# 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**

**ISSUE DATE: FEB. 2,1999**

*Prepared for*

**Kohler Co.**
**444 Highland Drive**
**Kohler, WI 53044**
**USA**

*Prepared by*


**COMPLIANCE ENGINEERING SERVICES, INC.**
*d.b.a.*
**COMPLIANCE CERTIFICATION SERVICES**
**1366 BORDEAUX DRIVE**
**SUNNYVALE, CA 94089, USA**
**TEL: (408) 752-8166**
**FAX: (408) 752-8168**


**LAB CODE:200065-0**

# VERIFICATION OF COMPLIANCE

| | | |
|---|---|---|
| COMPANY NAME | : | KOHLER COMPANY<br>444 HIGHLAND DRIVE<br>KOHLER, WI 53044 |
| CONTACT PERSON | : | D2M INC.<br>DR. DAVE SHAFER<br>405 W. EVELYN<br>MOUNTAIN VIEW, CA 94040<br>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 | : | FEB. 02, 1999 |
| REPORT NUMBER | : | 99U0050-1 |

| | |
|---|---|
| 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.

MIKE C.I. KUO / VICE PRESIDENT
COMPLIANCE ENGINEERING SERVICES,INC.



COMPLIANCE CERTIFICATION SERVICES DOCUMENT NO:CCSUP4032A
1366 BORDEAUX DRIVE, SUNNYVALE CA 94089 TEL:(408)752-8166 FAX:(408)752-8168

| | |
|---|---|
| Applicant: | Kohler Co.<br>444 Highland Drive<br>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<br>561F Monterey Road<br>Morgan Hill, CA 95087 |

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**

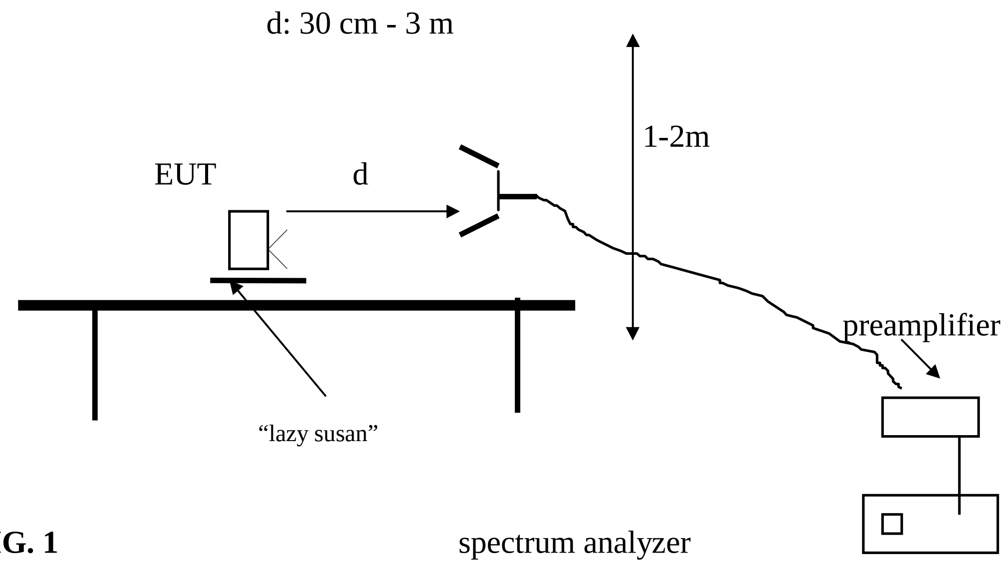



**FIG. 1**

**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

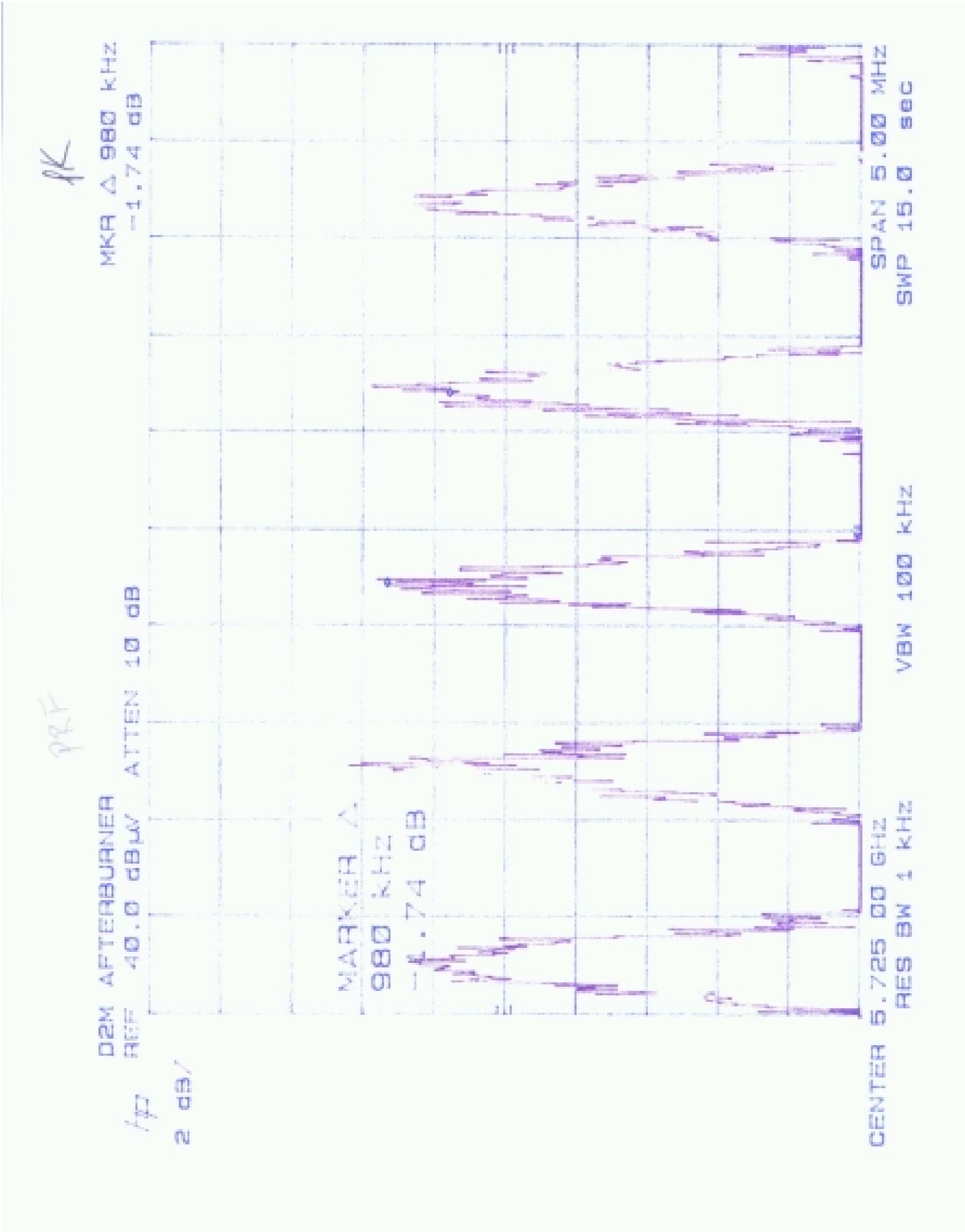
RES BW of the analyzer will either resolve a single spectral line (called “line spectrum”) or will resolve several spectral lines (called “pulse spectrum”).

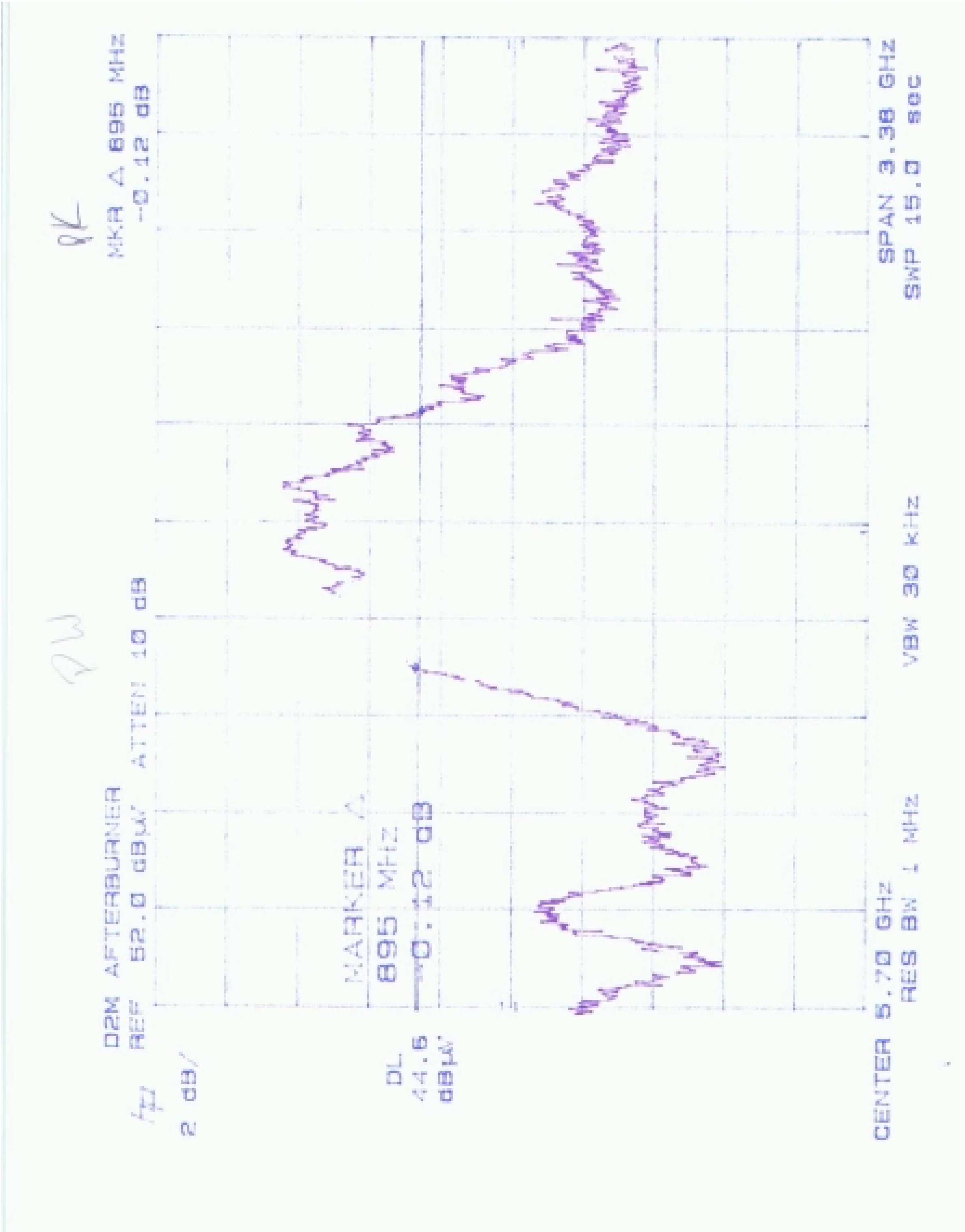
I. The following conditions must be met for the occurrence of a **line spectrum display**:

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

**line spectrum desensitization factor = $a_L$ = 20 log $\tau$eff*/T**

The test configuration met the requirements for a line spectrum display. The 980 KHz PRF is equal to **1/T**. The quantity **$\tau$eff** is designed to be approximately 1 nsec. Actual measurements were made using Method 1.1 per the test plan [sin(x)/x = 2/π or –3.922dB (=20log2/π)]. The 3.992 dB bandwidth (see spectrum analyzer chart) is 895 MHz, representing a τeff 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.


D2M AFTERBURNER
REF 40.0 dBμV ATTEN 10 dB
MKR Δ 980 kHz
-1.74 dB
MARKER Δ
980 kHz
-1.74 dB
2 dB/
CENTER 5.725 00 GHz
SPAN 5.00 MHz
RES BW 1 kHz
VBW 100 kHz
SWP 15.0 sec


D2M AFTERBURNER
REF 52.0 dBµV ATTEN 10 dB
MKR Δ 895 MHz
-0.12 dB
MARKER Δ
895 MHz
-0.12 dB
DL
44.6
dBµV
2 dB/
CENTER 5.70 GHz
SPAN 3.38 GHz
RES BW 1 MHz
VBW 30 kHz
SWP 15.0 sec

### 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**

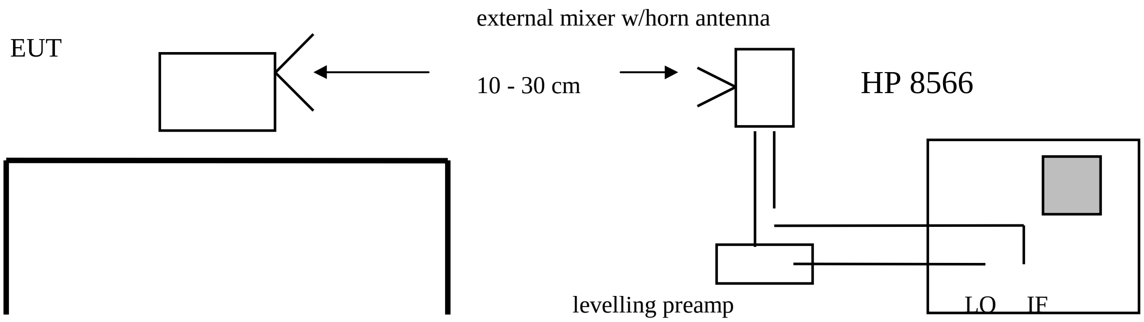



**FIG.2**

**Test Procedures**

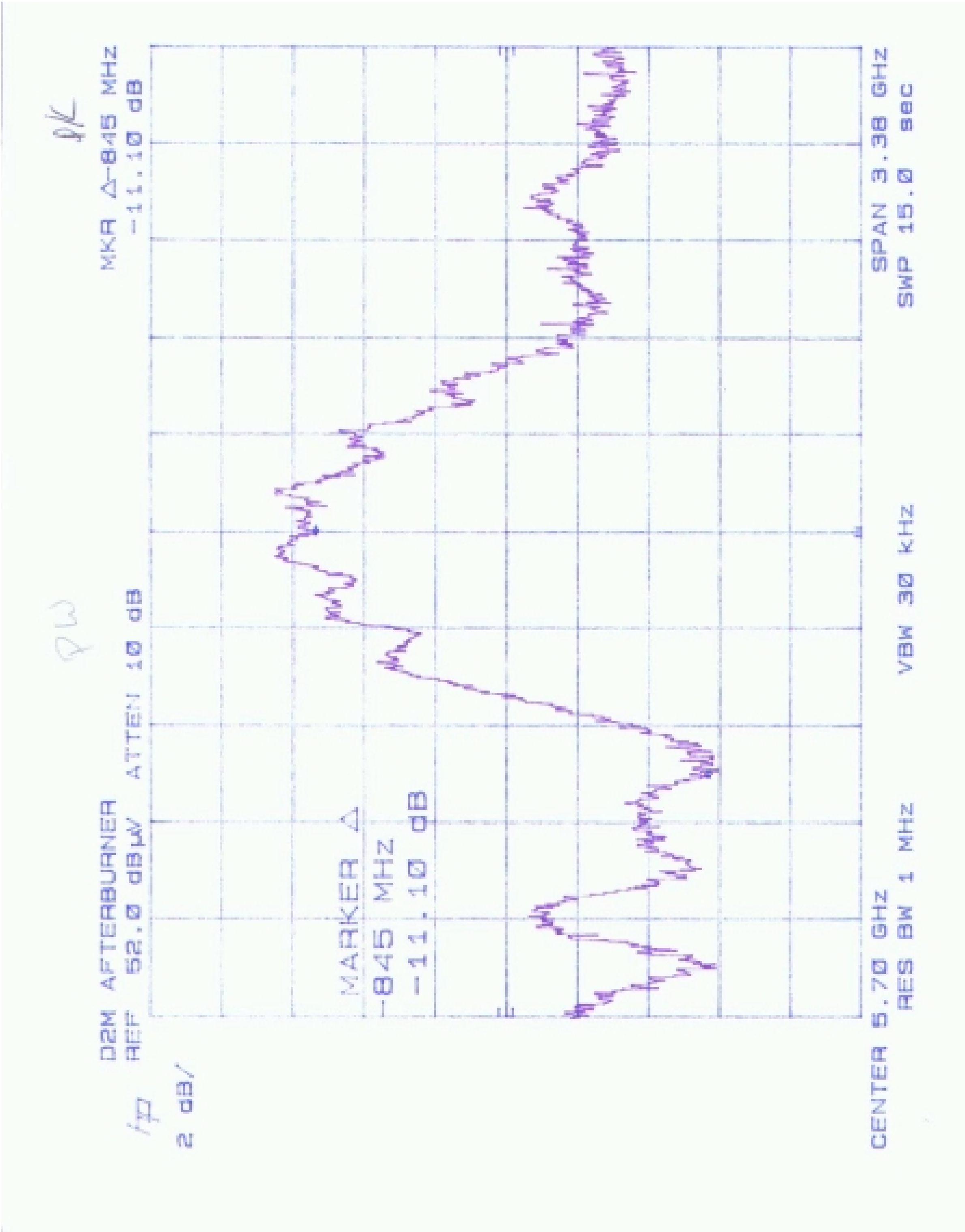
1. The EUT was placed on a wooden table. The search antenna was placed 30 cm from the EUT. The spectrum analyzer was tuned to the first frequency for investigation, per instructions in the HP 11970 Harmonic Mixer Series user manual.

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.


D2M AFTERBURNER
REF 52.0 dBµV ATTEN 10 dB
MKR Δ-845 MHz
-11.10 dB
2 dB/
MARKER Δ
-845 MHz
-11.10 dB
CENTER 5.70 GHz
RES BW 1 MHz
VBW 30 kHz
SPAN 3.38 GHz
SWP 15.0 sec

**A.2 Out of Band Emissions, 15.245(b)(3)**

Radiated emissions outside the specified were below 15.209 limits. Worst-case out of band transmitter emission was at 5805 MHz. Refer to radiated emissions spreadsheet.

Compliance Engineering Services Inc.

Project No. : 99U0050
Report No. : 990203A1
Date : 02/03/1999
Time : 11:19
Test Engr : PETE K

>> 3 M RADIATED EMISSION DATA <<

Company : D2M
Equipment Under Test : KOHLER AFTERBURNER
Test Configuration : EUT ONLY
Type of Test : FCC CLASS B
Mode of Operation : NORMAL

| Freq. | dBuV | PreAmp | Ant | Cable | dBuV/m | Limit | Margin | Pol | Hgt(m) | Az |
|---|---|---|---|---|---|---|---|---|---|---|
| NO EMISSIONS FOUND. BELOW ALL NOISE FLOOR. | | | | | | | | | | |
| Bilog 2049 ; Pre-amp = 8447D-P1 2944A06833: | | | | | | | | | | |
| 31.00 | 38.50 | -26.70 | 17.16 | 0.79 | 29.76 | 40.00 | -10.24 | V | 1.0 | 0 |
| 40.00 | 40.40 | -26.60 | 11.55 | 0.96 | 26.31 | 40.00 | -13.69 | V | 1.0 | 0 |
| 50.00 | 38.60 | -26.62 | 6.77 | 1.01 | 19.76 | 40.00 | -20.24 | V | 1.0 | 0 |
| 60.00 | 41.50 | -26.65 | 5.35 | 1.13 | 21.33 | 40.00 | -18.67 | V | 1.0 | 0 |
| 70.00 | 39.60 | -26.64 | 4.54 | 1.21 | 18.71 | 40.00 | -21.29 | V | 1.0 | 0 |
| 80.00 | 39.30 | -26.66 | 7.35 | 1.34 | 21.33 | 40.00 | -18.67 | V | 1.0 | 0 |

Total # of data 6
V. a2.

**AfterBurner (2/3/99)**

| | | | |
|---|---|---|---|
| S/N | 002 | | |
| Lobe Wid | 895 | MHz | to -3.2 dB points |
| Pulse Len | 1.1 | nsec | by lobe measurment |
| 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 ±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 ±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.



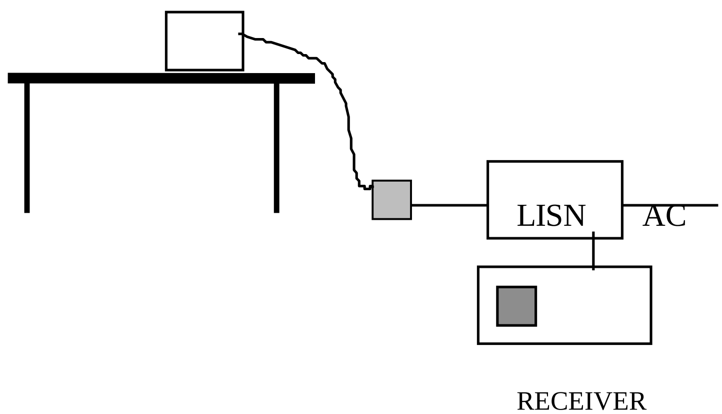
COMPLIANCE CERTIFICATION SERVICES DOCUMENT NO:CCSUP4032A
1366 BORDEAUX DRIVE, SUNNYVALE CA 94089 TEL:(408)752-8166 FAX:(408)752-8168

**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**



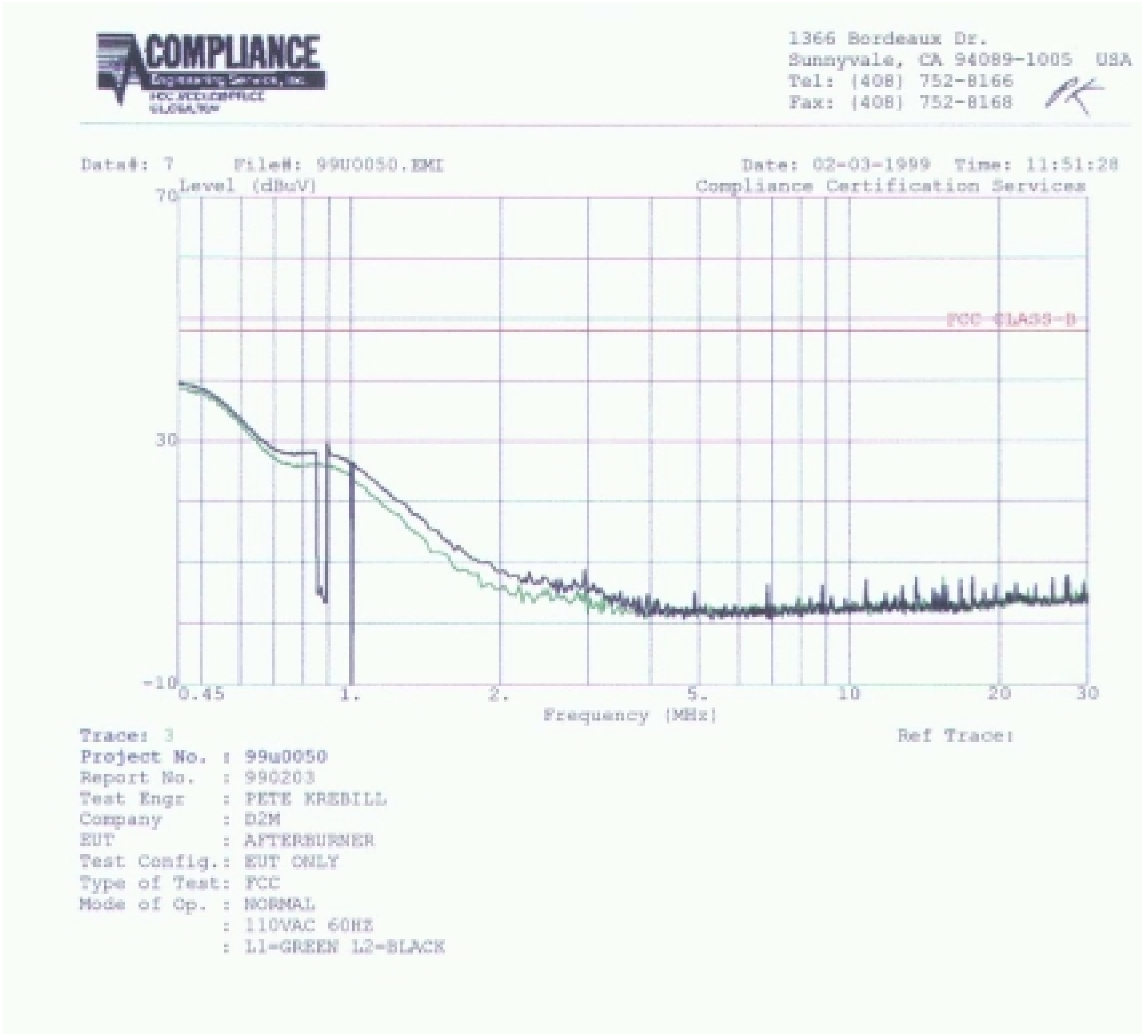

**Test Procedure**

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)


COMPLIANCE
1366 Bordeaux Dr.
Sunnyvale, CA 94089-1005 USA
Tel: (408) 752-8166
Fax: (408) 752-8168
Data#: 7 File#: 99U0050.EMI
Date: 02-03-1999 Time: 11:51:28
Level (dBuV)
Compliance Certification Services
70
30
-10
FCC CLASS-B
0.45
1.
2.
5.
10
20
30
Frequency (MHz)
Trace: 3
Ref Trace:
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