



**ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT  
CERTIFICATION TO FCC PART 15 REQUIREMENTS**

*for*

**INTENTIONAL RADIATOR**

**5.8 GHz TOILET VENTILATION ACCESSORY  
(RANGE-GATED FIELD-DISTURBANCE SENSOR)**

**FCC ID: N82PNA1**

**REPORT NUMBER: 99U0050-1 AND 01U0855-1**

**ISSUE DATE: FEBRUARY 02, 1999 AND  
JULY 02, 2001**

*Prepared for*

**KOHLER CO.  
444 HIGH LAND DRIVE  
KOHLER, WI 53044  
USA**

*Prepared by*

**COMPLIANCE ENGINEERING SERVICES, INC.**

*d.b.a.*

**COMPLIANCE CERTIFICATION SERVICES**

**561 F MONTEREY ROAD  
MORGAN HILL, CA 95037, USA**

**TEL: (408) 463-0885**

**FAX: (408) 463-0888**

**NVLAP<sup>®</sup>**  
LAB CODE:200065-0

**VERIFICATION OF COMPLIANCE**

COMPANY NAME : KOHLER COMPANY  
444 HIGHLAND DRIVE  
KOHLER, WI 53044 USA

CONTACT PERSON : D2M INC.  
DR. DAVE SHAFER  
405 W. EVELYN  
MOUNTAIN VIEW, CA 94040 USA  
TEL: (650) 567-9995 x: 207

EUT DESCRIPTION : 5.8GHz TOILET VENTILATION ACCESSORY

MODEL NAME/NUMBER : K-4657

SERIAL NO : 002

FCC ID : N82PNA1


DATE TESTED : FEBRUARY 02, 1999 and JUNE 28, 2001

REPORT NUMBER : 99U0050-1 and 01U0855-1

TYPE OF EQUIPMENT	INTENTIONAL RADIATOR
EQUIPMENT TYPE	5.8GHz RANGE-GATED FIELD-DISTURBANCE SENSOR
MEASUREMENT PROCEDURE	ANSI 63.4 / 1992
LIMIT TYPE	CERTIFICATION
FCC RULE	CFR 47, PART 15, SECTION 15.245

The above equipment was tested by Compliance Engineering Services, Inc. for compliance with the requirement set forth in CFR 47, PART 15. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

Tested By:

  
\_\_\_\_\_  
JESSE SALDIVAR  
ASSOCIATE EMC ENGINEER  
COMPLIANCE CERTIFICATION SERVICES

Approved & Released For CCS By:

  
\_\_\_\_\_  
STEVE CHENG  
EMC ENGINEERING MANAGER  
COMPLIANCE CERTIFICATION SERVICES

**Applicant:** Kohler Co.  
444 Highland Drive  
Kohler, WI 53044

**FCC ID:** N82PNA1

**Center Frequency:** 5.8 GHz

**RF pulse length:** 1 nsec

**Pulse Rep Frequency:** 1.0 MHz

**FCC Rule Part:** 15.245

**Used For:** Activate toilet fan when toilet is in use.

**Power Source:** 12VDC plug in wall supply, regulated to 8.0 & 3.3 V on board.

**Test Location:** Compliance Certification Services  
561F Monterey Road  
Morgan Hill, CA 95037

Tests were performed in accordance to the test plan, which is an appendix to this report. Because the RF pulse durations are very short, **pulse desensitization** corrections are applied to spectrum analyzer readings to determine true peak levels of the fundamental frequency emission.

Pulse desensitization is applied only to **fundamental** and **harmonic emissions**; bandedge measurements are made in the standard way: 3 MHz RES BW and 3 MHz VID BW analyzer settings for peak reading measurements, and 1MHz/10 Hz settings for average reading measurements.

Data shows radiated emission levels well below the maximum levels allowed in 15.205 and 15.245.

## TEST RESULTS

### A.1 Radiated Emissions

Test Requirement: 15.205, 15.245(b)(1)

#### A.1.1 Radiated Field Strength, 1 - 26 GHz

##### Measurement Equipment Used:

HP 8564E Spectrum Analyzer

HP 8449 B Preamplifier, 1-26 GHz

Double Ridge Waveguide Horn, 1 - 18 GHz

Waveguide Horn, 18 - 26 GHz, or equivalent

##### Test Set-Up

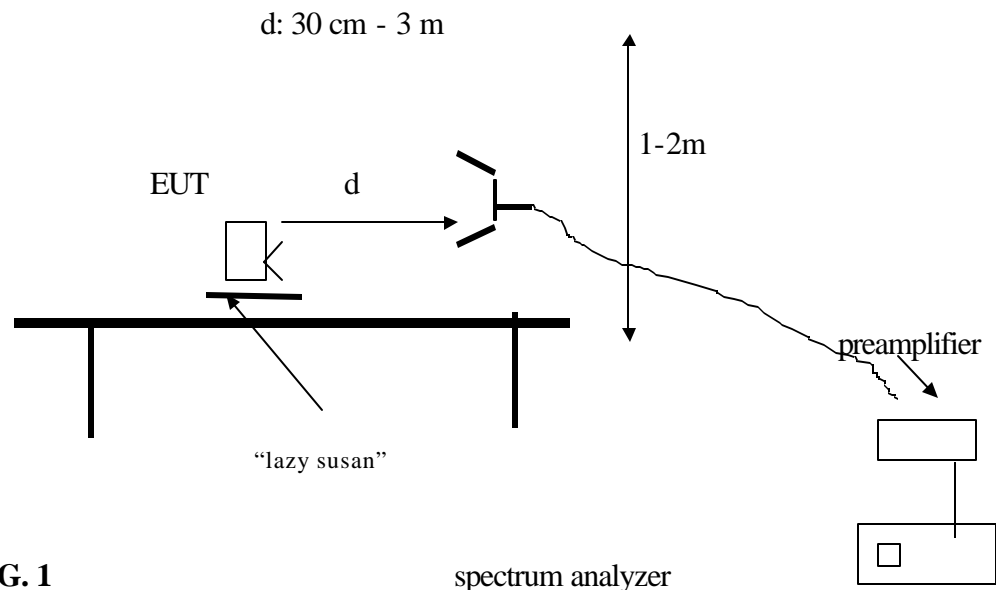


FIG. 1

spectrum analyzer

##### Test Procedures

1. The EUT was placed on a wooden table. The search antenna was placed 3 ft. from the EUT.
2. The EUT was slowly rotated to locate the direction of maximum emission at each emission being measured. Maximum were found to be coming from the EUT antenna, as expected.
3. For each emission detected, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded on the data sheets.

**NOTE:**

The EUT has a duty cycle consisting of 1 nsec wide pulses with a PRF of 1 MHz

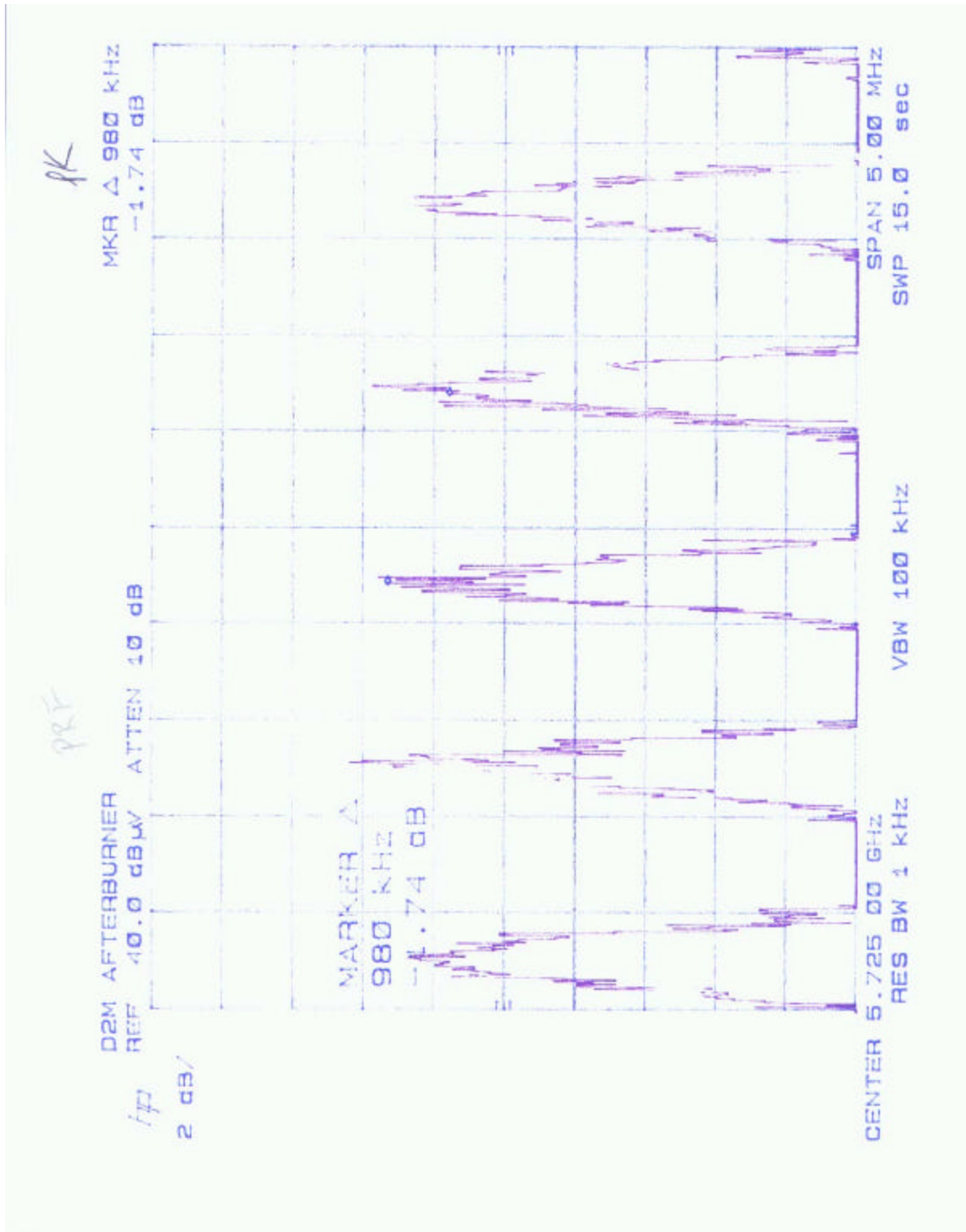
RES BW of the analyzer will either resolve a single spectral line (called "line spectrum") or will resolve several spectral lines (called "pulse spectrum").

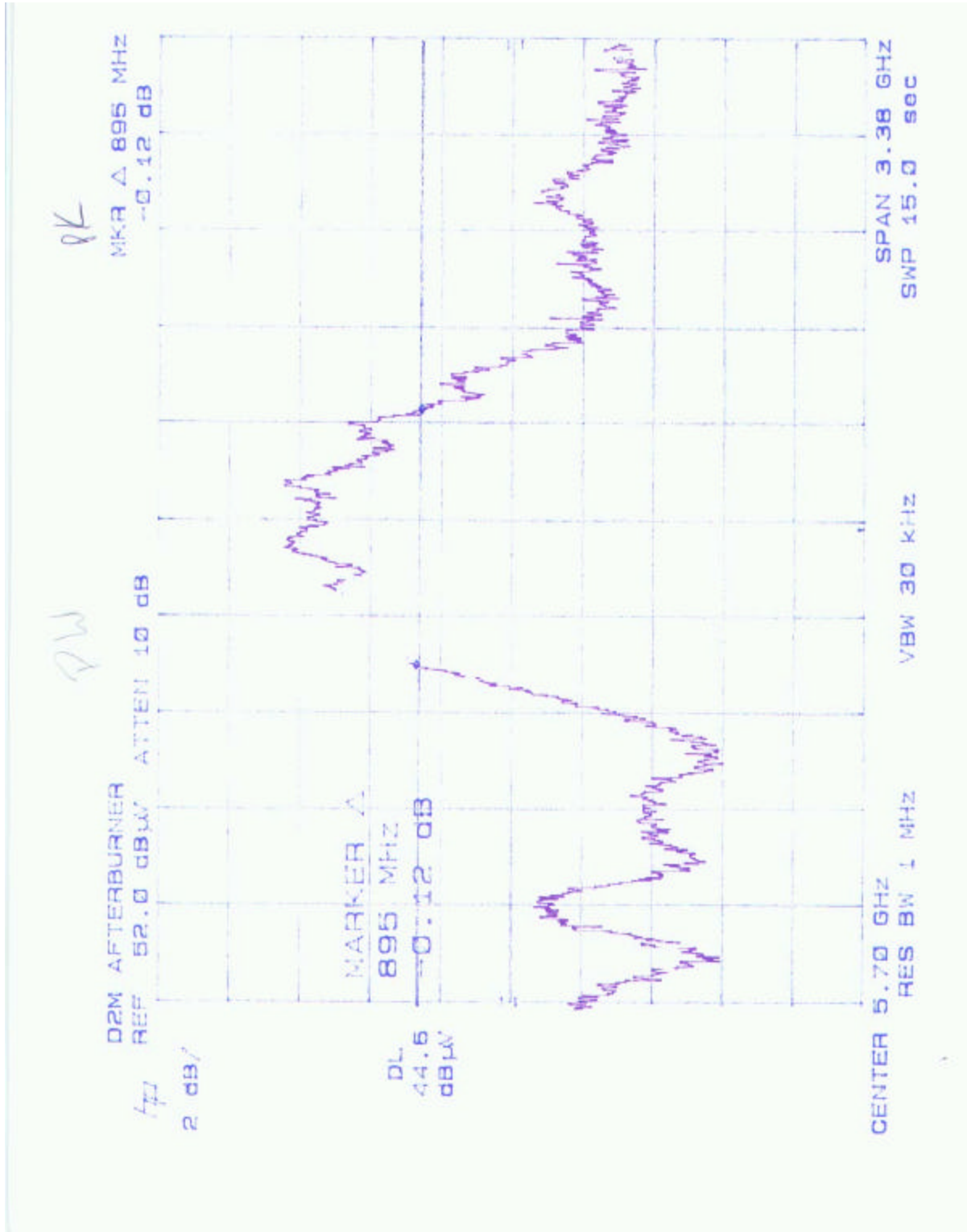
I. The following conditions must be met for the occurrence of a **line spectrum display**:

- (a) Resolution Bandwidth:  $B < 0.3 \text{ PRF}$
- (b) Scan Time:  $T_s > (F_s/B^2)$  where  $F_s = \text{scan width Hz/div}$
- (c) Peak input power to analyzer  $P_{\text{peak}} = -10 \text{ dBm}$

**line spectrum desensitization factor =  $aL = 20 \log t_{\text{eff}}^*/T$**

The test configuration met the requirements for a line spectrum display. The 980 KHz PRF is equal to  $1/T$ . The quantity  $t_{\text{eff}}$  is designed to be approximately 1 nsec. Actual measurements were made using Method 1.1 per the test plan [ $\sin(x)/x = 2/\pi$  or  $-3.922\text{dB}$  ( $=20\log 2/\pi$ )]. The 3.992 dB bandwidth (see spectrum analyzer chart) is 895 MHz, representing a  $t_{\text{eff}}$  of 1.12 nsec, in good agreement with the 1 nsec design parameter, and which will be used for calculation of line spectrum desensitization factor.





### A.1.2 Radiated Emissions, 26 - 40 GHz

#### Measurement Equipment Used:

HP 8566 Spectrum Analyzer

HP 11975A Preamplifier, 2 - 8 GHz (used with HP11970 external mixers)

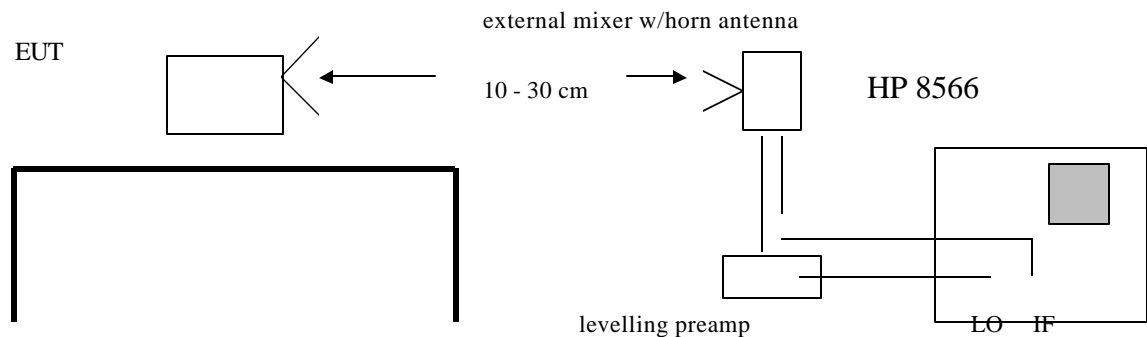
Antenna Research Associates MWH 1826/B, 18 - 26.5 GHz

HP 11970K Harmonic mixer, 18 - 26.5 GHz

HP 11970A Harmonic mixer, 26.5 - 40 GHz with horn antenna

Low loss antenna cable (0.7 dB/ft @ 24 GHz) for leveling preamplifier connections

#### Test Set-Up



**FIG.2**

#### Test Procedures

1. The EUT was placed on a wooden table. The search antenna was placed 30 cm from the EUT. The spectrum analyzer was tuned to the first frequency for investigation, per instructions in the HP 11970 Harmonic Mixer Series user manual.

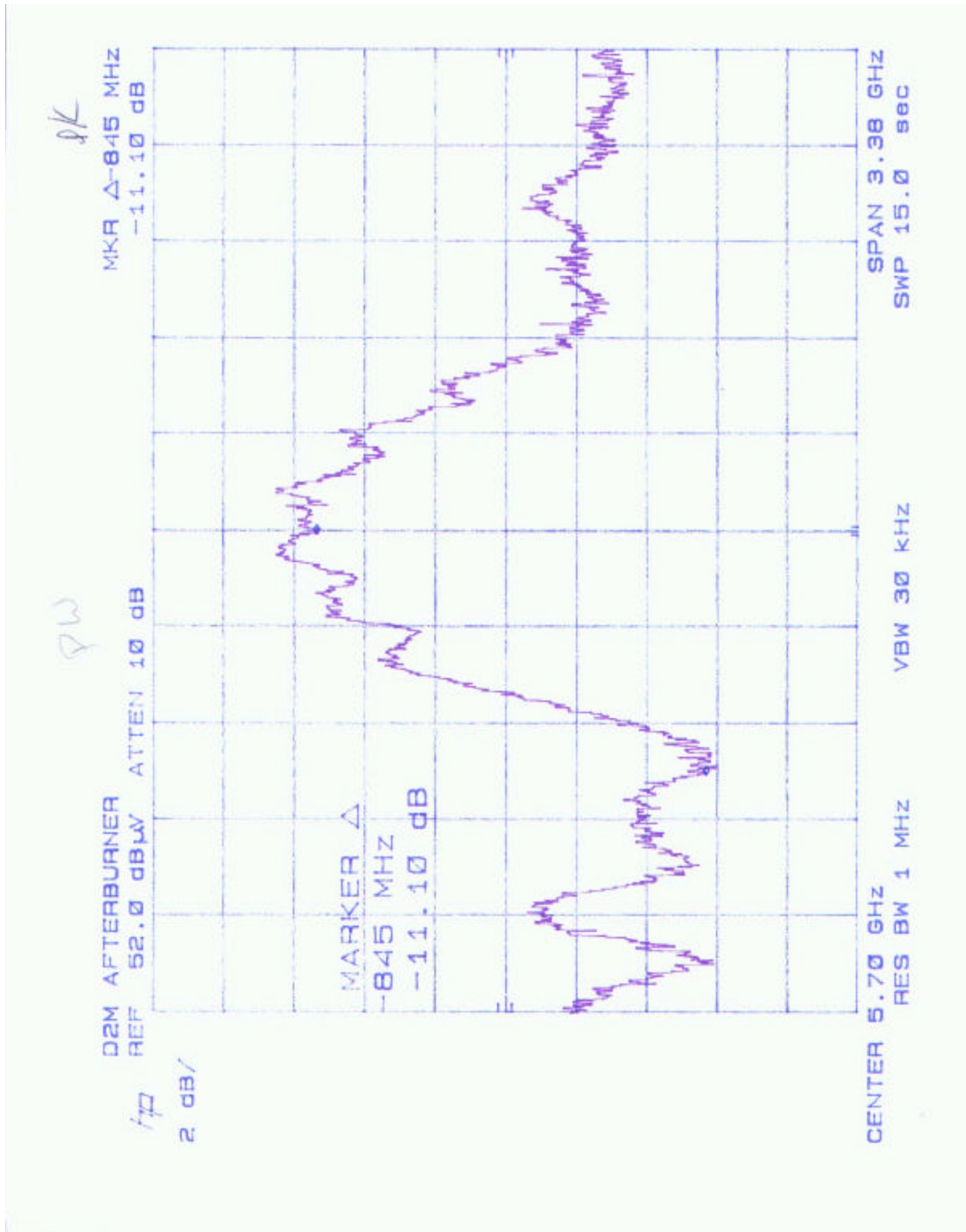
2. Signal identification routines were run per the HP 11970 Harmonic Mixer Series user manual, to determine whether a displayed signal is a mixer generated spurious or an actual emission from the EUT.

3. For each identified signal emission, the EUT was slowly rotated to locate the direction of maximum emission at each frequency being measured. Maximum emissions were found to come from the EUT antenna, as expected.

3. The search antenna was raised and lowered in both vertical and horizontal polarization. The maximum readings so obtained are recorded on the data sheets.

Pulse desensitization corrections were applied as in A.1 above.







AfterBurner (2/3/99)

S/N 002  
 Lobe Wid 895 MHz to -3.2 dB points  
 Pulse Len 1.1 nsec by lobe measurement  
 Null Dist 845 MHz center to first null  
 Pulse Len 1.2 by null measurement  
 PRF 0.98 MHz by line spectrum spacing

F MHz	Distance feet	Reading dBuV	AF dB/m	CL dB	Amp dB	Dist Corr dB	Total dBuV/m	Desens dB	Peak dBuV/m	Average dBuV/m	Peak Lim dBuV/m	Avg Lim dBuV/m	Margin dB
5805P	3.0	53.6	35.2	4.8	-35.0	-10.5	48.1	59.2	107.4		114.0		-6.6
5805A	3.0	53.6	35.2	4.8	-35.0	-10.5	48.1	0.0		48.1		94.0	-45.9
5725P*	3.0	53.0	35.2	4.8	-35.0	-10.5	47.5	0.0	47.5		74.0		-26.5
5725A*	3.0	53.0	35.2	4.8	-35.0	-10.5	47.5	0.0		47.5		54.0	-6.5
5883P*	3.0	52.8	35.2	4.8	-35.0	-10.5	47.3	0.0	47.3		74.0		-26.7
5883A*	3.0	52.8	35.2	4.8	-35.0	-10.5	47.3	0.0		47.3		54.0	-6.7
5458P**	3.0	51.4	35.0	4.7	-35.0	-10.5	45.6	0.0	45.6		74.0		-28.4
5458A**	3.0	51.4	35.0	4.7	-35.0	-10.5	45.6	0.0		45.6		54.0	-8.4
5133P**	3.0	46.8	34.5	4.5	-35.0	-10.5	40.3	0.0	40.3		74.0		-33.7
5133A**	3.0	46.8	34.5	4.5	-35.0	-10.5	40.3	0.0		40.3		54.0	-13.7
4302P	3.0	47.7	33.0	4.1	-35.0	-10.5	39.3	0.0	39.3		74.0		-34.7
4302A	3.0	47.7	33.0	4.1	-35.0	-10.5	39.3	0.0		39.3		54.0	-14.7

\*) Bandedge reading (no pulse desens)  
 \*\*) Restricted band readings (no pulse desens)

Due to the width of the fundamental emission some energy is present in the restricted bands of 3.6-4.4GHz, 4.5-5.15GHz and 5.35-5.46GHz, this energy is not necessary for the performance of the device, but could not be practically filtered without affecting the necessary transmission, as explained below. Readings are given in the above table. These were taken at 3ft., since they were not detectable at 3 meters.

The sensor uses a short pulse of RF transmission centered at 5.8 GHz, with most of the power centered within about  $\pm 250$  MHz of the carrier. In the ideal case this gives a round-trip distance resolution of about 2 feet, because the two main-lobe frequencies farthest from the carrier fall into and out of phase with each other every 2 nsec. Since light travels about 1 foot/nsec, and the round-trip distance difference is twice the amount of target motion, the sensor can reliably accept a target at a distance of, say, D, and reject a target at a distance of D + 1 foot.

For this application, that amount of range gate uncertainty is adequate, and we need to illuminate about 500 MHz of spectrum. It is not possible with practical filters to limit the spectrum to an absolute "brick wall" at this value, but if we could build such filters, the effect on the sensing performance of the device would be minimal, as long as a relatively flat spectrum could be maintained over the  $\pm 250$  MHz interval. Sharp filtering of the transmitted pulse would cause ringing in the time domain, but this would contain only as much energy as was removed by the filter. For this sensor, such a filter would remove less than 10% of the transmitted energy, and so we would have a "tail" on the pulse of about 10% of the peak amplitude. This would not affect the sensing because it follows the main peak of the pulse, and any coupling to the receiver appears as a DC component in the sampler's output, and is rejected by the baseband amplifier.

## AC Line Conducted Emissions

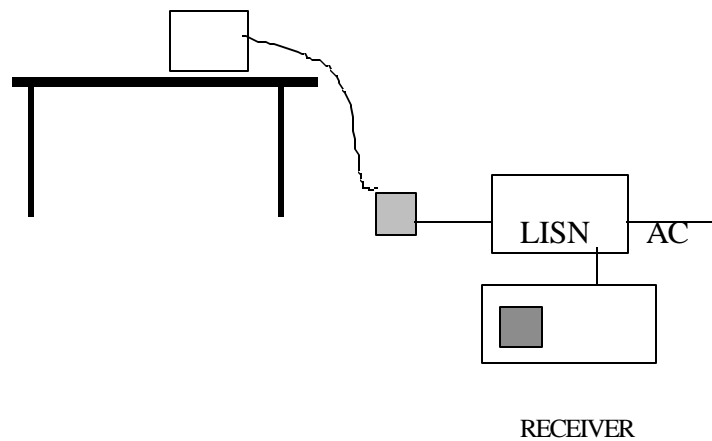
Test Requirement: 15.207

### Measurement Equipment Used:

Rhode & Schwarz EMI Receiver ESHS-20

Fischer Custom Communication LISN, FCC-LISN-50/250-25-2

### Test Set-up



### Test Procedure

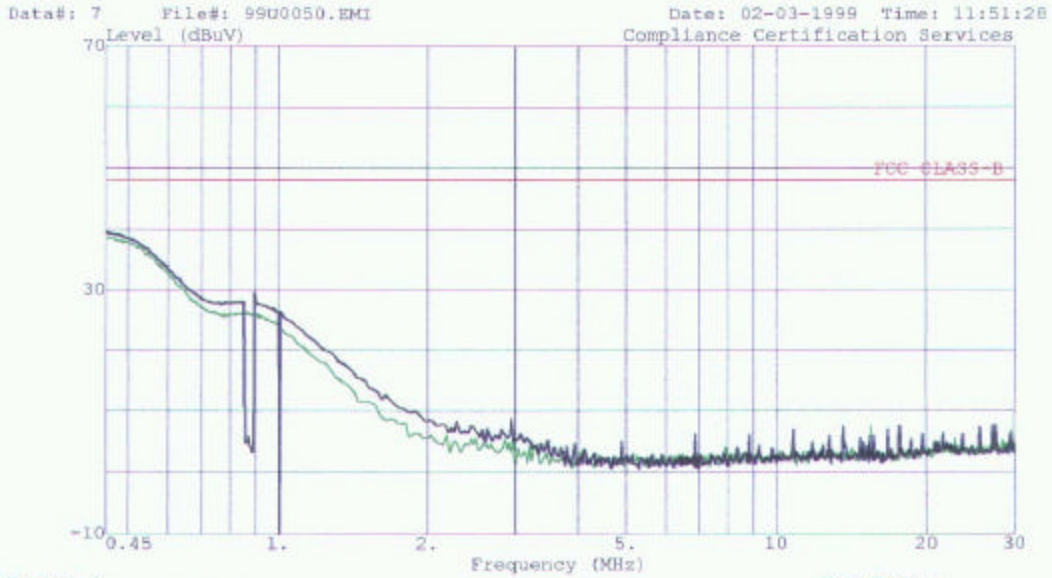
1. The EUT was placed on a wooden table 40-cm from a vertical ground plane and approximately 80-cm above the horizontal ground plane on the floor. The EUT was set to transmit in a normal mode.
2. Line conducted data was recorded for both NEUTRAL and HOT lines.

### Test Results

Refer to attached graph. (One page)



1366 Bordeaux Dr.  
Sunnyvale, CA 94089-1005 USA  
Tel: (408) 752-8166  
Fax: (408) 752-8168

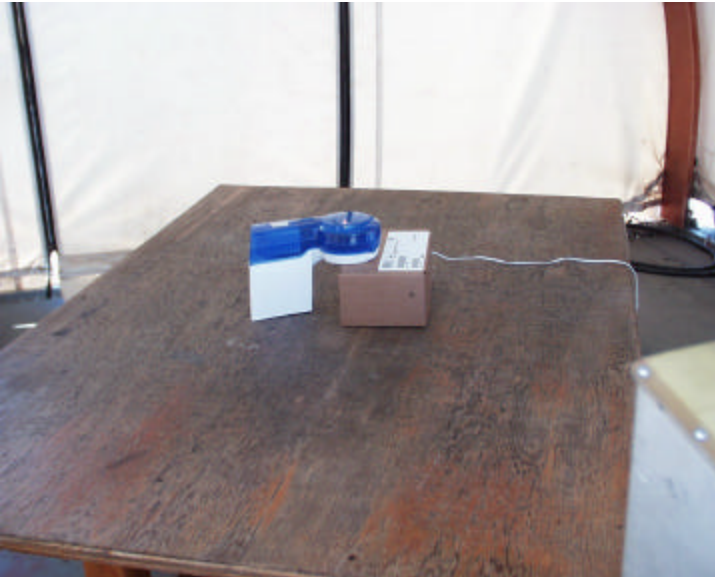


Trace: 3  
Project No. : 99u0050  
Report No. : 990203  
Test Engr : PETE KREBILL  
Company : D2M  
EUT : AFTERBURNER  
Test Config.: EUT ONLY  
Type of Test: FCC  
Mode of Op. : NORMAL  
: 110VAC 60HZ  
: L1=GREEN L2=BLACK

**SETUP PHOTO 02/02/99**



**SETUP PHOTO 06/28/01**



28-Jun-01 AfterBurner Sensor FCC Measurement  
 Compliance Certification Services, Morgan Hill Open Field Site

Equipment for 1-22 GHz

HP8566B Analyzer  
 HP8448B Preamp  
 EMCO 3115 Antenna  
 Cable: 16.0 feet

Equipment for 22.58 GHz

HP8566B Analyzer  
 HP 11975A Amplifier (LO)  
 xxx: External mixer/antenna  
 Cable: IF Only (321 MHz)

Equipment for 28.22 GHz

HP8566B Analyzer  
 HP 11975A Amplifier (LO)  
 xxx: External mixer/antenna  
 Cable: IF Only (321 MHz)

Average Measurements:

1 MHz Resolution Bandwidth  
 Average Detector  
 10 Hz Video Filter

Peak Measurements:

Pulse Desens = -20\*log(PRF\*tau)  
 Peak = Average + Pulse Desens

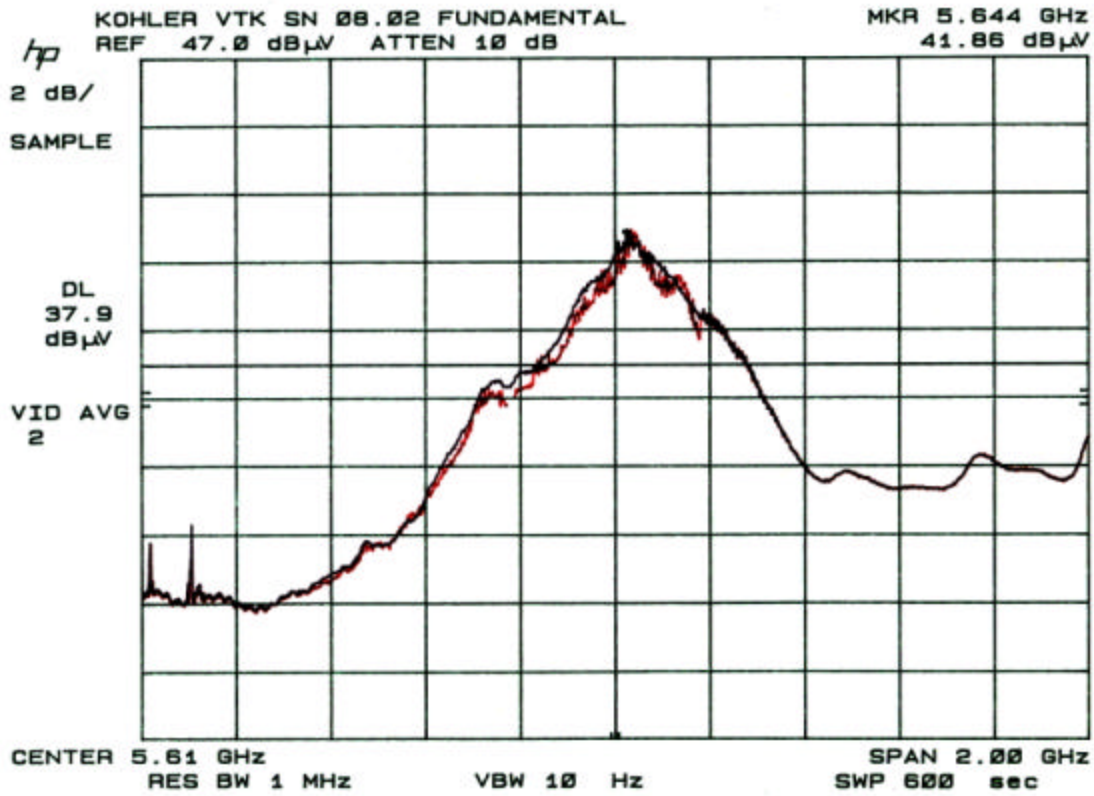
EUT SN: 08.02  
 Lobe Wid: 448 MHz to -3.92 dB points  
 Pulse Len: 2.2 nsec by lobe measurement  
 PRF: 1.01 MHz by line spectrum spacing  
 Peak Lim: 60.0 dB over average limit by waiver request

f GHz	Dist feet	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Avg dBuV/m	Desen dB	Peak dBuV/m	Avg Lim dBuV/m	Pk Lim dBuV/m	Avg Mar dB	Pk Mar dB	Notes
5.64	3.0	41.9	34.3	6.8	-35.5	-10.3	37.1	52.9	90.0	54.0	114.0	-16.9	-24.0	Horizontal
5.64	3.0	48.3	34.3	6.8	-35.5	-10.3	43.6	52.9	96.5	54.0	114.0	-10.4	-17.5	Horizontal (Peak Detect)
5.23	3.0	35.4	33.5	6.4	-35.5	-10.3	29.5	52.9	82.4	54.0	114.0	-24.5	-31.6	Vertical
11.29	3.0	33.7	38.7	9.8	-35.5	-10.3	36.4	52.9	89.3	54.0	114.0	-17.6	-24.7	No Emissions Found
16.93	3.0	37.1	42.3	13.1	-35.5	-10.3	46.6	52.9	99.6	54.0	114.0	-7.4	-14.4	No Emissions Found
22.58	1.0	37.6	32.5	0.0	0.0	-19.9	50.2	52.9	103.2	54.0	114.0	-3.8	-10.8	No Emissions Found
28.22	1.0	39.3	24.2	0.0	0.0	-19.9	43.6	52.9	96.6	54.0	114.0	-10.4	-17.4	No Emissions Found

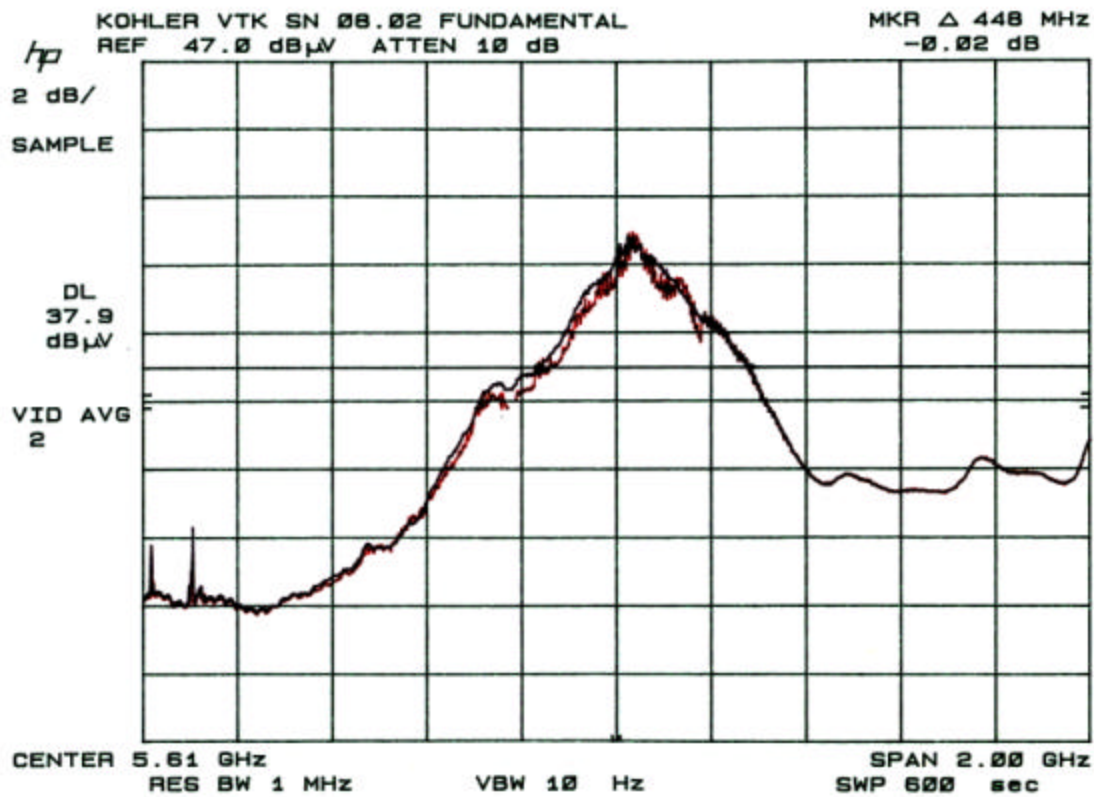
f Measurement Frequency  
 Dist Distance to Antenna  
 Read Analyzer Reading  
 AF Antenna Factor  
 CL Cable Loss  
 Amp Preamp Gain  
 D Corr Distance Correct to 3 meters  
 Avg Average Field Strength @ 3 m  
 Desen Pulse Desens (Peak to Average)  
 Peak Calculated Peak Field Strength  
 Avg Lim Average Field Strength Limit  
 Pk Lim Peak Field Strength Limit  
 Avg Mar Margin vs. Average Limit  
 Pk Mar Margin vs. Peak Limit

This is the Average Field Strength over 5-7 GHz (Average Detector, 1 MHz RBW, ~1m measurement distance) and the Harmonic Emissions (Average Detector, 1 MHz RBW).

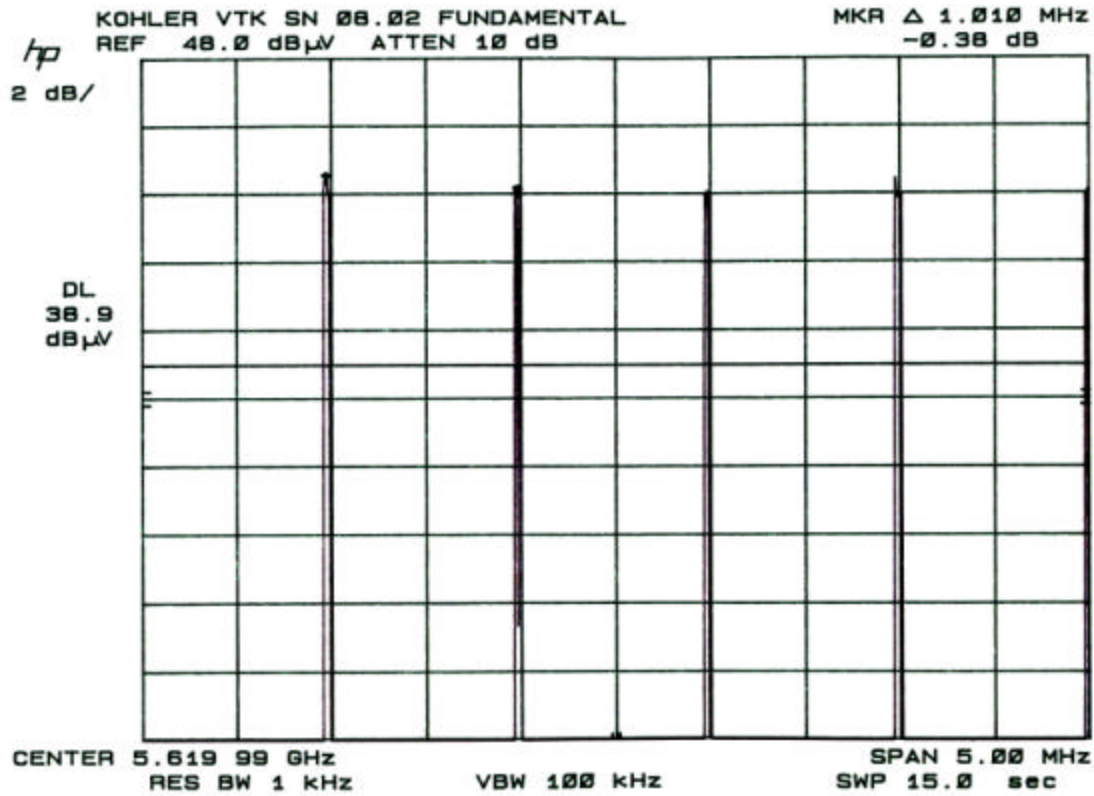




This is the Emission Bandwidth to -4dB points.



This is the Emission Bandwidth to -4dB points.

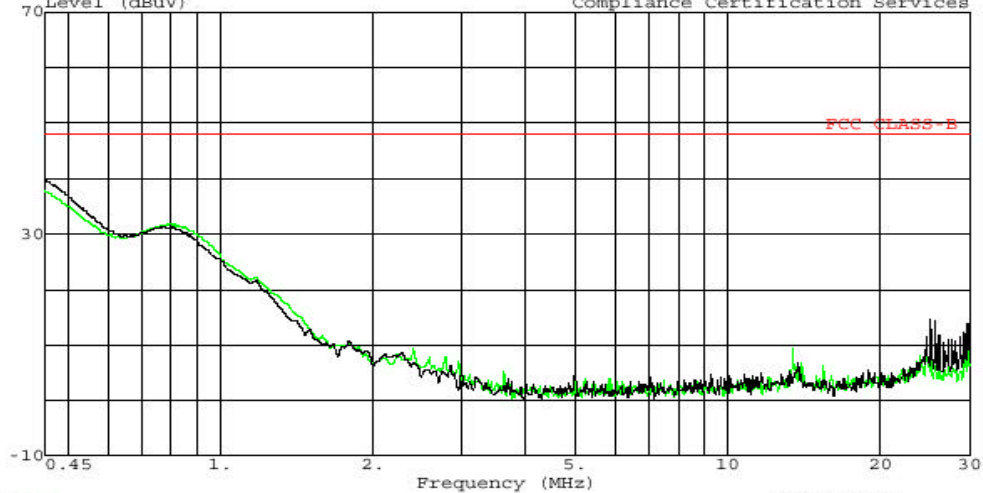


This is the Spacing of Spectral Line at 1MHz.



561 F Monterey Road, Route 2  
Morgan Hill, CA 95037-9001 USA  
Tel: (408) 463-0885  
Fax: (408) 463-0888

Data#: 14 File#: 01U0855.EMI Date: 06-28-2001 Time: 16:28:02  
Level (dBuV) Compliance Certification Services



Trace: 10 Ref Trace:  
Project No. : 014U0855-1  
Report No. : 010628  
Test Engr : Jesse Saldivar  
Company : D2M  
EUT Description : 5.8GHz Transmitter  
Model : K4657  
EUT Config. : EUT  
Type of Test : FCC Class B  
Mode of Operation: Continuous TX with Fan Motor Off  
: PEAK: L1 (Green), L2 (Black)  
: 115Vac, 60Hz

This is the AC Line Conducted Emissions.