The University of Michigan
Radiation Laboratory
3228 EECS Building
Ann Arbor, MI 48109-2122
Tel: (734) 764-0500

Measured Radio Frequency Emissions
From

Fujitsu Ten 76 GHz Adaptive Cruse Control Radar
Model(s): 271000-280, 271000-322

Report No. 415031-220
August 6, 2004

For:
TUV America Inc.
19333 Wild Mountain Road
Taylor Falls, MN 55084-0298

Contact:
Joel Schneider
jschneider@tuvam.com
Tel: 651-638-0297
Fax: 651-638-02978
PO: CE16852

Measurements made by:
Valdis V. Liepa
Joseph D. Brunett

Tests supervised by:
Report approved by:
Valdis V. Liepa
Research Scientist

Summary
Tests for compliance with FCC Regulations, according to Part 15.253, and with Industry Canada Regulations, RSS-210, were performed on Fujitsu Ten 76 GHz Adaptive Cruse Control Radar. In testing performed during July 16 through 27, 2004, the device tested met the emission limits at the fundamental by 22.1 dB, at the harmonics by 47.8 dB, and at spurious by 3.4 dB. For RF Health Hazard, the maximum RF field at a 20 cm distance was calculated to be 0.37 mW/cm^2. The DUT is designed for automotive applications, and as such, digital radiated and conducted emissions are not subject to regulation.

1. Introduction

Fujitsu 76 GHz Adaptive Cruse Control Radar was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989, and with Industry Canada RSS-210, Issue 5, dated November 10, 2001. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-1992 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" and the new FCC Section 15.253, "Operation within the bands 46.7-46.9 GHz and 76.0-77.0 GHz". The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057).

2. Test Equipment Used

The pertinent test equipment commonly used in our facility for measurements is listed in Table 2.1 below. The middle column identifies the specific equipment used in these tests.

Table 2.1. Test Equipment.

Test Instrument	Eqpt. Used	Manufacturer/Model
Spectrum Analyzer (0.1-1500 MHz)		Hewlett-Packard, 182T/8558B
Spectrum Analyzer (9kHz-22GHz)		Hewlett-Packard 8592L, SN: 3710A00856
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8563E, SN: 3310A01174
Spectrum Analyzer (9kHz-40GHz)	X	Hewlett-Packard 8564E, SN: 3745A01031
Power Meter		Hewlett-Packard, 432A
Power Meter		Anritsu, ML4803A/MP
Harmonic Mixer (40-60 GHz)	X	Hewlett-Packard 11970U, SN: 2332A00500
Harmonic Mixer (60-90 GHz)	X	Pacific Millimeter Prod., VN, SN: 47
Harmonic Mixer (75-110 GHz)	X	Hewlett-Packard 11970W, SN: 2521A00179
Harmonic Mixer (140-220 GHz)	X	Pacific Millimeter Prod., GMA, SN: 26
X-band horn (8.2- 12.4 GHz)		Narda 640
X-band horn (8.2- 12.4 GHz)	X	Scientific Atlanta , 12-8.2, SN: 730
K-band horn (18-26.5 GHz)	X	FXR, Inc., K638KF
Ka-band horn (26.5-40 GHz)	X	FXR, Inc., U638A
U-band horn (40-60 GHz)	X	Custom Microwave, HO19
V-band horn (60-90 GHz)	X	Custom Microwave, HO12
W-band horn (75-110 GHz)	X	Custom Microwave, HO10
G-band horn (140-220 GHz)	X	Custom Microwave, HO5R
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2
Dipole Antenna Set (30-1000 MHz)		University of Michigan, RLDP-1,-2,-3
Dipole Antenna Set (30-1000 MHz)		EMCO 2131C, SN: 992
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan
Amplifier (5-1000 MHz)		Avantek, A11-1, A25-1S
Amplifier (5-4500 MHz)	X	Avantek
Amplifier (4.5-13 GHz)	X	Avantek, AFT-12665
Amplifier (6-16 GHz)	X	Trek
LISN (50 µH)		University of Michigan
Signal Generator (0.1-2060 MHz)		Hewlett-Packard, 8657B
Signal Generator (0.01-20 GHz)	X	Hewlett-Packard, 8550B / 83592A

3. Configuration and Identification of Device Under Test

The Device Under Test (DUT) is a 76 GHz Short Range Radar. It is a Tx/Rx 457 kHz (or 10 MHz) switched FM and CW device. The triangular frequency chirp at 353 Hz provides range information. Mechanical antenna scanning at 5 Hz is used to obtain target angular resolution. The RF power source is 5 dBm (typ.) based on a 9.6 GHz reference. The DUT is a basic radar unit; additional signal processing and controlling are done by other processors on the vehicle. When installed on a vehicle, the device will operate (transmit) only when the vehicle is in motion, i.e., typ. 20 MPH and above. The size of the DUT is 13(W) x 7(H) x 10(D) cm with a single connector on one side. For testing, a laptop was used to control the format of modulation. This included: (a) normal mode (CW, FM, and switching), (b) CW with 457 kHz switching, (c) CW only, plus others that were not used in these tests. Nominal operating voltage is 13.8 VDC; for testing this was supplied by a laboratory style power supply.

The DUT was manufactured by Fujitsu Ten Limited; 2-28, Gosho-dori 1-chome; Hyogo-Ku, Kobe 652-8510; Japan. It is identified as:

Fujitsu 76 GHz Adaptive Cruse Control Radar
Model(s): 271000-280, 271000-322
S/N: FCC SAMPLE B (standard unit)
S/N: FCC SAMPLE A (fixed antenna unit)
FCC ID(s): BAB271000-280, BAB271000-322
IC(s): 2024B-271280, 2024B-271280

Two model 271000-280 devices were provided: one is a standard model, and the other has the antenna scanning mechanically disabled. Both units were used in testing, depending on what data (information) was needed. The model 271000-322 device was not tested, as the only difference between it and the 271000-280 is that the yaw rate sensor has been depopulated. Depopulation of the yaw rate sensor should have no affect on the DUT emissions as explained in related letters provided in the exhibits.

3.1 Changes made to the DUT

None.

4. Microwave Emission Limits

4.1 Radiated Emission Limits

The DUT tested falls under the category of an Intentional Radiator, subject to Section 15.253 and all other sections referred to therein. The applicable critical testing frequencies with corresponding emission limits are given in Tables 4.1. As a digital device, it is exempt.

Table 4.1. Radiated Emission Limits (Ref: FCC: 15.253; IC: RSS-210, 6.6) --Transmitter.

Frequency (GHz)	Fundamental and Spurious*
0.030 - 40000 76.0 - 77.0 77.0 - 200.0 200.0 - 231.0	see 15.209 60 μW/cm^2 600 pW/cm^2 1000 pW/cm^2
up to 38.6 only	Restricted Bands

4.2 Conductive Emission Limit

Conductive emissions limits do not apply, as this is a vehicular 12 VDC device.

4.3 (Digital) Radiated Emission Limits

Table 4.2. Radiated Emission Limits (FCC: 15.33, 15.35, 15.109; IC: RSS-210, 7.3) -- Digital.

Freq. (MHz)	Class A, E_{lim} dB(μV/m)	Class B, E_{lim} dB(μV/m)
30-88	49.5	40.0
88-216	54.0	43.5
216-960	56.9	46.0
960-2000	60.0	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW)
Quasi-Peak readings apply to 1000 MHz (120 kHz BW)

5. Radiated Emission Tests and Results

5.1 Test Procedure

Prior to any measurements, all active components of the test setup were allowed a warm-up for a period of approximately one hour, or as recommended by their manufacturers.

For the tests, the unit was hand-held at a 3 or 1 (or even 0.25m) meter distance, depending on the available signal strength, and rotated through 360 degrees to determine the most intense radiation lobe. Care is taken such that there is no interference from the hand nor the body. Due to the rigid connection of the receive antenna to the spectrum analyzer, the DUT is also rotated around its antenna axes to match the polarizations of the emission for maximum readings.

5.2 Measurements

Because this is not a commonly tested device, some of the data that were taken and reported are for understanding of the operation of the device. Also many tests were repeated to verify the procedure and the measurement integrity. We started with measurements at the fundamental (76.4 GHz) and recorded number of plots. The following plots are presented:

Figure 5.1. Fundamental spectrum. RBW=2 MHz, VBW=3 MHz; 3 meters, peak hold. Here we observe the frequency chirp is from 76.289 GHz to 76.511 GHz, 221.7 MHz BW.

Figure 5.2. Time response at set frequency due to chirp, single scan. RBW=1 MHz, VBW=3 MHz, zero span. The pulses occur as the frequency sweeps through the receiver fixed at 76.5 GHz. Since the measurement is near the high side of the spectrum, the first peak represents the frequency going down followed by the peak representing frequency going up. Note the period of the chirp is 2.833 ms or 353 Hz.

Figure 5.3. Time response at set frequency due to the antenna scan. RBW=1 MHz, VBW=3 MHz, zero span. Here the pulses occur as the antenna scans past the receiving antenna. These pulses contain pulses shown in Figure 5.2. Since the scan is back-and-forth, the scan rate is 200 ms or 5 Hz.

Figure 5.4. Peak power measurement for CW scanning emission. RBW=1 MHz, VBW=3 MHz; 3 meters. For this measurement the DUT was set in CW mode. Here, we measured –24.28 dBm.

Figure 5.5. Tx/Rx switching. RBW=3 MHz, VBW=1 MHz; 3 meters. To minimize direct (unwanted) signal entering the receiver, the Tx/Rx function is diplexed at 457 kHz. This plot shows that the –20dB ON/OFF ratio is 2/3 or 0.667.

Figure 5.6. FM/ CW ratio. RBW=1 MHz, VBW=3 MHz, zero span; 3 meters. The device transmits FM for 51.67 ms, followed by CW for 48.33 ms. Both, the FM and CW are switched by the 457 kHz Tx/Rx diplexing. Note, this only depicts the ratio of FM and CW modes during normal operation.

Figure 5.7. CW -26 dBc emission bandwidth (EBW). RBW=10 kHz, VBW=10 kHz. For the CW mode, the -26 dBc emission bandwidth of the DUT is measured at 538 kHz.

5.3 Computations and Results

When the measurement is made at a distance other than 3m, the reading is extrapolated to the 3 m. This is done using the 20 dB/decade field behavior relation when translating in the far field, and 40 dB/decade relation when translating in the near field. The near-field/far-field criterion, N/F, is based on

$$N/F = 2\ D^2\ /\text{wavelength}$$

where D is the maximum dimension of the transmitter or receiver antenna , and the wavelength is that of the measurement frequency. Suppose N/F = 2 m and the measurement is made at 1 m. Here the 40 dB/ decade relation is applied from 1 to 2 m, and 20 dB/decade relation is applied from 2 to 3 m. In dB, this gives a 15.6 dB adjustment.

To convert the dBm measured and extrapolated to 3 m, the E_3(dBμV/m) is computed from

$$E_3(\text{dB}\mu\text{V/m}) = 107 + Pr + K_a - Kg + K_e$$

Where P_r = power recorded on spectrum analyzer, dBm (or extrapolated to 3 m distance)
K_a = antenna factor, dB/m
K_g = pre-amp gain, dB
K_e = pulse operation correction factor, dB (see 6.1)

For conversion to power densities specified in 15.253, we used

$$\text{EIRP (dBm)} = \text{S (dBm/cm}^2) + 10\ \text{Log}_{10}(4\ \pi\ \text{R(cm)}^\wedge 2)$$
$$\text{EIRP (dBm)} = \text{Pr (dBuV/m)} – 95.2\ \text{dB}$$

Thus, at a 3m distance:

$$\text{Pr (dBuV/m)} = \text{S (dBm/cm}^2) + 10\ \text{Log}_{10}(4\ \pi\ (300)^\wedge 2) + 95.2\ \text{dB} = \text{S (dBm/cm}^2) + 155.74\ \text{dB}$$

and we note that

$$60\ \mu\text{W/cm}^2 = -12.2\ \text{dBm/cm}^2$$
$$1000\ \text{pW/cm}^2 = -60.0\ \text{dBm/cm}^2$$
$$600\ \text{pW/cm}^2 = -62.2\ \text{dBm/cm}^2$$

For microwave measurements, either the receive antenna is connected directly to the spectrum analyzer, or it is connected to an external mixer followed by an insignificant length of cable. Hence, no cable loss term is used. The mixer conversion losses are programmed in the spectrum analyzer and are included in the dB values. However, for 125 GHz and up, an external mixer with an external LO and pre-amplifier was used. The mixer conversion loss, IF amp gain and cable losses are included in mixer conversion factor. The results are given in Tables 5.1 and 5.2. There we see that the DUT met the limits at fundamental by 22.1 dB, at harmonics by 47.8 dB, and at spurious by 3.4 dB.

6. Other Measurements and Computations

6.1 Peak-to-(Power)Average Ratio

The DUT is designed to operate with 457 kHz (or 7.5 MHz) Tx/Rx switching, 723.38 Hz FM (chirp) and 5 Hz antenna scan. Observing (measuring) the signal at a stationary point with the receiver, the signal is pulsed due to the 457 kHz Tx/Rx switching rate superimposed (multiplied) with the 5 Hz antenna scanning frequency.

From Figure 5.5 we deduce that the -20 dB ON/OFF time is 2/1, corresponding to -3.6 dB. The fractional presence of signal due to the narrow antenna beam scan is addressed in Figure 5.3. An accurate assessment of illumination time may be determined by taking the antenna beamwidth (2.7 deg.) and dividing it by the scan angle (16 deg.), is used in this formulation. Thus, the applicable Peak-to (Power) Average Ratio is

$$2/3 \times 2(2.7/16) = 0.225 \text{ or } -6.5 \text{ dB}$$

6.2 Correction for Pulse Operation

Apply –6.5 dB above 40 GHz on signal only when measured in peak mode.

6.3 Effect of Supply Voltage Variation

The DUT is designed to operate on 13.8 VDC, originating from a vehicular 12-volt system. The relative radiated emissions and frequency were recorded at the "fundamental" (76.4 GHz) as the supply voltage was varied from 7 to 18 VDC. Figure 6.2 shows the emission power variation. Current at 14.0 VDC was 310 mA.

6.4 Effect of Temperature Variation on Fundamental Frequency

The DUT was cooled to –20deg C and its temperature was slowly increased to 50deg C, during which time the fundamental emission was monitored. Measurements of band-edge frequencies were taken every 10deg C. Figure 6.3 shows the emission center frequency as a function of temperature.

6.5 Conducted Emission Measurements

Not applicable.

6.6 Potential Health Hazard EM Radiation Level

We use two methods to determine health hazard levels and these are obtained (1) by probing the near field and (2) by computing EIRP from measured emission data.

(1) The maximum radiation level from the unit is determined using a W-band Standard Gain horn fed directly into the spectrum analyzer. The analyzer is set to RBW=1 MHz, VBW=3 MHz for peak power detection. If the 1 mW/cm^2 limit were exceeded, the maximum distance from the DUT would be determined by measurement at a greater distance (where the field density is 1 mW/cm^2). The physical aperture of the horn antenna is 1.869 x 2.461cm (A = 4.60 cm^2). Its effective aperture at 76.5 GHz is 2.23 cm^2, based on a Gain of 22.6 dB.

For the subject DUT, the near-field region was probed, rotating the probe on all axis and polarizations. Maximum received power was detected at the center of the radome, co-polarized with the transmit signal. The reading was –10.8 dBm or 0.083 mW. For other axis and polarizations, the power was negligible. Power from spurious and harmonic emissions are also negligible.

Hence the maximum emitted power density of the device is measured to be

$$p(\text{mW/cm}^2) = P/A_{eff} = 0.083 \text{ mW}/ 2.23 \text{ cm}^2 = 0.037 \text{ mW/cm}^2$$

and, hence, meets the 1.1307, 1.1310, 2.1091, and 2.0193 requirements. Note, this is a peak value; the average would be lower.

(2) The minimum separation distance calculated following FCC OET Bulletin 65 is calculated as follows, where S is power density,

Smeas (3m) = -27.8 dBm/cm^2 (pk; from Table 5.2, ave + duty factor)
= 0.00166 mW/cm^2
= 12.2 dBm/m^2

EIRP = Smeas (3m) x $4\pi R^2$ = 12.2 + 20.5 = 32.7 dBm
= 1862 mW = 1.86 W

ERP = EIRP – 2.15 = 32.7 – 2.15 = 30.55 dBm
= 1135 mW = 1.14 W

Thus, the power density at 20 cm becomes $S(\text{mW/cm}^2) = \text{EIRP(mW)}/(4\pi\, R(\text{cm})^2) = 0.37\ \text{mW/cm}^2$

NOTE:
(1) Under no circumstances is the ERP of this device greater than 3W, as required by 2.1091 and the FCC mm-wave accepted test procedures,
(2) The DUT is only operating when the vehicle is in motion

6.7 Sample Field Computations

FUNDAMENTAL

Refer to: (a) Table 5.2 (f >= 40 GHz); line 2; p. 15.
(b) Section 5.2; Figure 5.4, peak power measurement; p. 11.
(c) Table 4.1; limit; p. 3; (60 μW/cm^2 = -12.2 dBm/cm^2)
(d) Section 6.1; peak-to-(power)average ratio, p. 6; (6.5 dB)

The approach is to follow standard equations for computing field strength, i.e. dB(μV/m), and then convert to power density. See equations and conversion factors in Section 5.3, p. 5 of the report.

To compute the field strength we use:

E_3 dB(μV/m) = 107 + Pr + Ka - Kg + Ke
= 107 – 24.3 + 45.3 + 0 – 6.5
= 121.5 dB(μV/m)
= -34.3 dBm/cm^2

The limit is 60 μW/cm^2 = -12.2 dBm/cm^2 (Note: 10 Log_{10}(uW/cm^2) – 30 dB = dBm/cm^2)

SPURIOUS

Here we present computation for the reference signal emission at 9.57 GHz.

Refer to: (a) Table 5.1 (f < 40 GHz); line 6; p. 14.
(c) Table 4.1; limit; p. 3; (54 dB(μV/m))

Using the same wave equation as above:

E_3 dB(μV/m) = 107 + Pr + Ka - Kg + Ke
= 107 – 48.9 + 29.5 – 37 + 0
= 50.6 dB(μV/m)

The limit is 54.0 dB(μV/m).

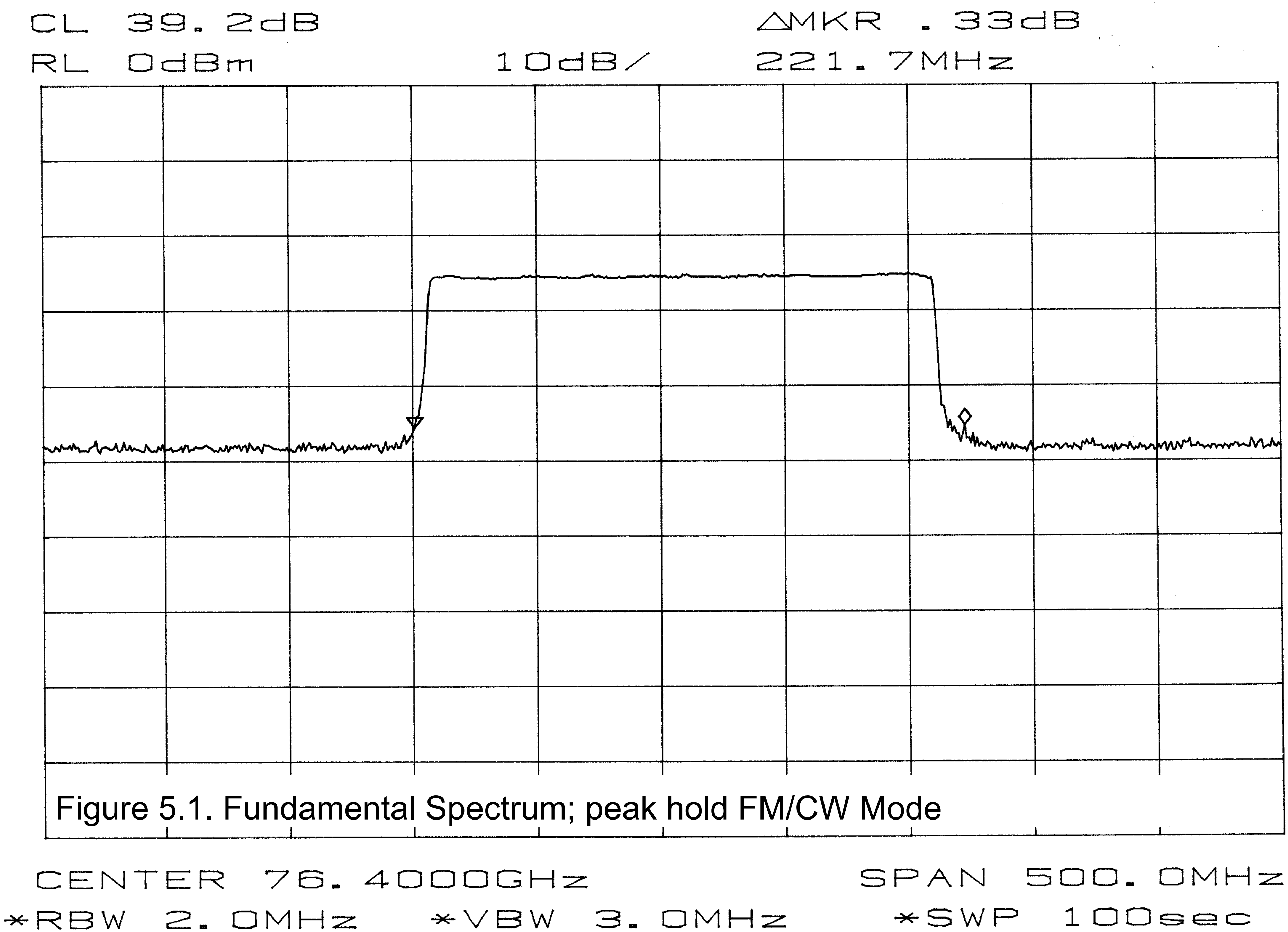


Figure 5.1. Fundamental Spectrum; peak hold FM/CW Mode

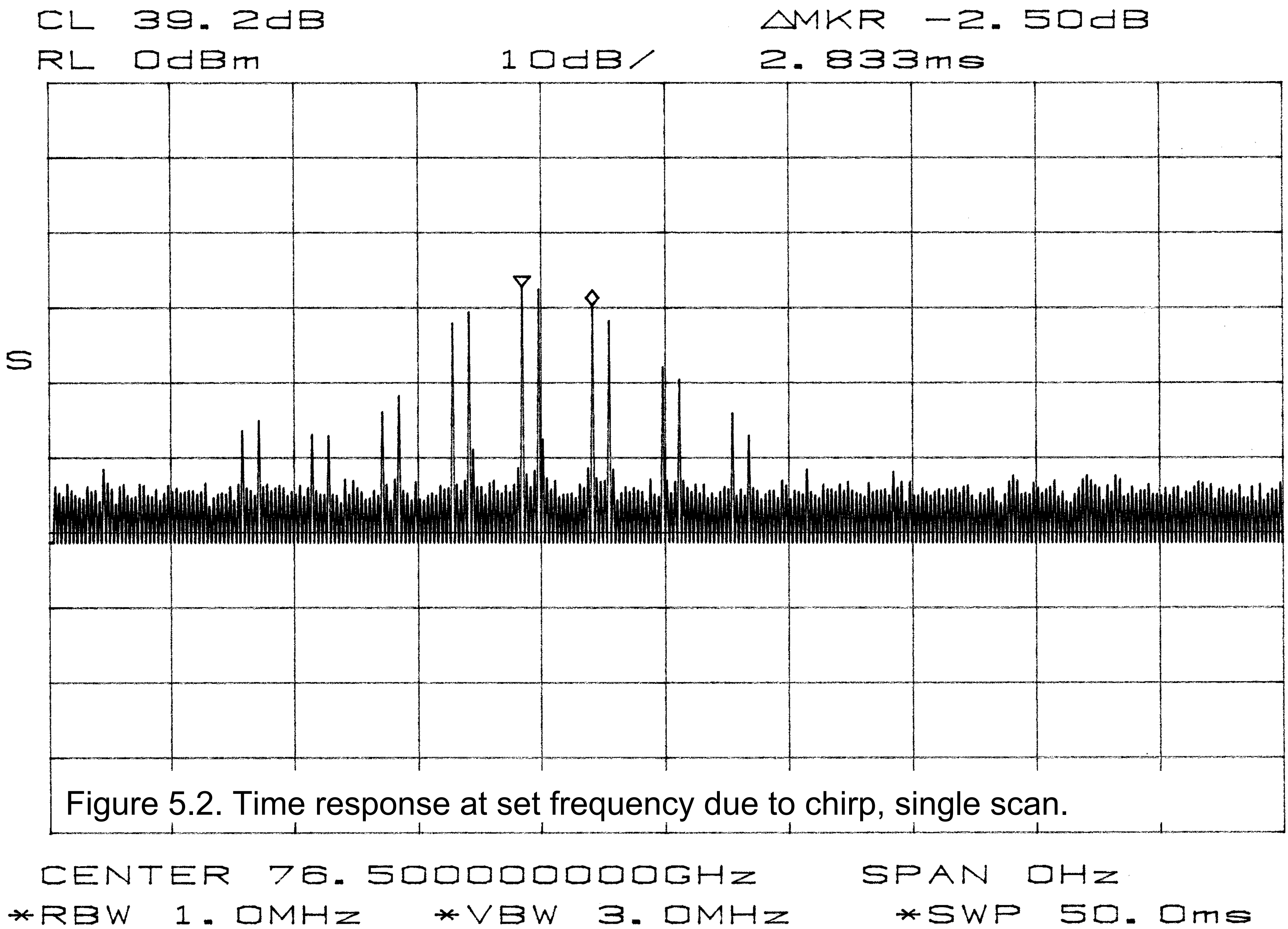


Figure 5.2. Time response at set frequency due to chirp, single scan.

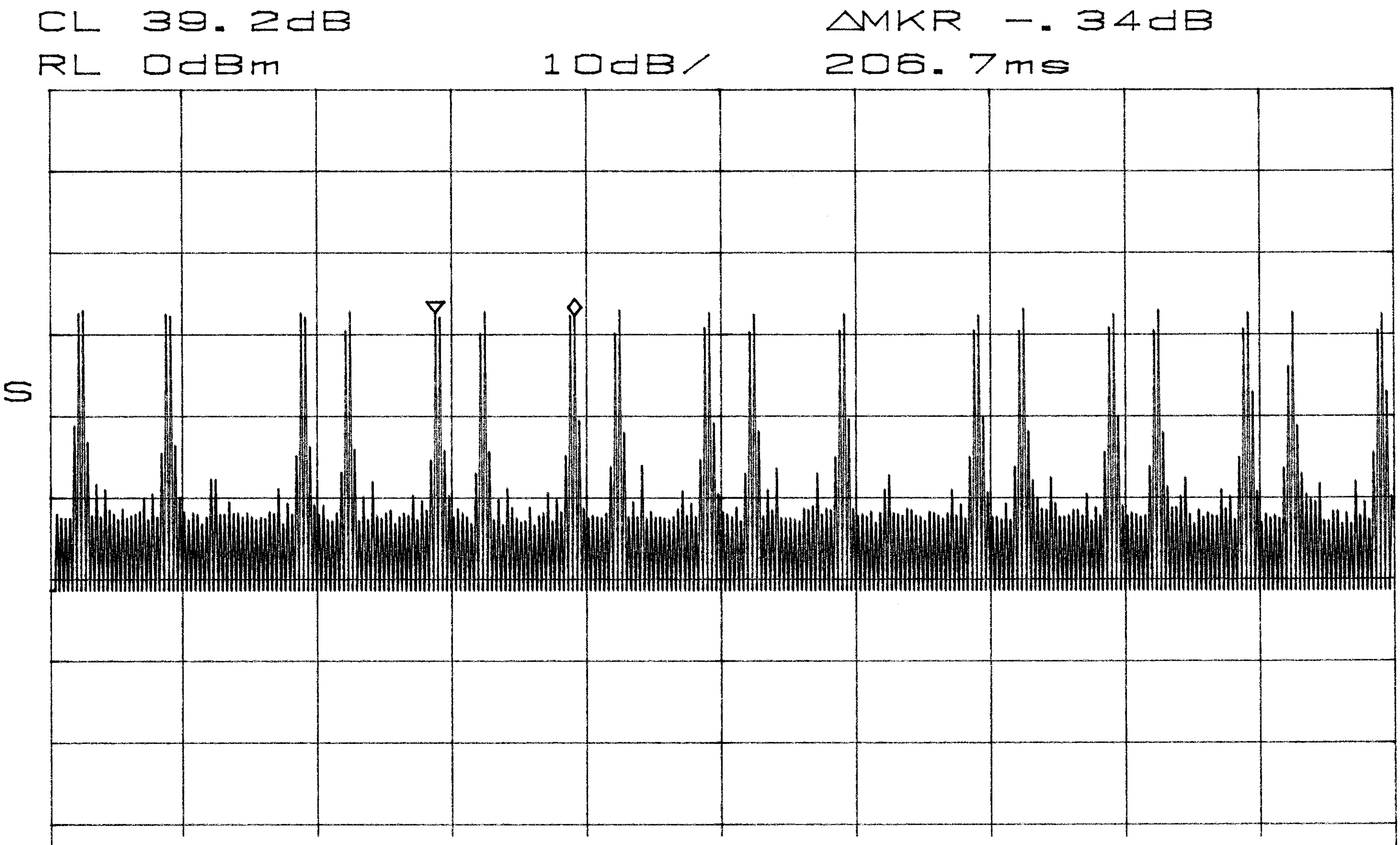


Figure 5.3. Time response at set frequency due to the antenna scan.

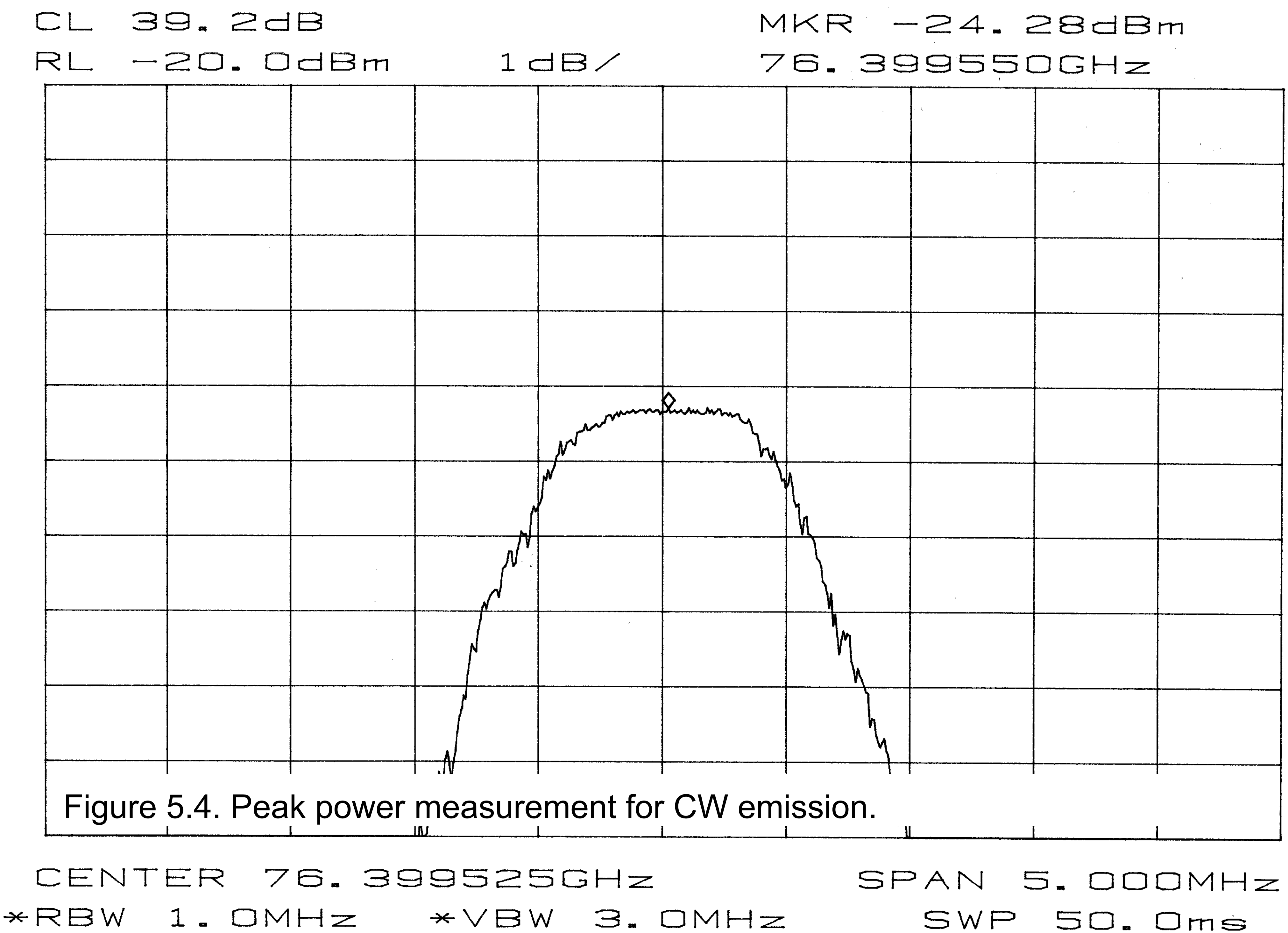


Figure 5.4. Peak power measurement for CW emission.

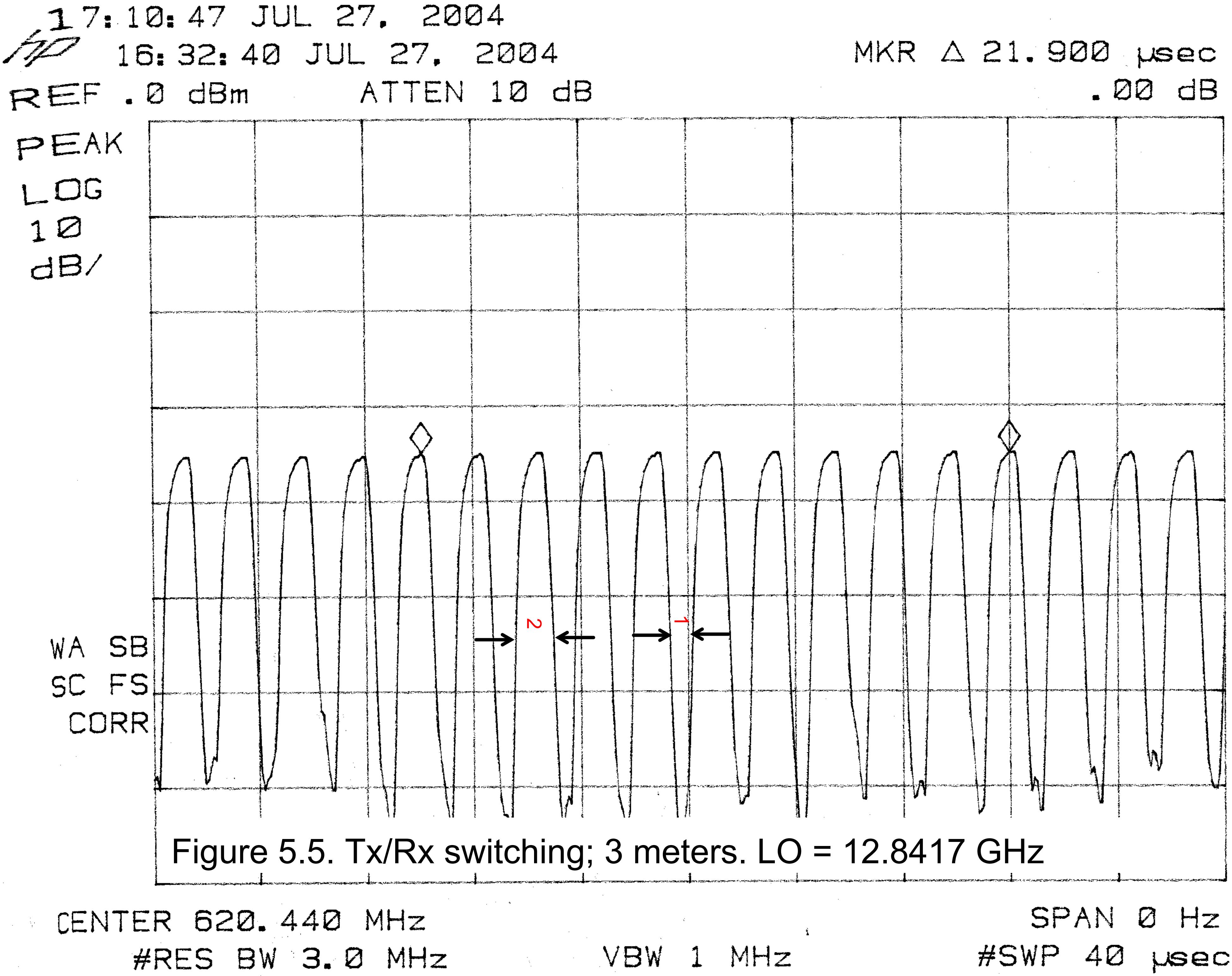


Figure 5.5. Tx/Rx switching; 3 meters. LO = 12.8417 GHz

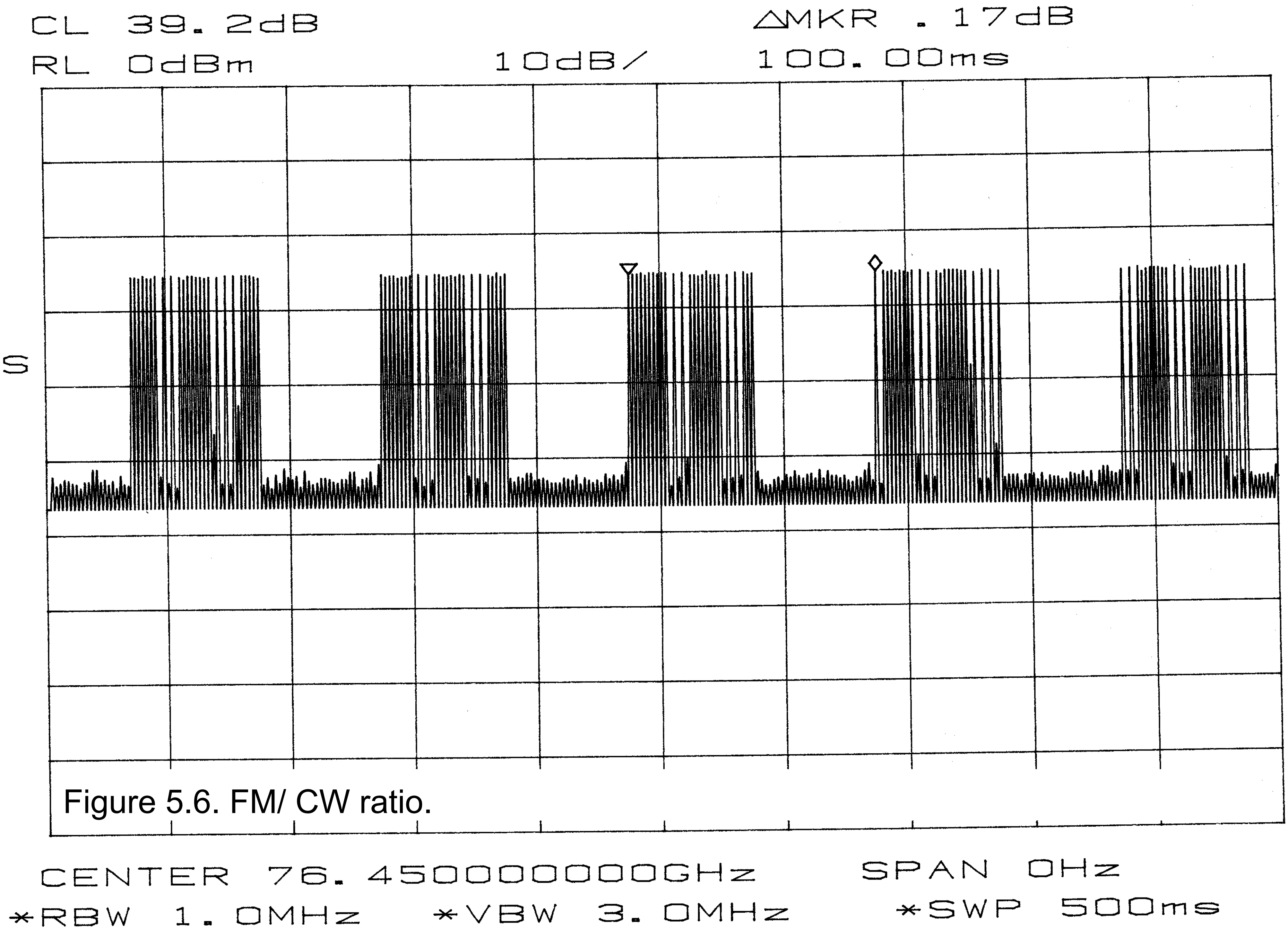


Figure 5.6. FM/ CW ratio.

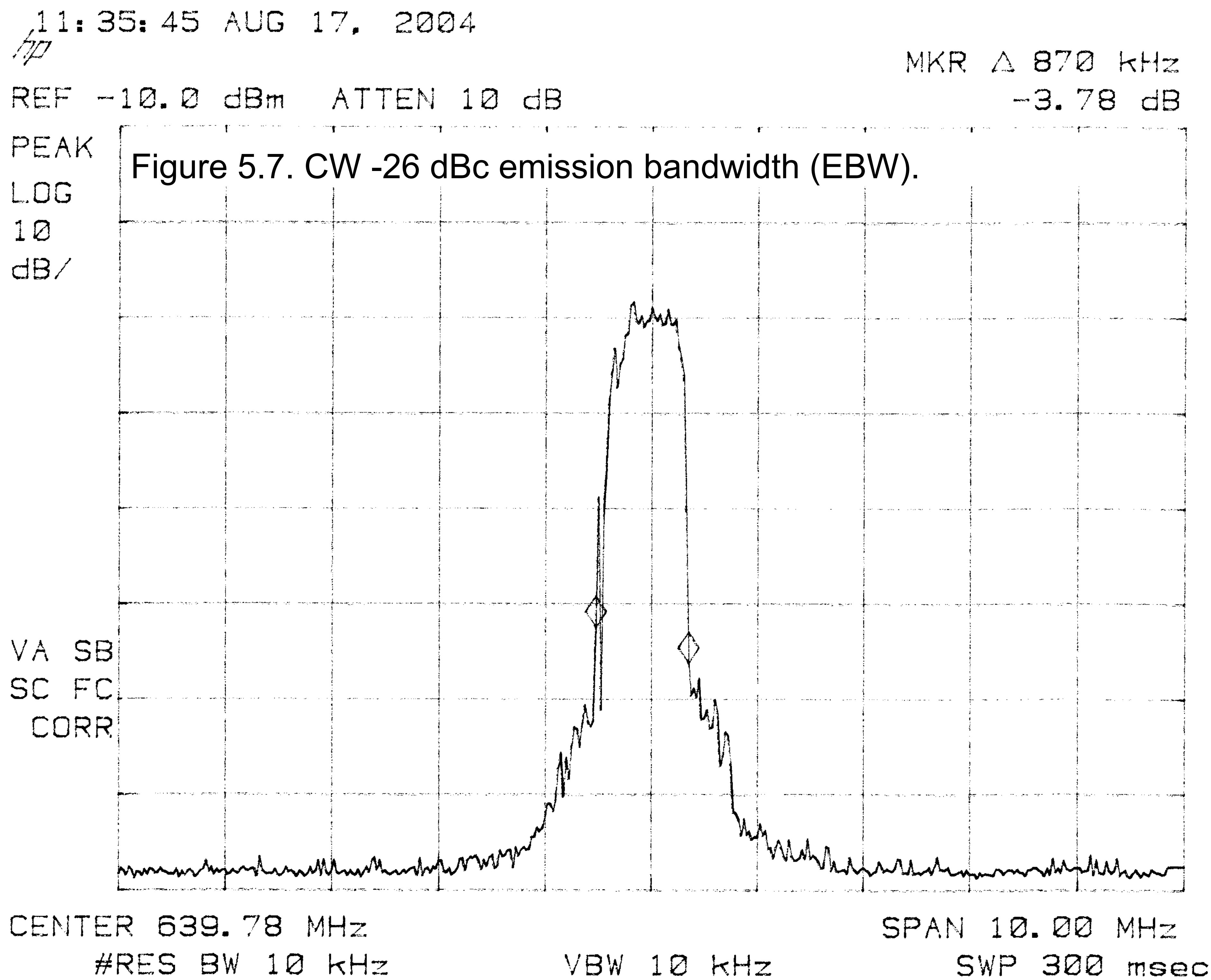


Figure 5.7. CW -26 dBc emission bandwidth (EBW).

Table 5.1 Highest Emissions Measured (f<40 GHz)

RF/Microwave Radiated Emissions — Fujitsu 280/322

#	Freq. GHz	Ant. Used	Ant. D,cm	Meas. dist, m	Pr dBm	N/F m	Pr(3m) dBm	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass dB	Comments (Notes)
1	.03 - 1	Bic		3.00	-78.0		-78.0	20.0	28.1	20.9	40.0	19.1	Noise, worst case
2	1 to 2	Horn	10.0	1.00	-62.9	0.10	-72.4	21.5	28.1	28.0	54.0	26.0	Noise, Pk (1,3,4,5,7)
3	2 to 4.5	Horn	5.0	1.00	-67.1	0.19	-76.6	26.0	25.0	31.4	54.0	22.6	Noise, Pk (1,3,4,5,7)
4	4.5 to 6	C-horn	21.6	1.00	-57.8	1.40	-76.9	24.7	37.5	17.3	54.0	36.7	Noise, Pk (1,3,4,5)
5	6 to 8.6	XN-horn	28.9	1.00	-53.5	3.34	-72.6	25.3	37.0	22.7	54.0	31.3	Noise, Pk (1,3,4,5)
6	8.6to13	X-horn	19.4	3.00	-53.1	2.16	-53.1	28.5	37.0	45.4	54.0	8.6	Noise, Pk (1,3,4,5)
7	9.564	X-horn	19.4	3.00	-48.9	2.40	-48.9	29.5	37.0	50.6	54.0	**3.4**	Signal, Ave (5,8)
9	13to18	Ku-horn	15.2	0.25	-50.2	2.00	-89.9	29.3	17.0	29.5	54.0	24.5	Noise, Pk (1,3,4,5)
10	18to26	K-horn	12.0	0.25	-55.6	1.73	-94.0	33.2	32.0	14.2	54.0	39.8	Noise, Ave (1,3,4,5)
11	26to40	Ka-horn	12.0	0.25	-76.5	2.50	-118.1	36.0	0.0	24.9	54.0	29.1	Signal, Pk (1,2,3,4,5)
12													
13													

NOTES:

(1) When measured at 0.25 cm from the DUT, no signal was detected anywhere, even at the radome

(2) Mixer conversion loss is programmed in the spectrum analyzer and automatically adjusts the readings

(3) When extrapolating to 3 m, use Near (40 dB/dec) and Far Fld (20 dB/dec) behavior

(4) For Ave. measurement a 1 Hz VBW was used, sometimes higher; RBW was always 1 MHz

(5) DUT max. antenna size, D= 12.0 cm

(6) Extermal mixer, LO, and 36.5 dB IF amp were used

(7) For ridge-horn (Horn) use aperture dimension of one half wavelength

(8) At 9.564 GHz, Peak to Average ratio was measured to be 4.0 dB

Digital Radiated Emissions

#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used			Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass dB	Comments
1													
2													
3													
4													
5	Not applicable												
6													
7													
8													
9													

Conducted Emissions

#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
1							
2	Not applicable						
4							

Meas. 7/16-23/04; U of Mich.

Table 5.2 Highest Emissions Measured (f>40 GHz)

RF/Microwave Radiated Emissions

Fujitsu 280/322

#	Freq. GHz	Ant. Used	Ant. D,cm	Meas. dist, m	Pr dBm	N/F m	Pr(3m) dBm	Ka dB/m	Kg dB	E3 dBm/cm2	E3lim dBm/cm2	Pass dB	Comments (Notes)
1	40-76	U-horn	12.0	0.25	-86.0	3.84	-129.2	41.0	0.0	-136.9	-62.2	74.7	Noise, ave. meas. (1-5)
2	76.4	W-horn	12.0	3.00	-24.3	7.33	-24.3	45.3	0.0	-27.7	-12.2	**22.1**	From Pk meas. (2-6)
3	77-125	W-horn	12.0	0.25	-52.1	7.39	-95.3	46.4	0.0	-97.6	-62.2	35.4	Noise, pk. meas.(1-5)
4	152.80	G-horn	12.0	0.25	-62.9	14.67	-106.1	51.3	0.0	-103.5	-62.2	47.8	Sig, pk. meas. (2-6)
5	229.20	G-horn	12.0	0.25	-67.2	22.00	-110.4	54.0	0.0	-105.1	-60.0	55.7	Noise, pk. meas. (1-5,7)
6	to 231	G-horn	12.0	0.25	-67.1	22.00	-110.3	54.0	0.0	-105.0	-60.0	55.6	Noise, pk. meas. (1-5,7)
7													
8													
9													
10													
11													
12													

NOTES:

(1) When measured at 0.25 cm from the DUT, no signal was detected anywhere, even at the radome

(2) Mixer conversion loss is programmed in the spectrum analyzer and automatically adjusts the readings

(3) When extrapolating to 3 m, use Near (40 dB/dec) and Far Fld (20 dB/dec) behavior

(4) For Ave. measurement a 1 Hz VBW was used, sometimes higher; RBW was always 1 MHz

(5) DUT max. antenna size, D= 12.0 cm

(6) Extermal mixer, LO, and 36.5 dB IF amp were used

(7) For ridge-horn (Horn) use aperture dimension of one half wavelength

Digital Radiated Emissions

#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used			Ka dB/m	Kg dB	E3 dBµV/m	E3lim dBµV/m	Pass dB	Comments
1													
2													
3													
4													
5	Not applicable												
6													
7													
8													
9													

Conducted Emissions

#	Freq. MHz	Line Side	Det. Used	Vtest dBµV	Vlim dBµV	Pass dB							Comments
1													
2	Not applicable												
4													

Meas. 7/16-23/04; U of Mich.

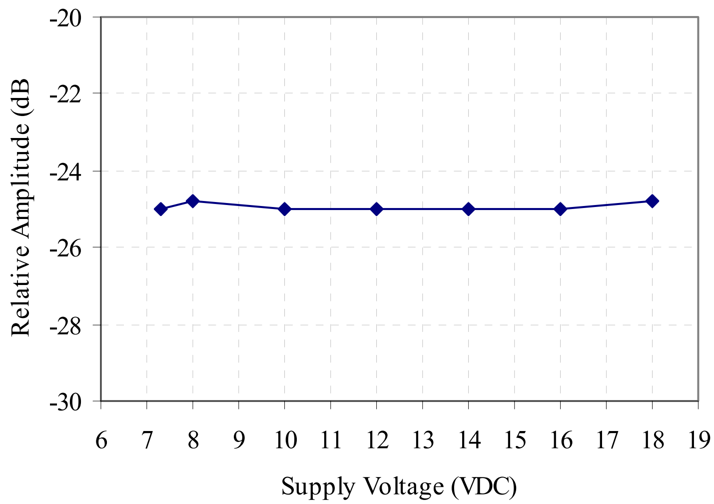


Figure 6.1. Relative emission at fundamental vs. supply voltage.

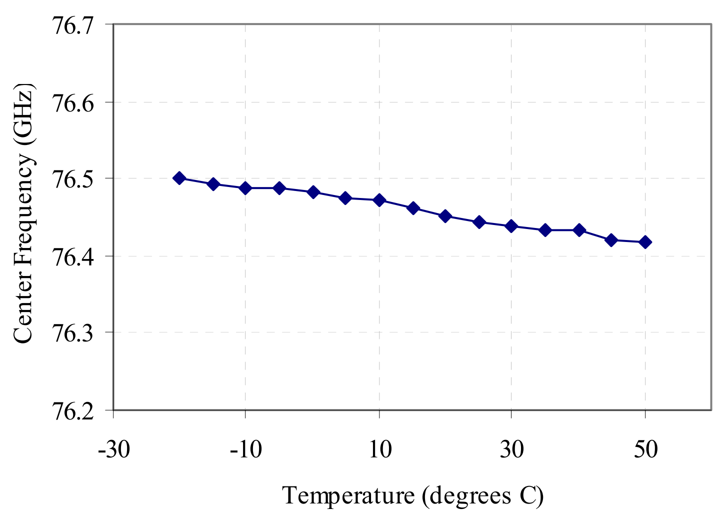
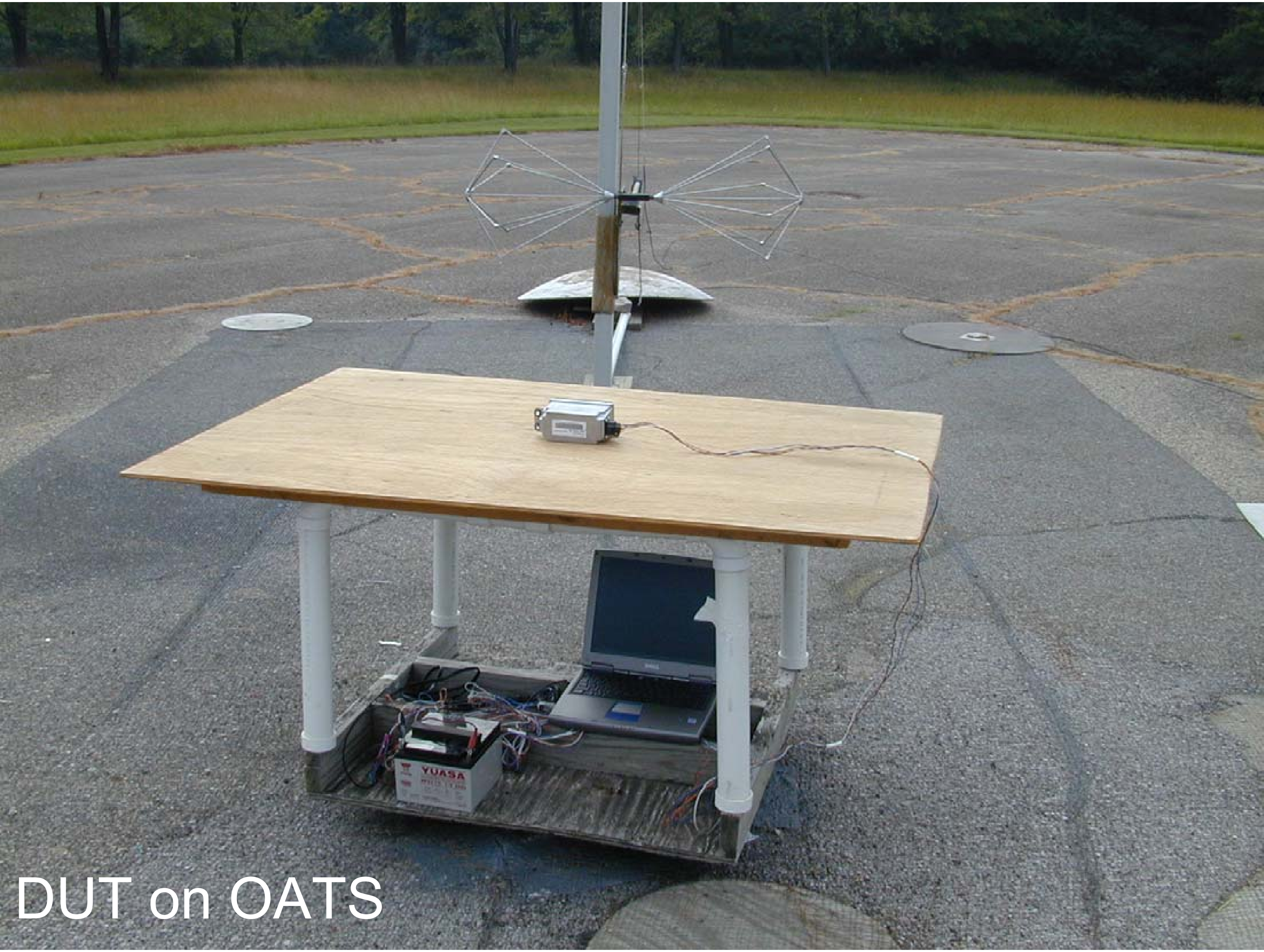
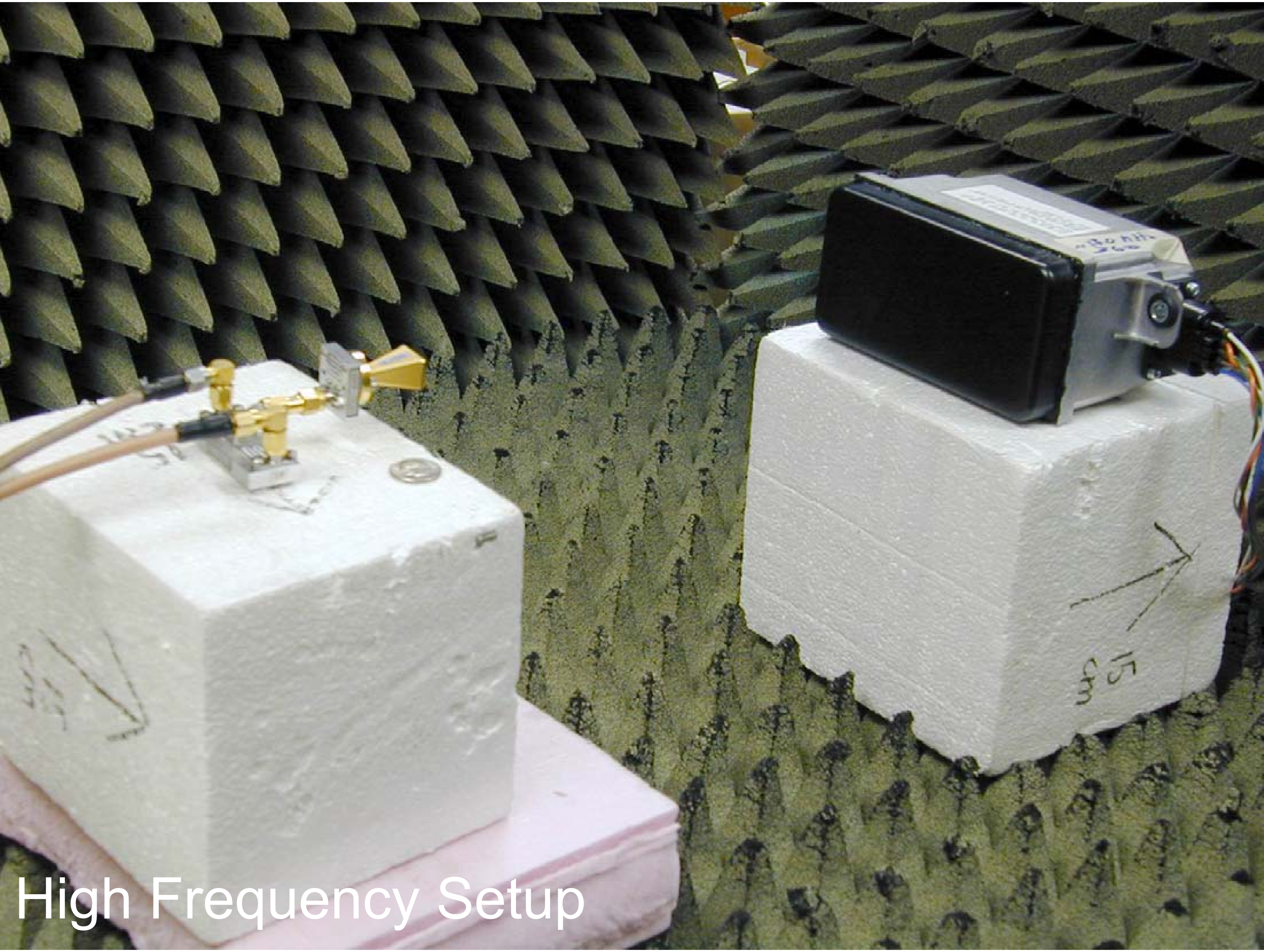


Figure 6.2. Center frequency vs. temperature.



DUT on OATS

Emission Setup (f>1 GHz)



High Frequency Setup