

FCC PART 95 EMI MEASUREMENT AND TEST REPORT

For

Tsuen Shing Enterprises Limited

8-10, 8/F, Kar Wah Industrial Bldg., Hei Yip St., YLTL#356
Yuen Long, NT, Hong Kong

FCC ID: PERWT402

October 8, 2001

This Report Concerns: ☒ Original Report	Equipment Type: Family Radio Service, Personal Radio Service
Test Engineer: Jeff Lee	
Test Date: September 28, 2001	
Reviewed By: 	
John Y. Chan – Engineering Manager	
Prepared By: Bay Area Compliance Laboratory Corporation 230 Commercial Street, Suite 2 Sunnyvale, CA 94085 Tel: (408) 732-9162 Fax: (408) 732 9164	

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1 – General Information

1.1 Product Description for Equipment Under Test (EUT)

The *Tsuen Shing Enterprises Limited.*'s product, FCC ID: *PERWT402* or the "EUT" as referred to in this report is a family radio transmitter which measures approximately 2.25' L x 1.25' W x 6.0' H.

For marketing purposes, the manufacturer would like to apply different model names to the EUT as following: WT-402, WT-404. The products are identical with reference to EMI emissions.

1.2 Objective

This report is prepared on behalf of *Tsuen Shing Enterprises Limited.* in accordance with Part 95 Subpart B of the Federal Communication Commissions rules.

The objective of the manufacturer is to demonstrate compliance with FCC rules for effective radiated power, modulation characteristics, occupied bandwidth, radiated spurious emissions, AC line conducted emissions and frequency stability.

1.3 Test Methodology

All measurements contained in this report were conducted with 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. All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.4 Test Facility

The Open Area Test site used by Bay Area Compliance Laboratory Corporation to collect radiated and conducted emission measurement data is located in the back parking lot of the building at 230 Commercial Street, Suite 2, Sunnyvale, California, USA.

Test site at Bay Area Compliance Laboratory Corporation has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-1992.

The Federal Communications Commission and Voluntary Control Council for Interference has the reports on file and is listed under FCC file 31040/SIT 1300F2 and VCCI Registration No.: C-1298 and R-1234. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, Bay Area Compliance Laboratory Corporation is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (NVLAP). The scope of the accreditation covers the FCC Method - 47 CFR Part 15 - Digital Devices, IEC/CISPR 22: 1998, and AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment test methods under NVLAP Lab Code 200167-0.

1.5 Test Equipment List

Manufacturer	Description	Model	Serial Number	Cal. Due Date
HP	Spectrum Analyzer	8564E	08303	12/6/01
HP	Spectrum Analyzer	8593B	2919A00242	12/20/01
HP	Amplifier	8349B	2644A02662	12/20/01
HP	Quasi-Peak Adapter	85650A	917059	12/6/01
HP	Amplifier	8447E	1937A01046	12/6/01
A.H. System	Horn Antenna	SAS0200/571	261	12/27/01
Com-Power	Log Periodic Antenna	AL-100	16005	11/2/01
Com-Power	Biconical Antenna	AB-100	14012	11/2/01
Solar Electronics	LISN	8012-50-R-24-BNC	968447	12/28/01
Com-Power	LISN	LI-200	12208	12/20/01
Com-Power	LISN	LI-200	12005	12/20/01
BACL	Data Entry Software	DES1	0001	12/20/01
Rohde & Schwarz	Signal Generator	SMIQ03B	1125.5555.03	7/10/02
Rohde & Schwarz	I/Q Modulation Generator	AMIQ	1110.2003.02	8/10/02

1.6 Equipment Under Test (EUT)

Manufacturer	Description	Model	Serial Number	FCC ID
Tsuen Shing Enterprises Limited.	Family Radio Transmitter	WT-402, WT-404	None	PERWT402

2 – System Test Configuration

2.1 Justification

The EUT was tested under typical operating modes to represent the worst case results during the final qualification test.

2.2 EUT Exercise Software

The EUT was powered and fully operated with option speaker/microphone connected. The unit was powered from 4 fully charged AAA batteries.

2.3 Special Accessories

As shown in section 2.5, interface cable used for compliance testing is shielded as normally supplied by customer and its respective support equipment manufacturers.

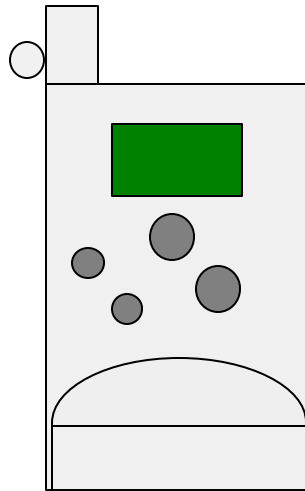
2.4 Schematics / Block Diagram

Appendix A contains a copy of the EUT's schematics diagram as reference.

2.5 Equipment Modifications

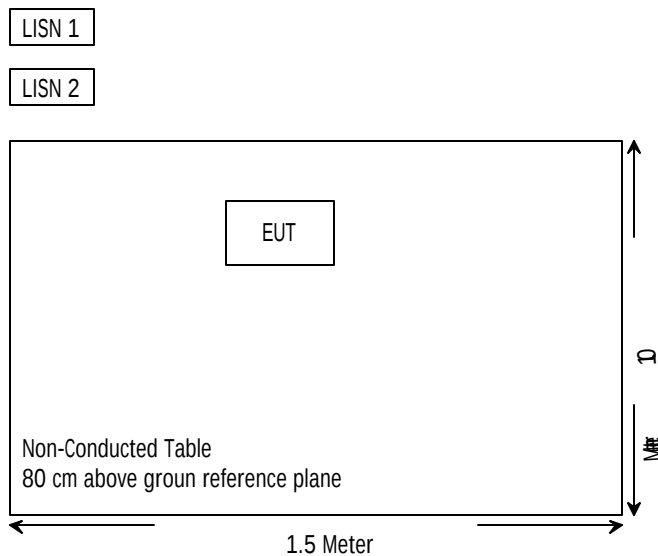
No modification was made by BACL Corp. to make sure the EUT to comply with the applicable limits.

2.6 Configuration of Test System



2.7 Test Setup Block Diagram

For tabletop systems, the EUT shall be centered laterally on the tabletop and its rear shall be flushed with the rear of the table. If the EUT is a stand-alone unit, it shall be placed in the center of the tabletop.



3 – Requirements of Provisions

3.1 Definition

Per FCC §95.191, the user is subject to the requirements on eligibility and responsibility, authorized locations, type of communications and FRS unit.

Per FCC §95.627, the FRS unit channel frequencies are:

<u>Channel No.</u>	<u>MHz</u>	<u>Channel No.</u>	<u>MHz</u>
1	462.5625	8	467.5625
2	462.5875	9	467.5875
3	462.6125	10	467.6125
4	462.6375	11	467.6375
5	462.6625	12	467.6625
6	462.6875	13	467.6875
7	462.7125	14	467.7125

3.2 Requirements and Test Summary

FCC Rules	Rules Description	Test Requirements	Test Results
Transmitter Section			
2.1046 95.639 (d)	Effective Radiated Power	< 0.500w	0.261w
2.1047 95.631 (d) 95.637 (a)	Modulation Characteristics F3E analogy voice Peak Frequency Deviation Audio Frequency Response	Deviation: < 2.5 kHz	2.4kHz
2.1049 95.633 (c)	Occupied Bandwidth	12.5 kHz	Pass
2.1053 95.635	Field Strength of Spurious Radiation	Attenuation by 43+10lgP	Worst Case Frequency: 925.42 MHz Margin: -1.0 dB
95.635	Spurious Emission	See the plots	Pass
15.107	Line Conducted Emissions		
2.1055 95.621	Frequency Stability Vs. Temperature Vs. Voltage	<2.5ppm	Pass
Receiver Section			
15.109 (a)	Radiated Emission	See the Standards	Worst case frequency: 925.42 MHz Margin: -1.0 dB

3.3 Labeling Requirement

Each equipment for which a type acceptance applications is filed on or after May 1, 1981, shall bear an identification plate or label pursuant to §2.295 (Identification of Equipment) and §2.926 (FCC identifier)

4 – Effective Radiated Power

4.1 Provision Applicable

Per FCC §2.1046 and FCC § 95.639, no FRS unit, under any condition of modulation, shall exceed 0.500W effective radiated power (ERP).

4.2 Test Procedure

1. Place the EUT on the bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

4.3 Test equipment

Hewlett Packard HP8566B Spectrum Analyzer (S.A.)

4.4 Test Results

Alternative Measurement

- Connect the antenna from the EUT to a power meter.

Manufacturer: HP

Model: HP463A

Serial #: 1507A14038

Last Calibration: 2/5/01

Calibration Due Day: 2/5/02

Result: Pass.

The measured result showed as follows:

Low Frequency: 24.17dBm at 462.5625MHz

High Frequency: 24.17dBm at 467.7125MHz

5 – Modulation Characteristics

5.1 Provision Applicable

Per FCC § 2.1047 and FCC §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, and the audio frequency response must not exceed 3.125 kHz.

5.2 Test Procedure

5.2.1 Audio Frequency Response

The RF output of the transceiver was connected to the input of a FM deviation meter through sufficient attenuation so as not to overload the meter or distort the reading. An audio signal generator was coupled into the external microphone jack of the transceiver, or alternatively, the microphone element was removed the generator output was connected to the microphone connectors.

The audio signal input level was adjusted to obtain 20% of the maximum rated system deviation at 1 kHz, and recorded as DEV_{REF}. With the audio signal generator level unchanged, set the generator frequency between 300 Hz to 5000 Hz. The transmitter deviations (DEV_{FREQ}) were measured and the audio frequency response was calculated as

$$20\log_{10} [\text{DEV}_{\text{FREQ}} / \text{DEV}_{\text{REF}}]$$

5.2.2 Audio Low-Pass Filter Response

An audio signal generator and an audio spectrum analyzer were connected to the input and output of the post limiter low pass filter respectively. The audio signal generator frequency was set between 1000 MHz and the upper low pass filter limit. The audio frequency response at test frequency was calculated as

$$\text{LEV}_{\text{FREQ}} - \text{LEV}_{\text{REF}}$$

5.2.3 Modulation Limiting

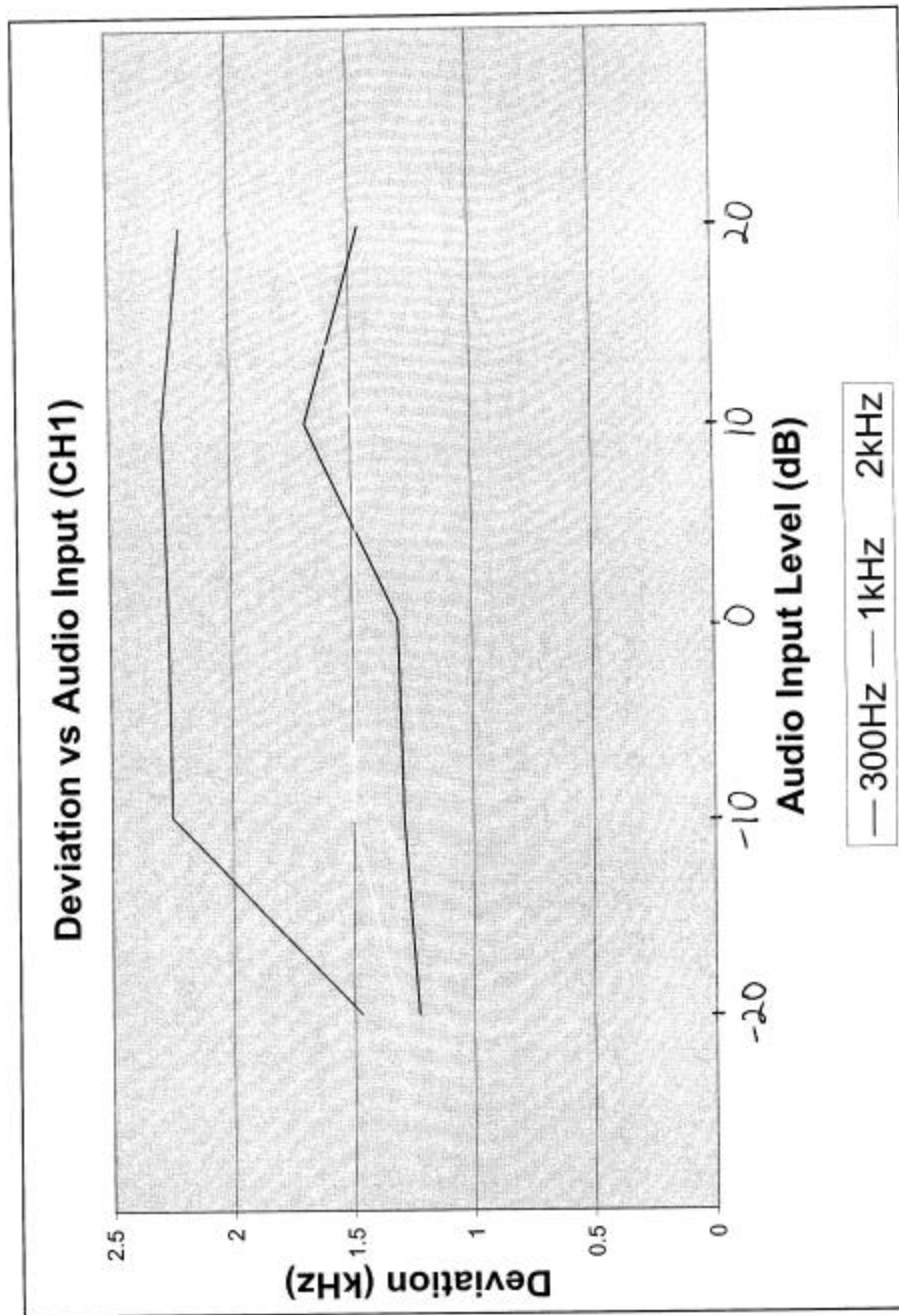
With the same setup as section 5.2.1 above, at three different modulating frequencies, the output level of the audio generator was varied and the FM deviation level was recorded.

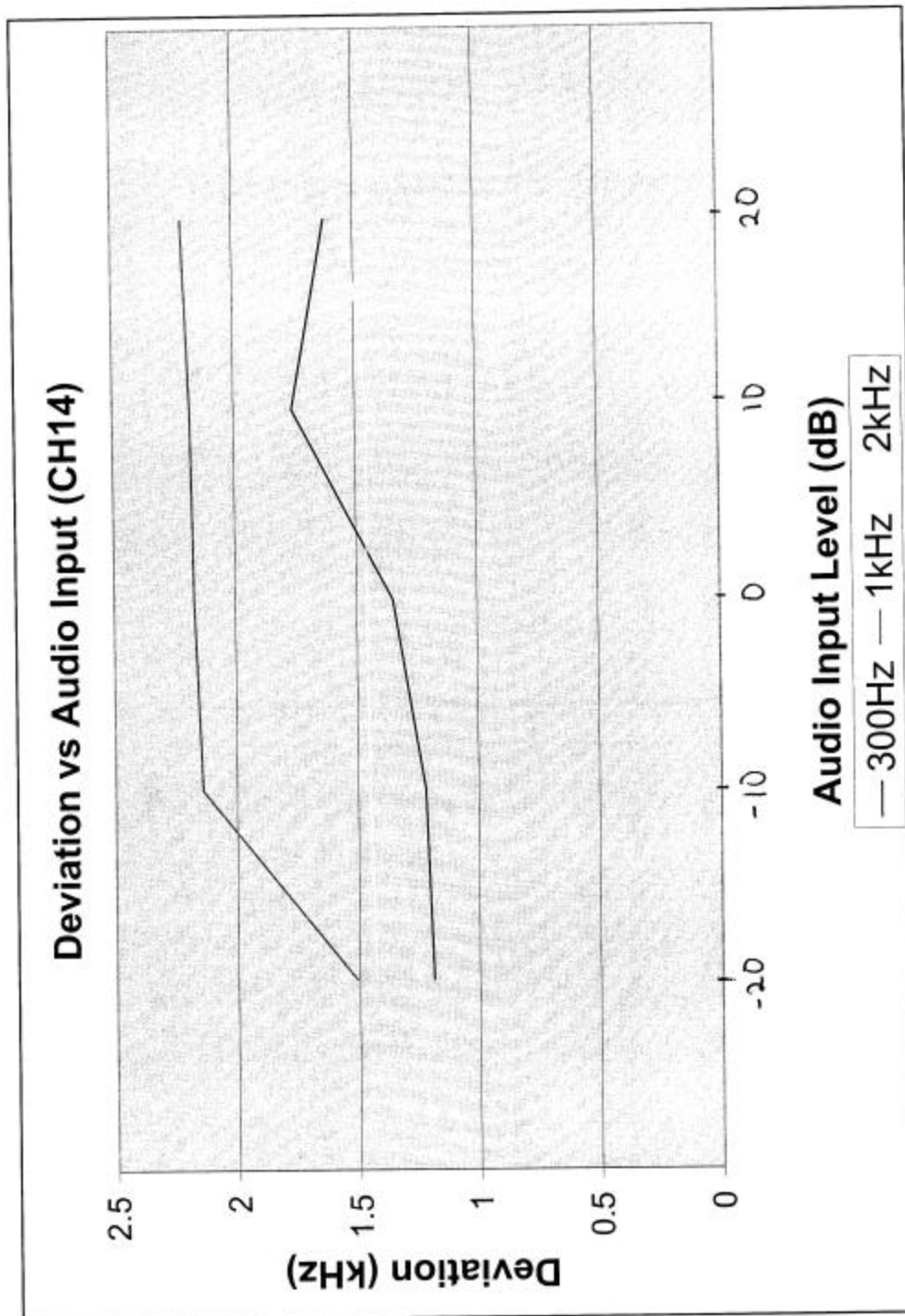
5.3 Test Equipment

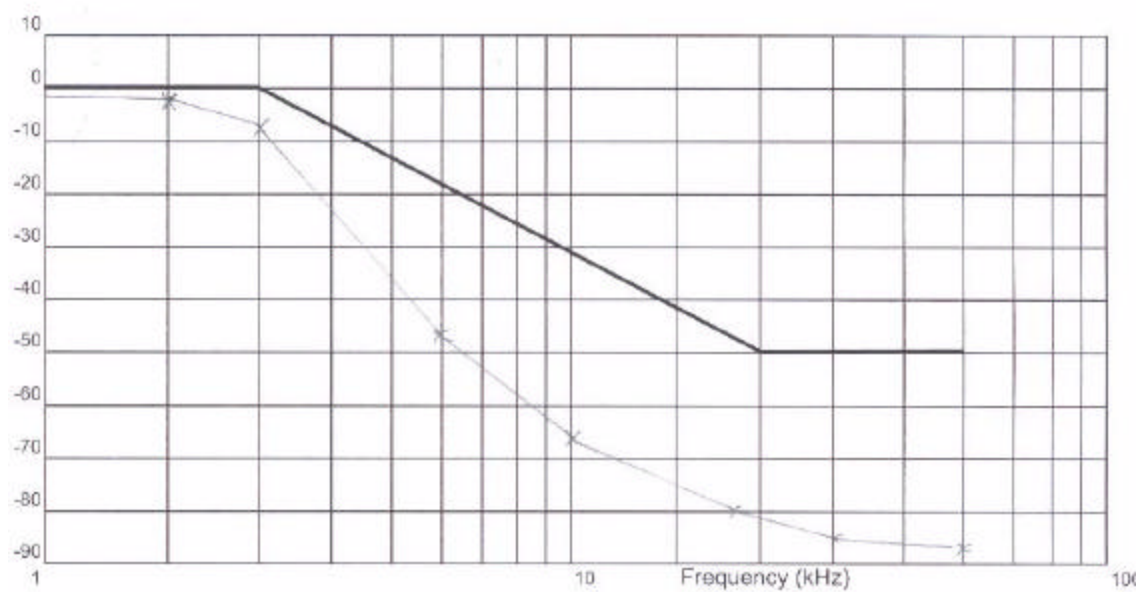
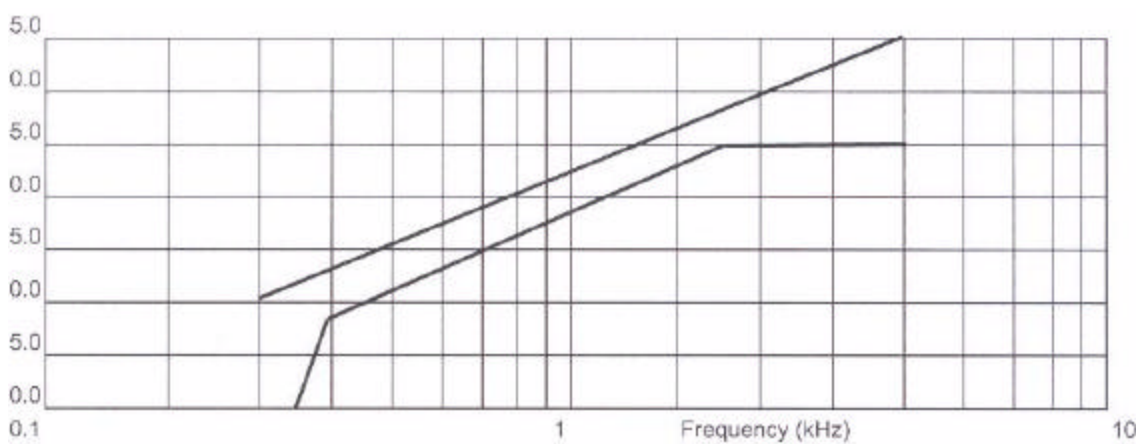
Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Hewlett Packard HP8901A Modulation Analyzer
Lecroy 9350A Oscilloscope

5.4 Test Results

The plot(s) of modulation characteristic is presented hereinafter as reference.







6 – Occupied Bandwidth of Emission

6.1 Provision Applicable

Per FCC §2.1049 and FCC §95.633 (c), the authorized bandwidth for emission type F3E transmitted by a FRS unit is 12.5 kHz.

6.2 Test Procedure

The antenna was disconnected from the transmitter and the short cable was connected to the transmitter RF output.

The RF output was connected to the input of the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set up at least 10 times higher than the authorized bandwidth of the transmitter. With the transmitter keyed, the level of the unmodulated carrier was set to the full scale reference line of the spectrum analyzer. This is used as a 0dB reference for emission mask measurements.

The transmitter was then modulated with a 3750 Hz tone at an input level 20 dB greater than the necessary to produce 50% of rated system deviation. The resolution bandwidth of the spectrum analyzer was set up to 100 Hz and the spectrum of the transmitting signal was recorded. This spectrum was compared to the required emission mask.

6.3 Test Equipment

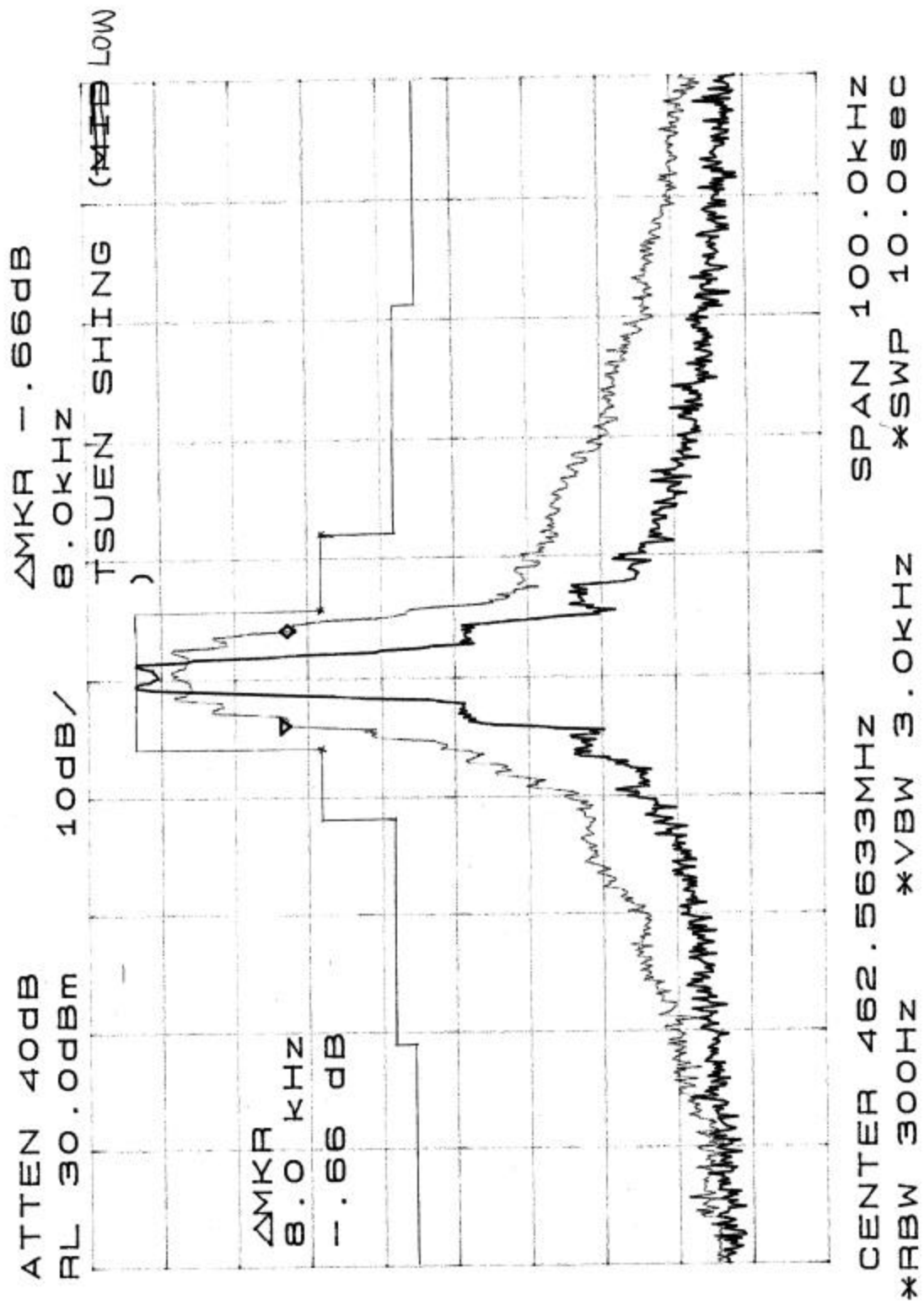
Leader LFG-1300S Function Generator
Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter

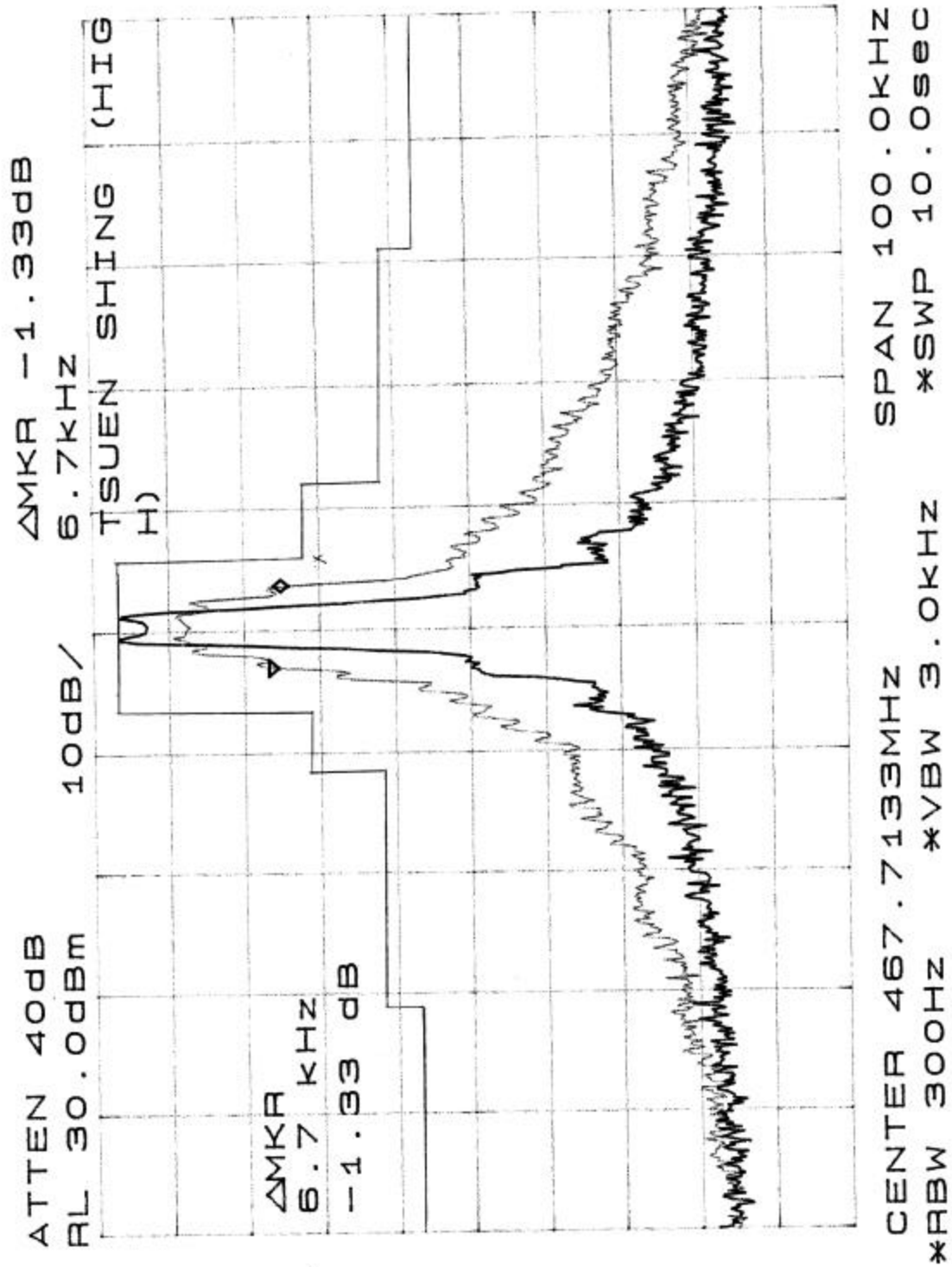
6.4 Test Results

Test Result: Pass
Please refer the following curve and plots.

6.5 Emission Designator

$2M + 2D = (2 \times 3 \text{ kHz}) + (2 \times 2.5 \text{ kHz}) = 11K0F3E$





7 – Field Strength of Emission

7.1 Provision Applicable

According to FCC §2.1053, measurements shall be made to detect spurious emission that may be radiated directly from the cabinet, control circuits, power leads, or intermediated circuit elements under normal condition of installation and operation. Information submitted shall include the relative radiated power of spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from a halfwave dipole antenna.

7.2 Test Procedure

The transmitter was placed on a wooden turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3 orthogonal axis.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.

The spurious harmonic attenuation was calculated as the difference between E in dB (uV/m) at the fundamental frequency and at the spurious emission frequency.

Spurious attenuation limit in dB = $43 + 10 \log_{10} (\text{power out in Watts})$

7.3 Test Equipment

CDI B100/200/300 Biconical Antennas
EMCO Bi-logcon Antenna
EMCO 3115 Horn Antenna
HP 8566B Spectrum Analyzer
Preamplifiers

7.4 Test Results

7.4.1 Final Test Data at 462.5625 MHz, 30 - 10000MHz

INDICATED		TABLE	ANTENNA		CORRECTION FACTOR			CORRECTED AMPLITUDE	FCC 95	
Frequency MHz	Ampl. dBmV/m	Angle Degree	Height Meter	Polar H/ V	Antenna dBmV/m	Cable dB	Amp. dB	Corr. Ampl. dBmV/m	Limit dBmV/m	Margin dB
462.56	120.3	270	2.1	H	17.8	3.7	25.0	119.4		
462.56	111.7	270	3.0	V	17.8	3.7	25.0	118.7		
925.22	81.9	90	1.0	H	24.7	4.4	30.0	81.0	82.23	-1.2
1387.63	78.5	90	1.0	H	25.9	3.7	30.0	78.1	82.23	-4.1
925.22	76.0	270	1.2	V	24.7	4.4	30.0	75.1	82.23	-7.1
1387.63	67.7	90	1.5	V	25.9	3.7	30.0	67.3	82.23	-14.9
317.36	48.67	270	1.0	H	15.9	3.7	25.0	43.3	82.23	-39.0
444.91	47.4	180	1.5	H	17.4	2.7	25.0	42.5	82.23	-39.7
282.82	38.7	90	1.0	H	14.6	5.8	25.0	34.1	82.23	-48.2
114.44	45.0	180	2.0	V	11.7	1.3	25.0	33.0	82.23	-49.2

7.4.2 Test Data at 467.7125 MHz, 10000 MHz

INDICATED		TABLE	ANTENNA		CORRECTION FACTOR			CORRECTED AMPLITUDE	FCC 95	
Frequency MHz	Ampl. dBmV/m	Angle Degree	Height Meter	Polar H/ V	Antenna dBmV/m	Cable dB	Amp. dB	Corr. Ampl. dBmV/m	Limit dBmV/m	Margin dB
467.71	120.7	270	1	H	17.8	3.7	25.0	119.4		
467.71	109.8	45	2.1	V	17.8	3.7	25.0	118.7		
935.41	82.9	270	1.0	H	24.6	3.7	30.0	81.2	82.29	-1.1
1403.12	78	270	1	H	25.9	3.7	30.0	77.6	82.29	-4.7
935.41	78.6	180	2.5	V	24.6	3.7	30.0	76.9	82.29	-5.4
1403.12	65.35	180	1.2	V	25.9	3.7	30.0	65.0	82.29	-17.3
601.41	41.17	135	2	H	20.1	3.0	25.0	39.3	82.29	-43.0
400.93	40.2	180	2.0	H	16.5	2.9	25.0	34.6	82.29	-47.7
126.89	42.5	315	2.0	V	12.3	1.8	25.0	31.6	82.29	-50.7
168.27	38.3	180	3.0	V	13.3	2.1	25.0	28.7	82.29	-53.6

8 – Spurious Emission

8.1 Standard Applicable

Per FCC §95.635 (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.

Per FCC §95.635 (3), 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.

Per FCC §95.635 (7), at least $43 \pm 10 \log_{10}(T)$ dB on any frequency removed from the center of the authorized bandwidth by more than 250%.

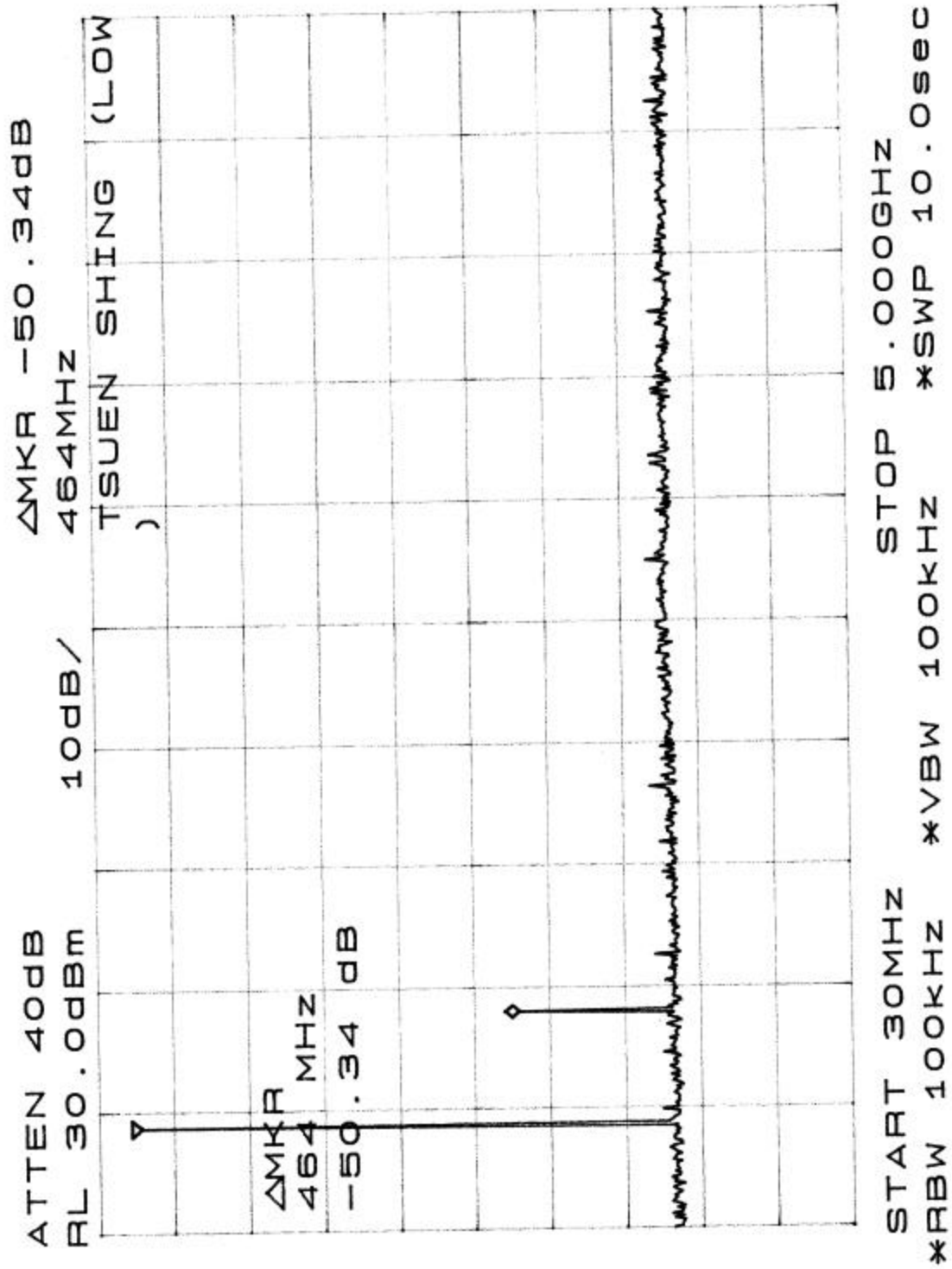
8.2 Measurement Procedure

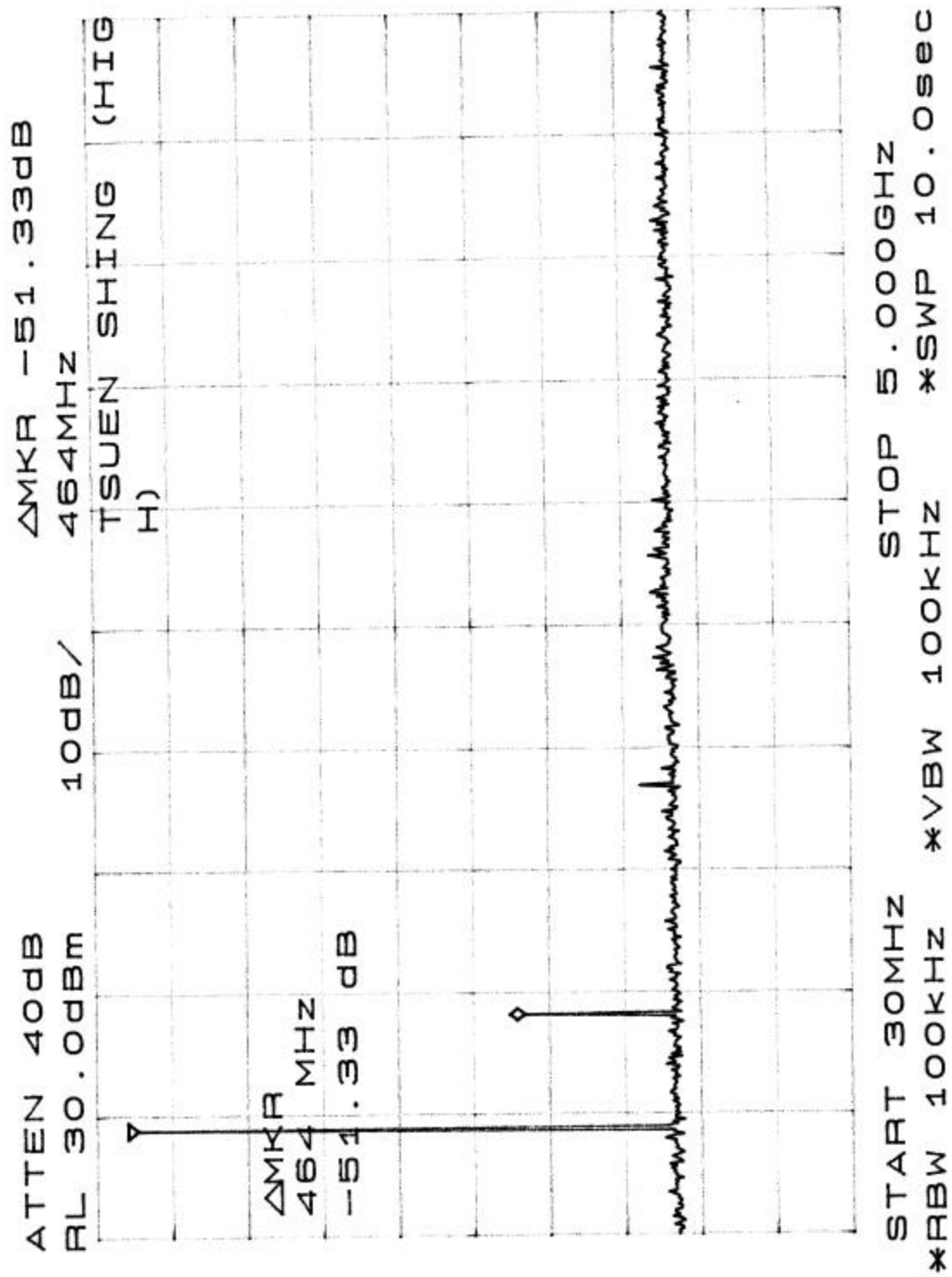
1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set the SA on Max-Hold Mode, and then keep the EUT in transmitting mode. Record all the signals from each channel until each one has been recorded.
4. Set the SA on View mode and then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.
6. Spurious attenuation limits in dB = $43 + 10\log_{10}(\text{power out in Watts})$

8.3 Test Result

Result: Pass

Please refer the hereinafter plots for more information.





9 – AC Line Conducted Emissions

9.1 Applicable Requirements

According to ANSI C63.4 and FCC §15.107, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is connected back onto the AC power line on any frequency or frequencies within the band 450 kHz to 30 MHz shall not exceed 250 microvolts. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

9.2 Test Procedure

The EUT shall be connected to the DC power supply which shall be connected to the AC line through the first LISN. Both hot and neutral leads shall be tested.

9.3 Test Equipment

HP 8566B Spectrum Analyzer
LSIN

9.4 Test Results

Not applicable because of battery operation.

10 – Frequency Stability Measurement

10.1 Provision Applicable

According to FCC §2.1055(a)(1), the frequency stability shall be measure with variation of ambient temperature from -30°C to $+50^{\circ}\text{C}$, and according to FCC 2.1055(d)(2), the frequency stability shall be measured with reducing primary supply voltage to the battery operating end point which is specified by the manufacturer.

According to FCC §95.627, each FRS unit must be maintained within a frequency tolerance of 0.00025%.

10.2 Test Procedure

10.2.1 Frequency stability versus environmental temperature

The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feedthrough attenuators. The EUT was placed inside the temperature chamber.

After the temperature stabilized for approximately 20 minutes, the frequency of the output signal was recorded from the counter.

10.2.2 Frequency Stability versus Input Voltage

At room temperature ($25\pm 5^{\circ}\text{C}$), an external variable DC power supply was connected to the EUT. The frequency of the transmitter was measured for 115%, 100% and 85% of the nominal operating input voltage.

10.3 Test Equipment

Temperature Chamber, -50°C to $+100^{\circ}\text{C}$
 Hewlett Packard HP8566B Spectrum Analyzer
 Hewlett Packard HP 7470A Plotter
 Hewlett Packard HP 5383A Frequency Counter
 Goldstar DC Power Supply, GR303

10.4 Test Results

Reference Frequency: 462.56 MHz, Limit: 2.5ppm			
Environment Temperature ($^{\circ}\text{C}$)	Power Supplied (Vdc)	Frequency Measure with Time Elapsed	
		MCF (MHz)	PPM Error
50	New Batt.	462.5610	2.1
40	New Batt.	462.5608	1.7
30	New Batt.	462.5600	0.0
20	New Batt.	462.5611	2.3
10	New Batt.	462.559	-2.1
0	New Batt.	462.5600	0.0
-10	New Batt.	462.5593	-1.5
-20	New Batt.	462.5601	0.2