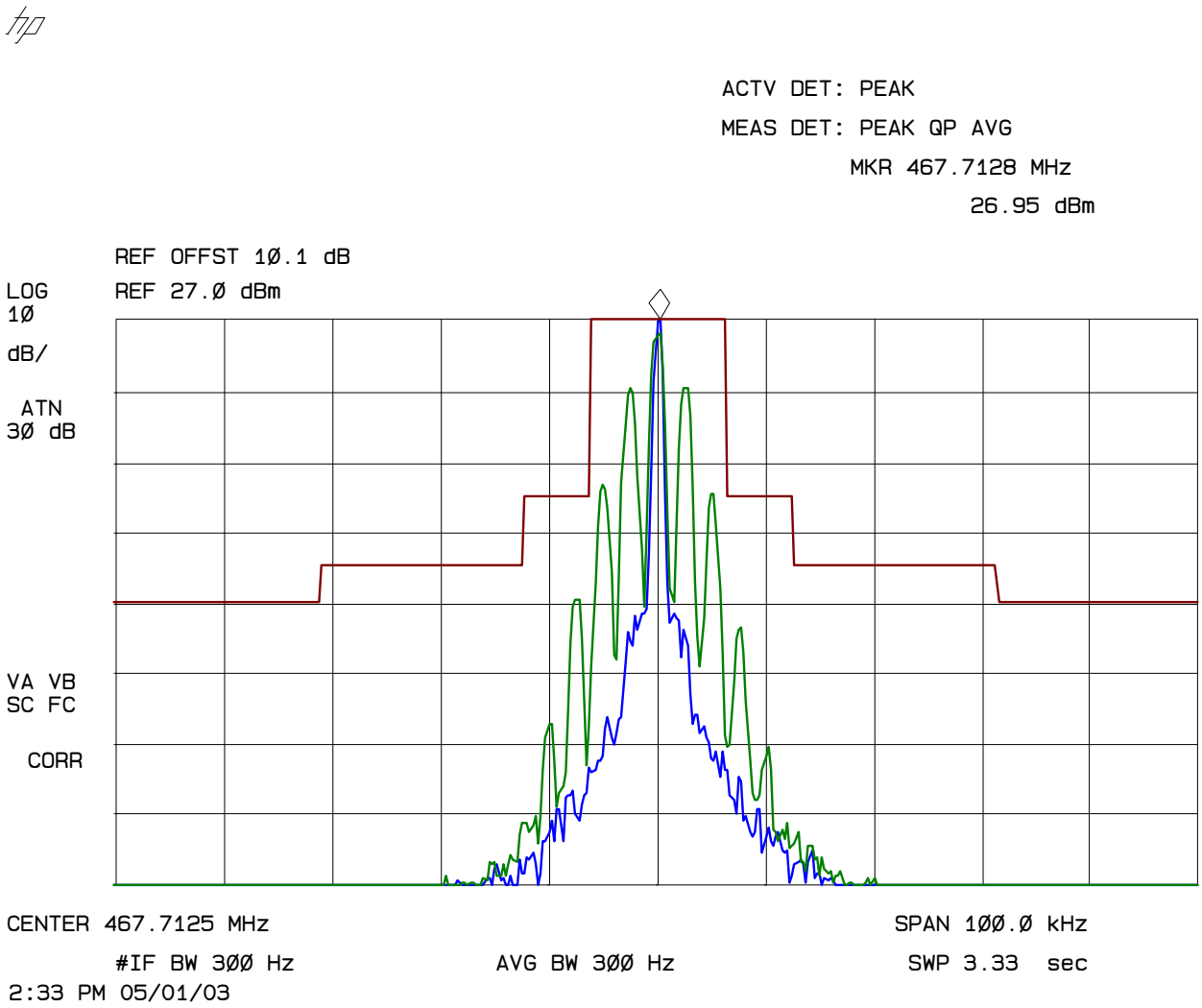
Plot 9:
Emission Limitation
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: OFF
CTCSS Code: OFF



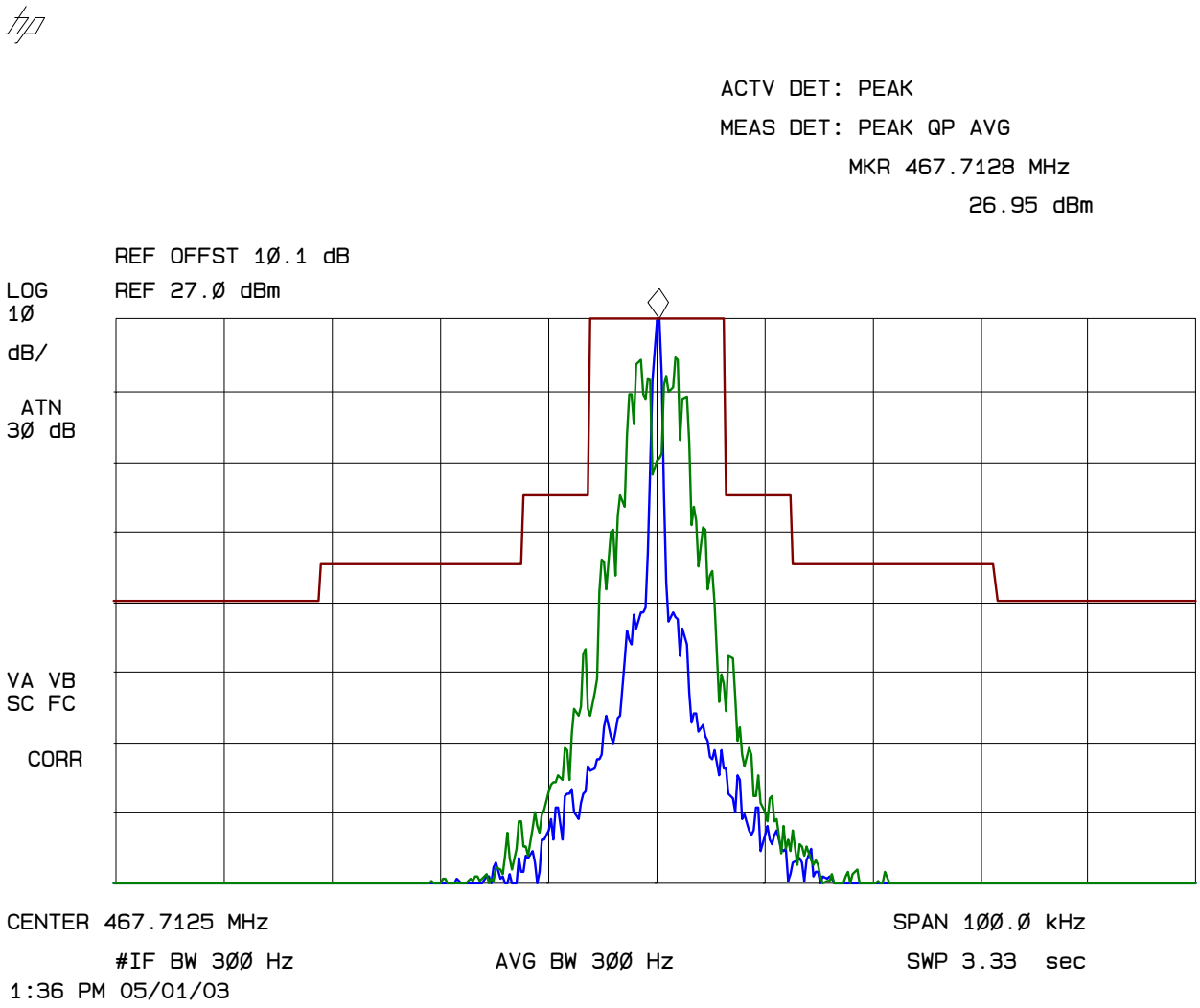
Plot 10:
Emission Limitation
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: OFF
CTCSS Code: CH 01 (67.0 Hz)



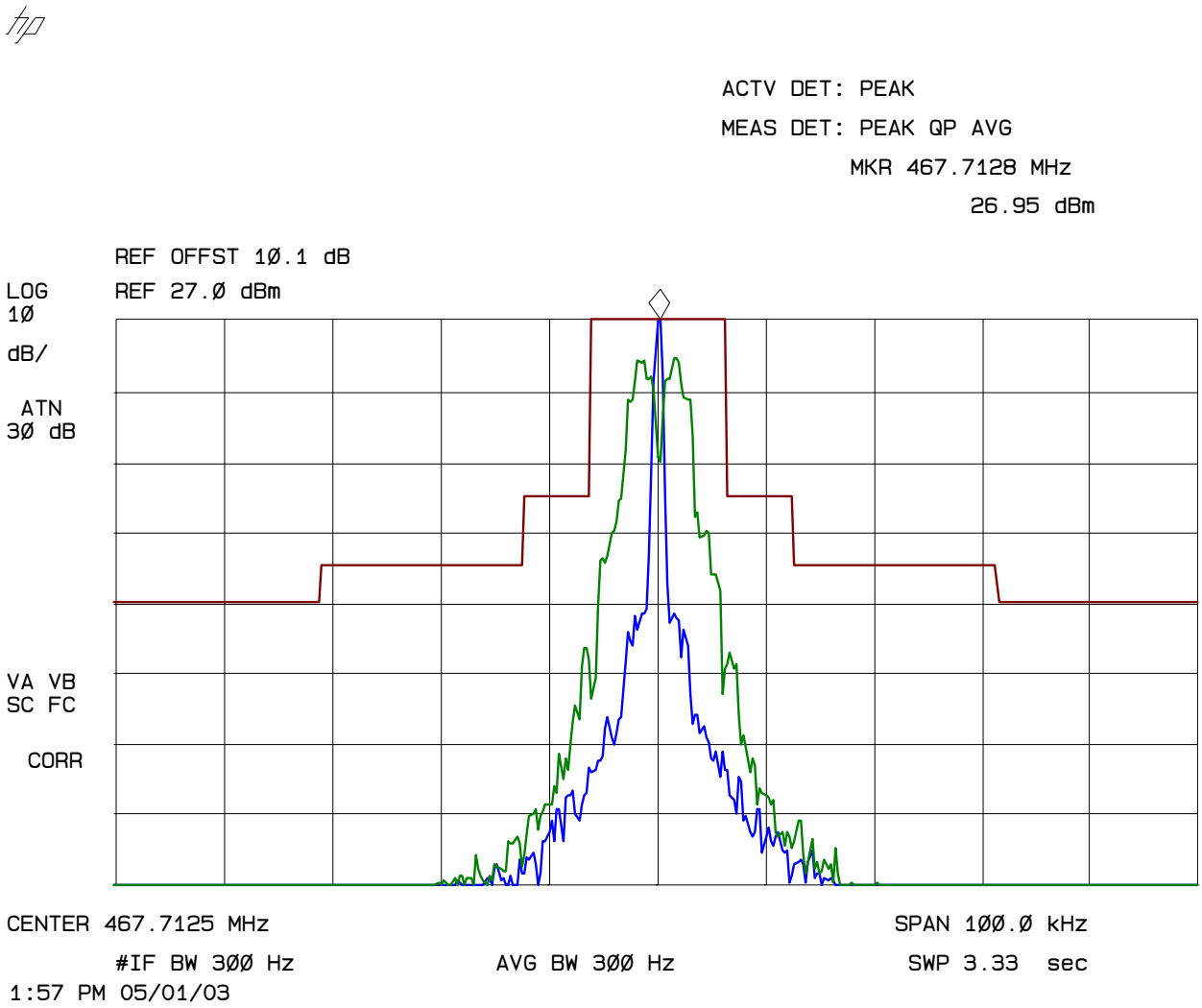
Plot 11:
Emission Limitation
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: OFF
CTCSS Code: CH 38 (250.3 Hz)



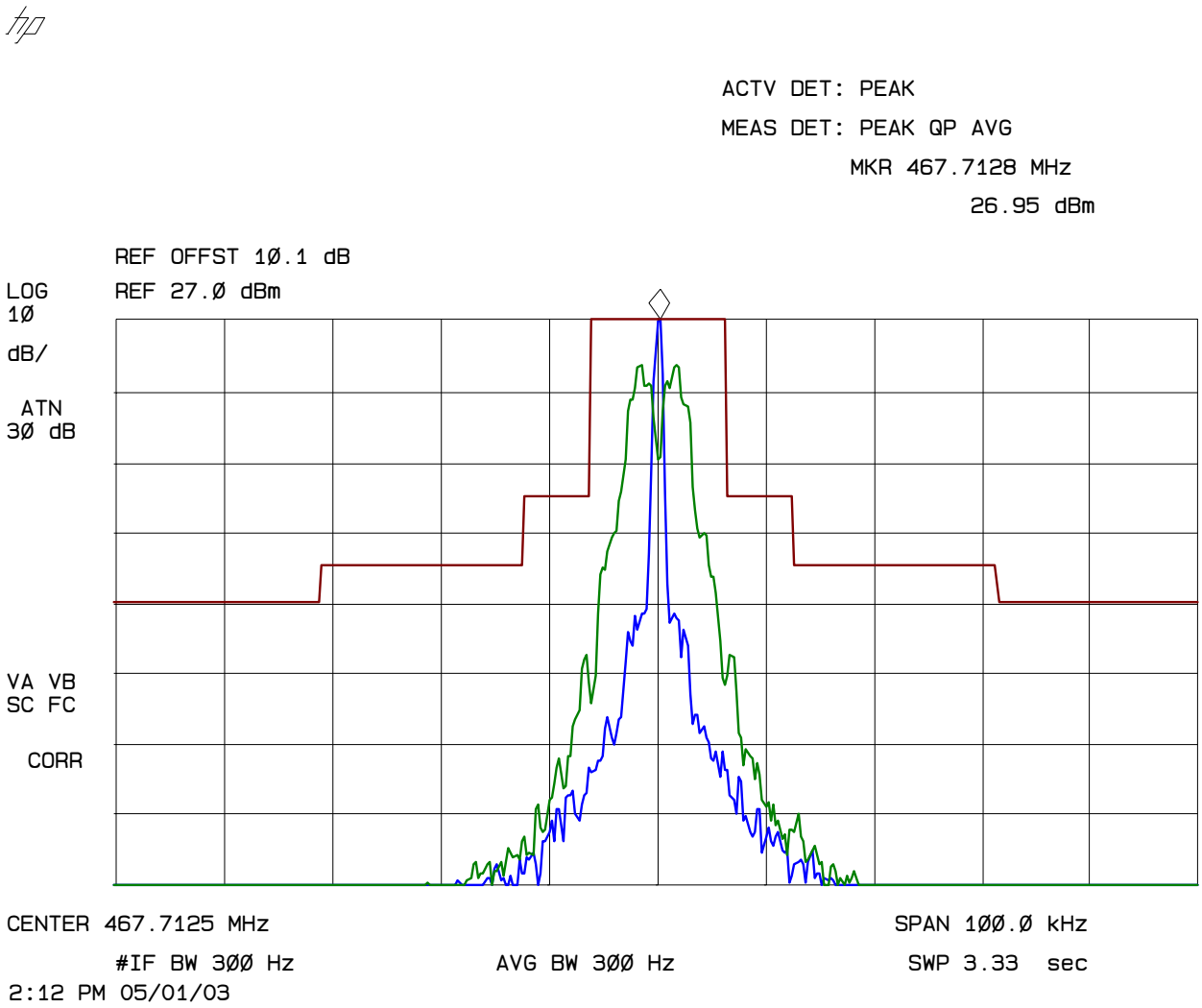
Plot 12:
Emission Limitation
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: ON
CTCSS Code: OFF



Plot 13:
Emission Limitation
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: ON
CTCSS Code: CH 01 (67.0 Hz)



Plot 14:
Emission Limitation
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave
Voice Scrambler Function: ON
CTCSS Code: CH 38 (250.3 Hz)



6.9. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§§ 2.1051 & 95.635(a)(b)]

6.9.1. Limits

§ 95.635(b): Emissions shall be attenuated below the mean output power of the transmitter as follows:

(1) At least 25 dB (decibels) on any frequency removed from the center of the authorized bandwidth by more than 50% up to and including 100% of the authorized bandwidth.

(2) At least 35 dB on any frequency removed from the center of the authorized bandwidth by more than 100% up to and including 250% of the authorized bandwidth.

(3) At least 43 + 10 log10 (TP) dB on any frequency removed from the center of the authorized bandwidth by more than 250%.

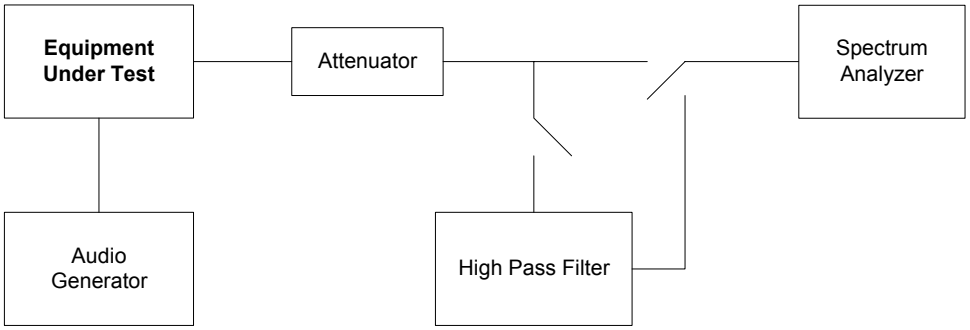
6.9.2. Method of Measurements

Refer to Exhibit 8 section 8.5 of this report for measurement details

6.9.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3710A00223	9 kHz – 22 GHz
Audio Generator	Stanford Research Systems	DS345	34591	1μHz – 30.2 MHz
Attenuator	Weinschel Corp	24-10-34	BJ0039	DC – 8.5 GHz
High Pass Filter	Mini-Circuits	SHP-600	--	Cut-off Frequency at 600 MHz

6.9.4. Test Arrangement

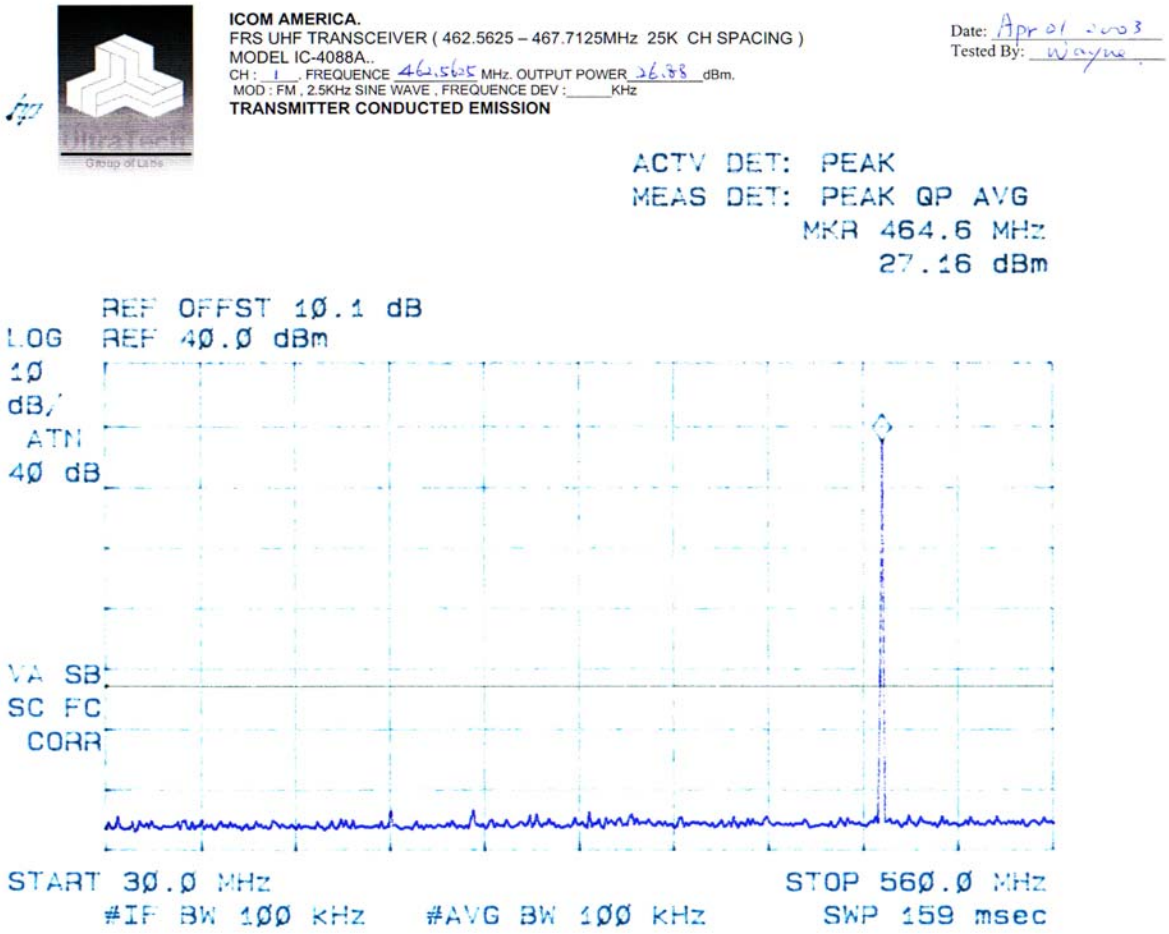


6.9.5. Test Data

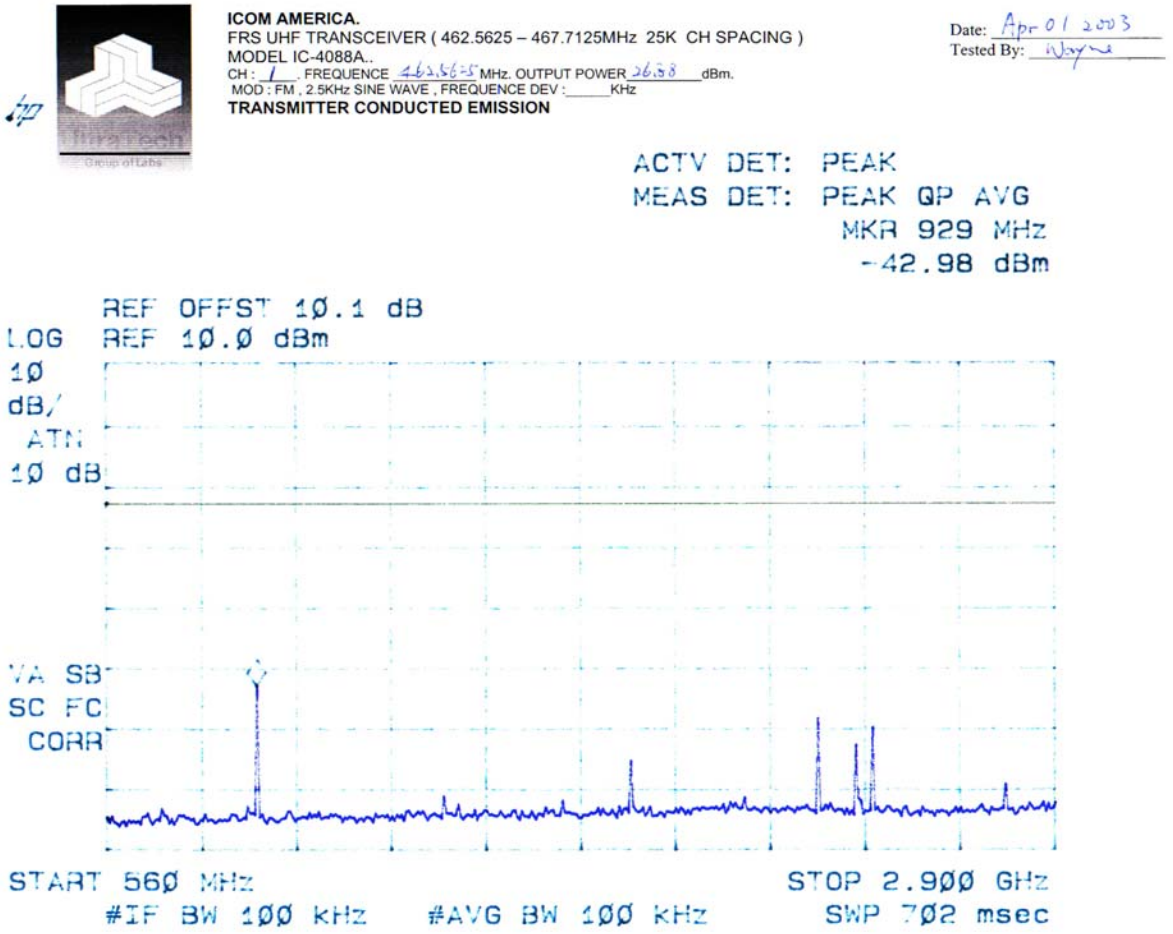
6.9.5.1. Near Lowest Frequency (462.5625 MHz)

The emissions were scanned from 30 MHz to 5 GHz; all spurious emissions were more than 20dB below the limit. See the following test data plots (15 to 17) for measurement results:

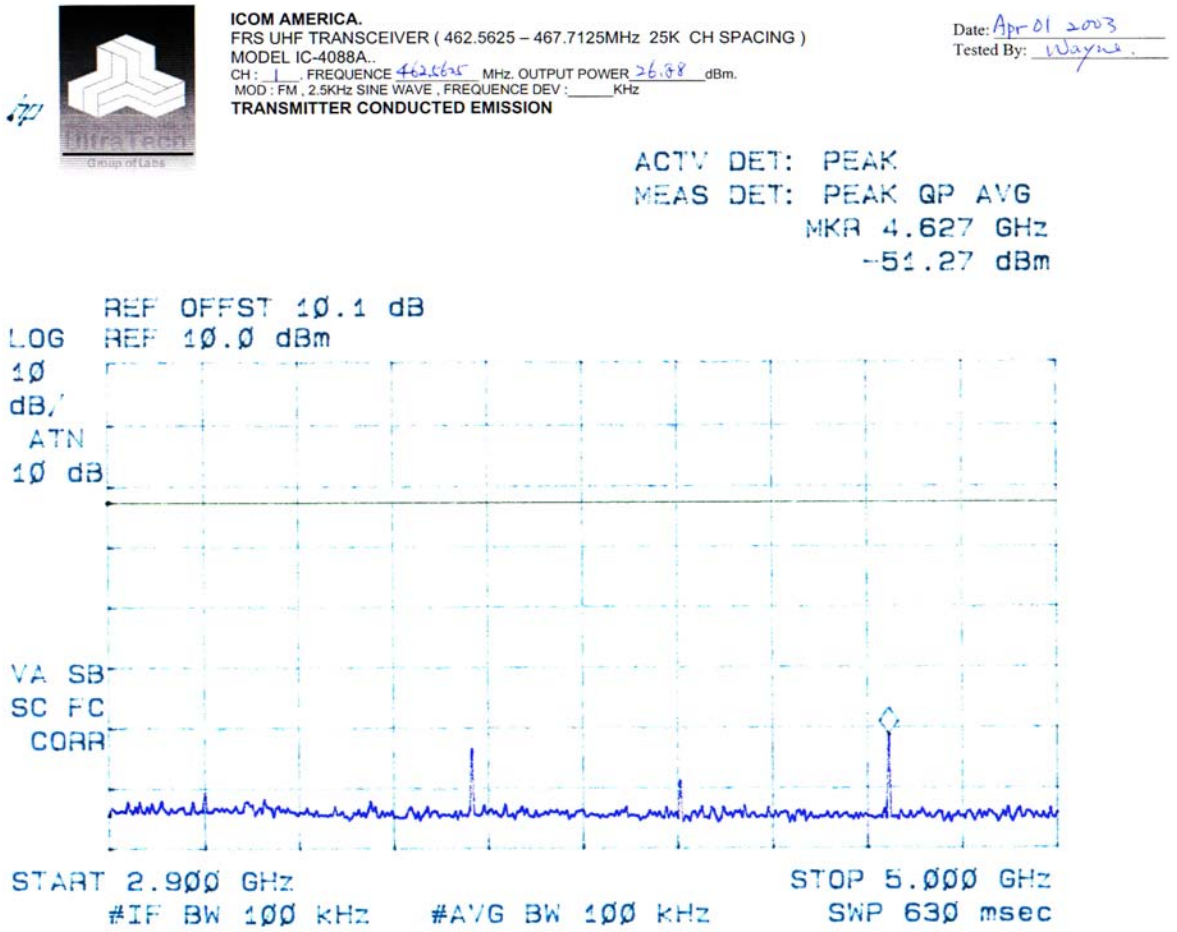
Plot 15:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave



Plot 16:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave



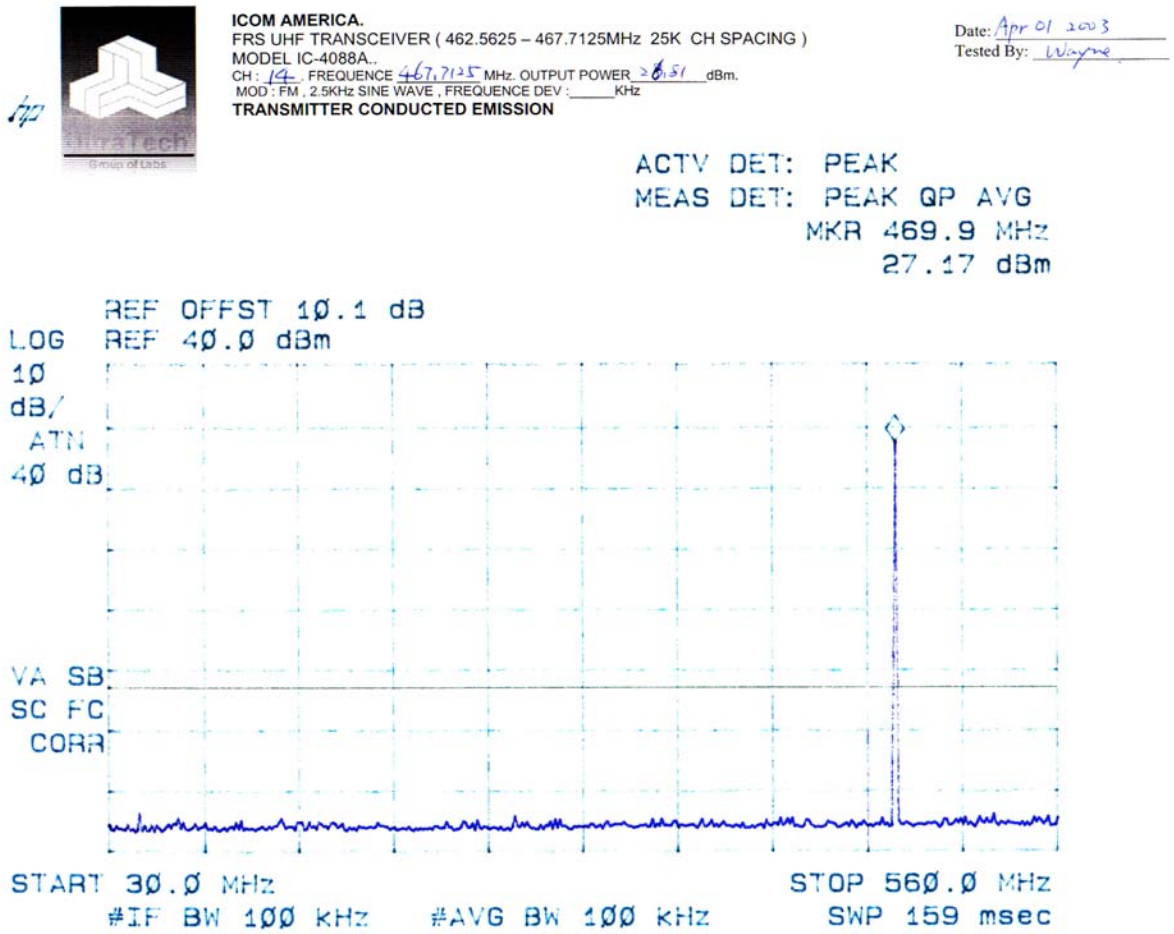
Plot 17:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 462.5625 MHz (CH 01)
Modulation: FM with 2.5 kHz sine wave



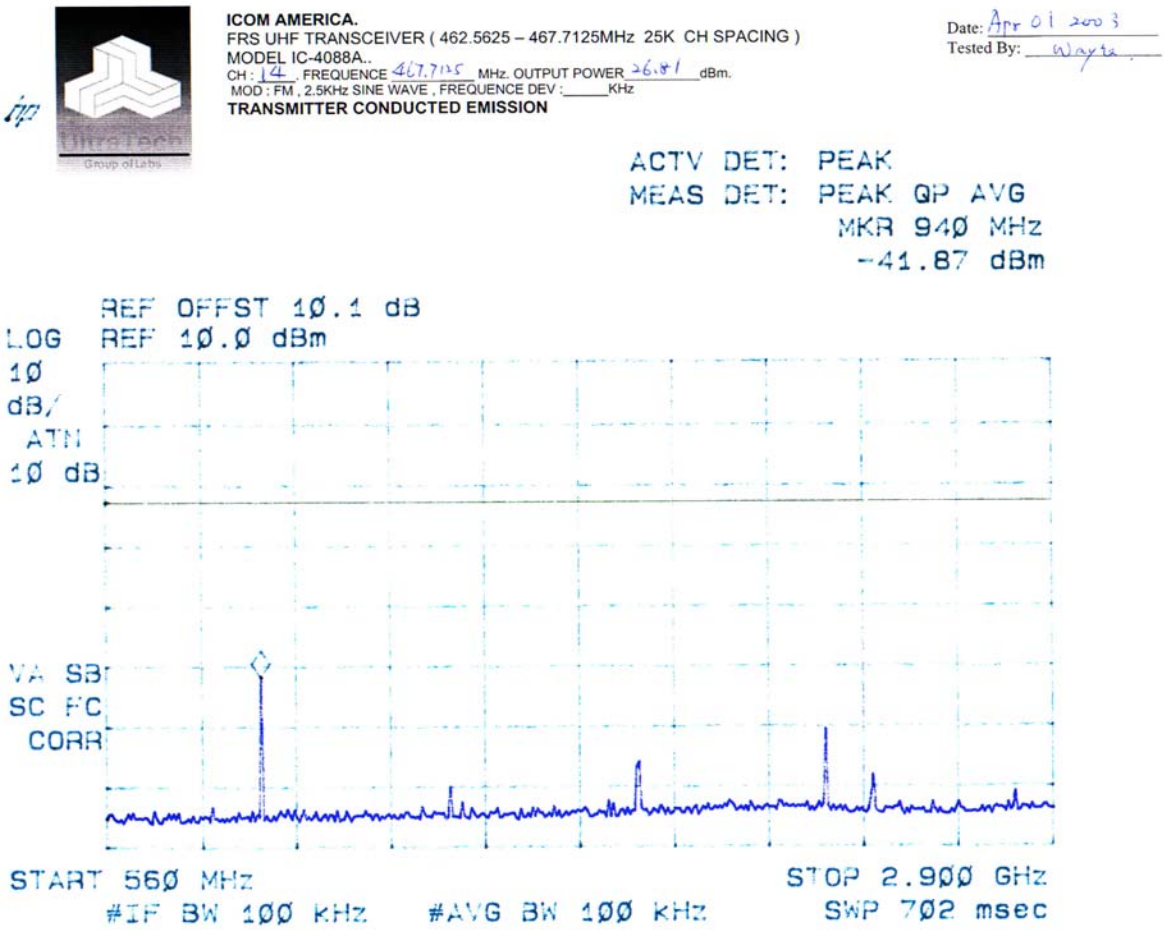
6.9.5.2. Near Highest Frequency (467.7125 MHz)

The emissions were scanned from 30 MHz to 5 GHz; all spurious emissions were more than 20dB below the limit. See the following test data plots (18 to 20) for measurement results:

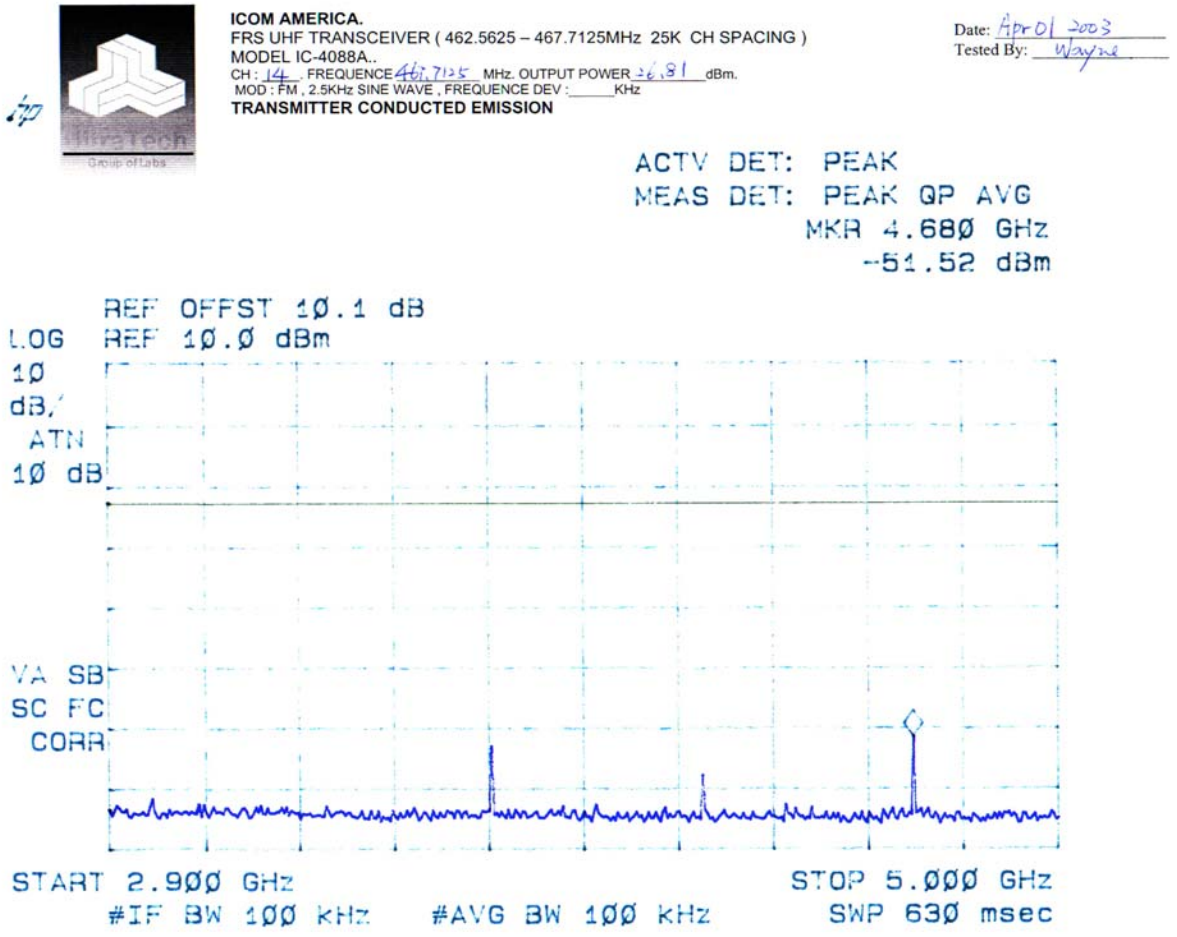
Plot 18:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave



Plot 19:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave



Plot 20:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 467.7125 MHz (CH 14)
Modulation: FM with 2.5 kHz sine wave



6.10. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1051 & 95.635(a)(b)]

6.10.1. Limits

§ 95.635(b): Emissions shall be attenuated below the mean output power of the transmitter as follows:

(1) At least 25 dB (decibels) on any frequency removed from the center of the authorized bandwidth by more than 50% up to and including 100% of the authorized bandwidth.

(2) At least 35 dB on any frequency removed from the center of the authorized bandwidth by more than 100% up to and including 250% of the authorized bandwidth.

(3) At least 43 + 10 log10 (TP) dB on any frequency removed from the center of the authorized bandwidth by more than 250%.

6.10.2. Method of Measurements

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

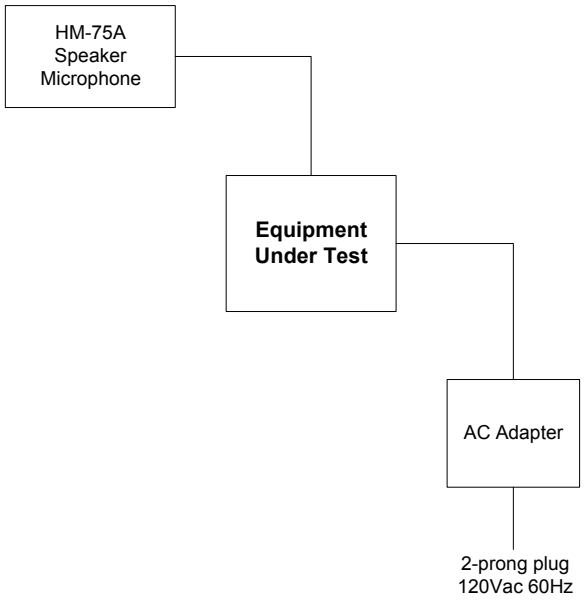
(1) If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.
(2) If the transmitter's antenna is non-integral and diverse, the lowest ERP of the carrier with 0 dBi antenna gain is used for calculation of the spurious/harmonic emissions in dBc:
Lowest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

ERP of spurious/harmonic (dBc) = ERP of carrier (dBm) – ERP of spurious/harmonic emission (dBm)

6.10.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8546A	…	9 kHz to 5.6 GHz with built-in 30 dB Gain Pre-selector, QP, Average & Peak Detectors.
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
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

6.10.4. Test Arrangement



6.10.5. Test Data

6.10.5.1. Near Lowest Frequency (462.5625 MHz)

Fundamental Frequency:	462.5625 MHz
RF Output Power:	24.14 dBm (ERP)
Modulation:	FM with 2.5 kHz Sine Wave Signal

The emissions were scanned from 30 MHz to 5 GHz; all spurious emissions were more than 20dB below the permissible limit.

6.10.5.2. Near Highest Frequency (467.7125 MHz)

Fundamental Frequency:	467.7125 MHz
RF Output Power:	22.96 dBm (ERP)
Modulation:	FM with 2.5 kHz Sine Wave Signal

The emissions were scanned from 30 MHz to 5 GHz; all spurious emissions were more than 20dB below the permissible limit.

6.11. FREQUENCY STABILITY [§§ 2.1055 & 95.627(b)]

6.11.1. Limits

§ 95.627 (b): Each FRS unit must be maintained within a frequency tolerance of 0.00025%.

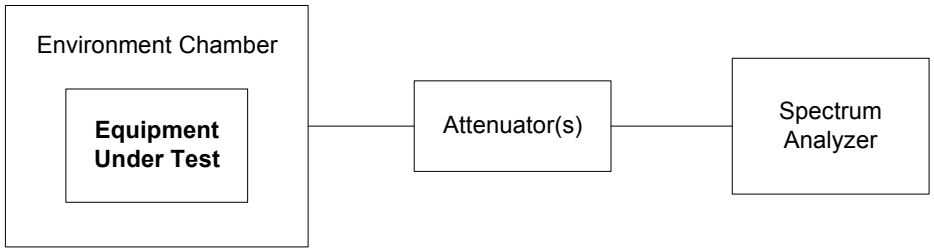
6.11.2. Method of Measurements

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

6.11.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
EMI Receiver / Spectrum Analyzer	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Attenuator	Weinschel Corp	24-10-34	BJ0039	DC – 8.5 GHz
Temperature & Humidity Chamber	Tenney	T5	9723B	-40^{o} to +60 ^{o} C range

6.11.4. Test Arrangement



6.11.5. Test Data

Product Name:	**FRS UHF FM Transceiver**
Model No.:	**IC-4088A**
Center Frequency:	462.5625 MHz
Full Power Level:	26.88 dBm
Frequency Tolerance Limit:	0.00025 % or 2.5 ppm (1156 Hz at 462.5625 MHz)
Max. Frequency Tolerance Measured:	-840 Hz (0.00018 % or 1.8 ppm)
Input Voltage Rating:	6 VDC

Ambient Temperature (^{o}C)	CENTER FREQUENCY & RF POWER OUTPUT VARIATION		
	Supply Voltage (Nominal) 6 VDC	Supply Voltage (85% of Nominal) 5.1 VDC	Supply Voltage (115% of Nominal) 6.9 VDC
	Hz	Hz	Hz
-20	-840	n/a	n/a
-10	+680	n/a	n/a
0	+720	n/a	n/a
+10	+760	n/a	n/a
+20	-460	-720	-460
+30	-620	n/a	n/a
+40	-420	n/a	n/a
+50	-760	n/a	n/a

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)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivit	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:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ 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).
- I f 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 = Tx on / (Tx on + Tx 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.

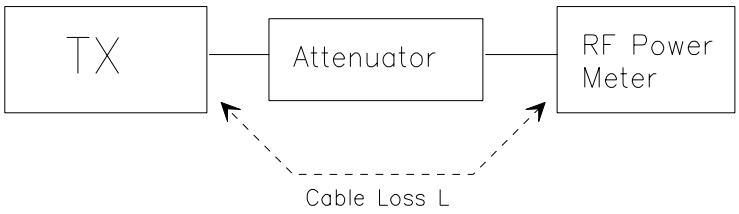
Step 2: Calculation of Average EIRP. See Figure 1

- 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:

EIRP = A + G + 10log(1/x)

{ X = 1 for continuous transmission => 10log(1/x) = 0 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 (dBuV/m) = Reading (dBuV) + 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^{o} 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:	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 (dBuV/m) = Reading (dBuV) + 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
EIRP = P + G1 = P3 + L2 - L1 + A + G1
ERP = EIRP – 2.15 dB
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

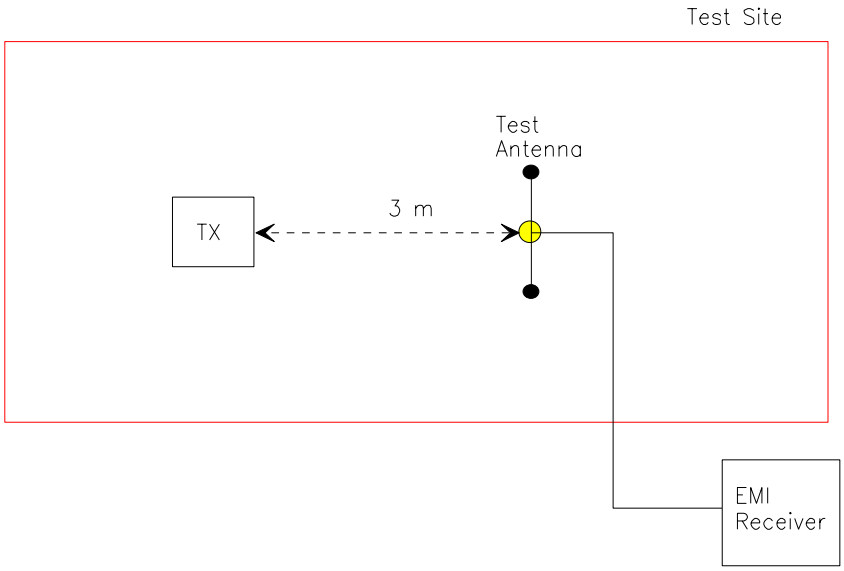
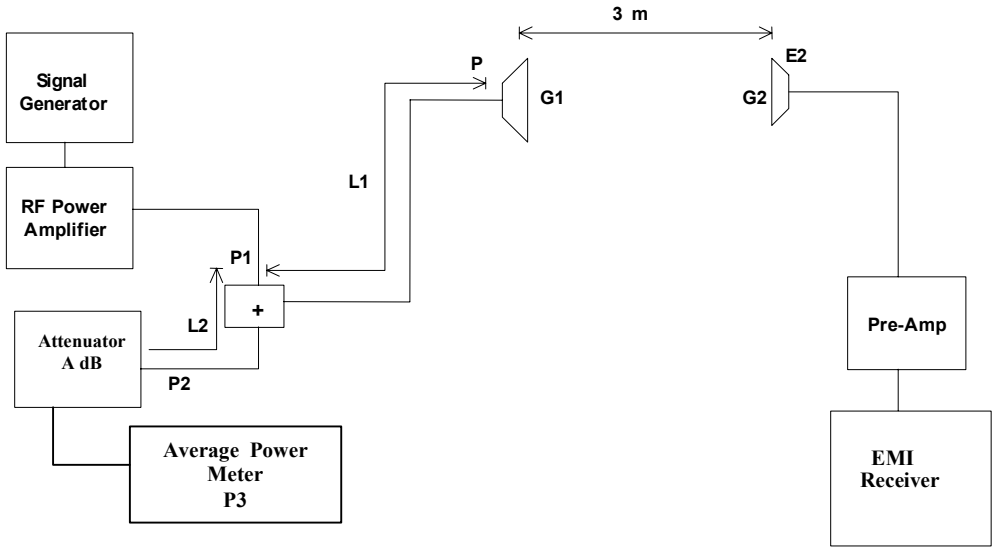


Figure 3



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

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. EMISSION MASK

Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(1):- 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.

8.5. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the EMI Receiver controls set as RBW = 30 kHz minimum , VBW $\geq$ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC 47 CFR, Para. 2.1057 - Frequency spectrum to be investigated: The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC 47 CFR, Para. 2.1051 - Spurious Emissions at Antenna Terminal: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.