A. FCC Measurement Report

A. FCC Measurement Report

I. Description Of The EUT

The EUT is a Digital Wireless Model WIT2400M modular frequency hopping, spread spectrum, nominal 100 mW transceiver intended for data-link applications in the 2400 - 2483.5 band.

The EUT has already been submitted and approved by the FCC. The purpose of this test was to test the EUT with 3 new types of antennas.

A. FCC Measurement Report (continued)

III. Test Site

Testing was performed at US Tech's measurement facility located at 3505 Francis Circle, Alpharetta, GA as described to and acknowledged by the FCC in the letter marked 31040/SIT/USTECH. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number IC2982.

IV. Modification

No modifications were made by US Tech to bring the EUT in to compliance.

V. Measuring Instruments

Spectrum Analyzer	9 kHz - 22 GHz	HP 8593E
Amplifier	1 - 26.5 GHz	HP 8449B
Amplifier	1 - 22 GHz	HP 8449A
Amplifier	0.1 - 1300 MHz	HP 8447D
Biconical Antenna	30 - 300 MHz	EMCO 3110
Log Periodic Antenna	200 - 1000 MHz	EMCO 3146
Double Ridge Horn Guide	1 - 18 GHz	EMCO 3115
Double Ridge Horn Guide	18 - 40 GHz	EMCO 3116
LISN 8012-50-R-24-BNC	120 V	Solar Ele.
Plotter		HP 7475A
High Pass Filter	H3ROZOG2	Microwave Circuits

A. FCC Measurement Report (continued)

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Field strength levels in 2483.5-2500MHz forbidden band for WIT2400M with 12dBi omnidirectional antenna, 14dBi Corner Reflector antenna, and 2dBi dipole antenna

As requested, additional field strength measurements at the restricted band of 2483.5MHz and above were made at US Tech on August 5th, 1998. The results of these tests are listed and explained below. Spectrum analyzer plots are also included for verification of these measurements.

Per ANSI recommendation, a 1MHz RBW is called for when measuring spurious levels above 1GHz. The requested measurement involved setting the radio to transmit at its uppermost frequency (2480MHz) and then making a measurement of spurious signals at 2483.5MHz and above. However, a problem comes up as you try to measure the spurious levels at 2483.5MHz with the radio transmitting at 2480MHz. The wide 1MHz RBW allows a portion of the transmitted signal to bleed over into the spurious measurement and produce artificially high (and erroneous) levels. To remedy this and still obtain meaningful measurements, we resorted to a technique outlined by G. Czumak in a series of phone calls made 2 years ago. I'm sure that you already know the technique but I will repeat it to ensure that you know I understand it.

Tune the radio to produce a modulated signal at its uppermost channel – 2480MHz. Measure the spurious power levels in the forbidden band using a RBW that faithfully shows the true shape of the modulated signal (30KHz in our case). Next, measure the power of the 2480MHz signal in a 1MHz RBW and then again in a 30KHz RBW. Calculate the difference in dB between the power levels of the 1MHz and the 30KHz signal measurements. Add this "correction factor" in dB to the spurious value that was measured in the forbidden band using the 30KHz RBW. This composite value should give the true spurious level as measured in a 1MHz bandwidth.

Measurement Results

I have numbered the spectrum analyzer plots 1 through 9. The explanations for each plot are listed below.

Plot #1

Field strength of 2480MHz modulated signal measured in 30KHz bandwidth for the WIT2400M with the 12dBi omni. Limit line set to maximum spurious level (-80.6dBm). Modulated signal level in 30KHz bandwidth is –21.32dBm.

Plot #2

Field strength of 2480MHz signal measured in 1MHz bandwidth for the WIT2400M with the 12dBi omni. The modulated signal level in a 1MHz RBW is –19.61dBm.

Plot #3

Shows the absence of any spurious at frequencies higher than shown in plots 1 and 2.

Plot #4

Field strength of 2480MHz modulated signal measured in a 30KHz bandwidth for WIT2400M with the 14dBi corner reflector antenna. Limit line is set to maximum spurious signal level (-82.1dBm). The modulated signal level in 30KHz bandwidth is –18.38dBm.

Plot #5

Field strength of 2480MHz signal measured in 1MHz bandwidth for the WIT2400M with the 14dBi corner reflector. The modulated signal level in a 1MHz RBW is –16.41dBm.

Plot #6

Shows the absence of any spurious at frequencies higher than shown in plots 4 and 5.

Plot #7

Field strength of 2480MHz modulated signal measured in a 30KHz bandwidth for WIT2400M with the 2dBi dipole antenna. Limit line is set to maximum spurious signal level (-81.9dBm). The modulated signal level in 30KHz bandwidth is –25.17dBm.

Plot #8

Field strength of 2480MHz signal measured in 1MHz bandwidth for the WIT2400M with the 2dBi dipole antenna. The modulated signal level in a 1MHz RBW is –23.90dBm.

Plot #9

Shows the absence of any spurious at frequencies higher than shown in plots 7 and 8.

Peak Field Strength Calculations

Constants and correction factors used for these calculations:

antenna factor @ 2480MHz = 31.3dB
Cable loss @ 2480MHz = 3.6dB
dBm to dBuV conversion factor = 107(uV/mW)

12dBi Omnidirectional

-80.6dBm + (21.32 - 19.61) = bandwidth corrected value = -78.55dBm

10^((-78.55 + 31.3 + 3.6 + 107)/20) = field strength = 1470.6uV/m

14dBi Corner Reflector

-82.1dBm + (18.4 – 16.4) = bandwidth corrected value = -80.1dBm

10^((-80.1dBm + 31.3 + 3.6 + 107)/20) = field strength = 1230.3uV/m

2dBi Dipole

-81.9dBm + (25.2 – 23.9) = bandwidth corrected value = -80.6dBm

10^((-80.6dBm + 31.3 + 3.6 + 107)/20) = field strength = 1161.4uV/m

Results

All of these peak field strength values fall below the peak limit of 5000uV/m. The average levels of the field strength was calculated by multiplying the peak values by a derating factor of (1/80) * (33/100). These two factors correspond to frequency hopping and transmit duty cycle derating. Both factors are explained in appendix A of this application.

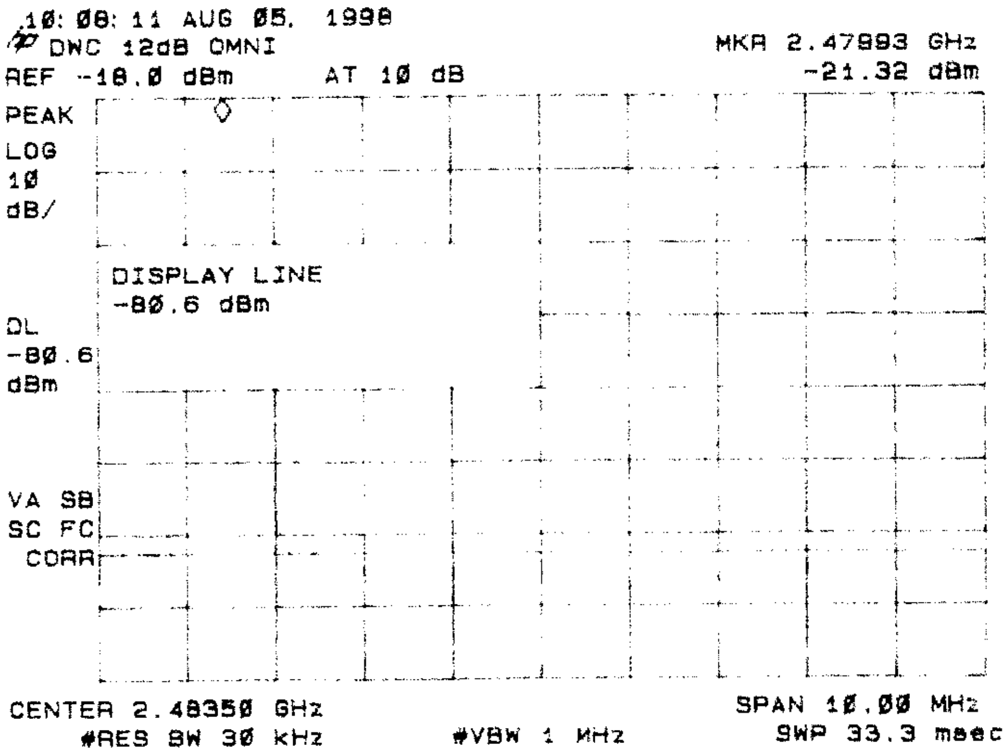
Average field strength in forbidden band for

12dBi omni; 1470.6uV/m * (1/80) * (33/100) = 6.12uV/m

14dBi Corner Reflector: 1230.3uV/m * (1/80) * (33/100) = 5.12uV/m

2dBi Dipole: 1161.4uV/m * (1/80) * (33/100) = 4.84uV/m

Note that all of these values fall under the 15.209 limit of 500uV/m.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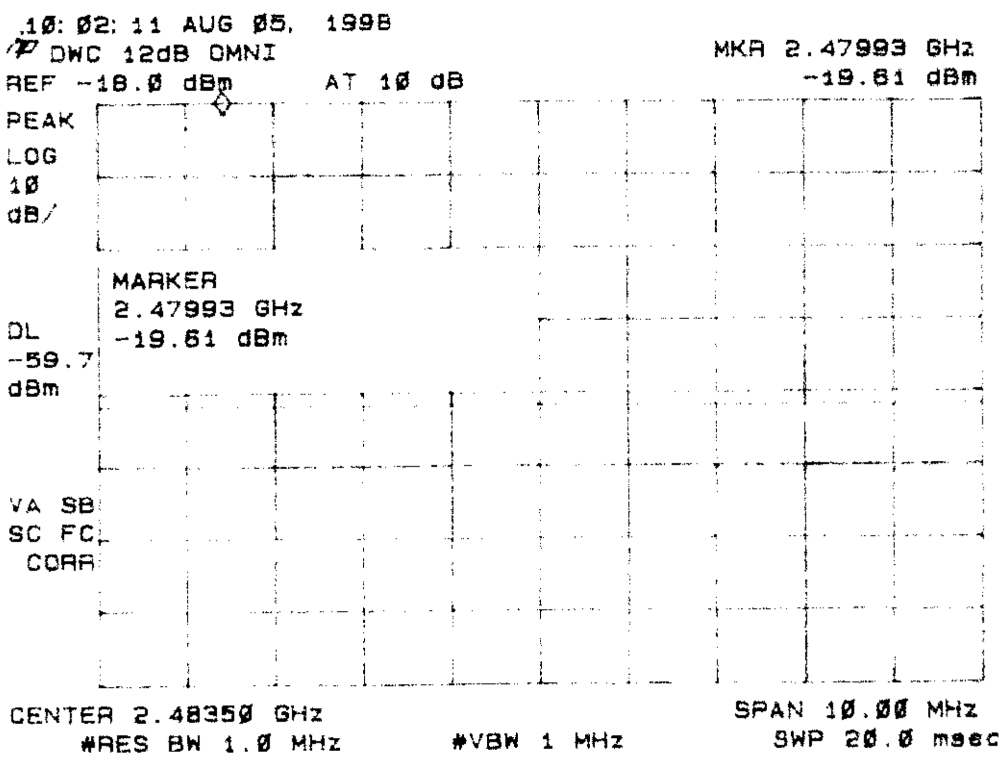
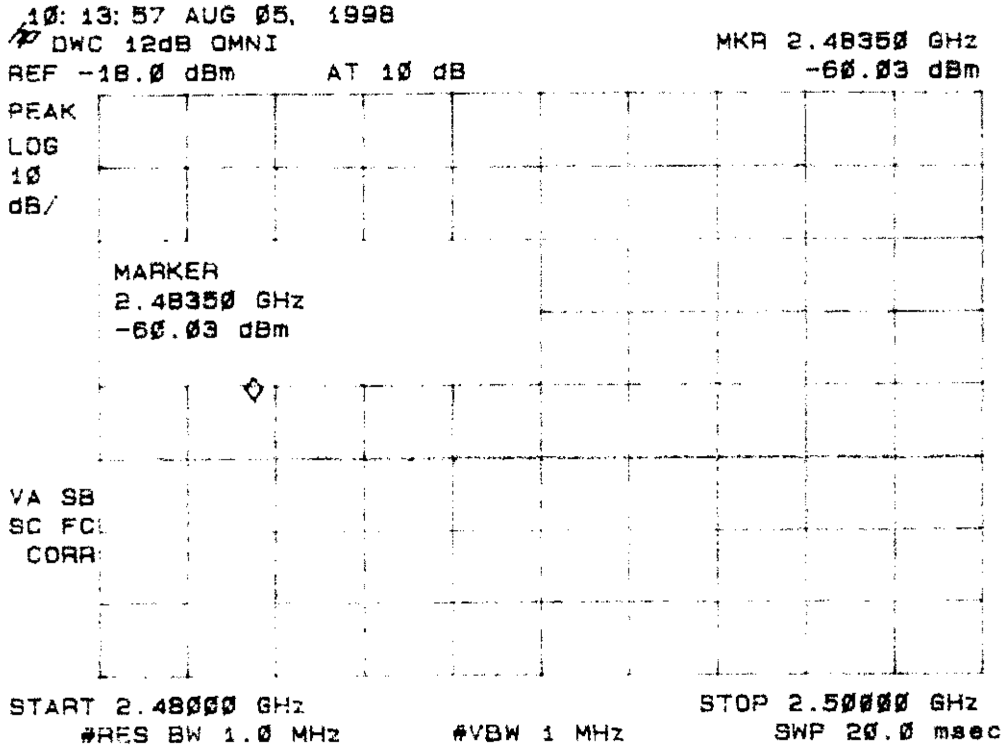
DWC 12dB OMNI
MKR 2.47993 GHz
REF -18.Ø dBm
AT 1Ø dB
-21.32 dBm
PEAK
LOG
1Ø
dB/
DISPLAY LINE
-8Ø.6 dBm
DL
-8Ø.6
dBm
VA SB
SC FC
CORR
CENTER 2.4835Ø GHz
SPAN 1Ø.ØØ MHz
#RES BW 3Ø kHz
#VBW 1 MHz
SWP 33.3 msec


1Ø: Ø2: 11 AUG Ø5, 1998
DWC 12dB OMNI
MKR 2.47993 GHz
REF -18.Ø dBm
AT 1Ø dB
-19.61 dBm
PEAK
LOG
1Ø
dB/
MARKER
2.47993 GHz
-19.61 dBm
DL
-59.7
dBm
VA SB
SC FC
CORR
CENTER 2.4835Ø GHz
SPAN 1Ø.ØØ MHz
#RES BW 1.Ø MHz
#VBW 1 MHz
SWP 2Ø.Ø msec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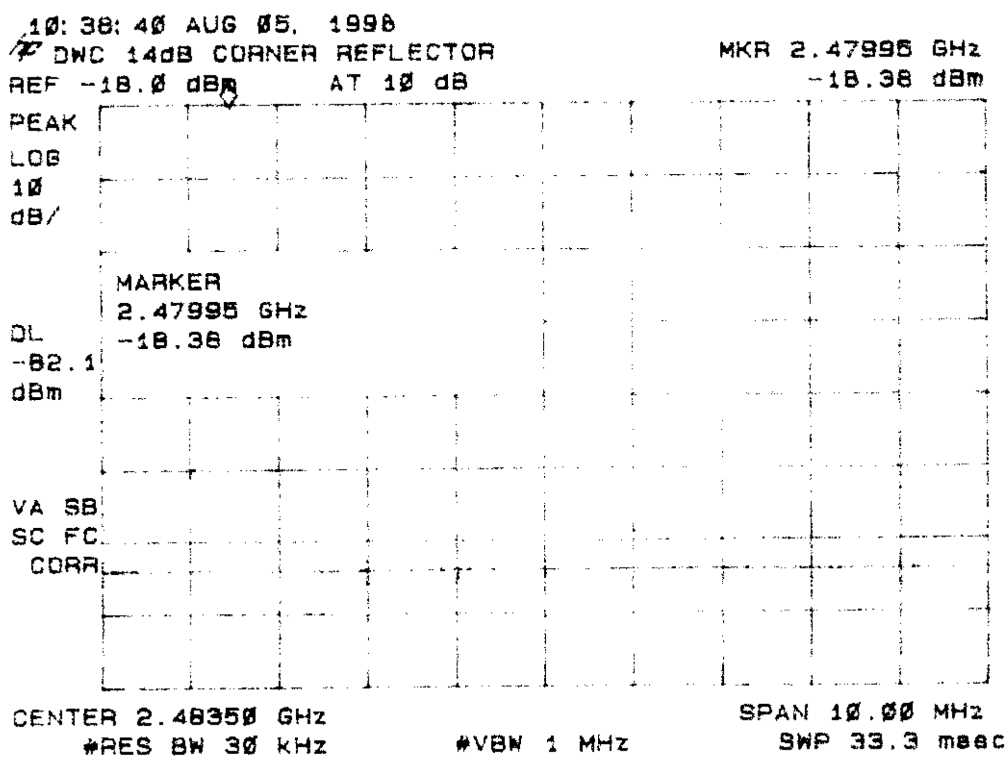
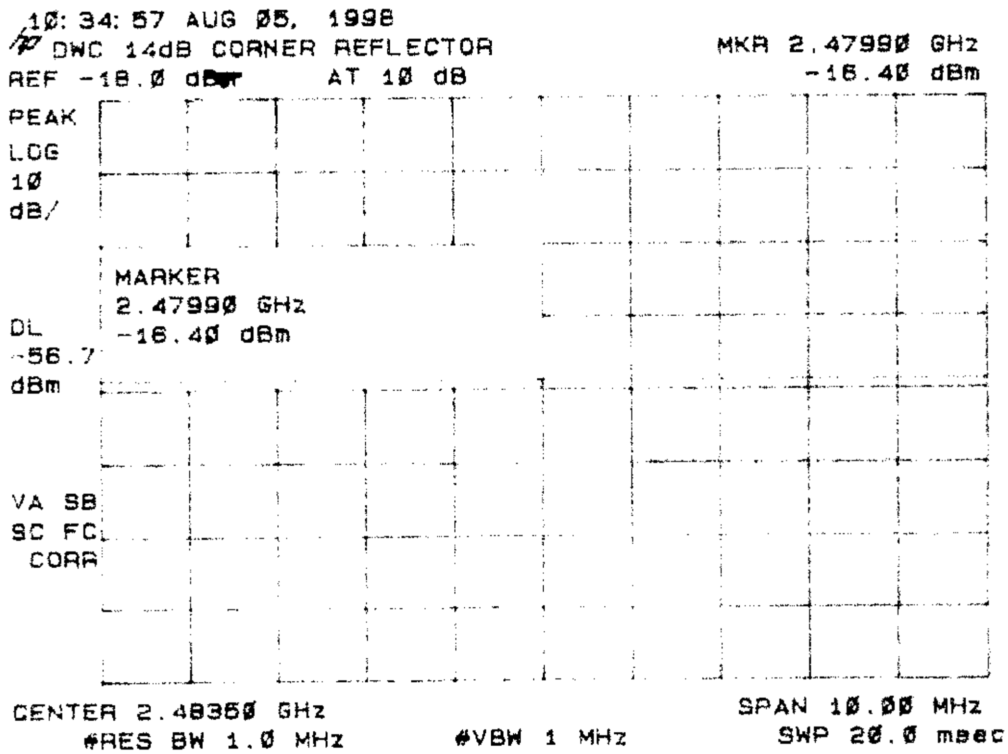
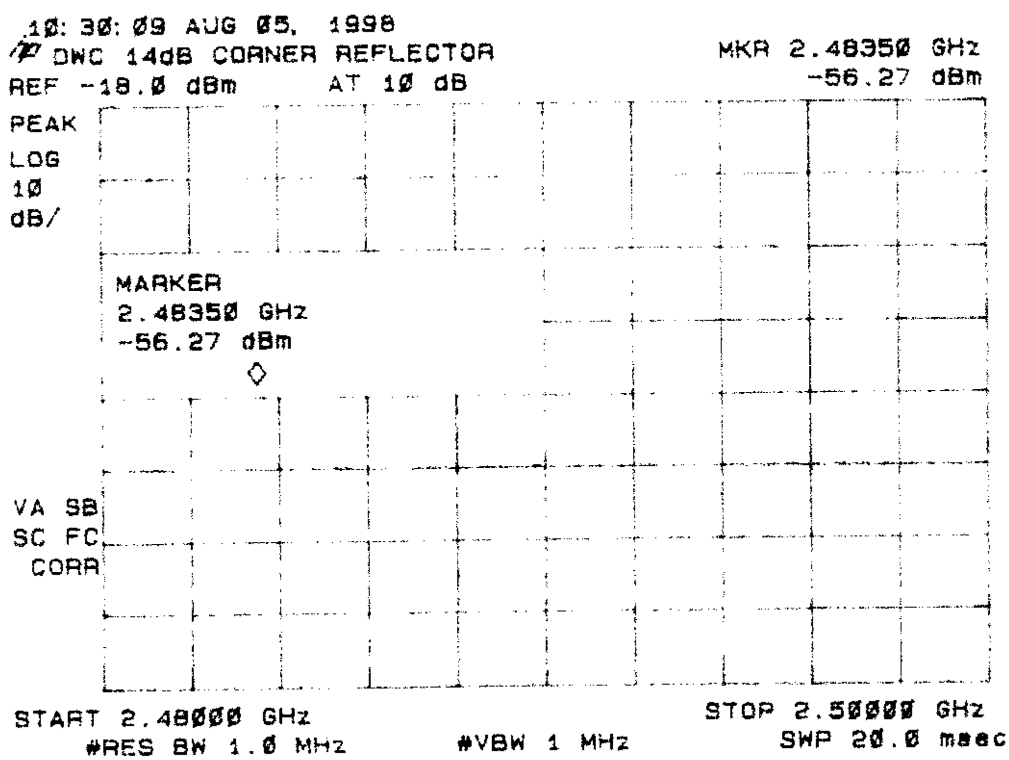
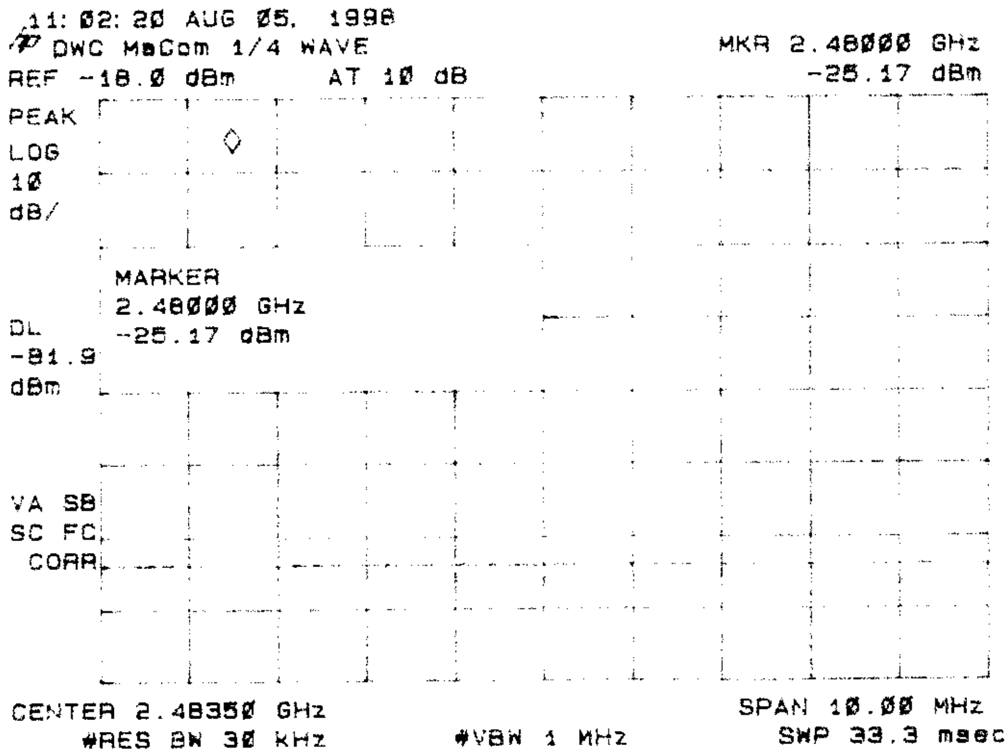
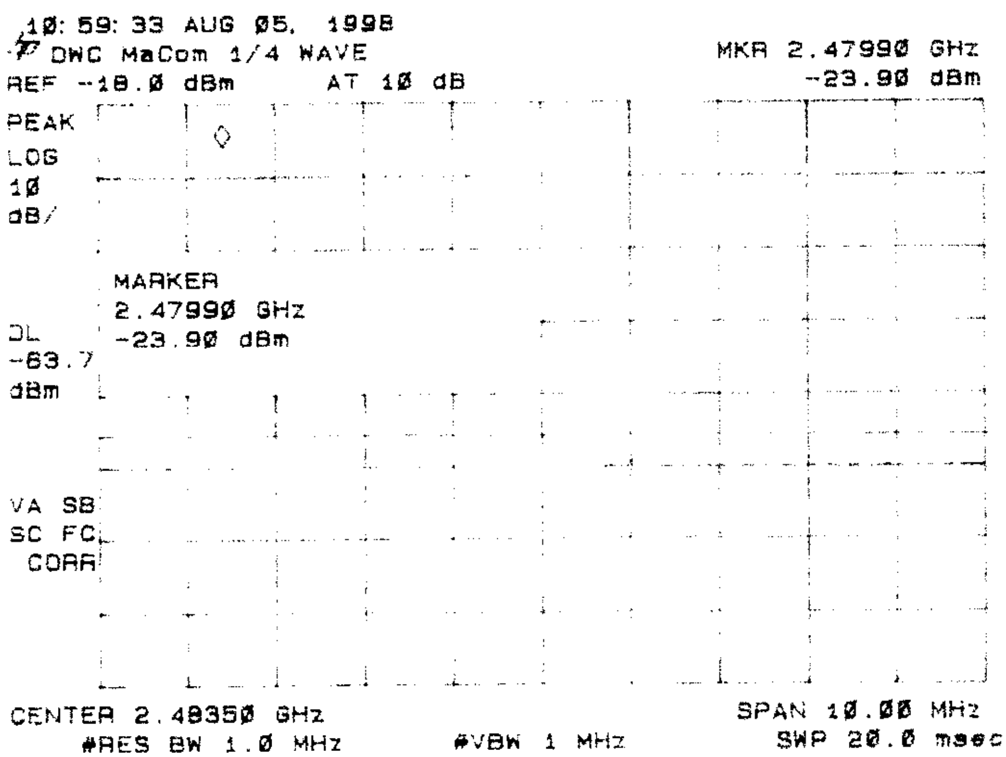
DWC 12dB OMNI
MKR 2.4835Ø GHz
REF -18.Ø dBm AT 1Ø dB
-6Ø.Ø3 dBm
PEAK
LOG
1Ø
dB/
MARKER
2.4835Ø GHz
-6Ø.Ø3 dBm
VA SB
SC FC
CORR
START 2.48ØØØ GHz
STOP 2.5ØØØØ GHz
#RES BW 1.Ø MHz
#VBW 1 MHz
SWP 2Ø.Ø msec


1Ø: 38: 4Ø AUG Ø5, 1998
DWC 14dB CORNER REFLECTOR
MKR 2.47995 GHz
REF -18.Ø dBm AT 1Ø dB
-18.38 dBm
PEAK
LOG
1Ø
dB/
MARKER
2.47995 GHz
-18.38 dBm
DL
-82.1
dBm
VA SB
SC FC
CORR
CENTER 2.4835Ø GHz
SPAN 1Ø.ØØ MHz
#RES BW 3Ø kHz
#VBW 1 MHz
SWP 33.3 msec


10: 34: 57 AUG 05, 1998
DWC 14dB CORNER REFLECTOR
MKR 2.47990 GHz
-16.40 dBm
REF -18.0 d
AT 10 dB
PEAK
LOG
10
dB/
MARKER
2.47990 GHz
-16.40 dBm
DL
-56.7
dBm
VA SB
SC FC
CORR
CENTER 2.48350 GHz
SPAN 10.00 MHz
#RES BW 1.0 MHz
#VBW 1 MHz
SWP 20.0 msec


10: 30: 09 AUG 05, 1998
DWC 14dB CORNER REFLECTOR
MKR 2.48350 GHz
-56.27 dBm
REF -18.0 dBm
AT 10 dB
PEAK
LOG
10
dB/
MARKER
2.48350 GHz
-56.27 dBm
VA SB
SC FC
CORR
START 2.48000 GHz
STOP 2.50000 GHz
#RES BW 1.0 MHz
#VBW 1 MHz
SWP 20.0 msec


11: Ø2: 2Ø AUG Ø5, 1998
DWC MaCom 1/4 WAVE
REF -18.Ø dBm AT 1Ø dB
MKR 2.48ØØØ GHz
-25.17 dBm
PEAK
LOG
1Ø
dB/
MARKER
2.48ØØØ GHz
-25.17 dBm
DL
-81.9
dBm
VA SB
SC FC
CORR
CENTER 2.4835Ø GHz
#RES BW 3Ø kHz
#VBW 1 MHz
SPAN 1Ø.ØØ MHz
SWP 33.3 msec


1Ø: 59: 33 AUG Ø5, 1998
DWC MaCom 1/4 WAVE
REF -18.Ø dBm AT 1Ø dB
MKR 2.4799Ø GHz
-23.9Ø dBm
PEAK
LOG
1Ø
dB/
MARKER
2.4799Ø GHz
-23.9Ø dBm
DL
-63.7
dBm
VA SB
SC FC
CORR
CENTER 2.4835Ø GHz
#RES BW 1.Ø MHz
#VBW 1 MHz
SPAN 1Ø.ØØ MHz
SWP 2Ø.Ø msec

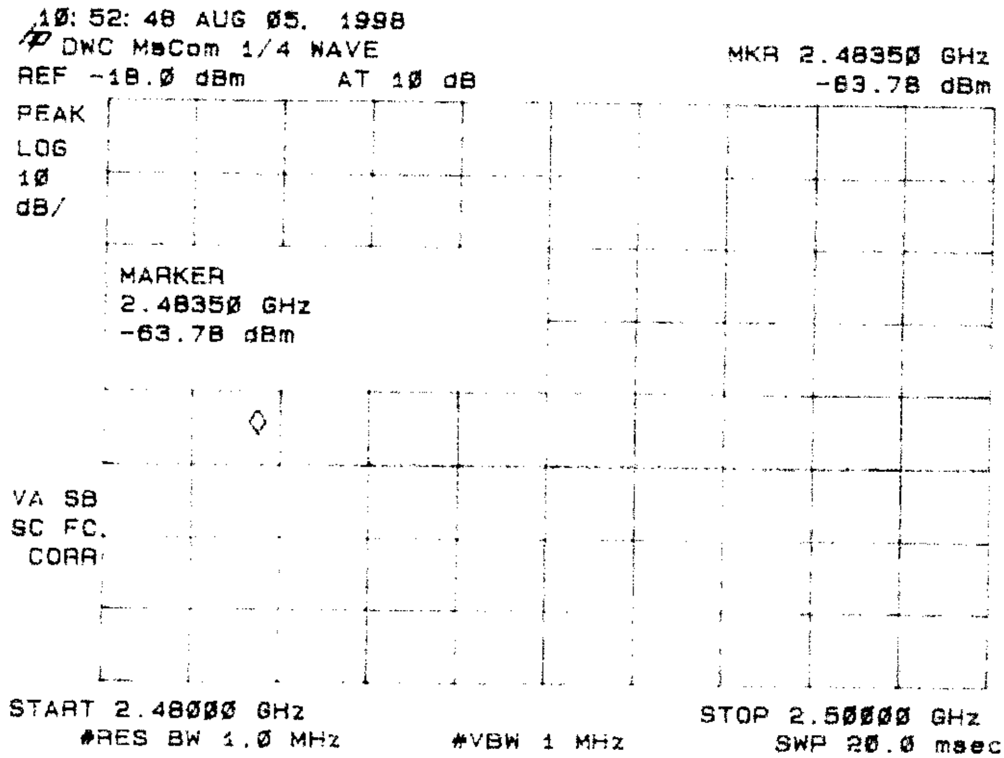
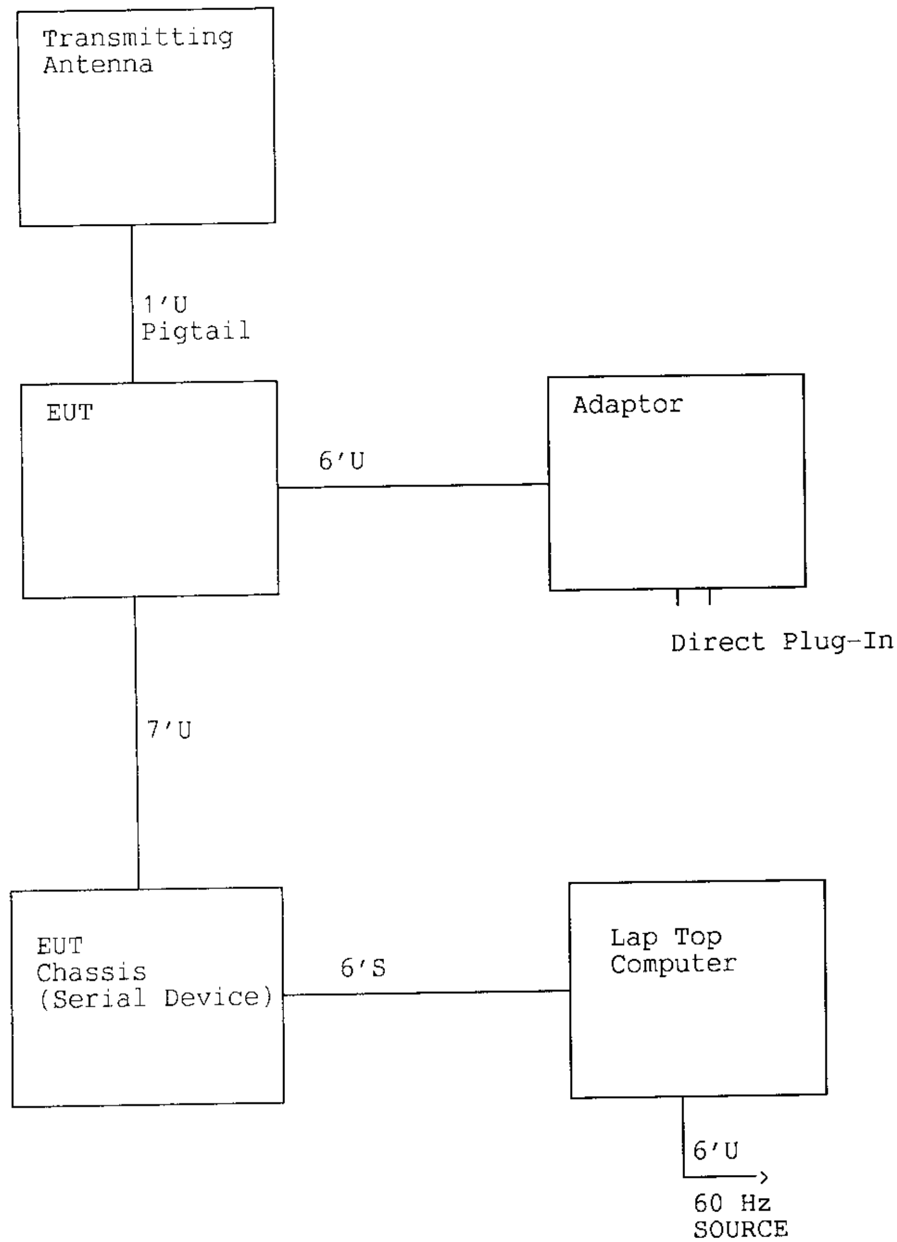

10: 52: 48 AUG 05, 1998
DWC MaCom 1/4 WAVE
REF -18.0 dBm AT 10 dB
MKR 2.48350 GHz
-63.78 dBm
PEAK
LOG
10
dB/
MARKER
2.48350 GHz
-63.78 dBm
VA SB
SC FC.
CORR
START 2.48000 GHz
STOP 2.50000 GHz
#RES BW 1.0 MHz
#VBW 1 MHz
SWP 20.0 msec

FIGURE 1. Test Set-up
Model WIT2400M



EUT and Peripherals

Description	Model No.	Serial No.	FCC ID	Cable Description
EUT Digital Wireless	WIT2400M	None	HSW-2400M	6' S
Lap Top Computer NEC Technologies	Prospeed 286	9200071HM	A3D5YRXB715A	6' U Power Cord
AC Adapter Cuistack	DV-1280	None	None	6' U

EUT and Peripherals Continued

Antenna	Manufacturer	Model No.	Gain	Connector
12 dB Omni	Mobile Mark	0D12-2400PTA	12 dBi	Reverse TNC
Corner Reflector	Mobile Mark	SCR14-2400PTA	14 dBi	Reverse TNC
Dipole	M/A Com	AND-C-107-1	2 dBi	SMA Male

Table 1A. PEAK RADIATED SPURIOUS EMISSIONS (Low End)
Model WIT2400M with 12dB Omni Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.802	-60.7	34.2	34.5	5.3	389.4	5000
7.203	-55.8	34.5	37.8	6.6	1132.9	5000
12.005	-62.5**	32.6	41.6	10.1	1514.6	5000

Table 1B. PEAK RADIATED SPURIOUS EMISSIONS (Middle)
Model WIT2400M with 12dB Omni Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.880	-58.9	34.2	34.8	5.3	498.9	5000
7.320	-56.7	34.5	37.9	6.7	1040.9	5000
12.200	-63.9**	32.5	41.4	10.4	1324.3	5000

Table 1C. PEAK RADIATED SPURIOUS EMISSIONS (High End)
Model WIT2400M with 12dB Omni Antenna

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.960	-61.8	34.2	35.1	5.4	372.4	5000
7.440	-56.3	34.5	38.0	6.7	1111.2	5000
12.400	-60.6**	32.4	41.2	10.7	1990.7	5000

SAMPLE CALCULATION:
RESULTS (uV/m @ 3m) = Antilog ((-60.7 - 34.2 + 34.0 + 5.3 + 107)/20) = 389.4
CONVERSION FROM dBm TO dBuV = 107 dB
* = Data adjusted by +1 dB for high pass filter
** = Instrumentation ground floor.

Table 2A. AVERAGE RADIATED SPURIOUS EMISSIONS (Low End)
Model WIT2400M with 12dB Omni Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.802	-108.3	34.2	34.5	5.3	1.6	500
7.203	-103.4	34.5	37.8	6.6	4.7	500
12.005	-110.1	32.6	41.6	10.1	6.3	500

Table 2B. AVERAGE RADIATED SPURIOUS EMISSIONS (Middle)
Model WIT2400M with 12dB Omni Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.880	-106.5	34.2	34.8	5.3	2.1	500
7.320	-104.3	34.5	37.9	6.7	4.3	500
12.200	-111.5	32.5	41.4	10.4	5.5	500

Table 2C. AVERAGE RADIATED SPURIOUS EMISSIONS (High End)
Model WIT2400M with 12dB Omni Antenna

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.960	-109.4	34.2	35.1	5.4	1.6	500
7.440	-103.9	34.5	38.0	6.7	4.6	500
12.400	-108.2	32.4	41.2	10.7	8.3	500

SAMPLE CALCULATION:
RESULTS (uV/m @ 3m) = Antilog ((-108.3 -34.2 + 34.5 + 5.3 + 107)/20) = 1.6
CONVERSION FROM dBm TO dBuV = 107 dB
* = Peak Data adjusted by +1 dB for high pass filter and worse case duty cycle by 20 log (33ms/100ms) +20 Log (1/80 ch) or -9.6dB + -38dB = -47.6dB
SEE APPENDIX A
** = Instrumentation ground floor.

Table 3A. PEAK RADIATED SPURIOUS EMISSIONS (Low End)
Model WIT2400M with Corner Reflector Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.802	-57.7	34.2	34.5	5.3	550.1	5000
7.203	-54.5	34.5	37.8	6.6	1315.9	5000
12.005	-59.8**	32.6	41.6	10.1	2066.8	5000

Table 3B. PEAK RADIATED SPURIOUS EMISSIONS (Middle)
Model WIT2400M with Corner Reflector Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.920	-61.2	34.2	34.8	5.3	382.8	5000
7.400	-57.7	34.5	37.9	6.7	927.7	5000
12.360	-59.0**	32.2	41.4	10.4	2328.1	5000

Table 3C. PEAK RADIATED SPURIOUS EMISSIONS (High End)
Model WIT2400M with Coorner Reflector Antenna

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.960	-62.8**	34.2	35.1	5.4	331.9	5000
7.440	-54.7	34.5	38.0	6.7	1336.0	5000
12.400	-58.9**	32.4	41.2	10.7	2421.0	5000

SAMPLE CALCULATION:
RESULTS (uV/m @ 3m) = Antilog ((-57.7 - 34.2 + 34.5 + 5.3 + 107)/20) = 550.1
CONVERSION FROM dBm TO dBuV = 107 dB
* = Data adjusted by +1 dB for high pass filter
** = Instrumentation ground floor.

Table 4A. AVERAGE RADIATED SPURIOUS EMISSIONS (Low End)
Model WIT2400M with Corner Reflector Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.802	-105.3	34.2	34.5	5.3	2.3	500
7.203	-102.1	34.5	37.8	6.6	5.5	500
12.005	-107.4**	32.6	41.6	10.1	8.6	500

Table 4B. AVERAGE RADIATED SPURIOUS EMISSIONS (Middle)
Model WIT2400M with Corner Reflector Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.920	-108.8	34.2	34.8	5.3	1.6	500
7.400	-105.3	34.5	37.9	6.7	3.9	500
12.360	-106.6**	32.5	41.4	10.4	9.7	500

Table 4C. AVERAGE RADIATED SPURIOUS EMISSIONS (High End)
Model WIT2400M with Corner Reflector Antenna

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.960	-110.4	34.2	35.1	5.4	1.4	500
7.440	-102.3	34.5	38.0	6.7	5.6	500
12.400	-106.5**	32.4	41.2	10.7	10.1	500

SAMPLE CALCULATION:
RESULTS (uV/m @ 3m) = Antilog ((-105.3 - 34.2 + 34.5 + 5.3 + 107)/20) = 2.3
CONVERSION FROM dBm TO dBuV = 107 dB
* = Peak Data adjusted by +1 dB for high pass filter and worse case duty cycle by 20 log (33ms/100ms) +20 Log (1/80 ch) or -9.6dB + -38dB = -47.6dB
SEE APPENDIX A
** = Instrumentation ground floor.

Table 5A. PEAK RADIATED SPURIOUS EMISSIONS (Low End)
Model WIT2400M with Wave Dipole Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.802	-63.3	34.2	34.5	5.3	288.7	5000
7.203	-56.3	34.5	37.8	6.6	1069.6	5000
12.005	-60.2**	32.6	41.6	10.1	1973.8	5000

Table 5B. PEAK RADIATED SPURIOUS EMISSIONS (Middle)
Model WIT2400M with Wave Dipole Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.880	-63.4**	34.2	34.8	5.3	297.2	5000
7.320	-56.1	34.5	37.9	6.7	1115.3	5000
12.200	-60.2**	32.5	41.4	10.4	2027.7	5000

Table 5C. PEAK RADIATED SPURIOUS EMISSIONS (High End)
Model WIT2400M with Wave Dipole Antenna

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.960	-60.2	34.2	35.1	5.4	447.7	5000
7.440	-54.8	34.5	38.0	6.7	1320.7	5000
12.400	-61.9**	32.4	41.2	10.7	1714.0	5000

SAMPLE CALCULATION:
RESULTS (uV/m @ 3m) = Antilog ((-63.3 - 34.2 + 34.5 + 5.3 + 107)/20) = 288.7
CONVERSION FROM dBm TO dBuV = 107 dB
* = Data adjusted by +1 dB for high pass filter
** = Instrumentation ground floor.

Table 6A. AVERAGE RADIATED SPURIOUS EMISSIONS (Low End)
Model WIT2400M with Wave Dipole Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.802	-110.9	34.2	34.5	5.3	1.2	500
7.203	-103.9	34.5	37.8	6.6	4.5	500
12.005	-107.8**	32.6	41.6	10.1	8.2	500

Table 6B. AVERAGE RADIATED SPURIOUS EMISSIONS (Middle)
Model WIT2400M with Wave Dipole Antenna

Freq. (GHz)	Test Data* (dBm) @ 3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.880	-110.0**	34.2	34.8	5.3	1.2	500
7.320	-103.7	34.5	37.9	6.7	4.6	500
12.200	-107.8	32.5	41.4	10.4	8.5	500

Table 6C. AVERAGE RADIATED SPURIOUS EMISSIONS (High End)
Model WIT2400M with Wave Dipole Antenna

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) 3m	FCC Limits (uV/m)
4.960	-107.8	34.2	35.1	5.4	1.9	500
7.440	-102.4	34.5	38.0	6.7	5.5	500
12.400	-109.5**	32.4	41.2	10.7	7.1	500

SAMPLE CALCULATION:
RESULTS (uV/m @ 3m) = Antilog ((-110.0 + 34.2 + 34.5 + 5.3 + 107)/20) = 1.2
CONVERSION FROM dBm TO dBuV = 107 dB
* = Peak Data adjusted by +1 dB for high pass filter and worse case duty cycle by 20 log (33ms/100ms) +20 Log (1/80 ch) or -9.6dB + -38dB = -47.6dB
SEE APPENDIX A
** = Instrumentation ground floor.

B. Photographs of Transmit Antennas

Figure 2
Peak Spurious Emissions 15.247(c) Low

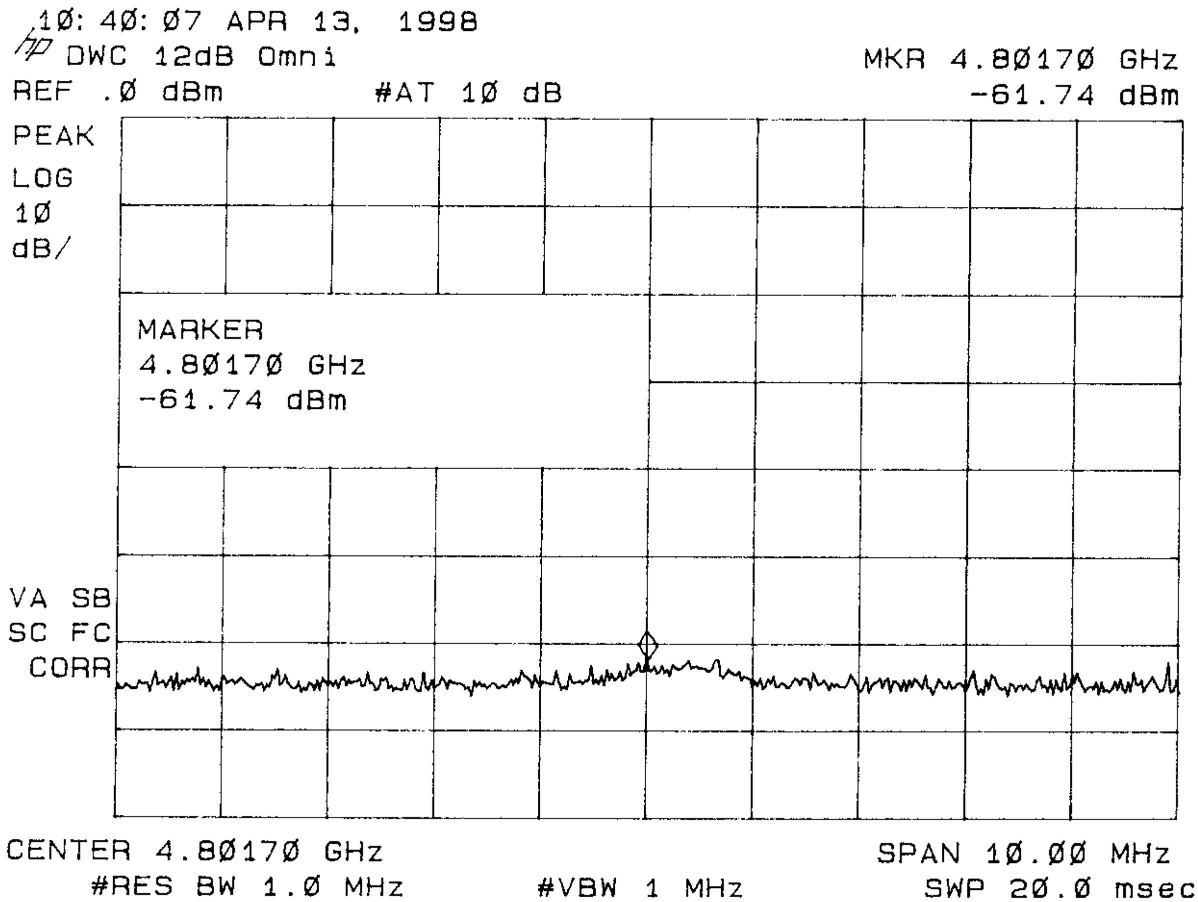


Figure 3
Peak Spurious Emissions 15.247(c) Low

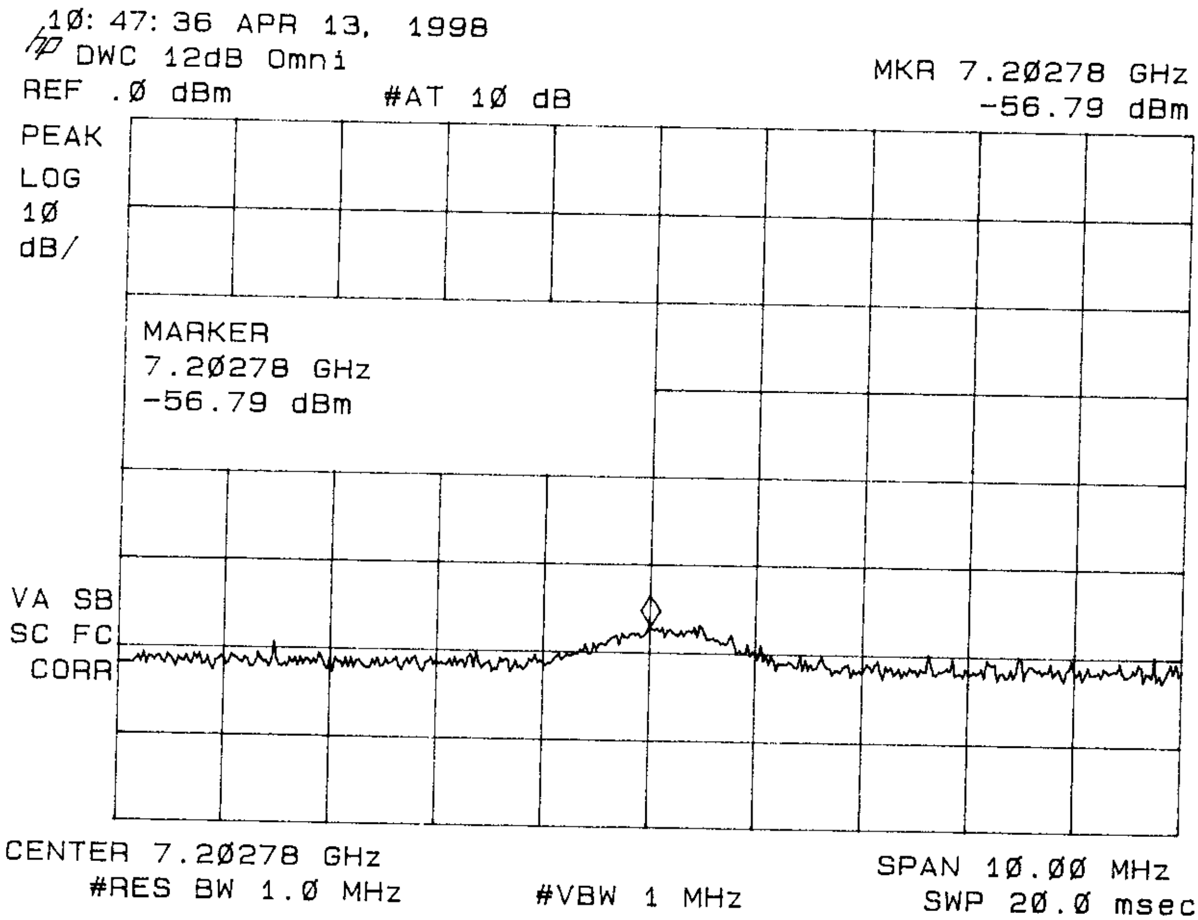


Figure 4
Peak Spurious Emissions 15.247(c) Low

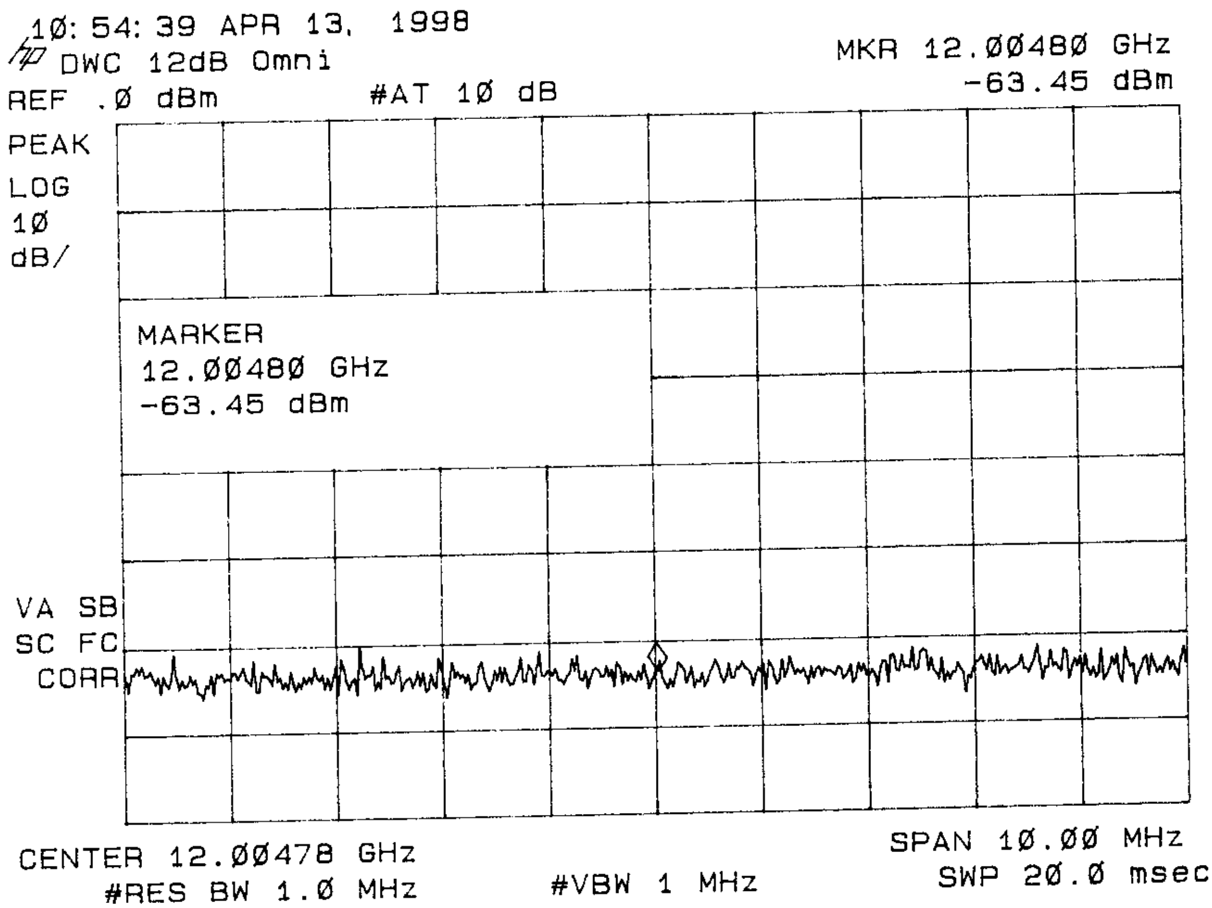


Figure 5
Peak Spurious Emissions 15.247(c) Mid

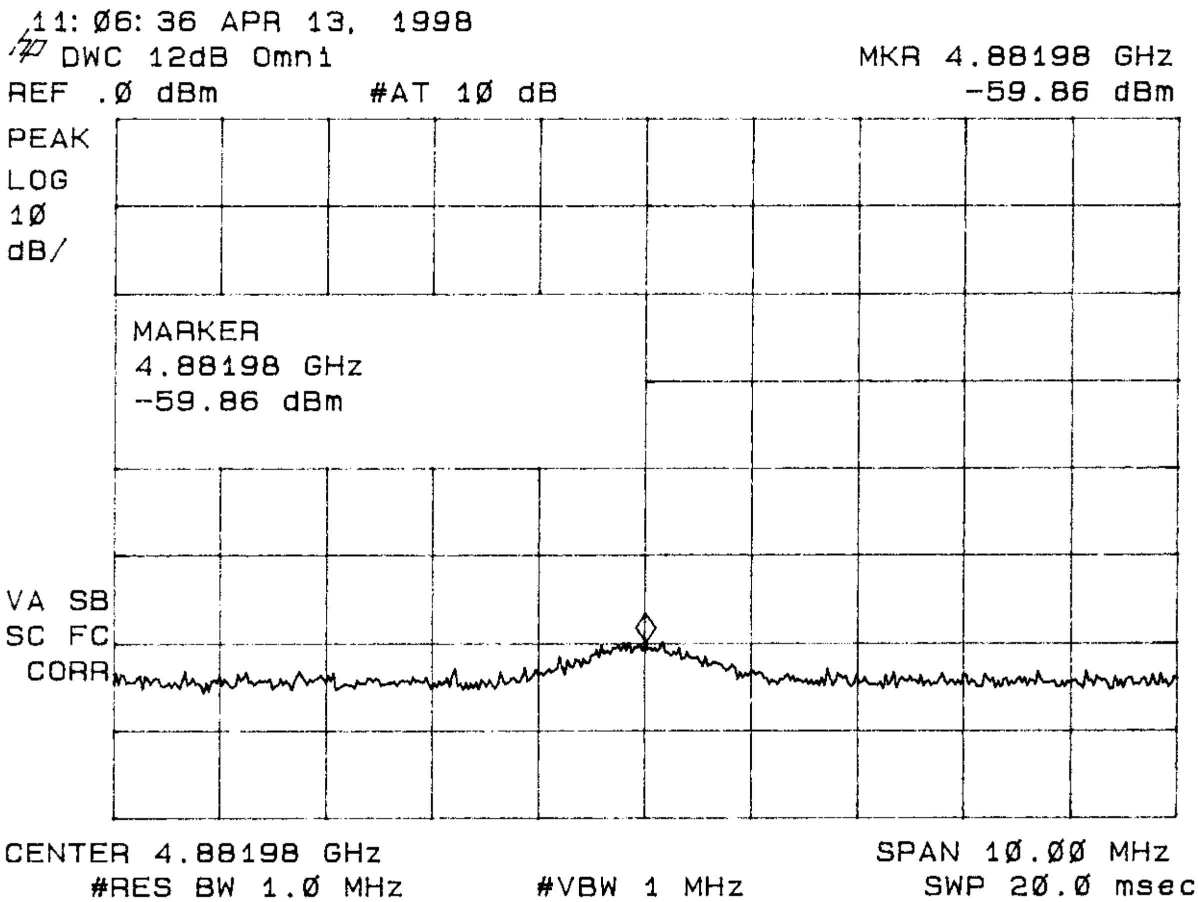


Figure 6
Peak Spurious Emissions 15.247(c) Mid

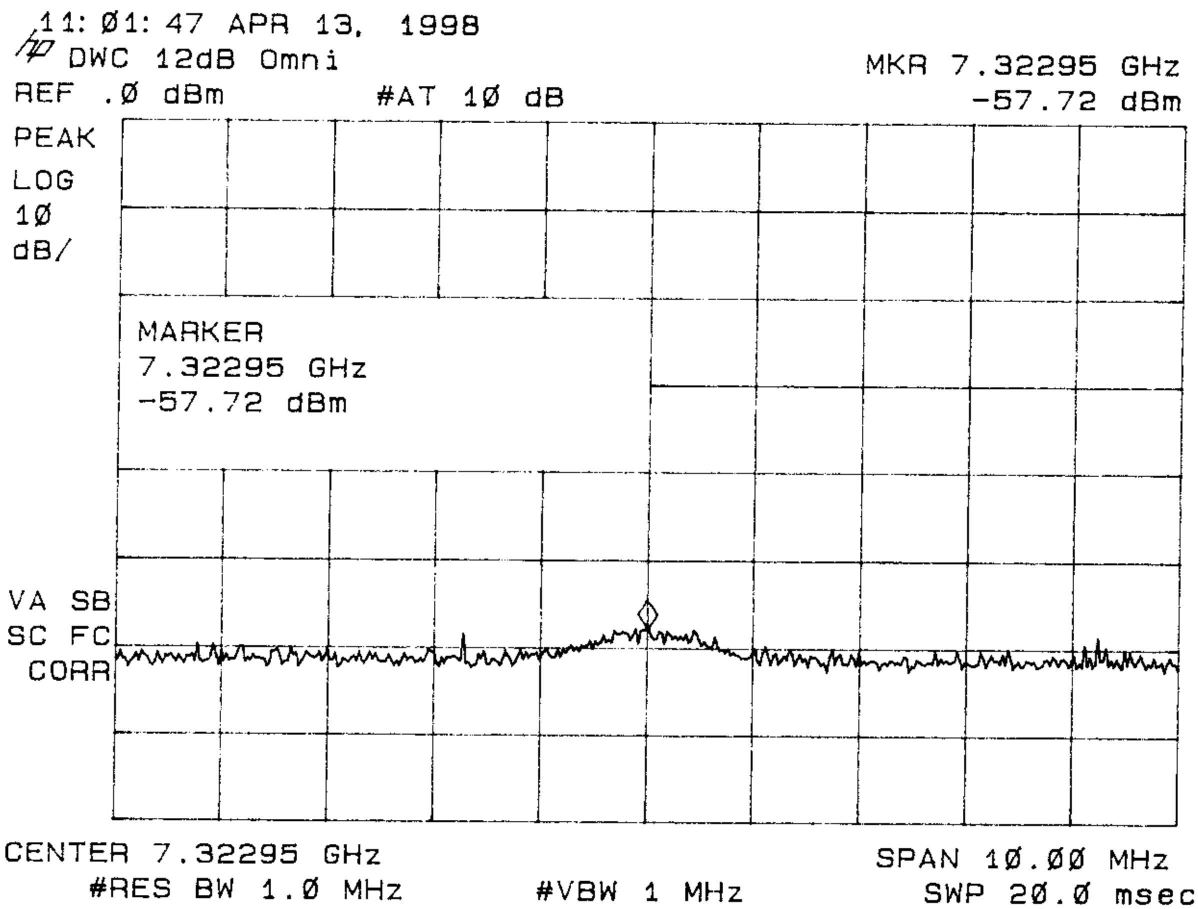


Figure 7
Peak Spurious Emissions 15.247(c) Mid

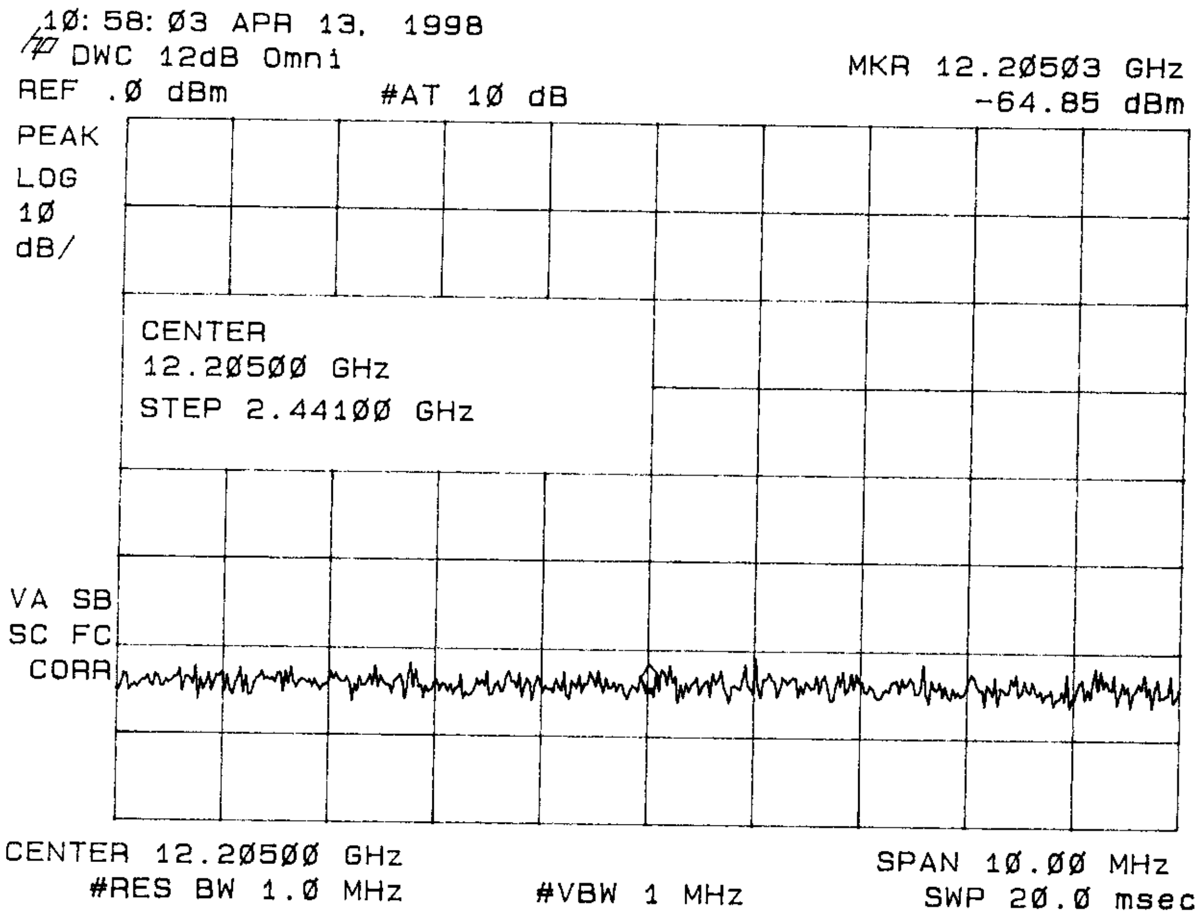


Figure 8
Peak Spurious Emissions 15.247(c) High

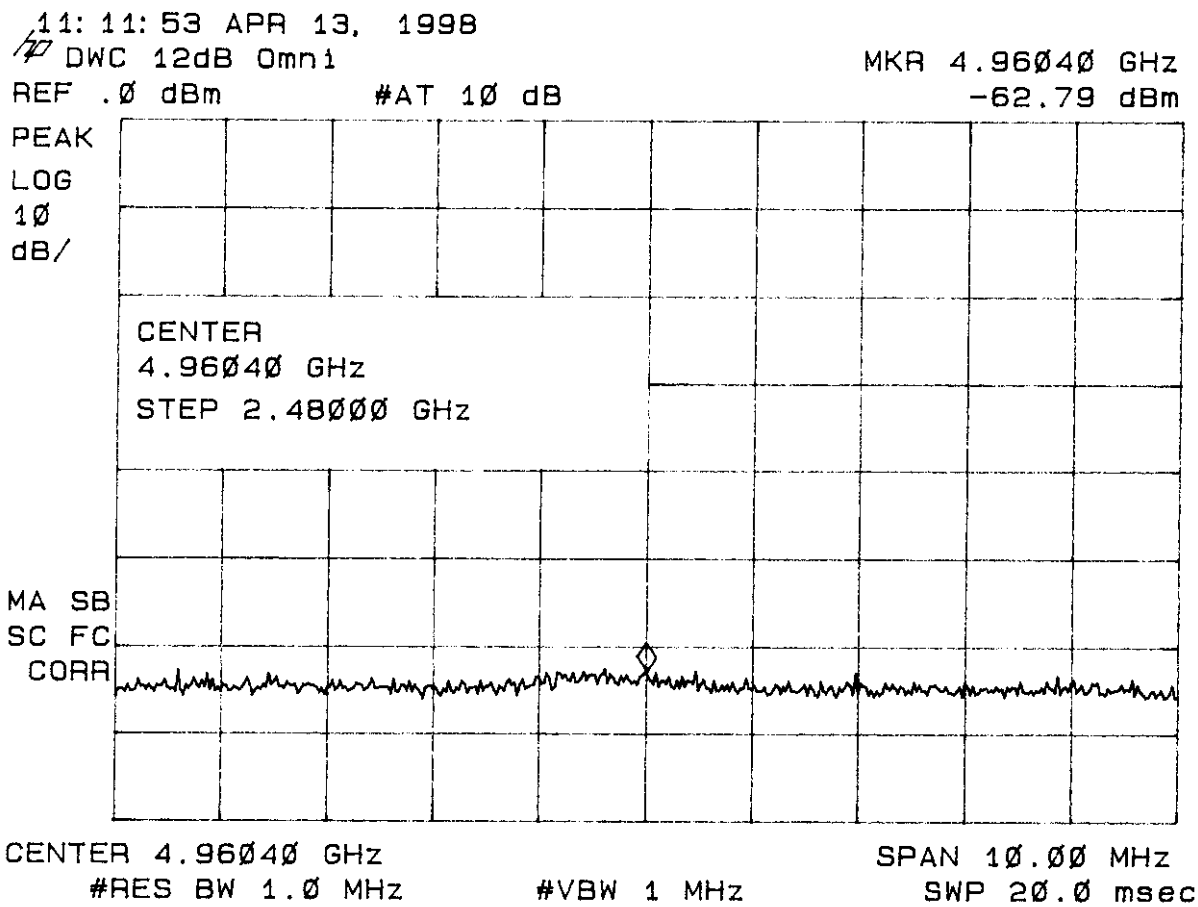


Figure 9
Peak Spurious Emissions 15.247(c) High

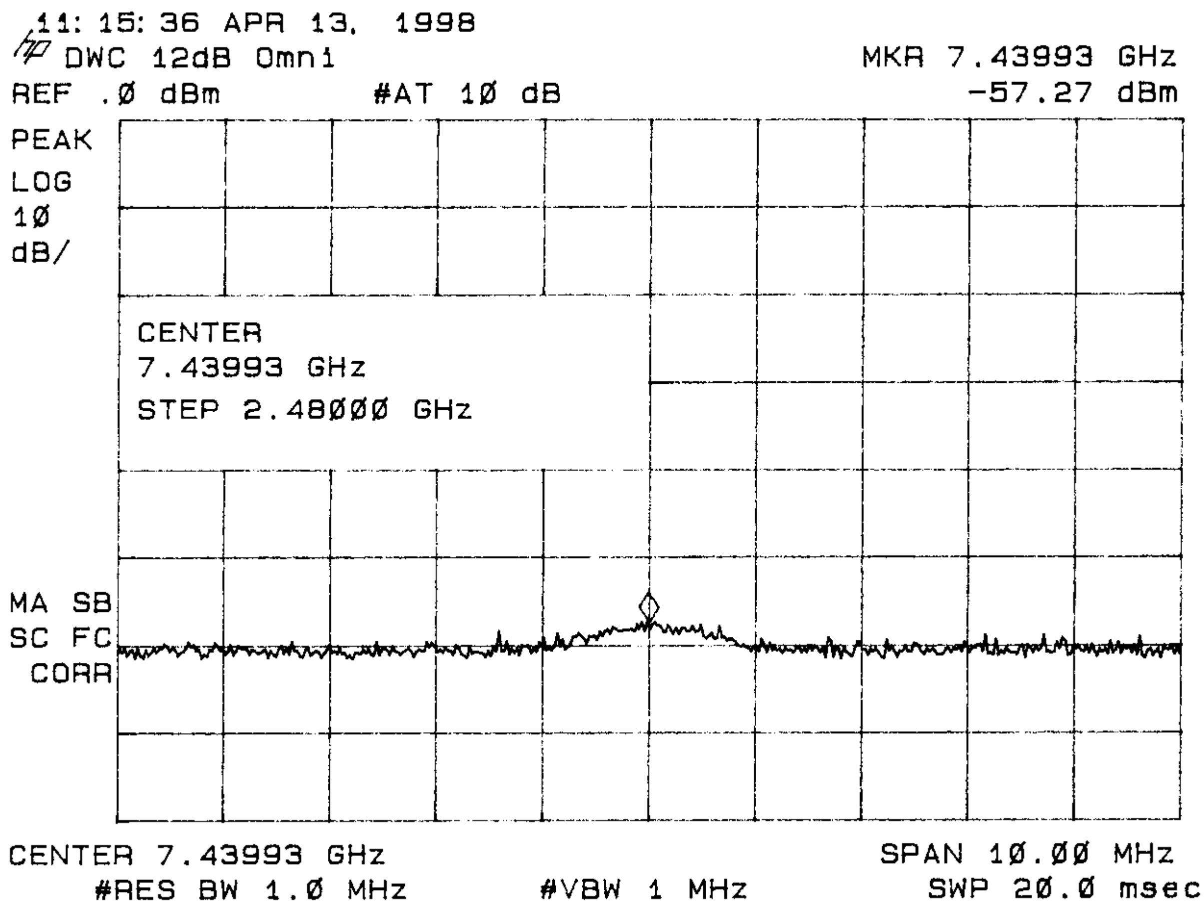


Figure 10
Peak Spurious Emissions 15.247(c) High

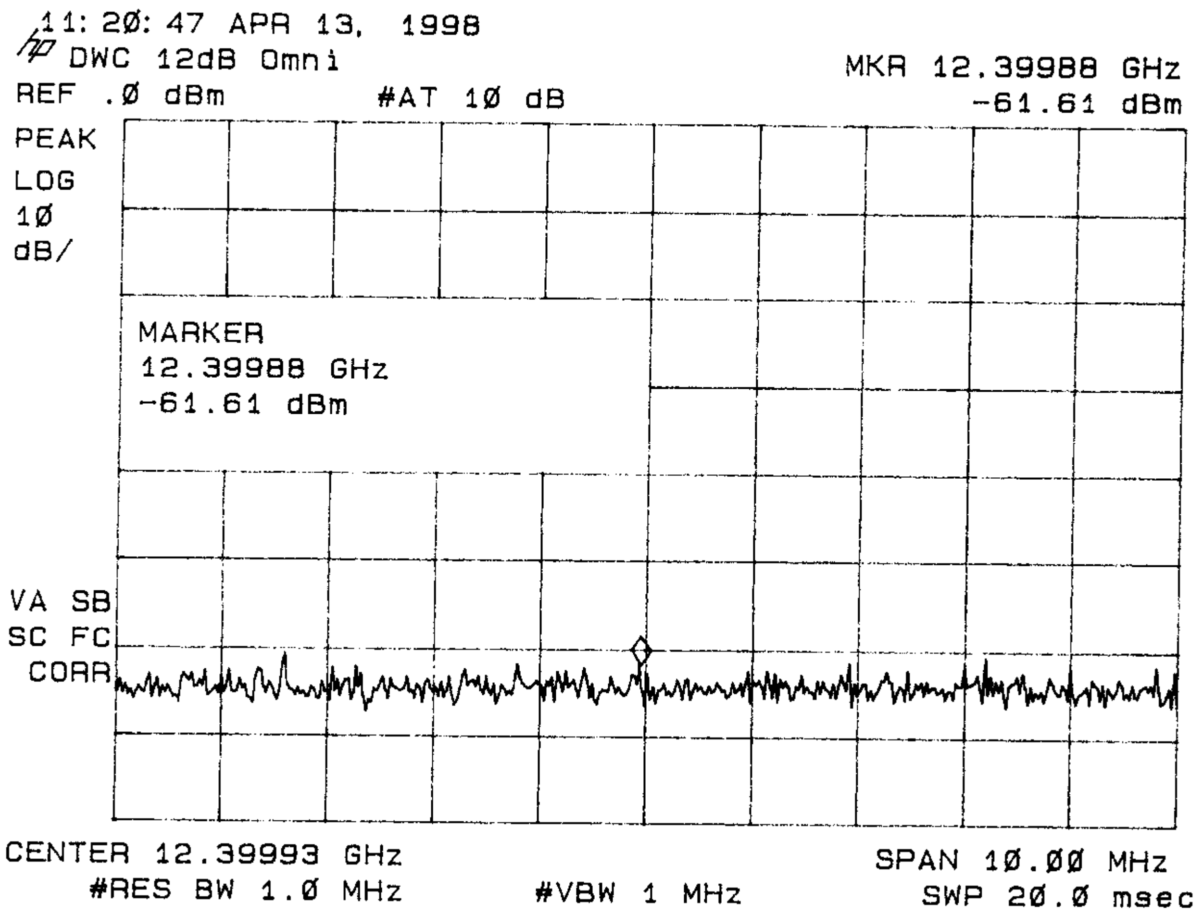


Figure 11
Peak Spurious Emissions 15.247(c) Low

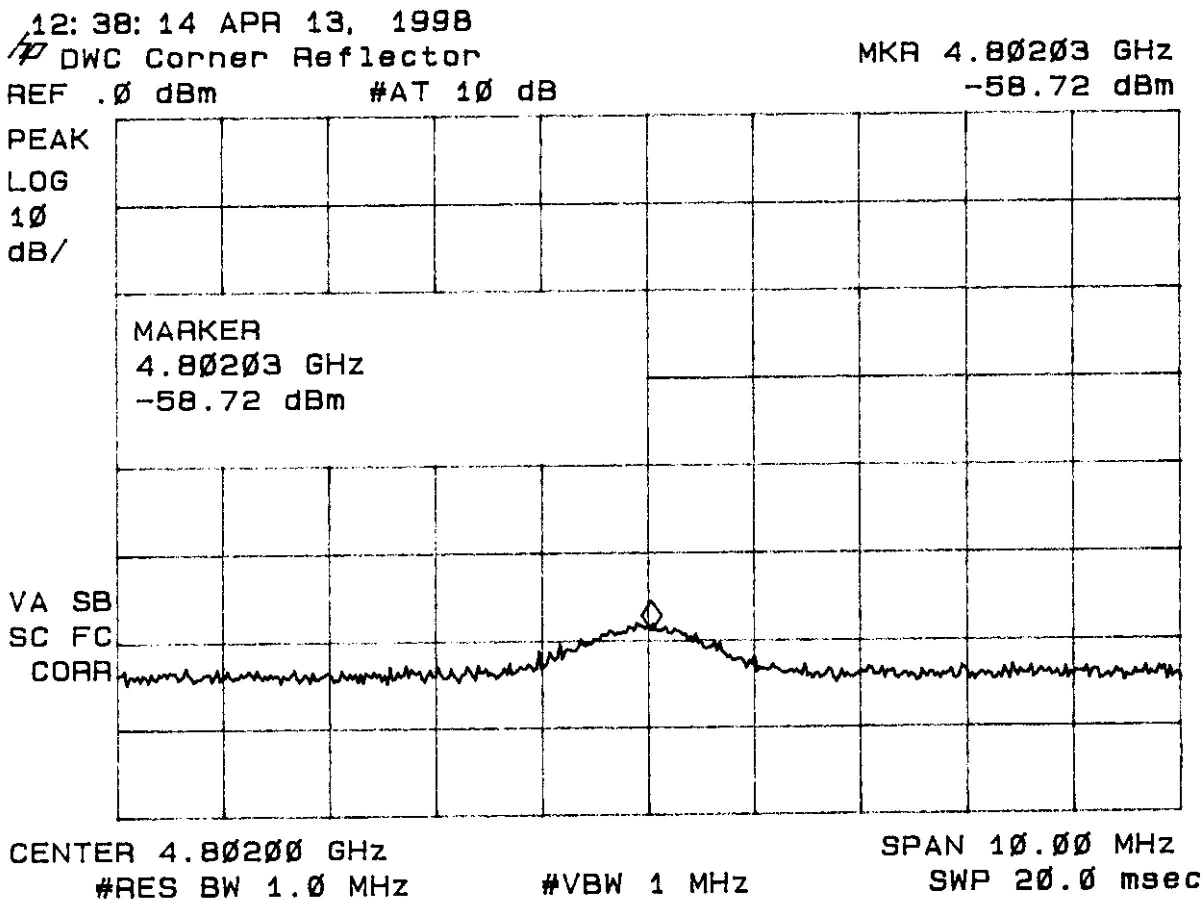


Figure 12
Peak Spurious Emissions 15.247(c) Low

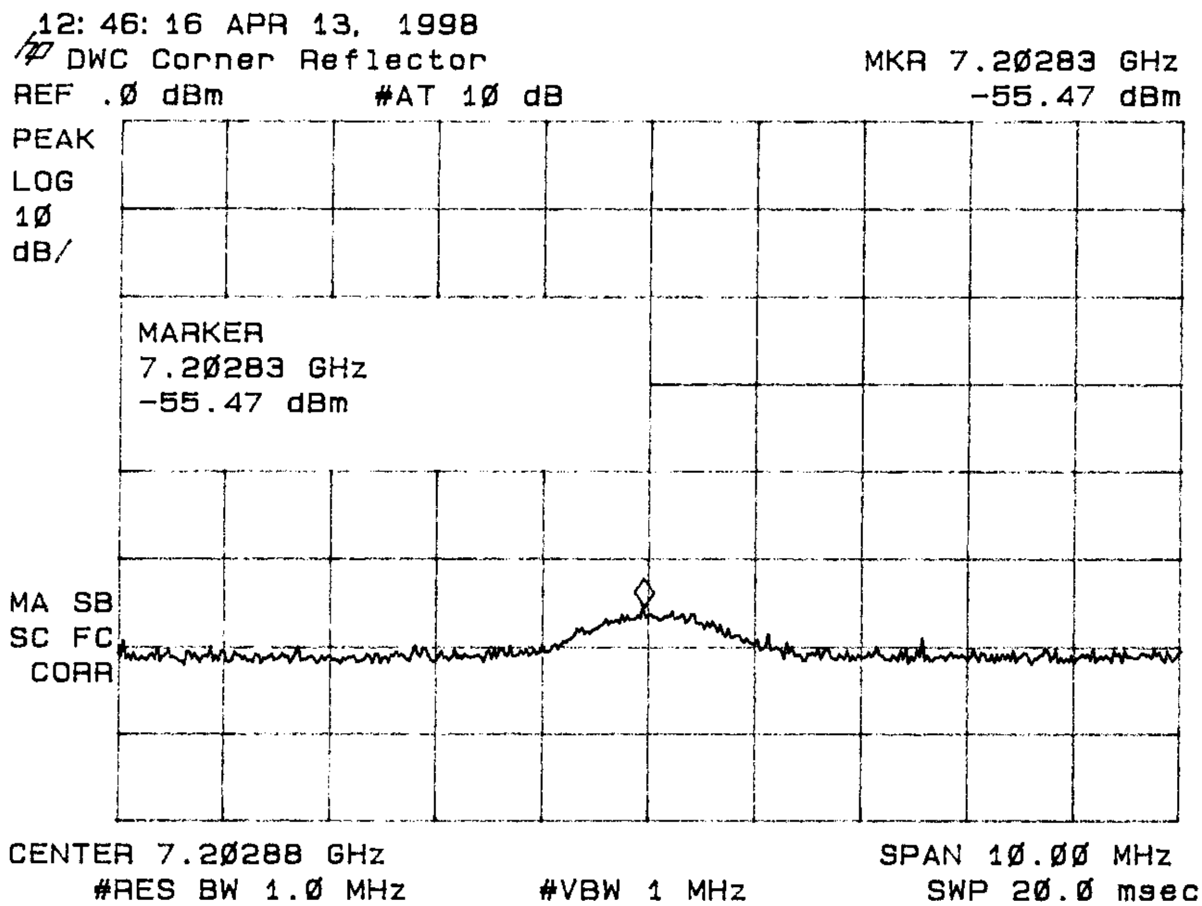


Figure 13
Peak Spurious Emissions 15.247(c) Low

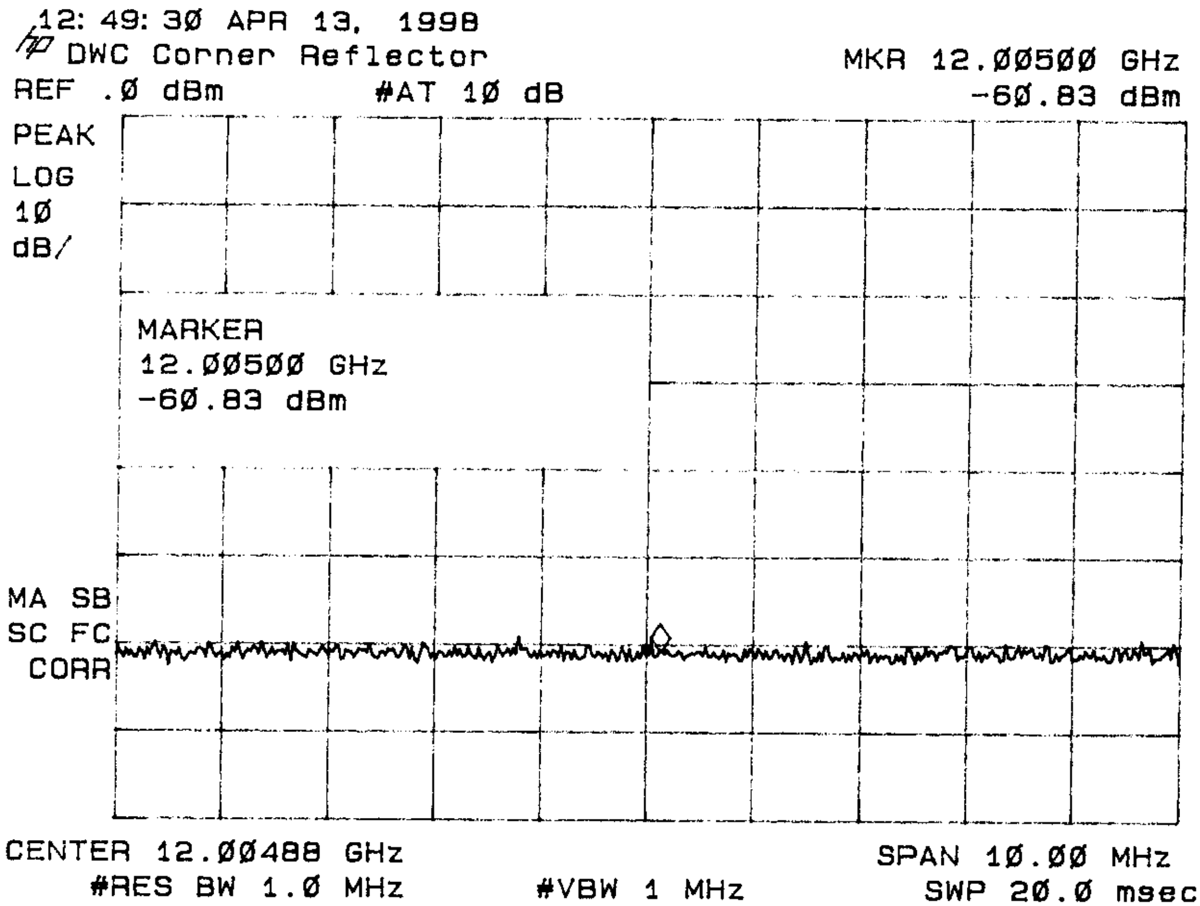


Figure 14
Peak Spurious Emissions 15.247(c) Mid

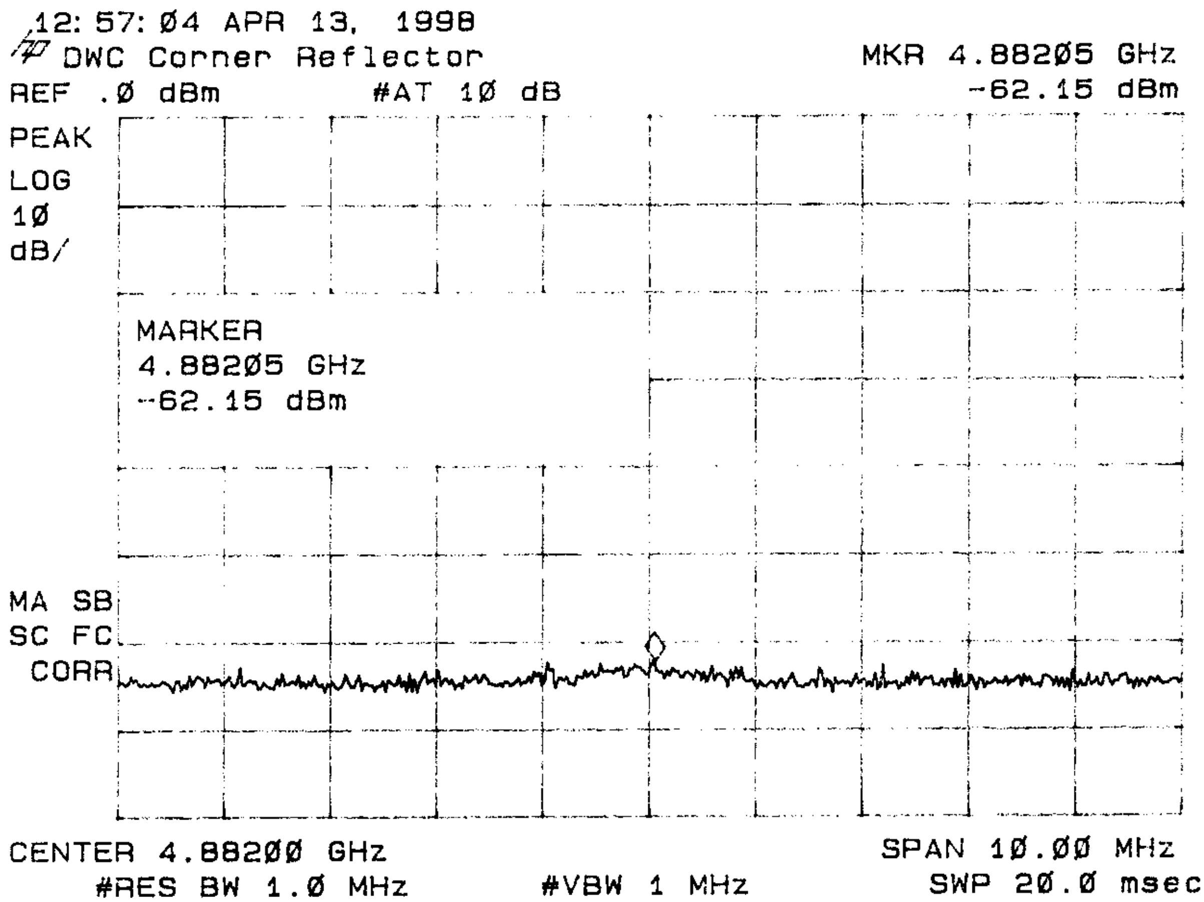


Figure 15
Peak Spurious Emissions 15.247(c) Mid

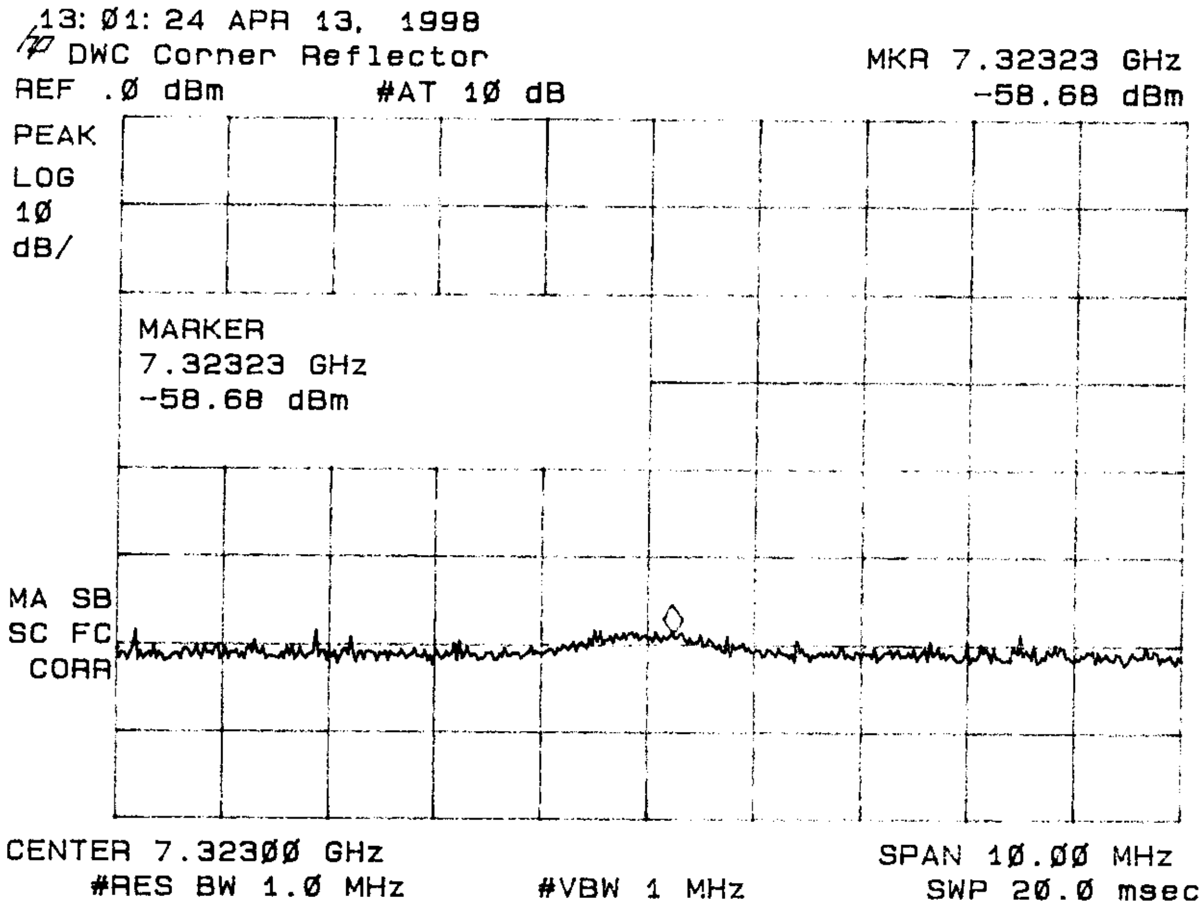


Figure 16
Peak Spurious Emissions 15.247(c) Mid

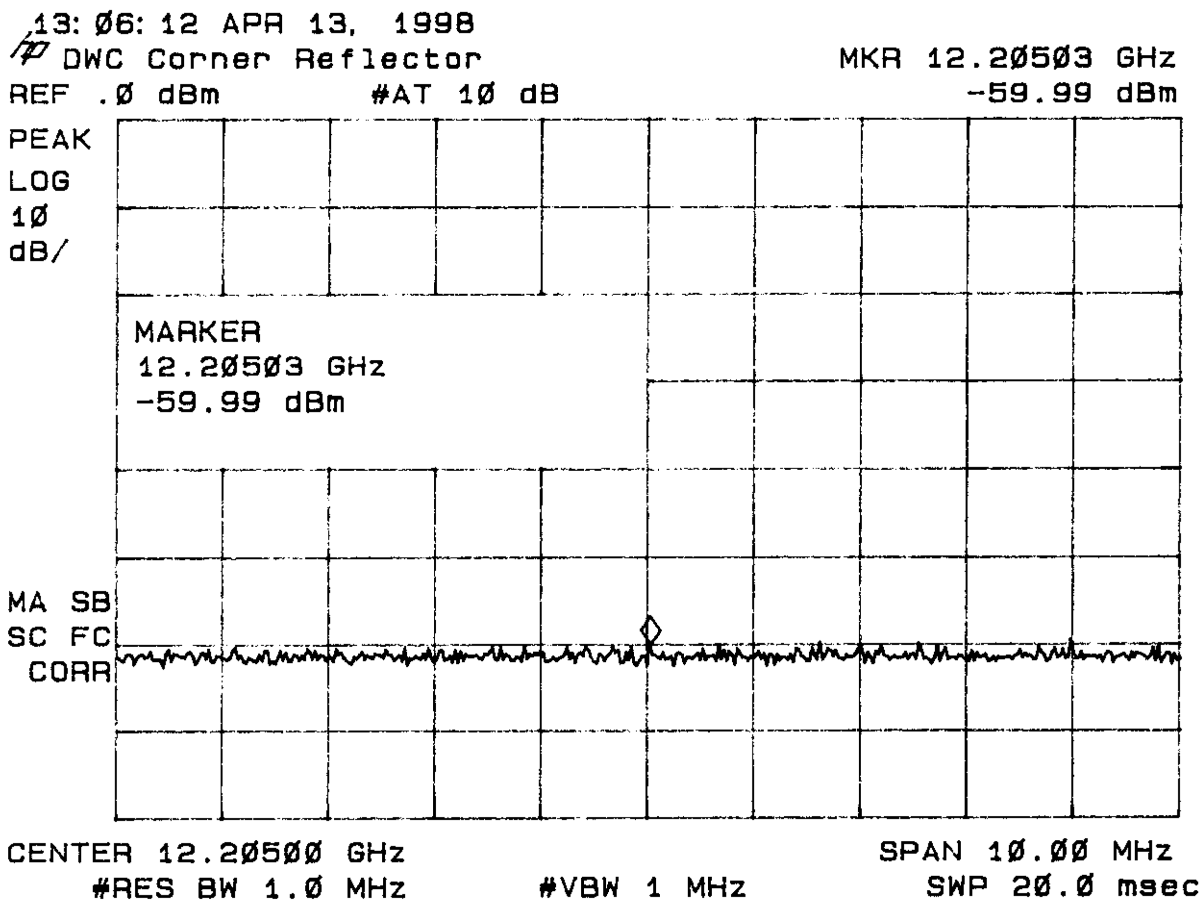


Figure 17
Peak Spurious Emissions 15.247(c) High

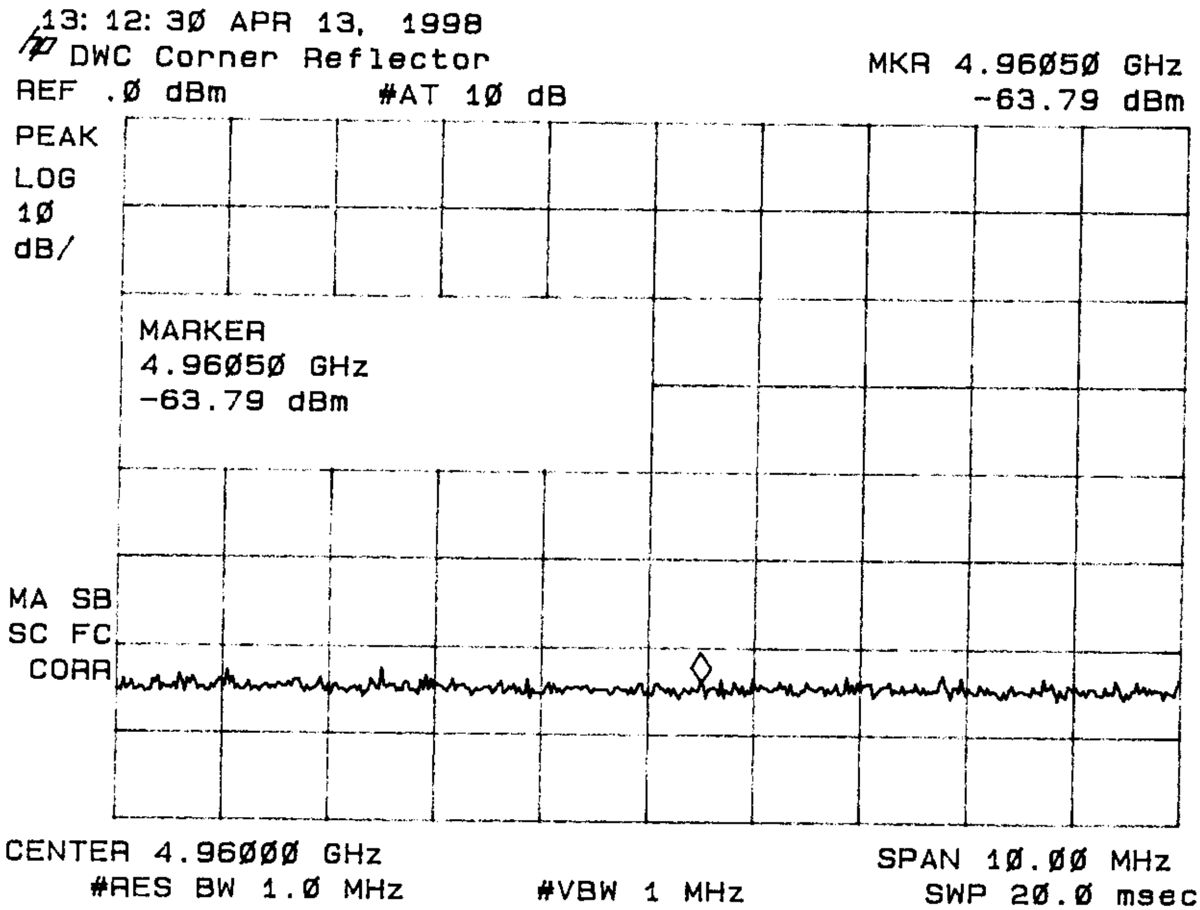


Figure 18
Peak Spurious Emissions 15.247(c) High

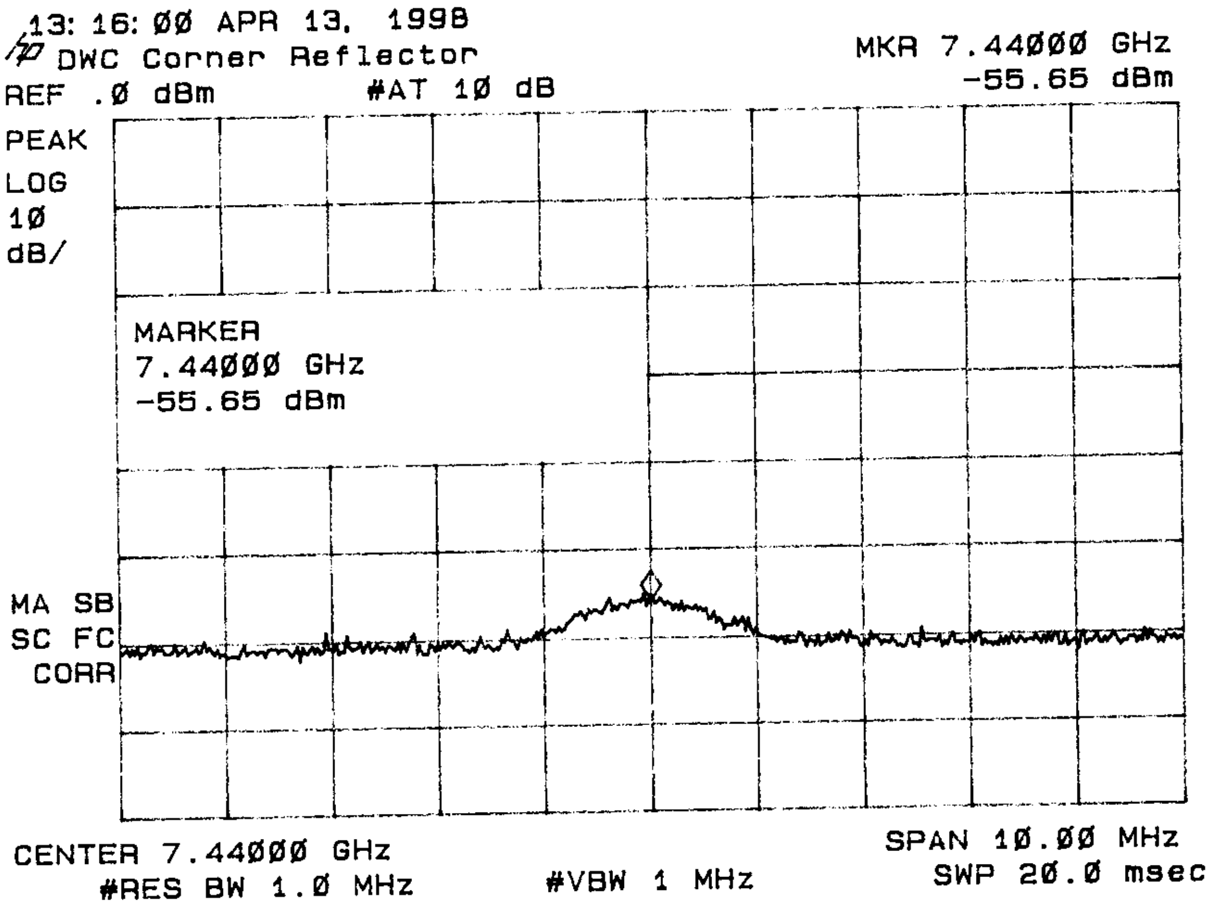


Figure 19
Peak Spurious Emissions 15.247(c) High

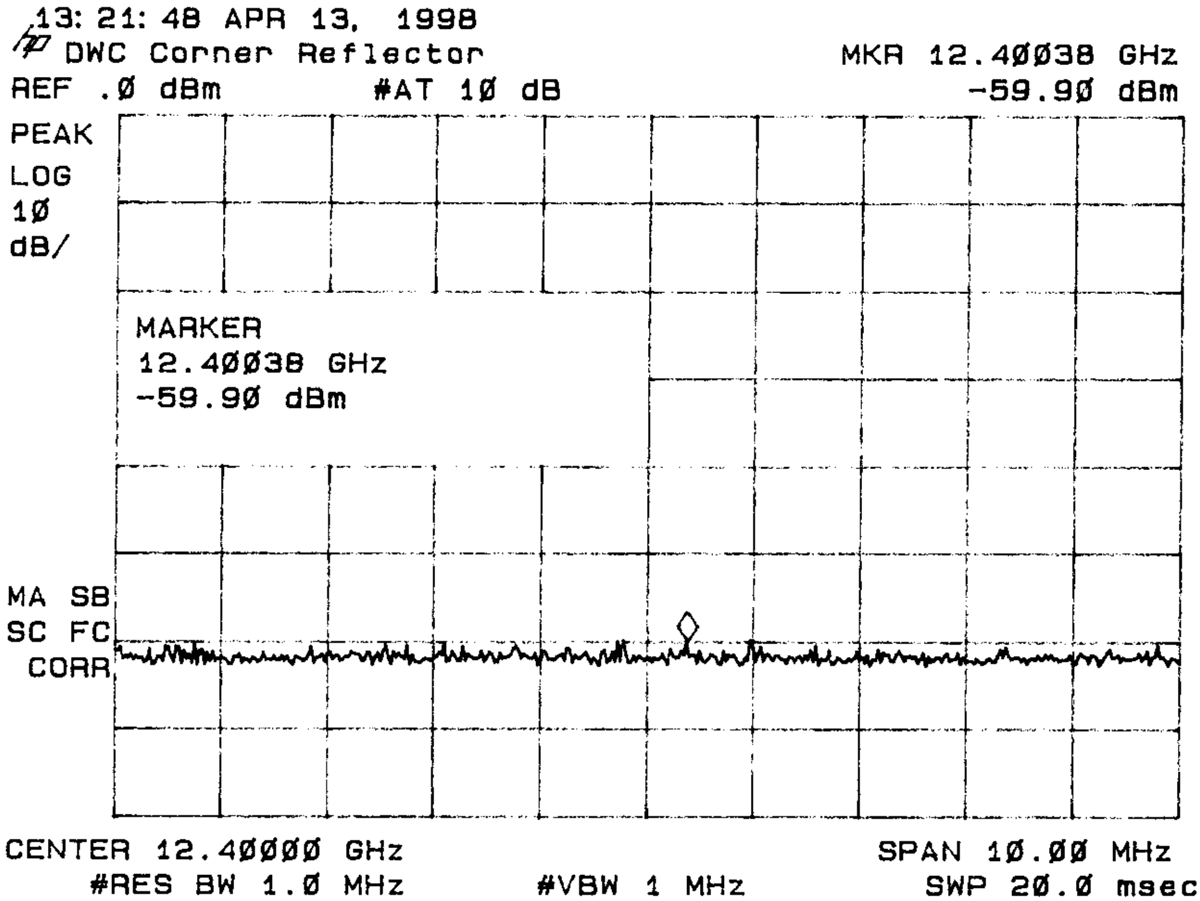


Figure 20
Peak Spurious Emissions 15.247(c) Low

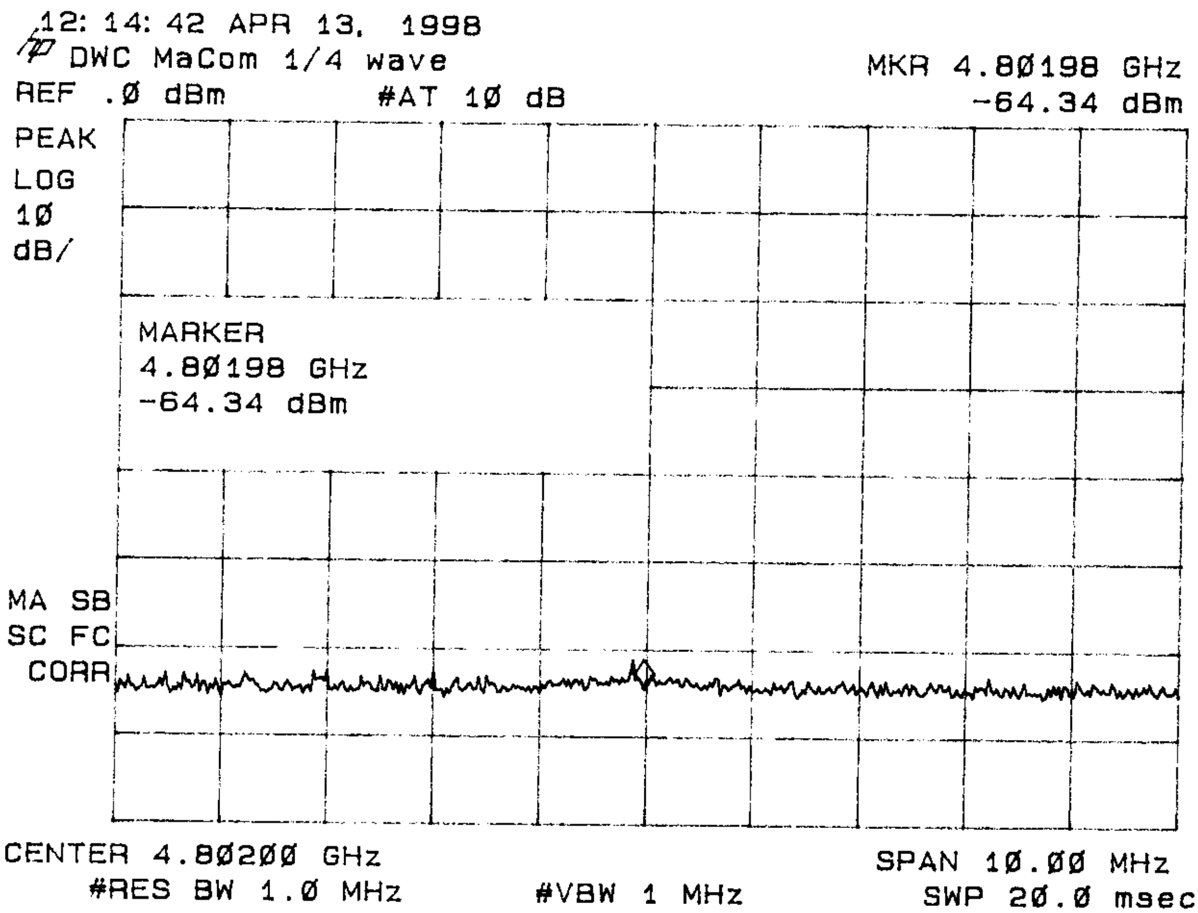


Figure 21
Peak Spurious Emissions 15.247(c) Low

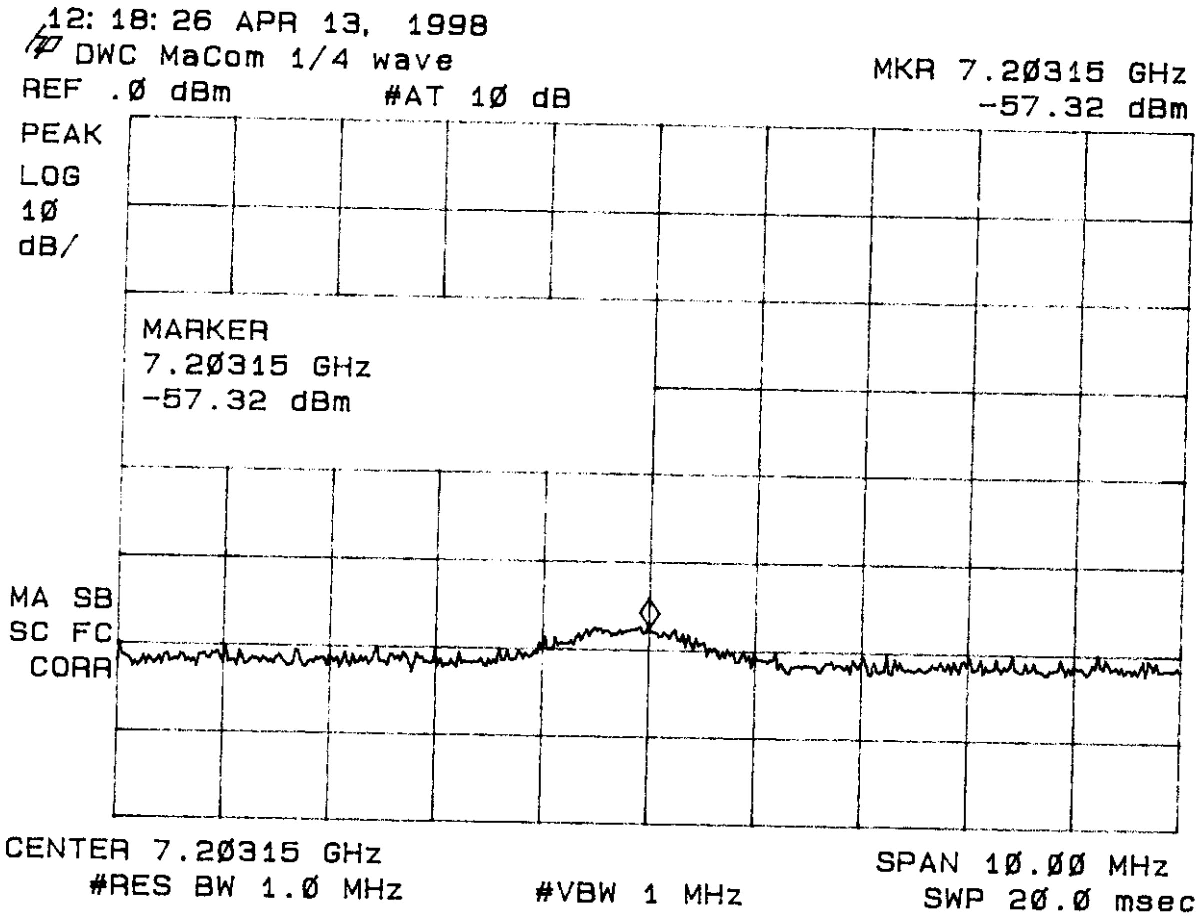


Figure 22
Peak Spurious Emissions 15.247(c) Low

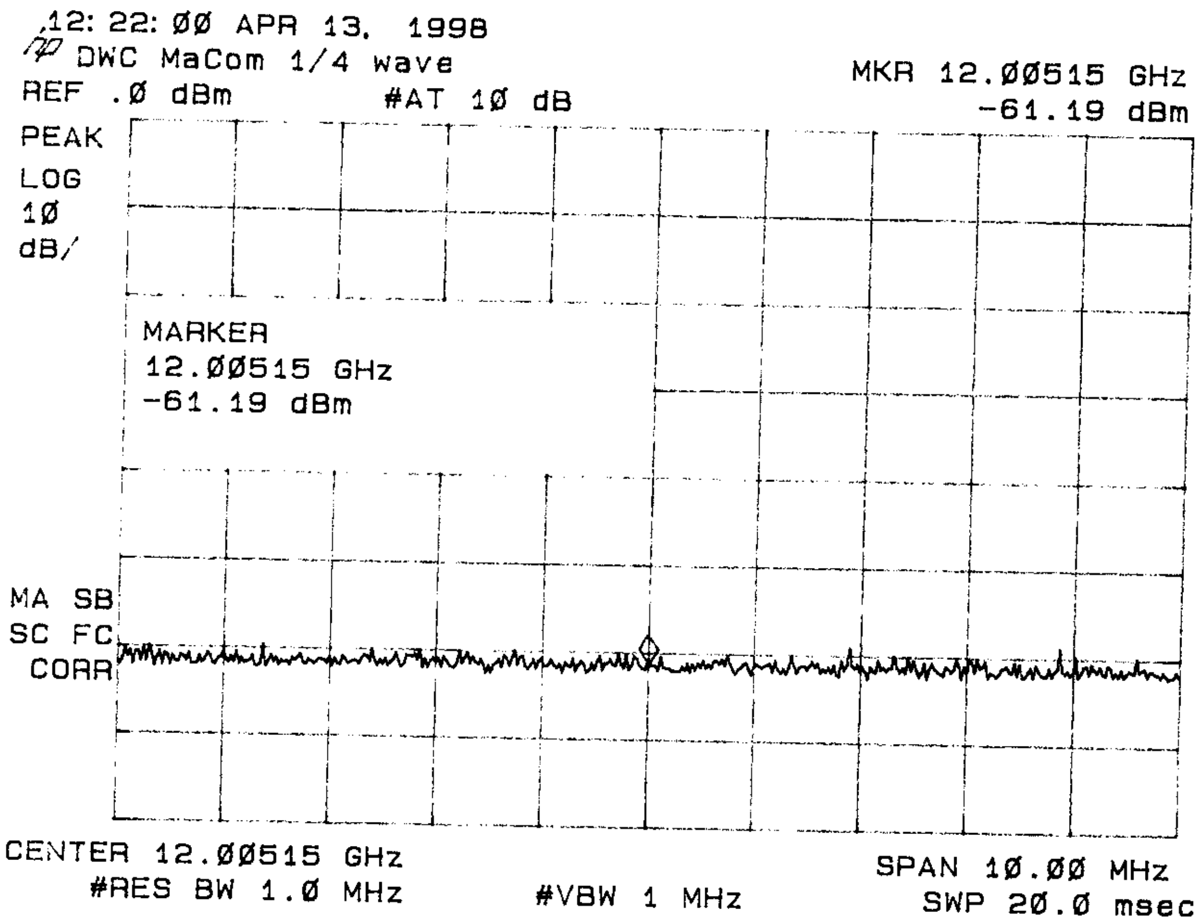


Figure 23
Peak Spurious Emissions 15.247(c) Mid

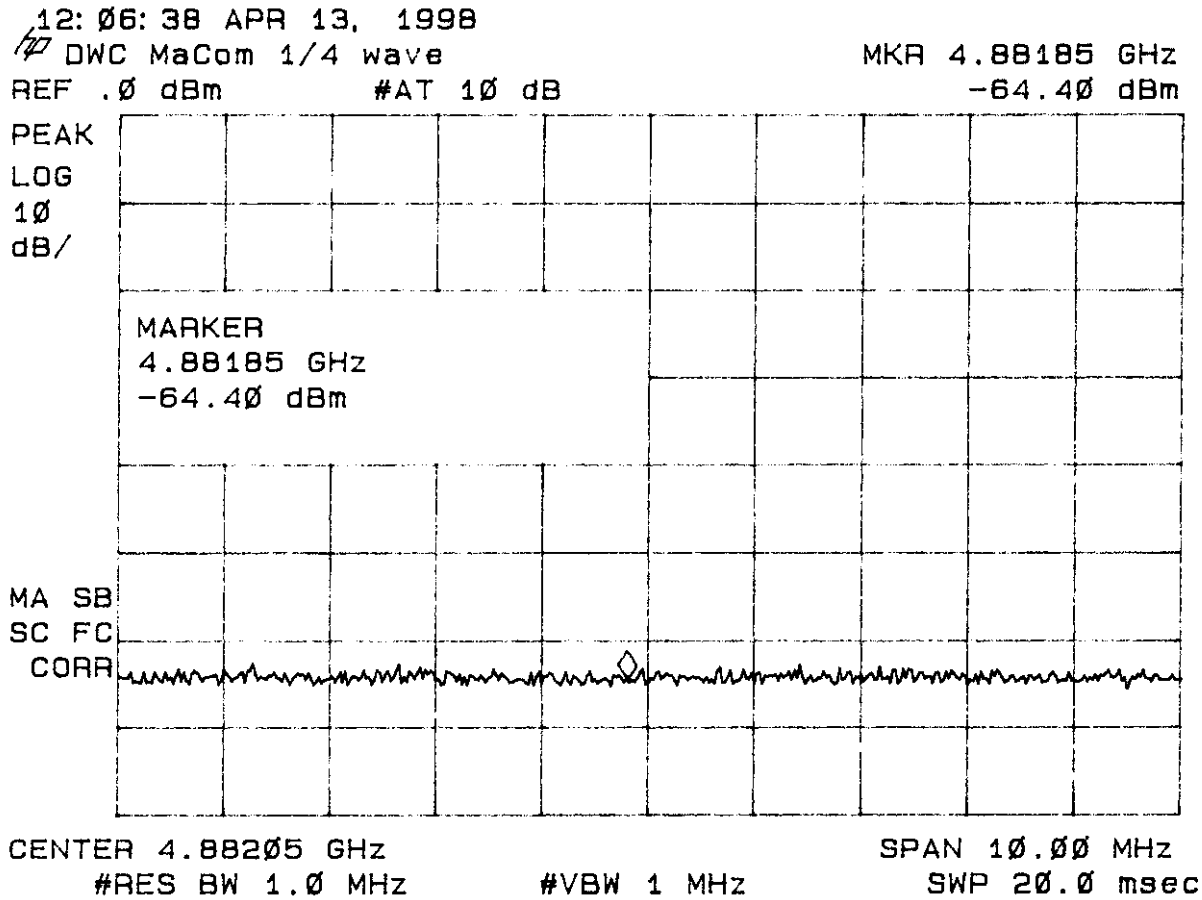


Figure 24
Peak Spurious Emissions 15.247(c) Mid

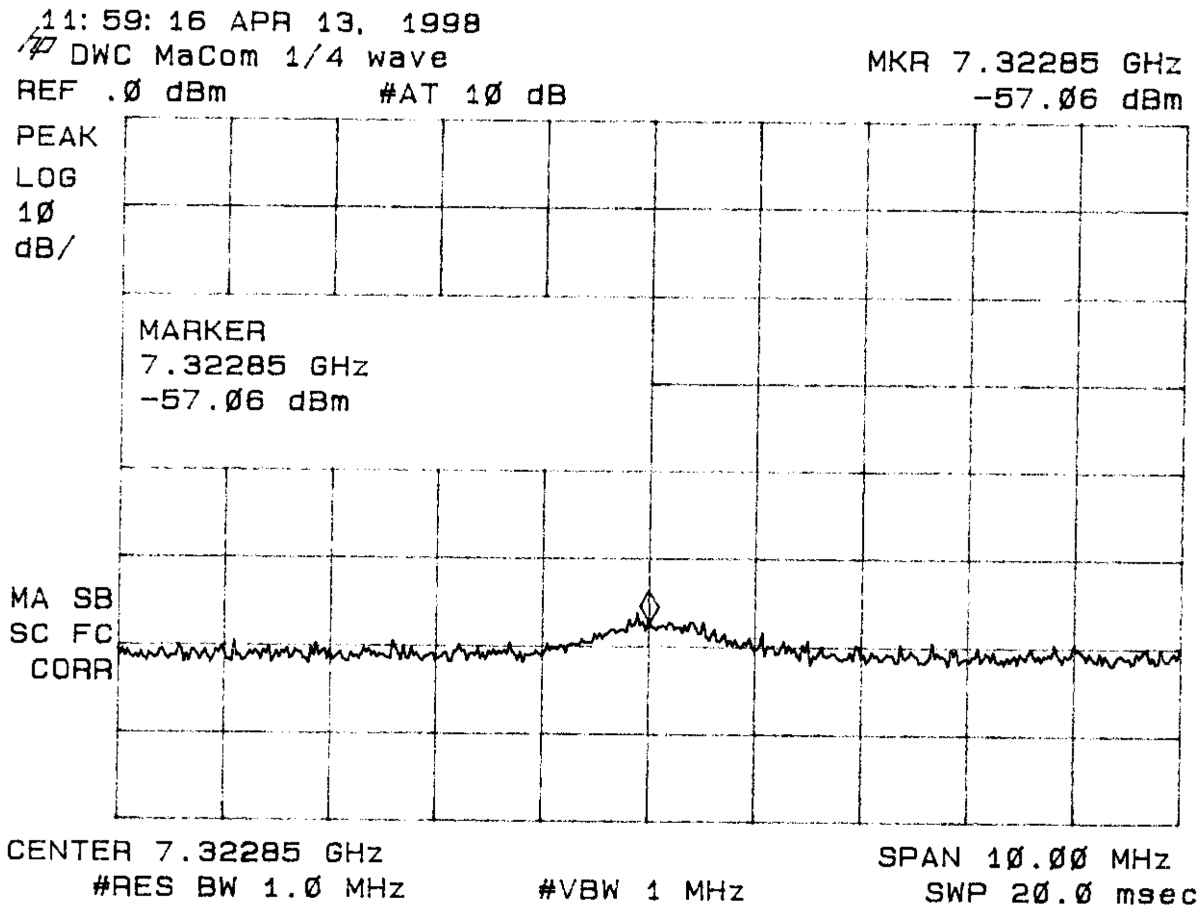


Figure 25
Peak Spurious Emissions 15.247(c) Mid

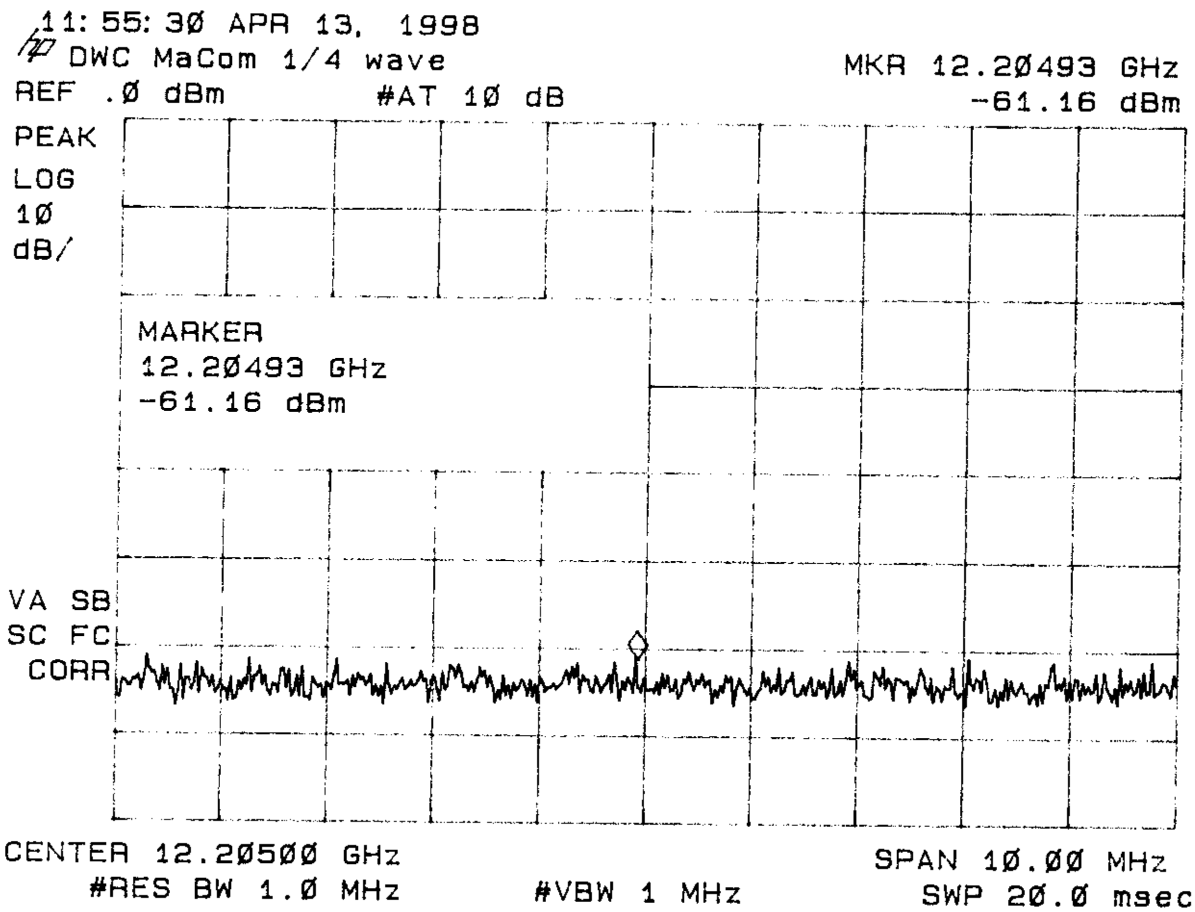


Figure 26
Peak Spurious Emissions 15.247(c) High

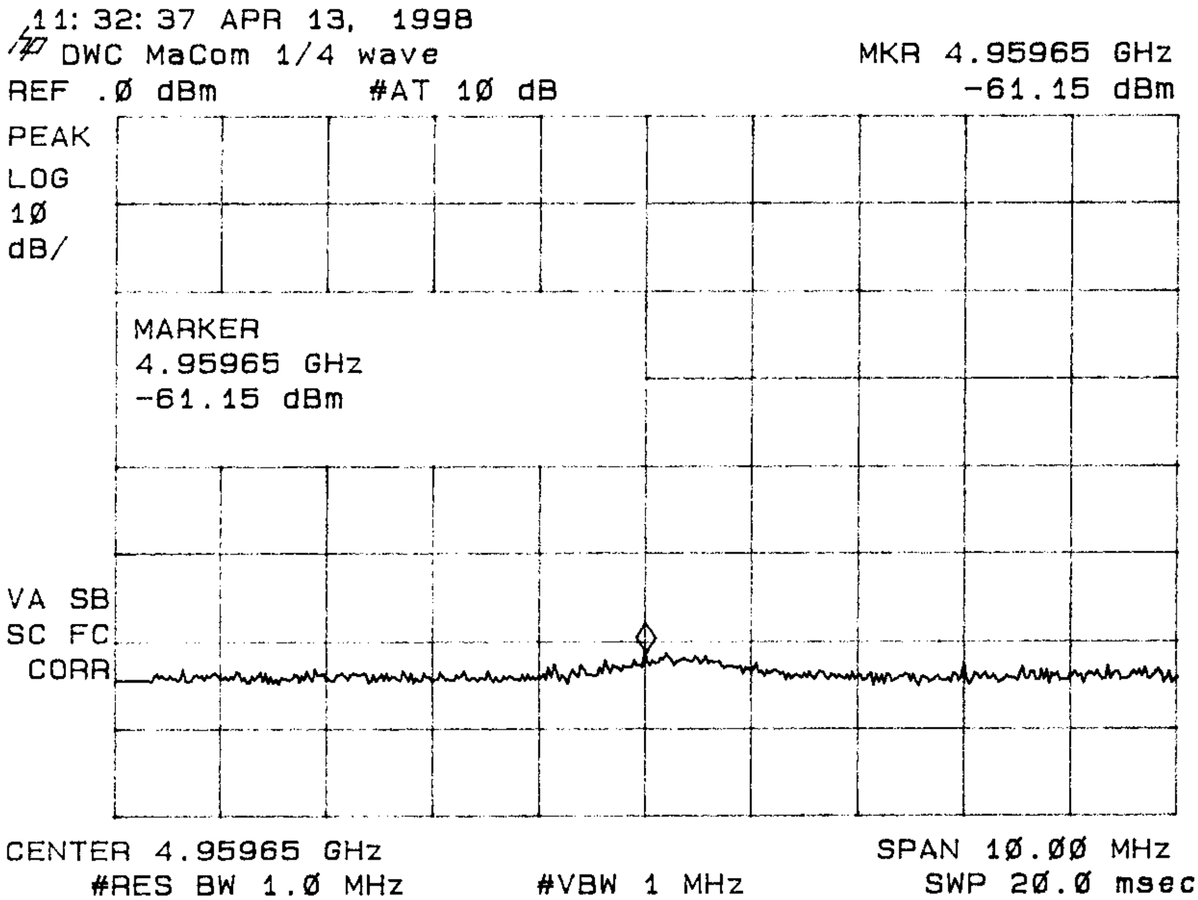


Figure 27
Peak Spurious Emissions 15.247(c) High

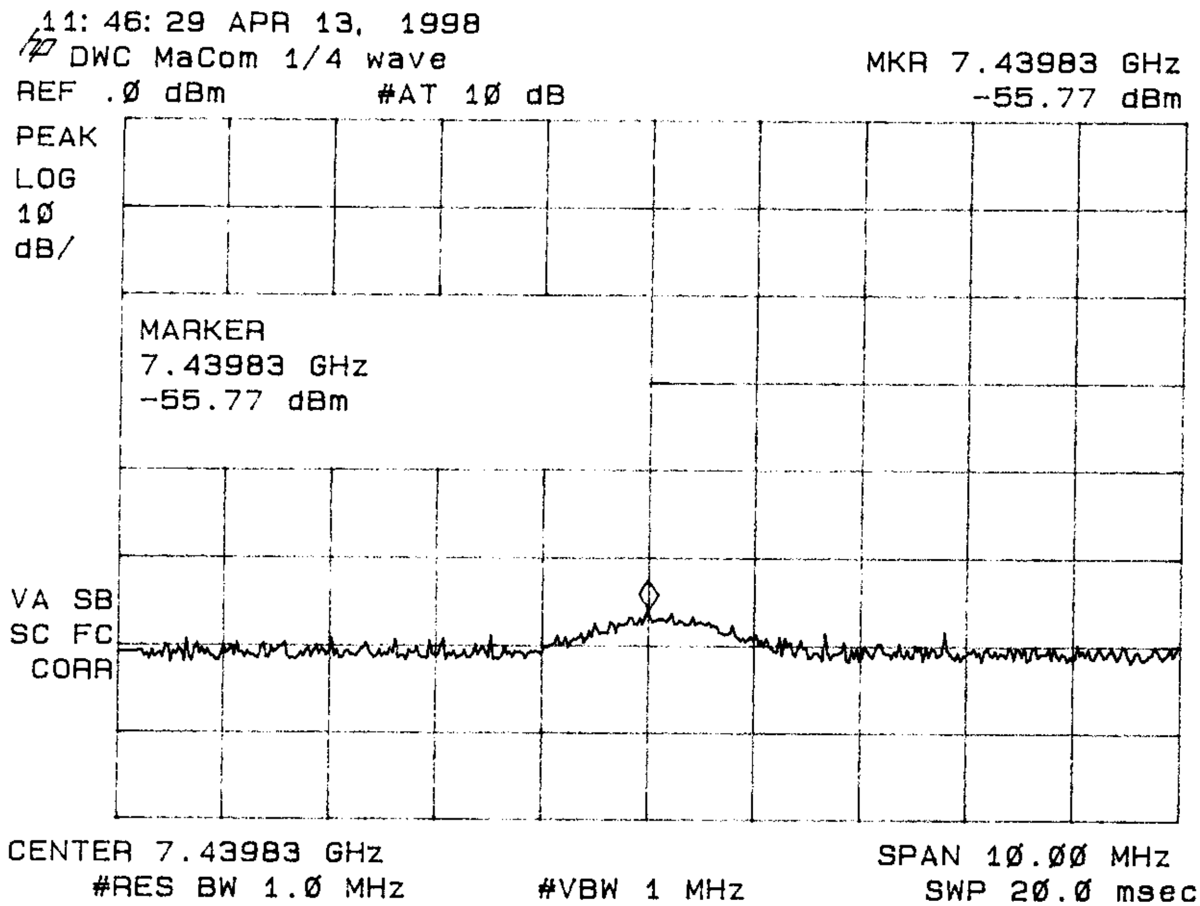
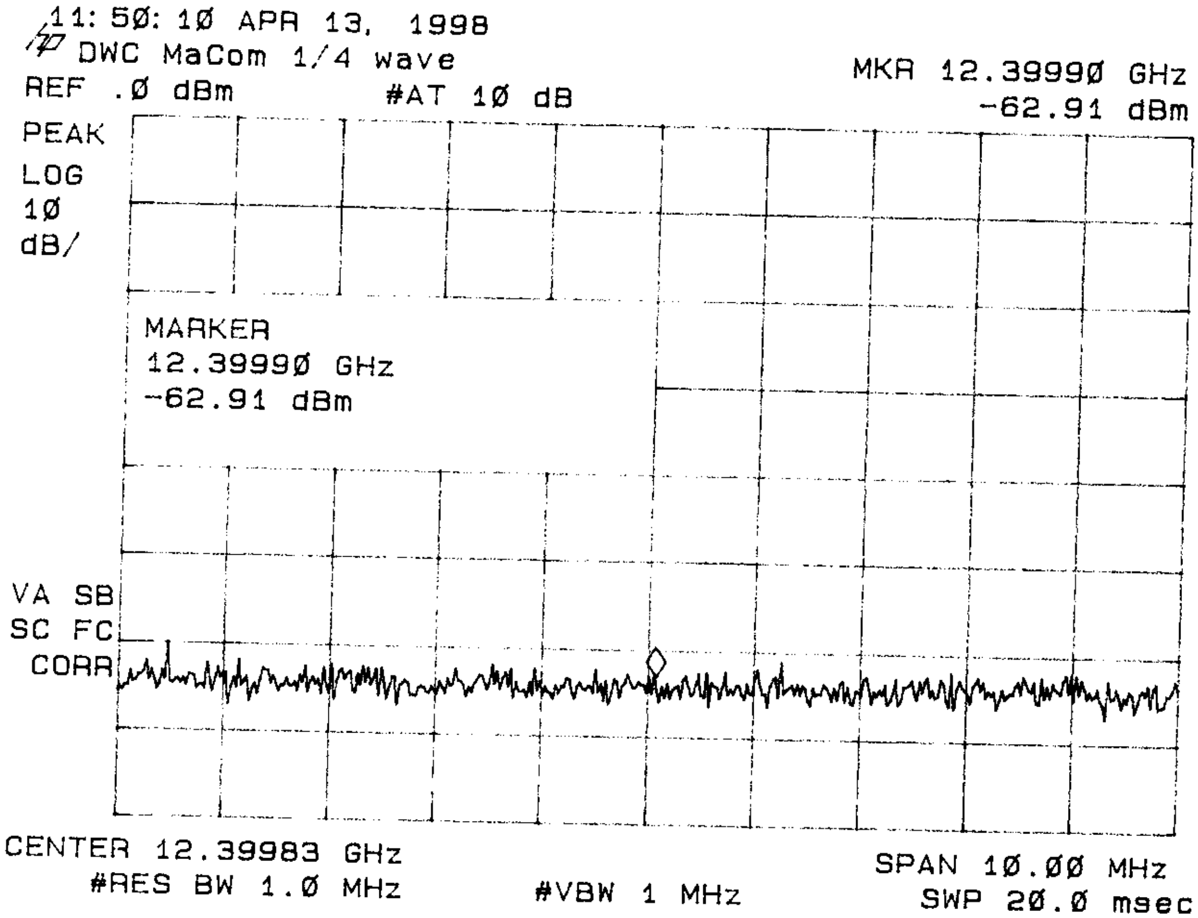


Figure 28
Peak Spurious Emissions 15.247(c) High



Appendix A. Worst Case Transmit Duty Cycle Information

Worst Case Transmit Duty Cycle for WIT2400E

The duty cycle derating factor used in the calculation of average radiated limits (per 15.209) is described below. This factor was calculated by first determining the worst case scenario for system operation - worst case being defined as the scenario when the WIT2400E would be transmitting the longest period during a dwell.

This worst case operating scenario is as follows:

1) A 40ms dwell time
(the dwell time is user configureable. This value is the maximum allowed)

2) point-to-point operation
(only two units communicating with one another)

3) data flow is almost completely unidirectional
(that is, one radio is relaying a large amount of data to the other radio with only synchronization data being passed back the other direction)

4) No other radios or signal sources are in the immediate vicinity
(Since the radios employ a CSMA sensing scheme, they normally would not transmit on a given dwell if they detected any other carriers or signals on that particular channel).

5) Retransmit backoff times are set to average value
(by definition in a CSMA system, these backoff times are random. The statistical average is used in this scenario)

6) The amount of data being fed to the sending radio is exactly portioned out to fit the maximum packet size allowable (260 bytes).
(this means that the radio always has the right number of bytes coming in at the right time to ensure smooth data transmission with no gaps)

7) ARQ is being employed by the user to obtain error free data
(this means that the transmitter will keep re-sending packets until obtaining an ACK from the receiver)

Given the above described worst case, the duty cycle factor is calculated by going through this scenario during a standard hop and adding up the total possible transmit time over a dwell period. For this example, a remote unit is transferring a large data file to a base unit. Since the remote unit will be transmitting almost all of the dwell period, we will keep track of it's transmit times. Those transmit times are highlighted by bold print and are underlined. The three columns correspond respectively to: elapsed time from the beginning of the dwell, duration of each event, and a description of event.

0s		**Start of Dwell**
	500us	Master synchronization packet from base to remote
500us		
	1.2ms	Backoff period (no transmission by base or remote)
1.7ms		
	8.32ms	Maximum length packet is sent from remote to base (260 bytes)
10.02ms		
	400us	Acknowledgement of data is sent from base to remote
10.42ms		
	1.2ms	Backoff period (no transmission by base or remote)
11.62ms		
	8.32ms	Maximum length packet is sent from remote to base (260bytes)
19.94ms		
	400us	Acknowledgement of data is sent from base to remote
20.34ms		
	1.2ms	Backoff period (no transmission by base or remote)
21.54ms		
	8.32ms	Maximum length packet is sent from remote to base (260bytes)
29.86ms		
	400us	Acknowledgement of data is sent from base to remote
30.26ms		
	1.2ms	Backoff period (no transmission by base or remote)
31.46ms		
	7.616ms	Smaller length packet is sent from remote to base (238 bytes)
39.076ms		
	400us	Acknowledgement of data is sent from base to remote
39.476ms		
	500us	Guard band at end of dwell (no transmission by base or remote)
39.976ms		
40ms		**End of Dwell**

The total time that the remote unit was transmitting for this worst case scenario was approximately 33ms. This transmission duty cycle results in a duty cycle correction factor of:

$$20 * \text{Log}_{10}(33\text{ms}/100\text{ms}) = \mathbf{-9.6\ dB}$$

The WIT2400 frequency hopping transceiver uses 80 different channel in its hop-set. Therefore, the output carrier and its harmonics fall in a given frequency slot only 1/80th of the time. Therefore an additional derating factor of

$$20 * \text{Log}_{10}\,(1/80\text{ch}) = \mathbf{-38\ dB}$$

is incurred due to the averaging factor of 1/80th duty cycle due to hopping.

The combination of Txon/Txoff duty cycle in conjunction with averaging due to hopping results in a total peak-to-average derating constant of

$$D_{duty\_cycle} + D_{hopping} = \mathbf{-47.6\ dB}$$