# FCC CFR47 PART 90, SUBPART I
# CERTIFICATION TEST REPORT

**FOR**

**UHF NARROW BAND MULTI CHANNEL TRANSMITTER**

**MODEL NUMBER: CDP-TX-02E-R 457MHz**

**FCC ID: V9X-CDP02ER457**

**REPORT NUMBER: 08J11754-1, Revision B**

**ISSUE DATE: MAY 30, 2008**

*Prepared for*
**CIRCUIT DESIGN, INC.**
**7557-1, HOTAKA, AZUMINO**
**NAGANO, JAPAN 399-8303**

*Prepared by*
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NVLAP LAB CODE 200065-0

Revision History

| Rev. | Issue Date | Revisions | Revised By |
|---|---|---|---|
| --- | 05/05/08 | Initial Issue | T. Chan |
| B | 05/30/08 | Added MPE, Revised Frequency Stability, and Revised Frequency Range Sections | T. Chan |

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# 1. ATTESTATION OF TEST RESULTS

| | |
|---|---|
| **COMPANY NAME:** | CIRCUIT DESIGN, INC<br>7557-1, HOTAKA, AZUMINO<br>NAGANO, JAPAN 399-8303 |
| **EUT DESCRIPTION:** | UHF NARROW BAND MULTI CHANNEL TRANSMITTER |
| **MODEL:** | CDP-TX-02E-R 457MHz |
| **SERIAL NUMBER:** | H000000 |
| **DATE TESTED:** | APRIL 23 -28, 2008 |

| APPLICABLE STANDARDS | |
|---|---|
| **STANDARD** | **TEST RESULTS** |
| FCC PART 90 SUBPART I | Pass |

Compliance Certification Services, Inc. (CCS) tested the above equipment in accordance with the requirements set forth in the above standards. All expressions of Pass/Fail in this report are opinions expressed by CCS based on interpretations of the test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note**: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Compliance Certification Services and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Compliance Certification Services will constitute fraud and shall nullify the document. No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

Approved & Released For CCS By:

THU CHAN
EMC SUPERVISOR
COMPLIANCE CERTIFICATION SERVICES

Tested By:

CHIN PANG
EMC ENGINEER
COMPLIANCE CERTIFICATION SERVICES

# 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with TIA/EIA 603C (2004), FCC CFR 47 Part 2, and FCC CFR 47 Part 90.

# 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.
CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://www.ccsemc.com.

# 4. CALIBRATION AND UNCERTAINTY

## 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

## 4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| PARAMETER | UNCERTAINTY |
|---|---|
| Power Line Conducted Emission | +/- 2.3 dB |
| Radiated Emission | +/- 3.4 dB |

Uncertainty figures are valid to a confidence level of 95%.

# 5. EQUIPMENT UNDER TEST

## 5.1. DESCRIPTION OF EUT

The EUT is a UHF narrow band multi channel transmitter operates at the frequency of 457.5-457.8875MHz. The module contains 32 selectable channels divided into 2 groups: Group A and Group B, only either one of the two groups can be selected by soldering the jumper ON (Group A) or OFF (Group B), the 16 channels in each group (25 kHz apart) can easily be selected using the 4-bit switch.

## 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

| Frequency Range (MHz) | Modulation | Conducted Output Power (dBm) | Conducted Output Power (W) |
|---|---|---|---|
| 457.5 - 457.8875 | CW | 10.90 | 0.012 |

## 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an Omnidirectional antenna, with a maximum gain of 2.14 dBi.

## 5.4. WORST-CASE CONFIGURATION AND MODE

The EUT with antenna at upright position is determined to be the worst case.

## 5.5. DESCRIPTION OF TEST SETUP

**SUPPORT EQUIPMENT**

| PERIPHERAL SUPPORT EQUIPMENT LIST | | | |
|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** |
| Oscilloscope, Digital | Tektronix | 11403 | B052990 |
| Power Splitter, 5 ~ 500 MHz | MCL | ZFRSC-2-1 | NA |
| Spectrum Analyzer, 40 GHz | Agilent / HP | 8564E | 3943A01643 |
| Arbitrary Waveform Generator | Agilent / HP | 33220A | MY44026694 |

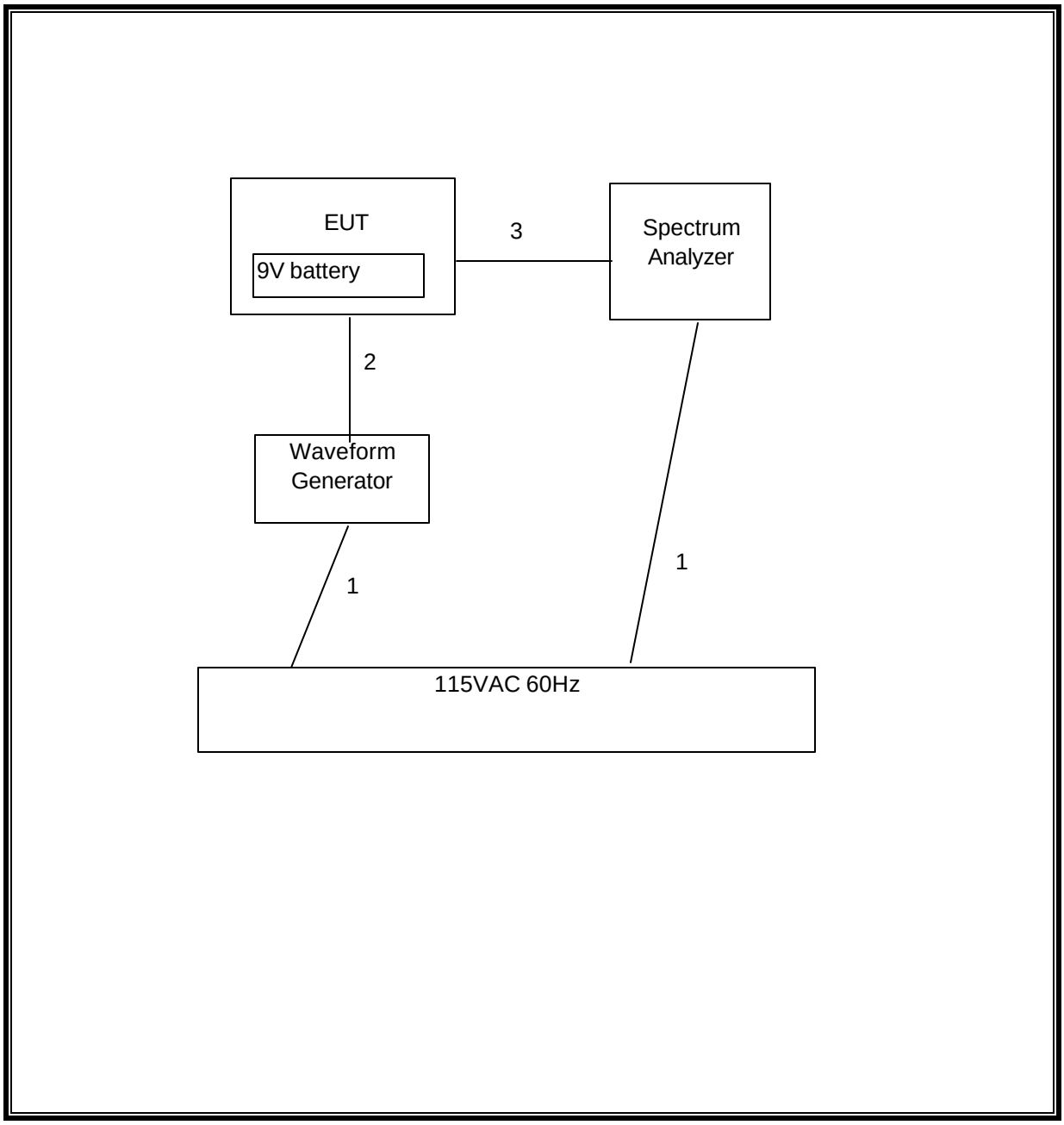
**I/O CABLES**

| I/O CABLE LIST | | | | | | |
|---|---|---|---|---|---|---|
| **Cable No.** | **Port** | **# of Identical Ports** | **Connector Type** | **Cable Type** | **Cable Length** | **Remarks** |
| 1 | AC | 2 | US115V | Un-Shielded | 2m | NA |
| 2 | BNC | 1 | Waveform | Un-Shielded | 2m | NA |
| 3 | Antenna | 1 | Spectrum Analyzer | Un-Shielded | 0.2m | NA |

**TEST SETUP**

The EUT is a stand-alone device. a 1200Hz rectangular waveform is input to the FM transmitter during test

**SETUP DIAGRAM FOR TESTS**



# 6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

| TEST EQUIPMENT LIST | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** | **Cal Due** |
| Arbitrary Waveform Generator | Agilent / HP | 33220A | C01146 | 5/2/2008 |
| Modulation Analyzer | Agilent / HP | 8901B | C00925 | 10/3/2008 |
| Spectrum Analyzer, 44 GHz | Agilent / HP | E4446A | C01012 | 3/3/2009 |
| EMI Receiver, 2.9 GHz | Agilent / HP | 8542E | C00957 | 6/12/2008 |
| RF Filter Section, 2.9 GHz | Agilent / HP | 85420E | C00958 | 6/12/2008 |
| Antenna, Horn, 18 GHz | EMCO | 3115 | C00872 | 4/22/2009 |
| Antenna, Bilog, 2 GHz | Sunol Sciences | JB1 | C01011 | 9/28/2008 |
| Preamplifier, 26.5 GHz | Agilent / HP | 8449B | C01052 | 8/3/2008 |
| Preamplifier, 1300 MHz | Agilent / HP | 8447D | C00885 | 3/31/2009 |
| Spectrum Analyzer, 40 GHz | Agilent / HP | 8564E | C00951 | 12/5/2008 |
| Oscilloscope, Digital | Tektronix | 11403 | N02469 | 11/2/2009 |
| Directional Coupler, 500 W, 40 dB | Werlatone | C6021 | C00907 | 4/23/2009 |
| Power Splitter, 5 ~ 500 MHz | MCL | ZFRSC-2-1 | N01550 | CNR |

# 7. LIMITS AND RESULTS

## 7.1. RF POWER OUTPUT

**LIMIT**

FCC part 90: The Maximum ERP transmitter power will be considered and authorized on a case-by-case basis. Please refer to the limitations on power and antenna heights are specified as Table 2 below.

Table 2—450–470 MHz—Maximum ERP/Reference HAAT for a Specific Service Area Radius

| | Service area radius (km) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **3** | **8** | **13** | **16** | **24** | **32** | **40[4]** | **48[4]** | **64[4]** | **80[4]** |
| Maximum ERP (w)[1] | 2 | 100 | [2]500 | [2]500 | [2]500 | [2]500 | [2]500 | [2]500 | [2]500 | [2]500 |
| Up to reference HAAT (m)[3] | 15 | 15 | 15 | 27 | 63 | 125 | 250 | 410 | 950 | 2700 |

[1]Maximum ERP indicated provides for a 39 dBu signal strength at the edge of the service area per FCC Report R–6602, Fig. 29 (See §73.699, Fig. 10 b).

[2]Maximum ERP of 500 watts allowed. Signal strength at the service area contour may be less than 39 dBu.

[3]When the actual antenna HAAT is greater than the reference HAAT, the allowable ERP will be reduced in accordance with the following equation: $ERP_{allow}=ERP_{max}\times (HAAT_{ref}/HAAT_{actual})^2$.

[4]Applications for this service area radius may be granted upon specific request with justification and must include a technical demonstration that the signal strength at the edge of the service area does not exceed 39 dBu.

at the signal strength at the edge of the service area does not exceed 37 dBu.

**TEST PROCEDURE**

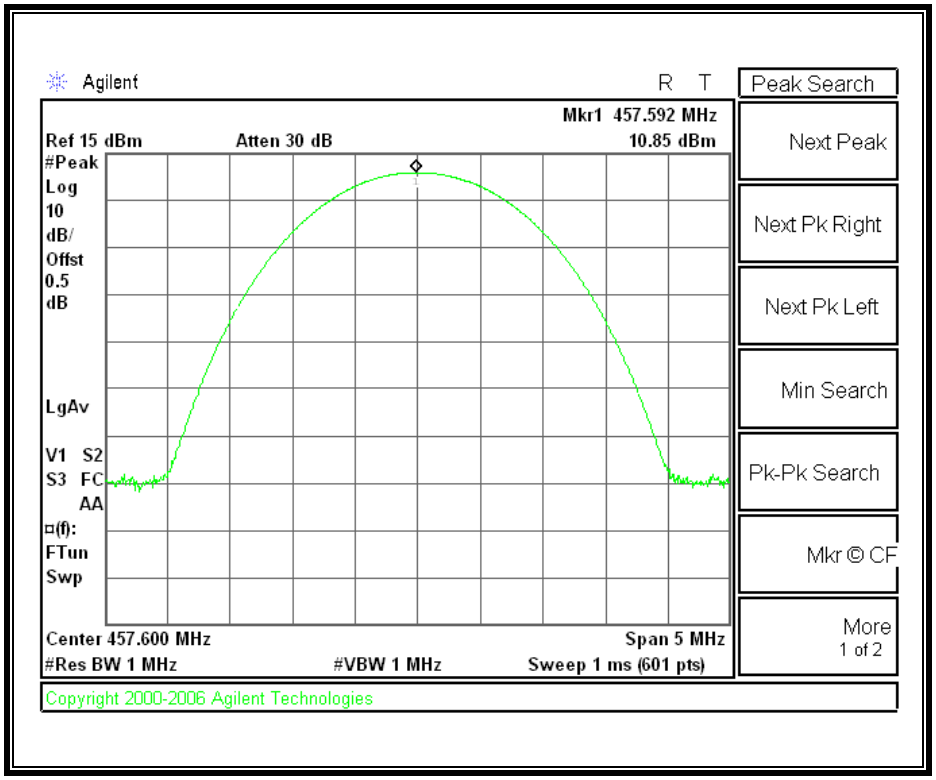
ANSI / TIA / EIA 603 Clause 3.2.1

**RESULTS**

**Conducted Output Power**

CW Output Power

| Channel | Frequency | Conducted Output Power (dBm) | Conducted Output Power (W) | ERP Output Power (dBm) | ERP Output Power (W) |
|---|---|---|---|---|---|
| Mid | 457.6 | 10.92 | 0.012 | 10.80 | 0.012 |



**ERP Output Power**

30 - 1000MHz Substitution Measurement
Compliance Certification Services, Fremont 5m B-Chamber

Company: Cirsuit Design
Project #: 08J11754-1
Date: 04/05/08
Test Engineer: Chin Pang
Configuration: EUT Alone
Mode: Tx On

**Test Equipment:**

| Bilog Antenna | Cable | Limit |
|---|---|---|
| 5m Chamber Sunol Bilog | 5m Chamber Cable | ERP |

| f MHz | SA reading (dBuV/m) | Ant. Pol. (H/V) | SG reading (dBm) | CL (dB) | Gain (dBi) | Gain (dBd) | ERP (dBm) | Notes |
|---|---|---|---|---|---|---|---|---|
| 457.60 | 85.3 | V | 9.4 | 2.5 | 6.1 | 4.0 | 10.8 | |
| 457.60 | 80.0 | H | 3.9 | 2.5 | 6.1 | 4.0 | 5.4 | |

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## 7.2. OCCUPIED BANDWIDTH

**LIMITS**

§ 90.209 Bandwidth limitations.
(5) Unless specified elsewhere, channel spacings and bandwidths that will be authorized in the following frequency bands are given in the following table.

Standard Channel Spacing/Bandwidth

| Frequency band (MHz) | Channel spacing (kHz) | Authorized bandwidth (kHz) |
|---|---|---|
| Below 25[2] | | |
| 25–50 | 20 | 20 |
| 72–76 | 20 | 20 |
| 150–174 | [1]7.5 | [1,3]20/11.25/6 |
| 216–220[5] | 6.25 | 20/11.25/6 |
| 220–222 | 5 | 4 |
| 406–512[2] | [1]6.25 | [13]20/11.25/6 |
| 806–809/851–854 | 12.5 | 20 |
| 809–824/854–869 | 25 | 20 |
| 896–901/935–940 | 12.5 | 13.6 |
| 902–928[4] | | |
| 929–930 | 25 | 20 |
| 1427–1432[5] | 12.5 | 12.5 |
| [3]2450–2483.5[2] | | |
| Above 2500[2] | | |

[1]For stations authorized on or after August 18, 1995.

[2]Bandwidths for radiolocation stations in the 420–450 MHz band and for stations operating in bands subject to this footnote will be reviewed and authorized on a case-by-case basis.

[3]Operations using equipment designed to operate with a 25 kHz channel bandwidth will be authorized a 20 kHz bandwidth. Operations using equipment designed to operate with a 12.5 kHz channel bandwidth will be authorized a 11.25 kHz bandwidth. Operations using equipment designed to operate with a 6.25 kHz channel bandwidth will be authorized a 6 kHz bandwidth.

[4]The maximum authorized bandwidth shall be 12 MHz for non-multilateration LMS operations in the band 909.75–921.75 MHz and 2 MHz in the band 902.00–904.00 MHz. The maximum authorized bandwidth for multilateration LMS operations shall be 5.75 MHz in the 904.00–909.75 MHz band; 2 MHz in the 919.75–921.75 MHz band; 5.75 MHz in the 921.75–927.25 MHz band and its associated 927.25–927.50 MHz narrowband forward link; and 8.00 MHz if the 919.75–921.75 MHz and 921.75–927.25 MHz bands and their associated 927.25–927.50 MHz and 927.50–927.75 MHz narrowband forward links are aggregated.

[5]See §90.259.

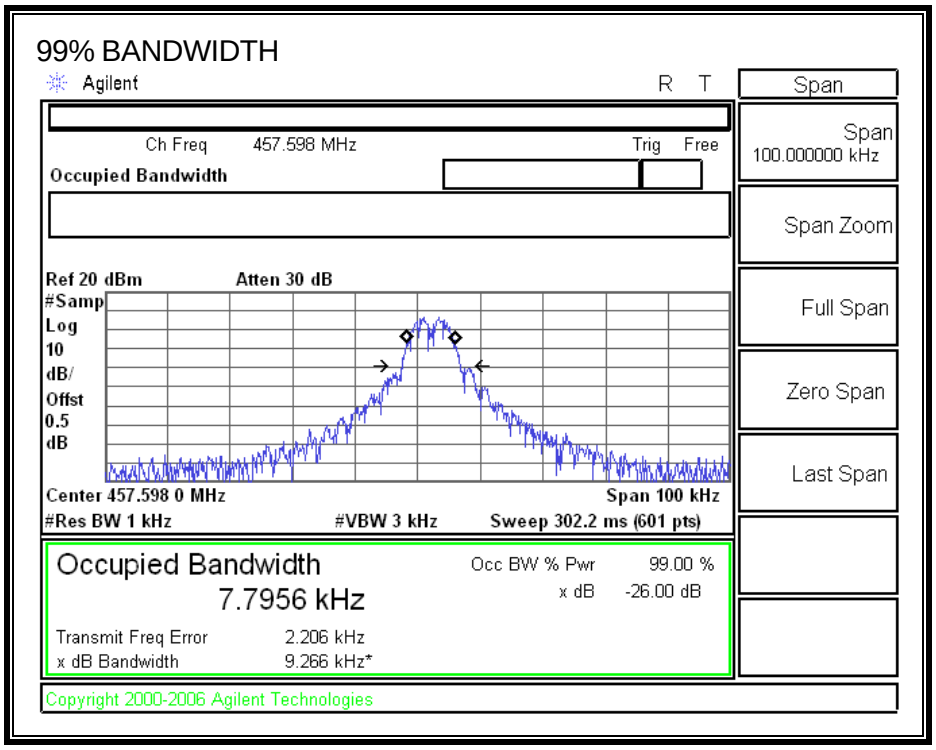
**TEST PROCEDURE**

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99% bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

**RESULTS**

99% BANDWIDTH

| Channel | Frequency (MHz) | Bandwidth (kHz) |
|---|---|---|
| Middle | 457.6 | 7.7956 |



## 7.3. EMISSION MASK

**LIMIT**

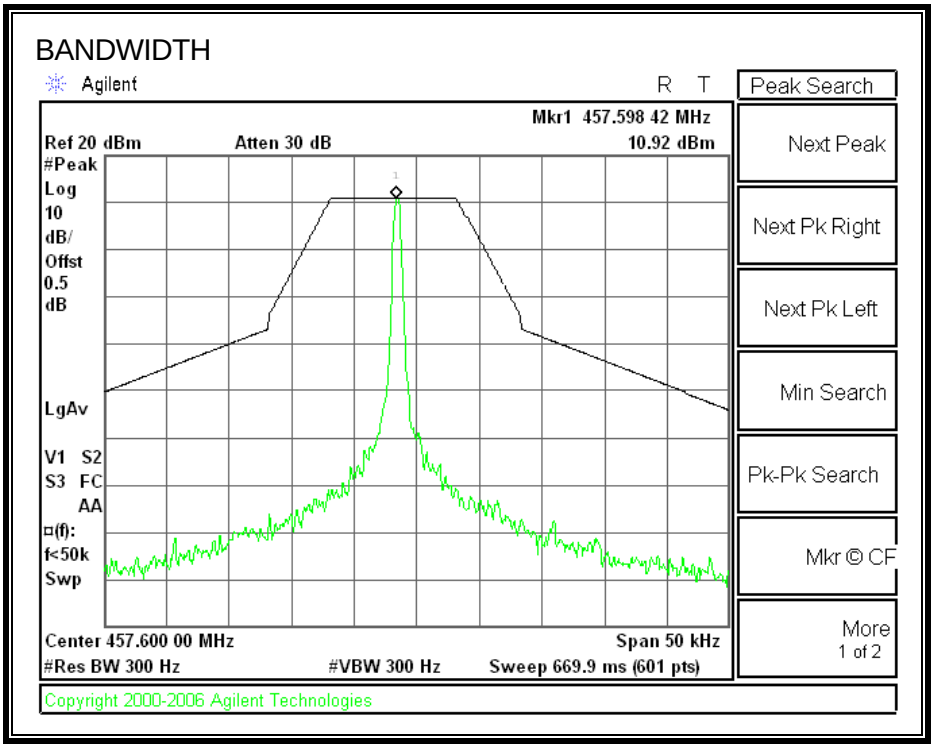
§ 90.210 Emission masks
(c) Emission Mask C. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:
(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (fd/5) dB;
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (fd 2/11) dB or 50 dB, whichever is the lesser attenuation;
(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

**TEST PROCEDURE**

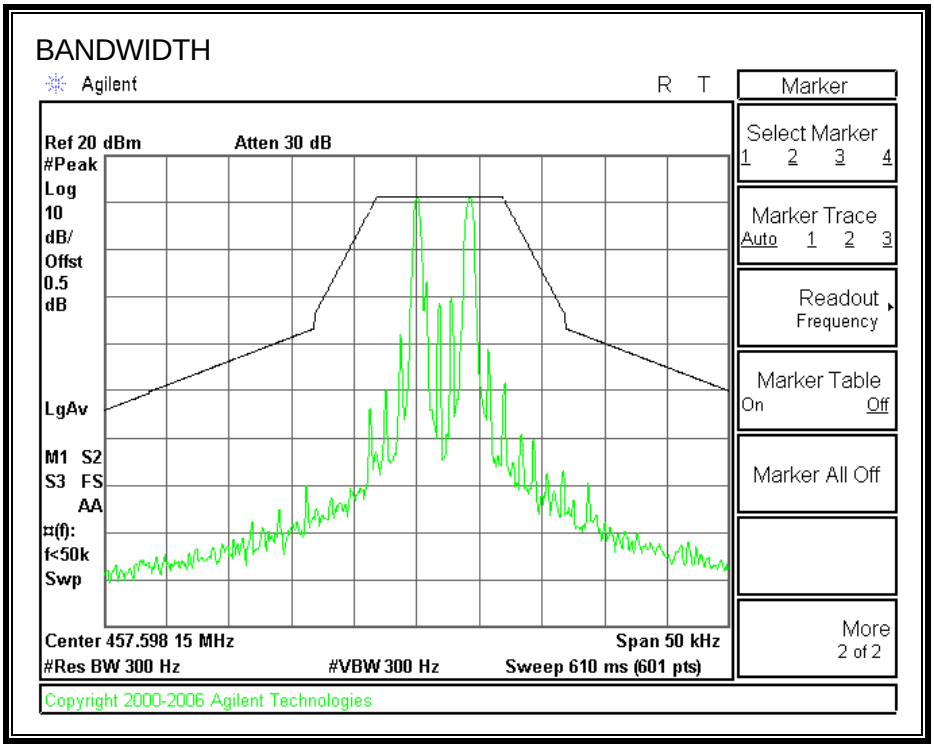
ANSI / TIA / EIA 603 Clause 3.2.13, & FCC 90.210

**RESULTS**

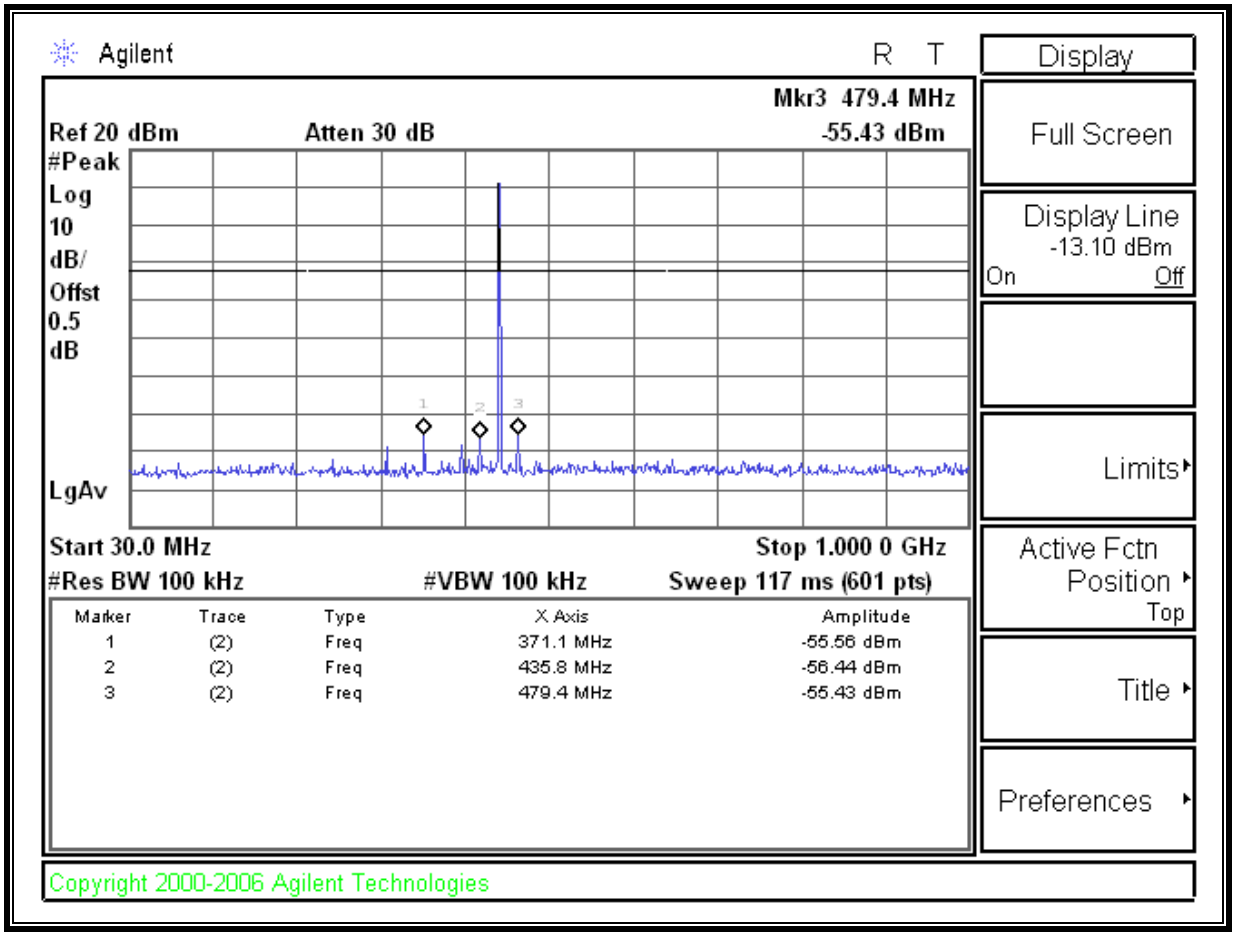
**C MASK**



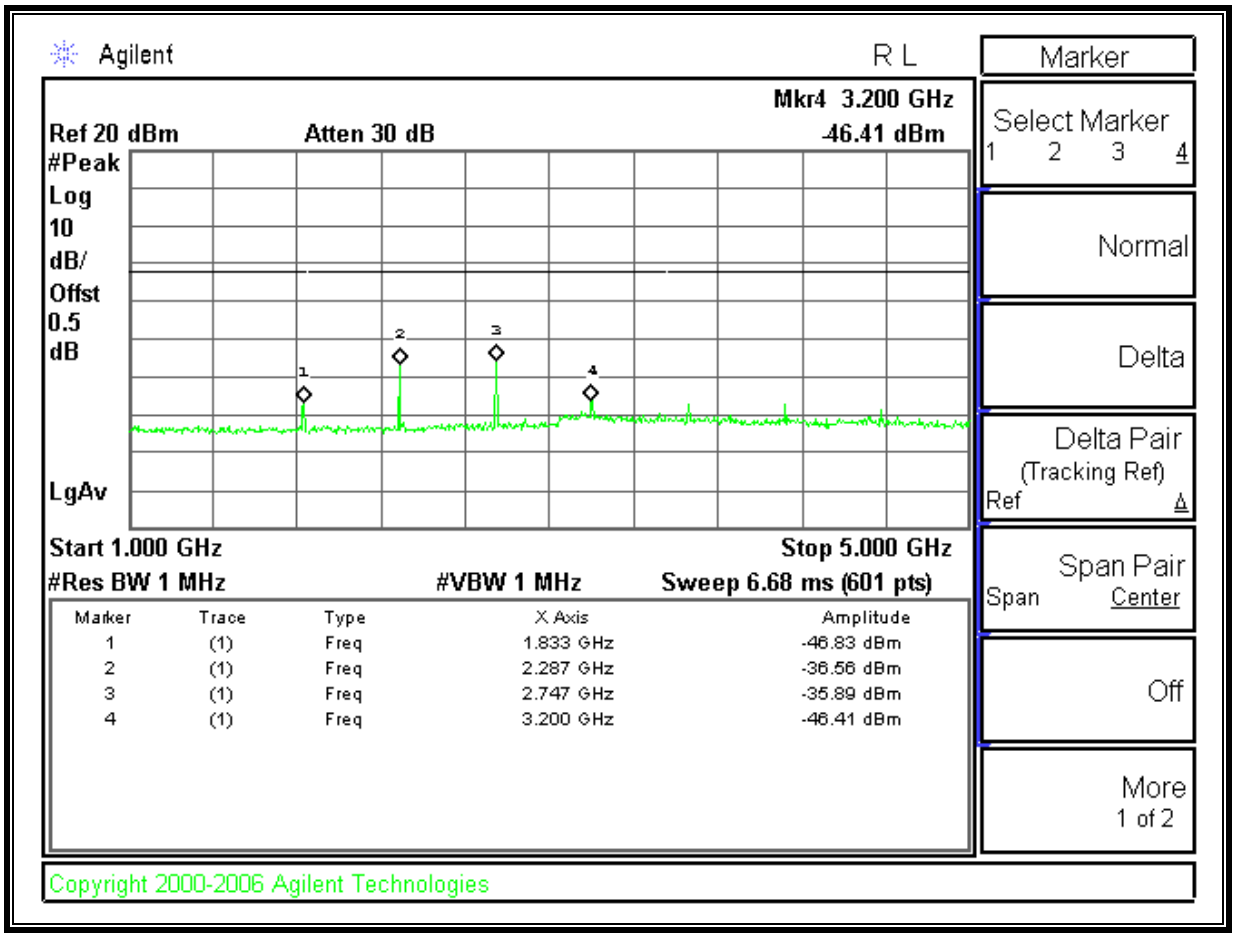
**C MASK WITH MODULATION**



**CONDUCTED SPURIOUS, 30MHz to 1000MHz**



**CONDUCTED SPURIOUS, 1000MHz to 5000MHz**



## 7.4. FIELD STRENGTH OF SPURIOUS RADIATION

**LIMIT**

§90.210 Out of band emissions, The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

**TEST PROCEDURE**

ANSI / TIA / EIA 603 Clause 3.2.13, & FCC 90.210

**RESULTS**

## 7.4.1. 30MHz TO 1000MHz SPURIOUS RADIATION

**Spurious & Harmonic (ERP)**

30 - 1000MHz Substitution Measurement
Compliance Certification Services, Fremont 5m B-Chamber

Company: Circuit Design
Project #: 08J11754
Date: 4/25/2009
Test Engineer: Chin Pang
Configuration: EUT with antenna
Mode: TX ( 457.6MHz )

Test Equipment:

| Bilog Antenna | Cable | Pre-amplifer 8447D | Limit |
|---|---|---|---|
| 5m Chamber Sunol Bilog | 5m Chamber Cable | T5 8447D | ERP |

| f MHz | SA reading (dBuV/m) | Ant. Pol. (H/V) | SG reading (dBm) | CL (dB) | Gain (dBi) | Gain (dBd) | ERP (dBm) | Limit (dBm) | Margin (dB) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| 414.80 | 54.0 | V | -50.4 | 2.4 | 6.1 | 3.9 | -48.9 | -13.0 | -35.9 | |
| 479.40 | 57.0 | V | -46.4 | 2.6 | 6.2 | 4.0 | -45.1 | -13.0 | -32.1 | |
| 915.90 | 79.0 | V | -18.2 | 3.7 | 6.8 | 4.6 | -17.2 | -13.0 | -4.2 | |
| 478.40 | 52.0 | H | -51.6 | 2.6 | 6.1 | 4.0 | -50.2 | -13.0 | -37.2 | |
| 915.60 | 65.0 | H | -32.4 | 3.7 | 6.8 | 4.6 | -31.4 | -13.0 | -18.4 | |

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## 7.4.2. 1000MHz TO 5000MHz SPURIOUS RADIATION

High Frequency Substitution Measurement
Compliance Certification Services, Fremont 5m B-Chamber

Company: Circuit Design
Project #: 08J11754
Date: 4/25/2008
Test Engineer: Chin Pang
Configuration: EUT with antenna
Mode: TX

Test Equipment:

EMCO Horn 1-18GHz: T73; S/N: 6717 @3m
Horn > 18GHz:
Limit: ERP
High Pass Filter: ☐
Hi Frequency Cables: ☐ (2 ft) ☐ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☑ (12 ft)
Pre-amplifer 1-26GHz: T144 Miteq 3008A0(
Pre-amplifer 26-40GHz:

| f GHz | SA reading (dBuV/m) | Ant. Pol. (H/V) | SG reading (dBm) | CL (dB) | Gain (dBi) | Gain (dBd) | ERP (dBm) | Limit (dBm) | Margin (dB) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.833 | 58.9 | H | -49.3 | 4.1 | 8.4 | 6.3 | -47.1 | -13.0 | -34.1 | |
| 2.287 | 62.0 | H | -44.4 | 4.7 | 9.3 | 7.2 | -41.9 | -13.0 | -28.9 | |
| 2.747 | 70.0 | H | -34.4 | 5.1 | 9.7 | 7.5 | -32.0 | -13.0 | -19.0 | |
| 3.200 | 52.0 | H | -50.5 | 5.5 | 9.8 | 7.6 | -48.4 | -13.0 | -35.4 | |
| 1.833 | 69.0 | V | -39.9 | 4.1 | 8.4 | 6.3 | -37.7 | -13.0 | -24.7 | |
| 2.287 | 69.5 | V | -37.1 | 4.7 | 9.3 | 7.2 | -34.6 | -13.0 | -21.6 | |
| 2.747 | 72.0 | V | -32.6 | 5.1 | 9.7 | 7.5 | -30.2 | -13.0 | -17.2 | |
| 3.200 | 54.0 | V | -48.6 | 5.5 | 9.8 | 7.6 | -46.5 | -13.0 | -33.5 | |

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## 7.5. FREQUENCY STABILITY

**LIMIT**

§90.213 Frequency stability

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

**Minimum Frequency Stability**

[Parts per million (ppm)]

| Frequency range (MHz) | Fixed and base stations | Mobile stations | |
|---|---|---|---|
| | | Over 2 watts output power | 2 watts or less output power |
| Below 25 | [1,2,3]100 | 100 | 200 |
| 25–50 | 20 | 20 | 50 |
| 72–76 | 5 | | 50 |
| 150–174 | [5,11]5 | [6]5 | [4,6]50 |
| 216–220 | 1.0 | | 1.0 |
| 220–222[12] | 0.1 | 1.5 | 1.5 |
| 421–512 | [7,11,14]2.5 | [8]5 | [8]5 |
| 806–809 | [14]1.0 | 1.5 | 1.5 |
| 809–824 | [14]1.5 | 2.5 | 2.5 |
| 851–854 | 1.0 | 1.5 | 1.5 |
| 854–869 | 1.5 | 2.5 | 2.5 |
| 896–901 | [14]0.1 | 1.5 | 1.5 |
| 902–928 | 2.5 | 2.5 | 2.5 |
| 902–928[13] | 2.5 | 2.5 | 2.5 |
| 929–930 | 1.5 | | |
| 935–940 | 0.1 | 1.5 | 1.5 |
| 1427–1435 | [9]300 | 300 | 300 |
| Above 2450[10] | | | |

[1]Fixed and base stations with over 200 watts transmitter power must have a frequency stability of 50 ppm except for equipment used in the Public Safety Pool where the frequency stability is 100 ppm.

[2]For single sideband operations below 25 MHz, the carrier frequency must be maintained within 50 Hz of the authorized carrier frequency.

[3]Travelers information station transmitters operating from 530–1700 kHz and transmitters exceeding 200 watts peak envelope power used for disaster communications and long distance circuit operations pursuant to §§90.242 and 90.264 must maintain the carrier frequency to within 20 Hz of the authorized frequency.

[4]Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands must have a frequency stability of 5 ppm.

[5]In the 150–174 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

[6]In the 150–174 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth or designed to operate on a frequency specifically designated for itinerant use or designed for low-power operation of two watts or less, must have a frequency stability of 5.0 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 2.0 ppm.

[7]In the 421–512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.

[8]In the 421–512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

[9]Fixed stations with output powers above 120 watts and necessary bandwidth less than 3 kHz must operate with a frequency stability of 100 ppm. Fixed stations with output powers less than 120 watts and using time-division multiplex, must operate with a frequency stability of 500 ppm.

[10]Except for DSRCS equipment in the 5850–5925 MHz band, frequency stability is to be specified in the station authorization. Frequency stability for DSRCS equipment in the 5850–5925 MHz band is specified in subpart M of this part.

[11]Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150–174 MHz band and 2.5 ppm in the 421–512 MHz band.

[12]Mobile units may utilize synchronizing signals from associated base stations to achieve the specified carrier stability.

[13]Fixed non-multilateration transmitters with an authorized bandwidth that is more than 40 kHz from the band edge, intermittently operated hand-held readers, and mobile transponders are not subject to frequency tolerance restrictions.

[14]Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

(b) For the purpose of determining the frequency stability limits, the power of a transmitter is considered to be the maximum rated output power as specified by the manufacturer.

**TEST PROCEDURE**

ANSI / TIA / EIA 603 Clause 2.3.1 and 2.3.2

**RESULTS**

| Reference Frequency: Mid Channel 457.598225Hz @ 25*C<br>Limit: ± 5 ppm = 2287.991 Hz | | | | |
|---|---|---|---|---|
| **Power Supply (Vdc)** | **Environment Temperature (*C)** | **Frequency Deviation Measureed with Time Elapse** | | |
| | | **(MHz)** | **Delta (ppm)** | **Limit (ppm)** |
| 9.00 | 60 | 457.59686 | 2.981 | ± 5.0 |
| 9.00 | 50 | 457.59737 | 1.860 | ± 5.0 |
| 9.00 | 40 | 457.59773 | 1.075 | ± 5.0 |
| 9.00 | 30 | 457.59803 | 0.424 | ± 5.0 |
| ***9.00*** | ***25*** | ***457.59823*** | ***0*** | ***± 5.0*** |
| 9.00 | 20 | 457.59753 | 1.514 | ± 5.0 |
| 9.00 | 10 | 457.60000 | -3.879 | ± 5.0 |
| 9.00 | 0 | 457.59882 | -1.294 | ± 5.0 |
| 9.00 | -10 | 457.59910 | -1.917 | ± 5.0 |
| 9.00 | -20 | 457.59941 | -2.587 | ± 5.0 |
| 9.00 | -30 | 457.59942 | -2.616 | ± 5.0 |
| 7.65 | 25 | 457.59821 | 0.042 | ± 5.0 |
| 10.35 | 25 | 457.59817 | 0.120 | ± 5.0 |

## 7.6. TRANSIENT FREQUENCY BEHAVIOR

**LIMIT**

.

Transmitters designed to operate in the 150–174 MHz and 421–512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

| Time intervals[1,2] | Maximum frequency difference[3] | All equipment | |
|---|---|---|---|
| | | 150 to 174 MHz | 421 to 512 MHz |
| Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels | | | |
| $t_1$[4] | ±25.0 kHz | 5.0 ms | 10.0 ms |
| $t_2$ | ±12.5 kHz | 20.0 ms | 25.0 ms |
| $t_3$[4] | ±25.0 kHz | 5.0 ms | 10.0 ms |
| Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels | | | |
| $t_1$[4] | ±12.5 kHz | 5.0 ms | 10.0 ms |
| $t_2$ | ±6.25 kHz | 20.0 ms | 25.0 ms |
| $t_3$[4] | ±12.5 kHz | 5.0 ms | 10.0 ms |
| Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels | | | |
| $t_1$[4] | ±6.25 kHz | 5.0 ms | 10.0 ms |
| $t_2$ | ±3.125 kHz | 20.0 ms | 25.0 ms |
| $t_3$[4] | ±6.25 kHz | 5.0 ms | 10.0 ms |

[1] $t_{on}$ is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

$t_1$ is the time period immediately following $t_{on}$.

$t_2$ is the time period immediately following $t_1$.

$t_3$ is the time period from the instant when the transmitter is turned off until $t_{off}$.

$t_{off}$ is the instant when the 1 kHz test signal starts to rise.

[2] During the time from the end of $t_2$ to the beginning of $t_3$, the frequency difference must not exceed the limits specified in §90.213.

[3] Difference between the actual transmitter frequency and the assigned transmitter frequency.

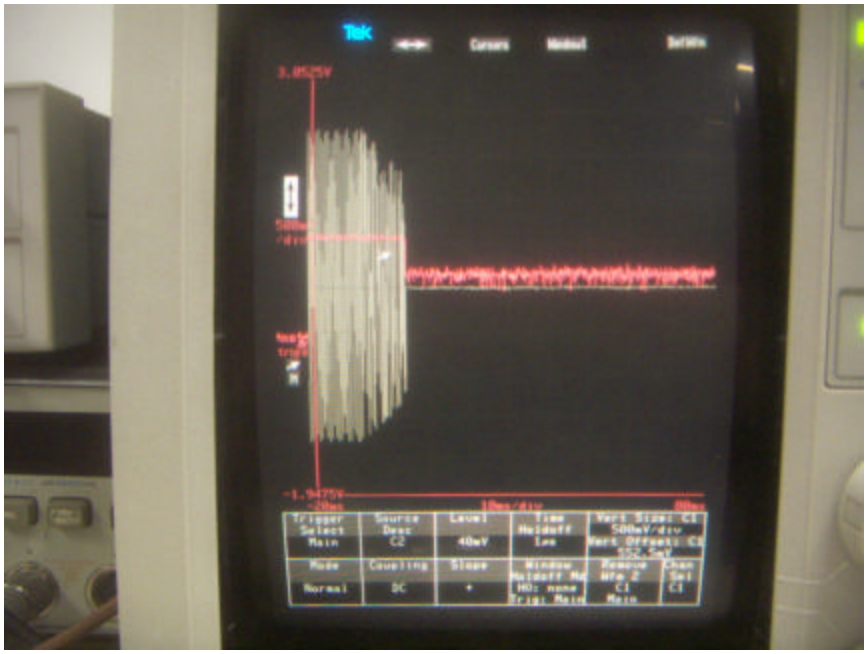
[4]If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

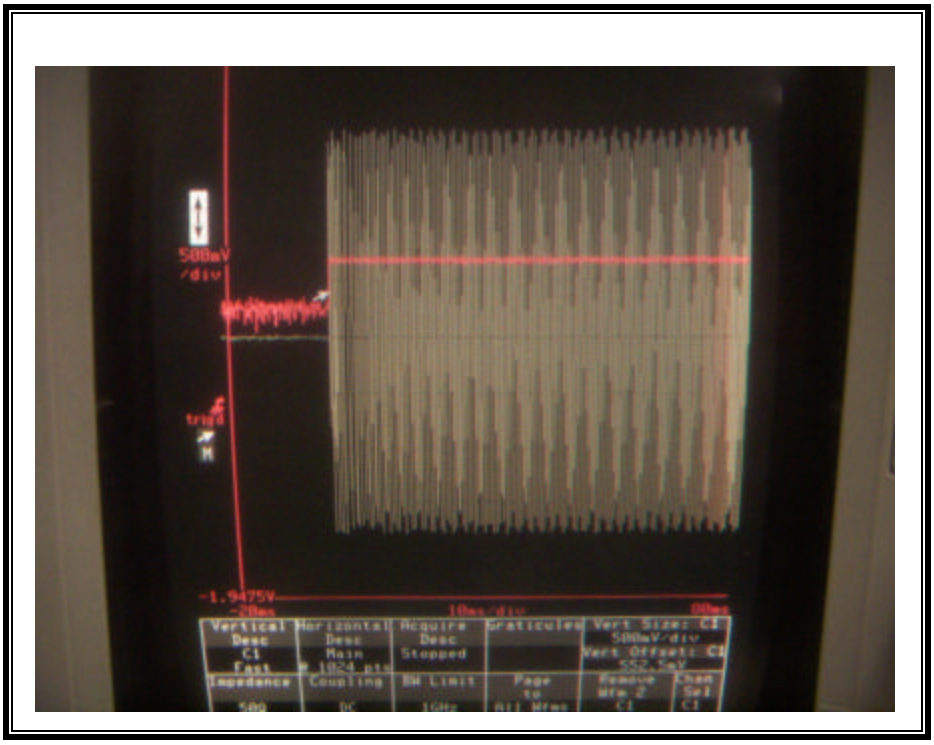
**TEST PROCEDURE**

ANSI / TIA / EIA 603 Clause 3.2.19

**RESULTS**

Please see pass results of TransientOn and TransientOff





# 8. MAXIMUM PERMISSIBLE EXPOSURE

**FCC RULES**

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density ($mW/cm^2$) | Averaging time (minutes) |
|---|---|---|---|---|
| (A) Limits for Occupational/Controlled Exposures | | | | |
| 0.3–3.0 | 614 | 1.63 | *(100) | 6 |
| 3.0–30 | 1842/f | 4.89/f | *($900/f^2$) | 6 |
| 30–300 | 61.4 | 0.163 | 1.0 | 6 |
| 300–1500 | | | f/300 | 6 |
| 1500–100,000 | | | 5 | 6 |
| (B) Limits for General Population/Uncontrolled Exposure | | | | |
| 0.3–1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34–30 | 824/f | 2.19/f | *($180/f^2$) | 30 |

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density ($mW/cm^2$) | Averaging time (minutes) |
|---|---|---|---|---|
| 30–300 | 27.5 | 0.073 | 0.2 | 30 |
| 300–1500 | | | f/1500 | 30 |
| 1500–100,000 | | | 1.0 | 30 |

f = frequency in MHz
* = Plane-wave equivalent power density
NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

**CALCULATIONS**

Given

$E = \sqrt{(30 * P * G) / d}$

and

$S = E \wedge 2 / 3770$

where

E = Field Strength in Volts/meter
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power Density in milliwatts/square centimeter

Combining equations, rearranging the terms to express the distance as a function of the remaining variables, changing to units of Power to mW and Distance to cm, and substituting the logarithmic form of power and gain yields:

$d = 0.282 * 10 \wedge ((P + G) / 20) / \sqrt{S}$

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm^2

Rearranging terms to calculate the power density at a specific distance yields

$S = 0.0795 * 10 \wedge ((P + G) / 10) / (d\wedge 2)$

The power density in units of mW/cm^2 is converted to units of W/m^2 by multiplying by a factor of 10.

**LIMITS**

From FCC §1.1310 Table 1 (B), the maximum value of S = 0.3 mW/cm^2

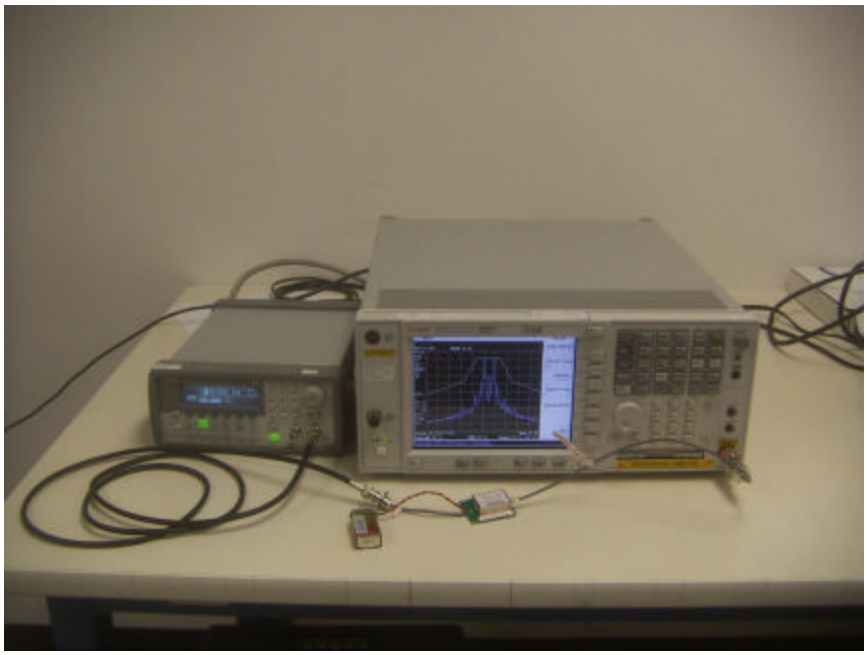
**RESULTS**

| Frequency Range (MHz) | MPE Distance (cm) | Output Power (dBm) | Antenna Gain (dBi) | FCC Power Density (mW/cm^2) |
|---|---|---|---|---|
| 457.5 - 458.5 | 20.0 | 10.90 | 2.14 | 0.004 |

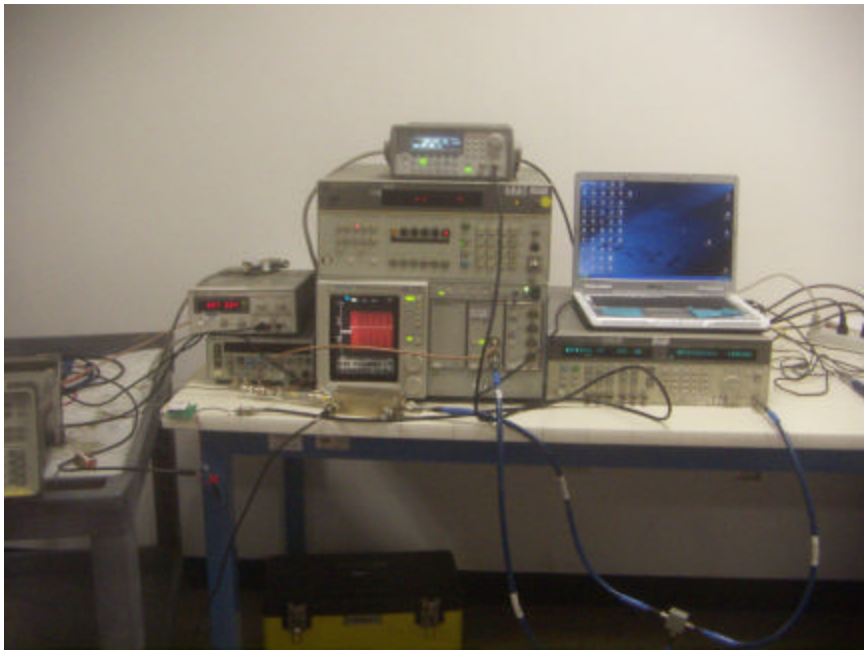
# 9. SETUP PHOTOS

**ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP**

ANTENNA PORT CONDUCTED PHOTO

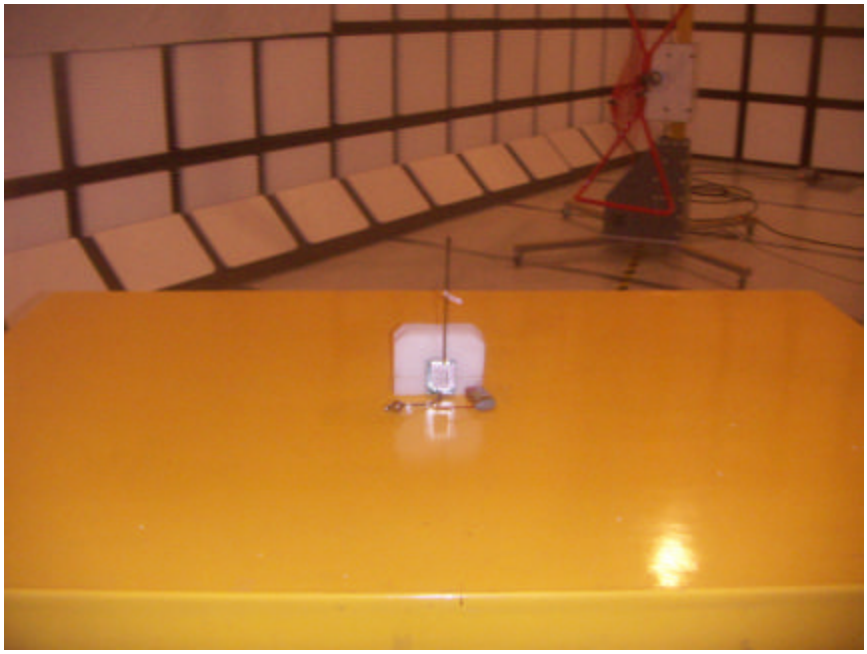


ANTENNA PORT CONDUCTED PHOTO



**RADIATED RF MEASUREMENT SETUP**

RADIATED FRONT PHOTO



RADIATED BACK PHOTO

**RF CONDUCTED MEASUREMENT OVER NORMAL AND EXTREME CONDITIONS**

ENVIRONMENTAL CHAMBER PHOTO

# END OF REPORT