

FCC Part 15 Subpart E Test Report
for
Wireless Bypass
on the
Cable Access Radio CPE
Model: DL-5800C24

FCC ID: PPS-DL-5800C24

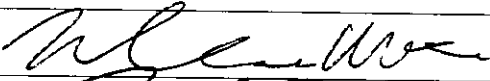
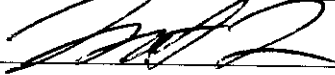
Date of Report: June 26, 2001

Job # J20046196

Date of Test: June 11, 2001 – June 19, 2001



Lab Code 100270-0

	Nicholas Abbondante, Test Engineer
	Michael F. Murphy, Staff Engineer

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The results contained in this report were derived from measurements performed on the identified test samples. Any implied performance of other samples on this report is dependent on the representative of the samples tested.

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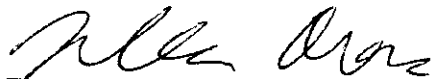
1.0 Summary of Tests

Wireless Bypass, Model: DL-5800C24

FCC ID: PPS-DL-5800C24

TEST	REFERENCE	RESULTS
Output power	15.407 (a)	Pass
26 dB Bandwidth*	15.407 (a)	For calculation only
Power Density	15.407 (a) (5)	Pass
The ratio of the peak excursion of the modulation envelope to the peak transmit power	15.407 (a) (6)	Pass
Out of Band Antenna Conducted Emission	15.407 (b)	Pass
Radiated Emission in Restricted Bands	15.205	Pass
AC Conducted Emission	15.207	Pass
Radiated Emission from Digital Module	15.209	Pass
Radiated Emission from Receiver	15.209	Pass
Radiation Exposure Requirement	1.1310	Pass
Frequency Stability	15.407(g)	Pass
Antenna Requirement	15.203	Pass, Professional Install

Test Engineer:



Nicholas Abbondante

Date:

6/29/01

Staff Engineer:



Michael F. Murphy

Date:

6/29/01

2.0 General Description

2.1 Product Description

The EUT Model No.: DL-5800C24 is an intentional transmitter used for wireless point-to-point and point-to-multipoint communications operating in the frequency range: 5.725-5.825 GHz.

A pre-production version of the sample was received on June 11, 2001 in good condition.

Overview of the Cable Access Radio CPE

Applicant	Wireless Bypass, Inc.
Trade Name & Model No.	Cable Access Radio CPE, Model: DL-5800C24
FCC Identifier	PPS-DL-5800C24
Use of Product	Point-to-point fixed and point-to-multipoint wireless interconnect
Type of Transmission	QPSK, 16 QAM
Maximum RF Output (dBm) *	17.5 dBm
Frequency Range (MHz)	5.725 – 5.825 GHz
Number of Channel(s)	2
Antenna(s) & Gain, dBi	Point-to-Point: Flat Panel Antenna, 23 dBi Parabolic Antenna, 28, 34.6, and 37.6 dBi Point-to-Multipoint: Flat Panel Antenna, 12, 15, 16, 18, and 23 dBi
Antenna Requirement	☐ The EUT uses a permanently connected antenna. ☐ The antenna is affixed to the EUT using a unique connector which allows for replacement of a broken antenna, but DOES NOT use a standard antenna jack or electrical connector. ☒ The EUT requires professional installation (attach supporting documentation if using this option).
Manufacturer name & address	Wireless Bypass, Inc. 43 Northwestern Drive Salem, MA, 03079

* The output power depends on the gain of the antenna used.

2.2 Related Submittal(s)/Grants

Cable Access Radio Hub
Model: DL-5800H24
FCC ID: PPS-DL-5800H24

2.3 Test Methodology

Both AC mains line-conducted and radiated emissions measurements were performed according to the procedures in ANSI C63.4 (1992). Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the Tables in this Application. All other measurements were made in accordance with the procedures in part 2 of CFR 47.

2.4 Test Facility

Site 1C (Top Site) is a 3m and 10m sheltered emissions measurement range located in a light commercial environment in Boxborough, Massachusetts. It meets the technical requirements of ANSI C63.4-1992 and CISPR 22:1993/EN 55022:1994 for radiated and conducted emission measurements. The shelter structure is entirely fiberglass and plastic, with outside dimensions of 33 ft x 57 ft. The structure resembles a quonset hut with a center ceiling height of 16.5 ft.

The testing floor is covered by a galvanized sheet metal groundplane that is earth-grounded via copper rods around the perimeter of the site. The joints between individual metal sheets are bridged with a 2 inch wide metal strips to provide low RF impedance contact throughout. The sheets are screwed in place with stainless steel, round-head screws every three inches. Site illumination and HVAC are provided from beneath the ground reference plane through flush entry ports, the port covers are electrically bonded to the ground plane.

A flush metal turntable with 12 ft. diameter and 5000 lb. load capacity is provided for floor-standing equipment. A wooden table 80 cm high is used for table-top equipment. The turntable is electrically connected to the ground plane with three copper straps. The straps are connected to the turntable at the center of it with ground braid.

The copper strap is directly connected to the groundplane at the edges of the turntable. The turntable is located on the south end of the structure and the antennas are mounted 3 and 10 meters away to the north. The antenna mast is a non-conductive with remote control of antenna height and polarization. The antenna height is adjustable from 1 to 4 meters.

All final radiated emission measurements are performed with the testing personnel and measurement equipment located below the ground reference plane. The site has a full basement underneath the turntable where support equipment may be remotely located. Operation of the antenna, turntable and equipment under test is controlled by remote controls that manipulate the antenna height and polarization and with a turntable control. Test personnel are located below the ellipse when measurements are performed, however the site maintains the ability of having personnel manipulate cables while monitoring test equipment. Ambient radiated emissions are 6 dB or more below the relevant FCC emission limits.

AC mains power is brought to the equipment under test through a power line filter, to remove ambient conducted noise. 50 Hz (240 VAC single phase), 60 Hz power (120 VAC single phase, 208 VAC three phase), and 60 Hz (480 VAC three phase) are available. Conducted emission measurements are performed with a Line Impedance Stabilization Network (LISN) or Artificial Mains Network (AMN) bonded to the ground reference plane. A removable vertical groundplane (2 meter X 2 meter area) is used for line-conducted measurements for table top equipment. The vertical groundplane is electrically connected to the reference groundplane.

3.0 System Test Configuration

3.1 Support Equipment, Cables, and Antenna List

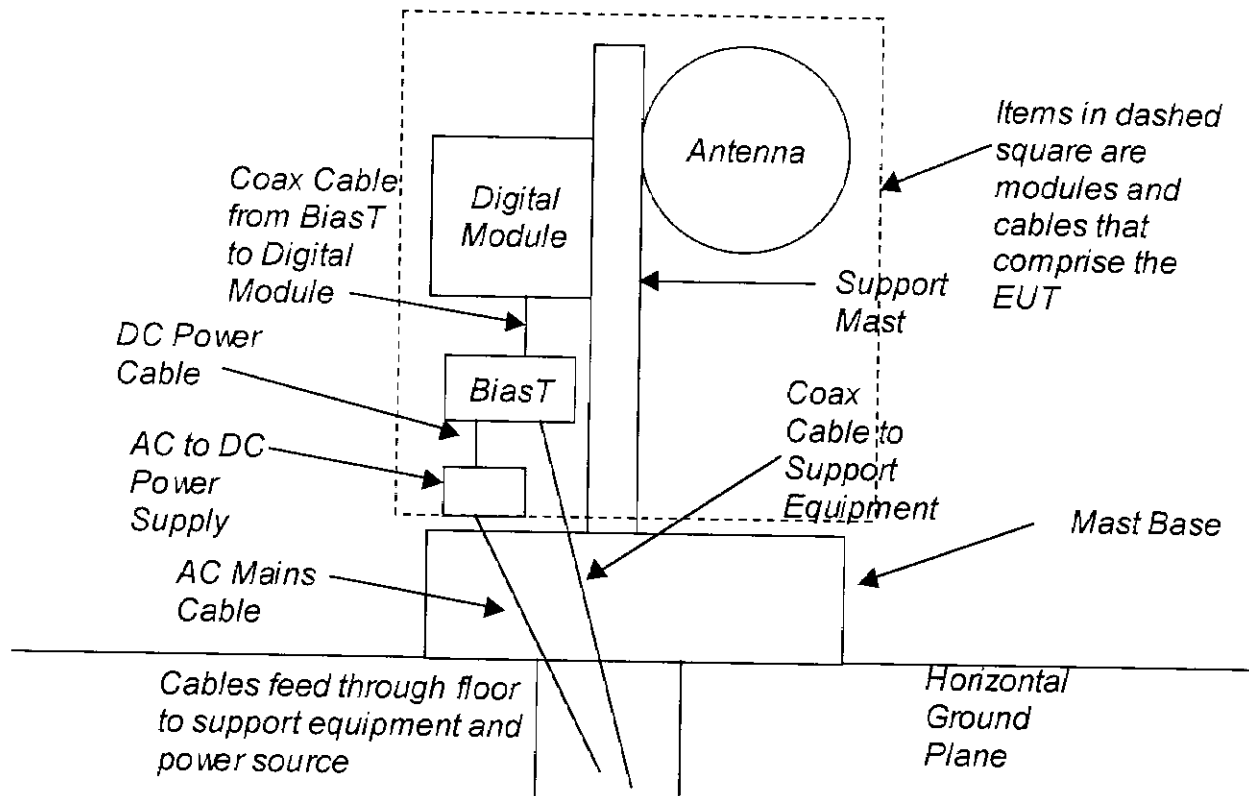
Description:	Model #:	Serial #:	FCC ID:
3Com Cable Modem	3CR29220	HAZHA8BDF8	N/L
3Com Cable Modem	3CR29220	HAZHA8BDCO	N/L
RIC Monitor	X-554M	CZC000405074	HSUTRLX-554
Samtron Monitor	SC-528UXL	A9439024501	CSYSC-528UX
3Com Hub	3C16592A	0100/7D9F042259	HED3C16593A
Riverdelta CMTS	BSR1000	0110A0006	N/L
WIN Computer	WNP-II233-128-18.2	WN9710-3754	N/L
Compaq Computer	5BW130	1X06DTY8120A	N/L
Compaq Mouse	334584-007	334584-007	JNZ201213
Microsoft Mouse	02695686	02695686	C3KKMP1
Compaq Keyboard	SDM454OUL	B354ABUOAJHPP0	N/L
NMB Keyboard	RT2348TW	C0281497	AQ6-MTN71BZ15DIP
Cable Access Radio Hub	DL-5800H24	ENG2	(Pending) PPS-DL-5800H24

Cables:

Description:	Shield:	Connector:	Length:	Quantity:
AC Mains	None	Plastic	2	1
Coaxial	Coaxial	Full 360° Metal	3	1

Antennas:

Description	Usage	Model No.
Cushcraft Flat Panel Antenna 12 dBi	Point-to-Multipoint	S57212AMP10SMF
Telex Flat Panel Antenna 15 dBi	Point-to-Multipoint	5840AA
Radiowaves Flat Panel Antenna 16 dBi	Point-to-Multipoint	SEC-5H-16-90
Gabriel Flat Panel Antenna 18 dBi	Point-to-Multipoint	DFPD 5-52
Gabriel Flat Panel Antenna 23 dBi	Point-to-Multipoint, Point-to-Point	DFPD 1-52
Radiowaves 2' Parabolic Antenna 28 dBi	Point-to-Point	SP2-5.8
Radiowaves 4' Parabolic Antenna 34.6 dBi	Point-to-Point	SP4-5.8
Radiowaves 6' Parabolic Antenna 37.6 dBi	Point-to-Point	SP6-5.8



3.3 Justification

For emission testing, the Equipment Under Test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). During testing, all cables were manipulated to produce worst case emissions.

The EUT is wired to transmit full power.

The signal is maximized through 360 degree rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

All support equipment was remotely located. The EUT was placed in the center of the turntable.

3.4 Software Exercise Program

The EUT exercise program used during testing was designed to exercise the various system components in a manner similar to a typical use. Data was transmitted through the system in order to activate the transmitter circuitry. The receiver circuitry was connected to the transmitted signal to activate receiver circuitry. Care was taken to ensure proper power supply voltages during testing.

3.5 Mode of operation during test

100% time transmitting signal on low and high channels.

3.6 Modifications required for Compliance

The following modifications were installed during compliance testing in order to bring the product into compliance (Please note that this list does not include changes made specifically by Wireless Bypass prior to compliance testing):

A prescan was performed to determine if the EUT had any spurious emissions. Due to the results of this scan, the following modifications were required:

- 1) Conductive gasket (Manufacturer: TennRich P/N:FBC0402) was placed between the access panel and the chassis of the EUT with paint removed for better conductive contact.
- 2) A minimum of 20' of coaxial cable must separate the BiasT Module of the EUT from the Digital Module.

3.7 Additions, deviations and exclusions from standards

No additions, deviations or exclusion have been made from standard.

4.0 Measurement Results**4.1 Conducted Output Power at Antenna Terminal
FCC Rule 15.407(a)**Requirement:

For fixed point-to-point U-NII devices operating in 5.725-5.825 GHz band, the peak transmit power shall not exceed the lesser of 1 W (30 dBm) or $17 \text{ dBm} + 10\log(B)$, where B is the 26 dB emission bandwidth in MHz (for antenna gain up to 6 dBi).

Procedure:

The antenna port of the EUT was connected to the input of a power meter. Power was read directly from the meter and cable loss connection was added to the reading to obtain power at the EUT antenna terminal.

Result:

Frequency, MHz	Output Power, mW	Output Power, dBm	Limit, dBm	Maximum allowed antenna gain, dBi
Low Channel: 5733	56.5	17.5	22.0	10.5(p-mp), 27.5(p-p)
High Channel: 5740	48.3	16.8	22.0	11.2(p-mp), 28.2(p-p)

Note:

1. The EUT Output Power was set to maximum to produce the worse case test result.
2. When a higher gain antenna is used, the Output Power will be reduced further by a 1:1 ratio equal to the amount by which the antenna gain exceeds the allowed antenna gain for point to multipoint use and for point to point use.
3. (p-mp) refers to "Point to Multipoint" operation, while (p-p) refers to "Point to Point" operation.

4.2 26 dB Bandwidth
FCC Rule 15.407(a) (for calculation only)

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer Res BW was set to 100 kHz. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A PEAK output reading was taken, a DISPLAY line was drawn 26 dB lower than PEAK level. The 26 dB bandwidth was determined from where the channel output spectrum intersected the display line.

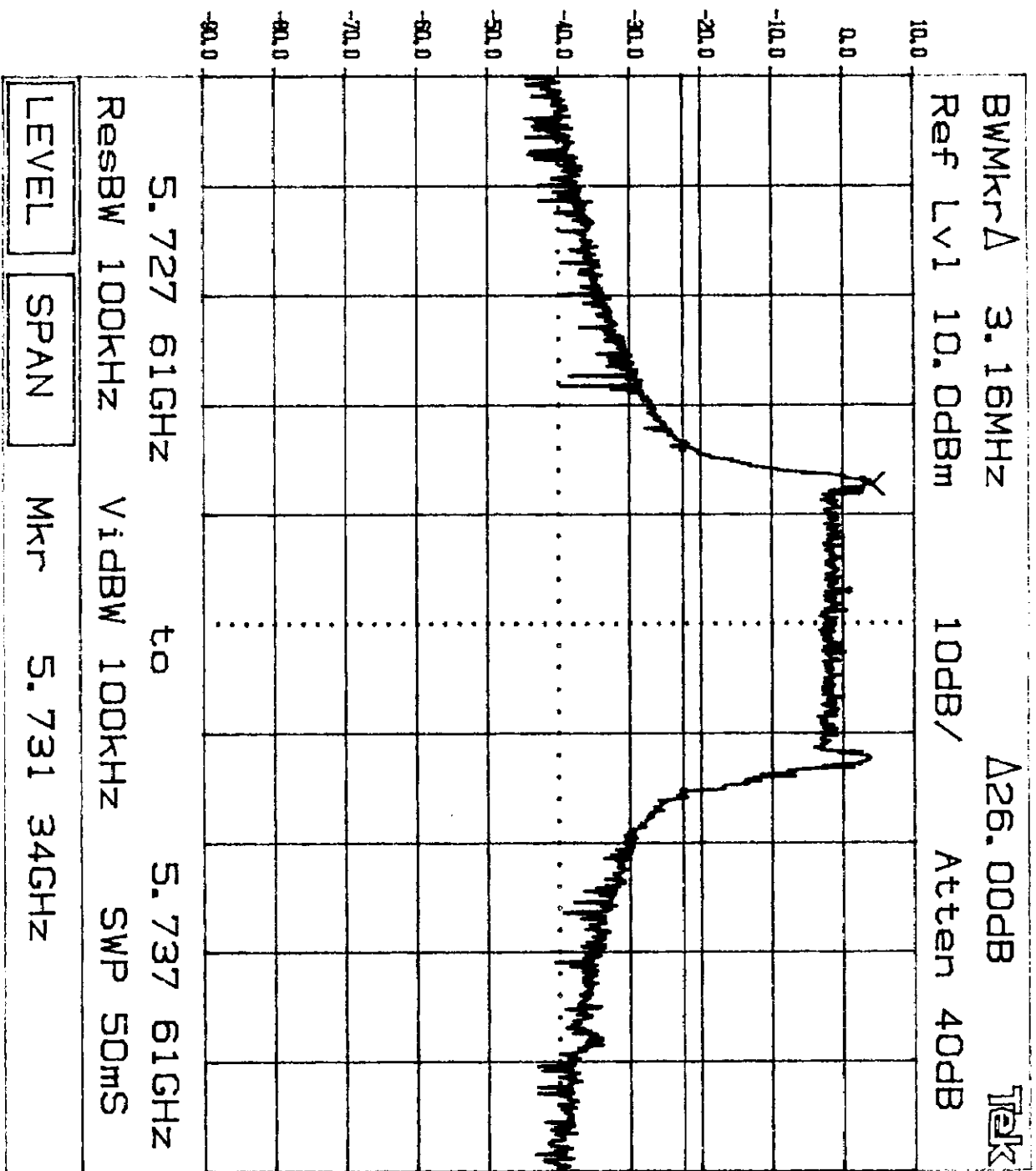
Frequency, MHz	26 dB Bandwidth, MHz
5733	3.16
5740	3.18

Refer to the following plots for 26 dB bandwidth:

Plot 1a: Low Channel 26 dB Bandwidth
Plot 1b: High Channel 26 dB Bandwidth

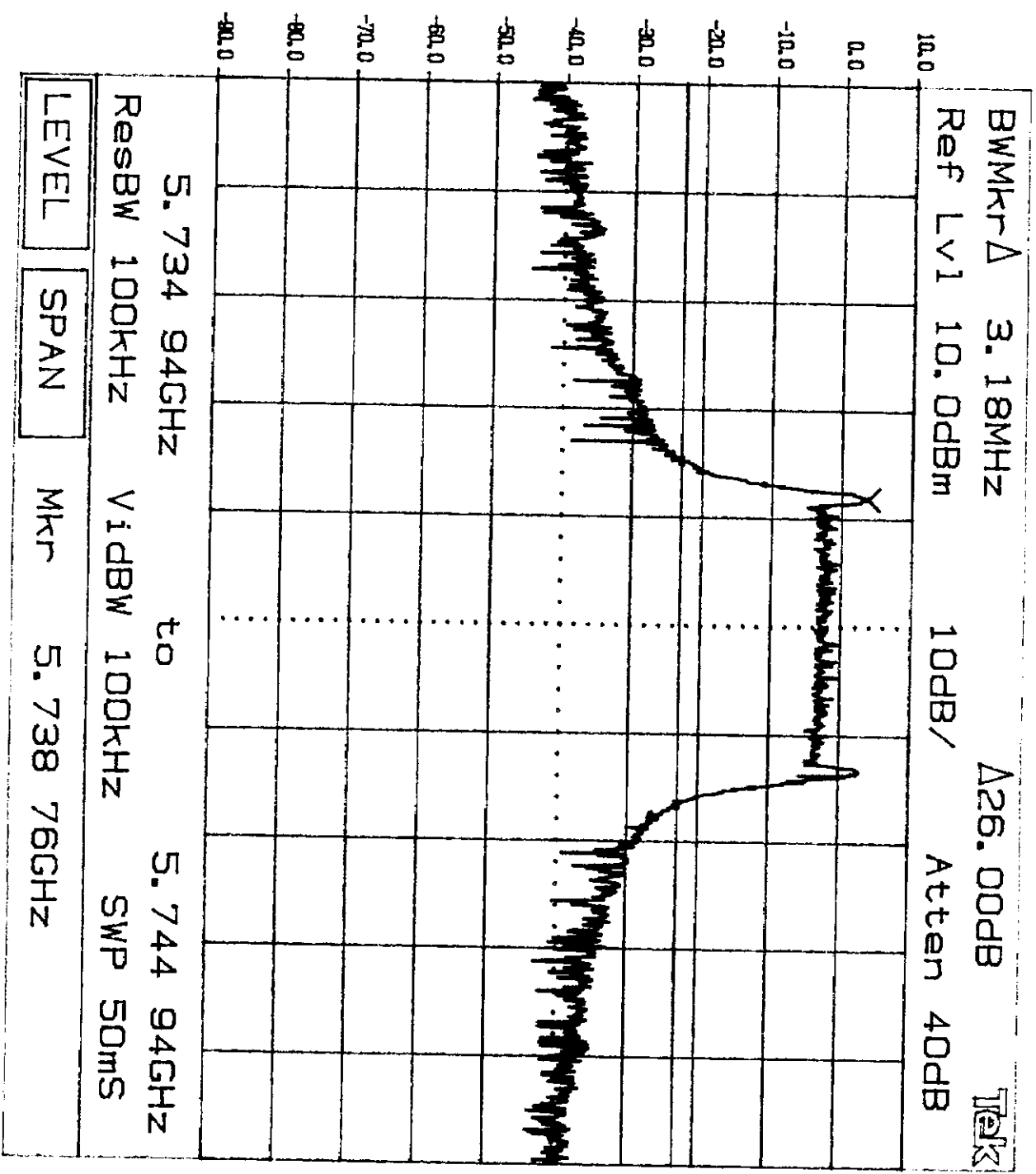
1a

600 Frequency Channel of CPE 26.15 BW



KN0B 2 KN0B 1 KEYPAD Tektronix 2784

16



KN0B 2 KN0B 1 KEYPAD Tektronix 2784

4.3 Power Density

Requirement:

For fixed point-to-point U-NII devices operating in 5.725-5.825 GHz band peak power spectral density shall not exceed 17 dBm in any 1 MHz band (for antenna gain up to 6 dBi for point to multipoint operation and gain up to 23 dBi for point to point operation). This gives an effective EIRP limit of 23.0 dBm for point to multipoint operation and 40 dBm for point to point operation.

Procedure:

Antenna output of the EUT was coupled directly to spectrum analyzer; an external attenuator and cable were used; the losses are 30 dB for the attenuator and 5.7 dB for the cable.

The spectrum analyzer Resolution Bandwidth was set to 1 MHz and Video Bandwidth was set to 3 MHz. The START and STOP frequencies were set to the band edges of the maximum output passband. The spectrum analyzer was set to video average, 100 sweeps were used. Maximum peak-power spectral density reading was recorded.

Result (includes losses through the measurement system):

Frequency MHz	Power Density DBm	EIRP Limit DBm	Maximum Allowed Antenna Gain dBi
5733	12.4	23.0(p-mp), 40(p-p)	10.6 (p-mp), 27.6 (p-p)
5740	12.5	23.0(p-mp), 40(p-p)	10.5 (p-mp), 27.5 (p-p)

Refer to the following plots for power density data:

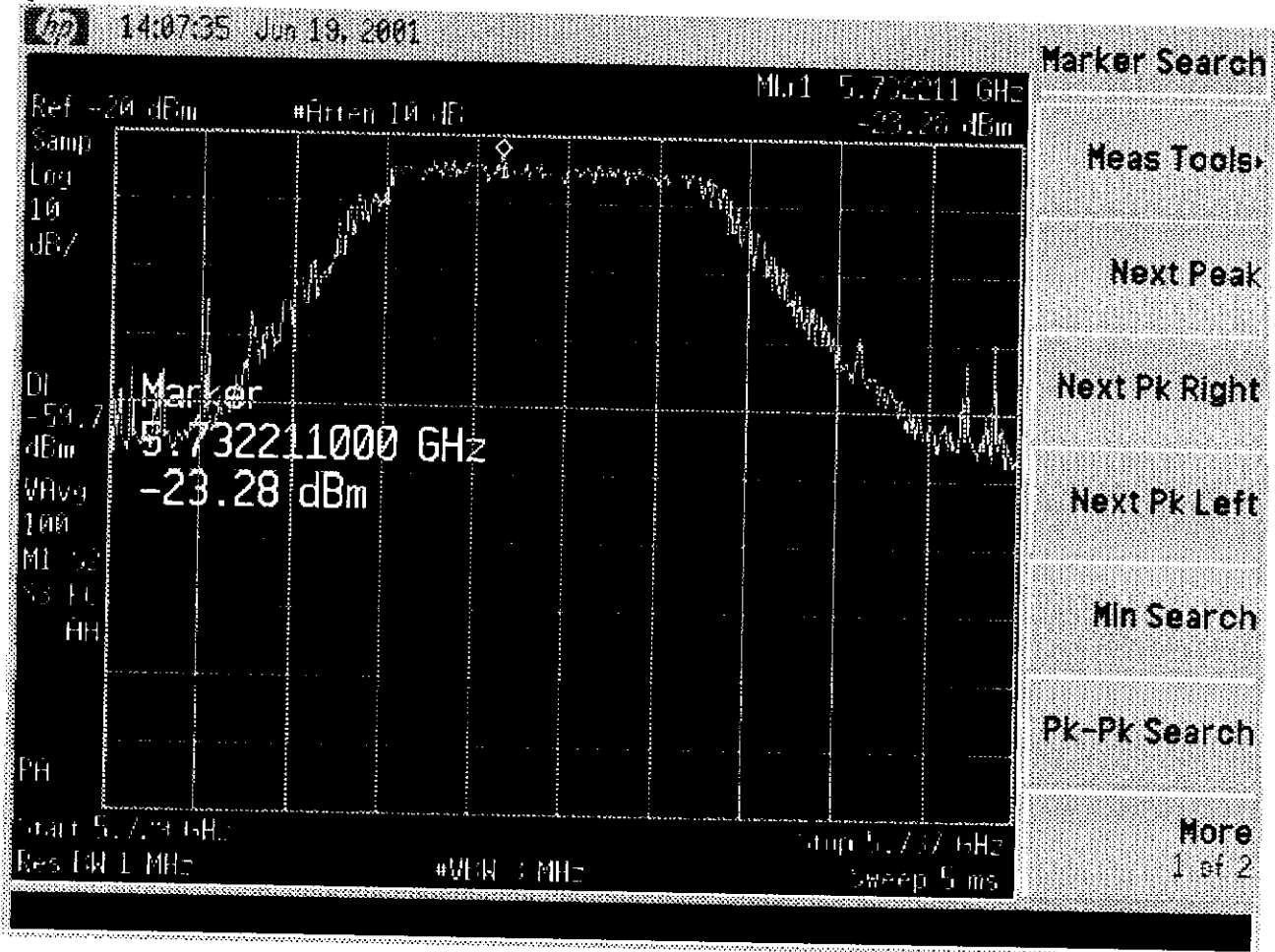
Plot 2a: Low Channel Power Density

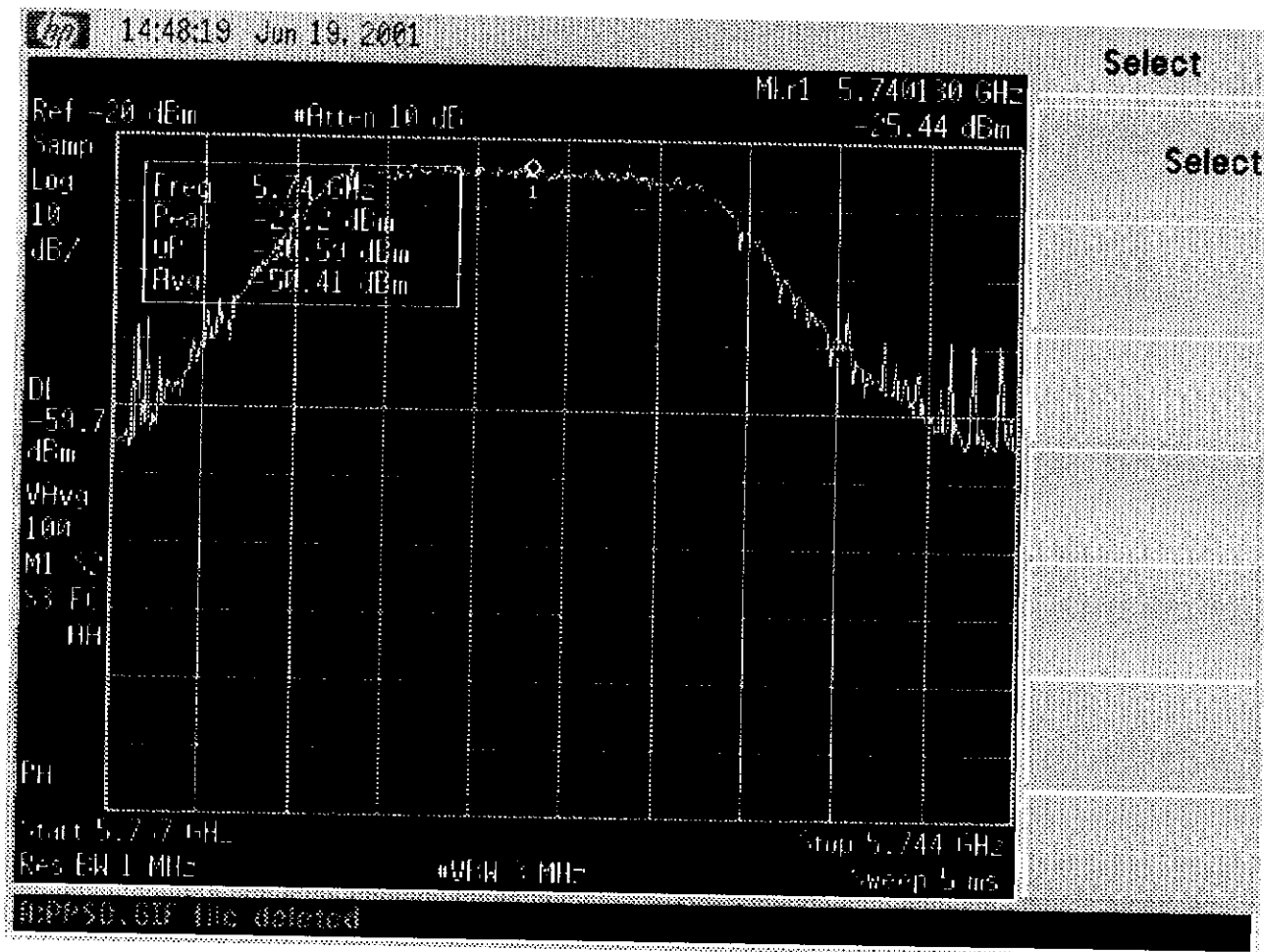
Plot 2b: High Channel Power Density

Note:

- (p-mp) refers to "Point to Multipoint" operation, while (p-p) refers to "Point to Point" operation.
- When an antenna is used with gain higher than that specified as allowable for either point to point or point to multipoint operation, the output power shall be reduced by the amount in dB that the antenna gain exceeds the allowed antenna gain.

2a





- 4.4 The ratio of the peak excursion of the modulation envelope to the peak power
FCC Rule 15.407(a)(6)

Requirement:

The ratio of the peak excursion of the modulation envelope to the peak transmit power shall not exceed 13 dB.

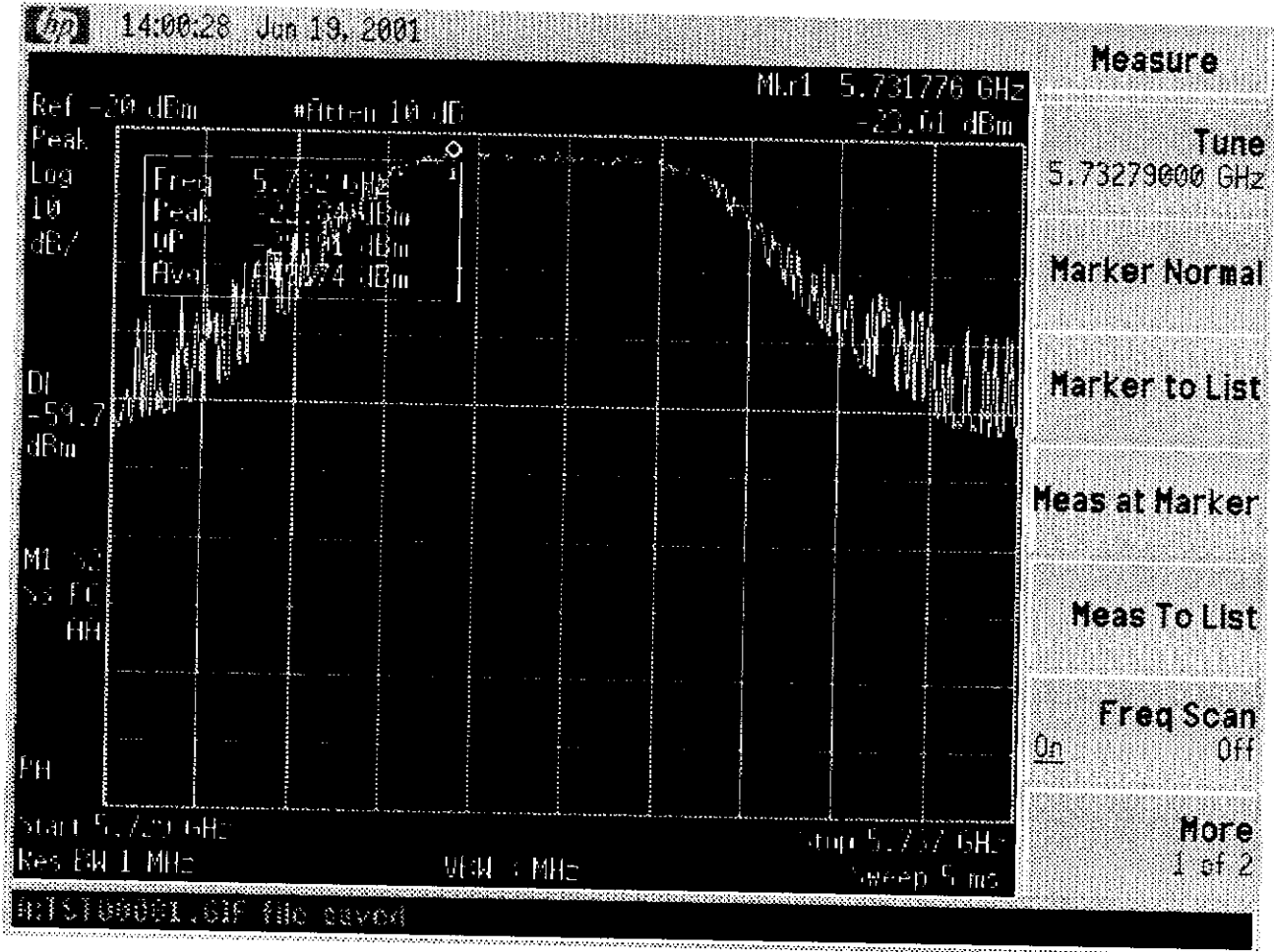
Procedure:

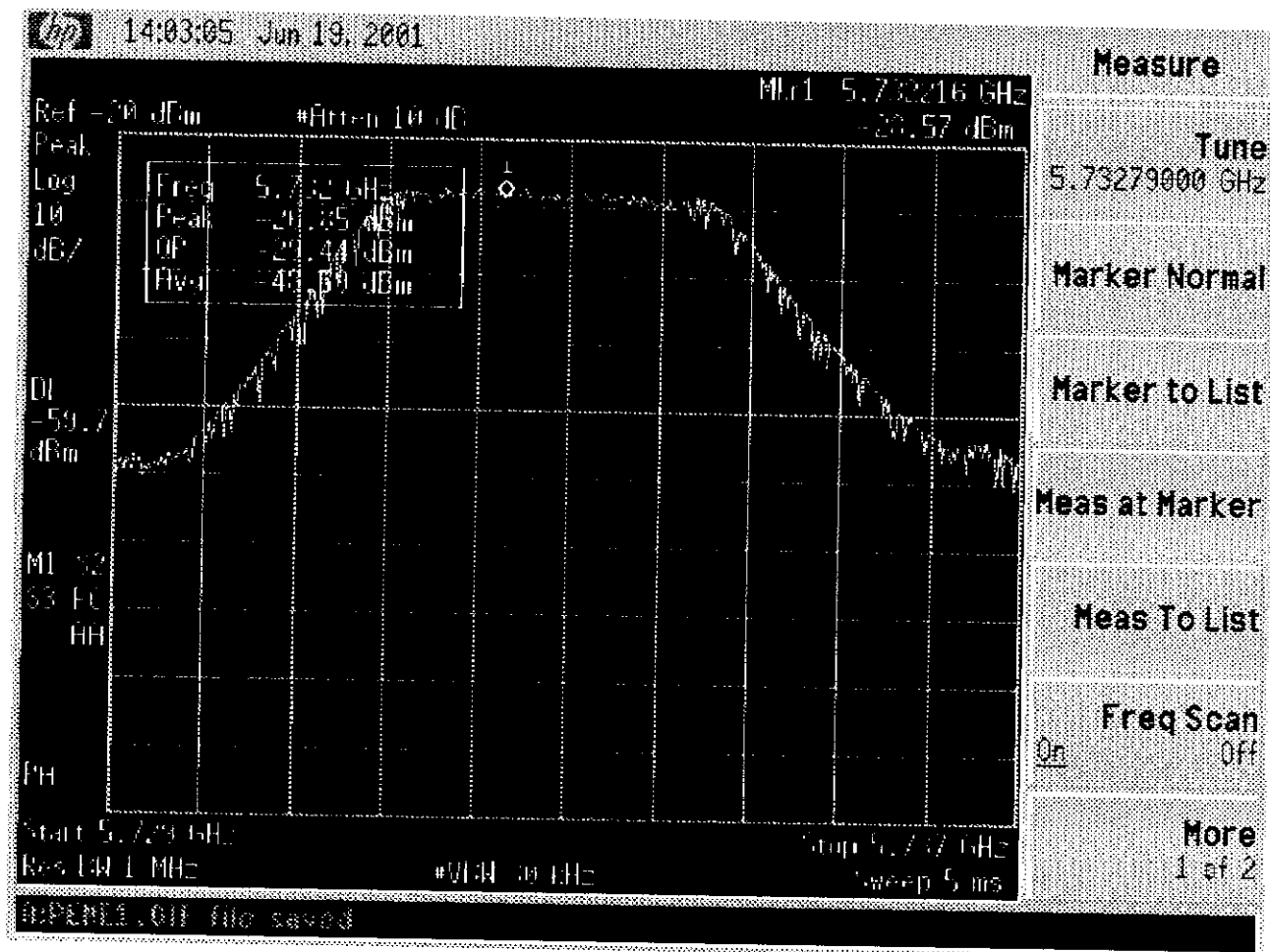
Spectrum Analyzer was connected to the output of the EUT. The Resolution Bandwidth was set to 1 MHz. Two plots were made in each band: with the Video Bandwidth set to 3 MHz and with the Video Bandwidth set to 30 kHz. The difference between spectrum analyzer readings indicates the ratio of the peak excursion of the modulation envelope to the peak transmit power.

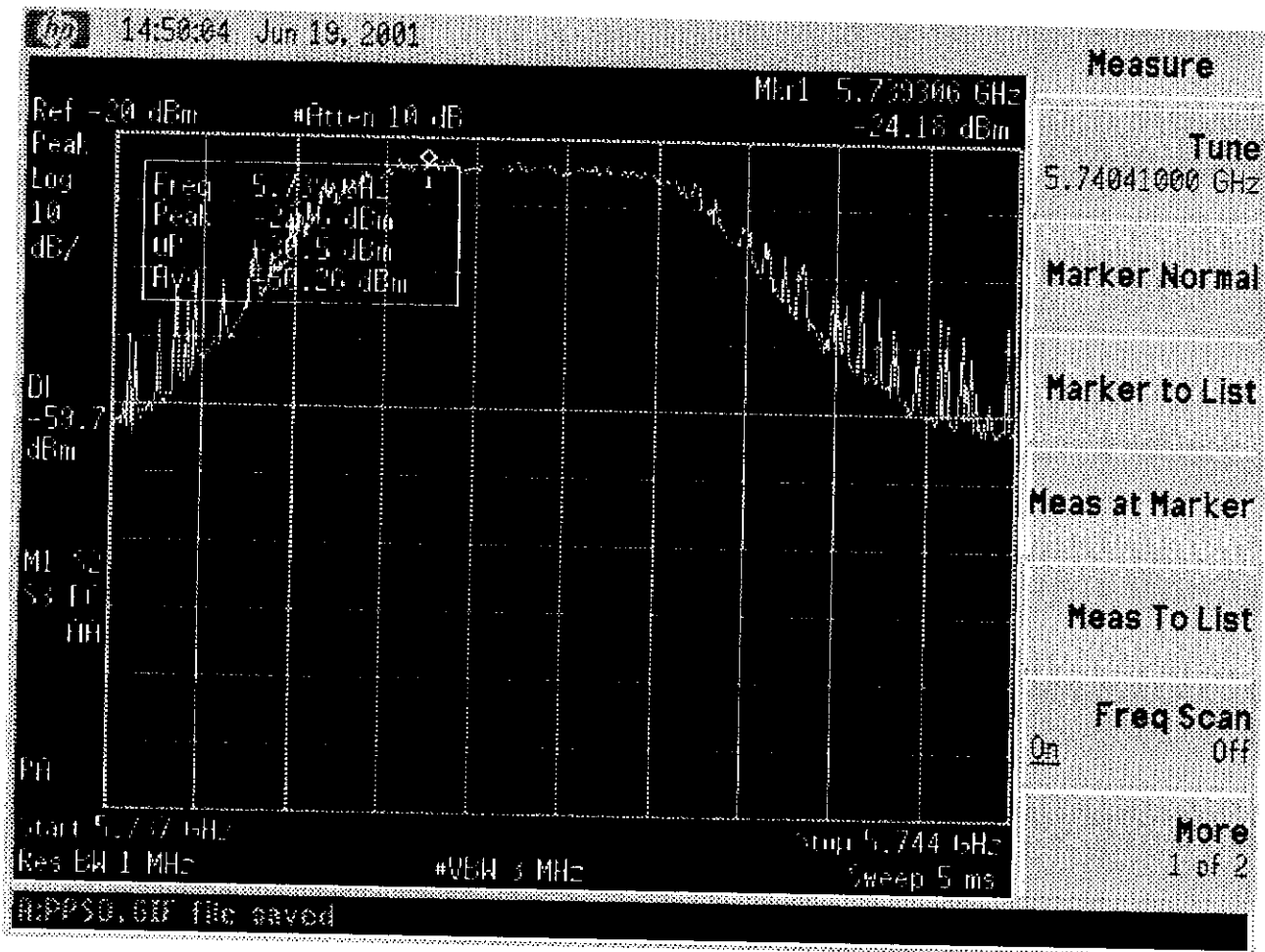
Test Result:

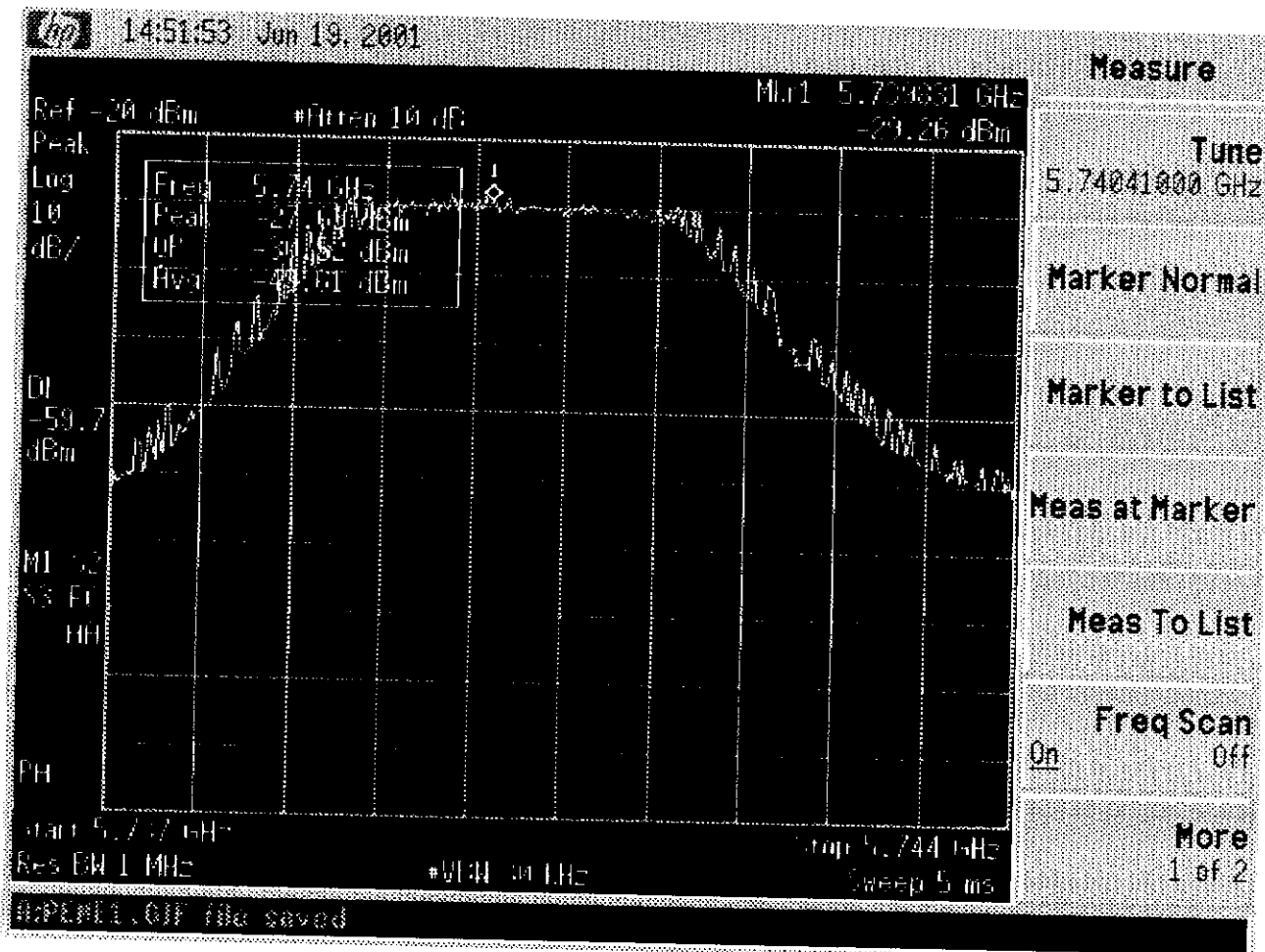
See attached plots 3.a1, 3.a2 and 3.b1, 3.b2. for the ratio of the peak excursion of the modulation envelope to the peak power. The maximum Ratio is 5.0 dB.

3a1









4.5 Out-of-Band Emissions
FCC Rule 15.407(b)

Requirement:

For transmitters operating in the 5.725-5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of -27 dBm/MHz.

The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

Note that this gives a spurious emission limit of 80 dBuV for out of band emissions, which far exceeds the limits set forth in 15.209. Therefore the limits of 15.209 were applied to any radiated emissions below 1 GHz.

Procedure:

For radiated spurious measurements, the spectrum analyzer was connected to an antenna set that spanned the range from 30 MHz to 40 GHz. The EUT was connected to the highest and lowest gain antenna of each type marketed with the EUT. For frequencies above 1 GHz, the Resolution Bandwidth was set to 1 MHz, and average measurements were performed. For frequencies below 1 GHz, the Resolution Bandwidth was set 100 kHz, and quasi-peak measurements were performed. Several plots were made in the frequency range from 30 MHz to 40 GHz. For band edge measurements, the spectrum analyzer was connected directly to the EUT antenna port via a 30 dB attenuator and a cable with 5.7 dB of loss at the transmit frequency range.

Result:

Note that all emissions detected above 1 GHz were determined to be ambient (by interrupting power to the EUT and observation that the emissions still persisted) with exception to the fundamental transmit frequency, which is measured elsewhere in this report. Also note that the marker resolution of the analyzer lead to inaccuracy in the frequency value of the fundamental emission. These values are not being measured. Photos are provided.

Refer to the following plots and data tables for spurious radiated emissions data:

Plot 4.a1 – 4.a8 and Table A: 2' Parabolic 28 dBi Gain (Point-Point)

Plot 4.b1 – 4.b8 and Table B: 6' Parabolic 37.6 dBi Gain (Point-Point)

Plot 4.c1 – 4.c8 and Table C: Flat Panel 23 dBi Gain (Point-Point)

Plot 4.d1 – 4.d8 and Table D: Flat Panel 23 dBi Gain (Point-Multipoint)

Plot 4.e1 – 4.e8 and Table E: Flat Panel 12 dBi Gain (Point-Multipoint)

Refer to the following plots for antenna conducted band edge measurements:

Plot 4.f1 – 4.f2: Low Channel Band Edge Measurements, 5733 MHz.

Plot 4.g1 – 4.g2: High Channel Band Edge Measurements, 5740 MHz.

The EUT was scanned for spurious emissions while connected to the highest and lowest gain antennas of each type that is marketed with the EUT. Band edge measurements were taken by directly connecting the spectrum analyzer to the EUT antenna port.

Operating frequency	Frequency, MHz	Conducted Level, dBm	EIRP Limit, dBm/MHz
5733 MHz	5725	-26.2 from plot 4.f1	-17
	5825	-45.3 from plot 4.f2	-17

Operating frequency	Frequency, MHz	Conducted Level, dBm	Limit, dBm/MHz
5740 MHz	5724	-32.0 from plot 4.g1	-17.0
	5826	-35.7 from plot 4.g2	-17.0

Intertek Testing Services

Radiated Emissions / Interference

Table: A

Company: Wireless Bypass

Model: DL-5800C

Job No.: J20046196

Date: 06/15/01

Standard: FCC15

Class: A

Group: None

Notes: Redlowaves 2' parabolic on CPE

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 6546A

Antenna: LOG1

PreAmp: 0

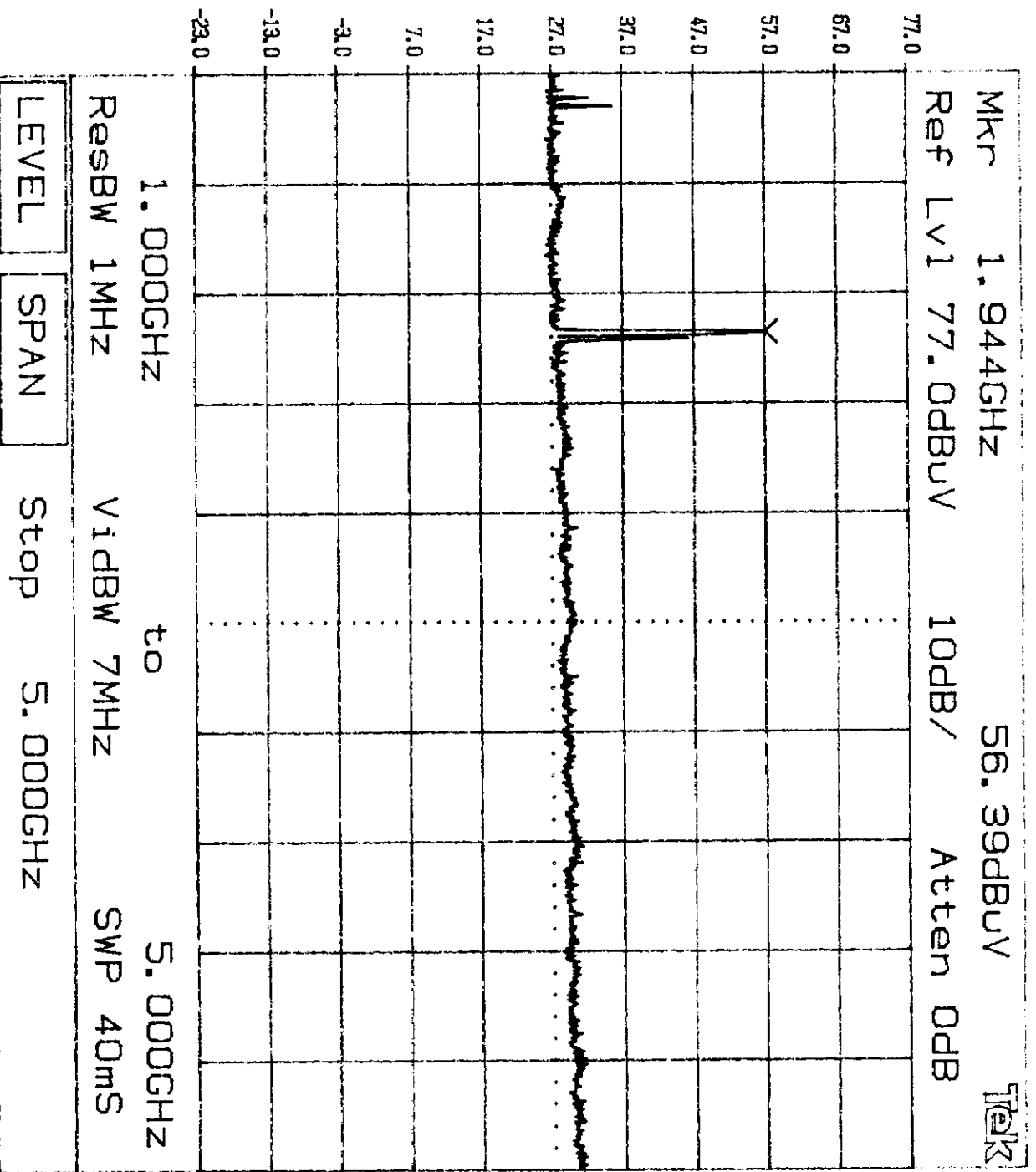
Cable(s): 1C, 3 METER, PRIMAR

Distance: 3 meters

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	39.510	20.0	12.7	0.7	0.0	0.0	33.4	40.0	-6.6
V	48.000	21.2	9.4	0.9	0.0	0.0	31.4	40.0	-8.6
V	69.250	21.2	6.6	0.8	0.0	0.0	28.7	40.0	-11.3
V	74.000	22.2	6.4	0.9	0.0	0.0	29.5	40.0	-10.5
V	109.000	12.1	7.3	1.3	0.0	0.0	20.6	43.5	-22.9
V	117.600	18.3	6.8	1.3	0.0	0.0	26.4	43.5	-17.1
V	135.800	16.7	7.1	1.4	0.0	0.0	25.3	43.5	-18.2

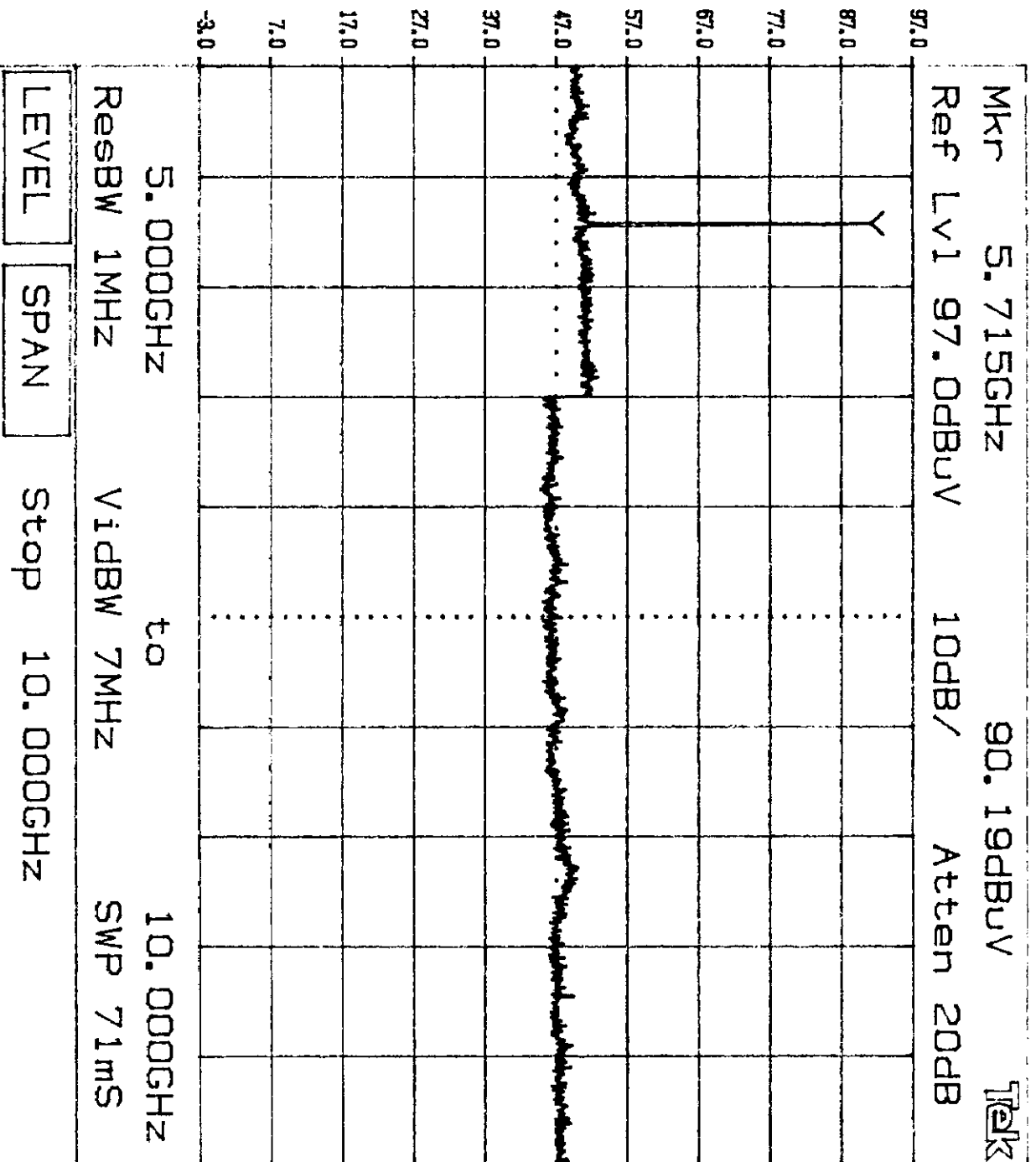
4a1

RA035 JUNE 67 PMA KATEL 000005



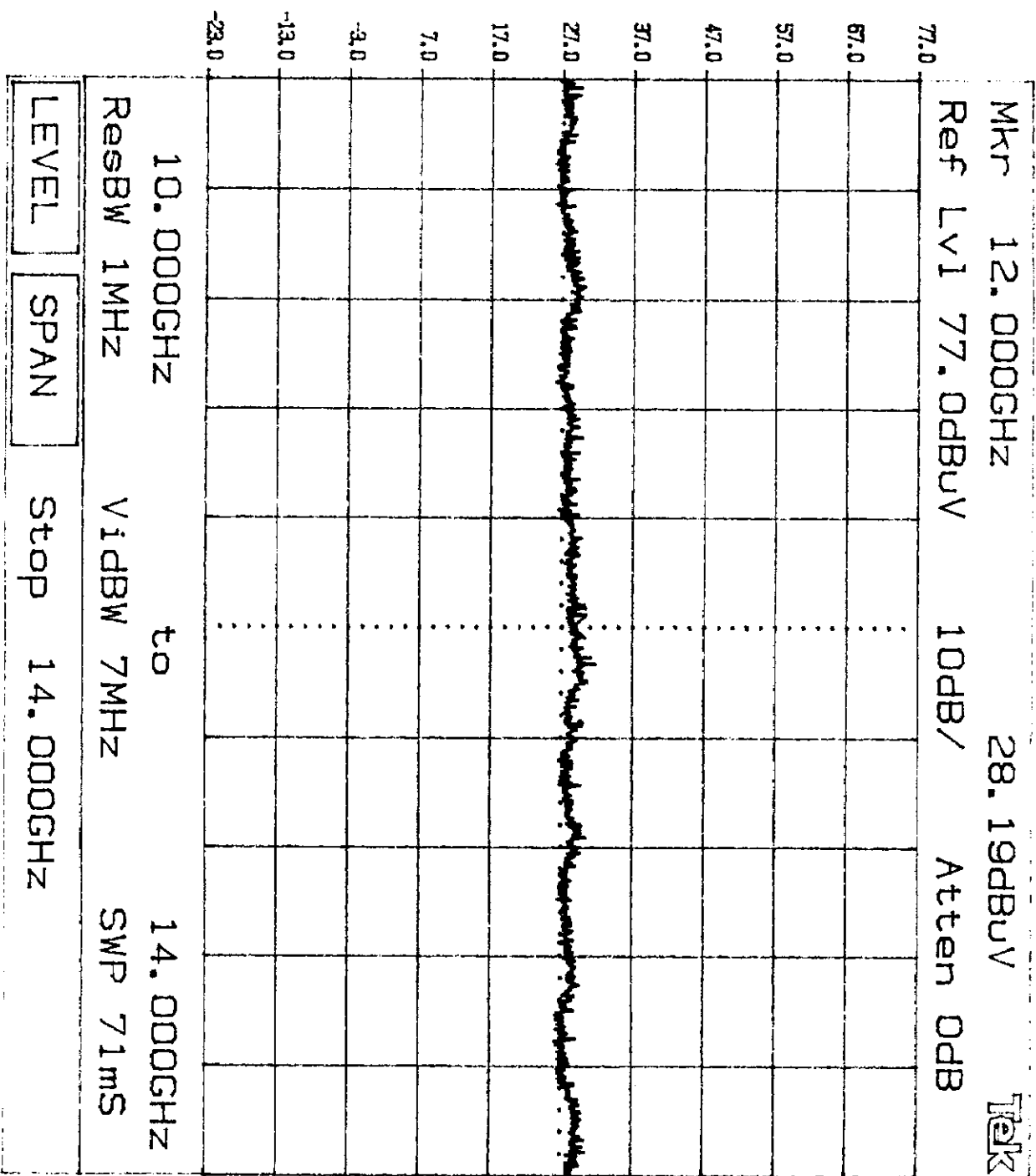
KNDB 2 KNDB 1 KEYPAD Tektronix 2784

4.2



KN0B 2 KN0B 1 KEYPAD Tektronix 2784

4.3



Knob 2

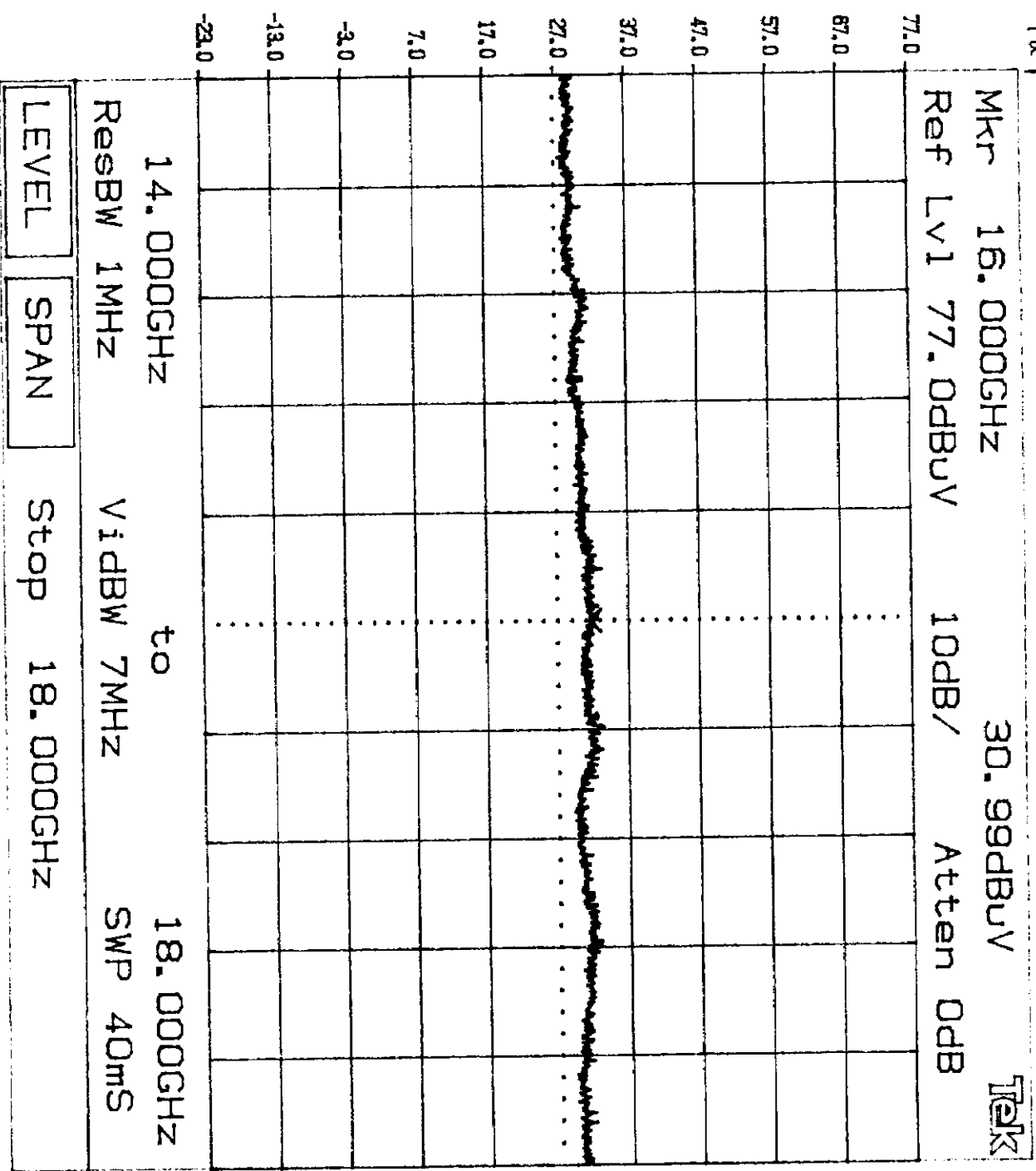
Knob 1

Keypad

Tektronix

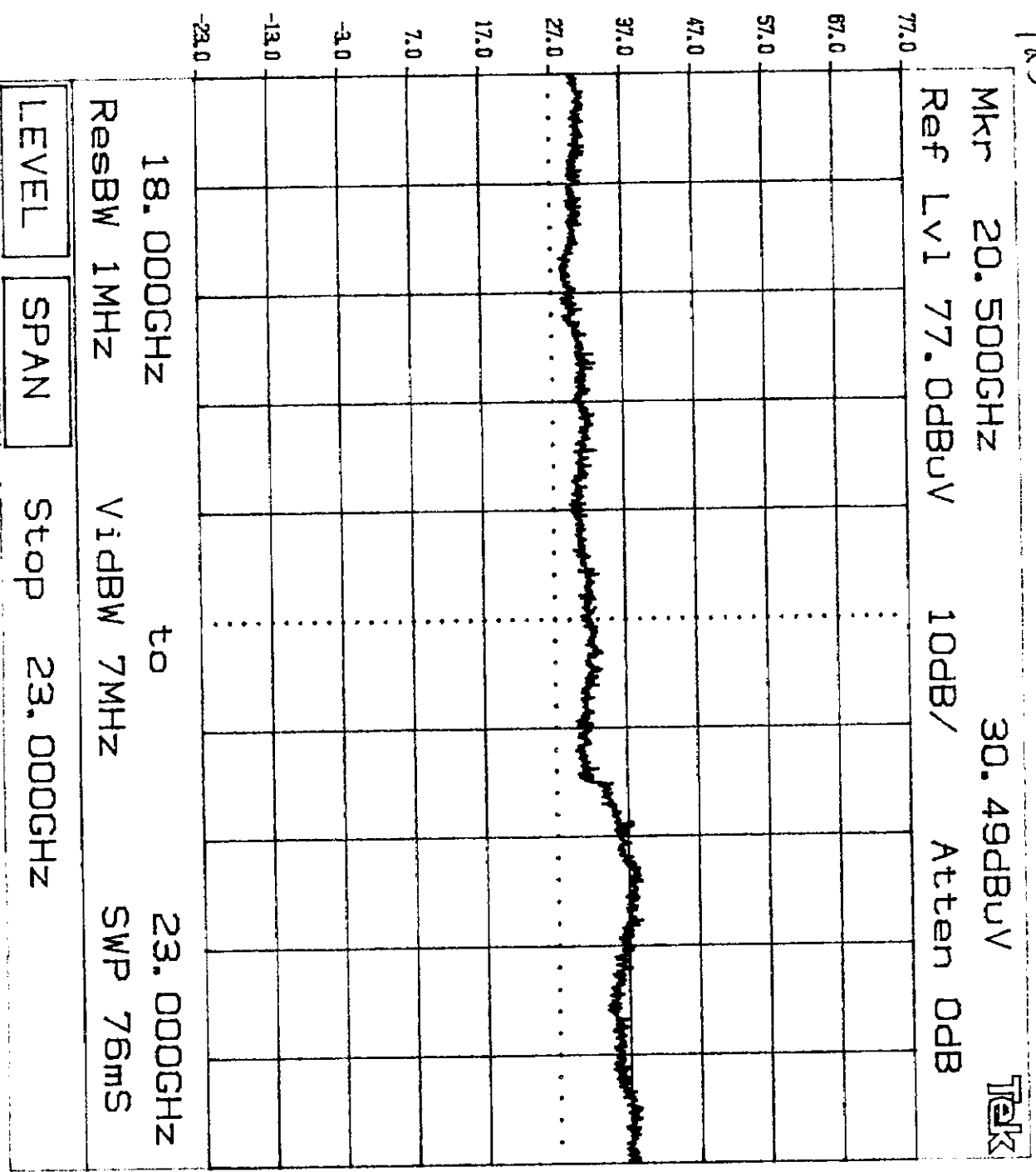
2784

4.4



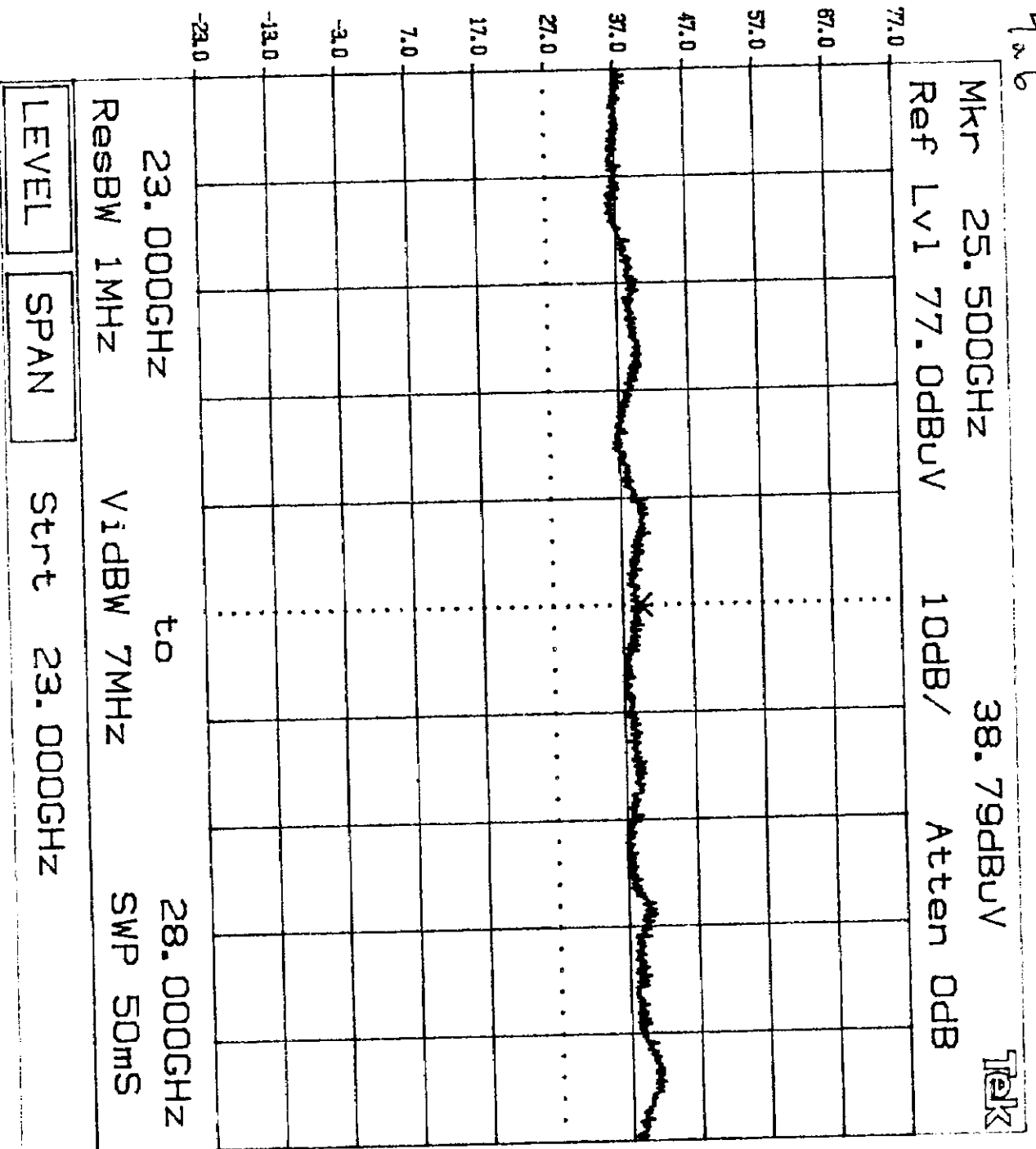
Knob 2 Knob 1 Keypad Tektronix 2784

4.5



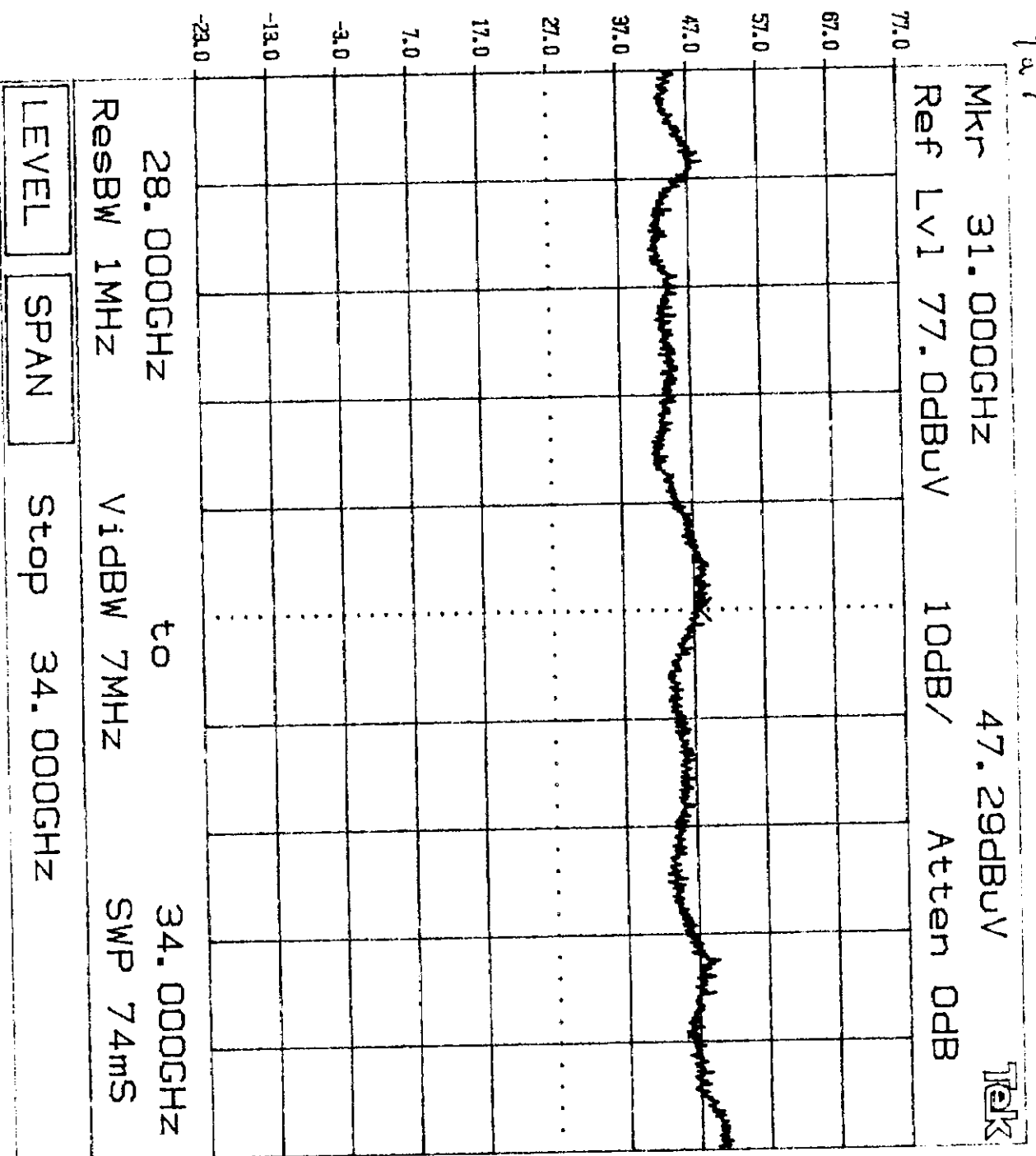
Knob 2 Knob 1 Keypad Tektronix 2784

4.6

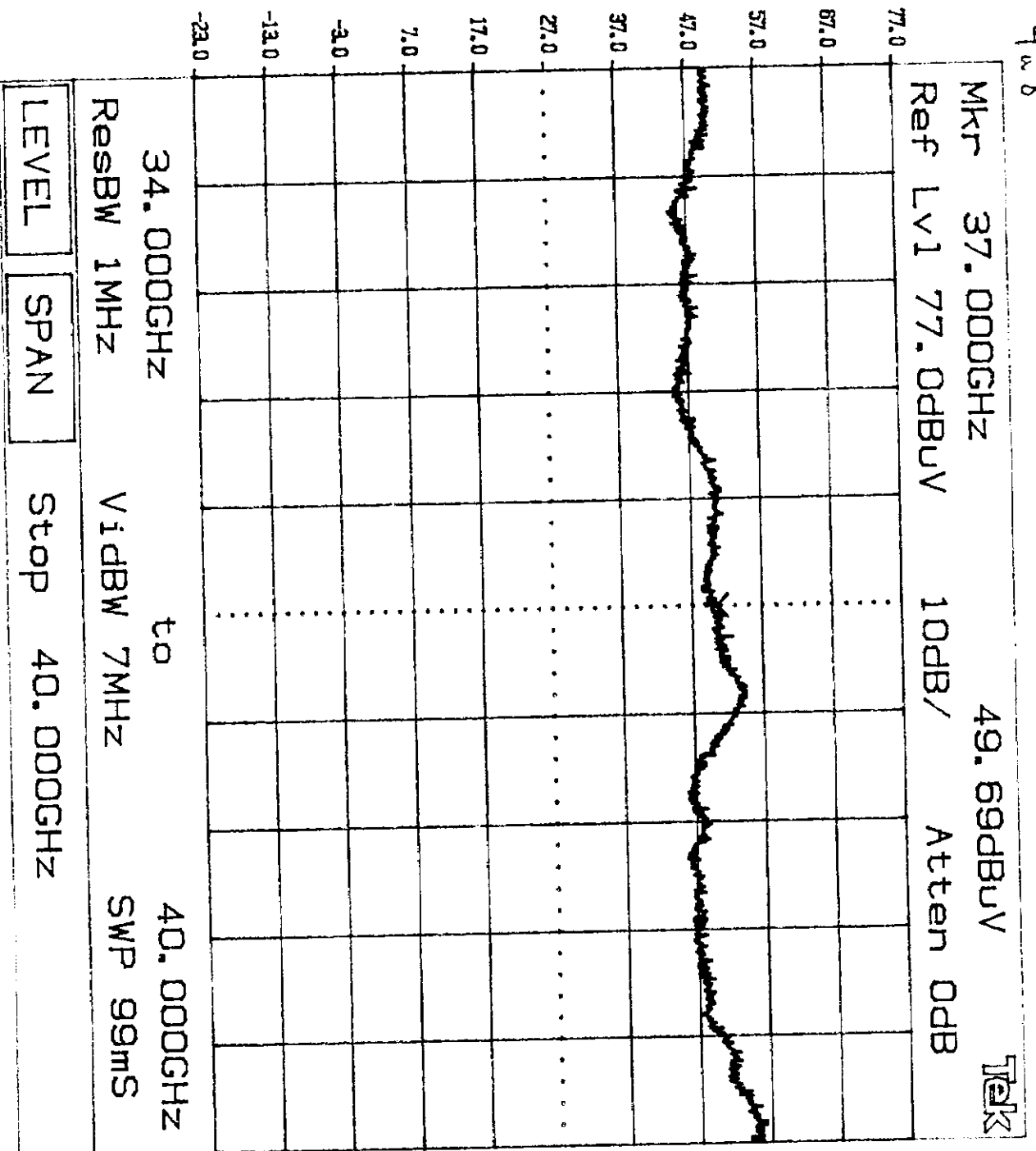


Knob 2 Knob 1 Keypad Tektronix 2784

4.7



4.8



Knob 2 Knob 1 Keypad Tektronix 2784

Intertek Testing Services

Radiated Emissions / Interference

Table: B

Company: Wireless Bypass

Model: DL-5600C

Job No.: J20046196

Date: 05/14/01

Standard: FCC15

Class: A

Group: None

Notes: Radiowaves 6' Parabolic on GPE

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

Antenna: LOG1

PreAmp: 0

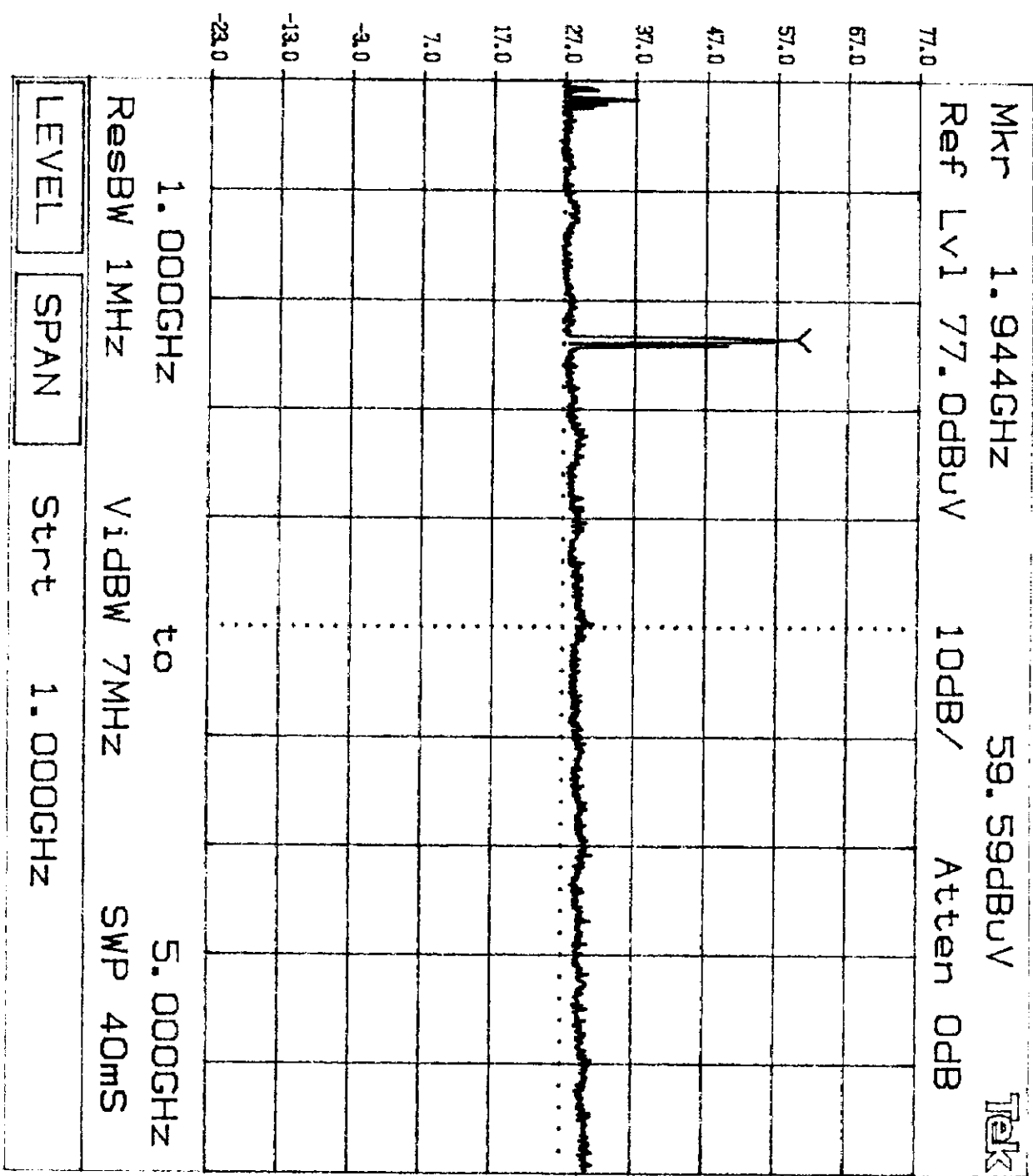
Cable(s): 1C, 3 METER, PRIMAR

Distance: 3 meters

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	40.120	20.8	12.4	0.7	0.0	0.0	33.9	40.0	-6.1
V	43.520	20.0	11.1	0.8	0.0	0.0	31.8	40.0	-8.2
V	74.540	23.5	6.4	0.9	0.0	0.0	30.8	40.0	-9.2
V	108.800	19.5	7.3	1.3	0.0	0.0	28.0	43.5	-15.5
V	118.300	17.3	6.8	1.3	0.0	0.0	25.4	43.5	-18.1
V	133.700	17.5	7.0	1.4	0.0	0.0	25.9	43.5	-17.6

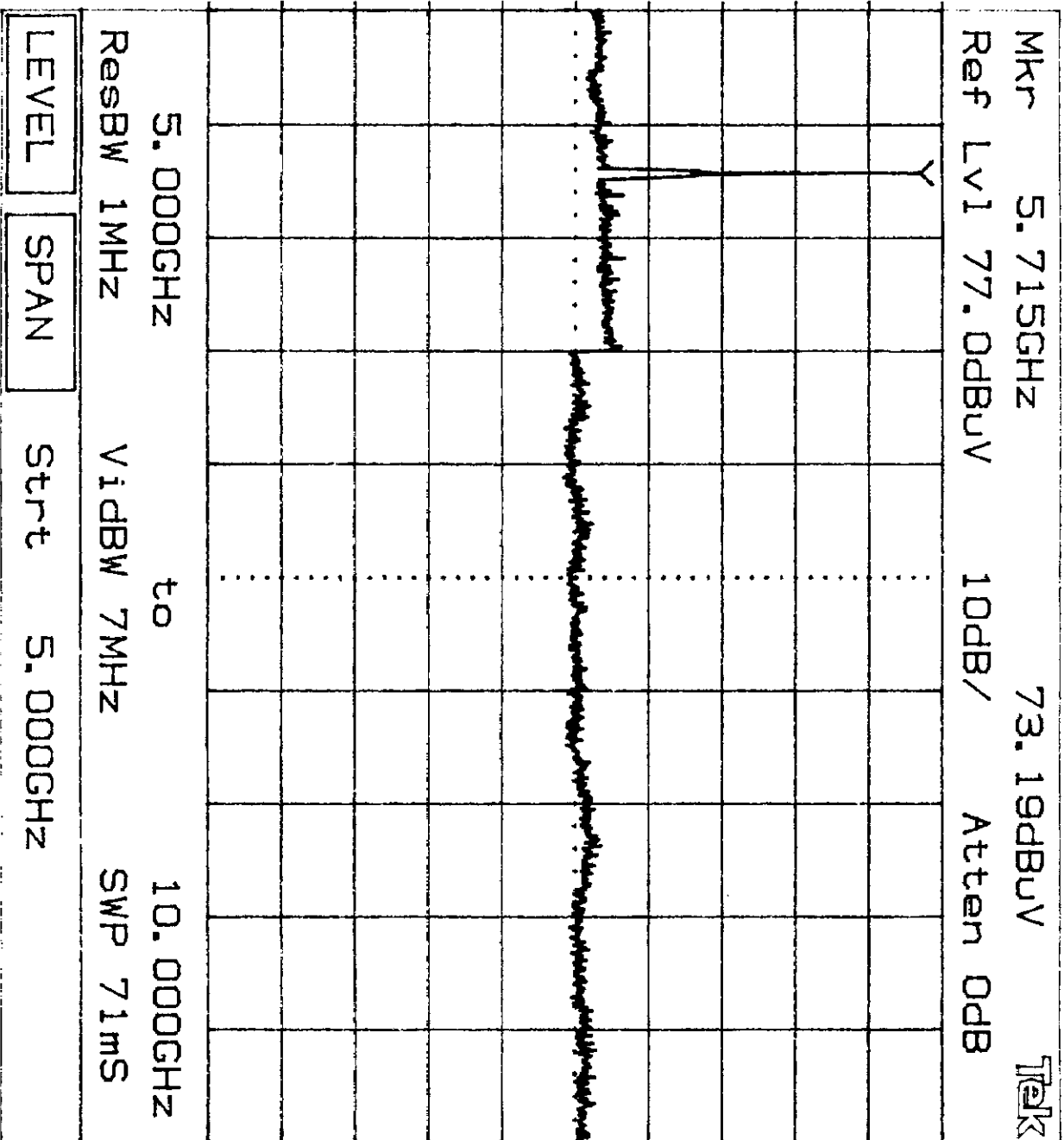
461

APPROXIMATELY 617 272840120 ON CPE



KNOB 2 KNOB 1 KEYPAD Tektronix 2784

462



KN0B 2

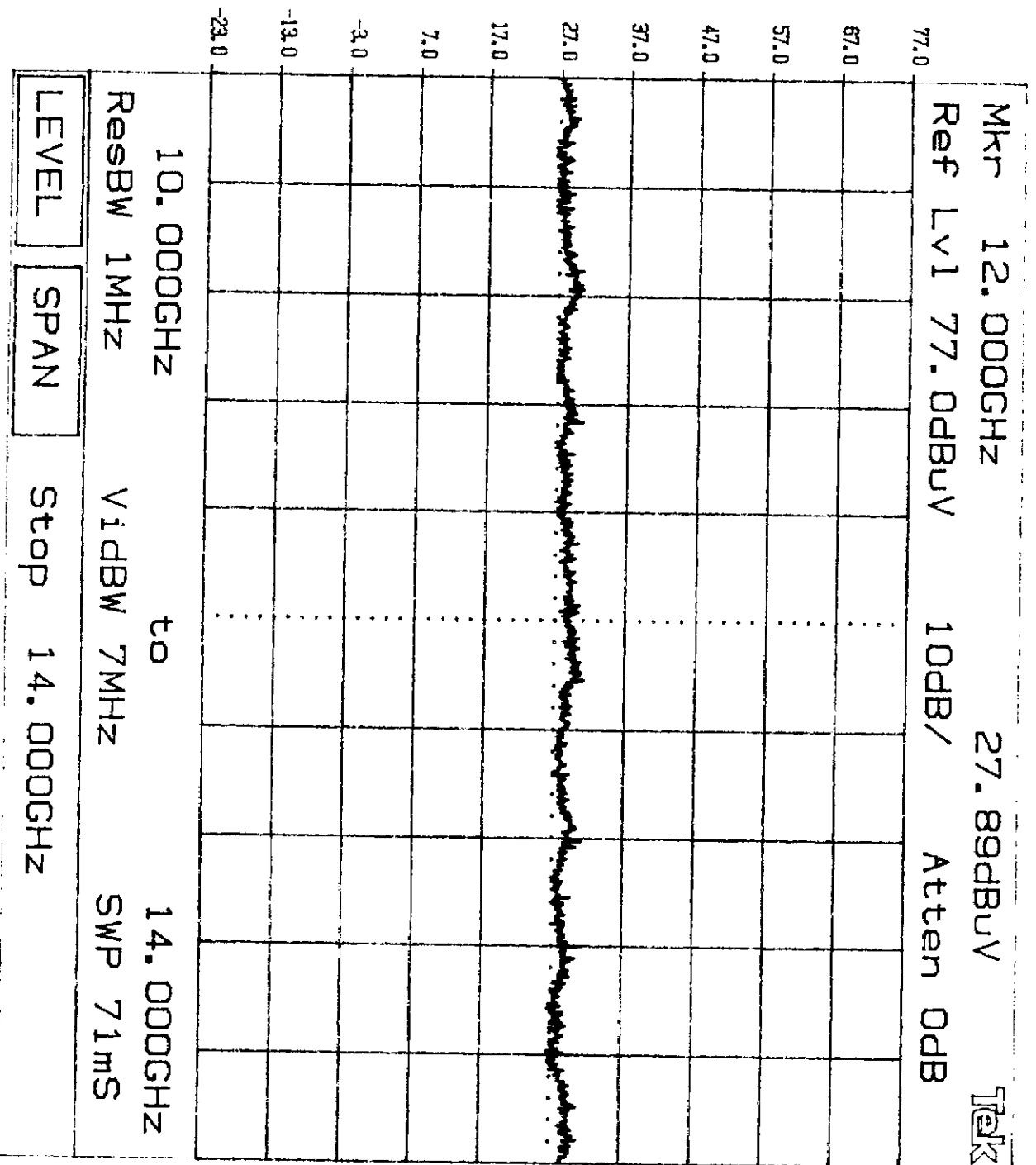
KN0B 1

KEYPAD

Takttronix

2784

463



KN0B 2

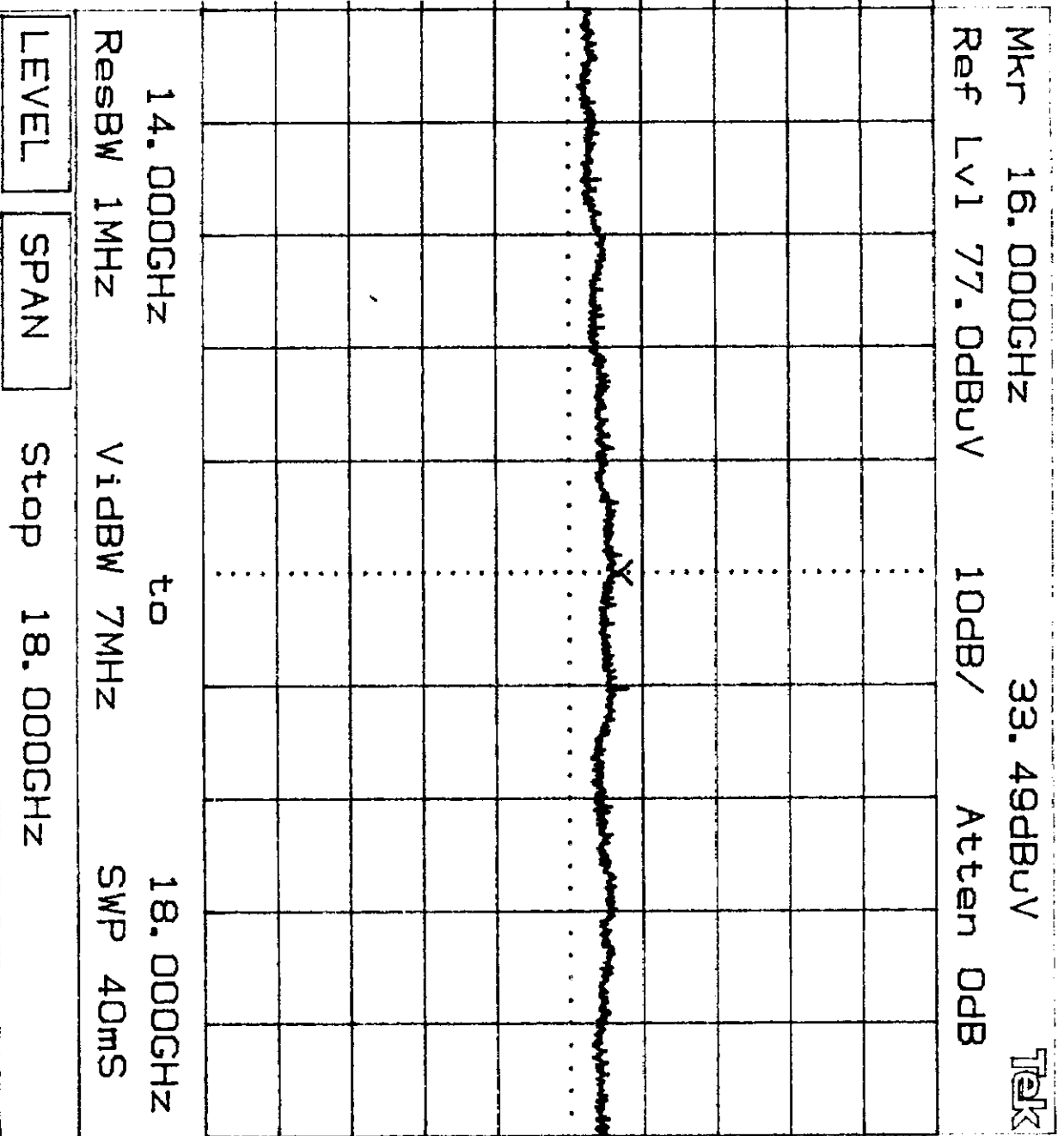
KN0B 1

KEYPAD

Tektronix

2784

464



KN0B 2

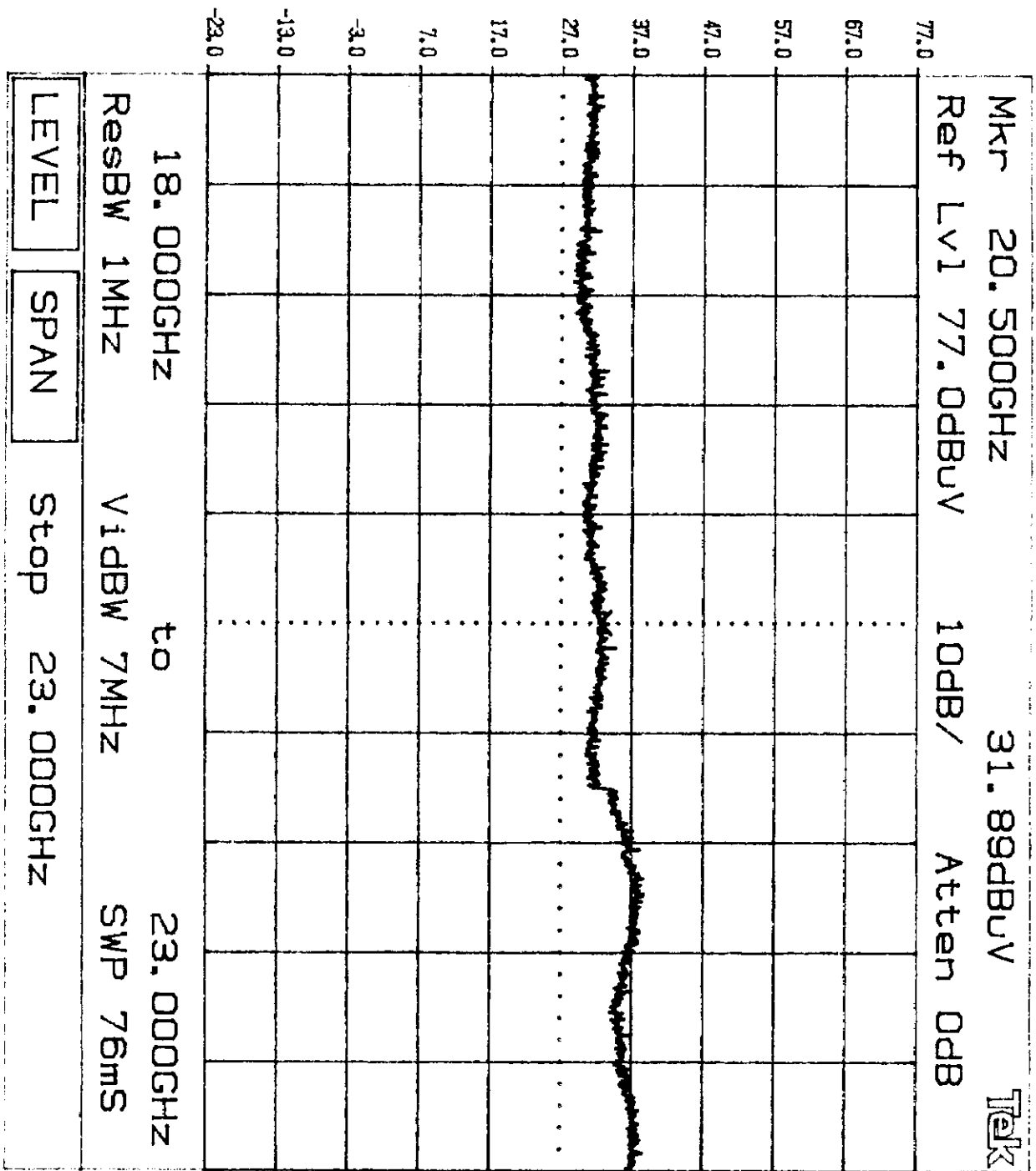
KN0B 1

KEYPAD

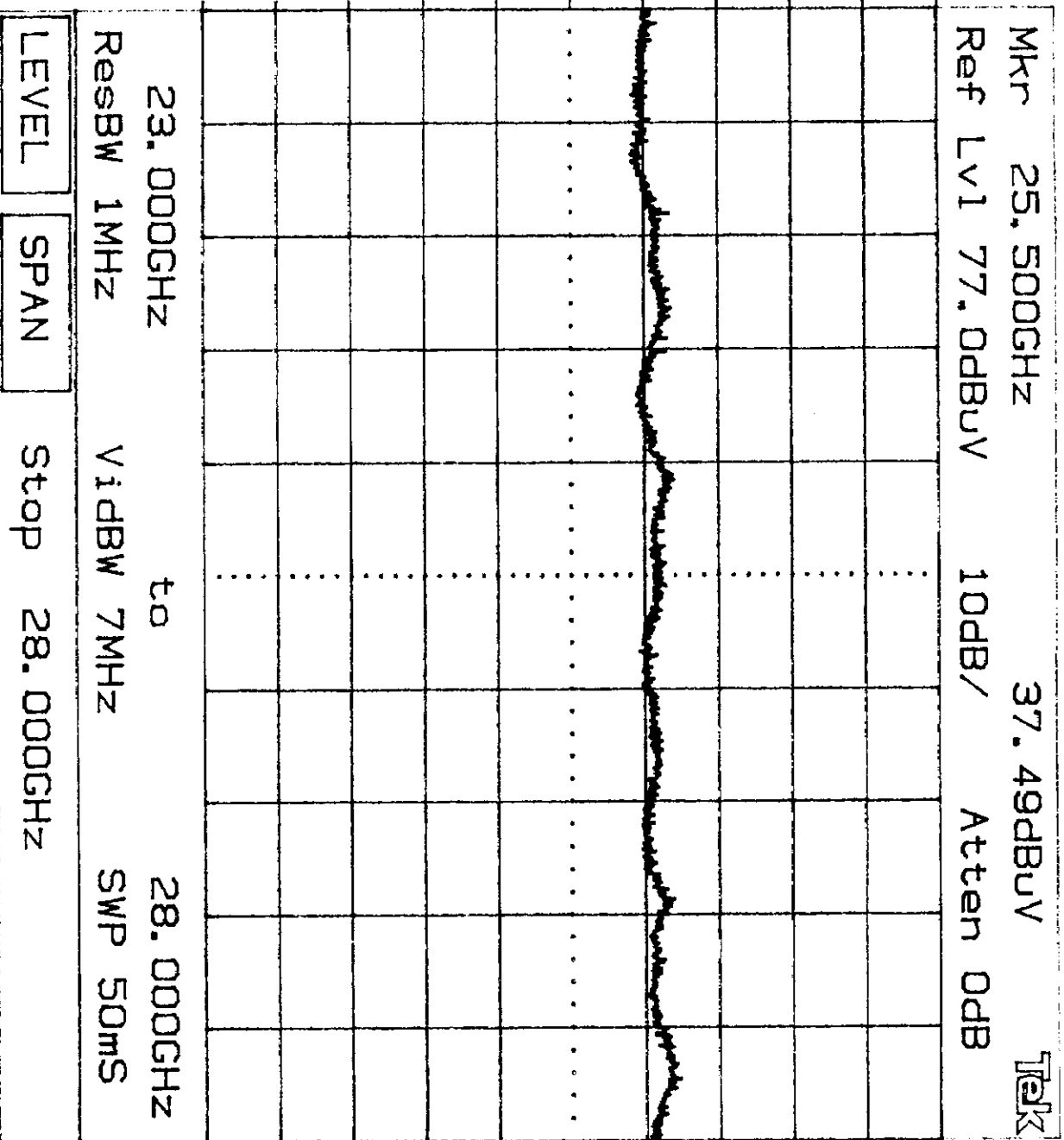
Tektronix

2784

465



466



KN0B 2

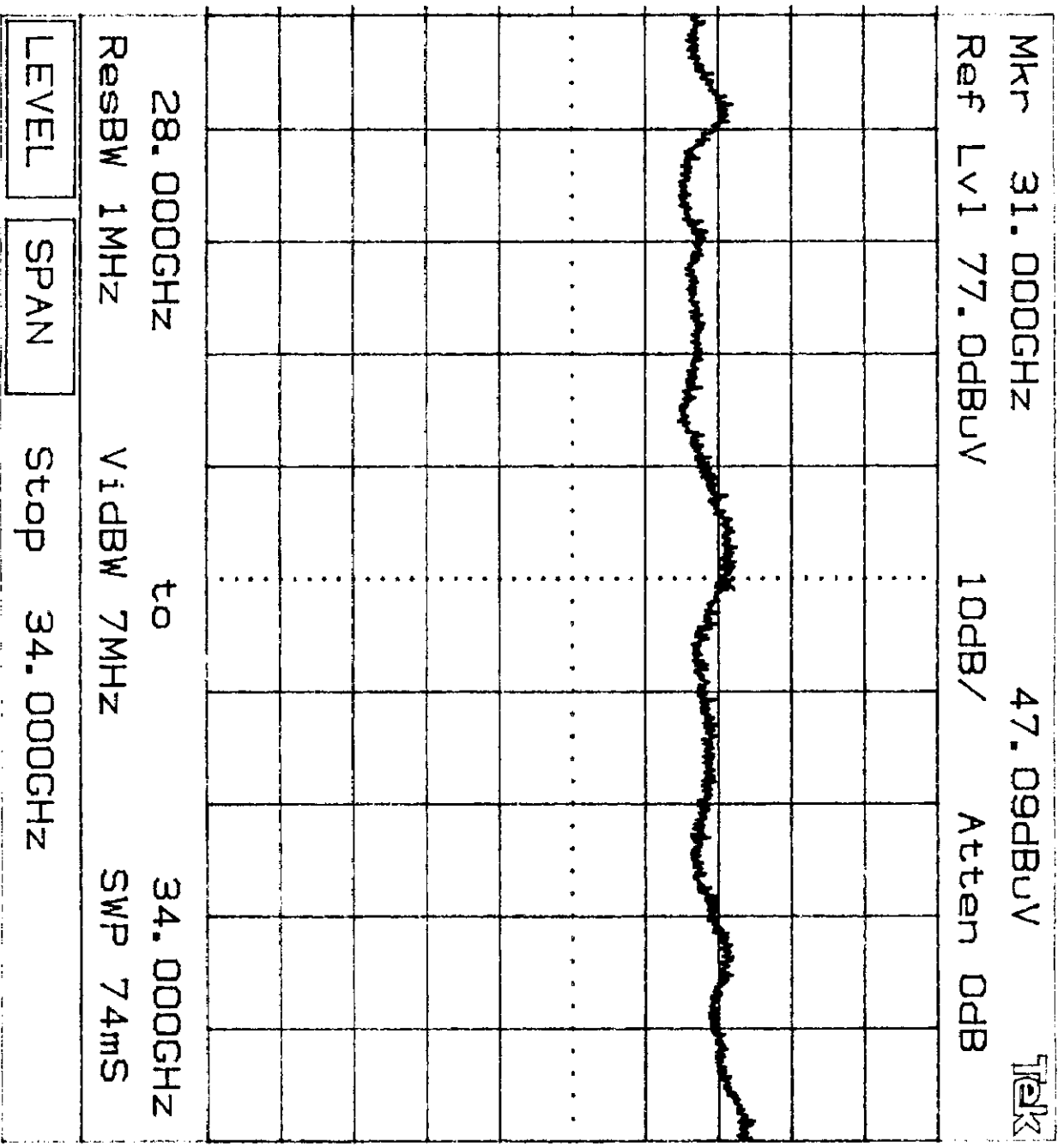
KN0B 1

KEYPAD

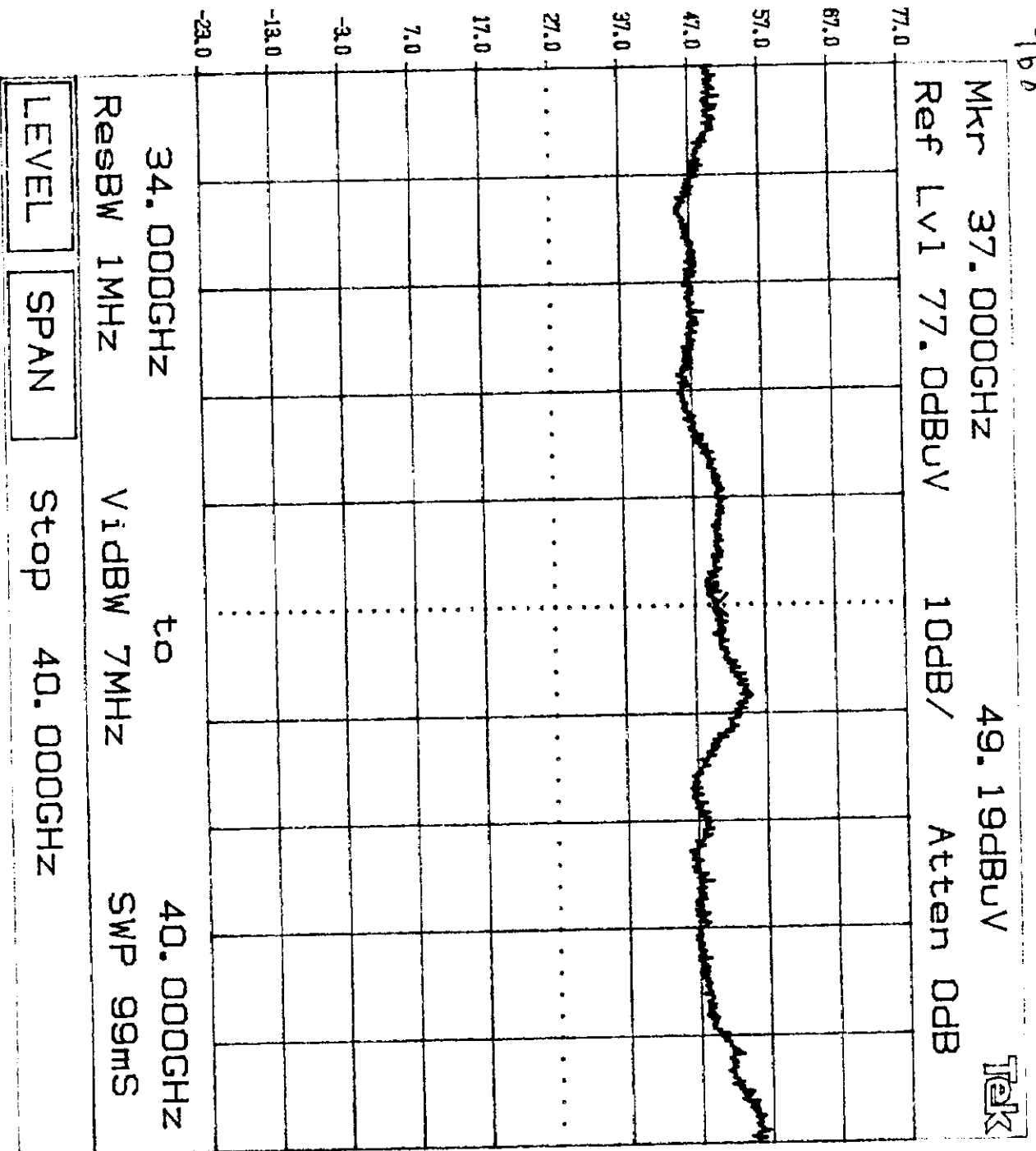
Tektronix

2784

467



468



Knob 2 Knob 1 Keypad Tektronix 2784

Intertek Testing Services

Radiated Emissions / Interference

Table: C

Company: Wireless Bypass

Model: DL-5800C

Job No.: J20046196

Date: 06/15/01

Standard: FCC15

Class: A

Group: None

Notes: Gabriel Flat panel on CPE p-p

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

Antenna: LOG1

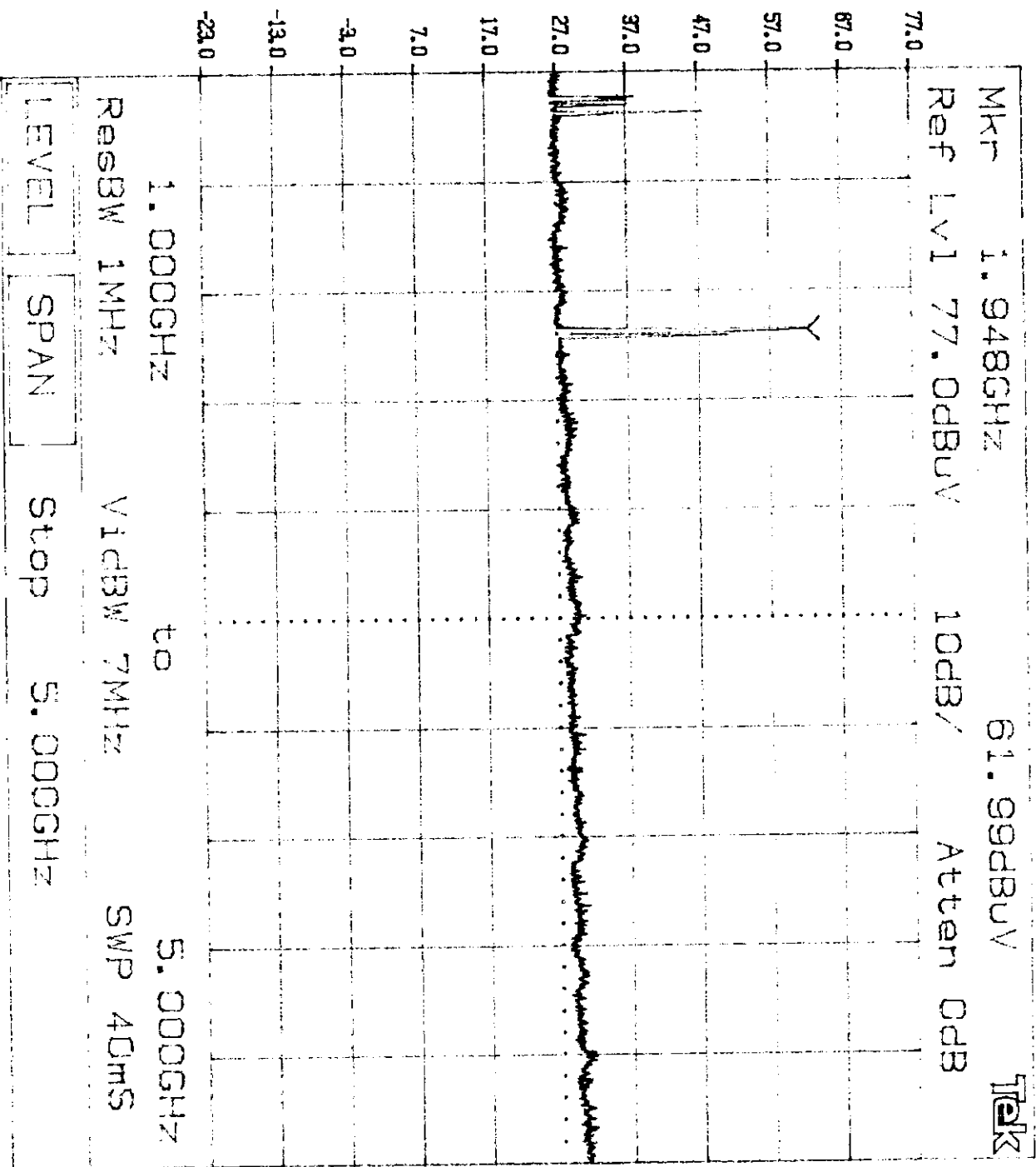
PreAmp: 0

Cable(s): 1C, 3 METER, PRIMAR

Distance: 3 meters

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	43.520	19.5	11.1	0.8	0.0	0.0	31.3	40.0	-8.7
V	45.680	19.8	10.2	0.8	0.0	0.0	30.9	40.0	-9.1
V	74.630	21.8	6.4	0.9	0.0	0.0	29.1	40.0	-10.9
V	86.070	19.6	6.8	1.2	0.0	0.0	27.6	40.0	-12.4
V	108.800	20.2	7.3	1.3	0.0	0.0	28.7	43.5	-14.8
V	121.800	17.1	6.7	1.3	0.0	0.0	25.1	43.5	-18.4
V	135.800	16.5	7.1	1.4	0.0	0.0	25.1	43.5	-18.4

4c1



Knob 2 Knob 1 Keypad Tektronix 2784

Mkr 5.715GHz

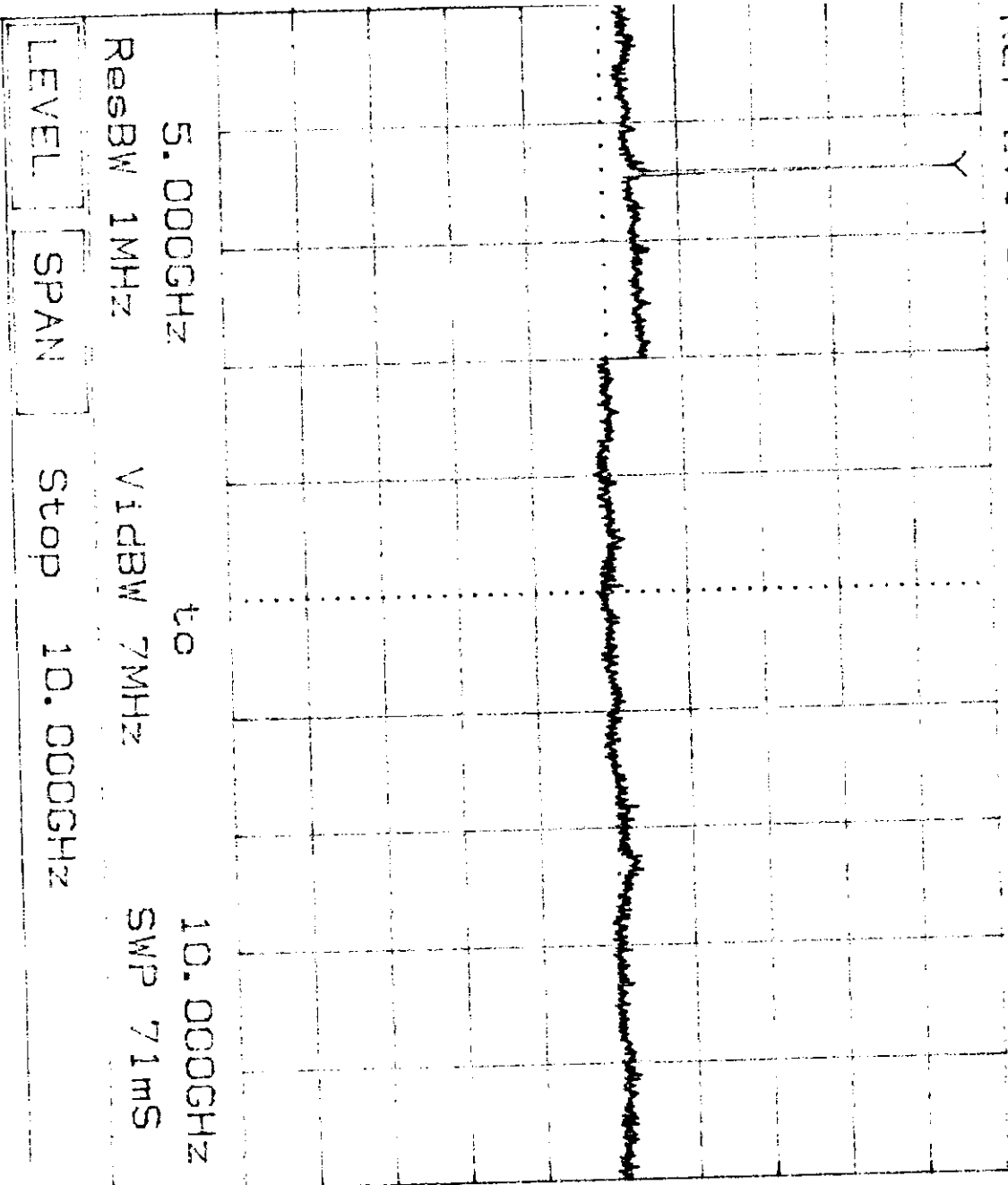
82.29dBV

Tek

Ref Lvl 87.0dBV

10dB/

Atten 10dB



5.000GHz

to

10.000GHz

ResBW 1MHz

VideoBW 7MHz

SWP 71ms

LEVEL

SPAN

Stop

10.000GHz

KN0B 2

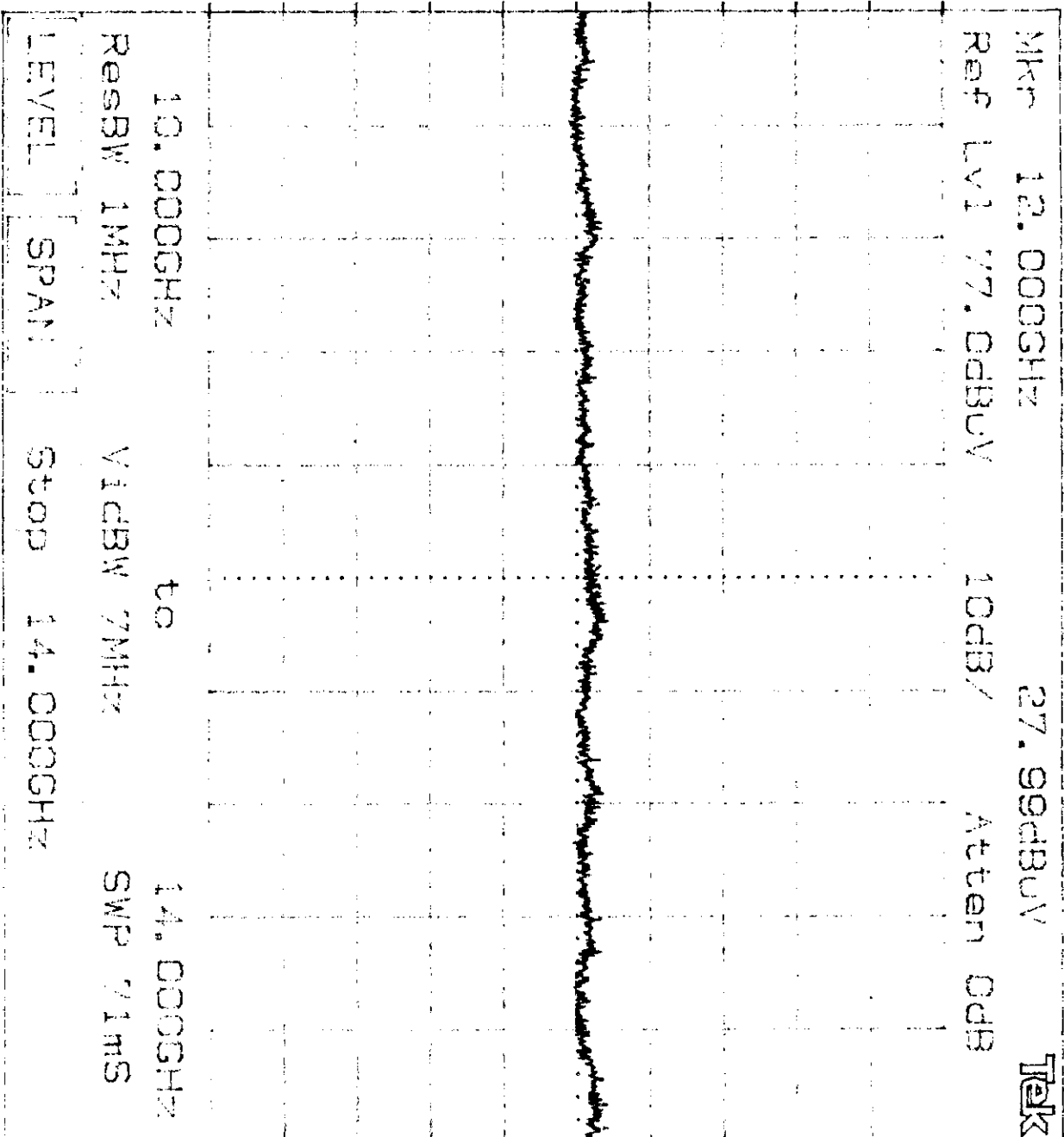
KN0B 1

KEYPAD

Tektronix

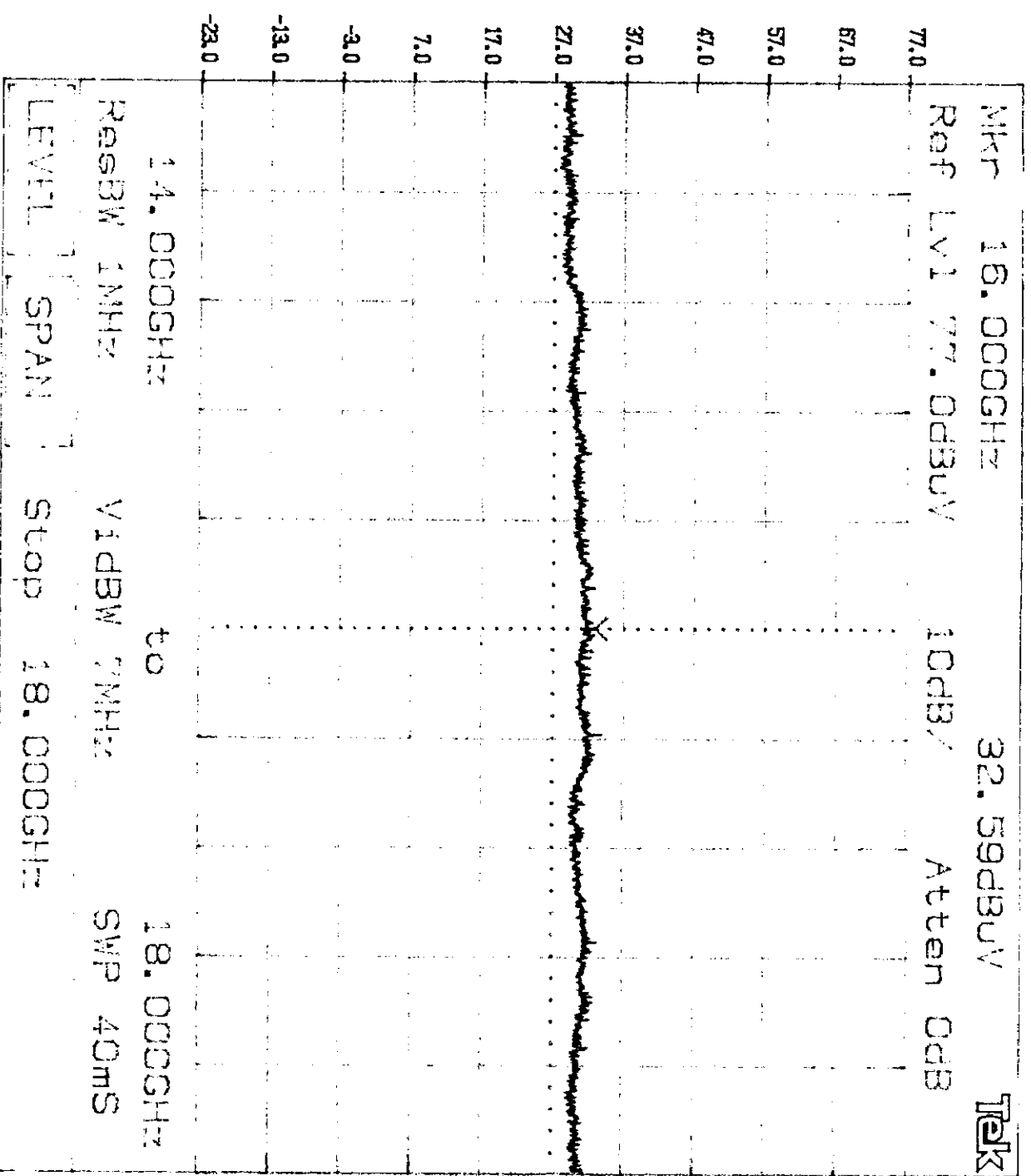
2784

4.3



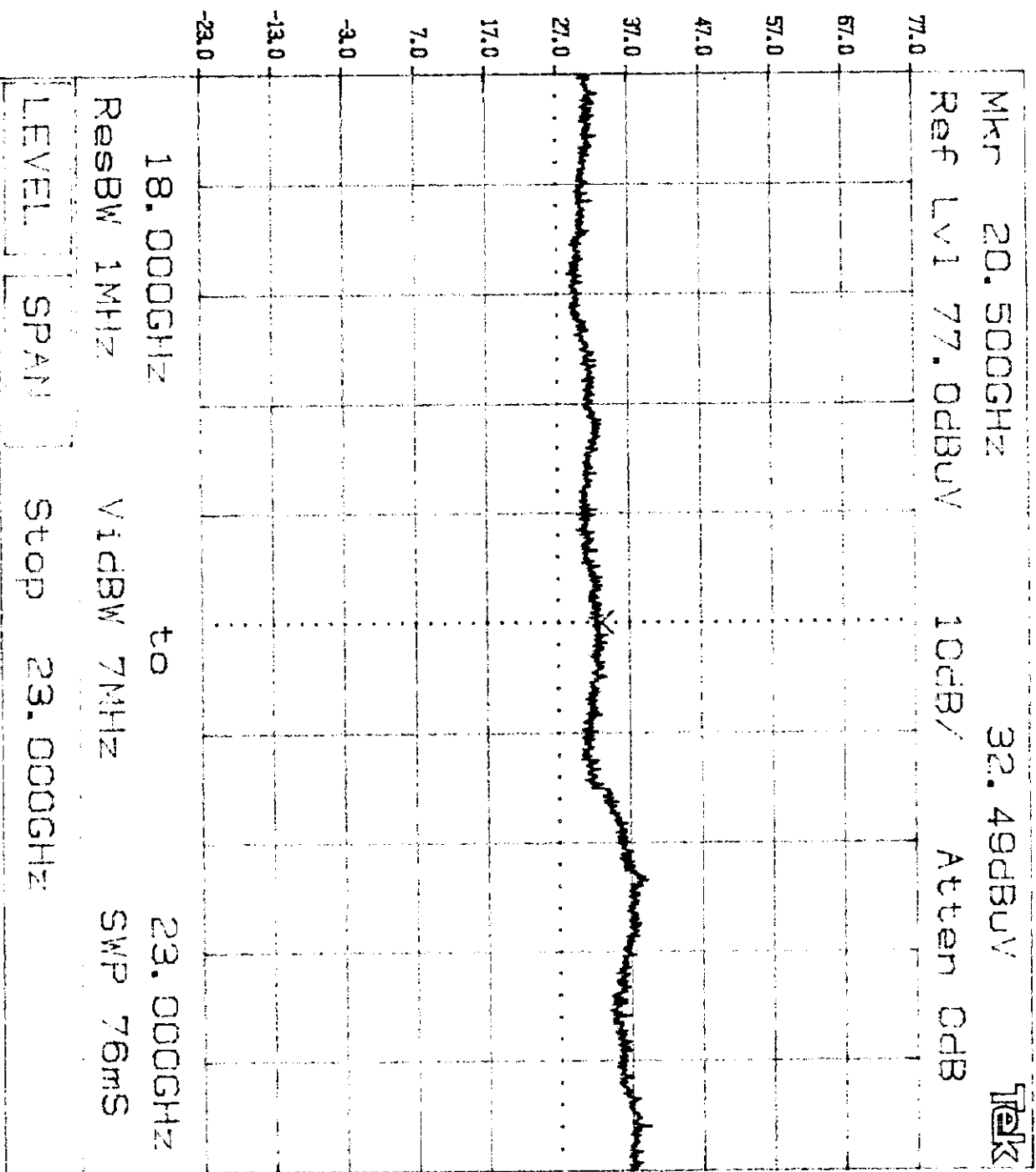
KNOB 2 KNOB 1 KEYPAD Tektronix 2784

4c4



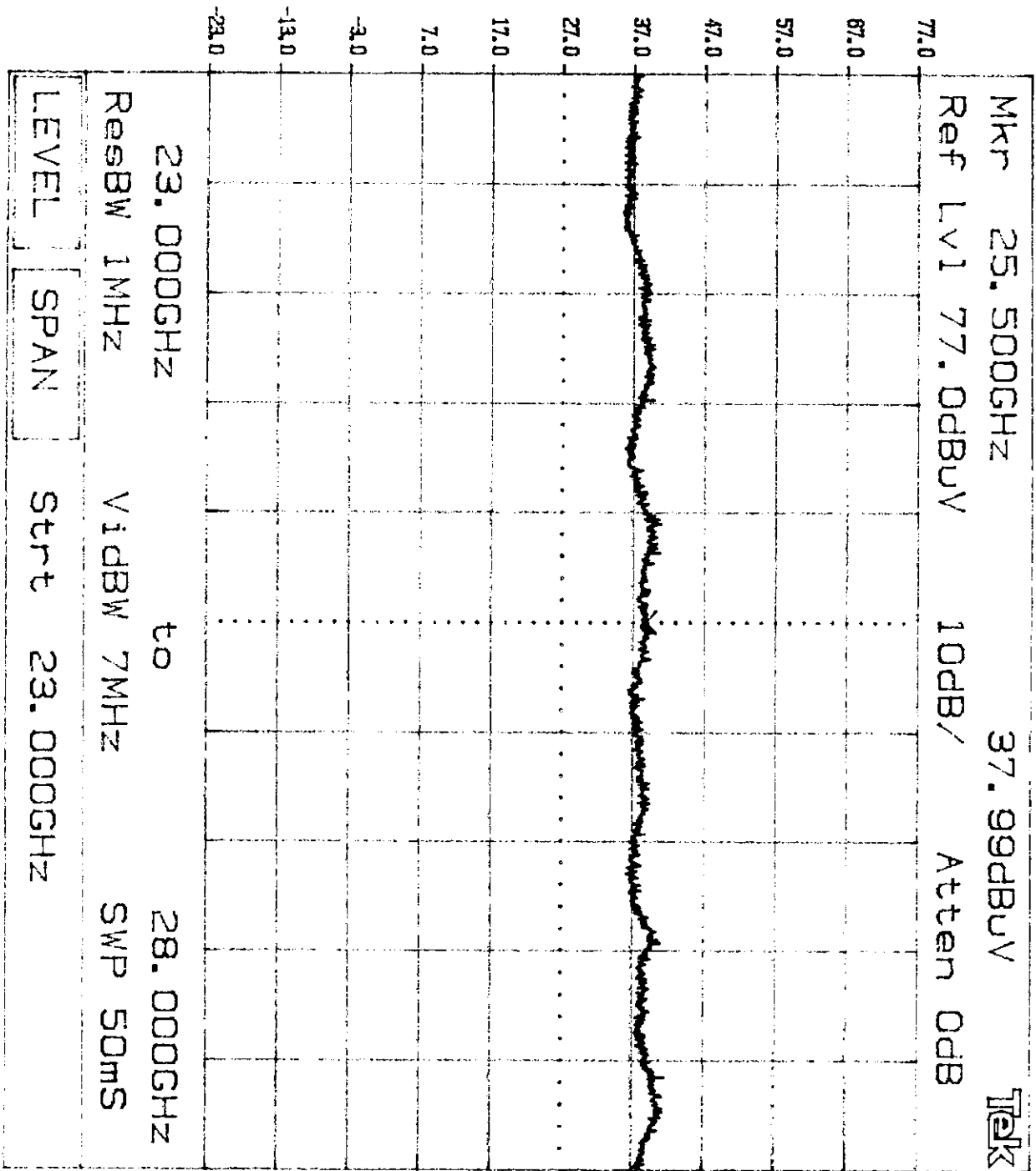
Knob 2 Knob 1 Keypad Tektronix 2784

4.5



Knob 2 Knob 1 Keypad Tektronix 2784

4.6



KNOB 2

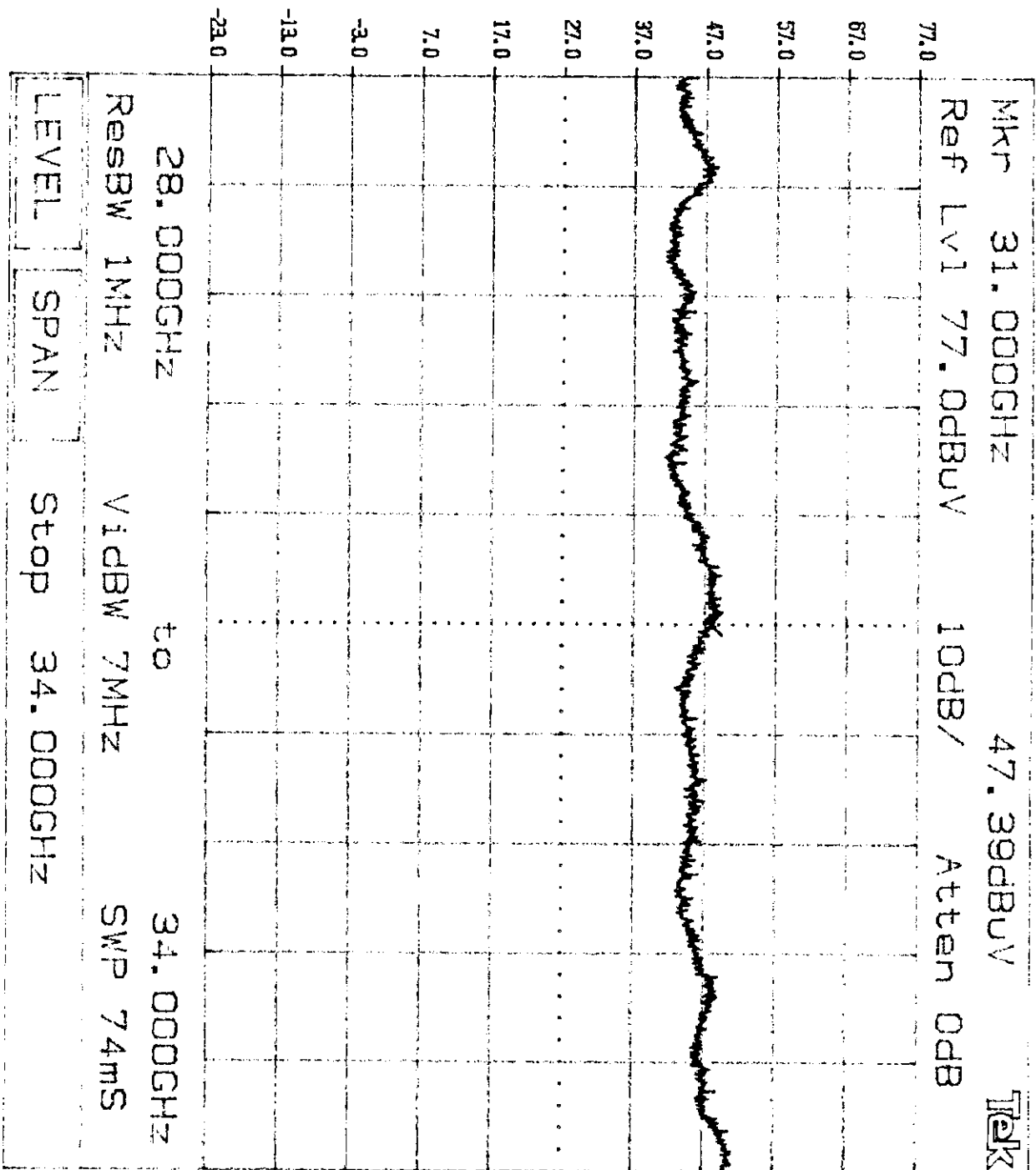
KNOB 1

KEYPAD

Tektronix

2784

4.7



KN0B 2

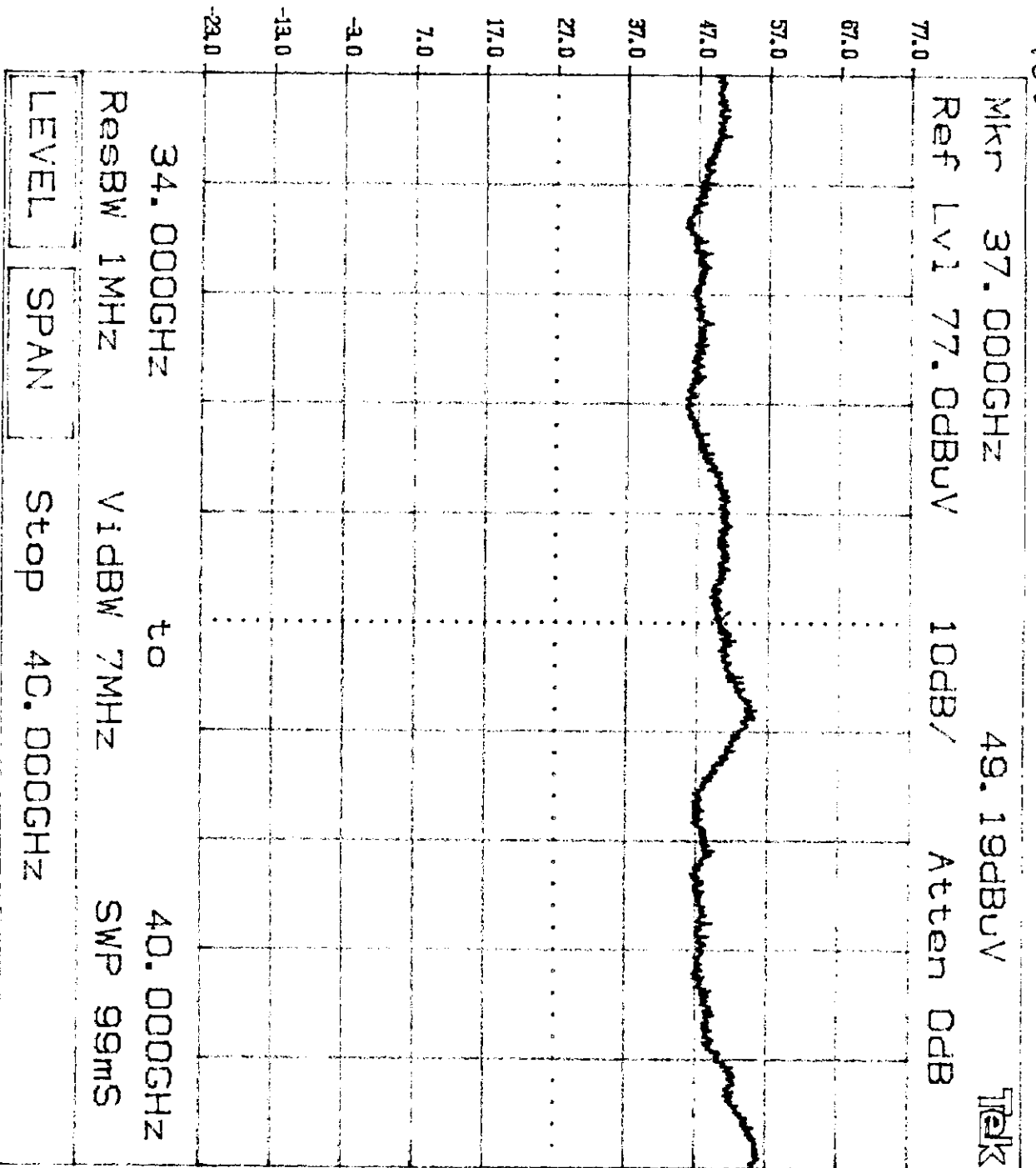
KN0B 1

KEYPAD

Tektronix

2784

4c8



KNOB 2

KNOB 1

KEYPAD

Tektronix

2784

Intertek Testing Services

Radiated Emissions / Interference

Table: D

Company: Wireless Bypass

Model: DL-5800C

Job No.: J20046196

Date: 06/14/01

Standard: FCC15

Class: A

Group: None

Notes: Gabriel Flat Panel Antenna on CPE p-mp

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

Antenna: LOG1

PreAmp: 0

Cable(s): 1C, 3 METER, PRIMAR

Distance: 3 meters

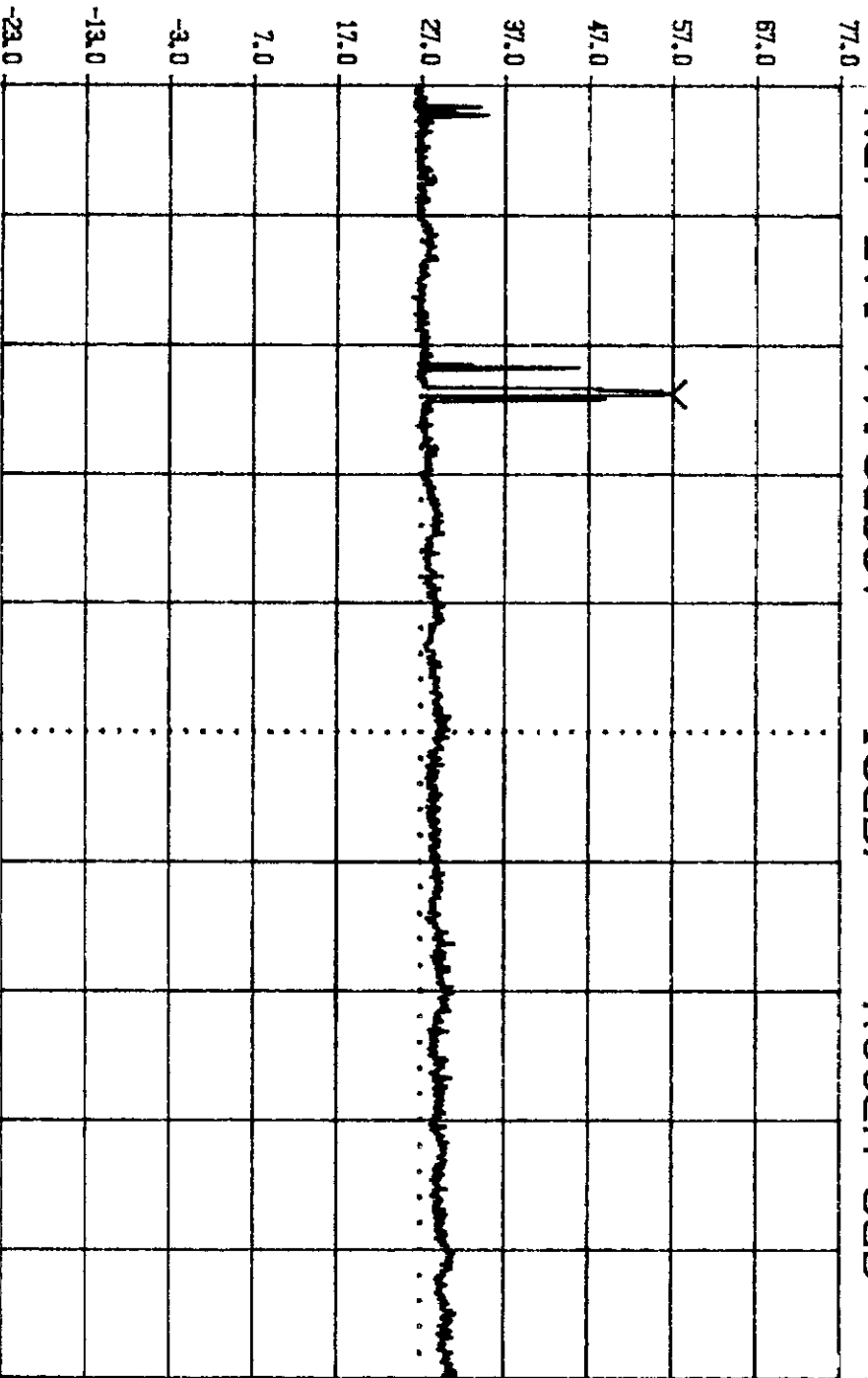
Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	40.340	20.8	12.3	0.7	0.0	0.0	33.8	40.0	-6.2
V	46.390	16.9	10.0	0.8	0.0	0.0	27.7	40.0	-12.3
V	74.560	18.6	6.4	0.9	0.0	0.0	25.9	40.0	-14.1
V	108.800	21.5	7.3	1.3	0.0	0.0	30.0	43.5	-13.5
V	117.600	18.0	6.8	1.3	0.0	0.0	26.1	43.5	-17.4
V	132.300	15.4	6.9	1.4	0.0	0.0	23.7	43.5	-19.8

421

6.58.24.01 Flat Panel ON CPE Pump

Mkr 1.952GHz 56.19dBuV Tek

Ref Lvl 77.0dBuV 10dB/ Atten 0dB



1.000GHz to 5.000GHz
ResBW 1MHz VidBW 7MHz SWP 40ms

LEVEL

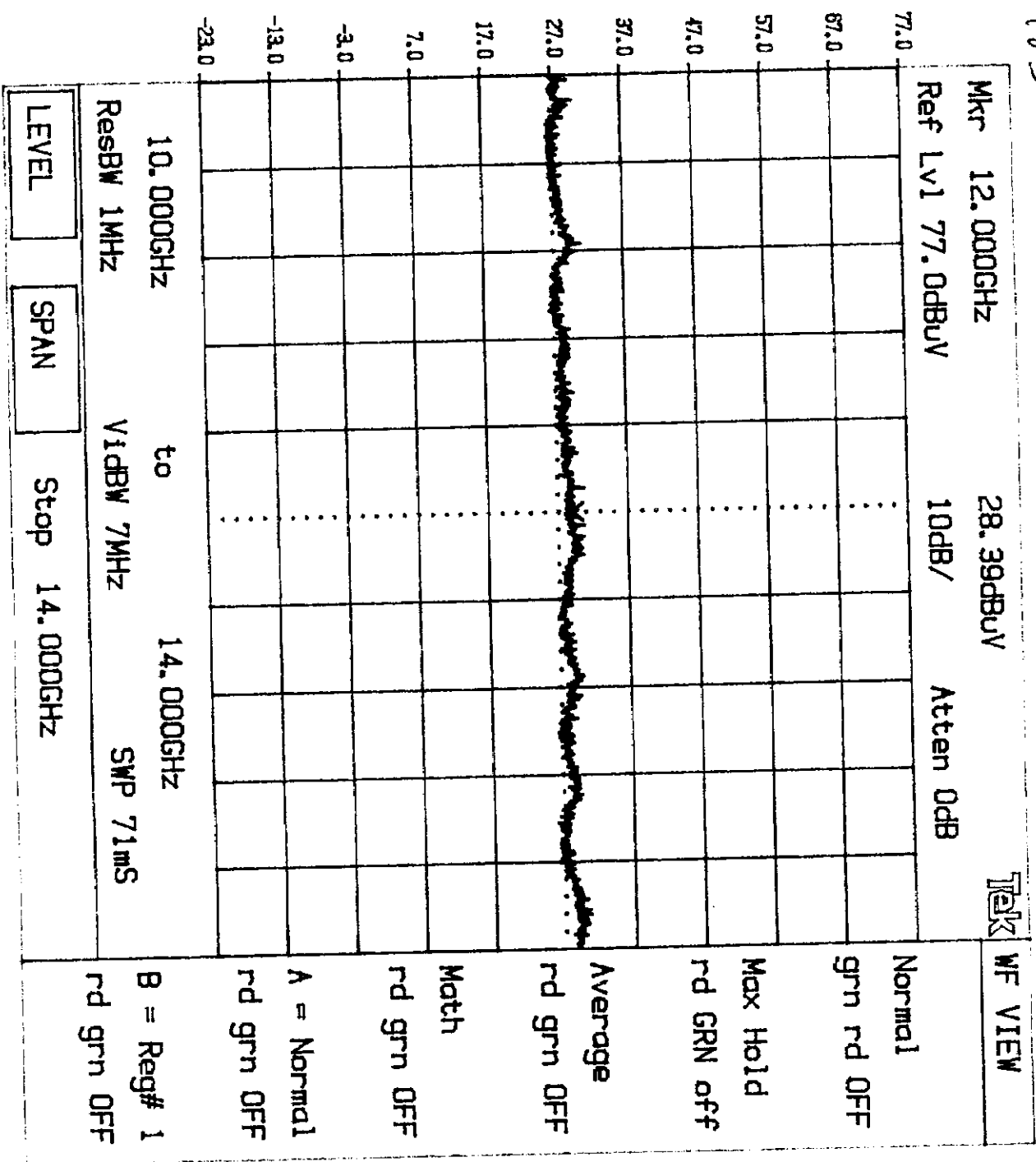
SPAN

Start

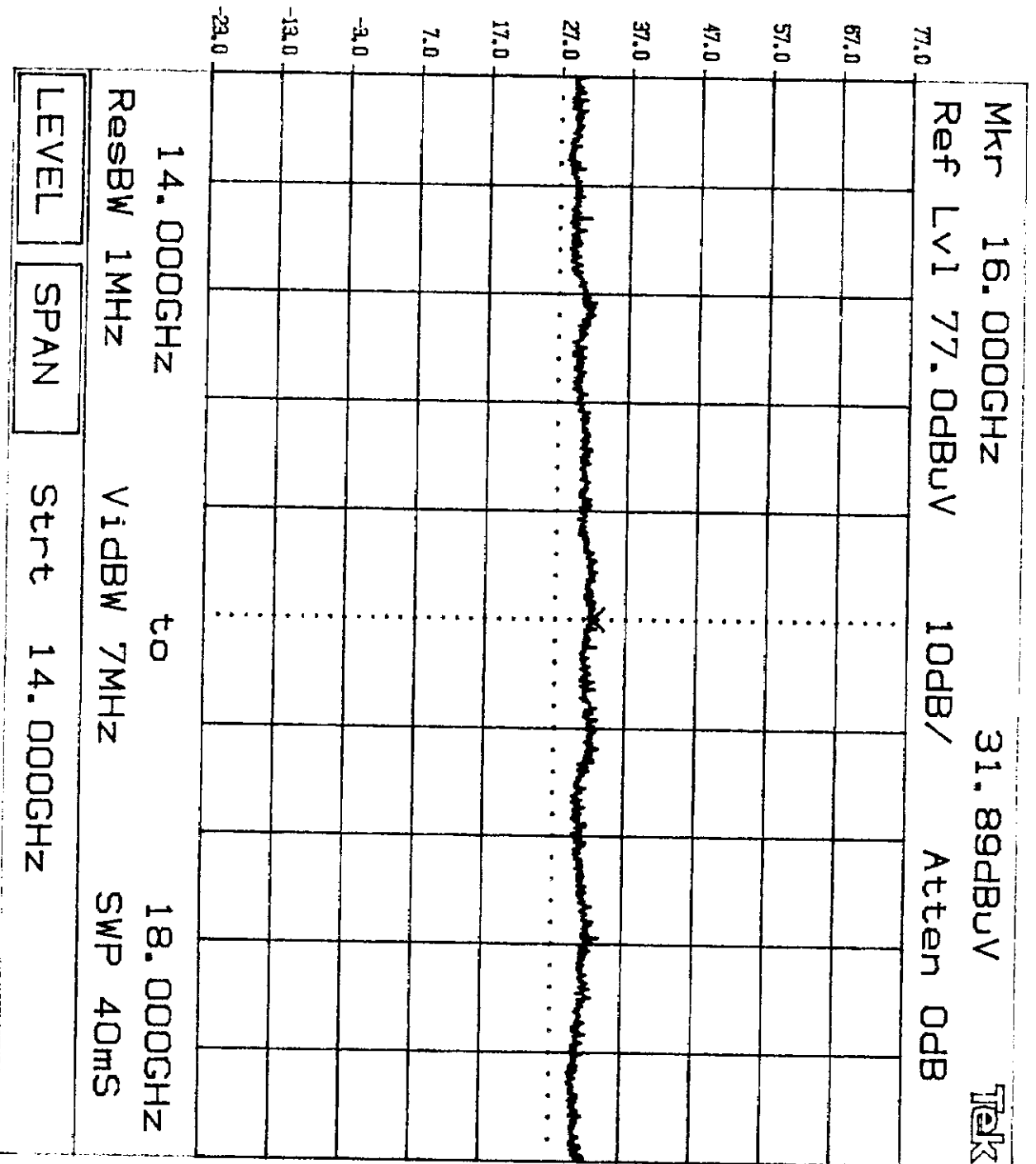
1.000GHz

Knob 2 Knob 1 Keypad Tektronix 2784

403



424



KN0B 2

KN0B 1

KEYPAD

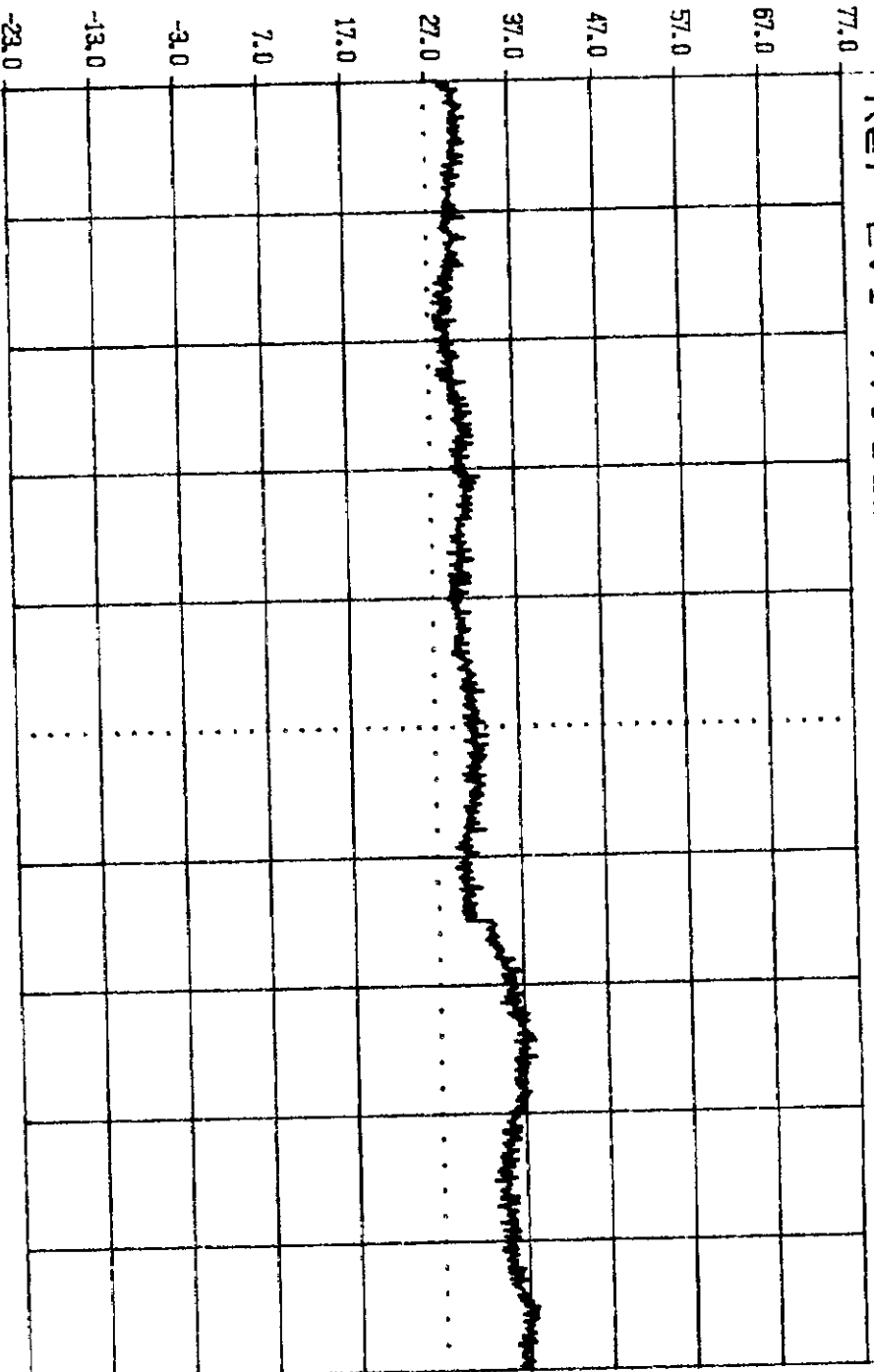
Tektronix

2784

405

Tek

Ref Lvl 77.0dBuV 10dB/ Atten 0dB



18.000GHz

to

23.000GHz

ResBW 1MHz

ViBW 7MHz

SMP 76mS

LEVEL

SPAN

Stop 23.000GHz

Knob 2

Knob 1

Keypad

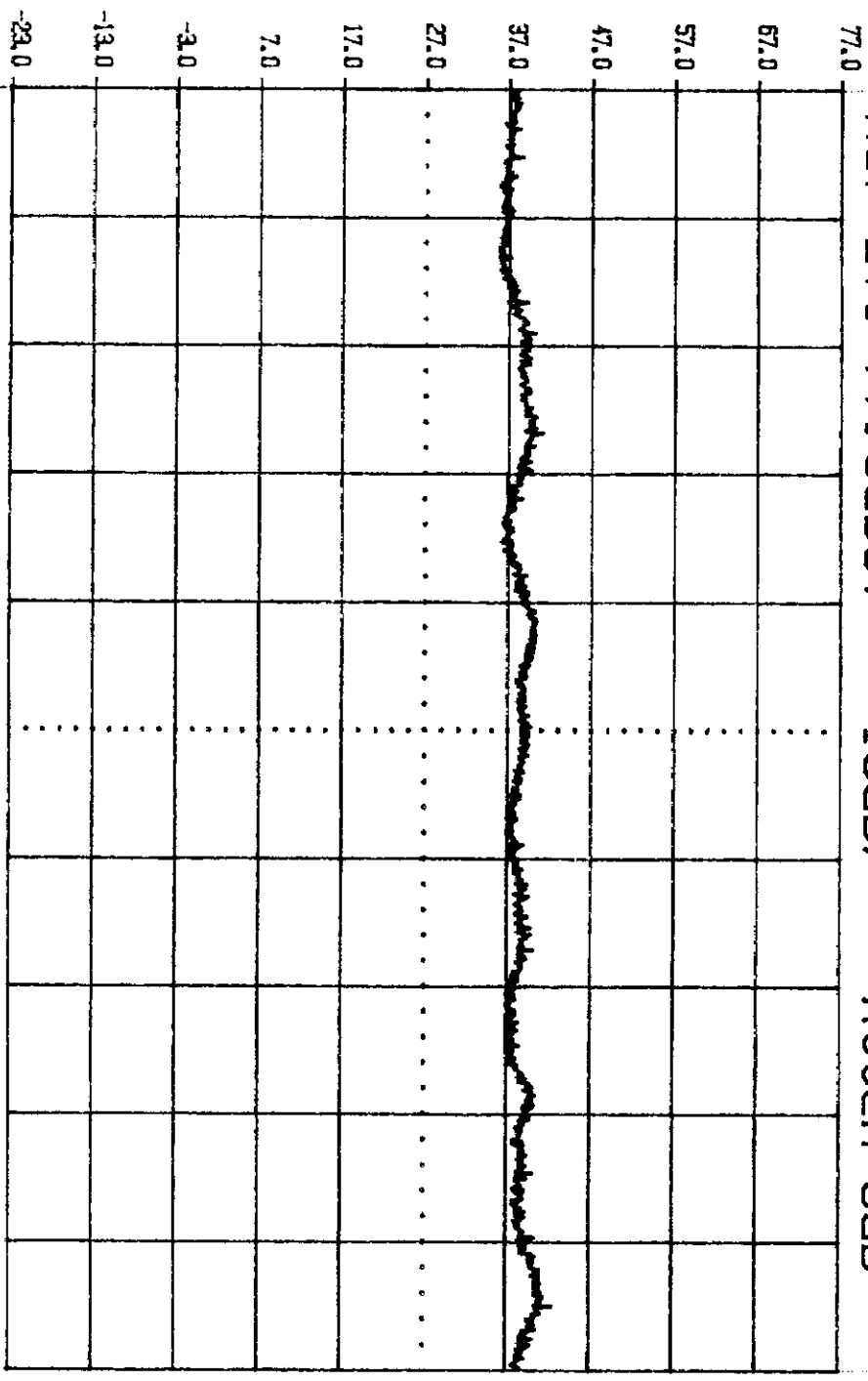
Tektronix

2784

426

Tek

Ref Lvl 77.0dBV 10dB/ Atten 0dB

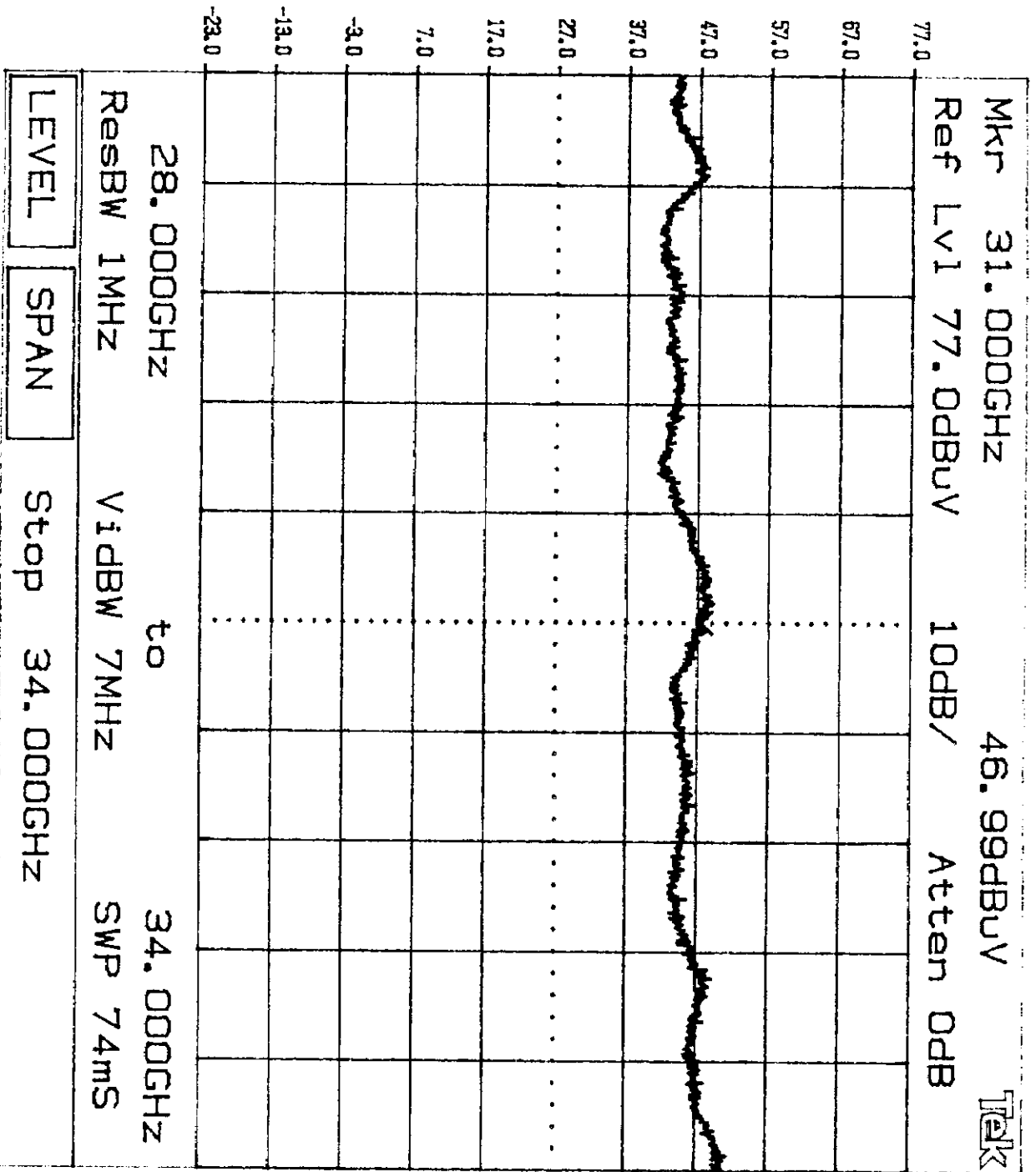


23.000GHz to 28.000GHz
ResBW 1MHz VidBW 7MHz SWP 50ms

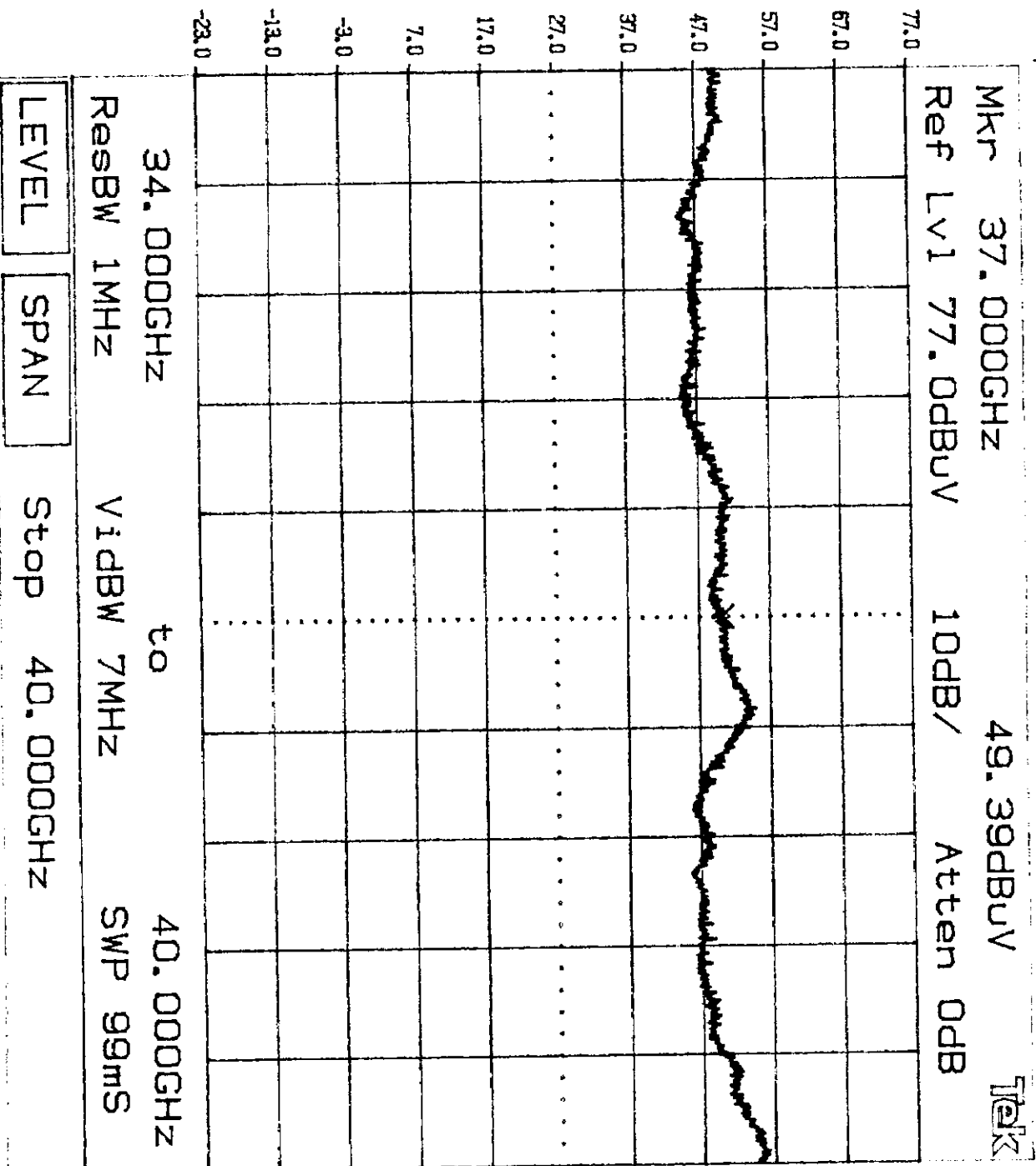
LEVEL SPAN Stop 28.000GHz

KN0B 2 KN0B 1 KEYPAD Tektronix 2784

487



428



Knob 2

Knob 1

Keypad

Tektronix

2784

Intertek Testing Services

Radiated Emissions / Interference

Table: E

Company: Wireless Bypass

Model: DL-5800C

Job No.: J20046196

Date: 05/14/01

Standard: FCC15

Class: A

Group: None

Notes: Cushcraft patch antenna on CPE

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

Antenna: LOG1

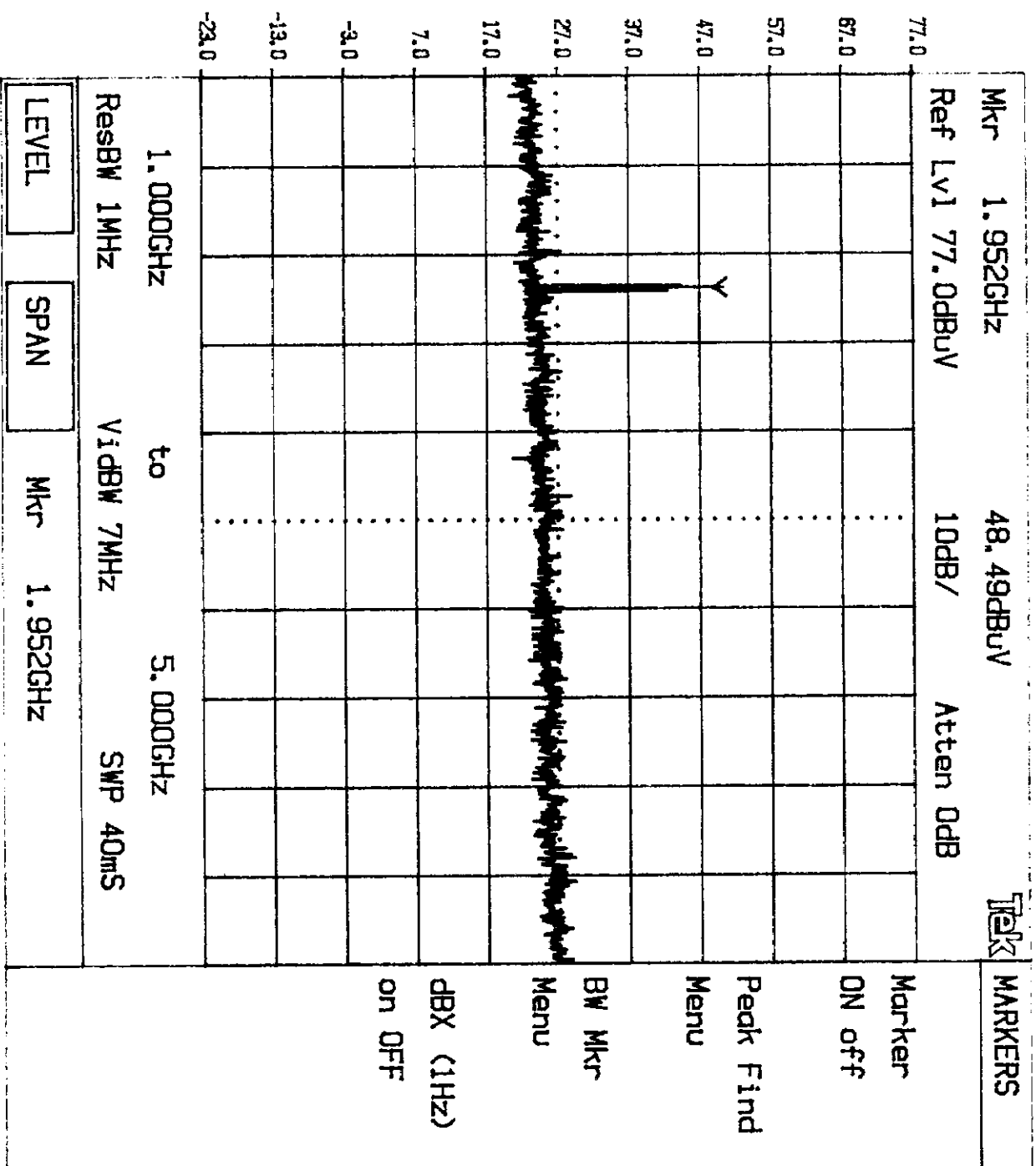
PreAmp: 0

Cable(s): 1C, 3 METER, PRIMAR

Distance: 3 meters

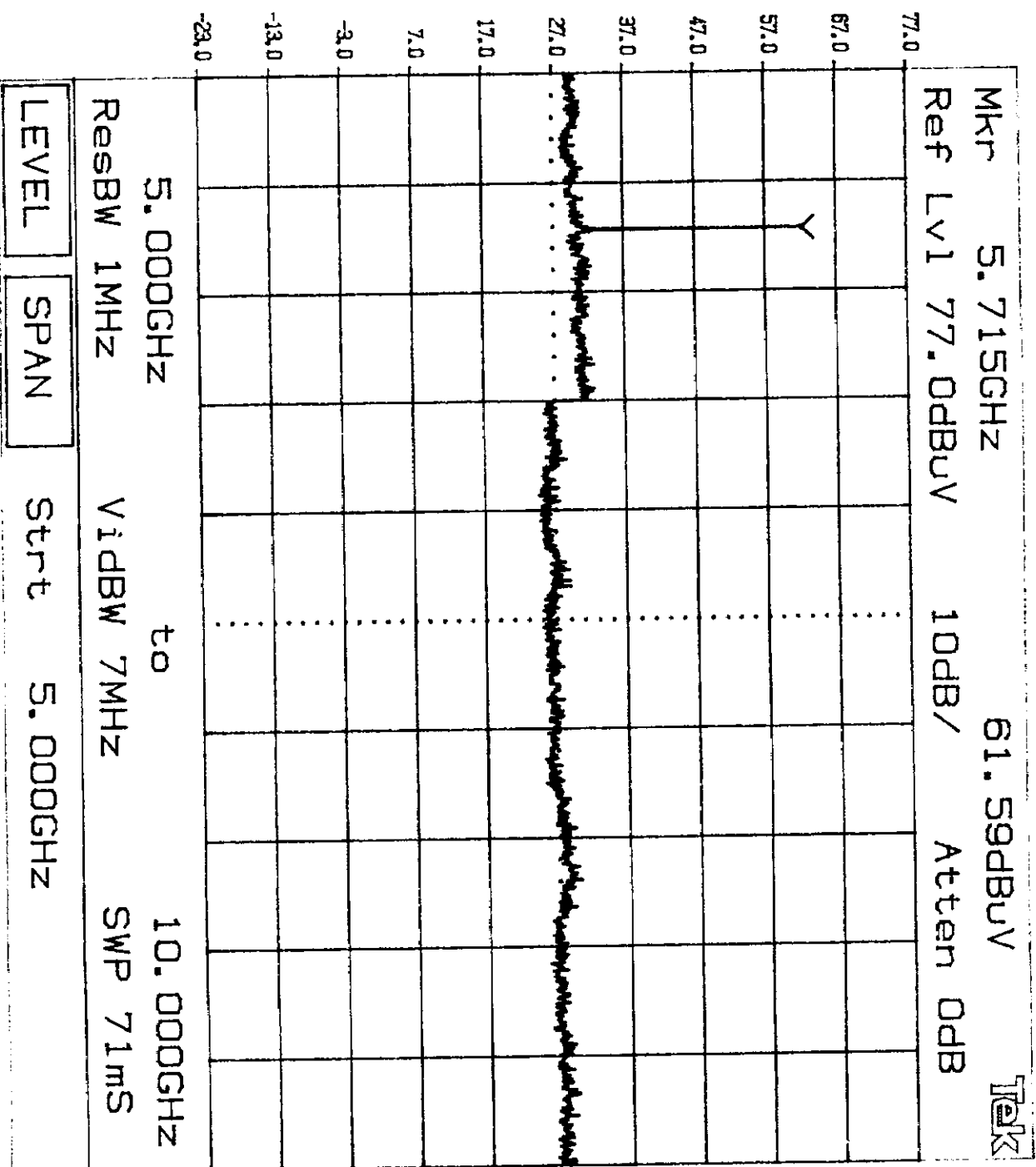
Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	40.340	22.1	12.3	0.7	0.0	0.0	35.1	40.0	-4.9
V	51.020	21.1	8.5	0.9	0.0	0.0	30.5	40.0	-9.5
V	73.970	19.1	6.4	0.9	0.0	0.0	26.4	40.0	-13.6
V	108.800	20.1	7.3	1.3	0.0	0.0	28.6	43.5	-14.9
V	137.700	17.3	7.3	1.4	0.0	0.0	26.0	43.5	-17.5
V	154.900	12.7	8.6	1.5	0.0	0.0	22.8	43.5	-20.7

4e1



Knob 2 Knob 1 Keypad Tektronix 2784

4e2



Knob 2

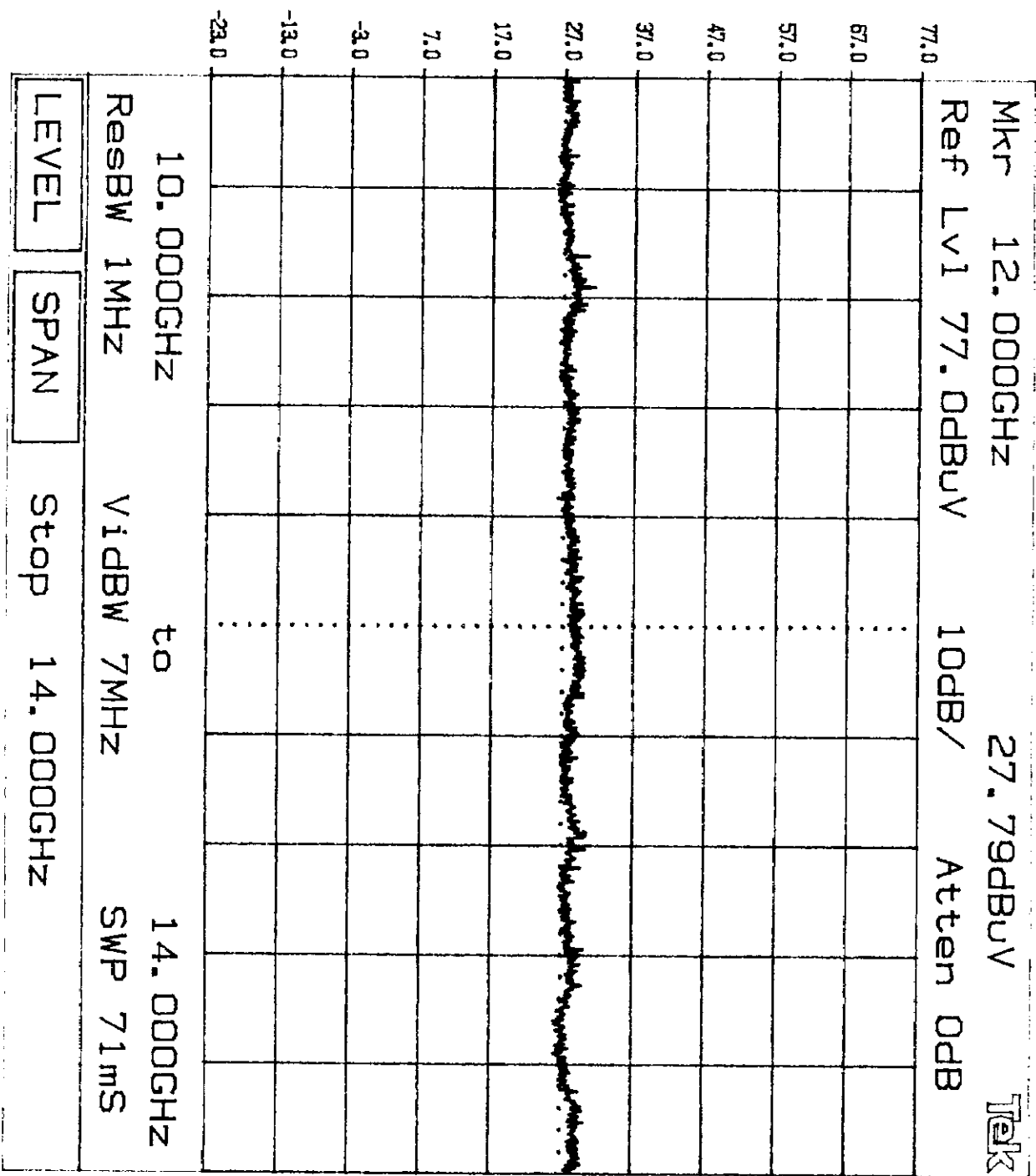
Knob 1

KEYPAD

Tektronix

2784

4e3



Knob 2

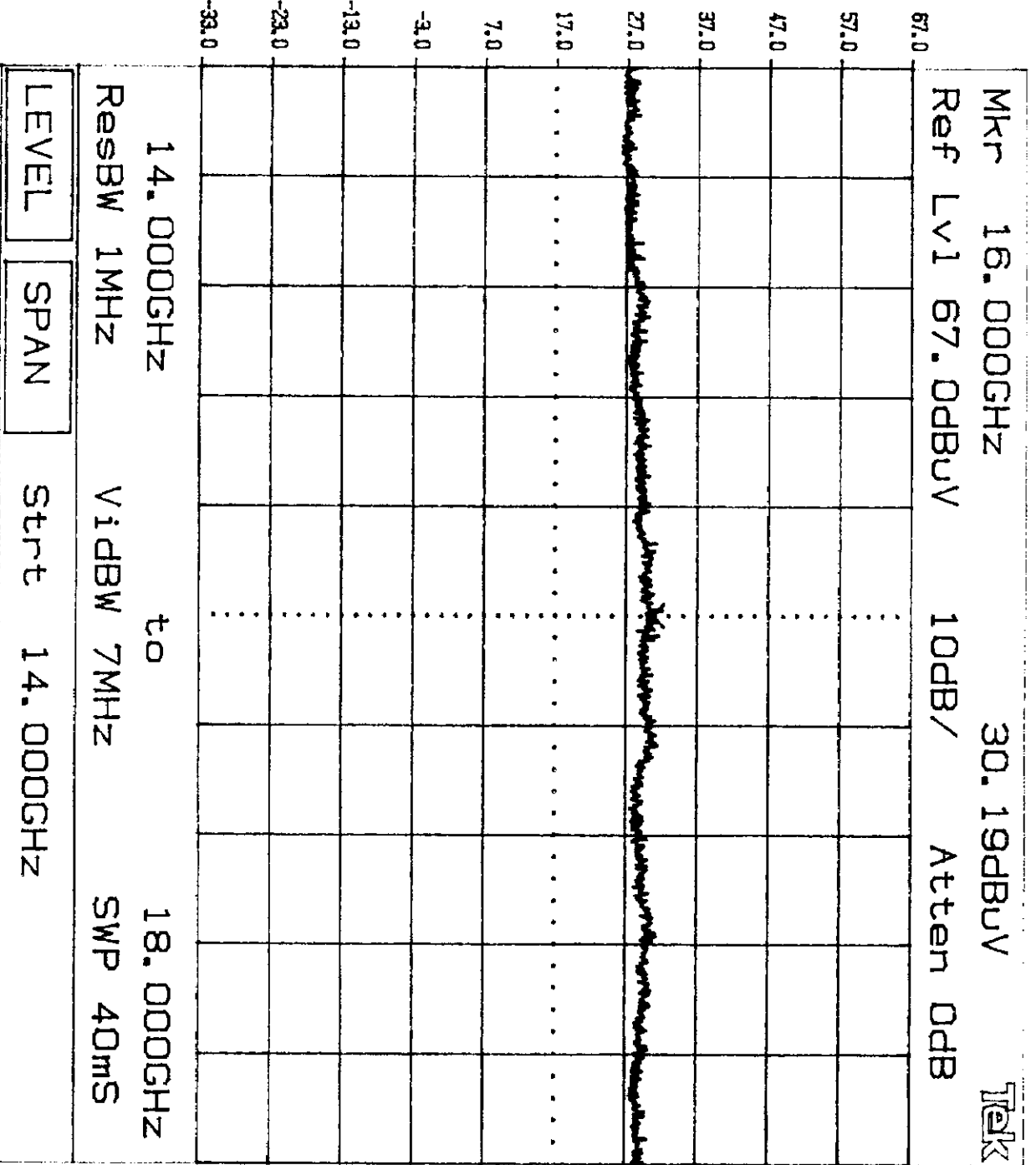
Knob 1

Keypad

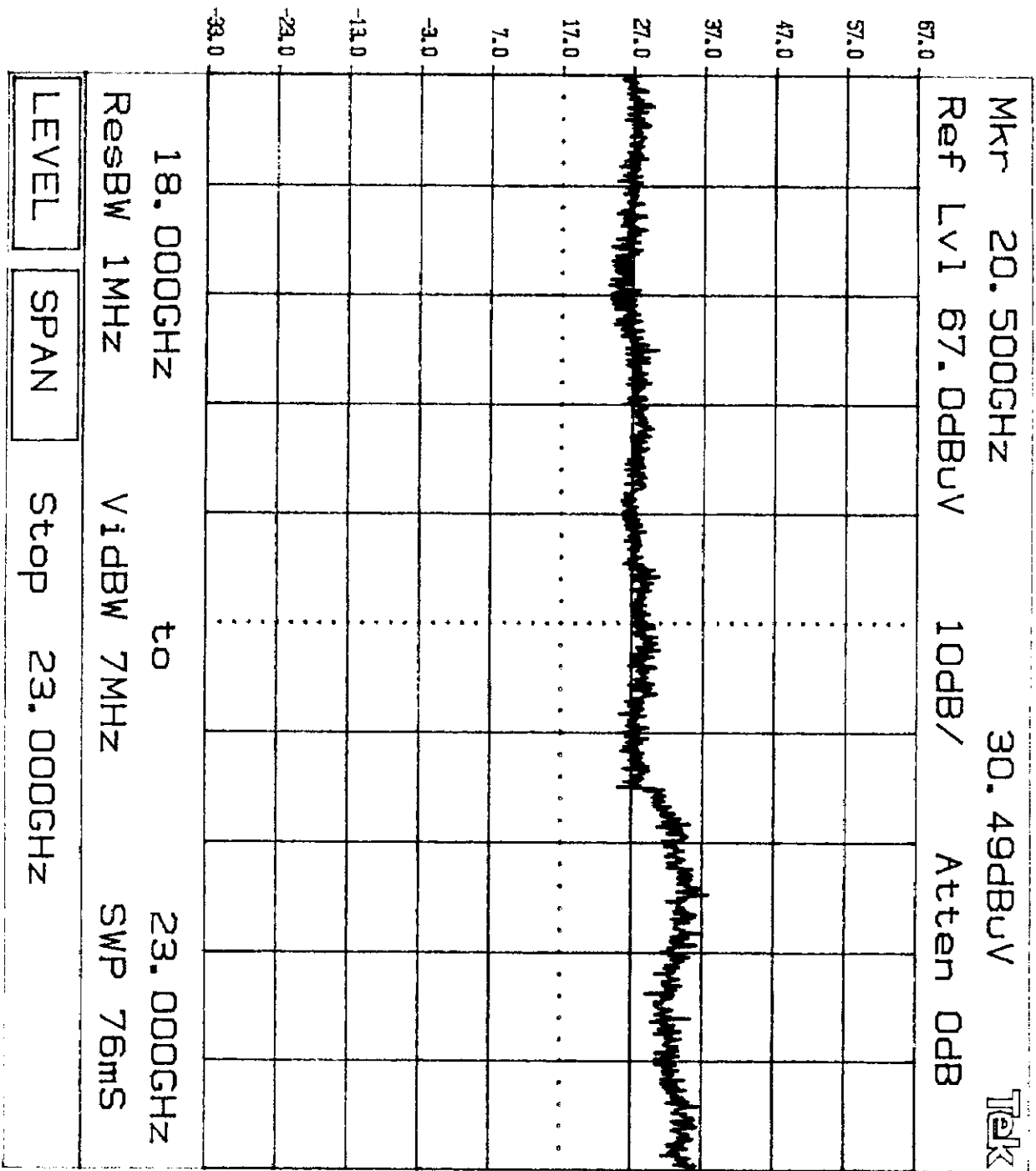
Tektronix

2784

4e4



yes



KN0B 2

KN0B 1

KEYPAD

Tektronix

2784

4e6

MKR 25.500GHz		33.99dBuV		Tek		FREQUENCY
Ref Lvl 67.0dBuV		10dB/		Atten 0dB		
67.0						Set
57.0						Frequency
47.0						Set
37.0						Start Freq
27.0						Set
17.0						Stop Freq
7.0						Configure
-3.0						Freq Menu
-13.0						Step Size
-23.0						Menu
-33.0						

23.000GHz	to	28.000GHz
ResBW 1MHz	VIDBW 7MHz	SWP 50ms
LEVEL	SPAN	Stop 28.000GHz

KNOB 2

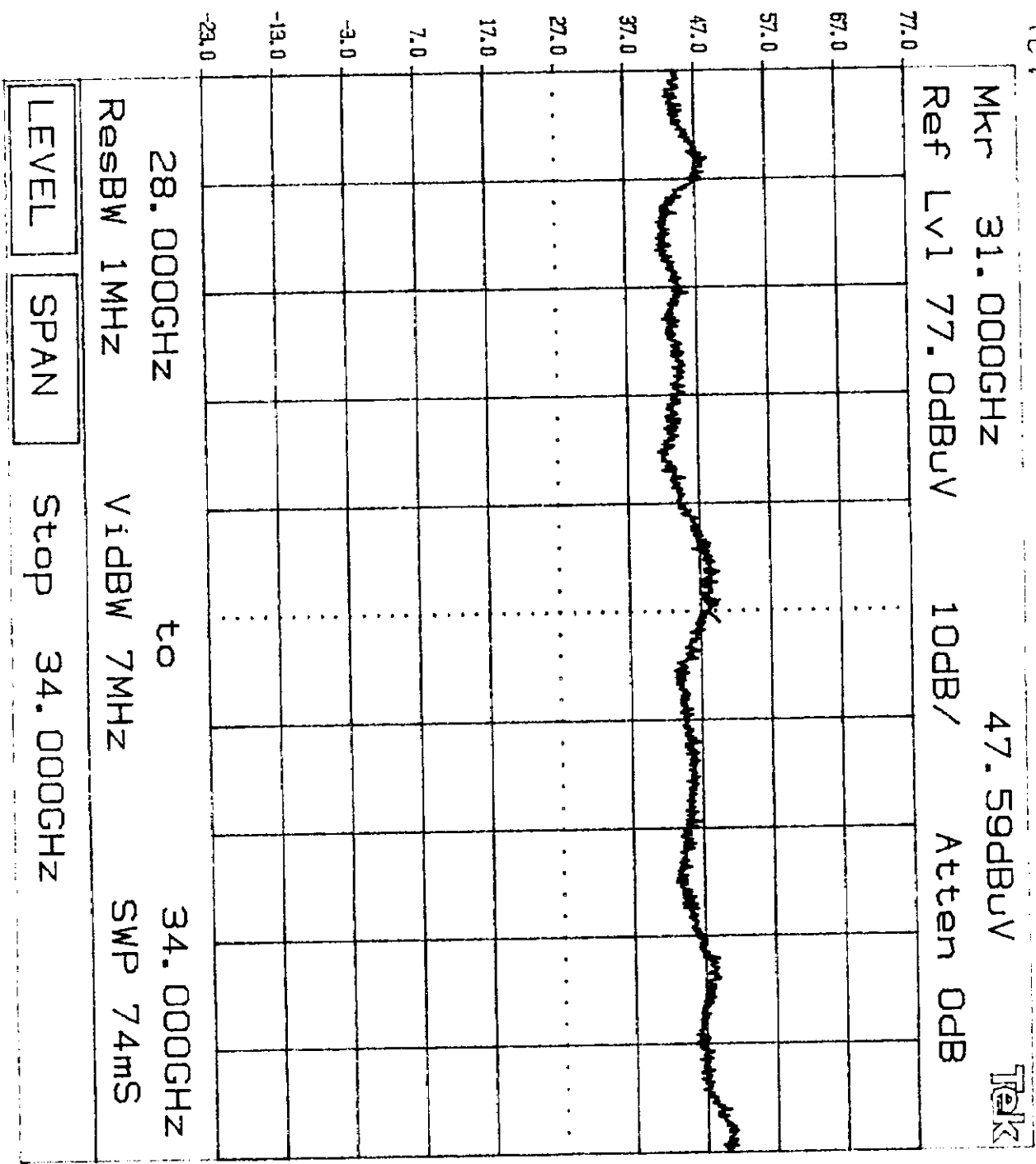
KNOB 1

KEYPAD

Tektronix

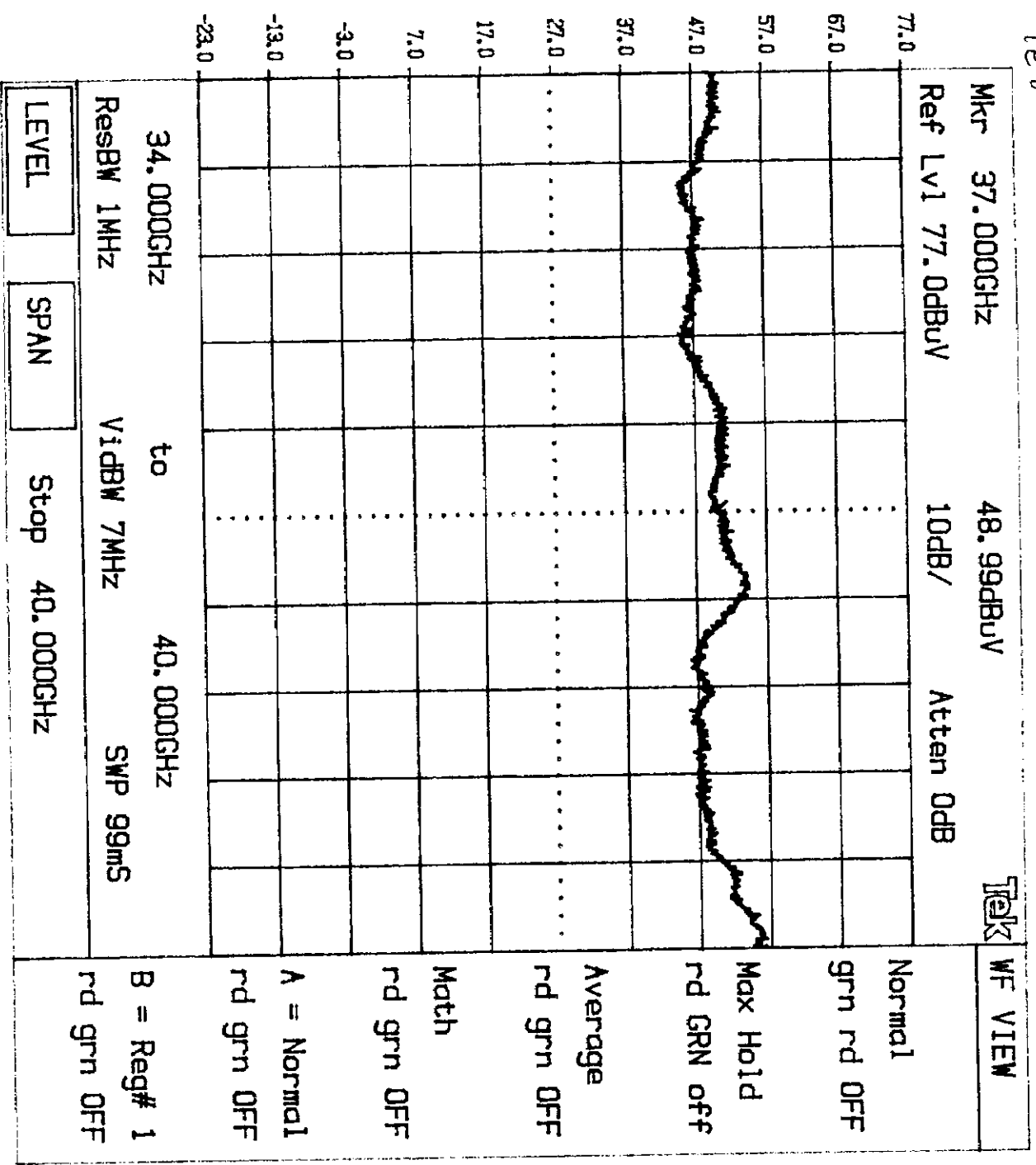
2784

4e7

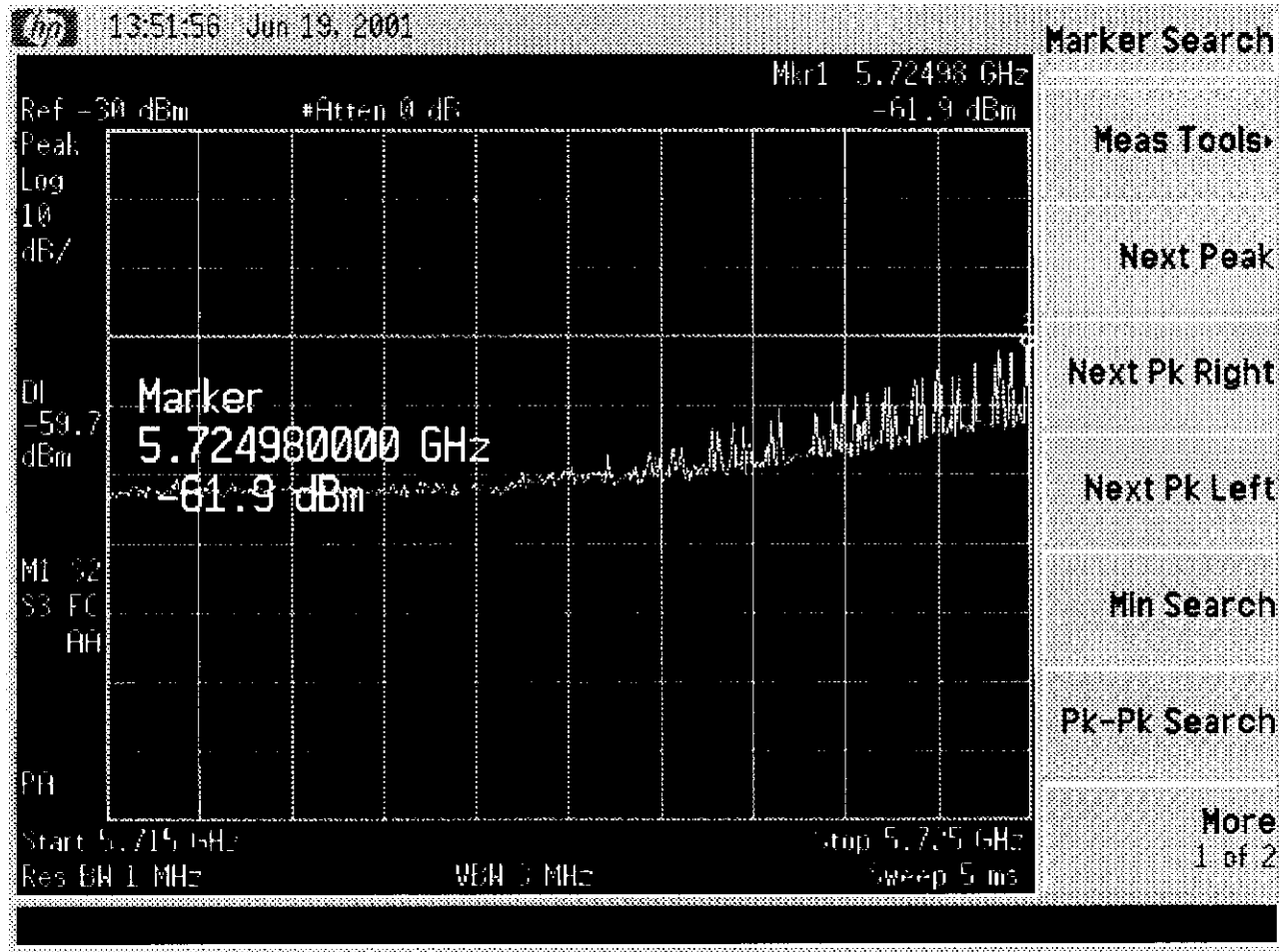


Knob 2 Knob 1 Keypad Tektronix 2784

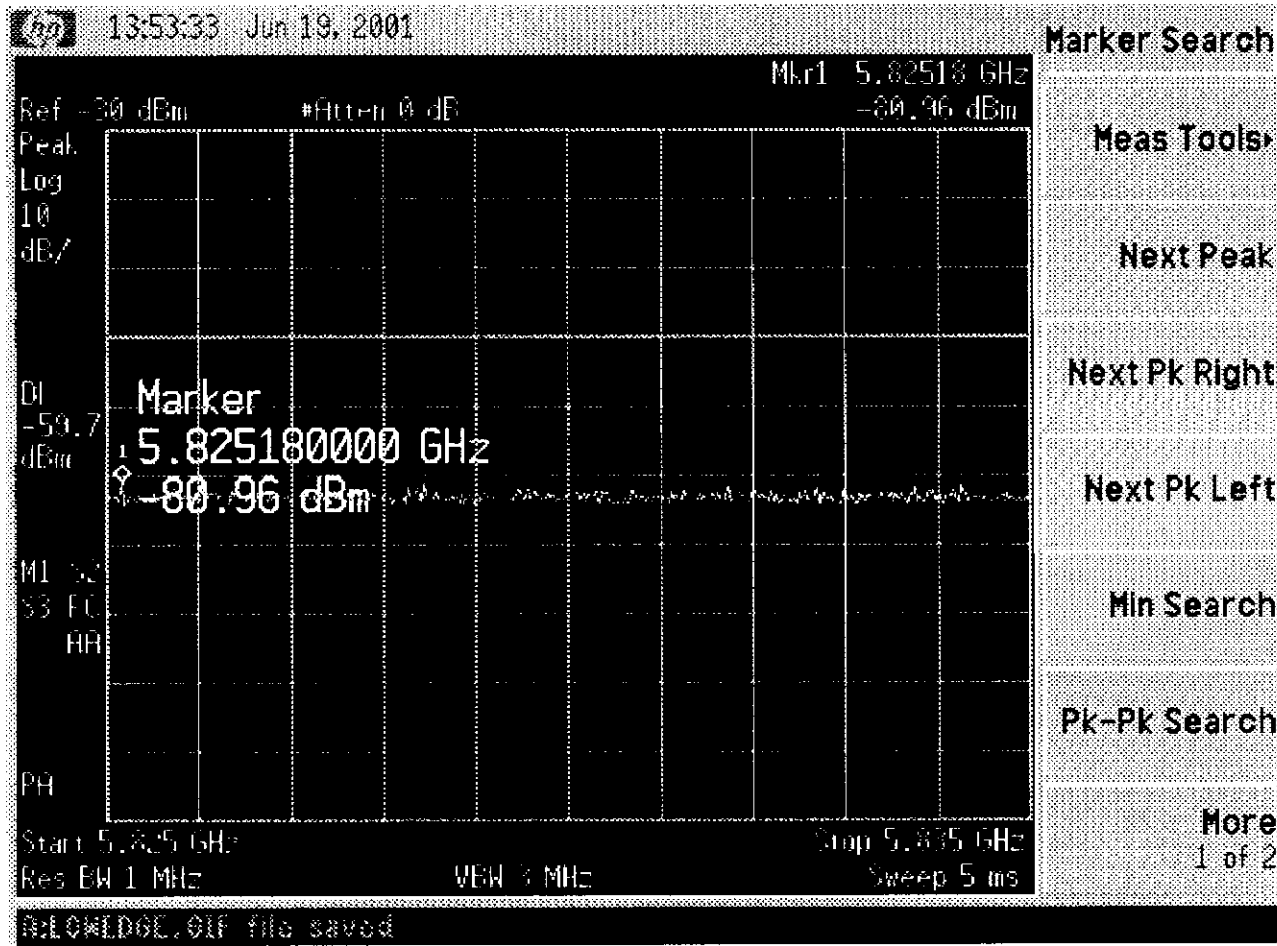
4e8



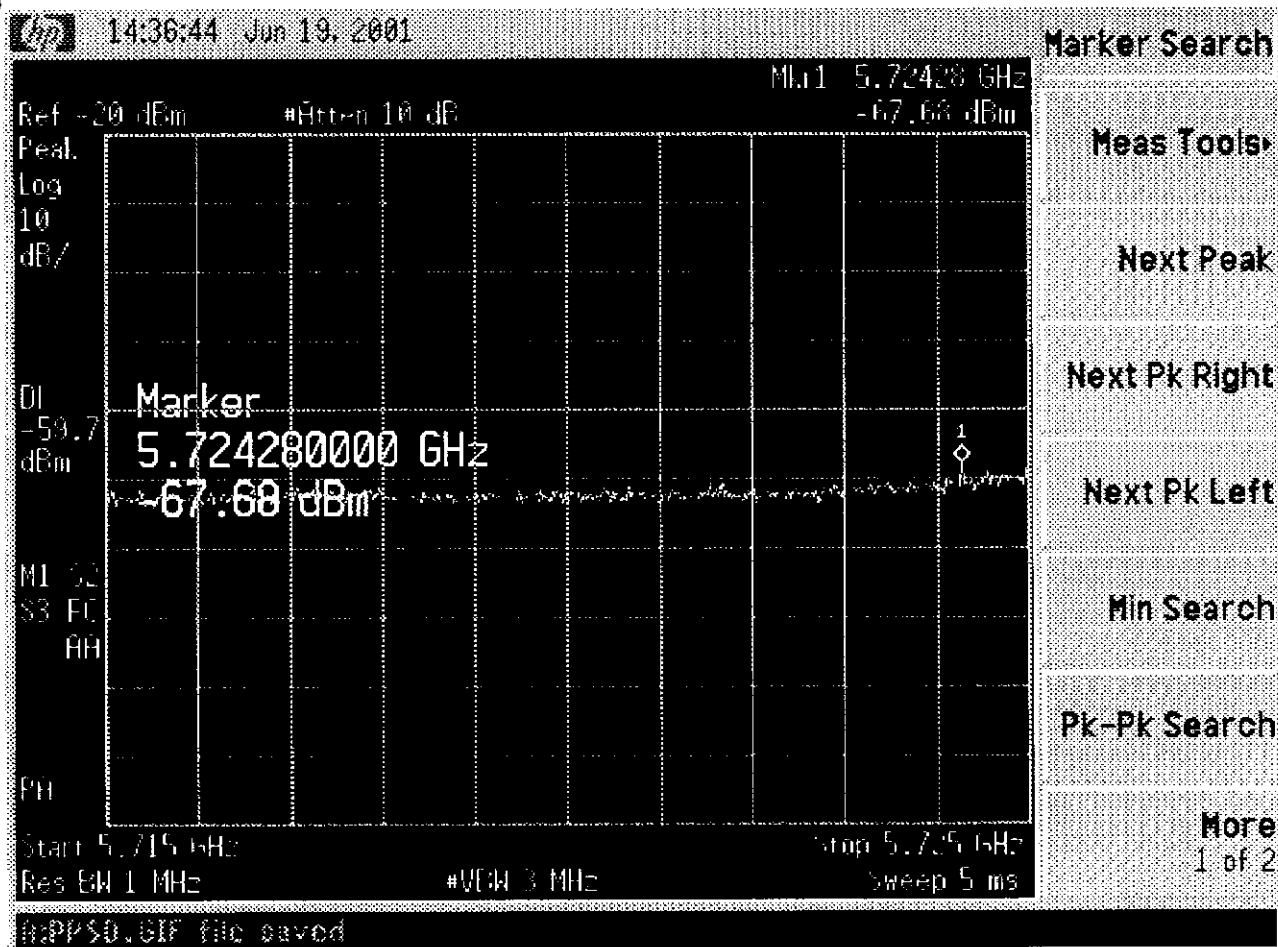
4f1



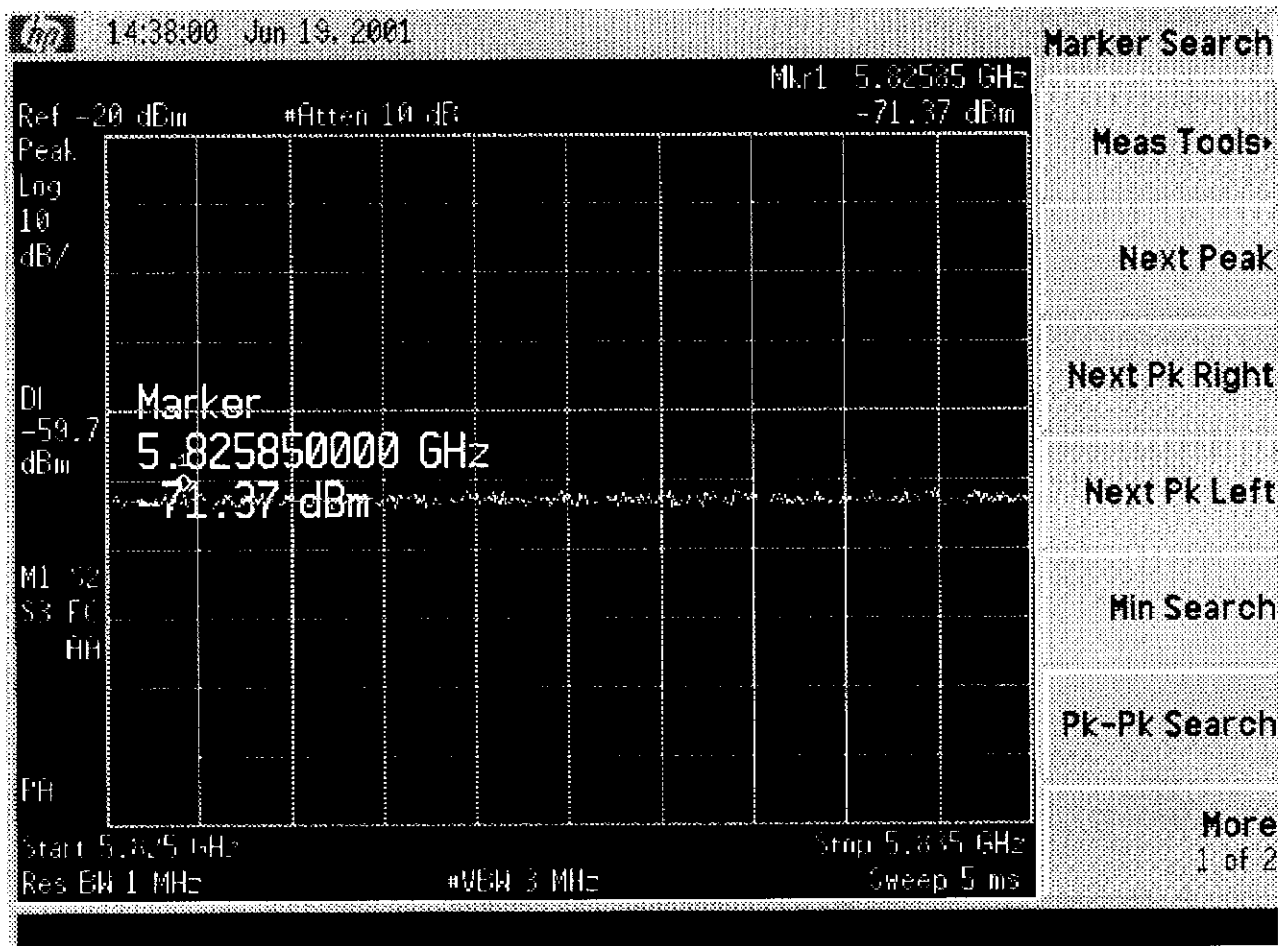
4f2



4g1

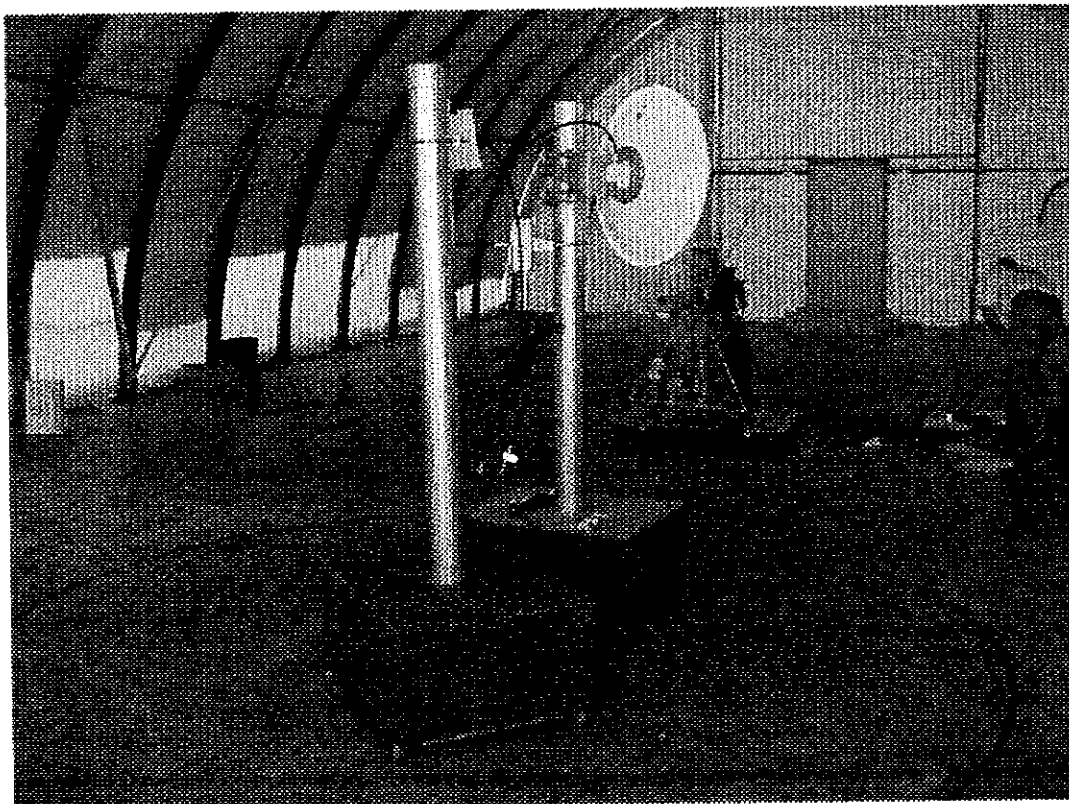
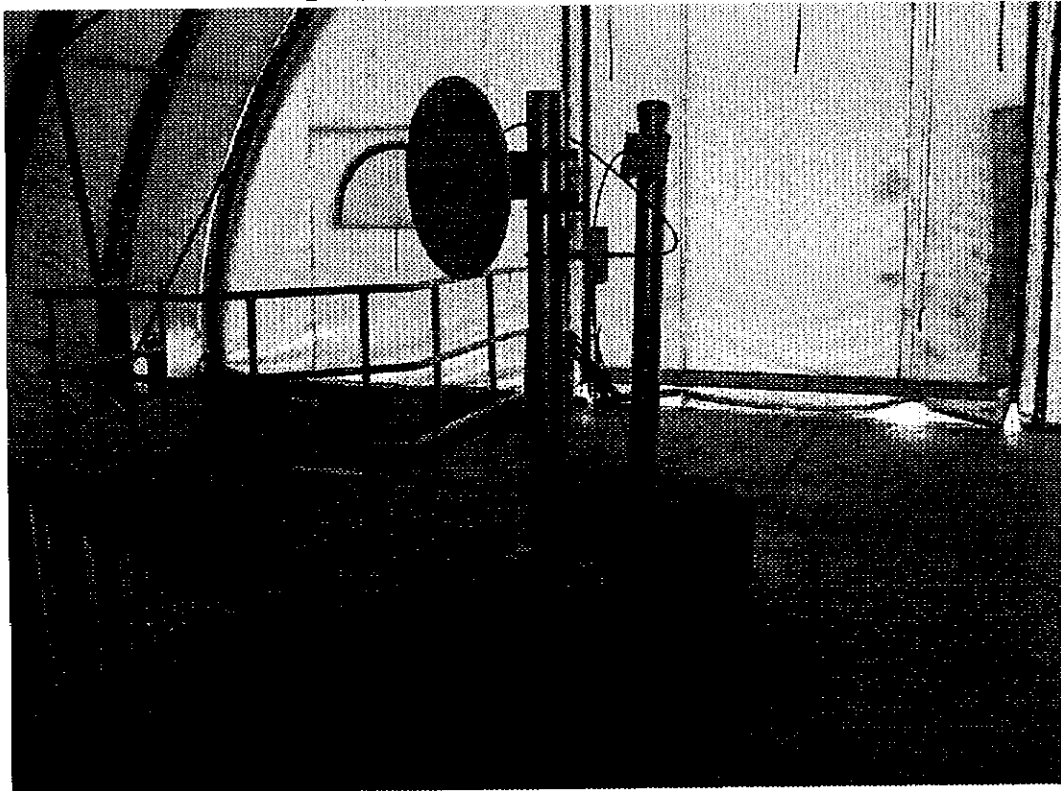


4g2



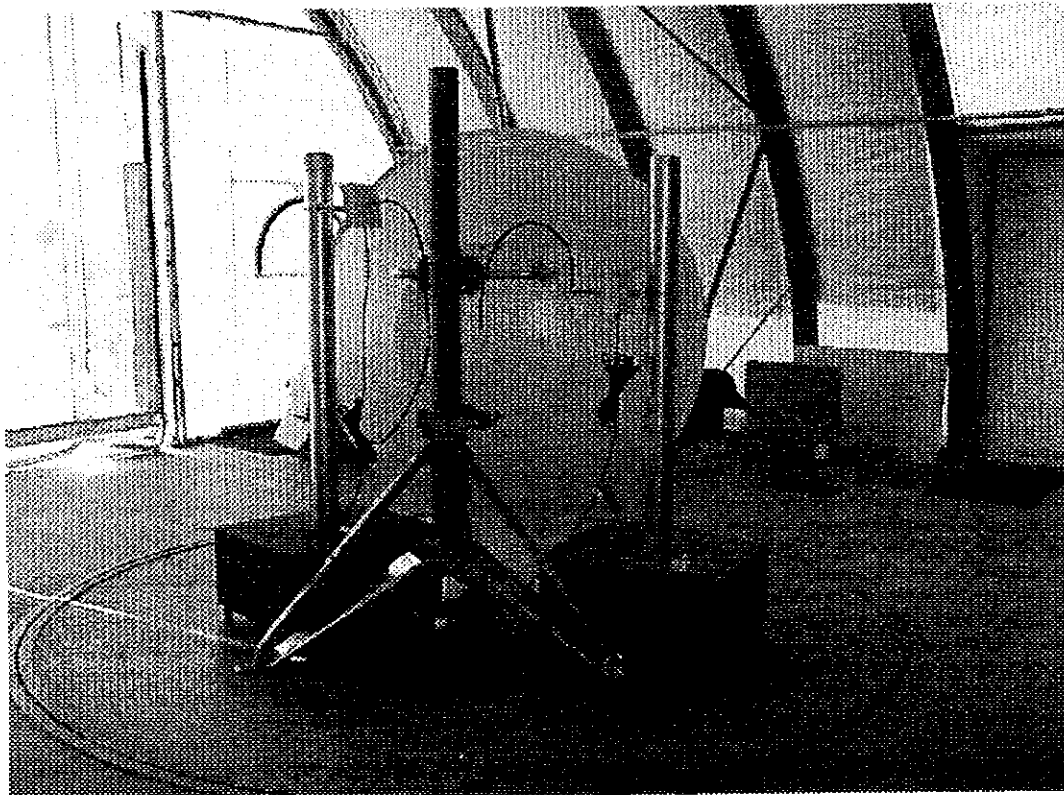
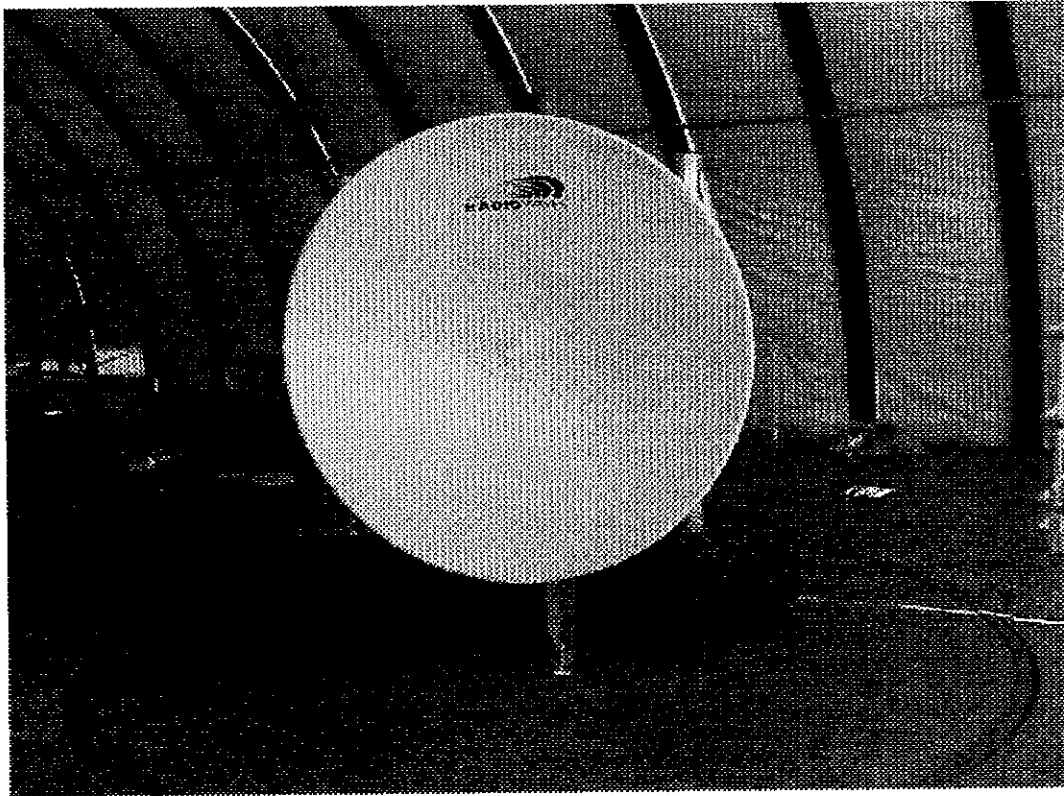
Configuration Photograph

2' Parabolic Point-to-Point 28 dBi Gain



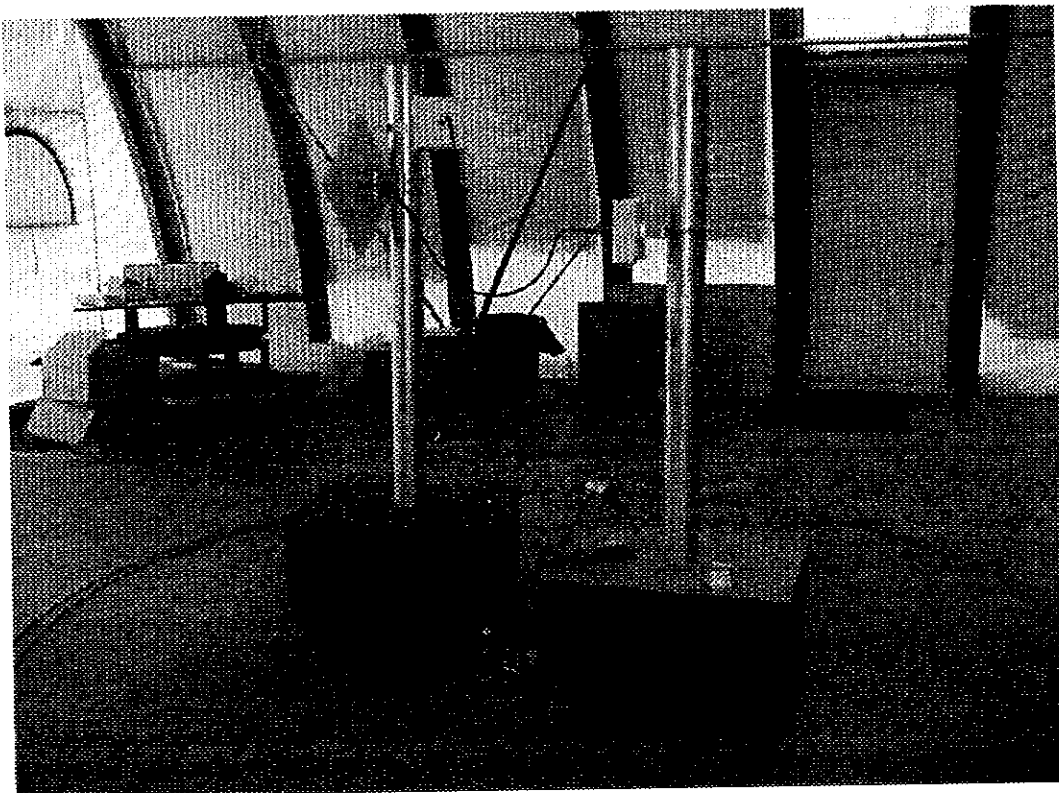
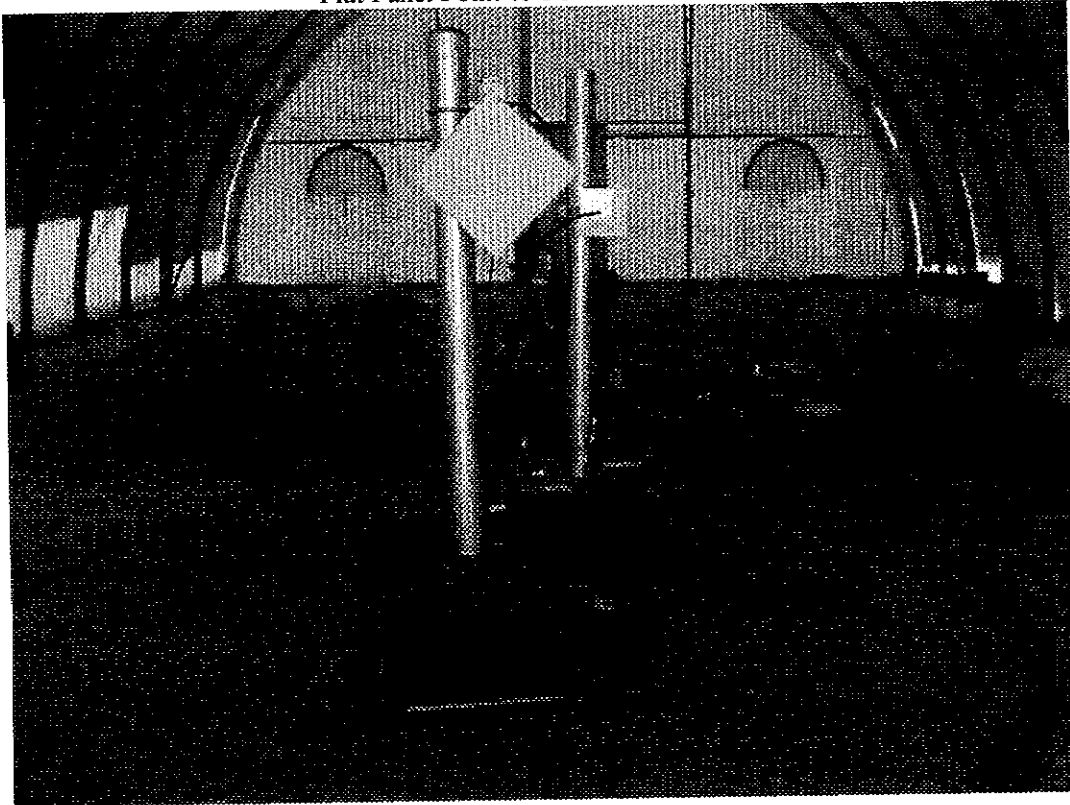
Configuration Photograph (Continued)

6' Parabolic Point-to-Point 37.6 dBi Gain



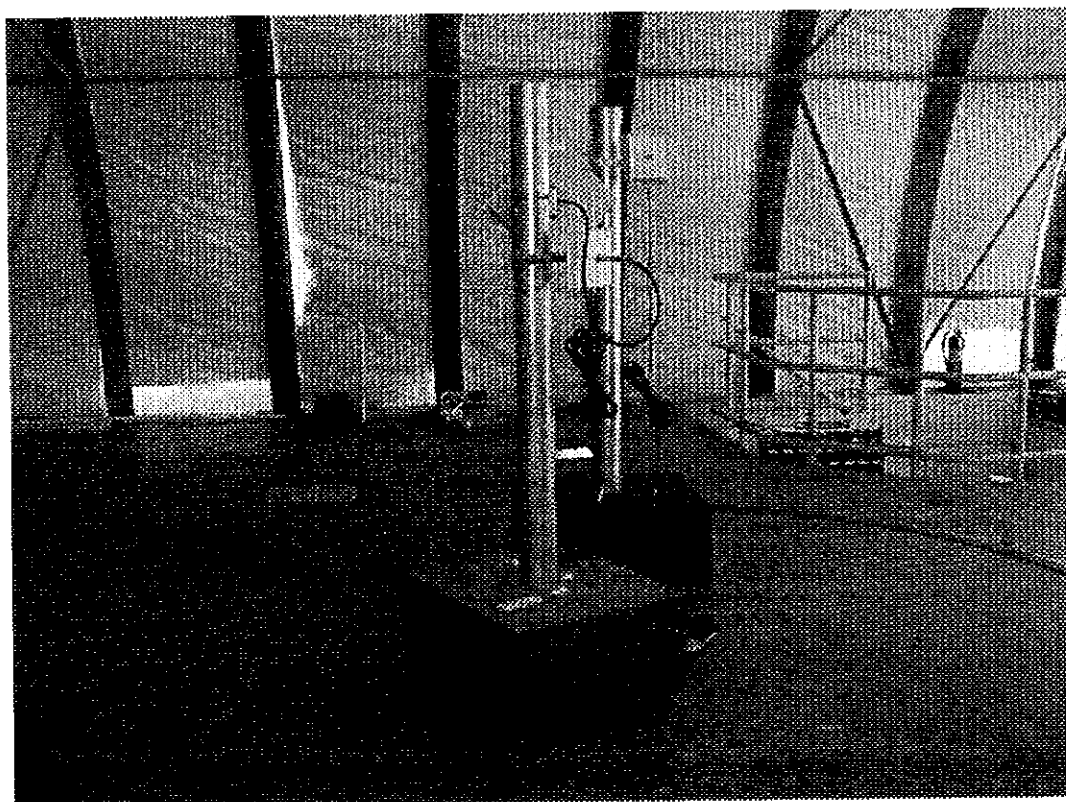
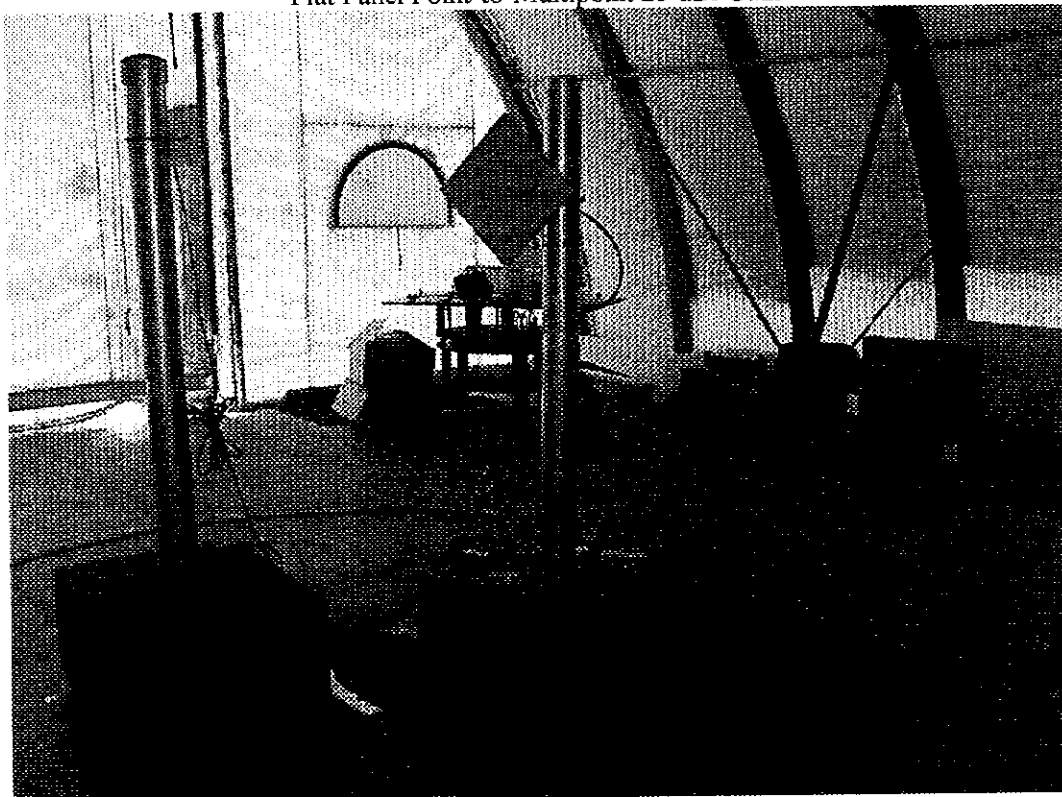
Configuration Photograph (Continued)

Flat Panel Point-to-Point 23 dBi Gain



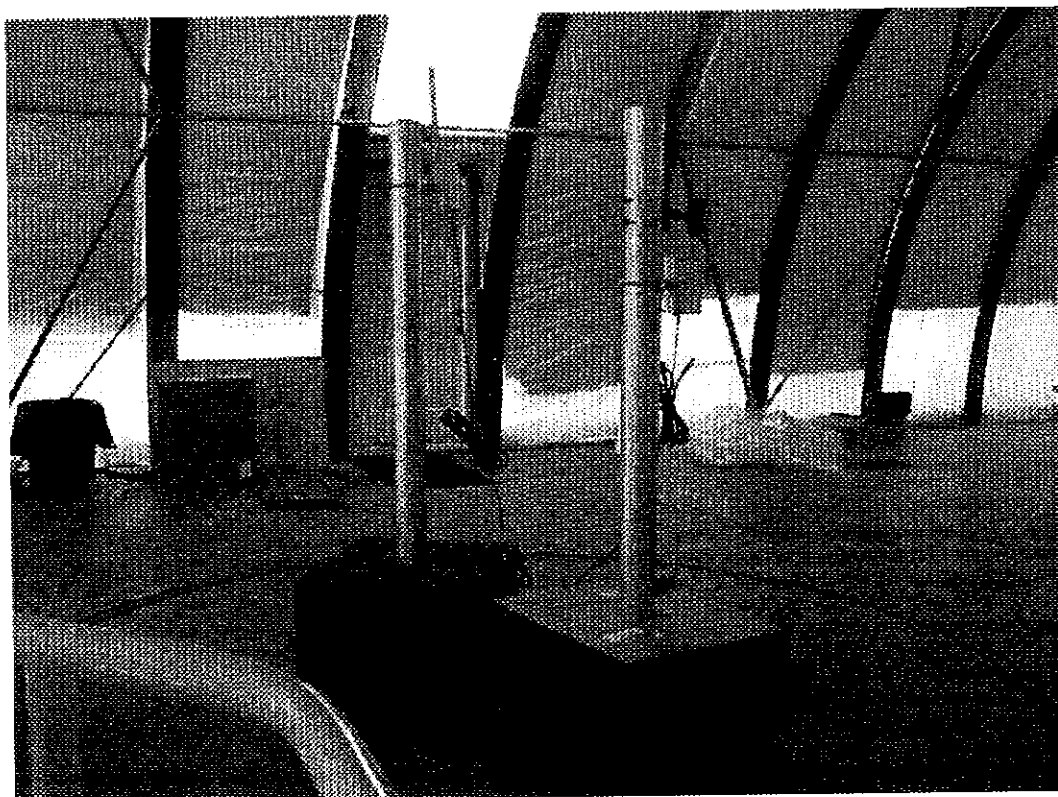
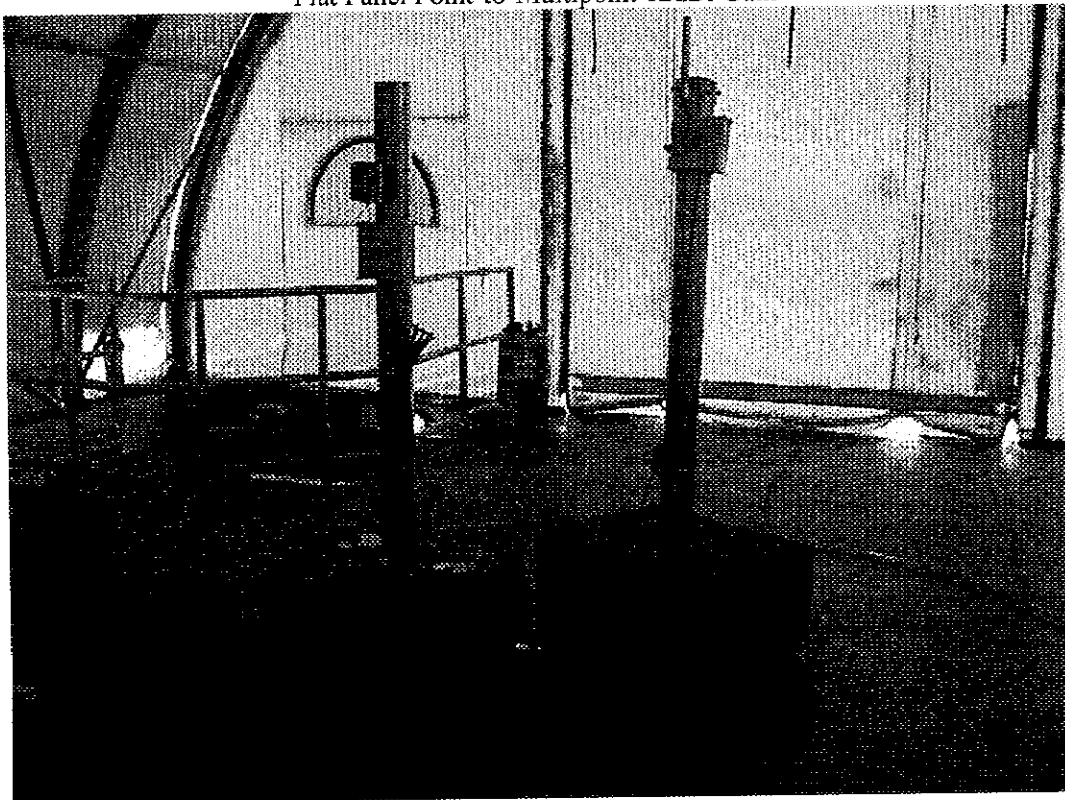
Configuration Photograph (Continued)

Flat Panel Point-to-Multipoint 23 dBi Gain



Configuration Photograph (Continued)

Flat Panel Point-to-Multipoint 12dBi Gain



4.6 Transmitter Radiated Emissions in Restricted Bands FCC Rule 15.205

Radiated emission measurements were performed from 30 MHz to 40,000 MHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz - for frequencies above 1000 MHz.

The EUT is placed on the wooden turntable. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

A sample calculation is included. All measurements were performed with quasi-peak detection unless otherwise specified. Emissions within the restricted bands are subject to the limits set forth in 15.209. No emissions were detected above 1 GHz. Refer to section 4.5 for data.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

where FS = Field Strength in dB μ V/m

RA = Receiver Amplitude (including preamplifier) in dB μ V

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows:

$$FS = RR + LF$$

where FS = Field Strength in dB μ V/m

RR = RA - AG in dB μ V

LF = CF + AF in dB

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}$$

$$RR = 23.0 \text{ dB}\mu\text{V}$$

$$CF = 1.6 \text{ dB}$$

$$LF = 9.0 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = RR - LF$$

$$FS = 23 + 9 = 32 \text{ dB}\mu\text{V/m}$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(32 \text{ dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}$$

4.8 AC Line Conducted Emission
FCC Rule 15.207

4.8.1 Line Conducted Emission Limits

Conducted Emissions Limits, Section 15.107(a)

Frequency (MHz)	Class B (μ V)	Class B (dB μ V)
0.45 - 1.705	250	48
1.705 to 30.000	250	48

Note: Three sets of units are commonly used for EMI measurement, decibels below one milliwatt (-dBm), decibels above a microvolt (dB μ V), and microvolts (μ V). To convert between them, use the following formulas: $20 \text{ LOG}_{10}(\mu\text{V}) = \text{dB}\mu\text{V}$, $\text{dBm} = \text{dB}\mu\text{V} - 107$.

Test Result

See Table F.
The EUT passed the test

Intertek Testing Services

Conducted Emissions / Interference

Table: F

Company: Wireless Bypass

Model: DL-5800C

Job No.: J20046196

Date: 06/12/01

Standard: FCC15E

Class: A

Group: None

Notes:

System Loss: Includes the Cable and LISN loss.

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: Agilent E7405A

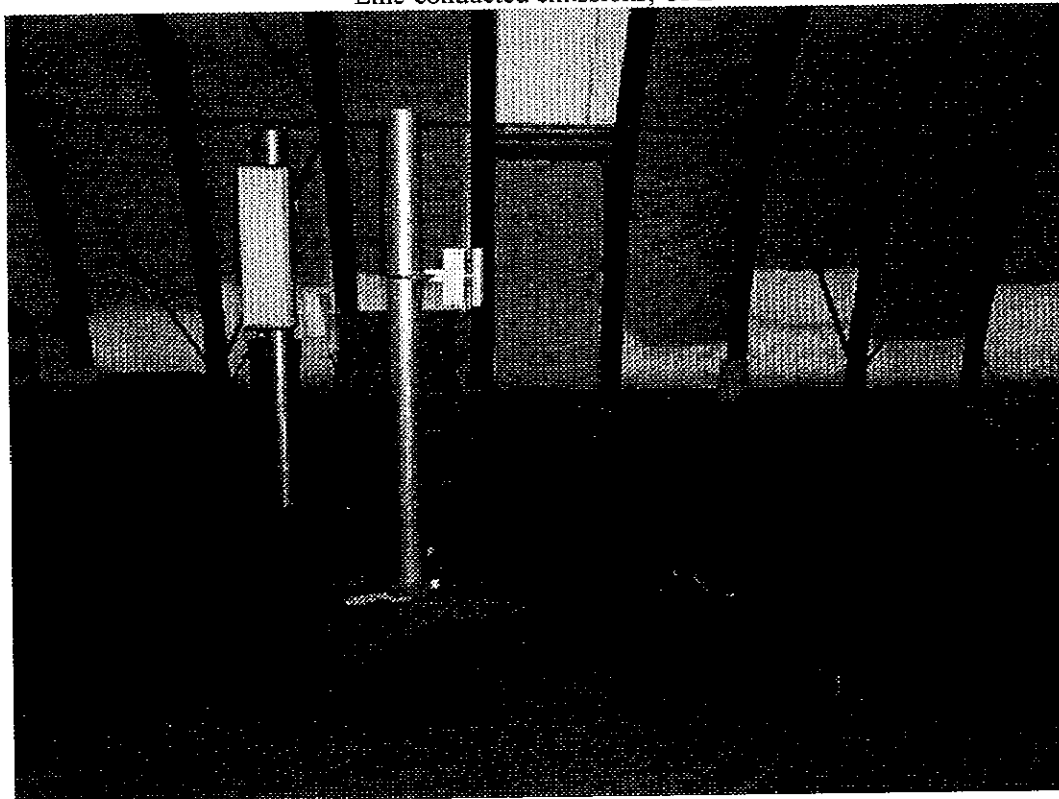
Cable(s): 1C, CBL11

Limiter: no

Frequency MHz	Reading Side A dB	Reading Side B dB	Attenuator Factor dB	System Loss dB	Quasi-Peak		
					Net dB(μ V)	Limit dB(μ V)	Margin dB
0.633	2.3	4.5	20.0	1.3	25.8	48.0	-22.2
0.949	4.1	6.3	20.0	0.5	26.8	48.0	-21.2
2.741	4.6	8.2	20.0	0.4	28.6	48.0	-19.4
5.905	12.1	12.2	20.0	0.6	32.8	48.0	-15.2
10.960	14.2	15.9	20.0	0.6	36.5	48.0	-11.5
16.230	17.9	18.8	20.0	0.8	39.6	48.0	-8.4
19.180	19.3	20.1	20.0	0.9	41.0	48.0	-7.0
22.760	18.9	19.6	20.0	1.0	40.6	48.0	-7.4

Configuration Photograph

Line-conducted emissions, CPE



4.9 Radiated Emissions from Digital Section
FCC Rule 15.109

Test was performed as described in the section 4.6.

The digital section was scanned at the same time as the entire system. Test data can be found in section 4.5. The limits are equivalent to the limits of 15.209.

4.10 Radiated Emissions from Receiver Section
FCC Ref: 15.109, 15.111

The receiver was scanned at the same time as the entire system and according to the procedure set forth in section 4.6. The limits are equivalent to those set forth in 15.209. Test data can be found in section 4.5.

4.11 Transmitter Duty Cycle Calculation / Measurements
FCC Rule 15.35(b), (c)

The EUT antenna output port was connected to the input of the spectrum analyzer. The analyzer center frequency was set to EUT RF channel carrier. The SWEEP function on the analyzer was set to ZERO SPAN. The transmitter ON time was determined from the resultant time-amplitude display:

Duty cycle = Maximum ON time in 100 msec/100

Duty cycle correction, dB = $20 * \log (DC)$

	See attached spectrum analyzer chart(s) for transmitter timing
	See transmitter timing diagram provided by manufacturer
X	Not applicable.

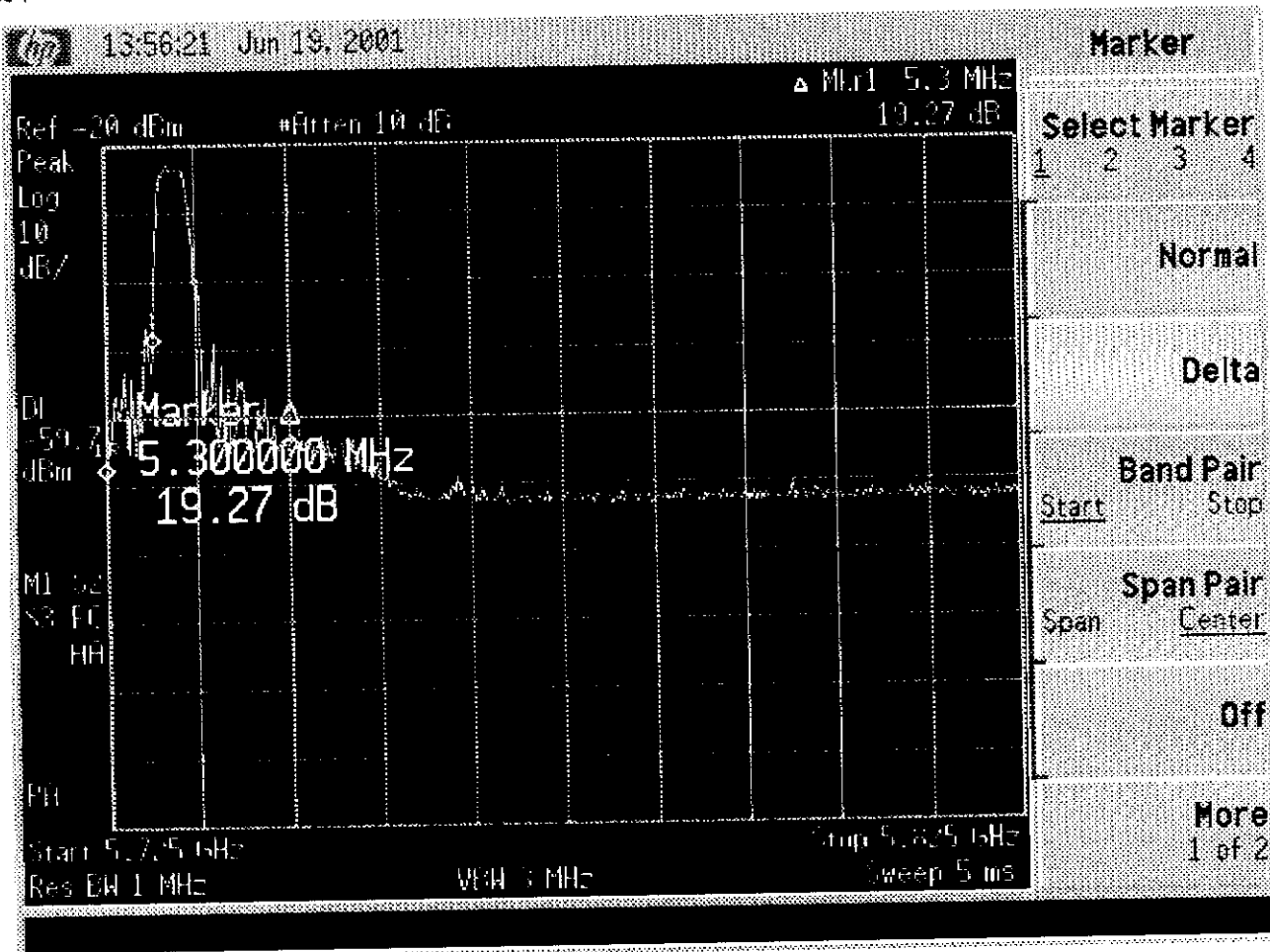
4.12 Frequency Stability
FCC Rule 15.407(g)

The EUT antenna output was connected directly to the input of the spectrum analyzer via a 30 dB attenuation pad and a high frequency cable with 5.7 dB of loss. Measurements were made from the 26dBc bandwidth point, or lower, of the fundamental frequency to the nearest band edge for both the high and low band edges. The frequency margin between these two points was then compared with the worst case frequency stability for the oscillators used. It was found that the frequency margin was much greater than the possible frequency deviation of the fundamental, so the EUT passes.

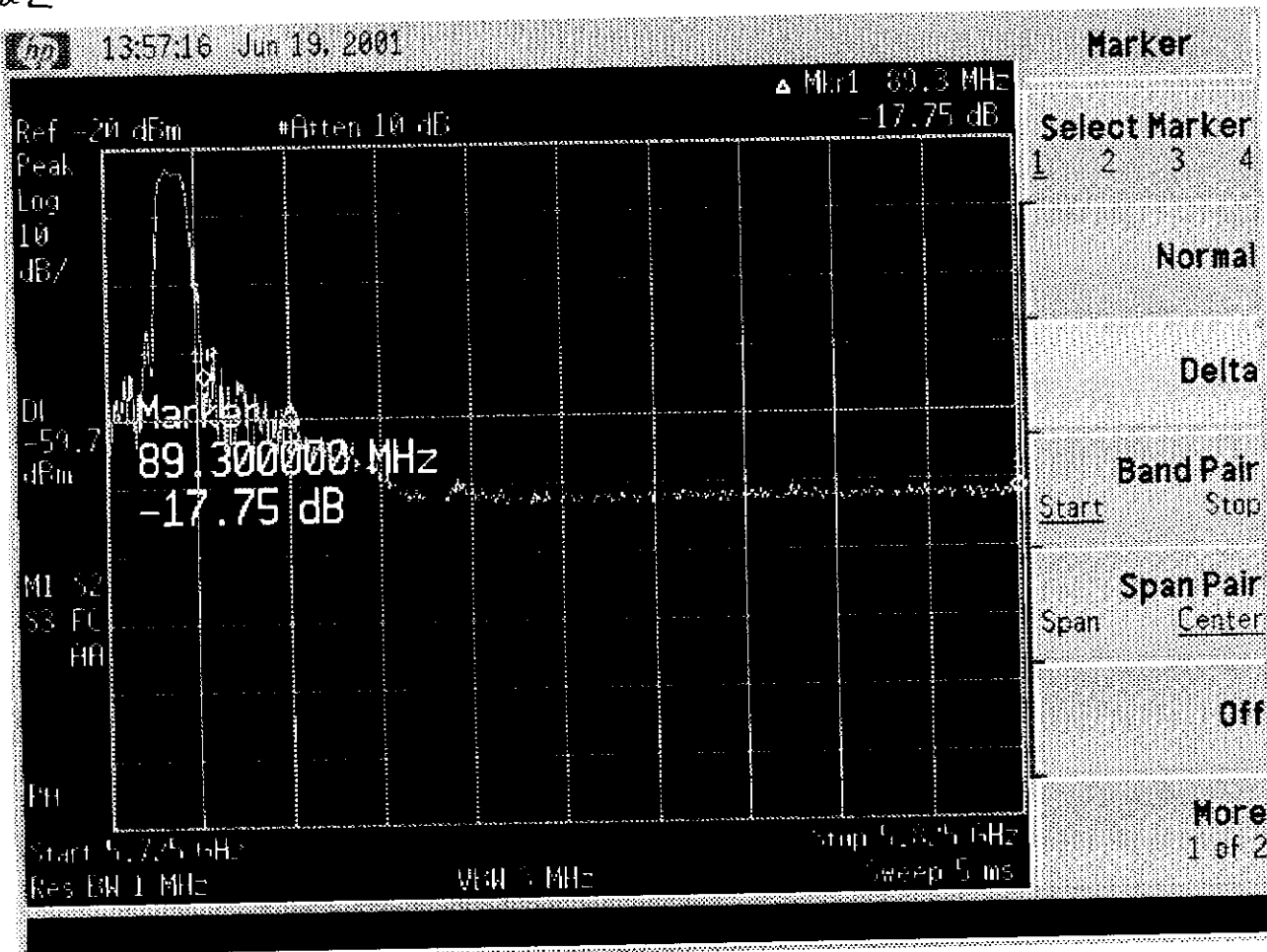
Refer to Exhibit A for a discussion of the worst case frequency stability of the EUT. Refer to the following plots for supporting data:

Plot 5.a1-5.a2: Frequency Stability Margin Low Channel
Plot 5.b1-5.b2: Frequency Stability Margin High Channel

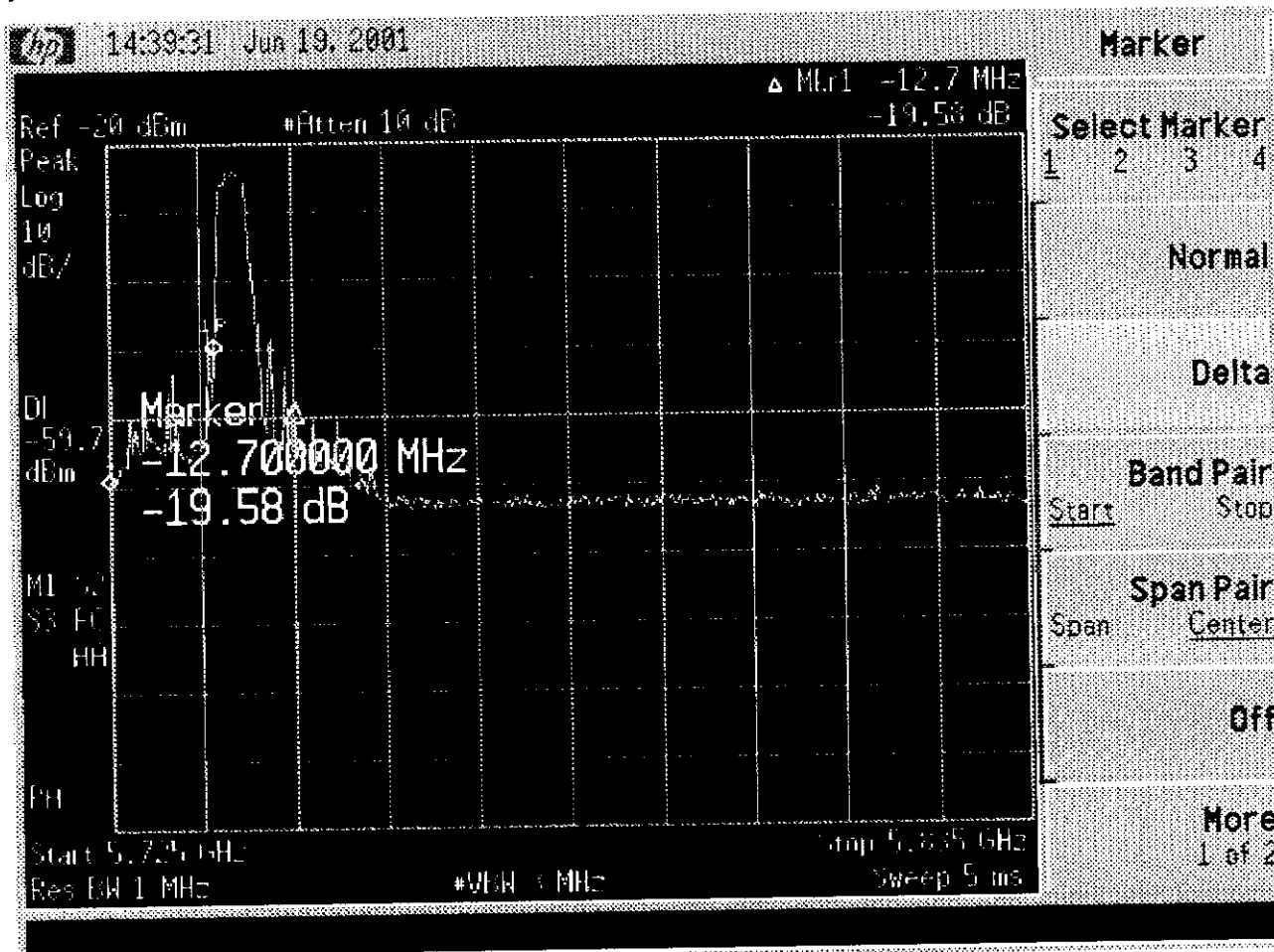
5a1



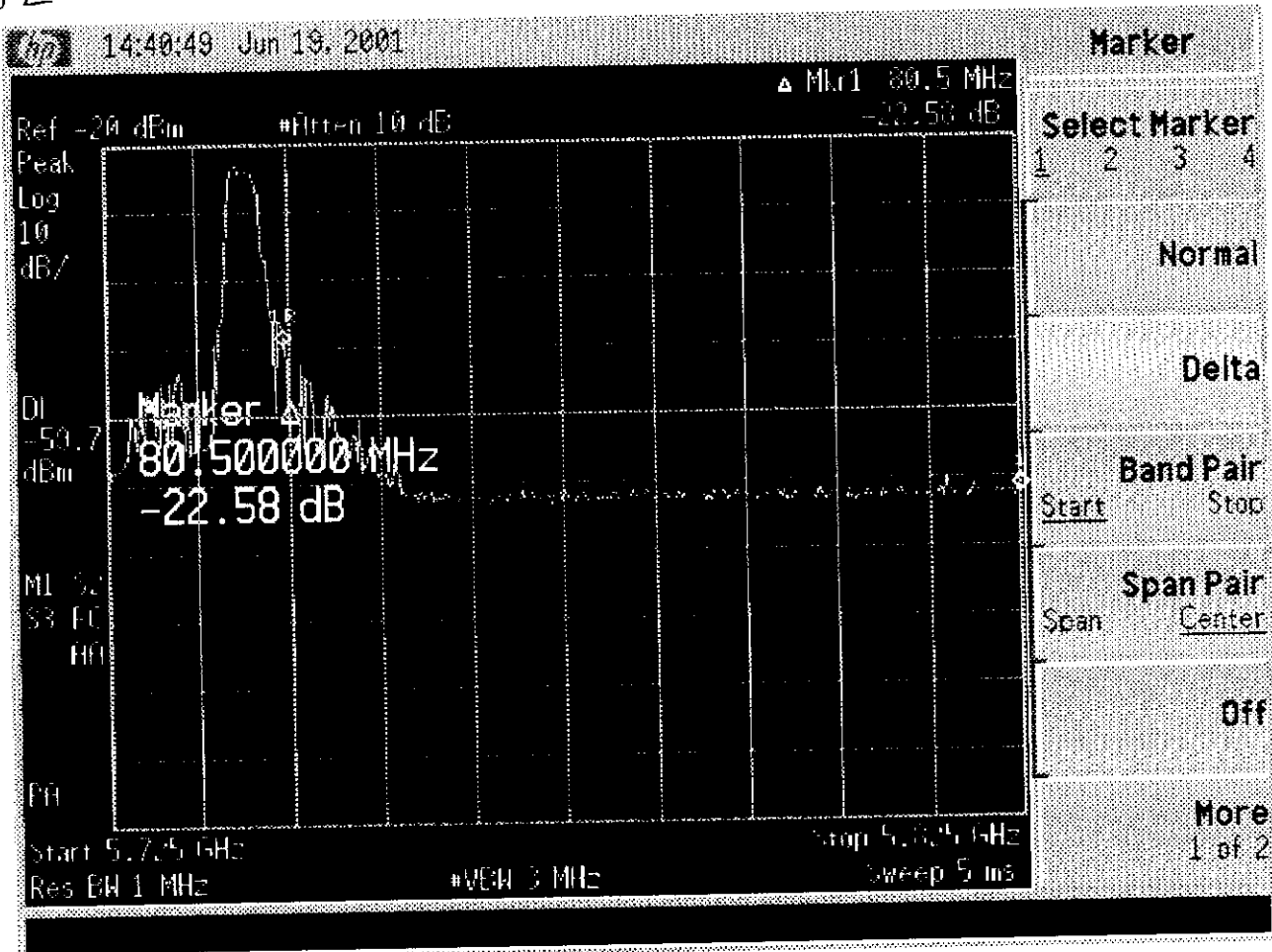
5a2

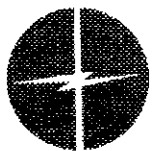


5b1



5b2





Wireless Bypass

wireless solutions for CMTS and CATV distribution

06/20/2001

Transmitter Mute Switch & Transmitter Frequency Stability

To Whom It May Concern:

Wireless Bypass has built a transmitter mute function into the U-NII models PPS-DL5800H24 & PPS-DL5800C24. These mute functions can be traced using the supplied documentation. Specifically, the transmitter mute will take effect from 90% to 10% in less than 1 millisecond in the event of a PLL out of lock, and less than 1 microsecond in the absence of data.

Frequency stability of the PPS-DL5800C24 is controlled by one upconversion at 5.700 GHz. Overall stability over temperature is ± 1.0 PPM & over time ± 1.0 PPM yielding a total of $\pm 11,400$ hz over time and temp.

Frequency stability of the PPS-DL5800H24 is controlled by two upconversions. One conversion is at 625 MHz, and the other is at 5.700 GHz. Overall stability over temperature is ± 1.0 PPM & over time ± 1.0 PPM yielding a total of $\pm 12,650$ hz over time and temp.

The attached crystal specification is applicable to all cases.

Thank you for your help in this matter,

David Blumberg,
Wireless Bypass
43 Northwestern Drive
Salem NH 03079

MODEL VTXO700

Voltage Controlled Temperature Compensated Crystal Oscillators
Low profile surface mountable VCTCXO available in custom frequencies from 8.2MHz to 32MHz with a clipped sinewave output

Product Description

This Colpitts oscillator uses the direct two-port temperature compensation method. Operating on the fundamental mode, the circular AT-cut crystal is housed in the environmentally rugged UM-1 SLIM resistance weld package.

The product can be configured to operate on any voltage between 2.7V and 5V. A mechanical trimmer is available for adjusting the frequency.

Customized frequencies readily available make this model suitable for many timing and frequency applications where an HCMOS output is required.



Features

- * Compatible with normal solder reflow processes
- * Excellent temperature stability performance
- * Able to operate over industrial temperature ranges
- * Low hysteresis
- * Low power consumption
- * Excellent vibration performance
- * Very good phase noise performance
- * Frequency control ranges from 6 to 50ppm available

1.0 SPECIFICATION REFERENCES

1.1	Model Description	VTXO710R 10.0 MHz
1.2	Reference Number	3515
1.3	Company	Wireless Bypass

2.0 FREQUENCY CHARACTERISTICS

Line	Parameter	Test Condition	Min.	Max.	Units
2.1	Nominal Frequency	Nominal Frequency referenced to 25 deg. C.		10.0	MHz
2.2	Frequency calibration	Frequency at 23 deg. C +/- 2 deg. C (see Note 1)		1.0	+/-ppm
2.3	Frequency stability over temperature	Referenced to frequency reading at 25 deg. C. Temperature varied at max. of 2 deg. C per minute. Control voltage held at voltage control range midpoint. (Note 2)		1.0	+/-ppm
2.4	Temperature range	The operating temperature range over which the frequency stability is measured (Note 3)	-20.0	70.0	Degrees C
2.5	Frequency perturbations	Peak to peak amplitude of frequency perturbation within operating temperature range (Note 1)		0.5	ppm
2.6	Frequency slope	Minimum of 1 frequency reading every 2 degrees C, over the operating		0.5	ppm/deg C

	of perturbations	temperature range (Note 1)		
2.7	Static temperature hysteresis	Frequency change after reciprocal temperature ramped over the operating range. Frequency measured before and after at 25 deg C	0.4	+/-ppm
2.8	Supply voltage stability	Supply voltage varied +/-5% at 25 deg C. Frequencies above 25MHz are not able to be specified below the max. value given. (Note 1)	0.3	+/-ppm
2.9	Load sensitivity	+/-10% load change	0.2	+/-ppm
2.10	Root Allan Variance	1 second Tau. (Note 1)	1.0	ppb
2.11	Long term stability	Frequency drift over 1 year (Note 1)	1.0	+/-ppm
2.12	G Sensitivity	Gamma vector of all three axes from 30Hz to 1500Hz (Note 1)	1.0	ppb/G
2.13	Trimmer adjustment	Manual adjustment using trimmer tool	3.0	+/-ppm

3.0 POWER SUPPLY

Line	Parameter	Test Condition	Min.	Max.	Units
3.1	Supply voltage	Supply voltage range based on nominal 5V	4.75	5.25	V
3.2	Current	At Max. supply voltage		2.0	mA

4.0 CONTROL VOLTAGE

Line	Parameter	Test Condition	Min.	Max.	Units
4.1	Control voltage range	Determined by supply voltage (Note 5). The nominal control voltage value is midway between the minimum and maximum.	0.5	4.5	V
4.2	Frequency tuning	Frequency shift from Min. to Max. control voltages (Note 6)	6.0		ppm
4.3	Frequency tuning linearity	Deviation from straight line curve fit (Note 1)		20.0	%
4.4	Port input impedance		100.0		K Ohms

5.0 OSCILLATOR OUTPUT

Line	Parameter	Test Condition	Min.	Max.	Units
5.1	Output waveform	Clipped sinewave			
5.2	Output voltage level	At min. supply voltage	1.0		V
5.3	Output load resistance	Operating range	18.0	22.0	K Ohms

5.4 Output load capacitance Operating range

4.5 5.5 pF

6.0 SSB PHASE NOISE

Line	Parameter	Test Condition	Min.	Max.	Units
<i>Quiescent measurement at room temperature. Phase noise dependent on oscillator frequency. The dBc/Hz are typical values.</i>					
6.1	SSB Phase noise density	1Hz offset		-70.0	dBc/Hz
6.2	SSB Phase noise density	10Hz offset		-100.0	dBc/Hz
6.3	SSB Phase noise density	100Hz offset		-130.0	dBc/Hz
6.4	SSB Phase noise density	1KHz offset		-145.0	dBc/Hz
6.5	SSB Phase noise density	10KHz offset		-150.0	dBc/Hz

7.0 ENVIRONMENTAL

The oscillator shall meet electrical characteristics and suffer no physical damage after being subject to the following conditions:

7.1	Shock	Half sinewave acceleration of 100G peak amplitude for 11ms duration, 3 cycles each plane.
7.2	Random Vibration	10G RMS 30Hz to 1500Hz duration of 6 Hours.
7.3	Humidity	After 48hours at 85 deg C +/-2% deg C 85% relative humidity non-condensing
7.4	Thermal shock test	Exposed at -40 deg C for 30 minutes then to 85 deg C for 30 minutes constantly for a period of 5 days.
7.5	Storage temperature	-40 to 85 deg C

8.0 MARKING

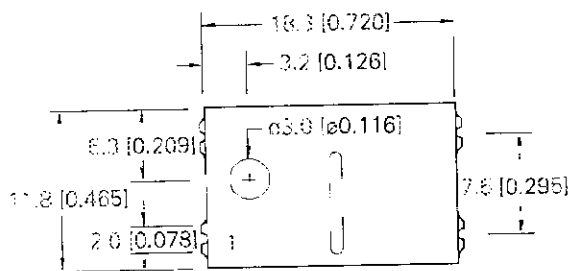
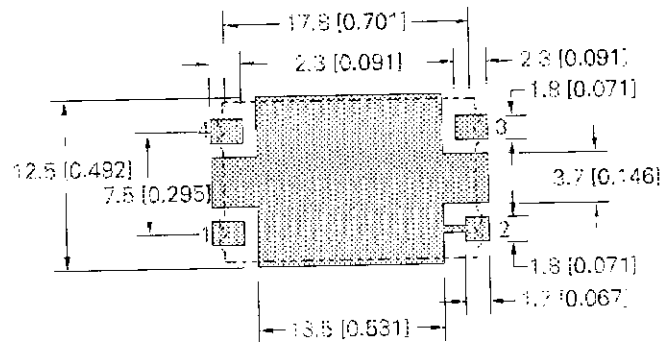
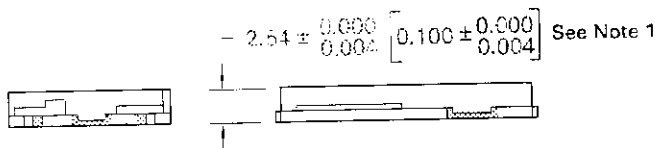
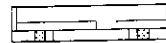
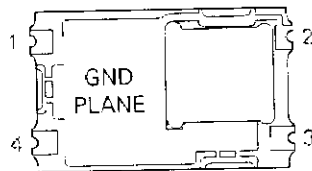
8.1	Type	Engrave
8.2	Line 1	Rakon logo
8.3	Line 2	Model descriptive
8.4	Line 3	Frequency in MHz (to 3 decimal places or greater depending on the no. of significant digits after the decimal point)
8.5	Line 4	Date code WWYY

9.0 MANUFACTURING INFORMATION

- | | | |
|-----|------------------------------|--|
| 9.1 | Reflow and washing | Able to withstand normal solder reflow processes but not aqueous washing due to presence of trimmer with open dielectric exposure. |
| 9.2 | Packaging description | Tape and reel |

10.0 SPECIFICATION NOTES

- | | | |
|------|---------------|---|
| 10.1 | Note 1 | The Max. value is the specification. A Min. value, if present, indicates the tightest specification available. |
| 10.2 | Note 2 | A max. frequency stability over the temperature is required to be specified. For this model, values between to $\pm 1\text{ppm}$ and $\pm 10\text{ppm}$ are available. Standard options are $\pm 1\text{ppm}$, $\pm 1.5\text{ppm}$, $\pm 2\text{ppm}$ and $\pm 2.5\text{ppm}$. |
| 10.3 | Note 3 | The operating temperature range needs to be specified. The extremes for this model are -40 and $+85$ deg C. If either or both ends of the operating temperature range are at these extremes, then the frequency stability options are limited to greater than $\pm 1.5\text{ppm}$. |
| 10.4 | Note 4 | Standard power supply options are 2.7V, 3V, 3.3V, 4V or 5V, but any value between Min. & Max. is available. |
| 10.5 | Note 5 | This range is normally 0.5V to Supply voltage less 0.5V i.e. for a supply voltage of 3V, the range is 0.5V to 2.5V. |
| 10.6 | Note 6 | The Min value is the specification. A Max value, if present, indicates the widest tuning range available for this model (subject to other parameters). |


TOP VIEW

**TOP VIEW
RECOMMENDED PAD LAYOUT**

END VIEW
SIDE VIEW

END VIEW

BOTTOM VIEW
PIN CONNECTIONS

- 1 CONTROL VOLTAGE
- 2 COMMON & CASE
- 3 OUTPUT
- 4 +Vcc

Note: 1. 2.54 Max Without Label

TITLE: VTXO700 MODEL

FILENAME: CAT024

REVISION: B

RELATED DRAWINGS: VTXO CLIPPED SINEWAVE
TEST CIRCUIT (CAT135)
700 SERIES TRAY (CAT095)

DATE: 27 JAN 99

SCALE: 2:1

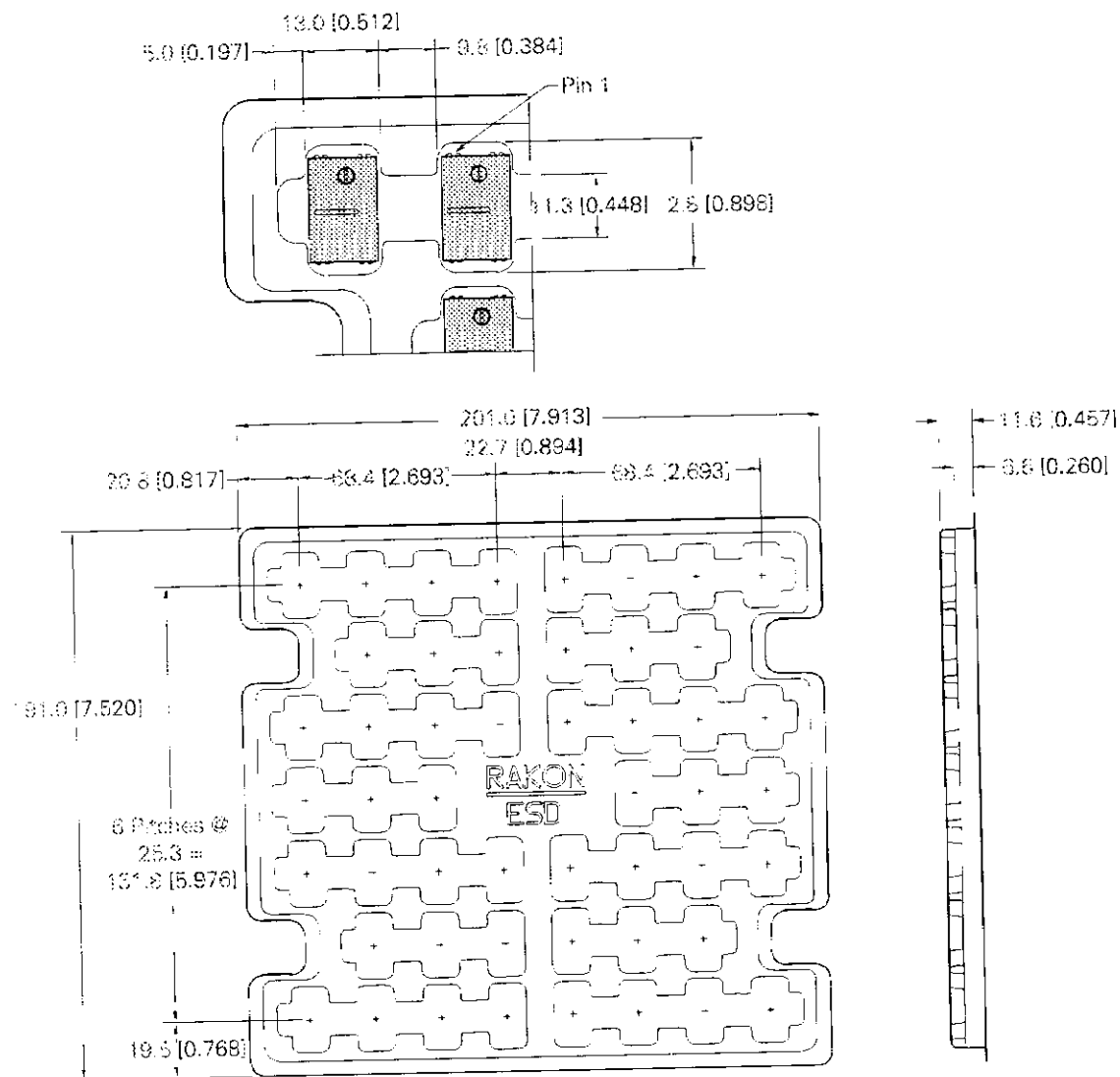
Millimetres [inch]

Tolerances:

- XX = ±0.5
- X.X = ±0.10
- X.XX = ±0.05
- X.XXX = ±0.05
- X° = ±1.0°
- Hole = ±0.10

RAKON
PRECISION QUARTZ CRYSTALS

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TRAY DETAIL (Scale 1:2)
 50 Oscillators Per Tray
 21 (20+1 top) Trays Per Small Box
 4 Small Boxes Per Large Box

TITLE: 700 SERIES TRAY

FILENAME: CAT095

REVISION: A

RELATED DRAWINGS: TXO700 MODEL (CAT017)
 VTXO700 MODEL (CAT024)

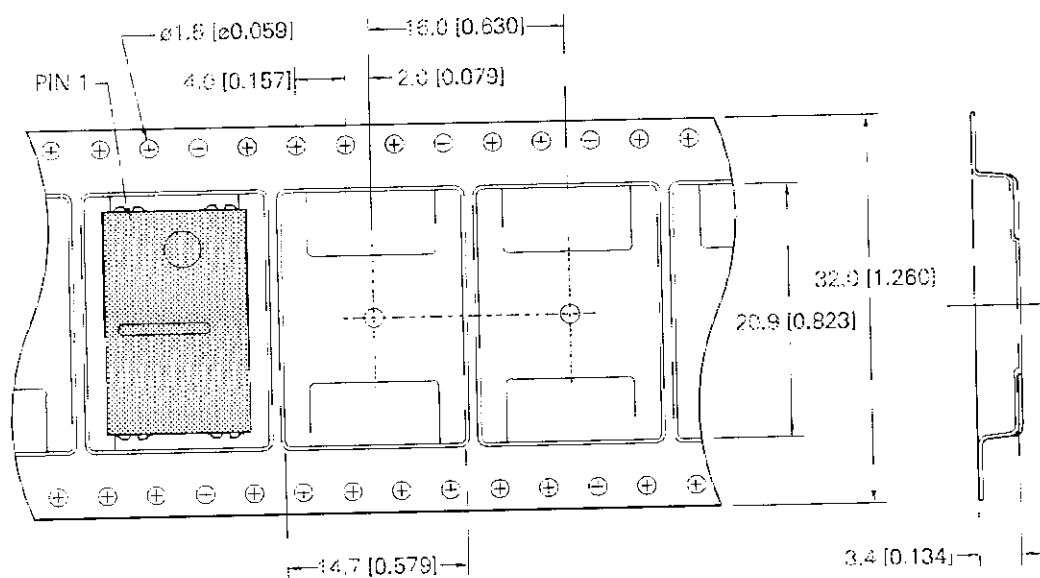
DATE: 24 JULY 98

SCALE: 1:1

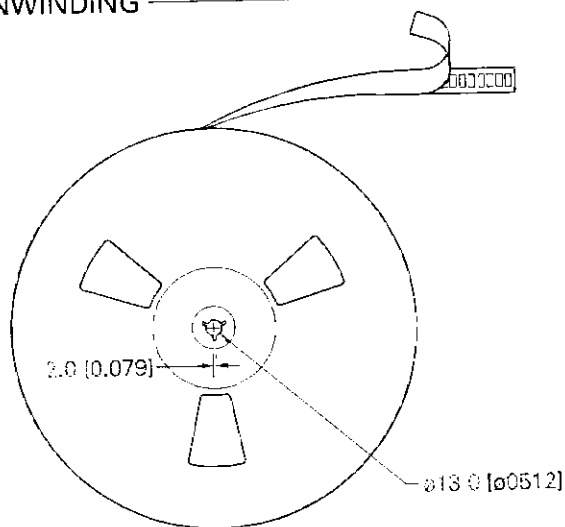
Millimetres [inch]

RAKON
 PRECISION QUARTZ CRYSTALS

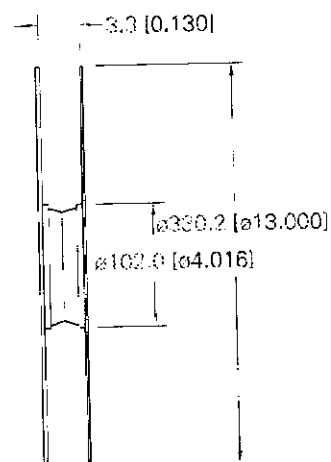
©1998 Rakon Limited



UNWINDING →



REEL DETAIL
SCALE 1:5



TITLE: 700 TAPE & REEL

FILENAME: CAT098

REVISION: A

RELATED DRAWINGS: TX0700 VTX0700

DATE: 16 DEC 98

SCALE: 2:1 1:5

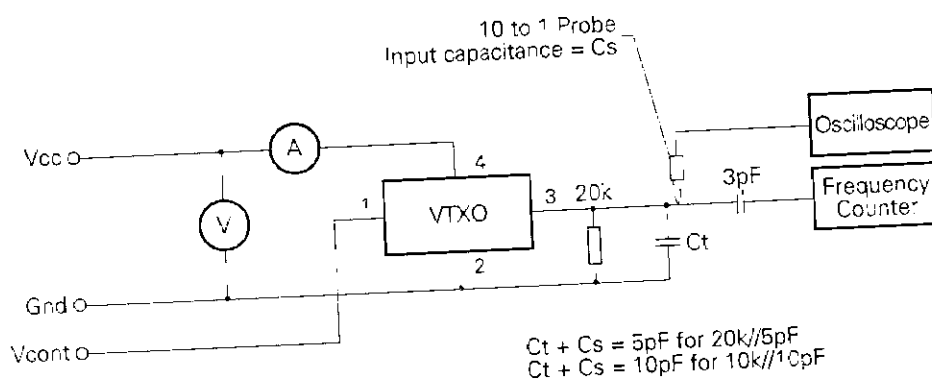
Millimetres [inch]

Tolerances:

XX = ±0.5
X.X = ±0.10
X.XX = ±0.05
X.XXX = ±0.05
X° = ±1.0°
Hole = ±0.10

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PRECISION QUARTZ CRYSTALS

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TITLE: VTXO CLIPPED SINEWAVE TEST CIRCUIT FILENAME: CAT135

RELATED DRAWINGS: VTXO400 VTXO500
 VTXO4080 VTXO700
 VTXO4080S

REVISION: A

DATE: 3 SEPT 98

SCALE: NTS

Millimetres (inch)

RAKON
 PRECISION QUARTZ CRYSTALS

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5.0 List of Test Equipment

Equipment	Manufacturer	Model	Serial #	Cal. Due
Spectrum Analyzer	Agilent	E7405A	US40240205	11/28/01
Spectrum Analyzer	Tektronix	2784	B010153	12/13/01
EMI Receiver Set W/RF Filter	Hewlett Packard	85462A	3325A00160	12/28/01
Plotter, Digital Pen	Hewlett Packard	7470A	2308A23938	#
Cable, SMA-SMA <18GHz	Sucoflex	104PE	CBLSHF203	8/21/01
Attenuator, 30 dB	Weinschel Corp.	23-30-34	AR6008	8/14/01
High Frequency Horn Antenna	EMCO	3116	9310-2222	2/04/02
Horn Antenna	EMCO	3115	9610-4980	11/01/01
Antenna	EMCO	3142	9701-1116	7/18/01
MW Cable (DC-40GHz) 24"	Astrolab	32029-2-2909K-24TC	CBL049	8/17/01
MW Cable (DC-40GHz) 48"	Astrolab	32029-2-2909K-48TC	CBL050	8/17/01
Cable, BNC/BNC	Alpha	RG58B/U	CBL110E	9/10/01
LISN, 50uH, .01-50MHz, 24A	Solar Electronics	9252-50-R-24-BNC	941712	5/02/02
Attenuator, 20 dB	Mini Circuits	20 dB, 50 Ohm	DS25A	8/14/01
Peak Power Meter	Hewlett Packard	8900D	3607U00673	7/31/01
Peak Power Sensor	Hewlett Packard	84811A	3318A05091	8/01/01

Calibration is not required