

**FCC Part 15 Subpart E Test Report**  
for  
**Wireless Bypass**  
on the  
**Cable Access Radio HUB**  
**Model: DL-5800H24**

**FCC ID: PPS-DL-5800H24**

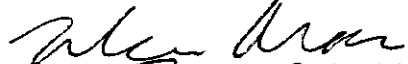
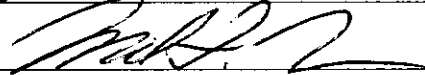
Date of Report: June 26, 2001

Job # J20046196

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



Lab Code 100270-0

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

This report shall not be reproduced except in full, without written approval of Intertek Testing Services.

This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government.

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.

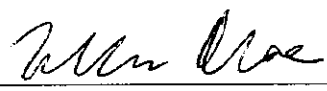
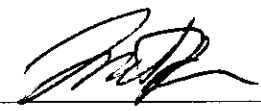
**Table of Contents**

|            |                                                                                   |           |
|------------|-----------------------------------------------------------------------------------|-----------|
| <b>1.0</b> | <b>Summary of Tests.....</b>                                                      | <b>1</b>  |
| <b>2.0</b> | <b>General Description .....</b>                                                  | <b>2</b>  |
| 2.1        | Product Description .....                                                         | 2         |
| 2.2        | Related Submittal(s) Grants.....                                                  | 2         |
| 2.3        | Test Methodology.....                                                             | 3         |
| 2.4        | Test Facility .....                                                               | 3         |
| <b>3.0</b> | <b>System Test Configuration.....</b>                                             | <b>4</b>  |
| 3.1        | Support Equipment and description.....                                            | 4         |
| 3.2        | Block Diagram of Test Setup .....                                                 | 5         |
| 3.3        | Justification .....                                                               | 6         |
| 3.4        | Software Exercise Program.....                                                    | 6         |
| 3.5        | Mode of operation during test .....                                               | 6         |
| 3.6        | Modifications required for Compliance.....                                        | 6         |
| 3.7        | Additions, deviations and exclusions from standards.....                          | 6         |
| <b>4.0</b> | <b>Measurement Results.....</b>                                                   | <b>7</b>  |
| 4.1        | Conducted Output Power at Antenna Terminal .....                                  | 7         |
| 4.2        | 26 dB Bandwidth .....                                                             | 8         |
| 4.3        | Power Density.....                                                                | 9         |
| 4.4        | The ratio of the peak excursion of the modulation envelope to the peak power...10 |           |
| 4.6        | Transmitter Radiated Emissions in Restricted Bands.....                           | 18        |
| 4.8        | AC Line Conducted Emission.....                                                   | 19        |
| 4.8.1      | Line Conducted Emission Limits.....                                               | 19        |
| 4.9        | Radiated Emissions from Digital Section .....                                     | 21        |
| 4.10       | Radiated Emissions from Receiver Section .....                                    | 22        |
| 4.11       | Transmitter Duty Cycle Calculation / Measurements.....                            | 23        |
| 4.12       | Frequency Stability.....                                                          | 24        |
| <b>5.0</b> | <b>List of Test Equipment.....</b>                                                | <b>25</b> |

## 1.0 Summary of Tests

Wireless Bypass, Model: DL-5800H24  
FCC ID: PPS-DL-5800H24

| 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 AbbondanteDate: 6/29/01Staff Engineer:   
Michael F. MurphyDate: 6/29/01

**2.0 General Description****2.1 Product Description**

The EUT Model No.: DL-5800H24 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 HUB**

|                             |                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Applicant                   | Wireless Bypass, Inc.                                                                                                                                                                                                                                                                                                                                                                                                       |
| Trade Name & Model No.      | Cable Access Radio HUB, Model: DL-5800H24                                                                                                                                                                                                                                                                                                                                                                                   |
| FCC Identifier              | PPS-DL-5800H24                                                                                                                                                                                                                                                                                                                                                                                                              |
| Use of Product              | Point-to-point fixed and point-to-multipoint wireless interconnect                                                                                                                                                                                                                                                                                                                                                          |
| Type of Transmission        | 256 QAM, 64 QAM                                                                                                                                                                                                                                                                                                                                                                                                             |
| Maximum RF Output (dBm) *   | 22.1 dBm                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Frequency Range (MHz)       | 5.725 – 5.825 GHz                                                                                                                                                                                                                                                                                                                                                                                                           |
| Number of Channel(s)        | 3                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Antenna(s) & Gain, dBi      | Point-to-Point:<br>Flat Panel Antenna, 23 dBi                      Parabolic Antenna, 28, 34.6, and 37.6 dBi<br>Point-to-Multipoint:<br>Flat Panel Antenna, 23 dBi                      Omni-Directional, 7.5 dBi                                                                                                                                                                                                           |
| Antenna Requirement         | <input type="checkbox"/> The EUT uses a permanently connected antenna.<br><input type="checkbox"/> 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.<br><input checked="" type="checkbox"/> The EUT requires professional installation (attach supporting documentation if using this option). |
| Manufacturer name & address | Wireless Bypass, Inc.<br>43 Northwestern Drive<br>Salem, MA, 03079                                                                                                                                                                                                                                                                                                                                                          |

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

**2.2 Related Submittal(s)/Grants**

Cable Access Radio CPE  
Model: DL-5800C24  
FCC ID: PPS-DL-5800C24

## 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**

| <b>Description:</b>    | <b>Model #:</b>    | <b>Serial #:</b> | <b>FCC ID:</b>           |
|------------------------|--------------------|------------------|--------------------------|
| 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-5800C24         | ENG1             | (Pending) PPS-DL-5800C24 |

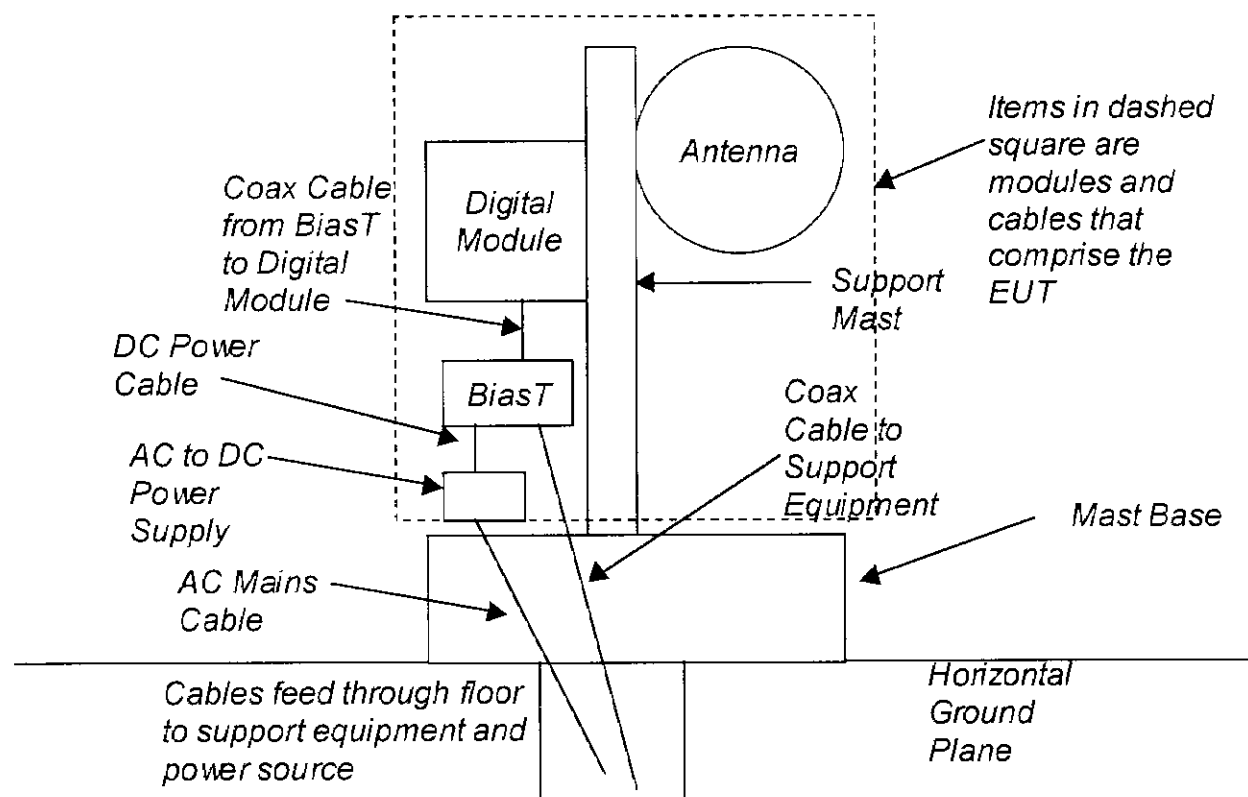
**Cables:**

| <b>Description:</b> | <b>Shield:</b> | <b>Connector:</b> | <b>Length:</b> | <b>Quantity:</b> |
|---------------------|----------------|-------------------|----------------|------------------|
| AC Mains            | None           | Plastic           | 2              | 1                |
| Coaxial             | Coaxial        | Full 360° Metal   | 3              | 1                |

**Antennas:**

| <b>Description</b>                       | <b>Usage</b>                           | <b>Model No.</b> |
|------------------------------------------|----------------------------------------|------------------|
| Telex Omni-Directional Antenna 7.5 dBi   | Point-to-Multipoint                    | 5830AA           |
| Gabriel Flat Panel Antenna 23 dBi        | Point-to-Multipoint,<br>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          |

## 3.2 Block Diagram of Test Setup



### 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 dBm + 10Log(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,<br>MHz  | Output Power,<br>mW | Output Power,<br>dBm | Limit, dBm | Maximum allowed<br>antenna gain, dBi |
|--------------------|---------------------|----------------------|------------|--------------------------------------|
| Low Channel: 5793  | 163.0               | 22.1                 | 24.7       | 8.6(p-mp), 25.6(p-p)                 |
| Mid Channel: 5805  | 102.2               | 20.1                 | 24.7       | 10.6(p-mp), 27.6(p-p)                |
| High Channel: 5817 | 65.0                | 18.1                 | 24.7       | 12.6(p-mp), 29.6(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,<br>MHz | 26 dB Bandwidth,<br>MHz |
|-------------------|-------------------------|
| 5793              | 5.81                    |
| 5805              | 5.86                    |
| 5817              | 5.84                    |

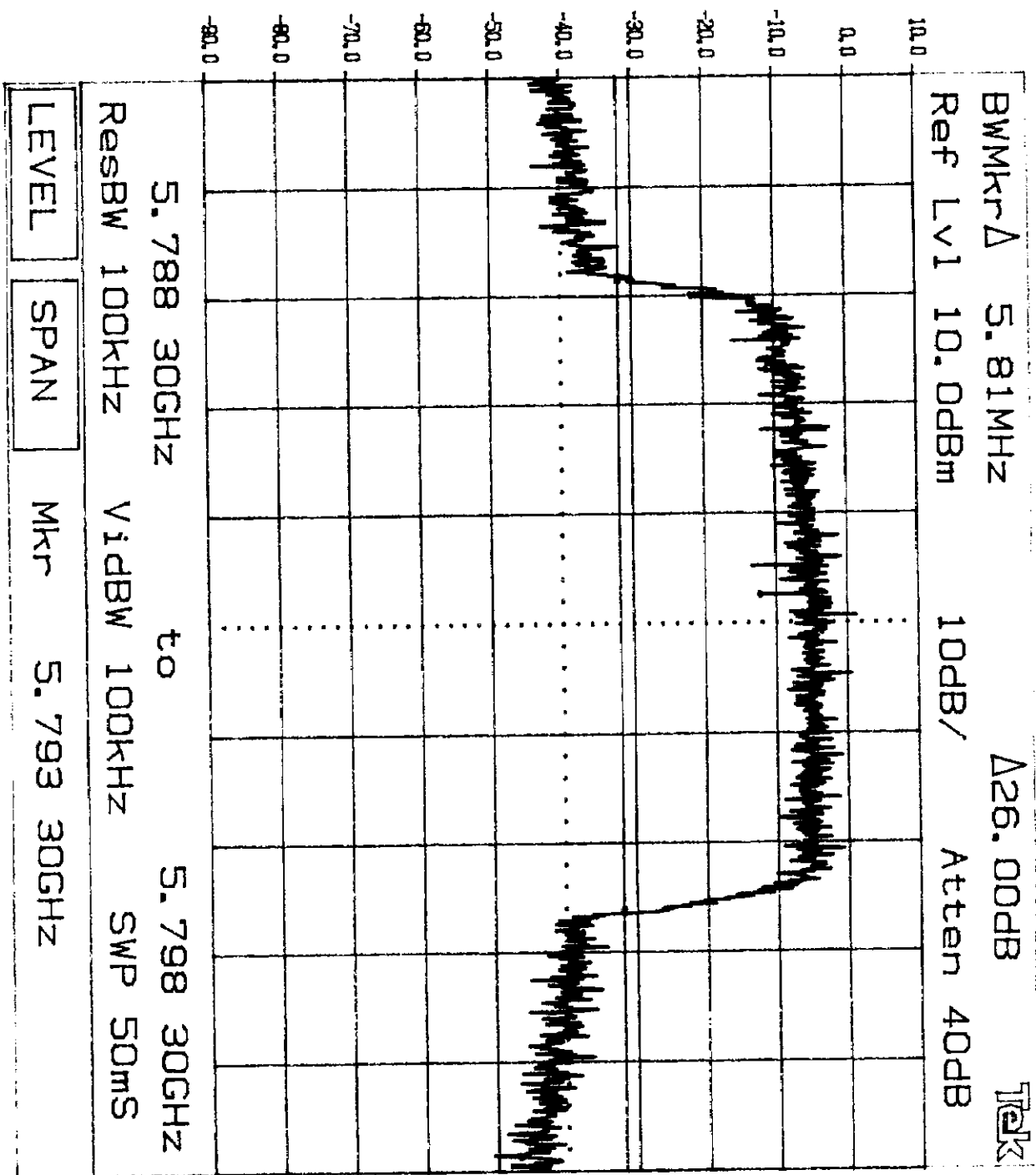
Refer to the following plots for 26 dB bandwidth:

Plot 1a: Low Channel 26 dB Bandwidth

Plot 1b: Mid Channel 26 dB Bandwidth

Plot 1c: High Channel 26 dB Bandwidth

12



KN0B 2

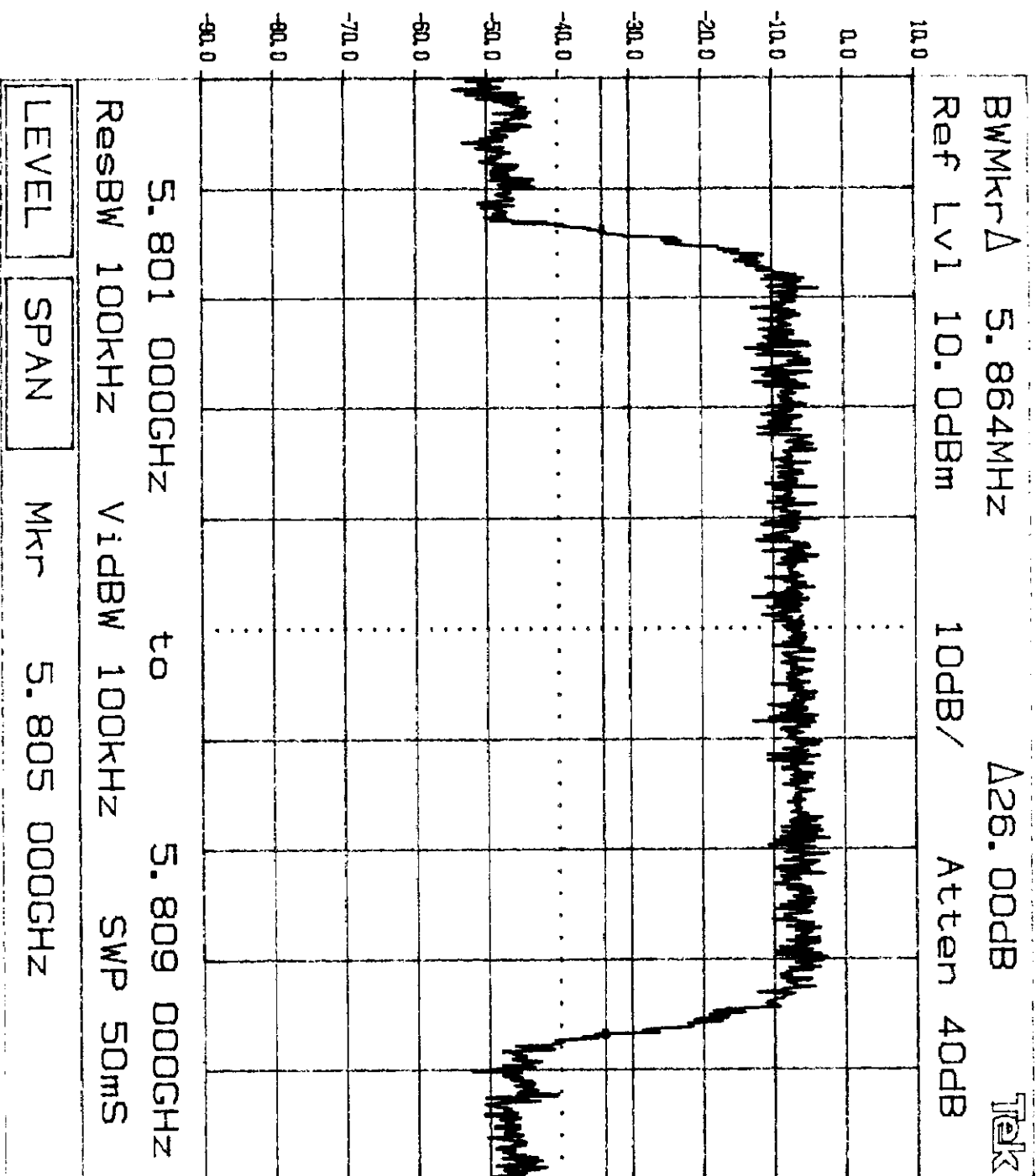
KN0B 1

KEYPAD

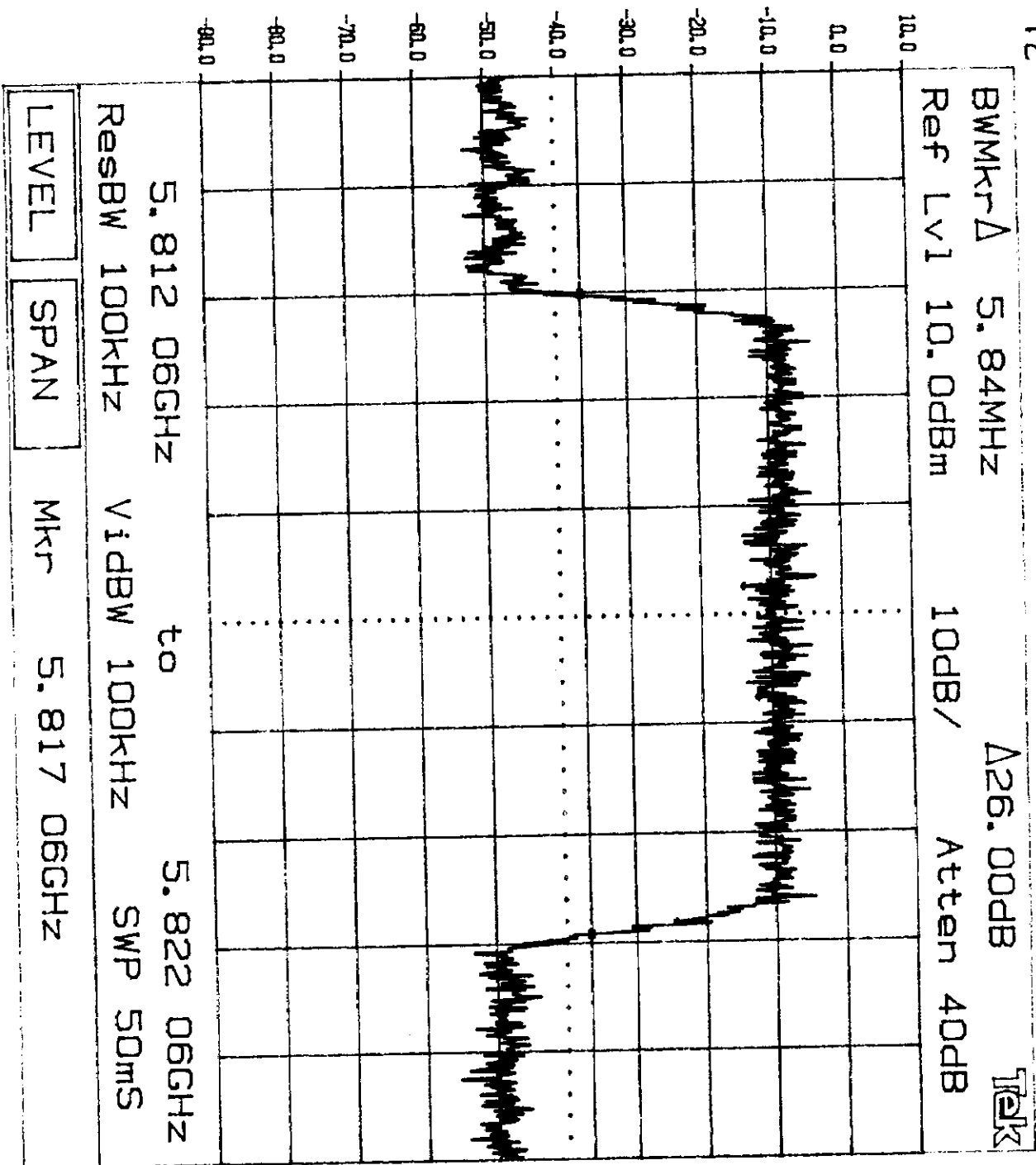
Tektronix

2784

16



1c



## 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<br>MHz | Power Density<br>DBm | EIRP Limit<br>DBm   | Maximum Allowed Antenna Gain<br>dBi |
|------------------|----------------------|---------------------|-------------------------------------|
| 5793             | 17.7                 | 23.0(p-mp), 40(p-p) | 5.3 (p-mp), 22.3 (p-p)              |
| 5805             | 16.9                 | 23.0(p-mp), 40(p-p) | 6.1 (p-mp), 23.1 (p-p)              |
| 5817             | 14.1                 | 23.0(p-mp), 40(p-p) | 8.9 (p-mp), 25.9 (p-p)              |

Refer to the following plots for power density data:

Plot 2a: Low Channel Power Density

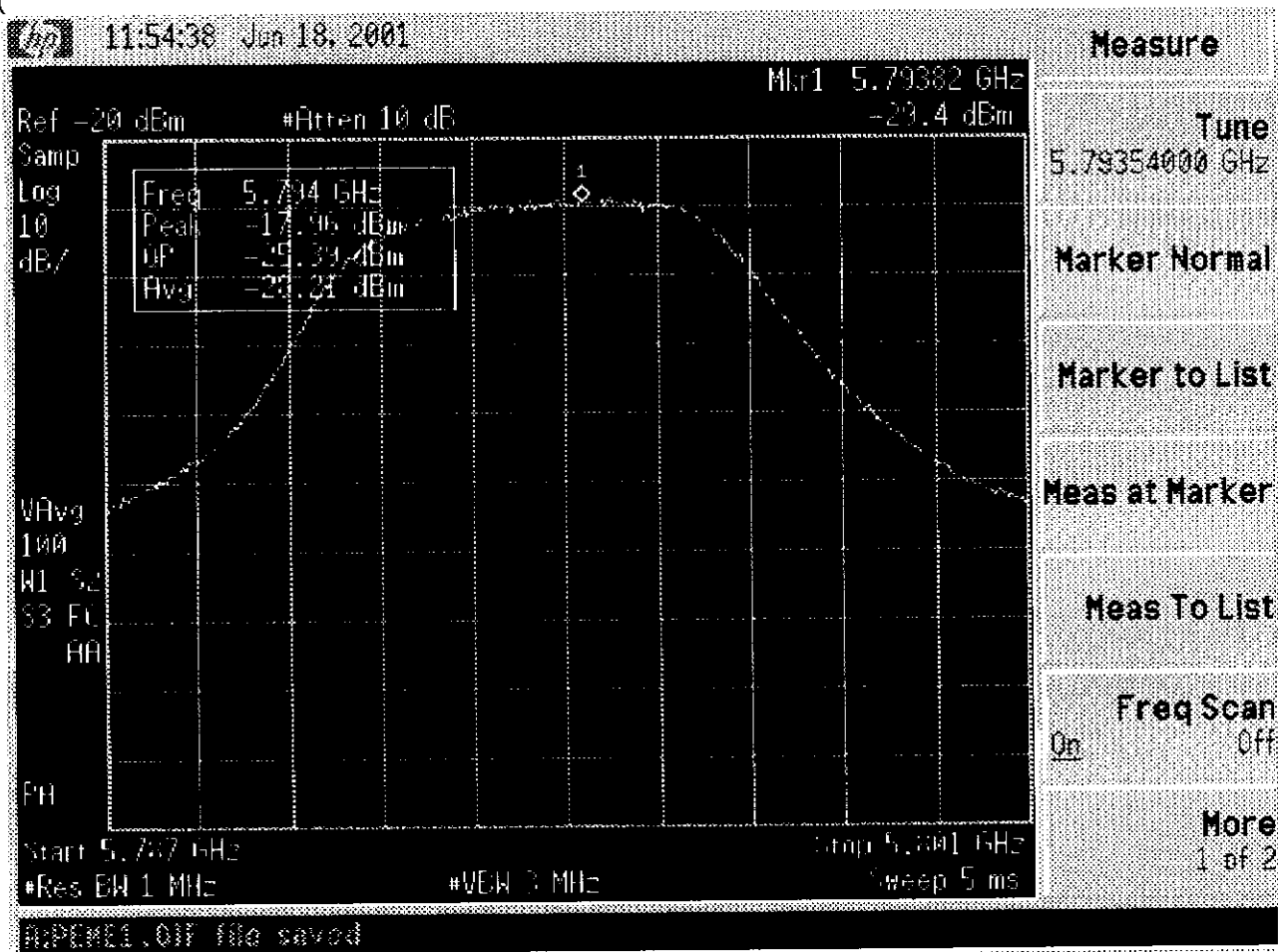
Plot 2b: Mid Channel Power Density

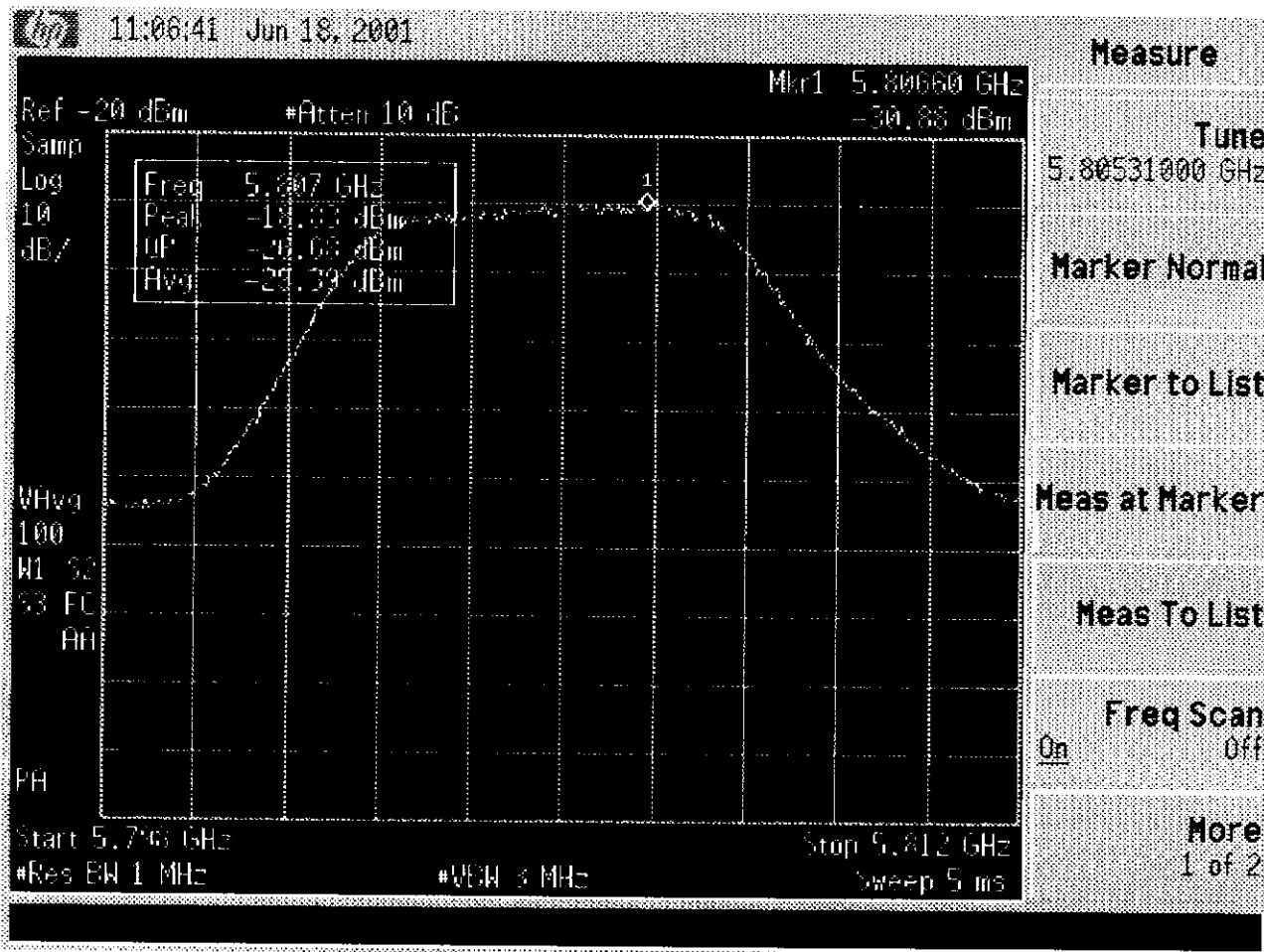
Plot 2c: High Channel Power Density

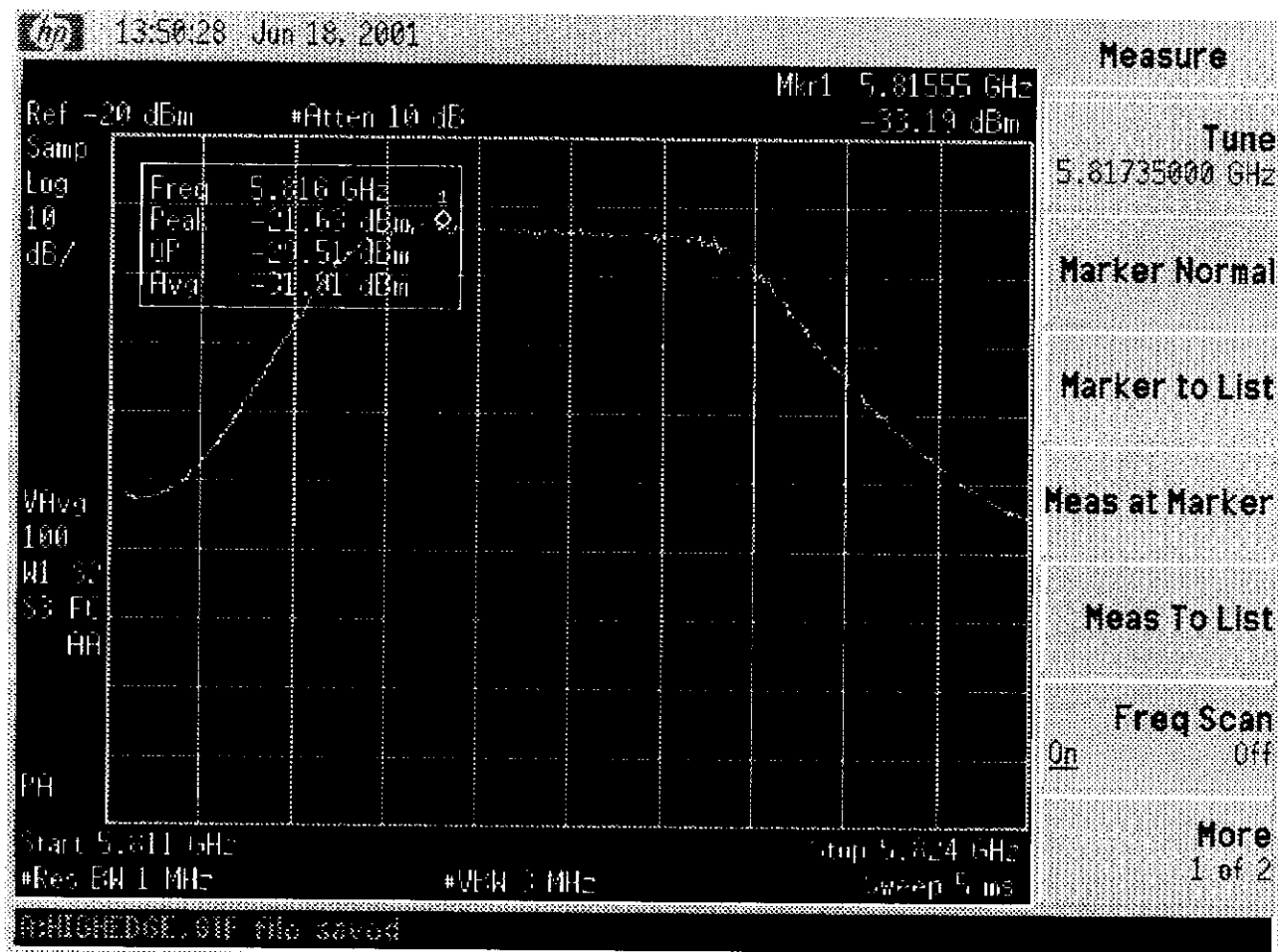
### Note:

1. (p-mp) refers to "Point to Multipoint" operation, while (p-p) refers to "Point to Point" operation.
2. 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:

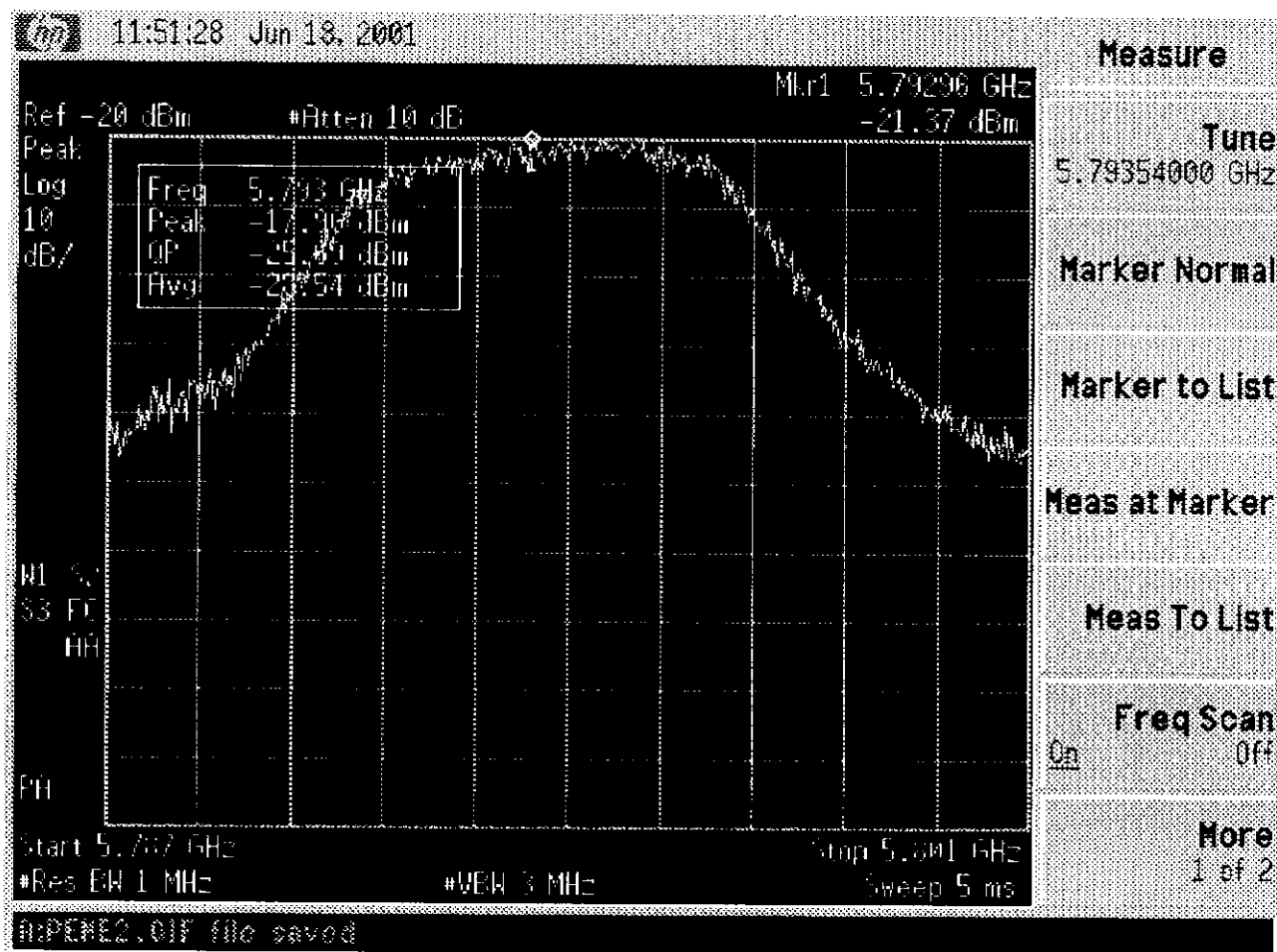
The ratio of the peak excursion of the modulation envelope to the peak transmit power shall not exceed 13 dB.

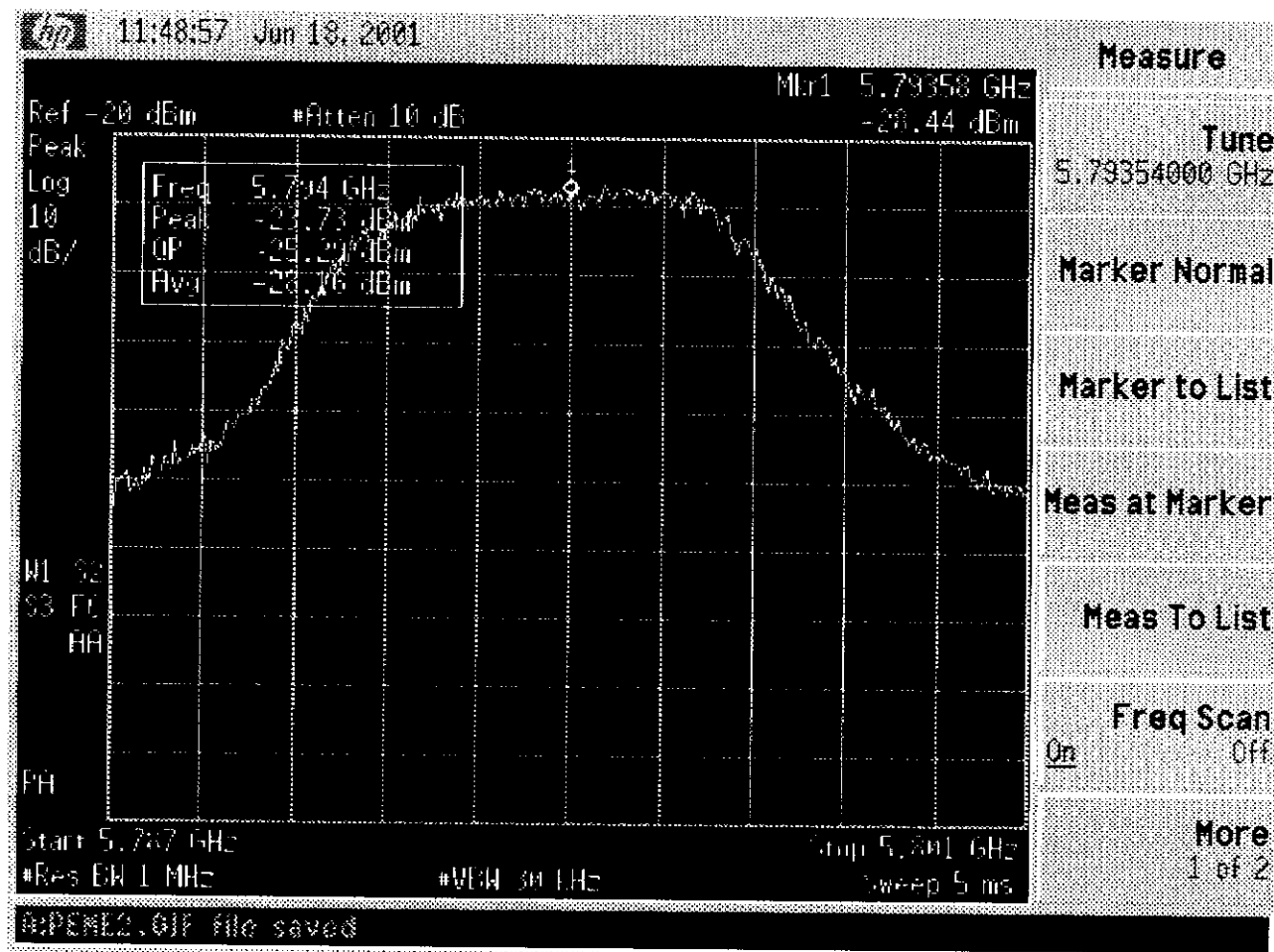
Procedure:

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.

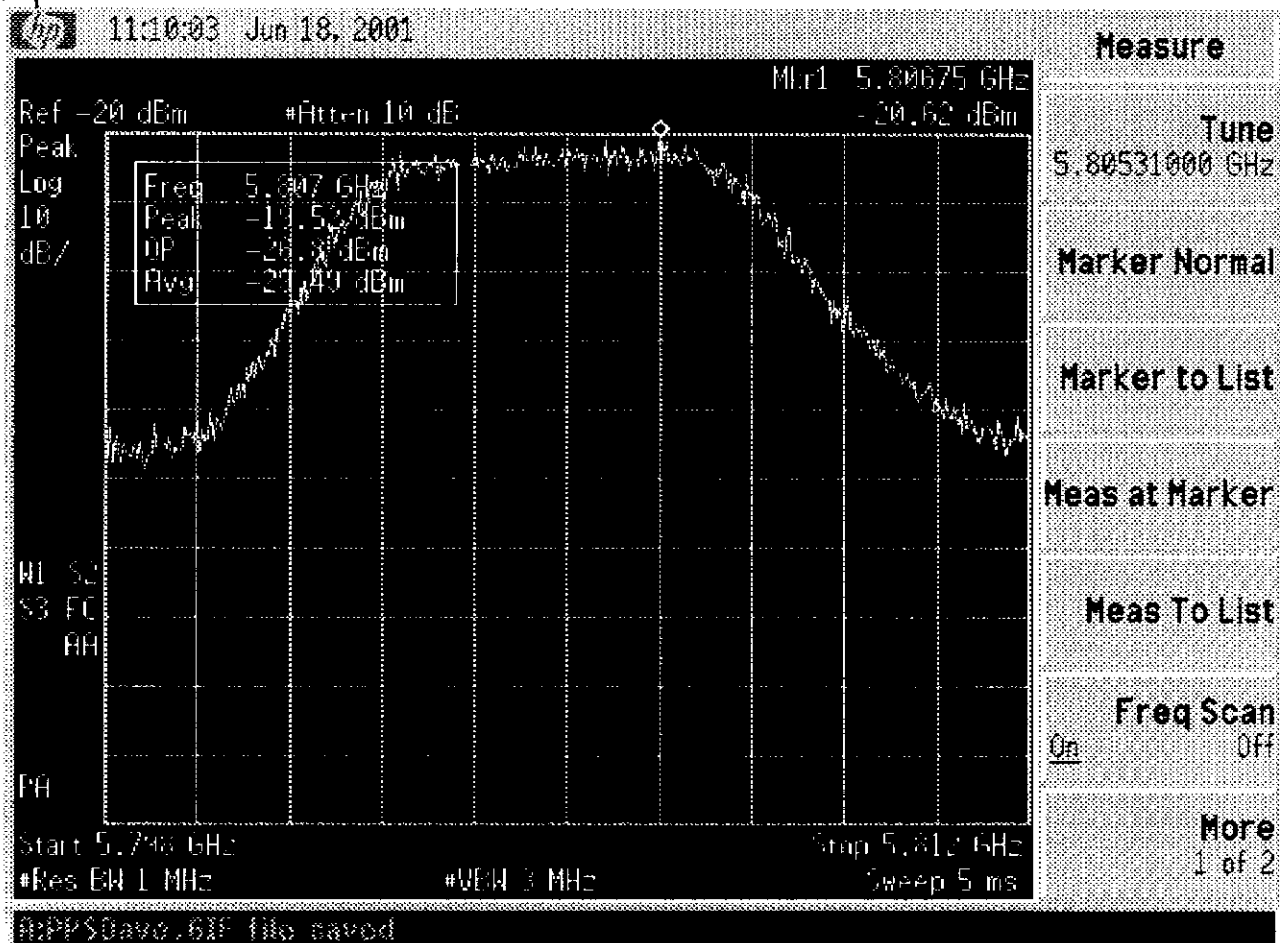
Test Result:

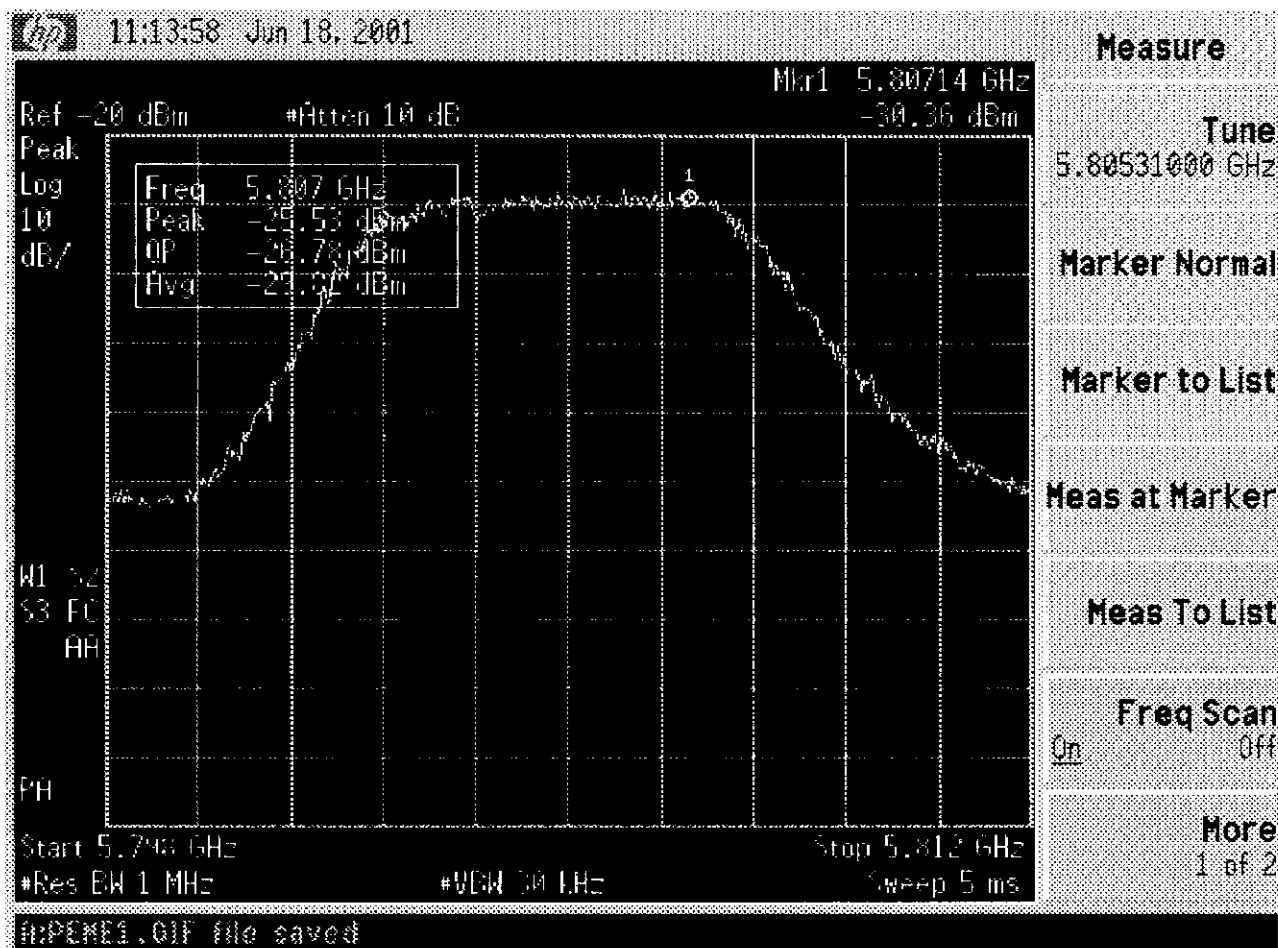
See attached plots 3.a1, 3.a2, 3.b1, 3.b2, 3.c1 and 3.c2 for the ratio of the peak excursion of the modulation envelope to the peak power. The maximum Ratio is 6.01 dB.

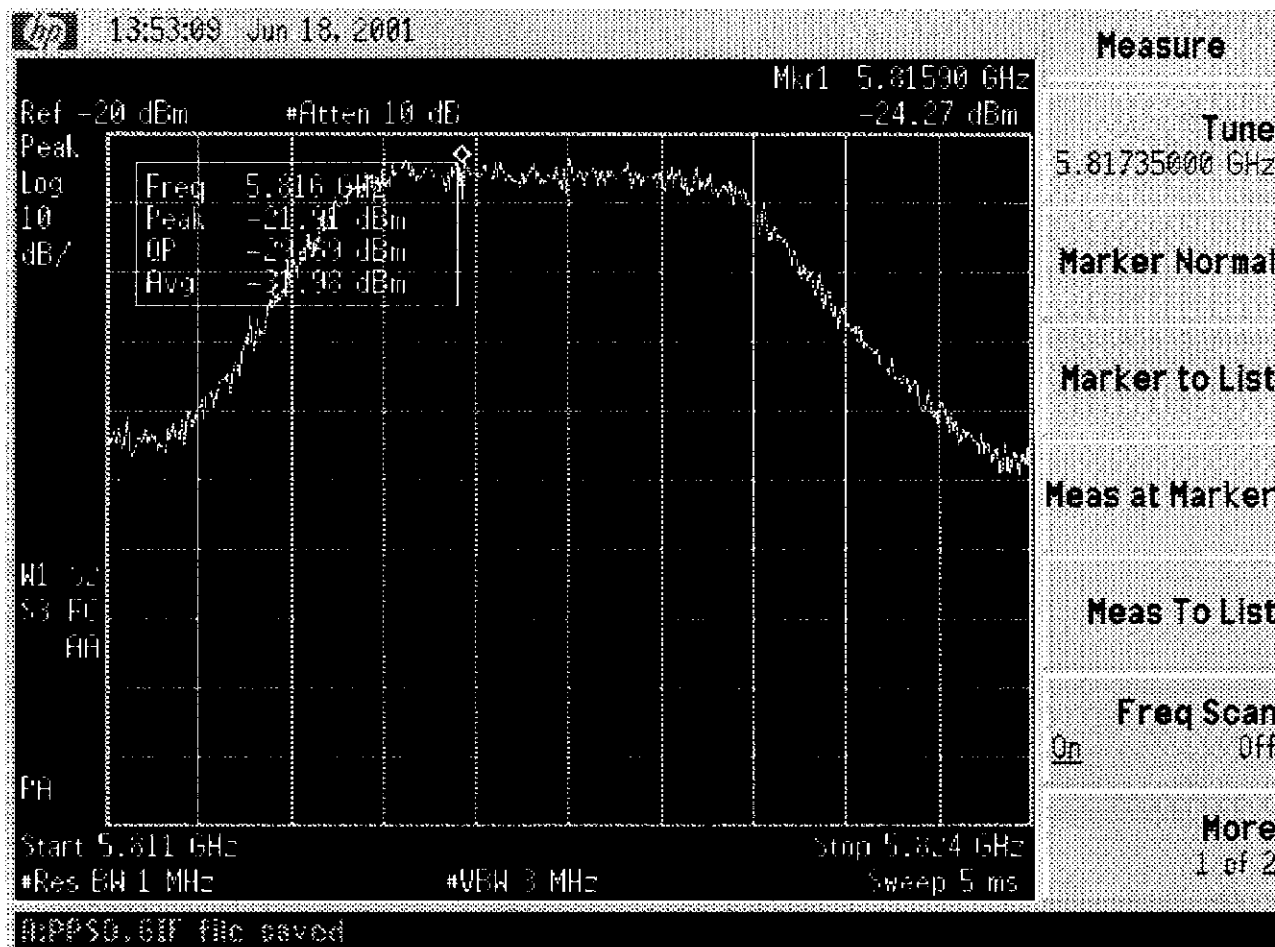




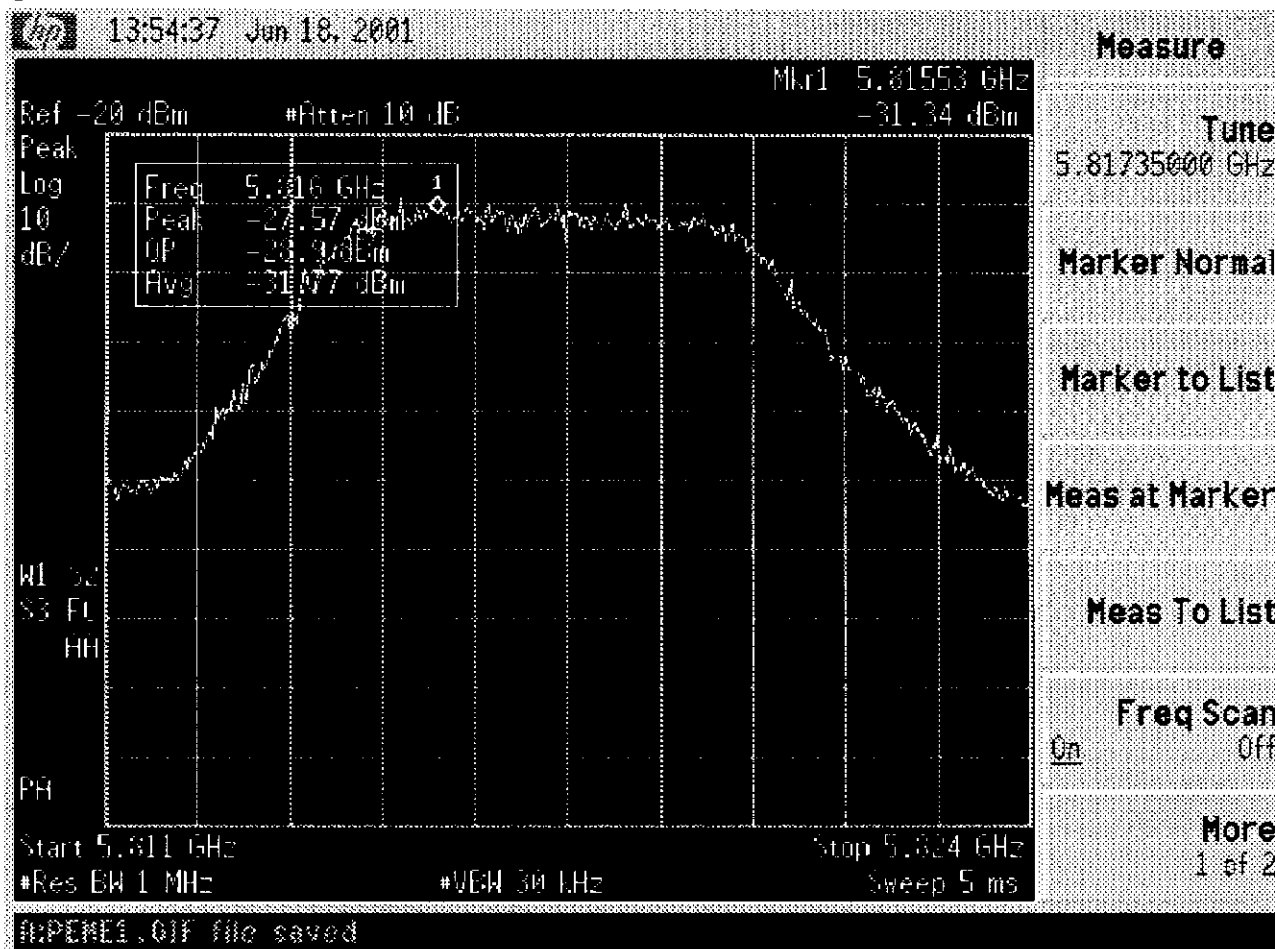
3b1







3c2



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: Omni-Directional 7.5 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, 5793 MHz.

Plot 4.g1 – 4.g2: Mid Channel Band Edge Measurements, 5805 MHz.

Plot 4.h1 – 4.h2: High Channel Band Edge Measurements, 5817 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 |
|---------------------|----------------|-------------------------|---------------------|
| 5793 MHz            | 5720           | -34.4<br>from plot 4.f1 | -17.0               |
|                     | 5830           | -26.3<br>from plot 4.f2 | -17.0               |

| Operating frequency | Frequency, MHz | Conducted Level, dBm    | Limit, dBm/MHz |
|---------------------|----------------|-------------------------|----------------|
| 5805 MHz            | 5723           | -34.7<br>from plot 4.g1 | -17.0          |
|                     | 5830           | -26.5<br>from plot 4.g2 | -17.0          |

| Operating frequency | Frequency, MHz | Conducted Level, dBm    | Limit, dBm/MHz |
|---------------------|----------------|-------------------------|----------------|
| 5817 MHz            | 5720           | -34.8<br>from plot 4.g1 | -17.0          |
|                     | 5830           | -25.9<br>from plot 4.g2 | -17.0          |

# Intertek Testing Services

## Radiated Emissions / Interference

Table: A

Company: Wireless Bypass

Model: DL-5600H24

Job No.: J20046196

Date: 06/15/01

Standard: FCC15

Class: A

Group: None

Notes: Radiowaves 2' parabolic on HUB

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

Antenna: LOG1

PreAmp: 0

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

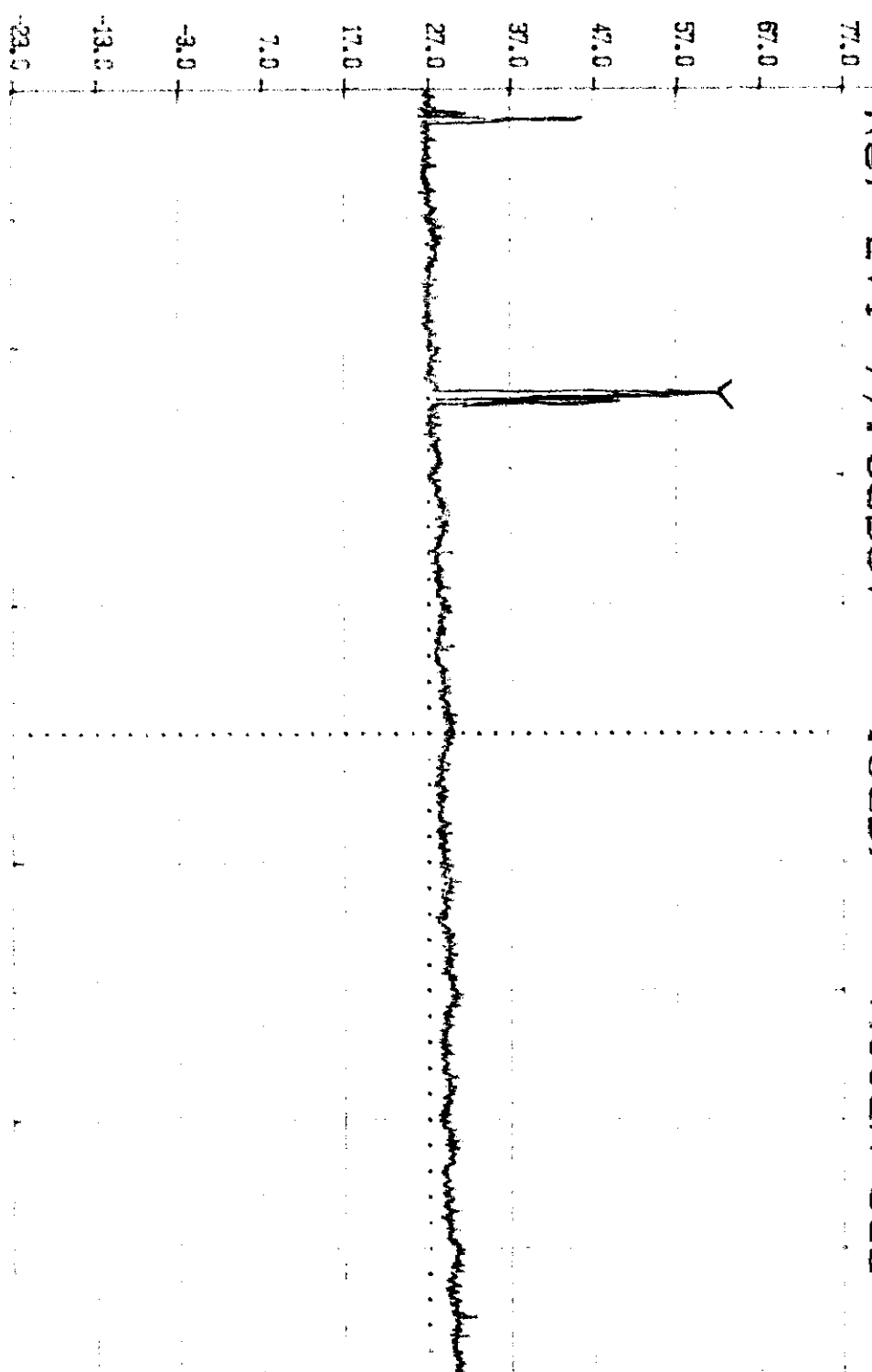
Distance: 3 meters

| Ant.<br>Pol.<br>(V/H) | Frequency<br>MHz | Reading<br>dB(uV) | Antenna<br>Factor<br>dB(1/m) | Cable<br>Loss<br>dB | Pre-amp<br>Factor<br>dB | Distance<br>Factor<br>dB | Net<br>dB(uV/m) | Limit<br>dB(uV/m) | Margin<br>dB |
|-----------------------|------------------|-------------------|------------------------------|---------------------|-------------------------|--------------------------|-----------------|-------------------|--------------|
| V                     | 38.020           | 14.8              | 13.5                         | 0.7                 | 0.0                     | 0.0                      | 29.0            | 40.0              | -11.0        |
| V                     | 43.780           | 23.4              | 11.0                         | 0.8                 | 0.0                     | 0.0                      | 35.1            | 40.0              | -4.9         |
| V                     | 62.220           | 19.4              | 7.1                          | 0.9                 | 0.0                     | 0.0                      | 27.4            | 40.0              | -12.6        |
| V                     | 74.560           | 21.7              | 6.4                          | 0.9                 | 0.0                     | 0.0                      | 29.0            | 40.0              | -11.0        |
| V                     | 108.800          | 14.5              | 7.3                          | 1.3                 | 0.0                     | 0.0                      | 23.0            | 43.5              | -20.5        |
| V                     | 126.300          | 16.7              | 6.8                          | 1.4                 | 0.0                     | 0.0                      | 24.8            | 43.5              | -18.7        |
| V                     | 136.700          | 13.3              | 7.2                          | 1.4                 | 0.0                     | 0.0                      | 21.9            | 43.5              | -21.6        |

4a1

Mkr 1.948GHz 61.49dBuV Tek

Ref Lvl 77.0dBuV 10dB/ Atten 0dB



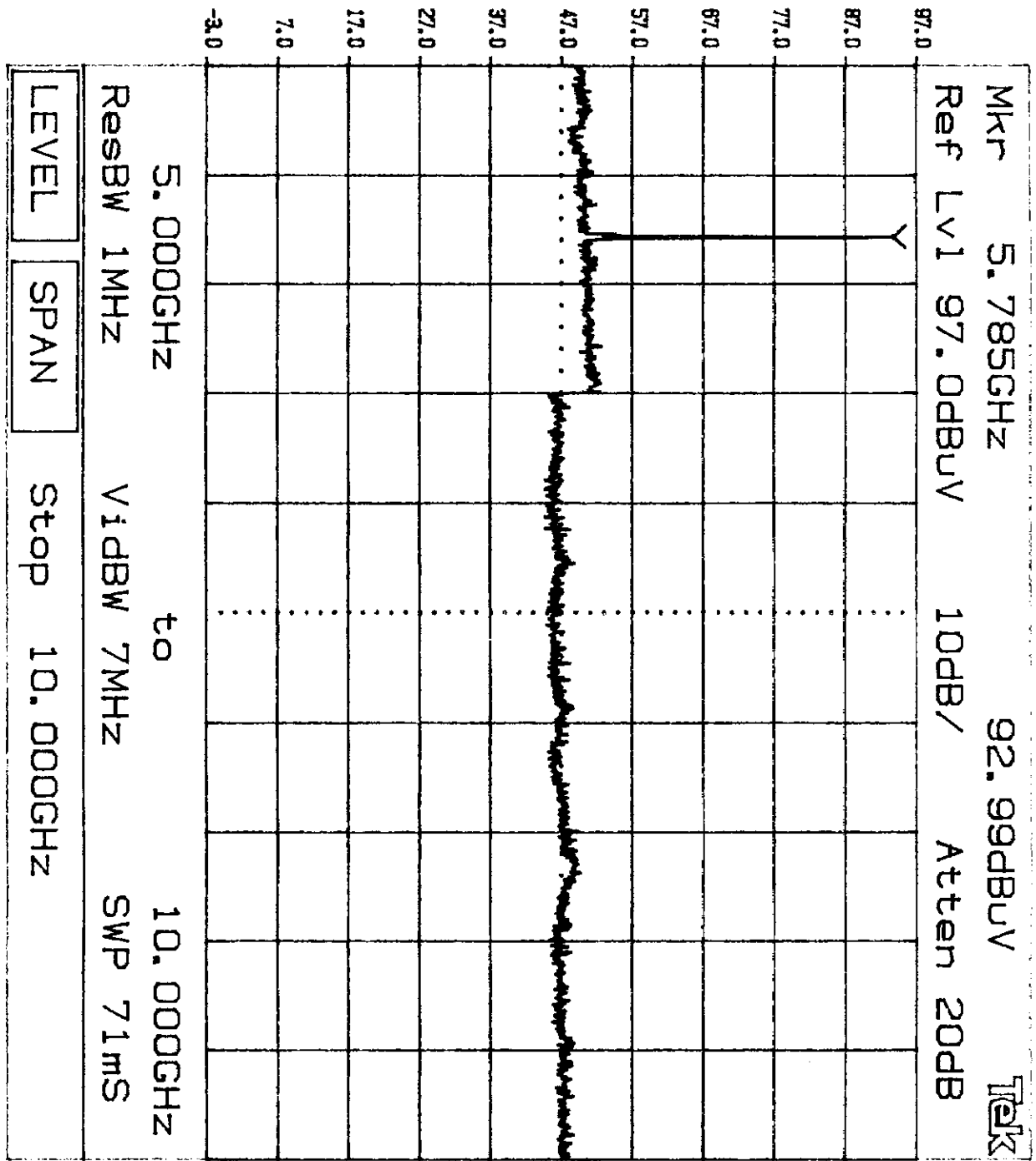
1.000GHz 6.0 3.000GHz

PROB 1MHz 14.0dB 1MHz SWP 10ms

LEVEL SPAN Stop 3.000GHz

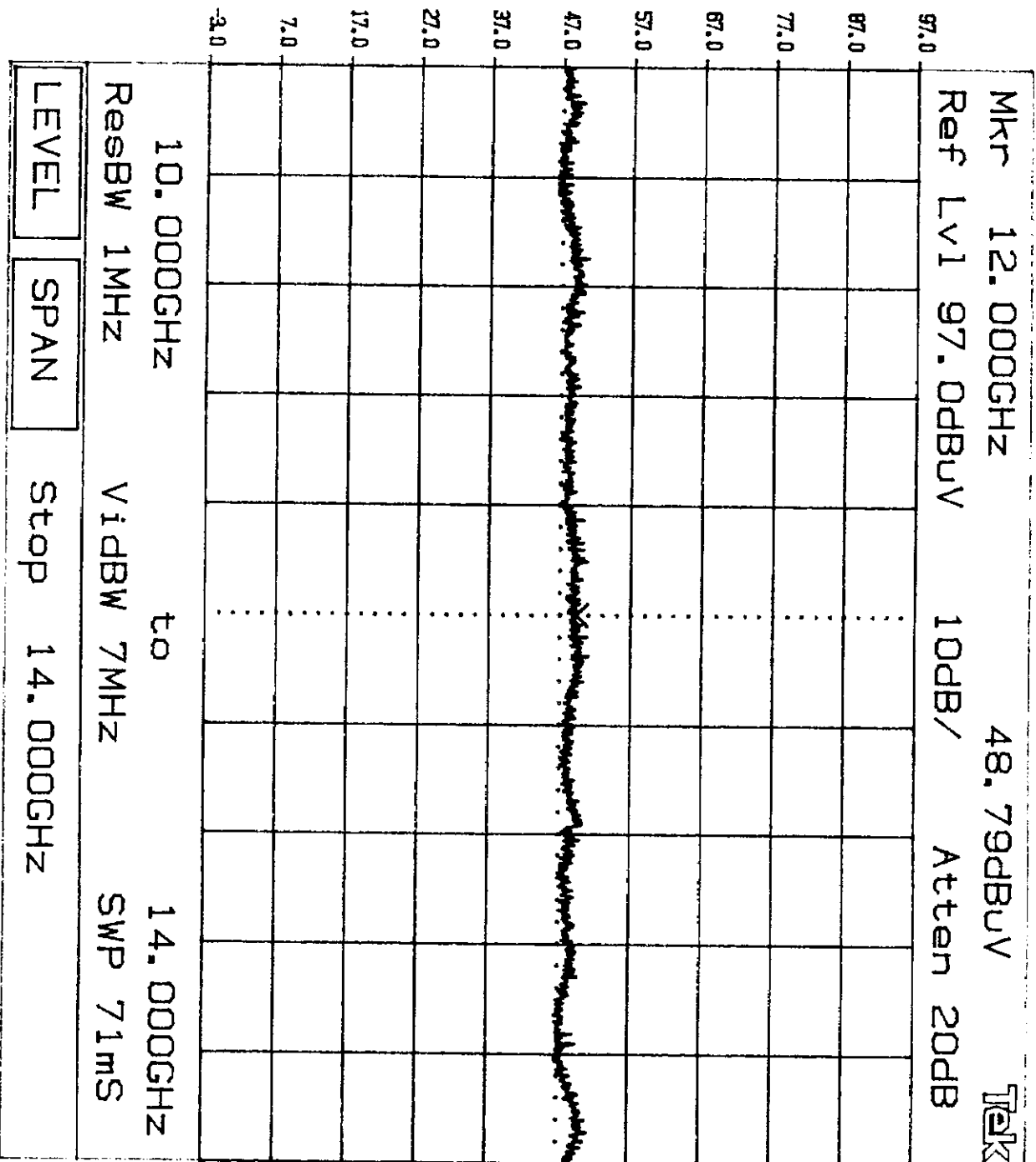
KN08 2 KN08 1 KEYPAD Tektronix 2784

4a2



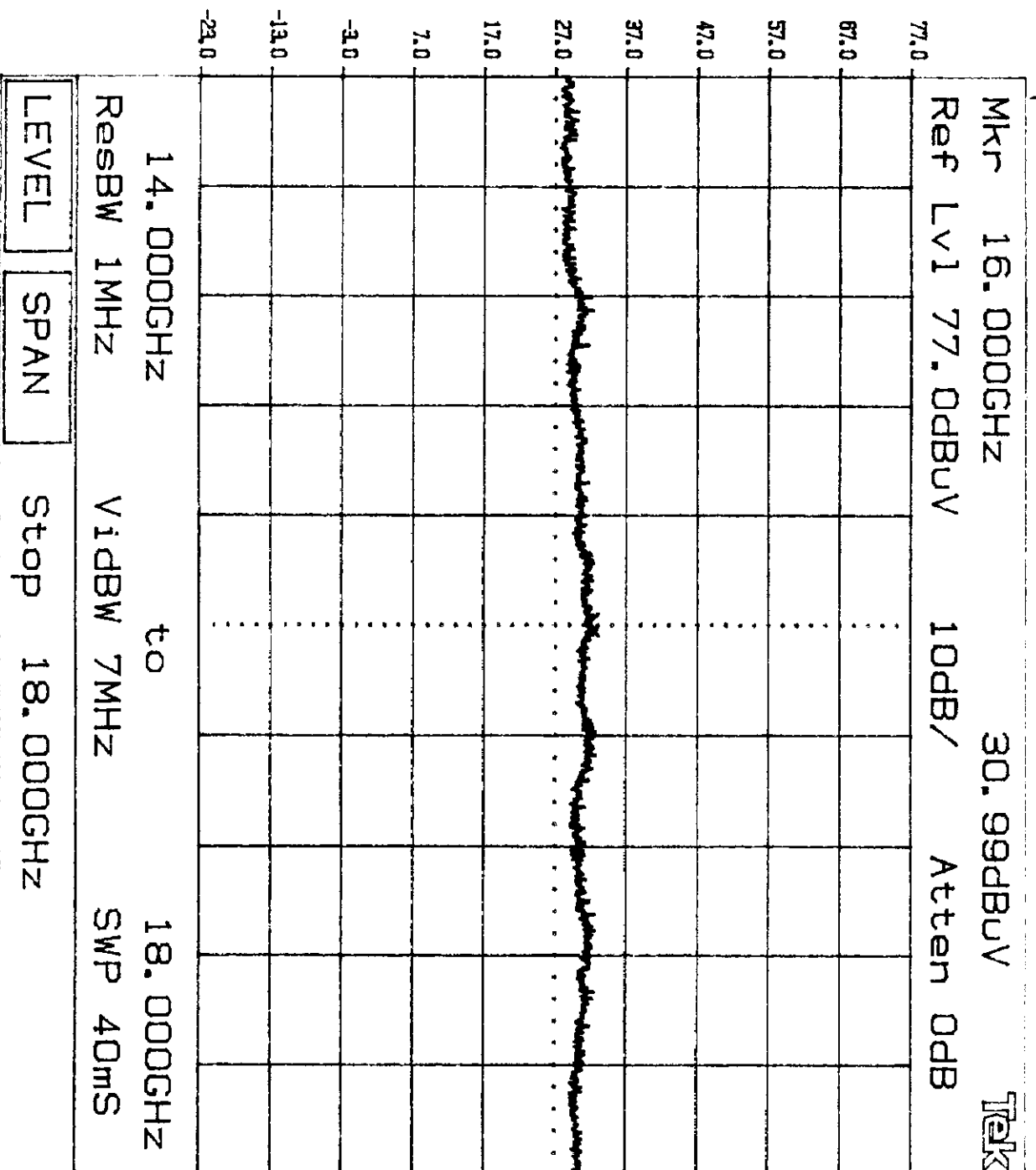
KNOB 2 KNOB 1 KEYPAD Tektronix 2784

4a3



Knob 2 Knob 1 Keypad Tektronix 2784

4.4



Knob 2

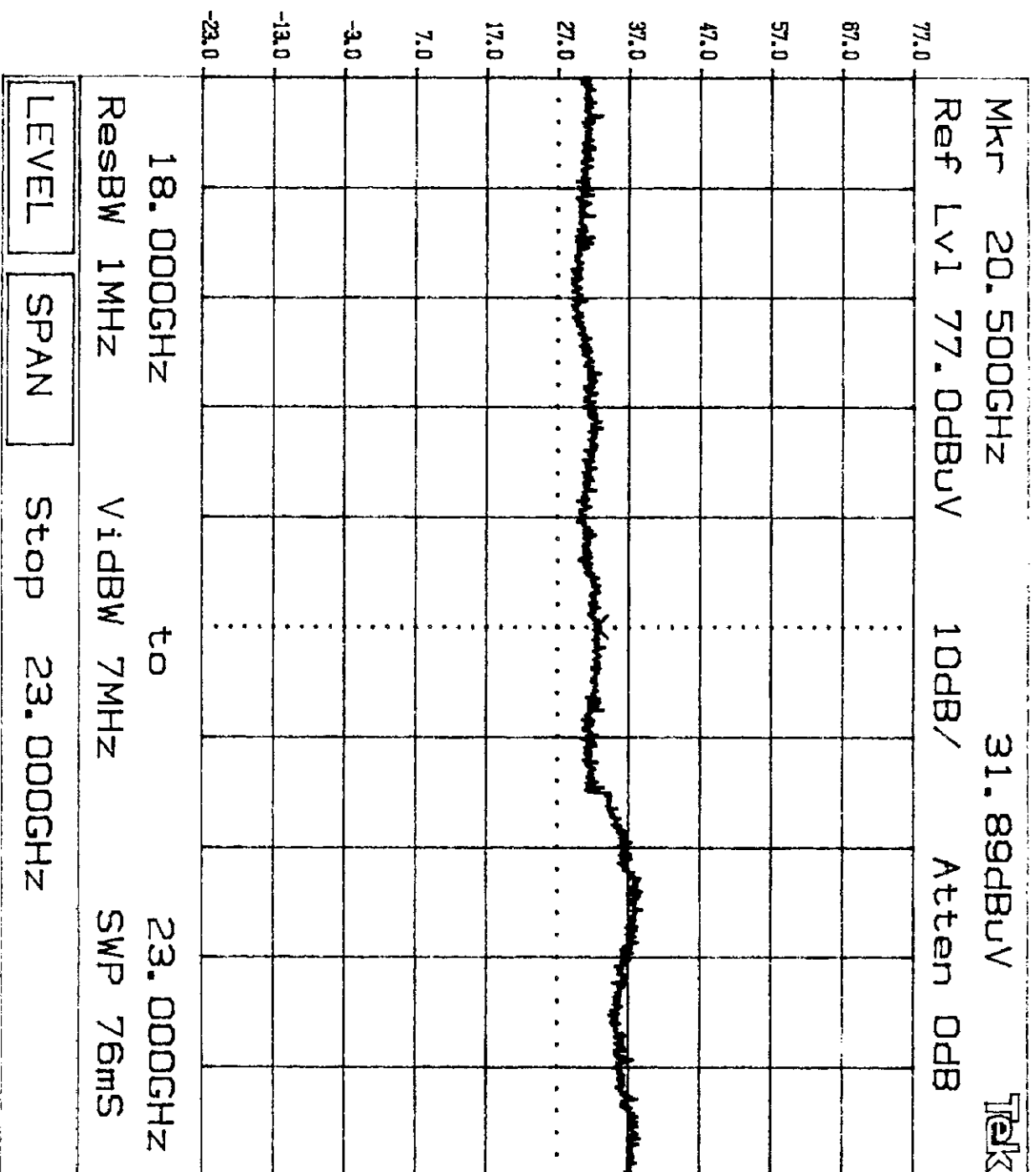
Knob 1

Keypad

Tektronix

2784

4<sub>us</sub>



KN0B 2

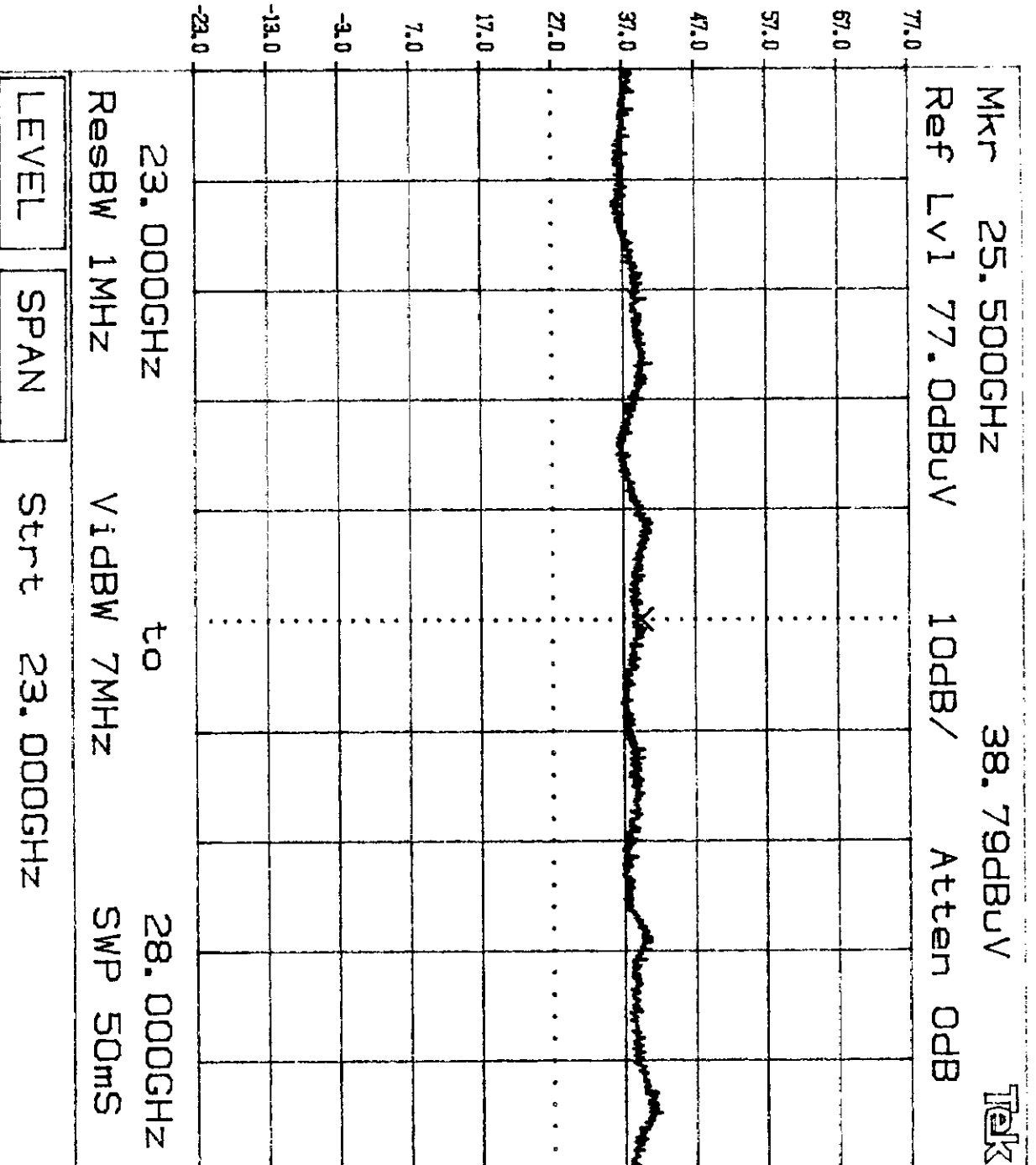
KN0B 1

KEYPAD

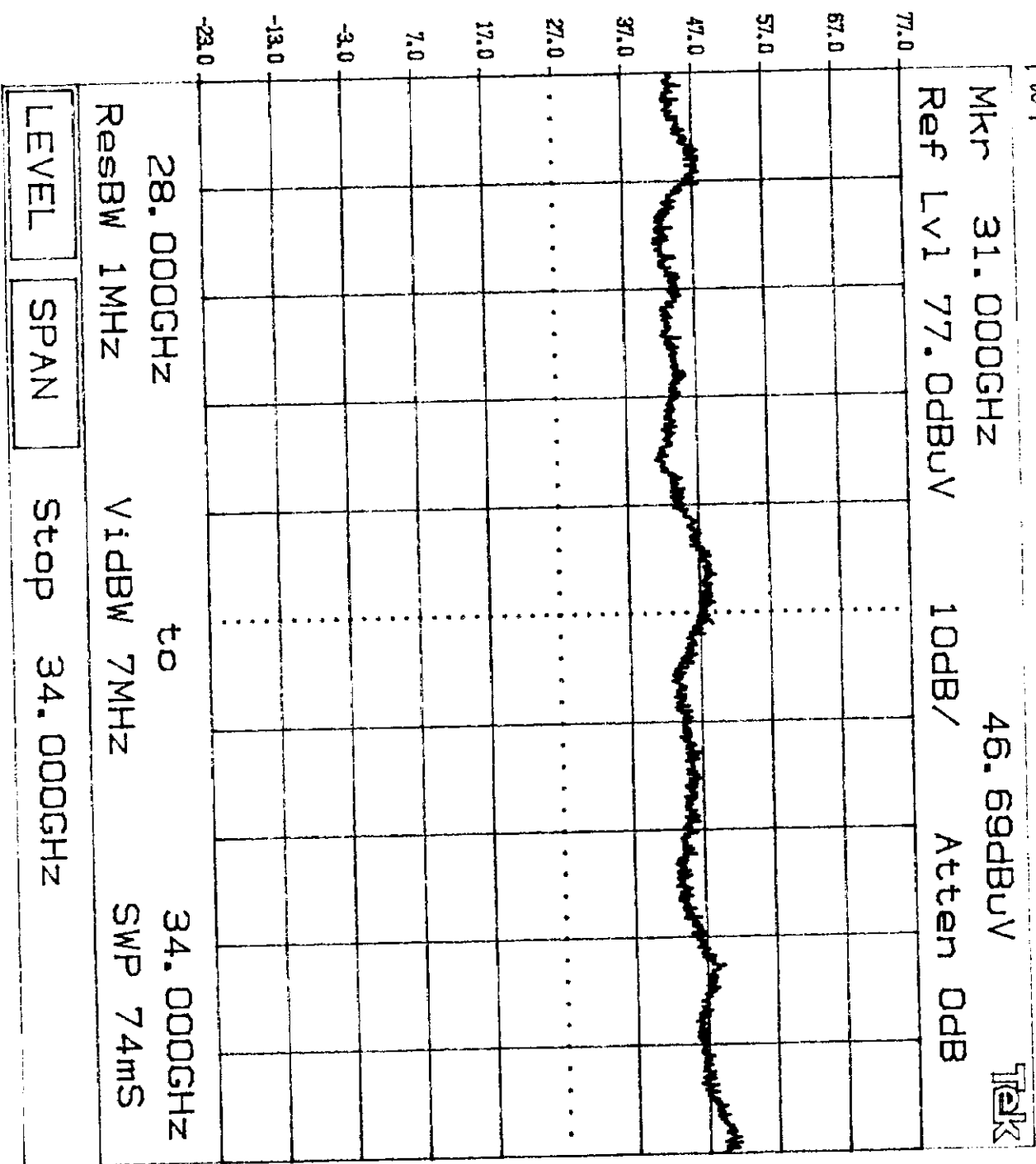
Tektronix

2784

4a6



4.7



Knob 2

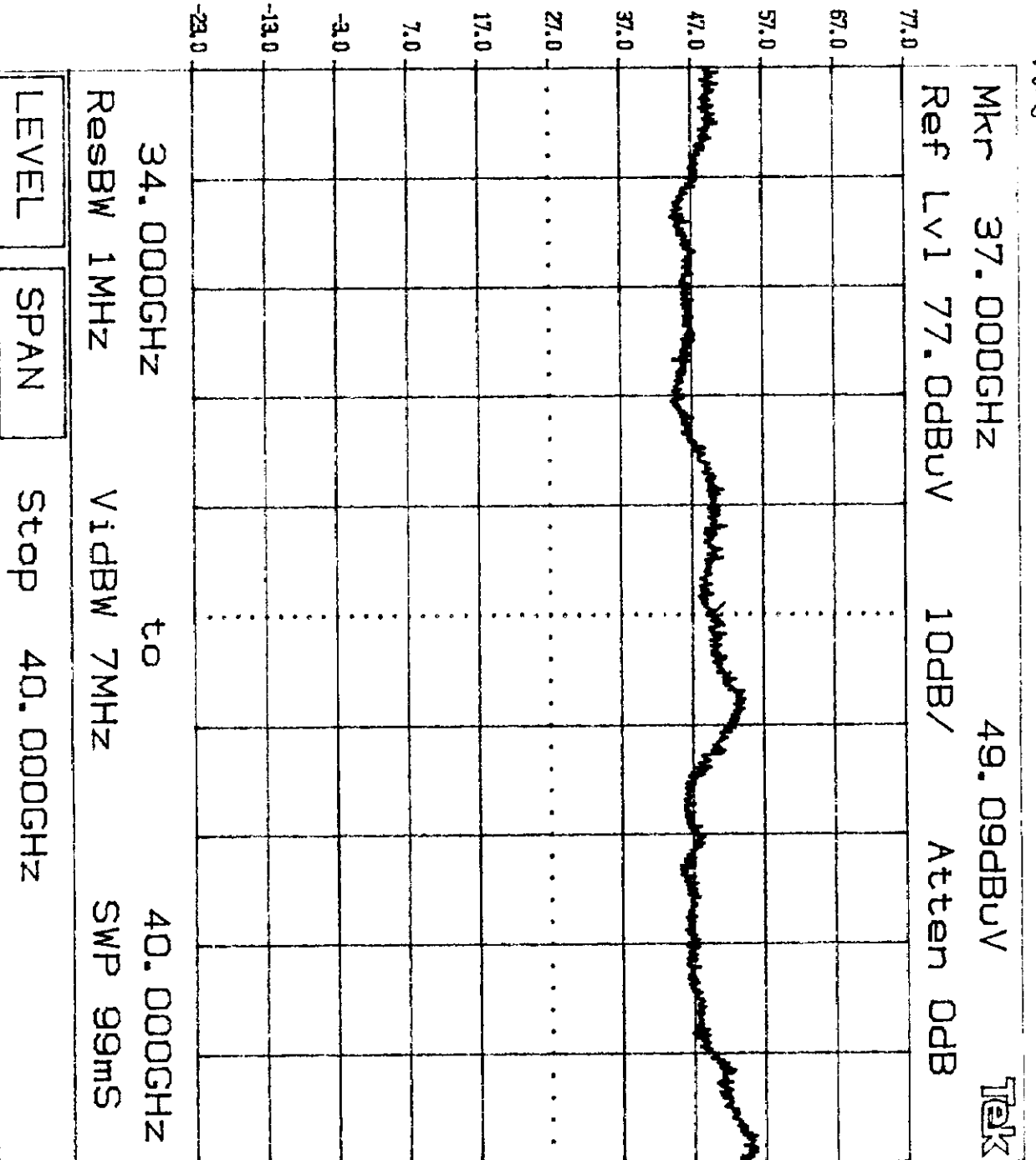
Knob 1

Keypad

Tektronix

2784

4.8



# Intertek Testing Services

## Radiated Emissions / Interference

Table: B

Company: Wireless Bypass

Model: DL-5800H24

Job No.: J20045196

Date: 06/14/01

Standard: FCC15

Class: A Group: None

Notes: Radiowaves 6' Parabolic on HUB

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

Antenna: LOG1

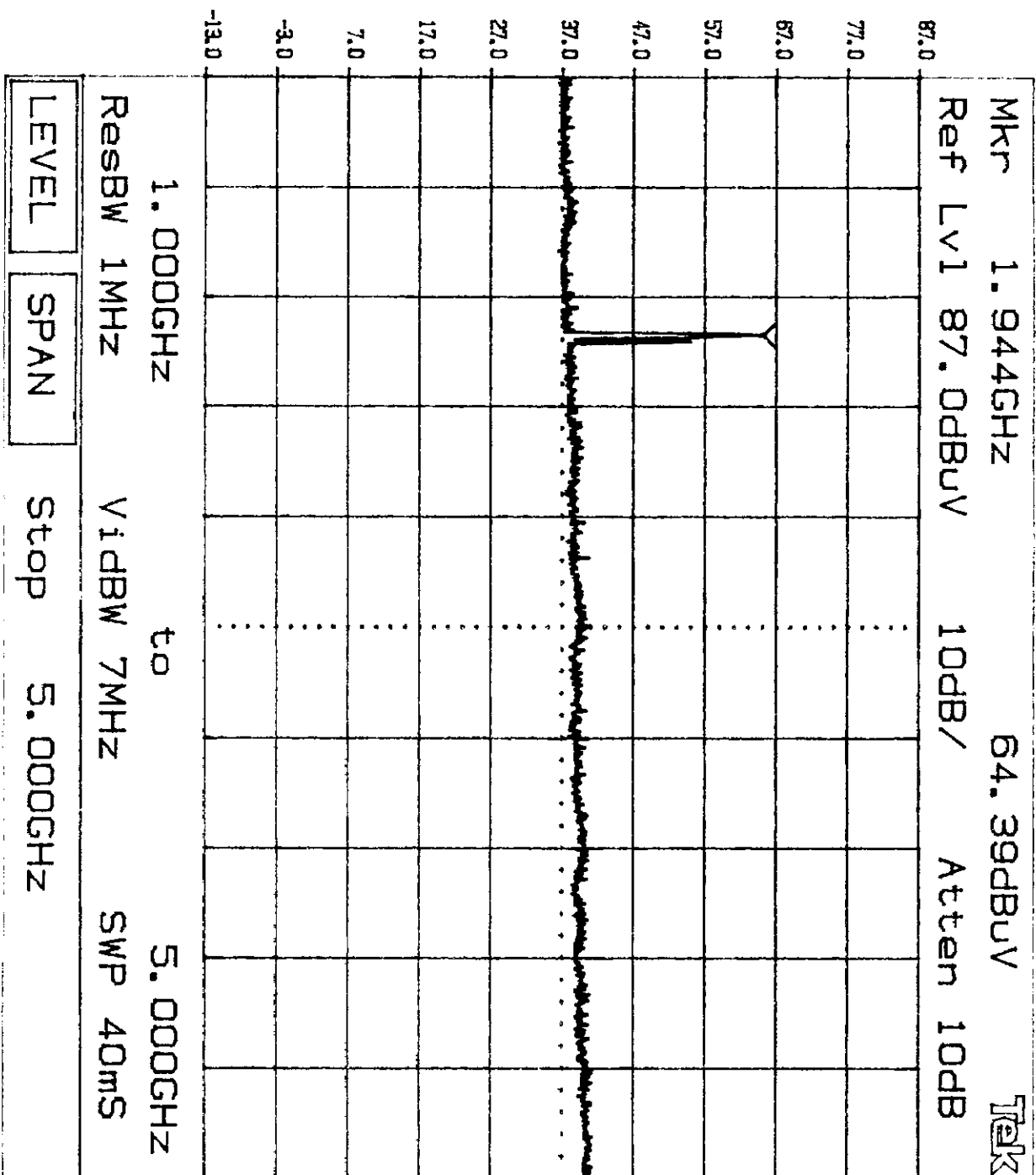
PreAmp: 0

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

Distance: 3 meters

| Ant.<br>Pol.<br>(V/H) | Frequency<br>MHz | Reading<br>dB(uV) | Antenna<br>Factor<br>dB(1/m) | Cable<br>Loss<br>dB | Pre-amp<br>Factor<br>dB | Distance<br>Factor<br>dB | Net<br>dB(uV/m) | Limit<br>dB(uV/m) | Margin<br>dB |
|-----------------------|------------------|-------------------|------------------------------|---------------------|-------------------------|--------------------------|-----------------|-------------------|--------------|
| V                     | 36.840           | 14.8              | 14.2                         | 0.7                 | 0.0                     | 0.0                      | 29.6            | 40.0              | -10.4        |
| V                     | 43.810           | 25.2              | 11.0                         | 0.8                 | 0.0                     | 0.0                      | 35.9            | 40.0              | -3.1         |
| V                     | 74.560           | 21.2              | 6.4                          | 0.9                 | 0.0                     | 0.0                      | 28.5            | 40.0              | -11.5        |
| V                     | 108.800          | 17.8              | 7.3                          | 1.3                 | 0.0                     | 0.0                      | 26.3            | 43.5              | -17.2        |
| V                     | 110.700          | 18.2              | 7.2                          | 1.3                 | 0.0                     | 0.0                      | 26.6            | 43.5              | -16.9        |
| V                     | 134.300          | 16.6              | 7.1                          | 1.4                 | 0.0                     | 0.0                      | 25.1            | 43.5              | -18.4        |
| V                     | 161.300          | 13.7              | 8.8                          | 1.6                 | 0.0                     | 0.0                      | 24.1            | 43.5              | -19.4        |

461



Knob 2

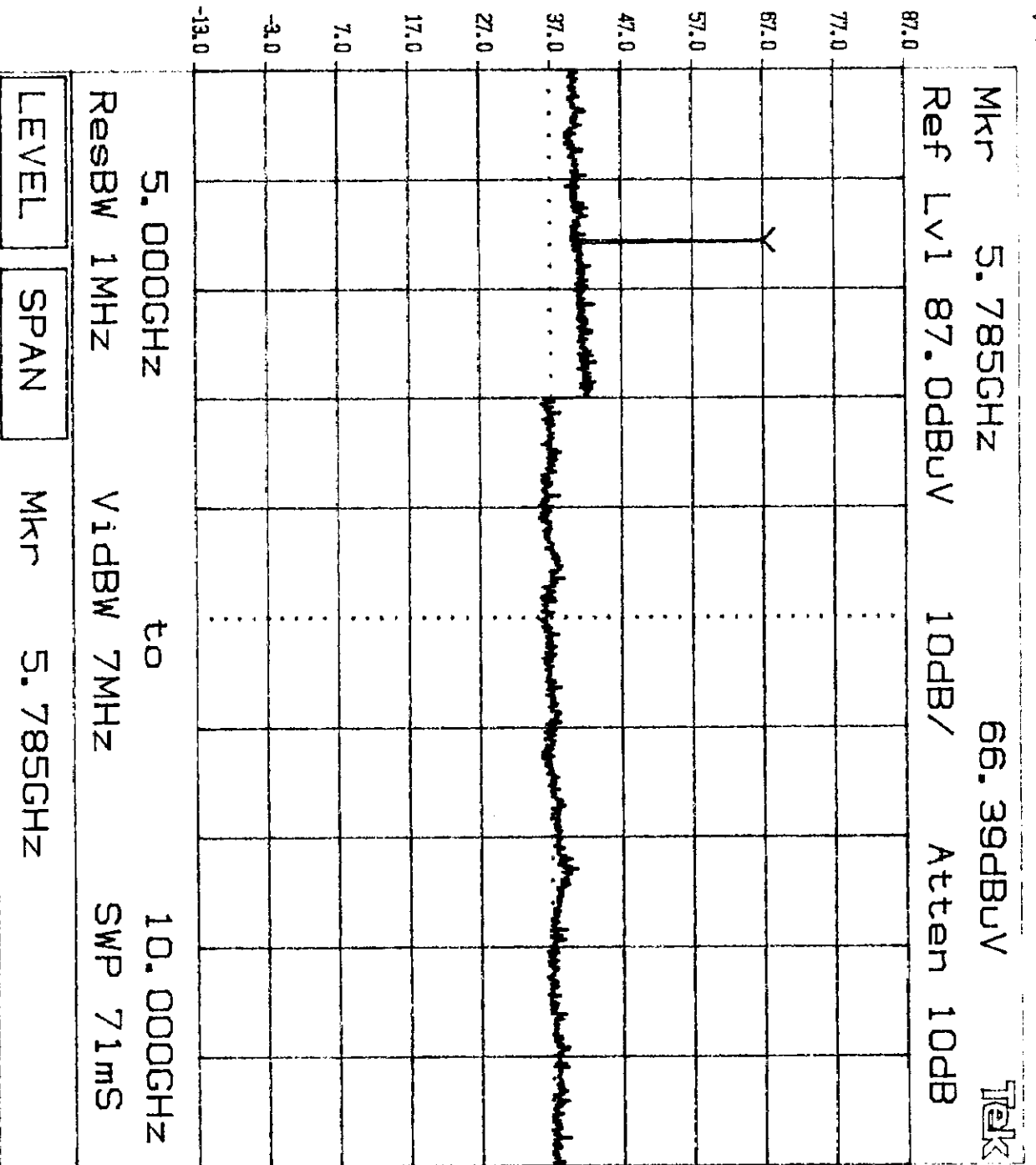
Knob 1

Keypad

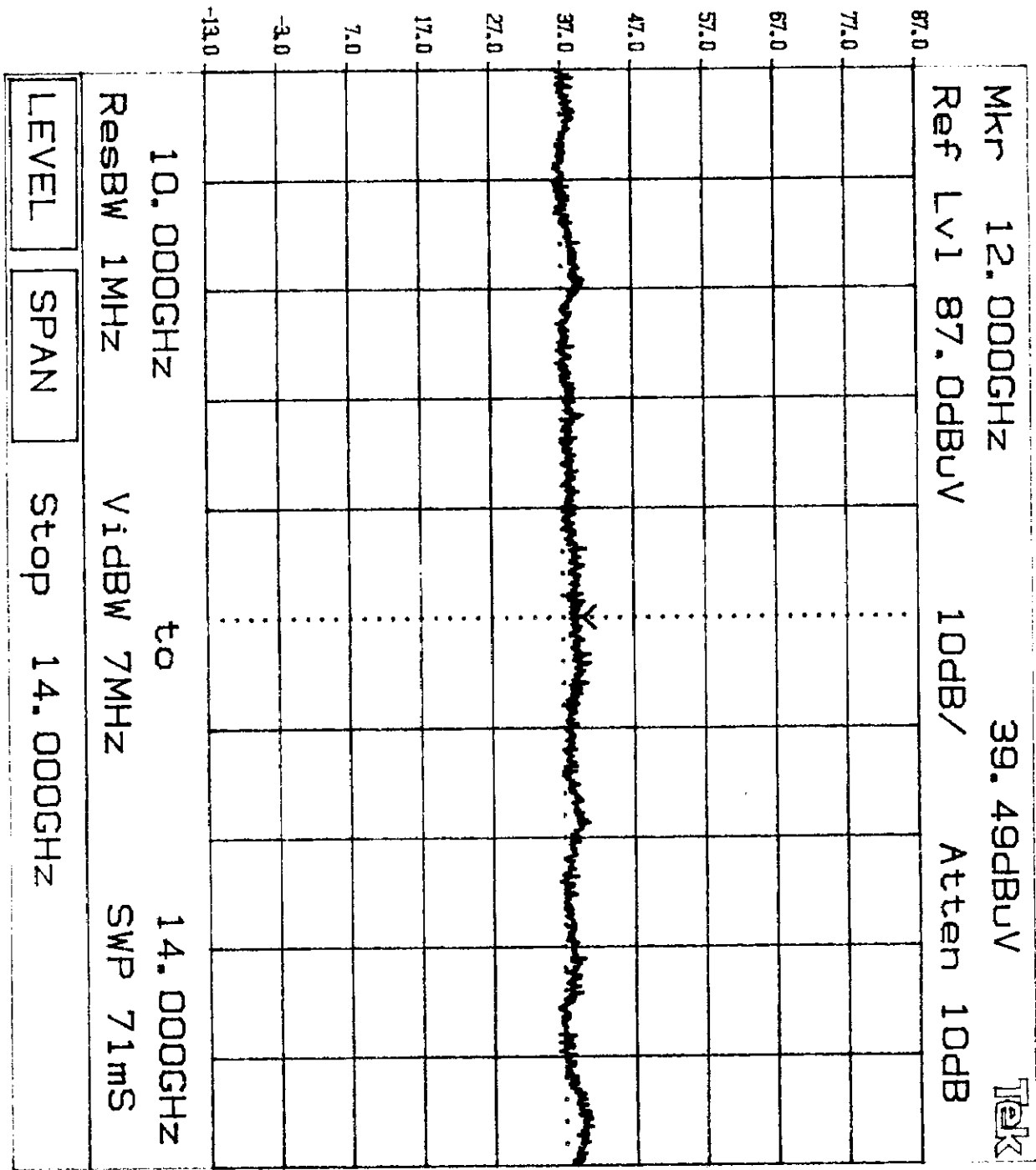
Tektronix

2784

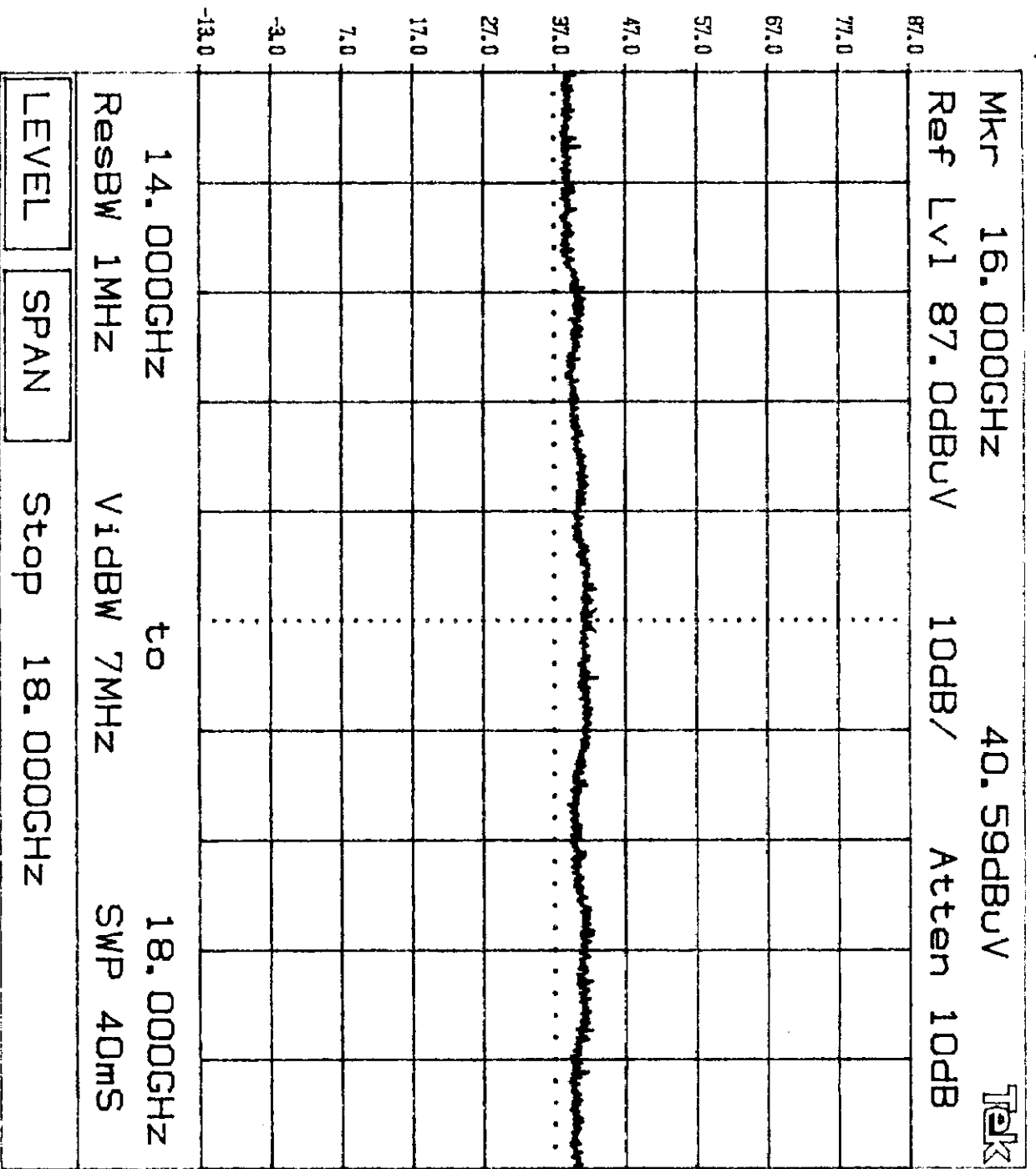
462



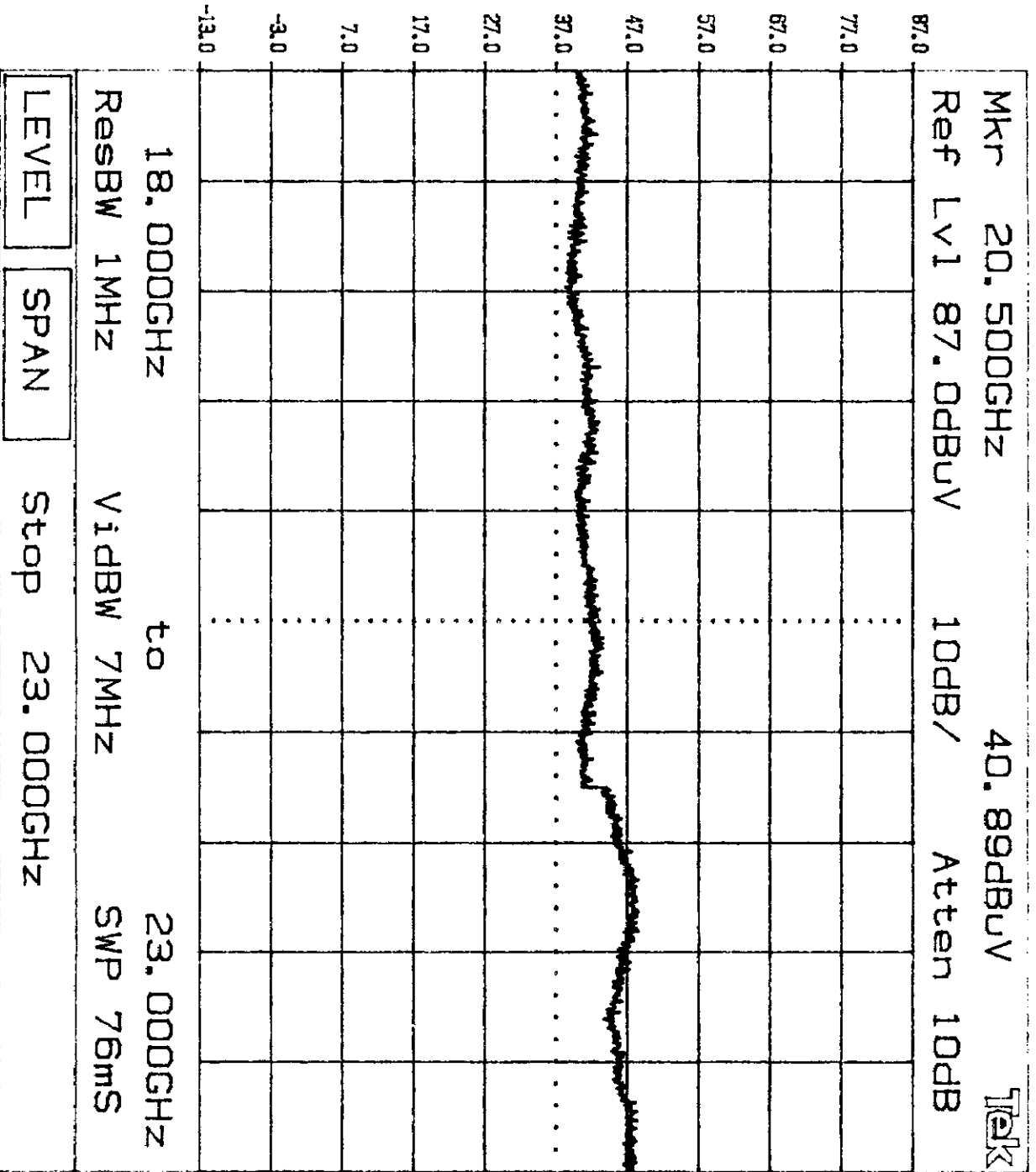
463



4/64



465



KN0B 2

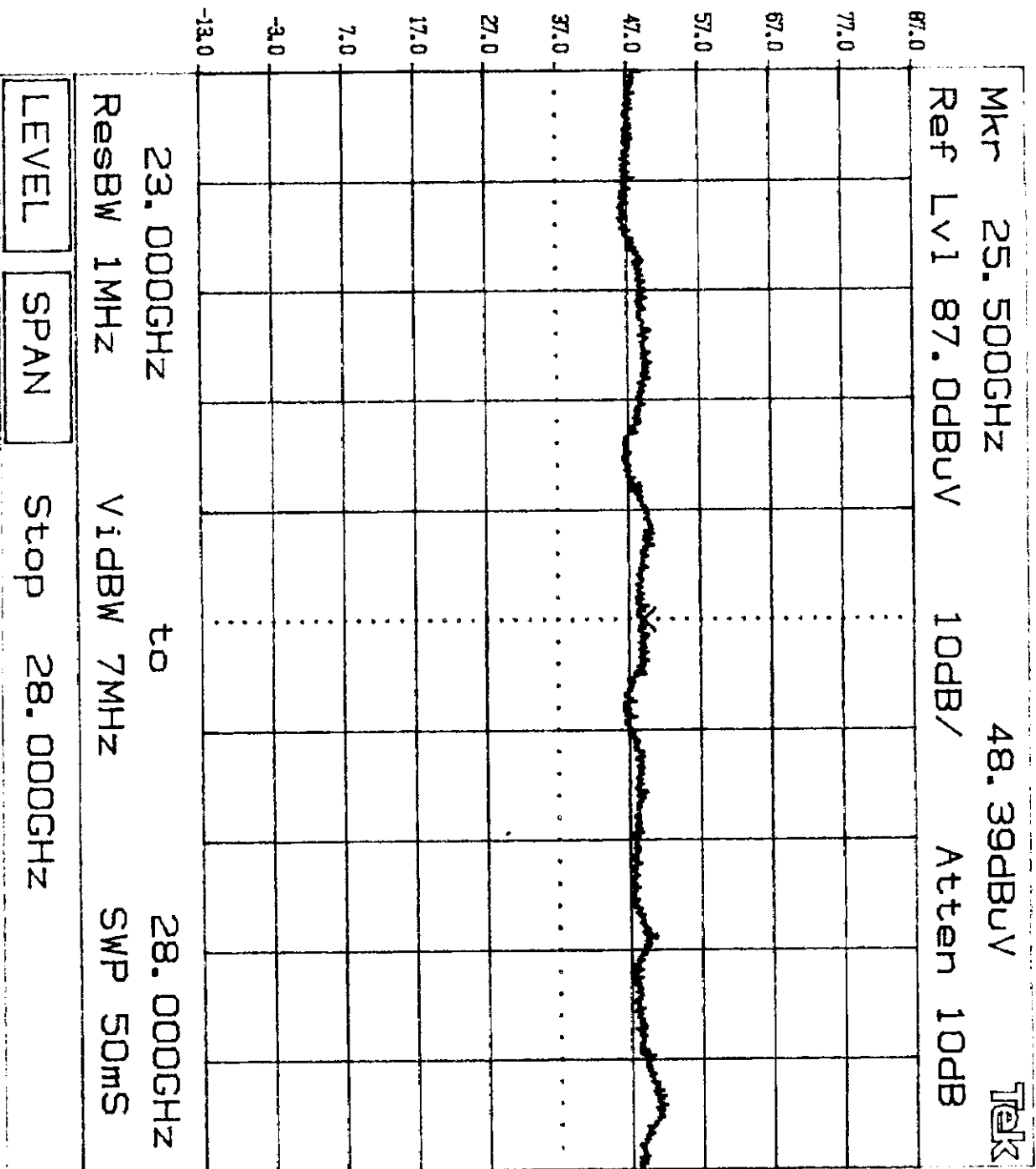
KN0B 1

KEYPAD

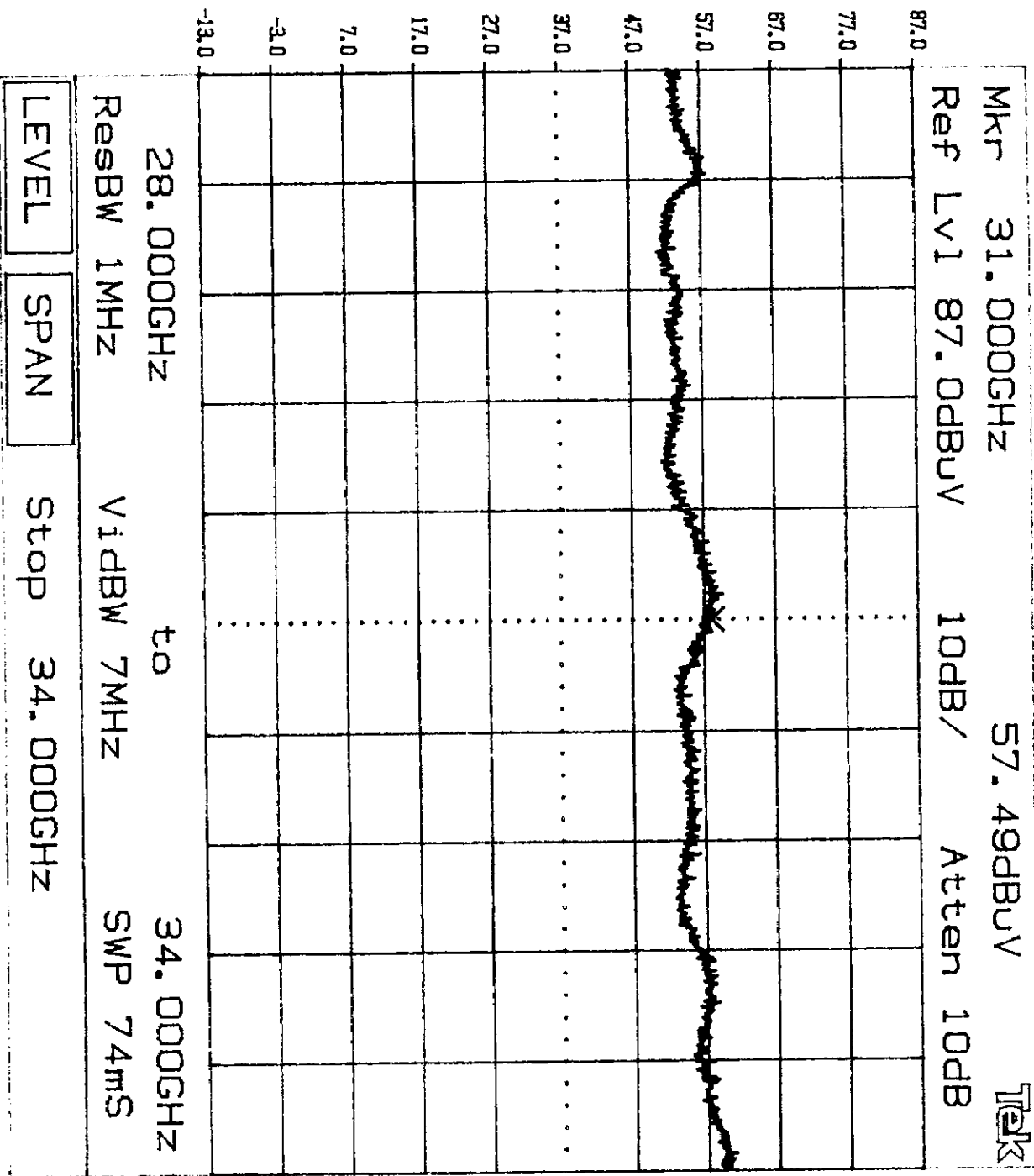
Tektronix

2784

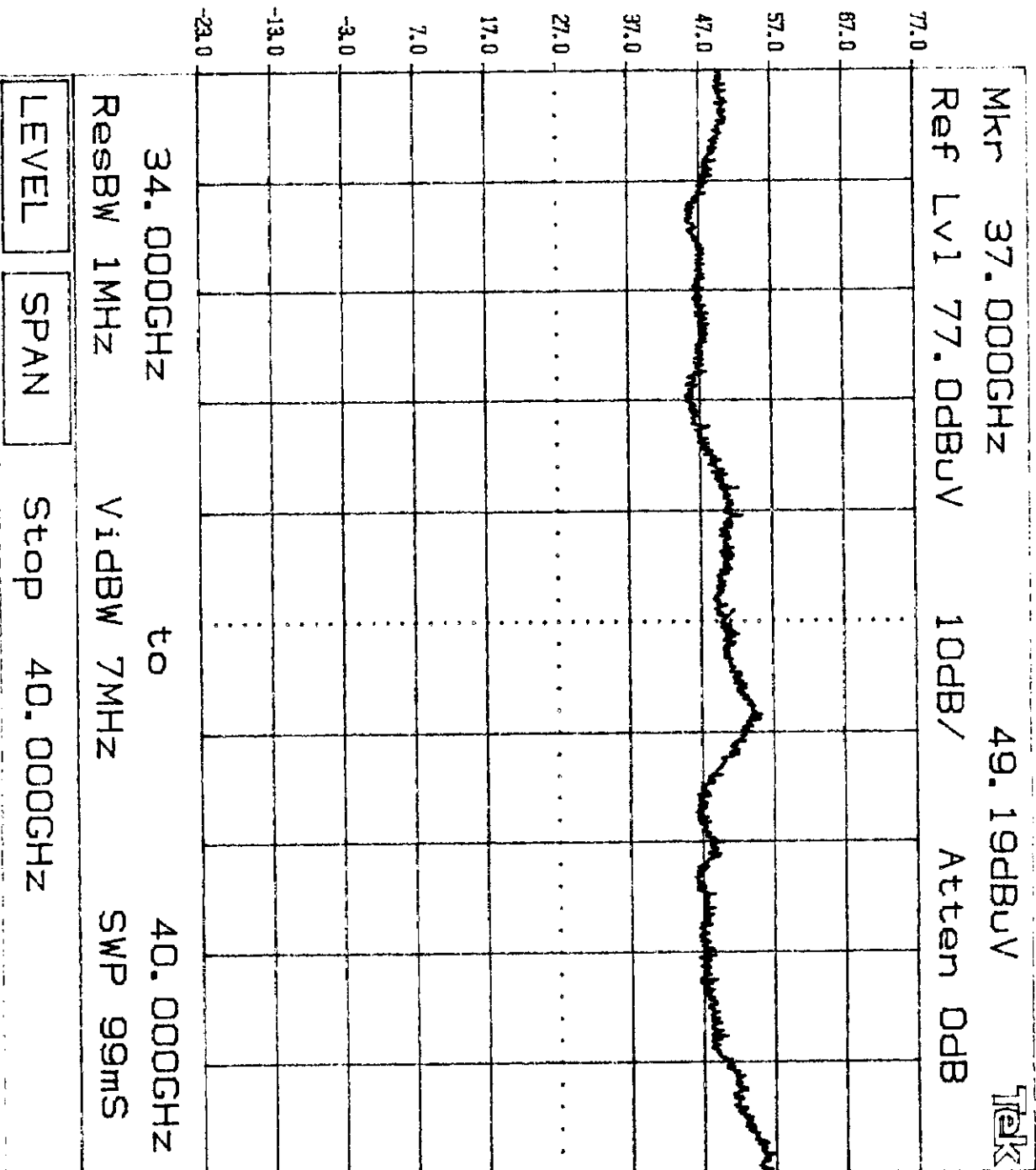
466



467



468



KN0B 2

KN0B 1

KEYPAD

Tektronix

2784

# Intertek Testing Services

## Radiated Emissions / Interference

Table: C

Company: Wireless Bypass

Model: DL-5800H24

Job No.: J20046196

Date: 06/15/01

Standard: FCC15

Class: A

Group: None

Notes: Gabriel Flat panel on HUB p-p

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

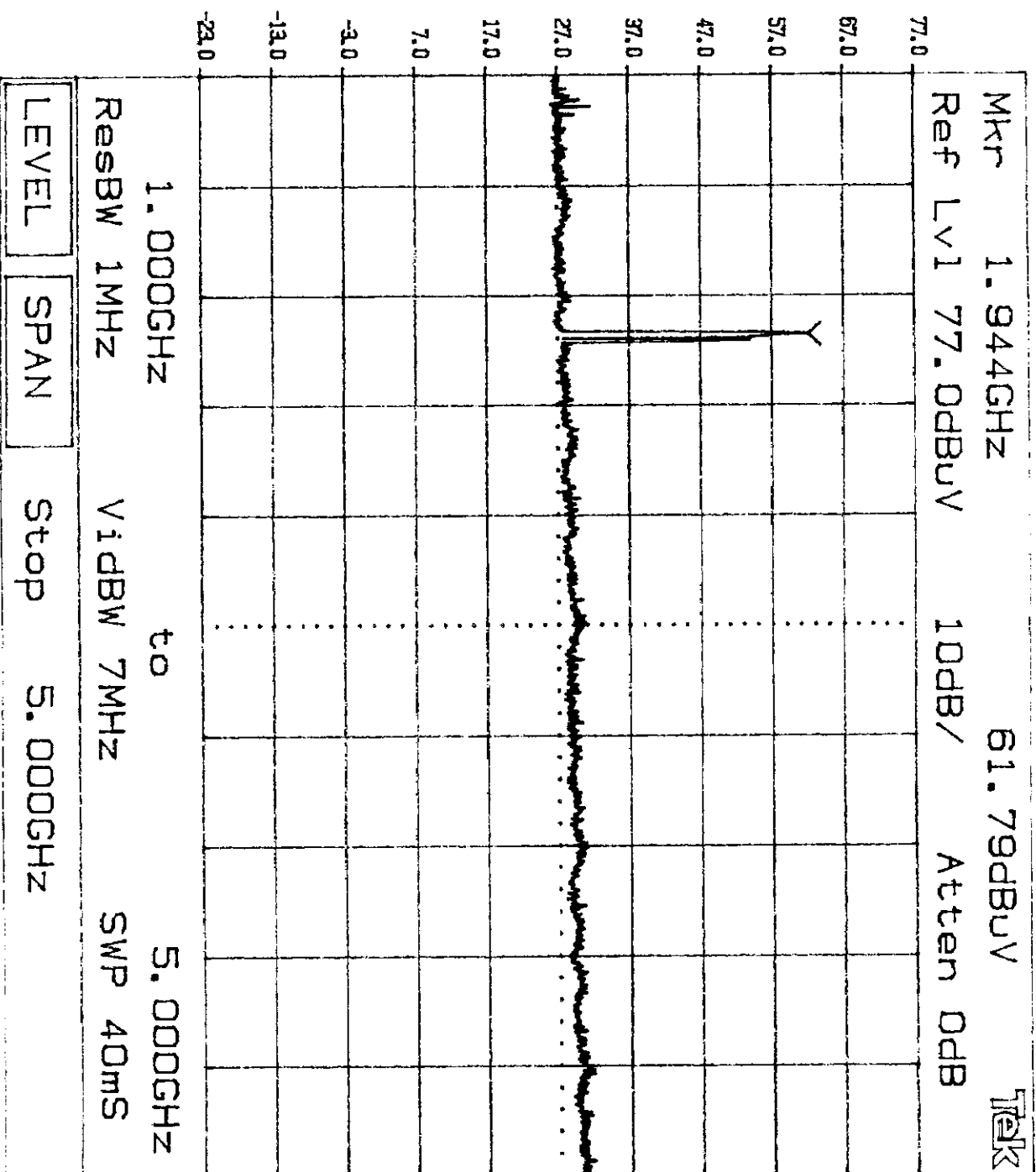
Antenna: LOG1

PreAmp: 0

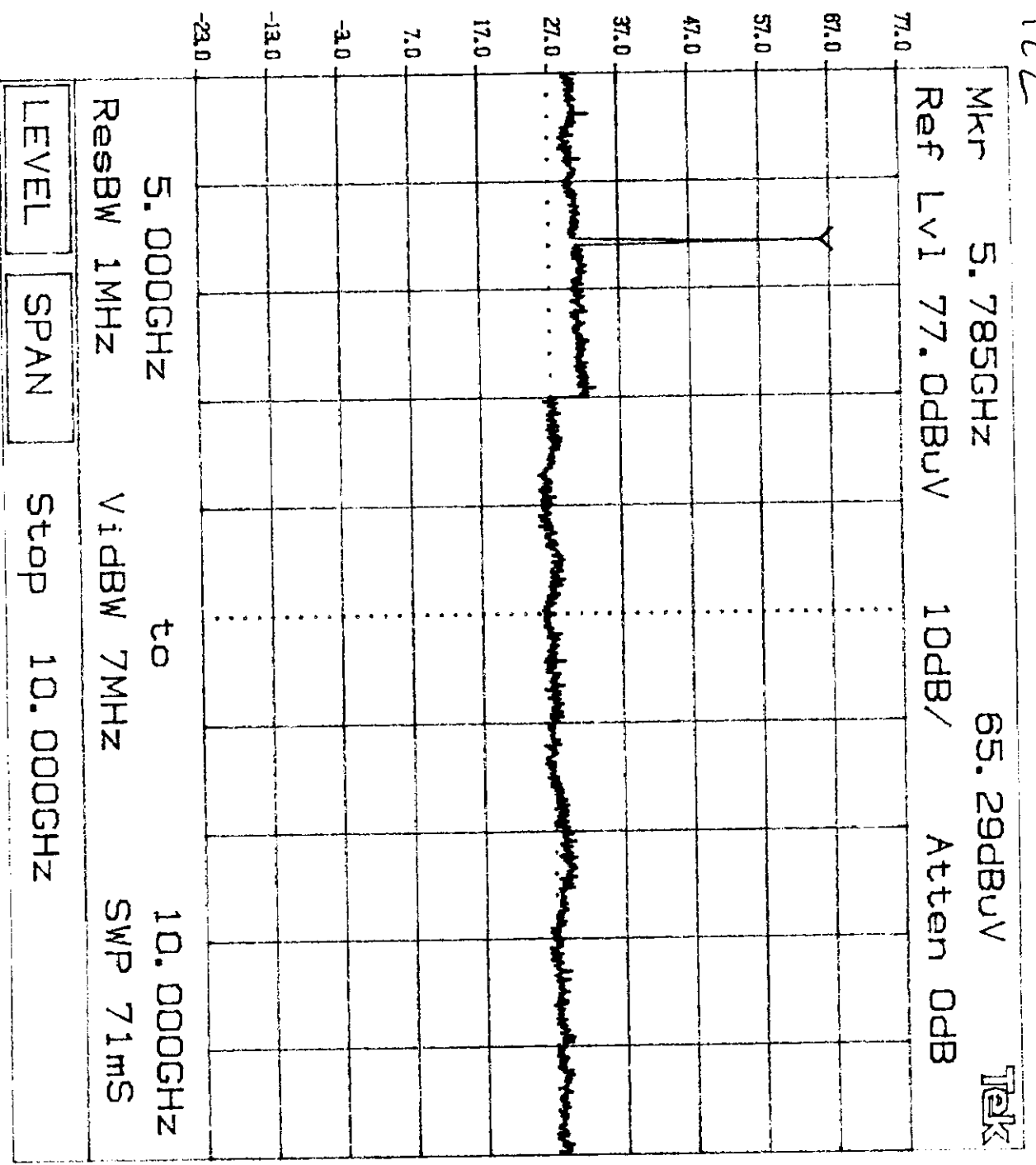
Cable(s): 1C, 3 METER, PRIMAR

Distance: 3 meters

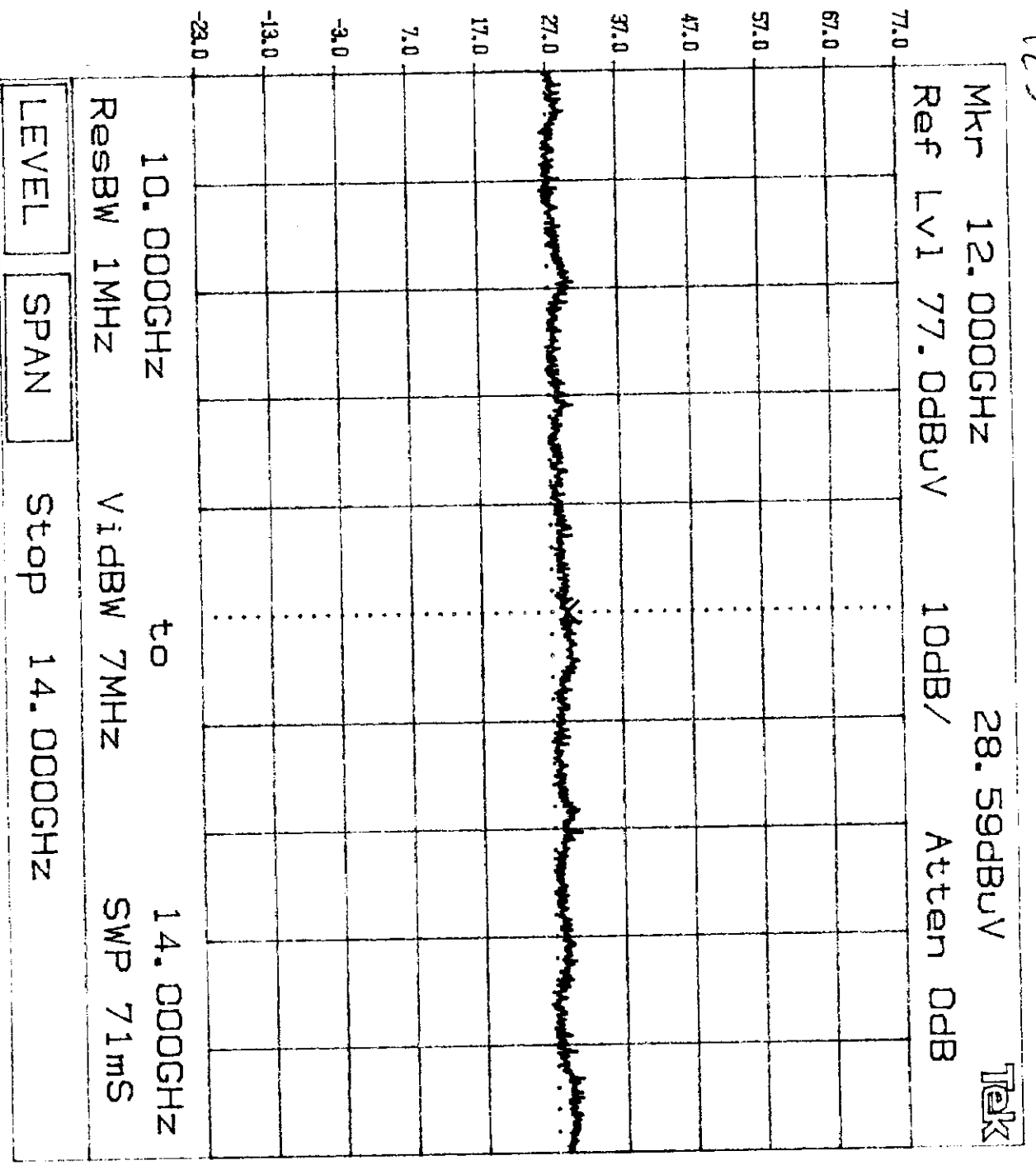
| Ant.<br>Pol.<br>(V/H) | Frequency<br>MHz | Reading<br>dB(uV) | Antenna<br>Factor<br>dB(1/m) | Cable<br>Loss<br>dB | Pre-amp<br>Factor<br>dB | Distance<br>Factor<br>dB | Net<br>dB(uV/m) | Limit<br>dB(uV/m) | Margin<br>dB |
|-----------------------|------------------|-------------------|------------------------------|---------------------|-------------------------|--------------------------|-----------------|-------------------|--------------|
| V                     | 41.610           | 21.4              | 11.8                         | 0.7                 | 0.0                     | 0.0                      | 33.9            | 40.0              | -6.1         |
| V                     | 48.020           | 23.7              | 9.4                          | 0.9                 | 0.0                     | 0.0                      | 33.9            | 40.0              | -6.1         |
| V                     | 74.510           | 16.3              | 6.4                          | 0.9                 | 0.0                     | 0.0                      | 23.6            | 40.0              | -16.4        |
| V                     | 87.060           | 14.4              | 6.9                          | 1.2                 | 0.0                     | 0.0                      | 22.5            | 40.0              | -17.5        |
| V                     | 108.800          | 20.8              | 7.3                          | 1.3                 | 0.0                     | 0.0                      | 29.3            | 43.5              | -14.2        |
| V                     | 122.500          | 20.2              | 6.7                          | 1.3                 | 0.0                     | 0.0                      | 28.3            | 43.5              | -15.2        |
| V                     | 133.000          | 15.1              | 7.0                          | 1.4                 | 0.0                     | 0.0                      | 23.5            | 43.5              | -20.0        |
| H                     | 611.100          | 19.5              | 21.0                         | 3.3                 | 0.0                     | 0.0                      | 43.7            | 46.0              | -2.3         |



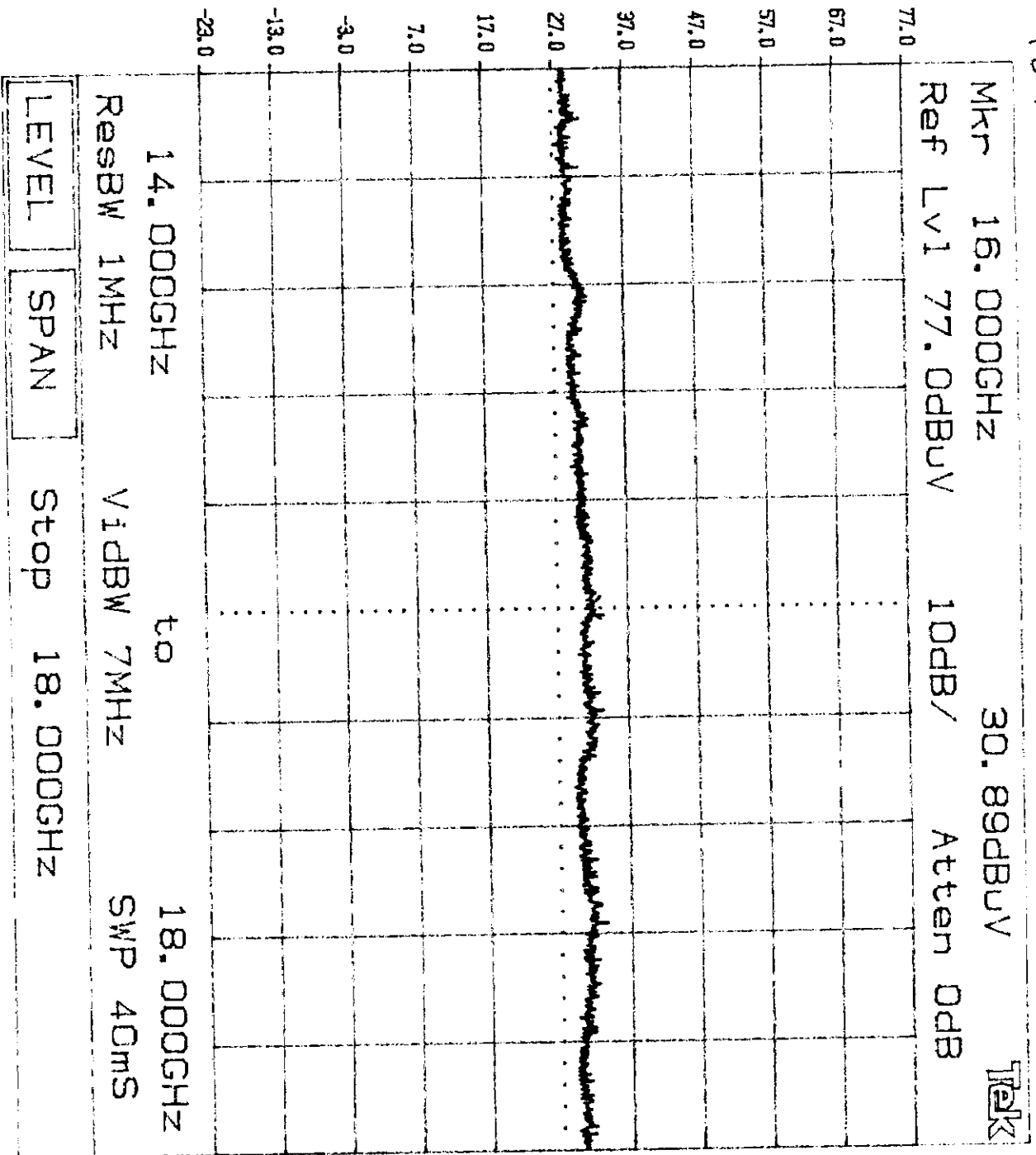
4c2



4c3



4c4



Knob 2

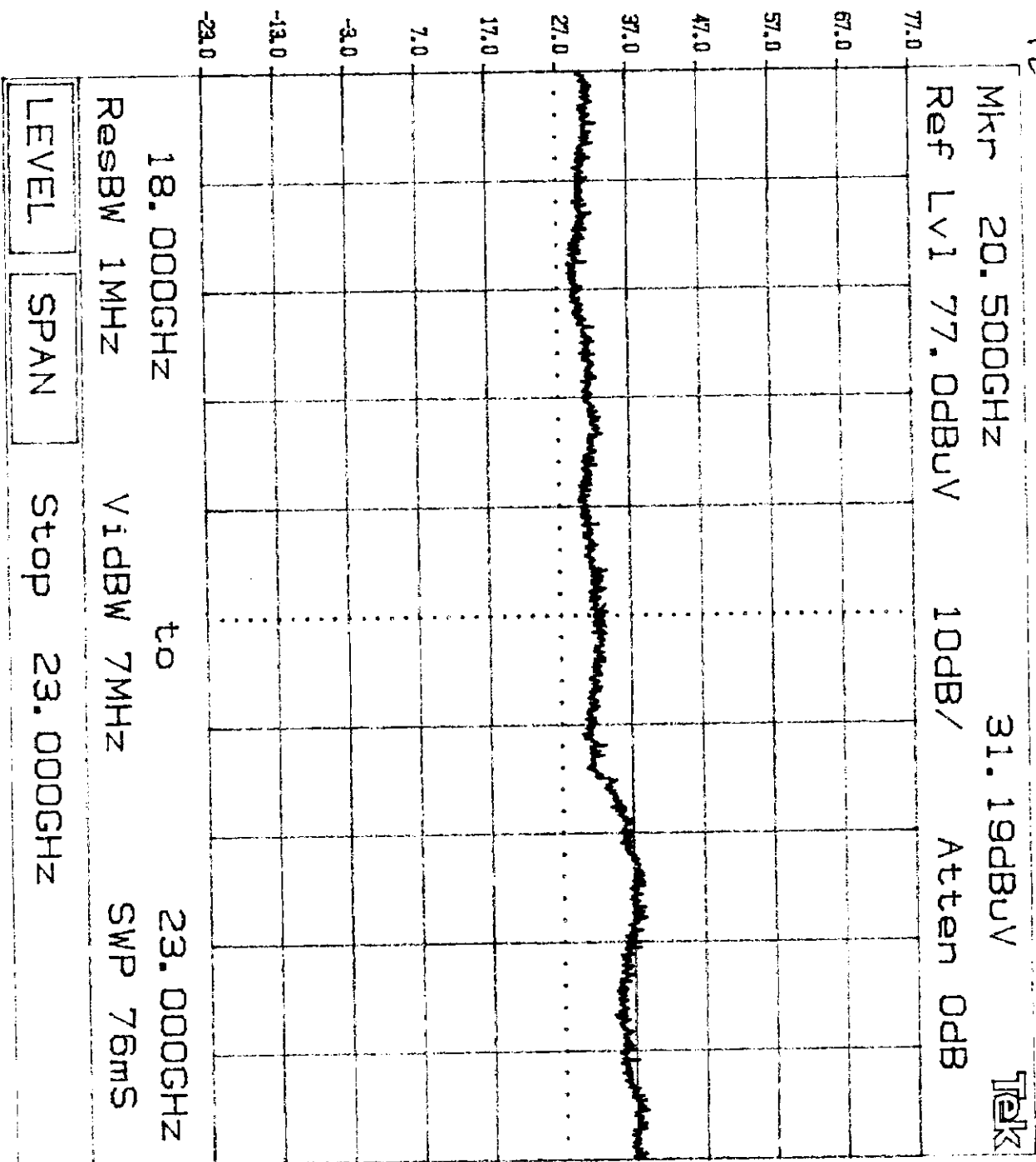
Knob 1

Keypad

Tektronix

2784

4c5



Knob 2

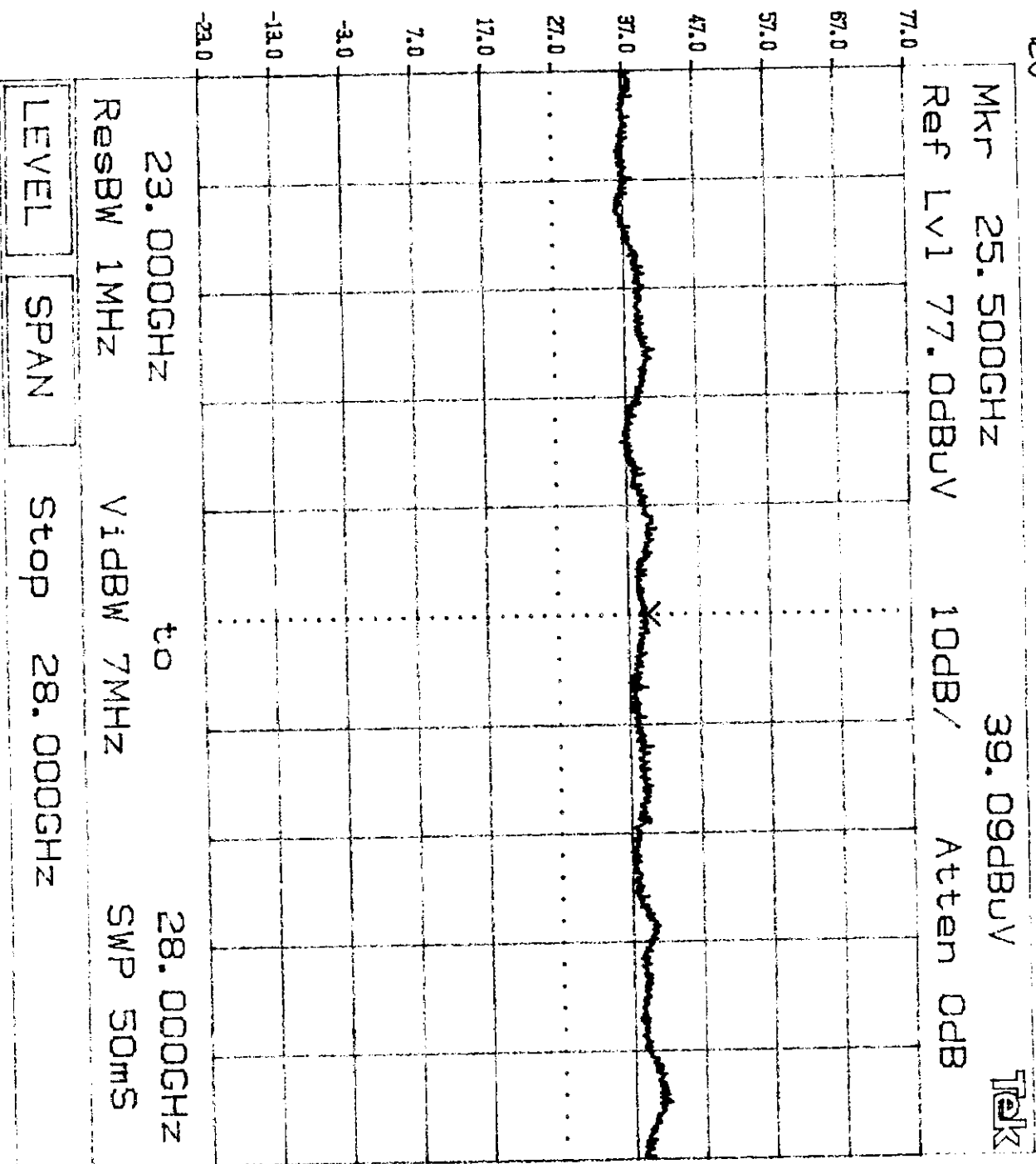
Knob 1

Keypad

Tektronix

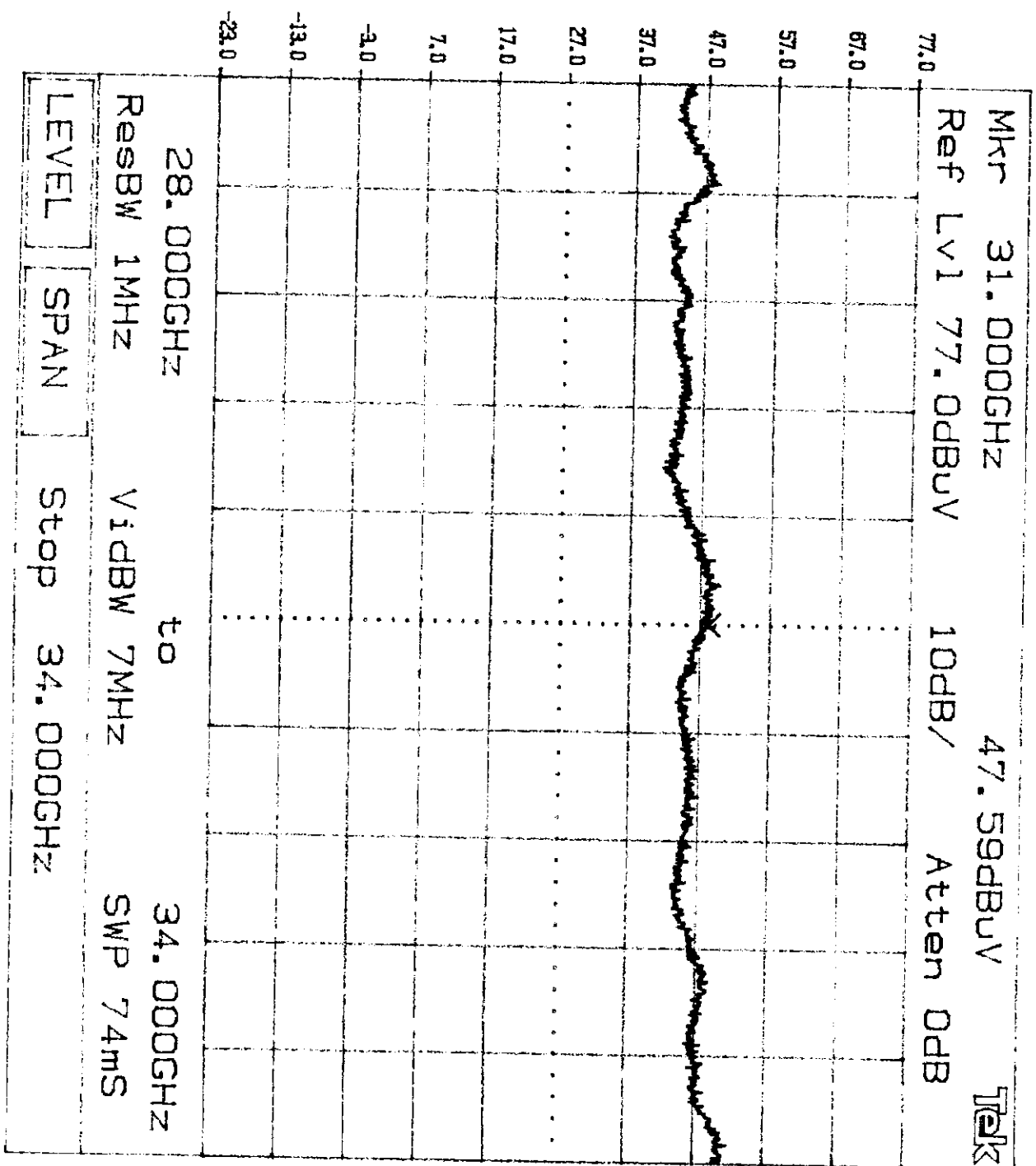
2784

46



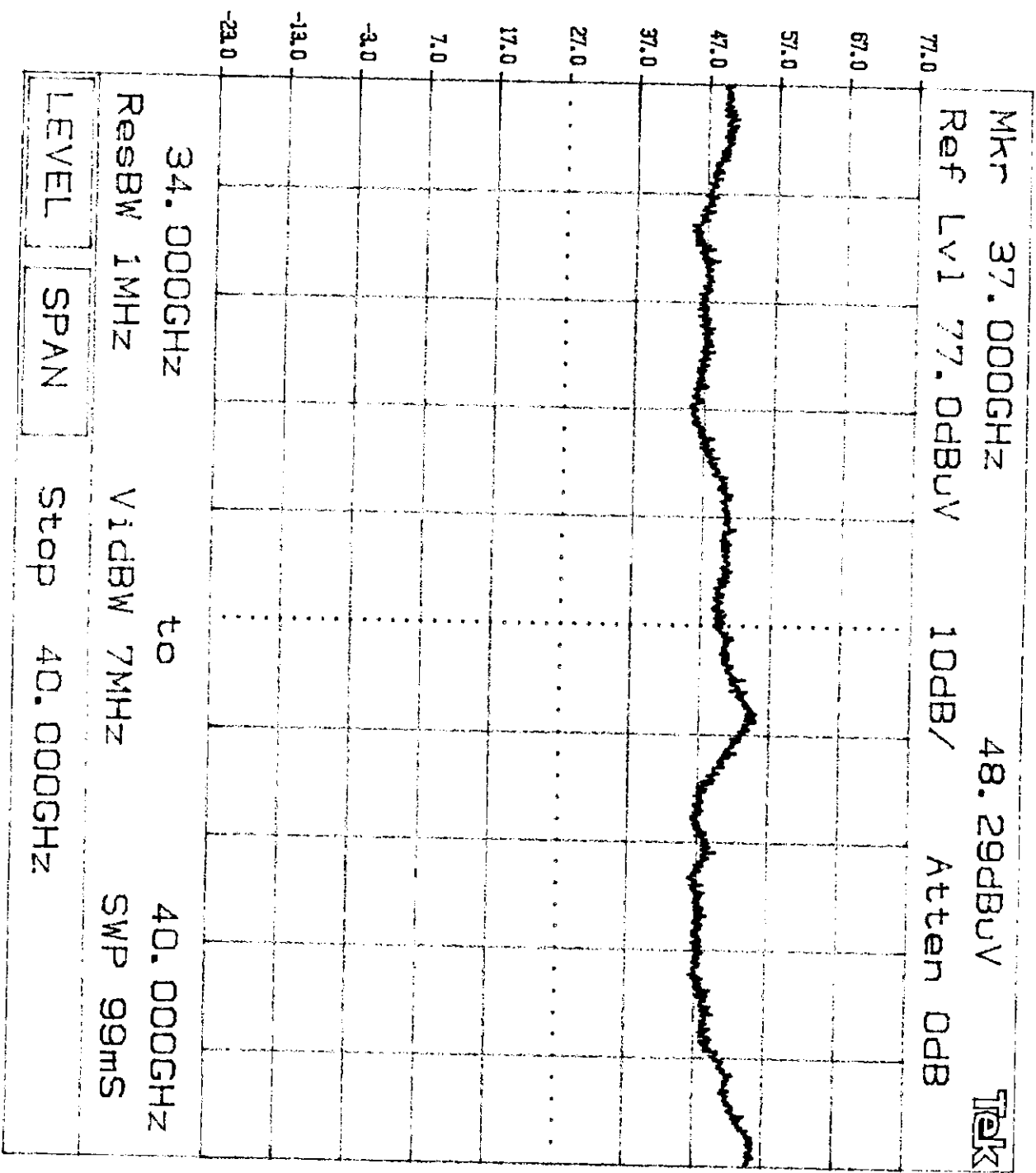
Knob 2 Knob 1 Keypad Tektronix 2784

467



KN0B 2 KN0B 1 KEYPAD Tektronix 2784

4c8



KN0B 2 KN0B 1 KEYPAD Tektronix 2784

# Intertek Testing Services

## Radiated Emissions / Interference

Table: D

Company: Wireless Bypass

Model: DL-5800H24

Job No.: J20045196

Date: 06/15/01

Standard: FCC15

Class: A

Group: None

Notes: Gabriel Flat panel on HUB p-mp

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

Antenna: LOG1

PreAmp: 0

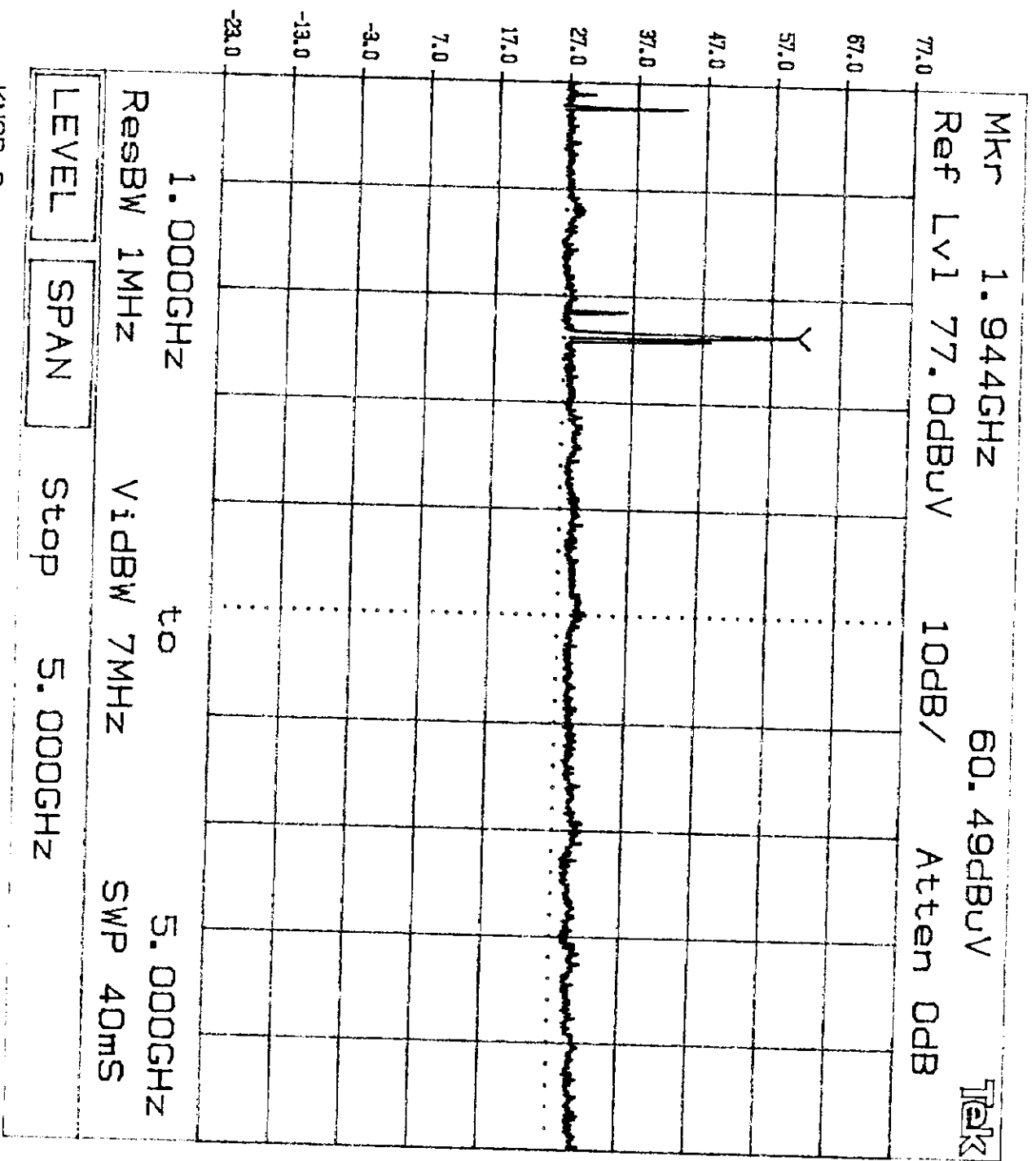
Cable(s): 1C, 3 METER, PRIMAR

Distance: 3 meters

| Ant.<br>Pol.<br>(V/H) | Frequency<br>MHz | Reading<br>dB(uV) | Antenna<br>Factor<br>dB(1/m) | Cable<br>Loss<br>dB | Pre-amp<br>Factor<br>dB | Distance<br>Factor<br>dB | Net<br>dB(uV/m) | Limit<br>dB(uV/m) | Margin<br>dB |
|-----------------------|------------------|-------------------|------------------------------|---------------------|-------------------------|--------------------------|-----------------|-------------------|--------------|
| V                     | 40.100           | 20.0              | 12.4                         | 0.7                 | 0.0                     | 0.0                      | 33.1            | 40.0              | -6.9         |
| V                     | 43.820           | 24.6              | 10.9                         | 0.8                 | 0.0                     | 0.0                      | 36.3            | 40.0              | -3.7         |
| V                     | 73.930           | 21.6              | 6.4                          | 0.9                 | 0.0                     | 0.0                      | 28.9            | 40.0              | -11.1        |
| V                     | 108.800          | 15.5              | 7.3                          | 1.3                 | 0.0                     | 0.0                      | 24.0            | 43.5              | -19.5        |
| V                     | 121.300          | 13.2              | 6.7                          | 1.3                 | 0.0                     | 0.0                      | 21.2            | 43.5              | -22.3        |
| V                     | 133.300          | 12.2              | 7.0                          | 1.4                 | 0.0                     | 0.0                      | 20.6            | 43.5              | -22.9        |

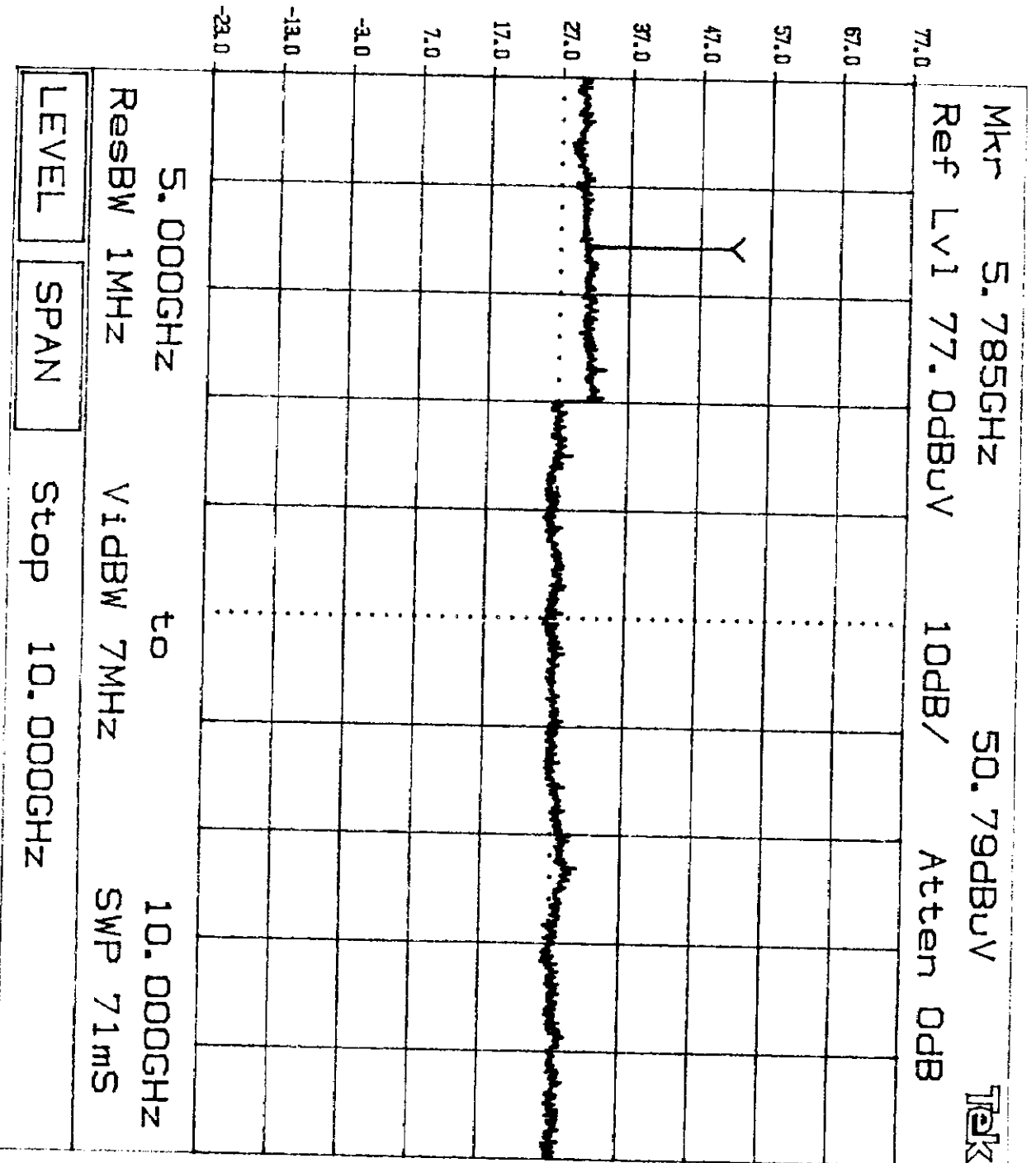
4d1

WAB:JAL CLEAR PANEL AND HUB P-101P



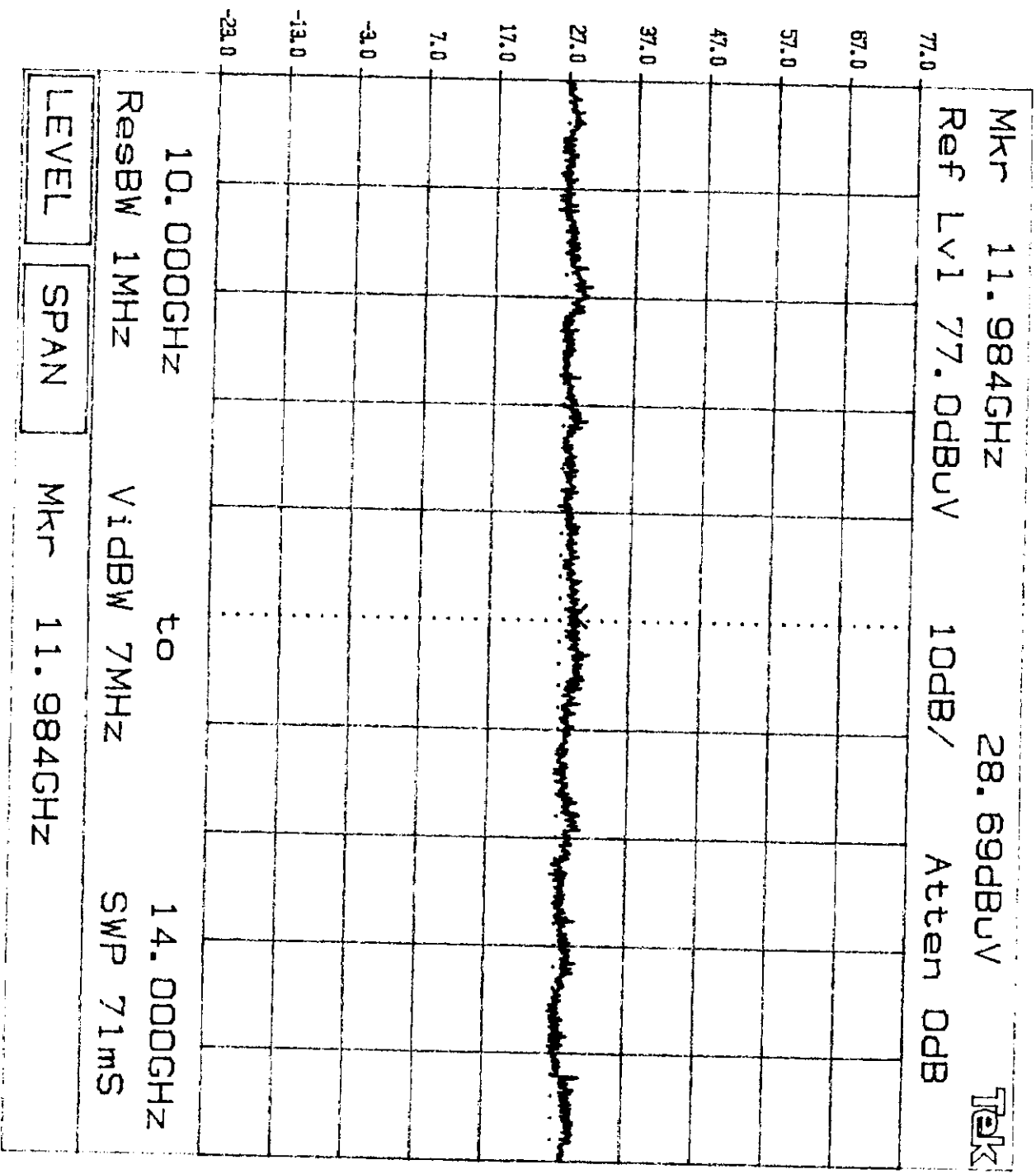
Knob 2 Knob 1 Keypad Tektronix 2784

402



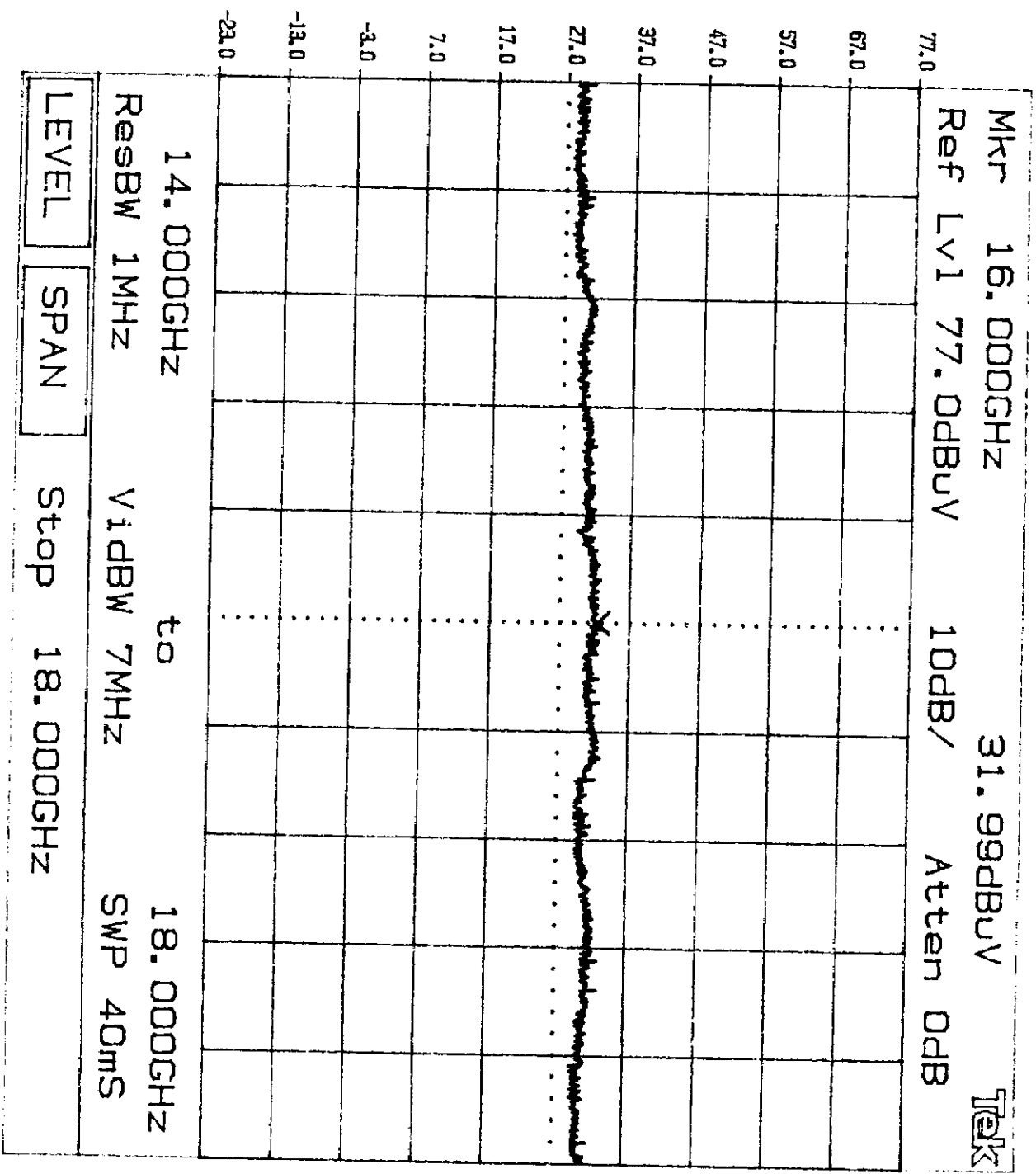
KN0B 2 KN0B 1 KEYPAD Tektronix 2784

4/3



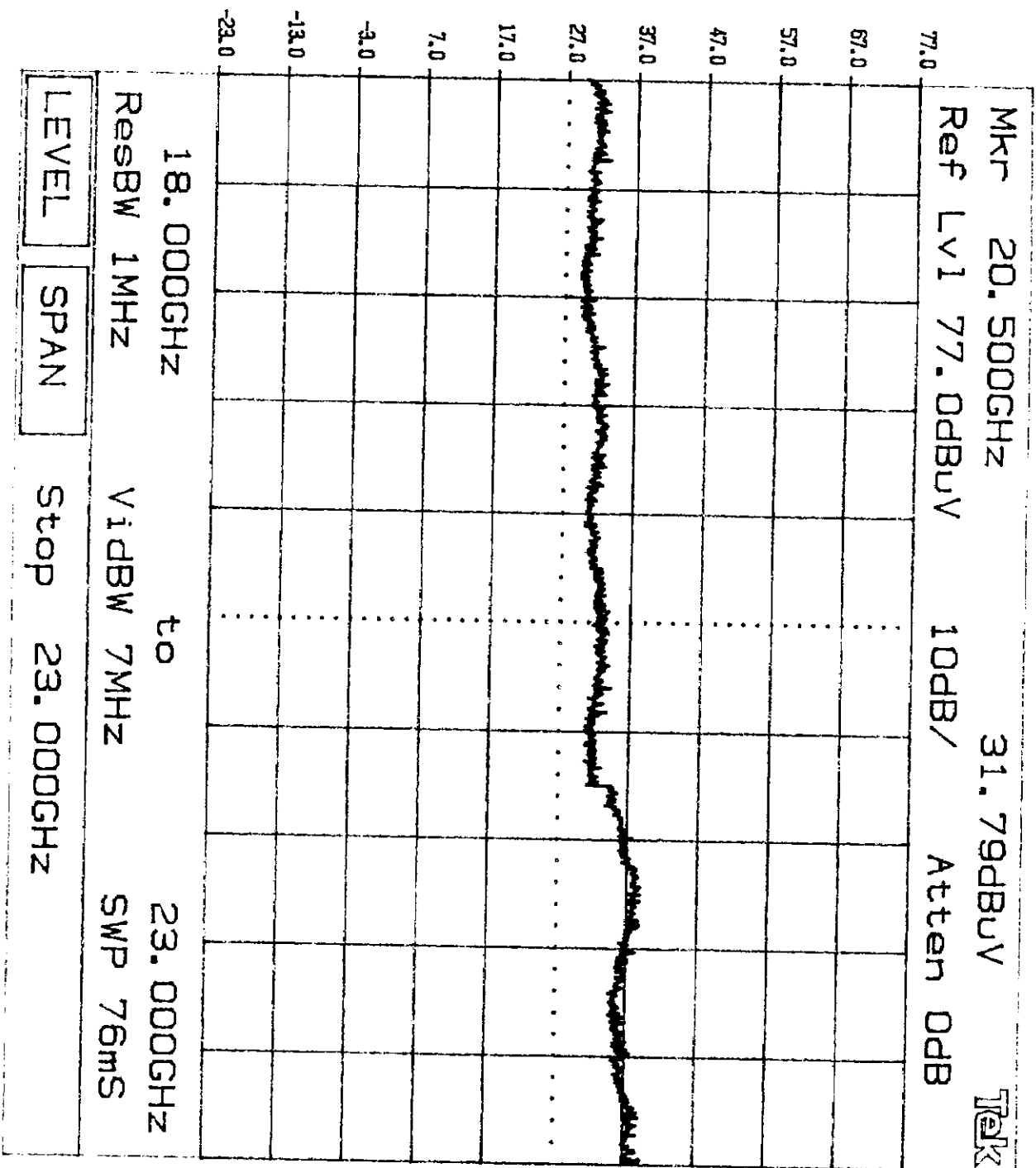
KNOB 2 KNOB 1 KEYPAD Tektronix 2784

4/14



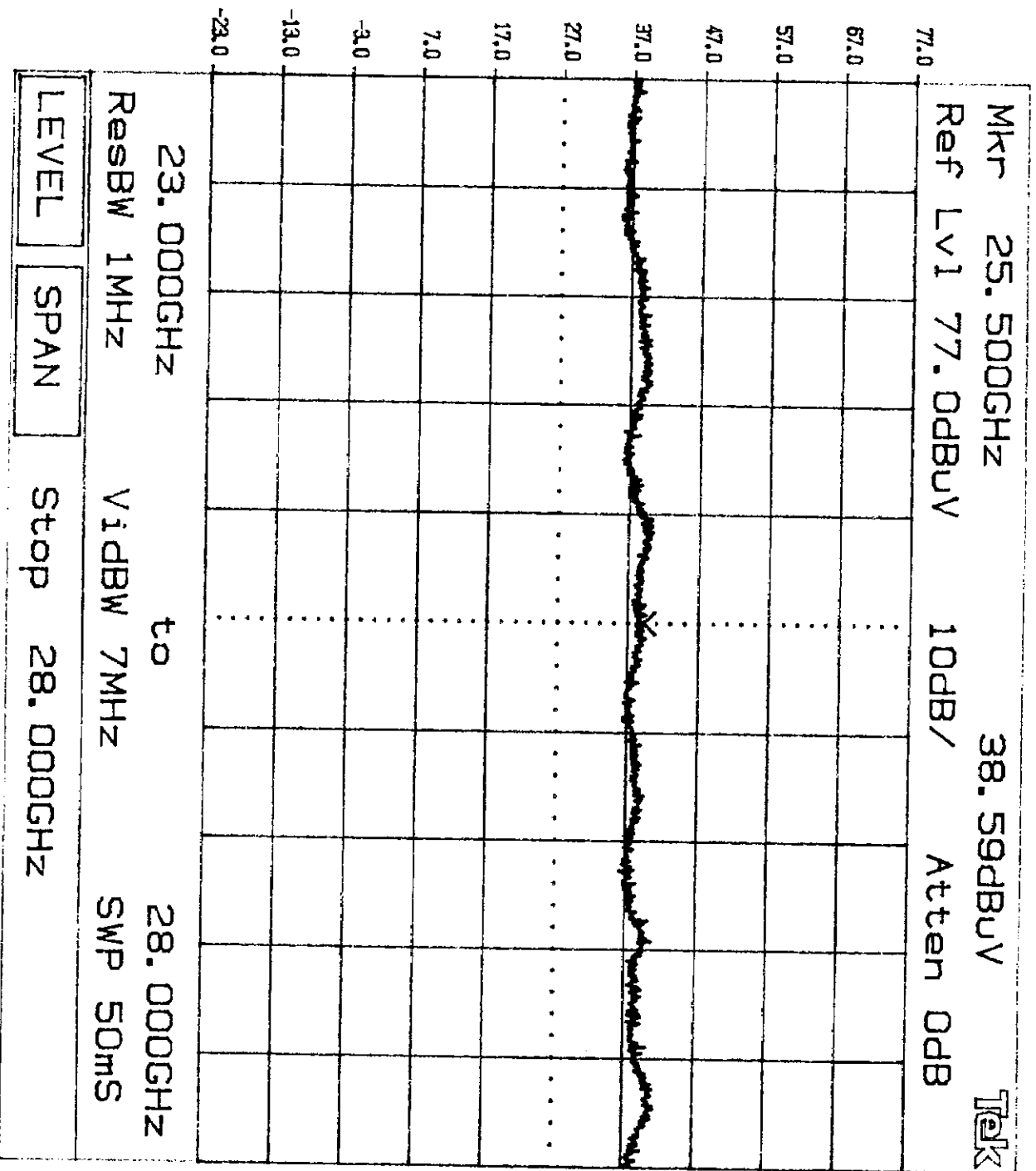
KN0B 2    KN0B 1    KEYPAD    Tektronix    2784

415



Knob 2 Knob 1 Keypad Taktronix 2784

426



KNDB 2

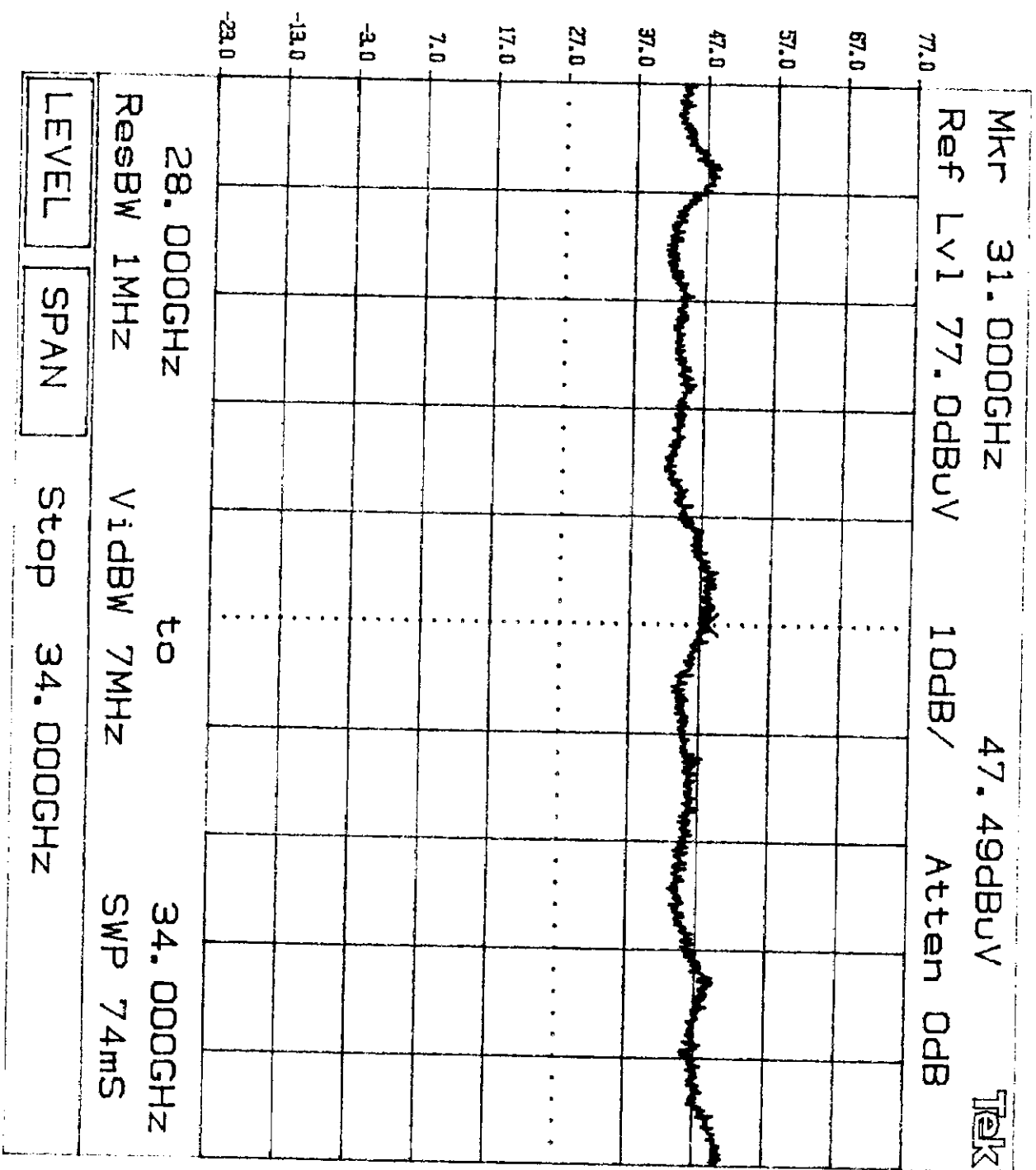
KNDB 1

KEYPAD

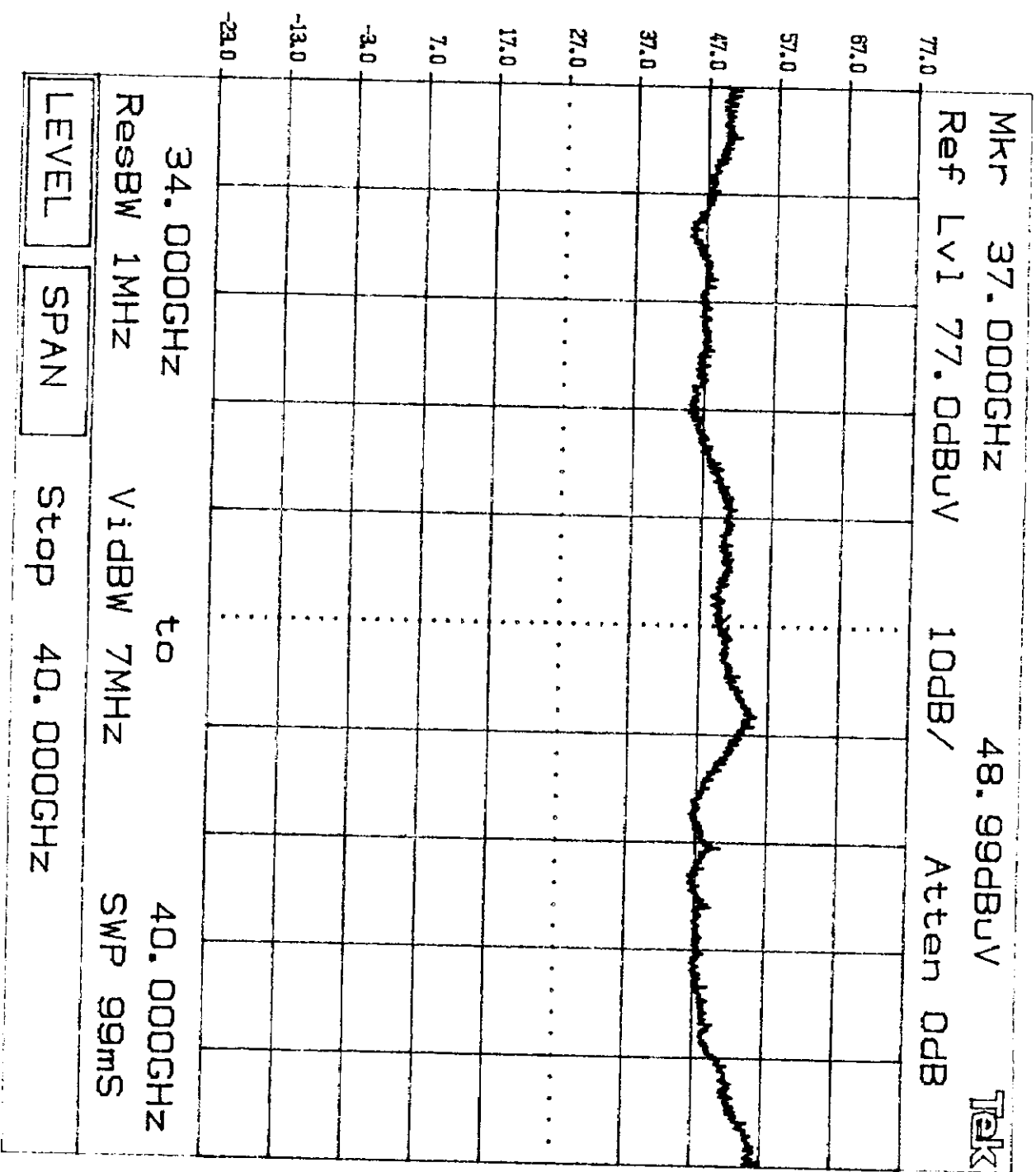
Tektronix

2784

487



428



Knob 2 Knob 1 Keypad Taktronix 2784

# Intertek Testing Services

## Radiated Emissions / Interference

Table: E

Company: Wireless Bypass

Model: DL-5800H24

Job No.: J20046196

Date: 06/14/01

Standard: FCC15

Class: A

Group: None

Notes: Omni Antenna on Hub

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: HP 8546A

Antenna: LOG1

PreAmp: 0

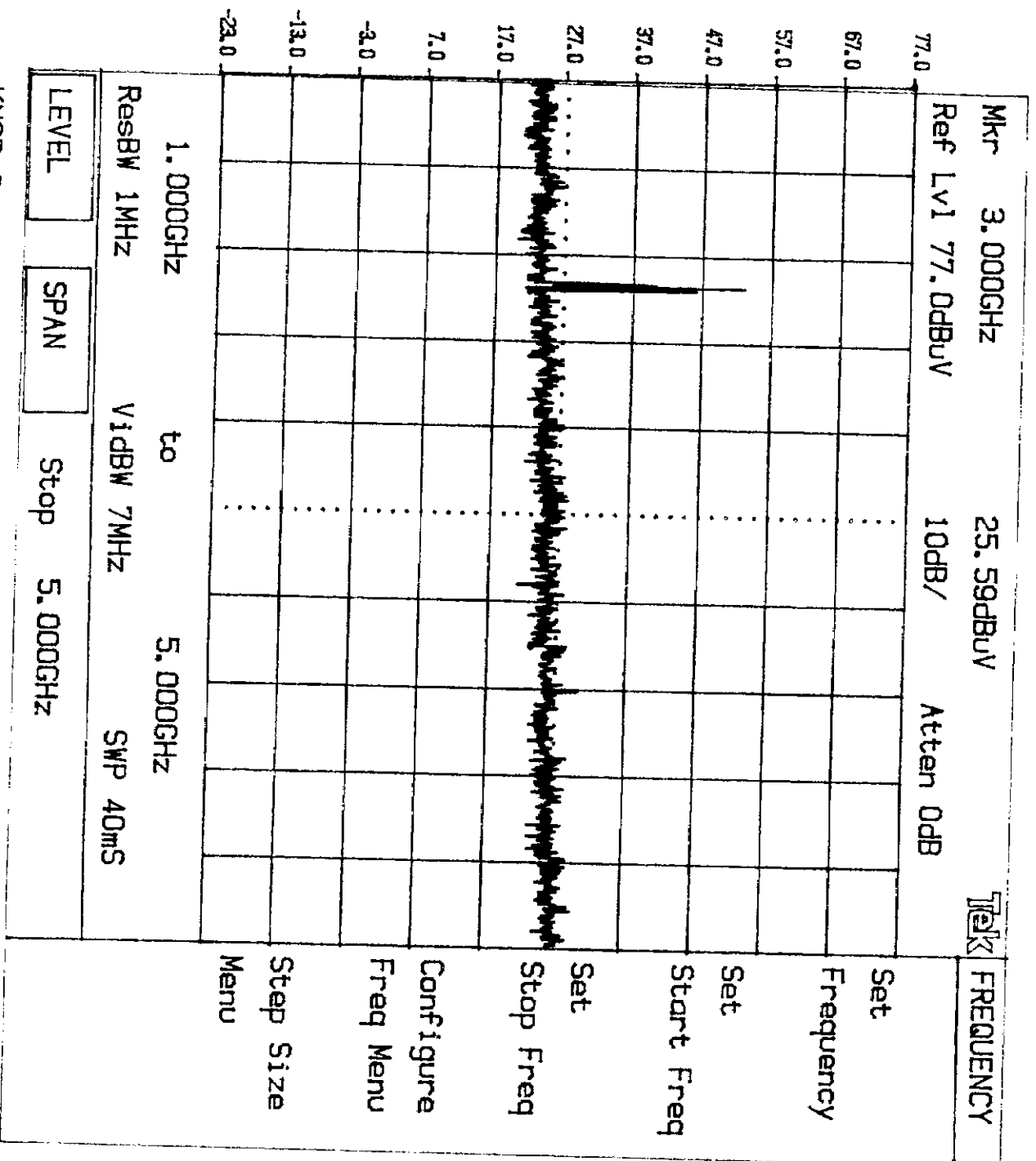
Cable(s): 1C, 3 METER, PRIMAR

Distance: 3 meters

| Ant.<br>Pol.<br>(V/H) | Frequency<br>MHz | Reading<br>dB(uV) | Antenna<br>Factor<br>dB(1/m) | Cable<br>Loss<br>dB | Pre-amp<br>Factor<br>dB | Distance<br>Factor<br>dB | Net<br>dB(uV/m) | Limit<br>dB(uV/m) | Margin<br>dB |
|-----------------------|------------------|-------------------|------------------------------|---------------------|-------------------------|--------------------------|-----------------|-------------------|--------------|
| V                     | 40.340           | 26.1              | 12.3                         | 0.7                 | 0.0                     | 0.0                      | 39.1            | 40.0              | -0.9         |
| V                     | 51.020           | 20.0              | 8.5                          | 0.9                 | 0.0                     | 0.0                      | 29.4            | 40.0              | -10.6        |
| V                     | 108.800          | 18.9              | 7.3                          | 1.3                 | 0.0                     | 0.0                      | 27.4            | 43.5              | -16.1        |
| V                     | 141.400          | 13.7              | 7.5                          | 1.4                 | 0.0                     | 0.0                      | 22.7            | 43.5              | -20.8        |
| V                     | 157.000          | 12.8              | 8.7                          | 1.5                 | 0.0                     | 0.0                      | 23.0            | 43.5              | -20.5        |
| V                     | 267.300          | 12.6              | 12.5                         | 2.1                 | 0.0                     | 0.0                      | 27.2            | 46.0              | -18.8        |

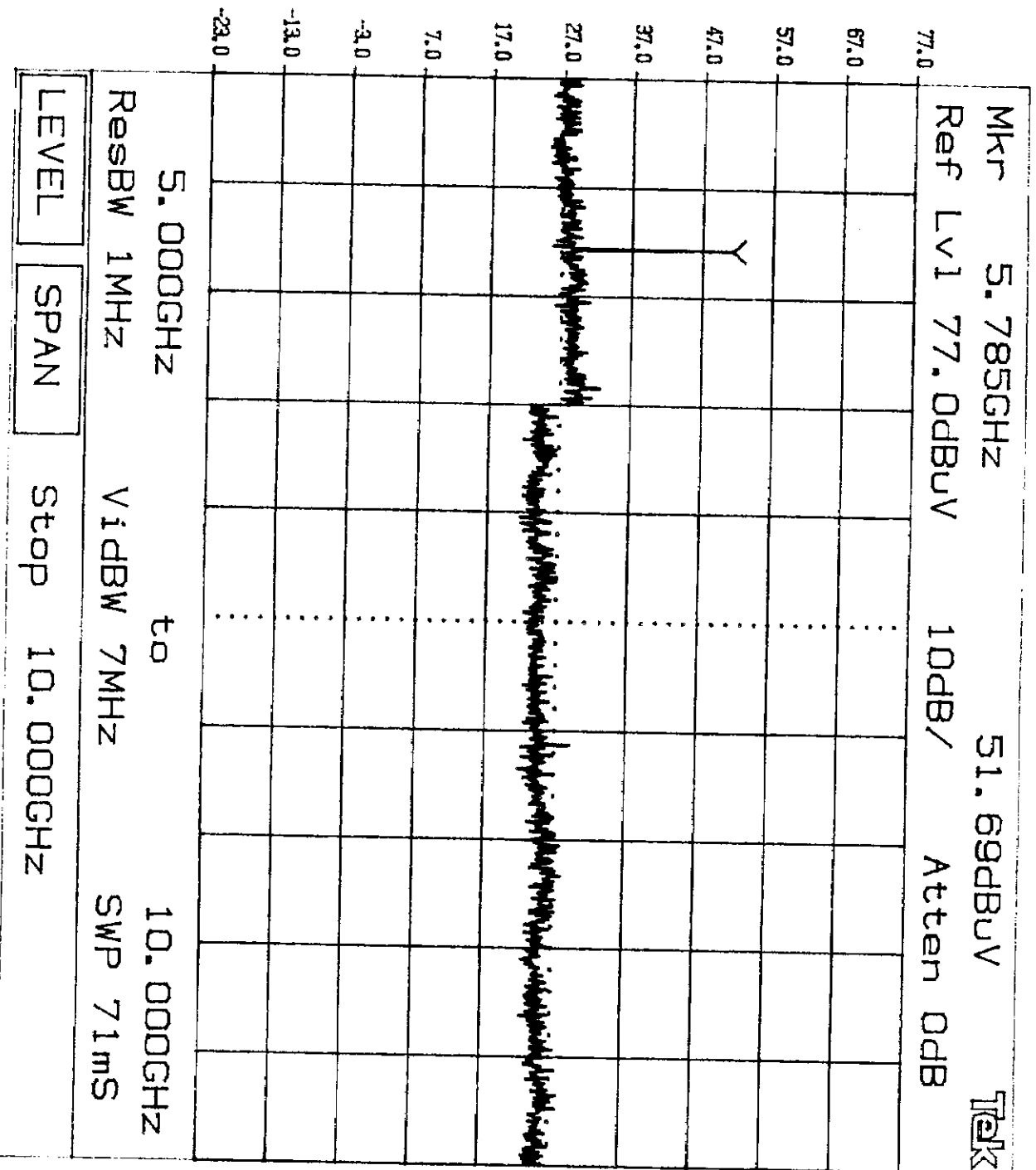
4e1

ORTE POWER ON HUB



KNOB 2 KNOB 1 KEYPAD Tektronix 2784

4e2



Knob 2

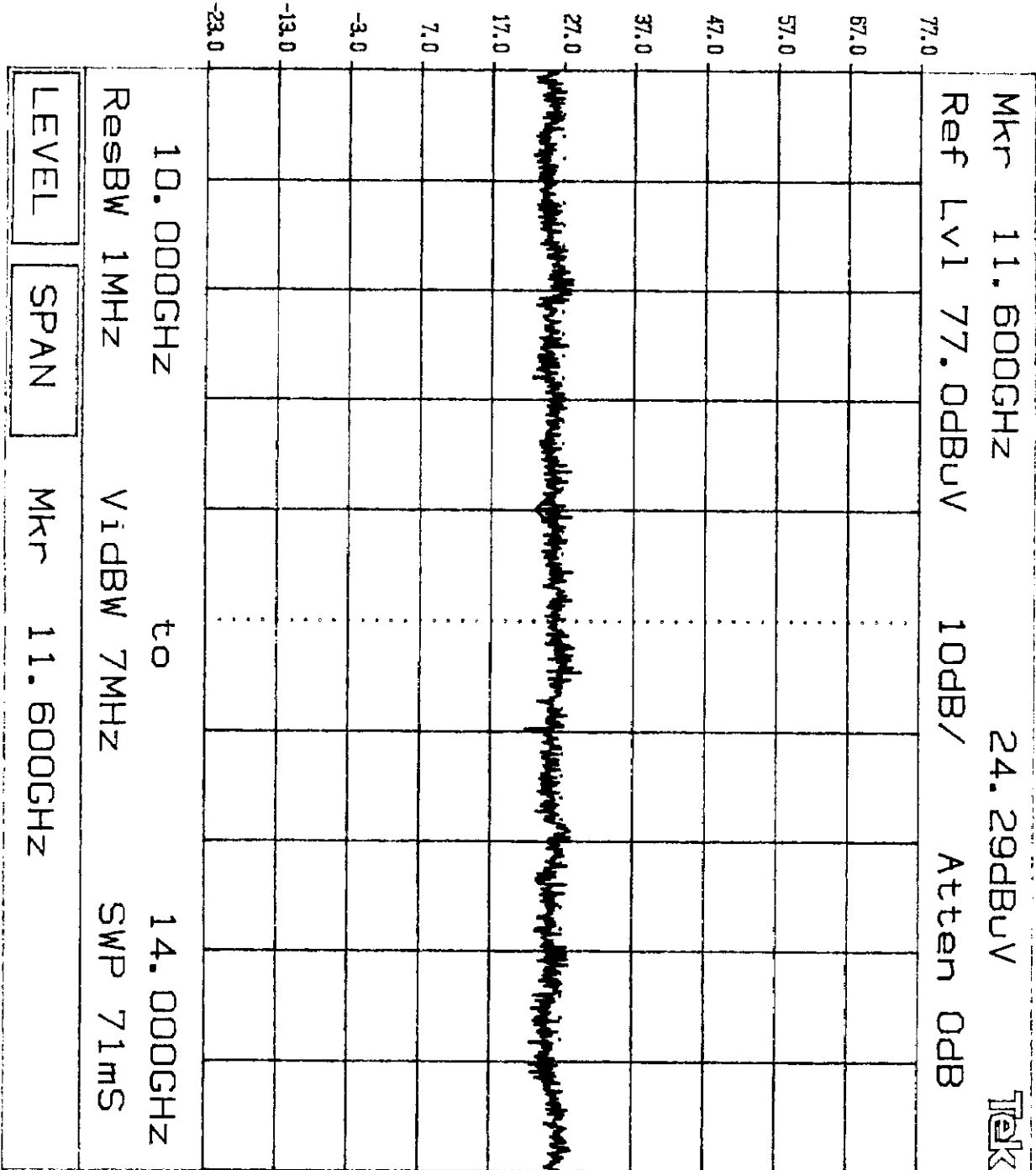
Knob 1

Keypad

Tektronix

2784

4e3



Knob 2

Knob 1

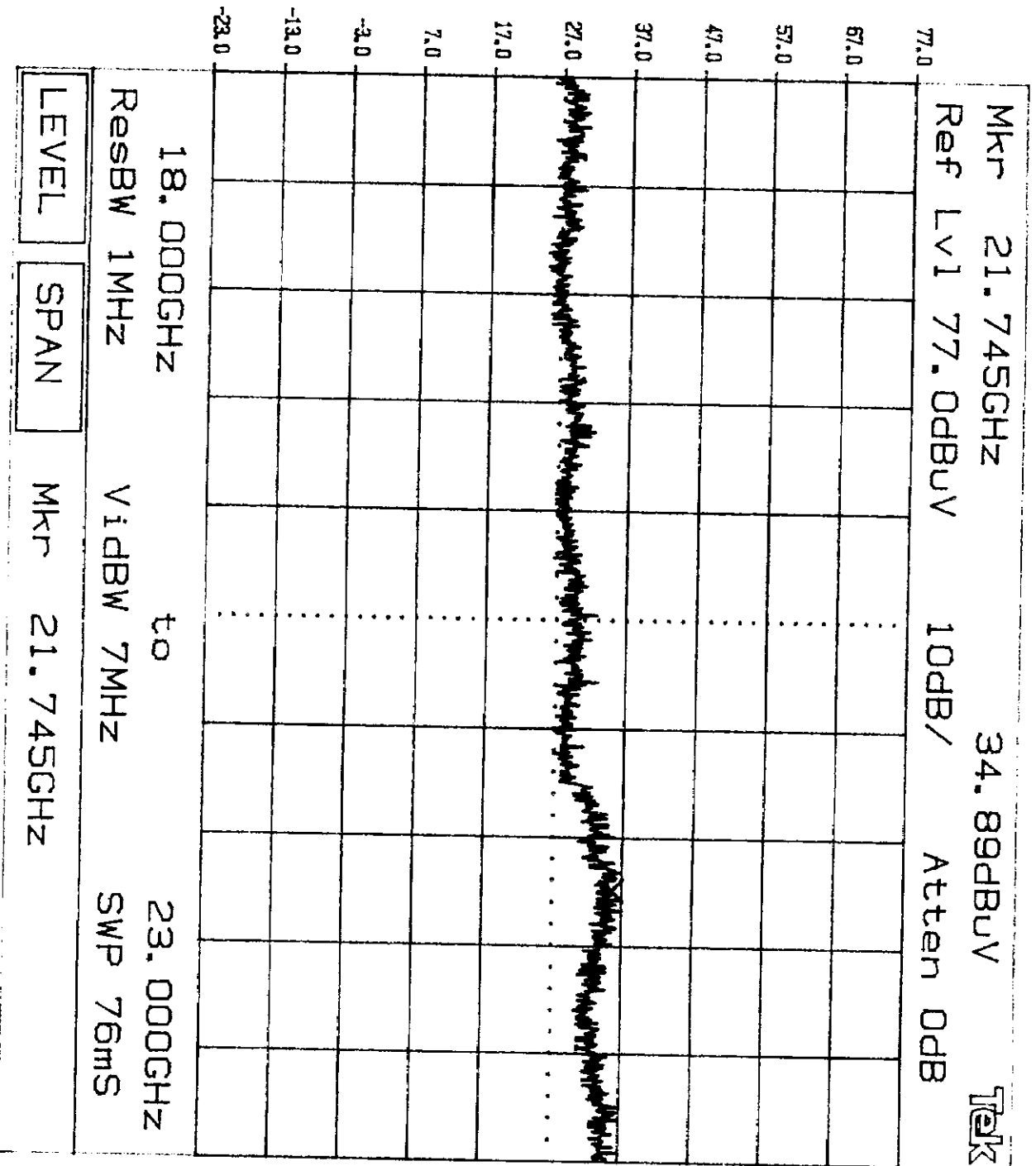
Keypad

Tektronix

2784



yes



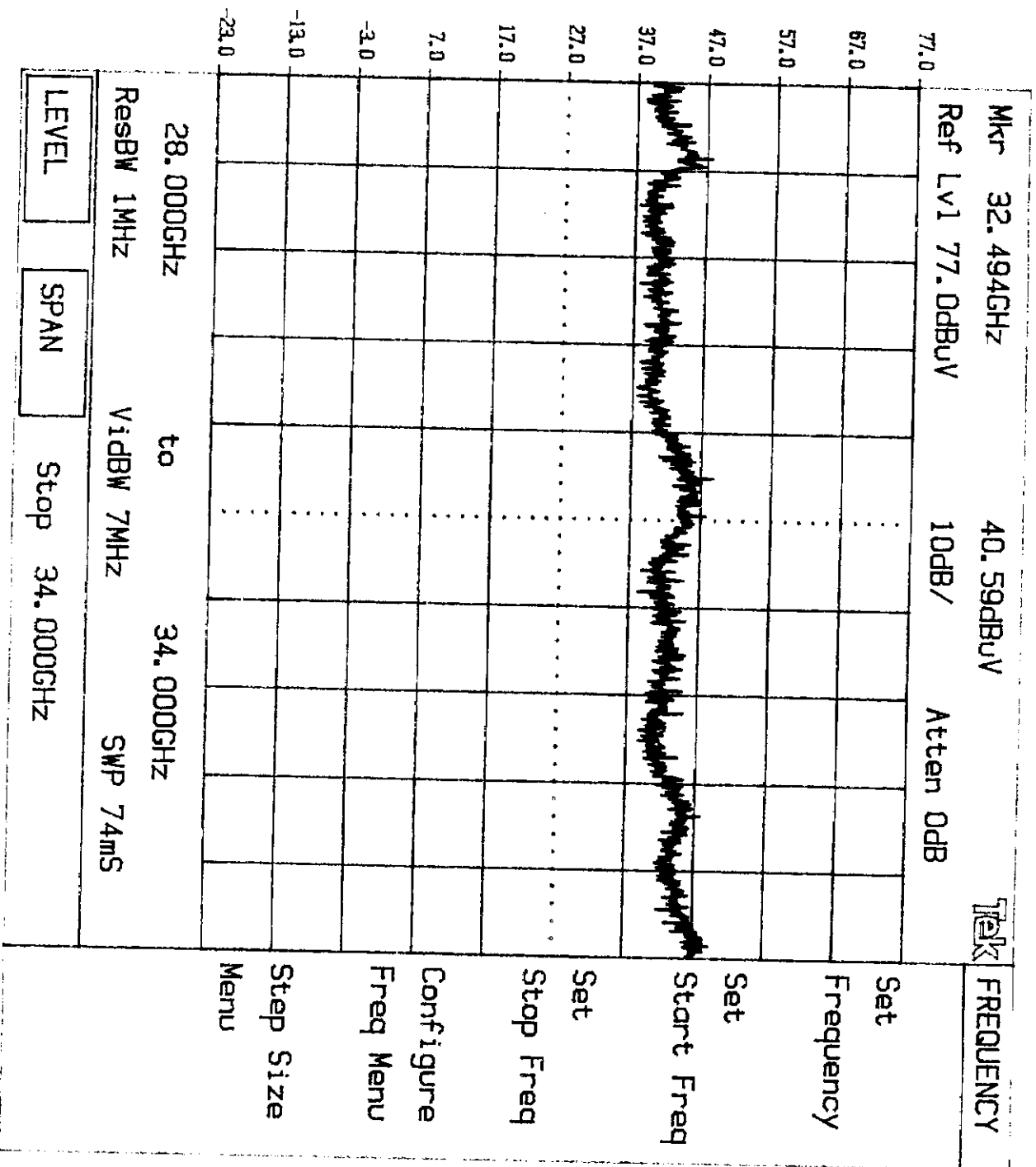
4e6

|                  |  |           |  |           |  |            |
|------------------|--|-----------|--|-----------|--|------------|
| Mkr 26.745GHz    |  | 33.69dBuV |  | Tek       |  | FREQUENCY  |
| Ref Lvl 77.0dBuV |  | 10dB/     |  | Atten 0dB |  |            |
| 77.0             |  |           |  |           |  | Set        |
| 67.0             |  |           |  |           |  | Frequency  |
| 57.0             |  |           |  |           |  | Set        |
| 47.0             |  |           |  |           |  | Start Freq |
| 37.0             |  |           |  |           |  | Set        |
| 27.0             |  |           |  |           |  | Stop Freq  |
| 17.0             |  |           |  |           |  | Configure  |
| 7.0              |  |           |  |           |  | Freq Menu  |
| -3.0             |  |           |  |           |  | Step Size  |
| -13.0            |  |           |  |           |  | Menu       |
| -23.0            |  |           |  |           |  |            |

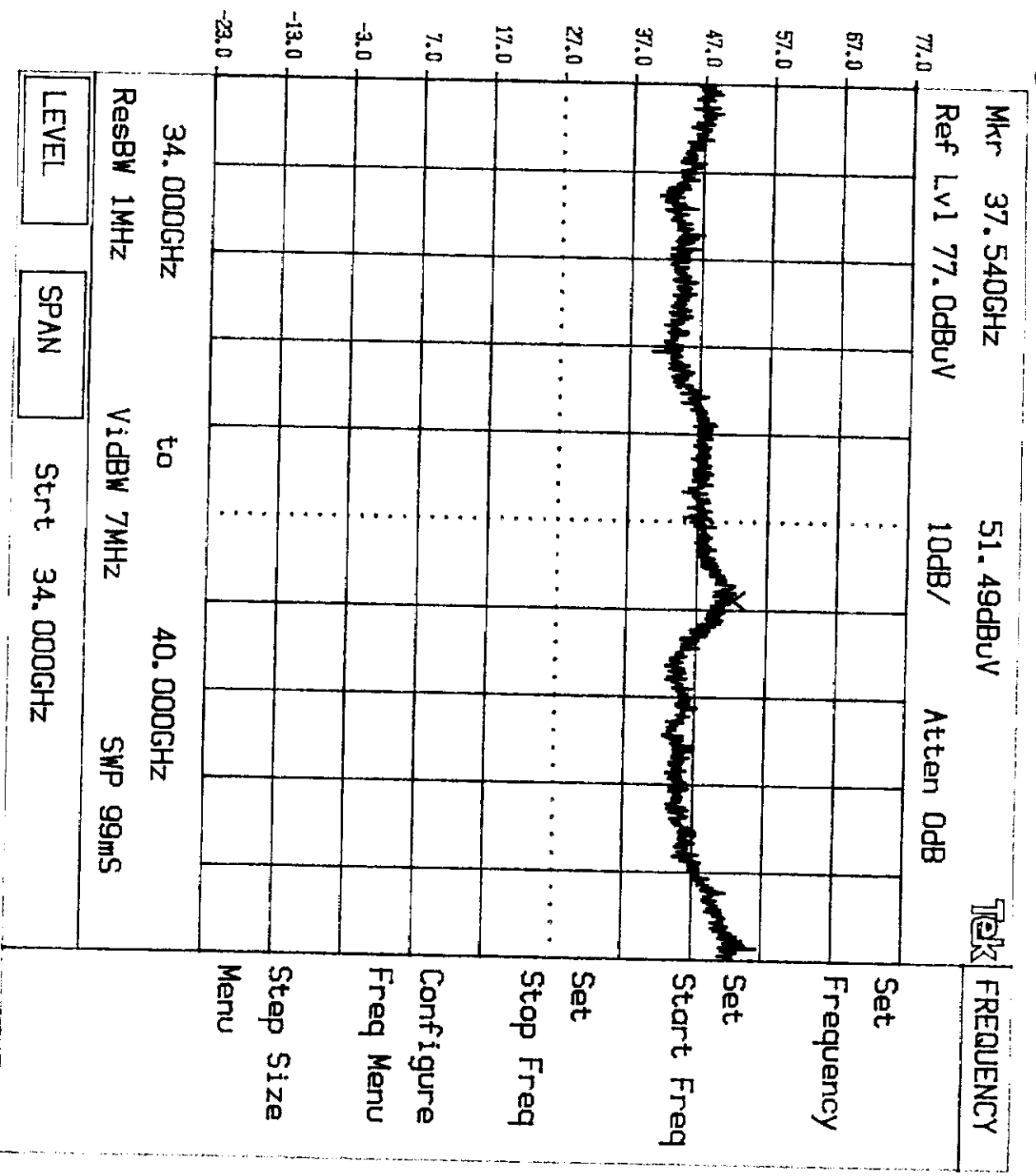
  

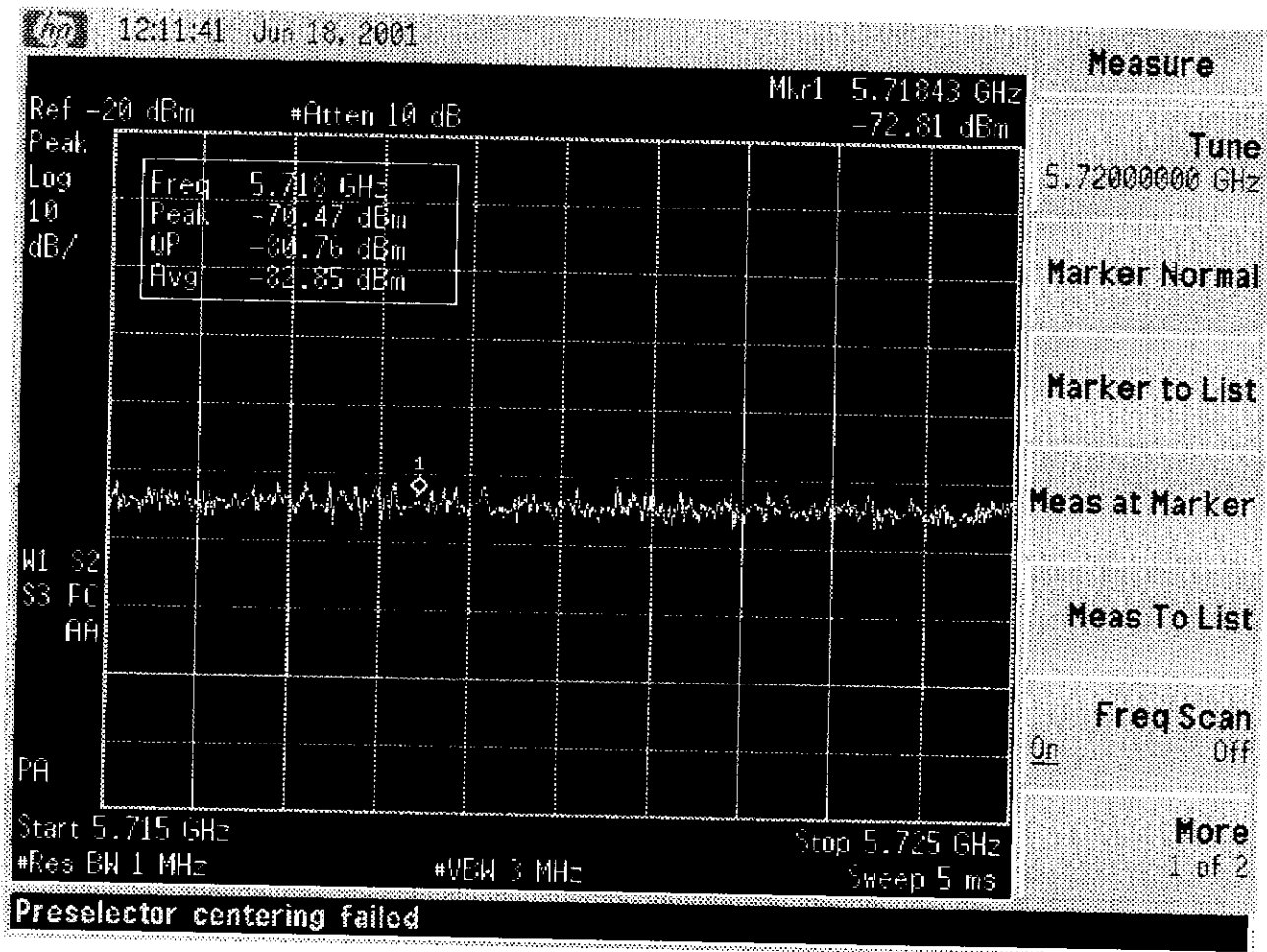
|            |      |                |  |           |  |
|------------|------|----------------|--|-----------|--|
| 23.000GHz  |      | to             |  | 28.000GHz |  |
| ResBW 1MHz |      | VidBW 7MHz     |  | SWP 50ms  |  |
| LEVEL      | SPAN | Stop 28.000GHz |  |           |  |

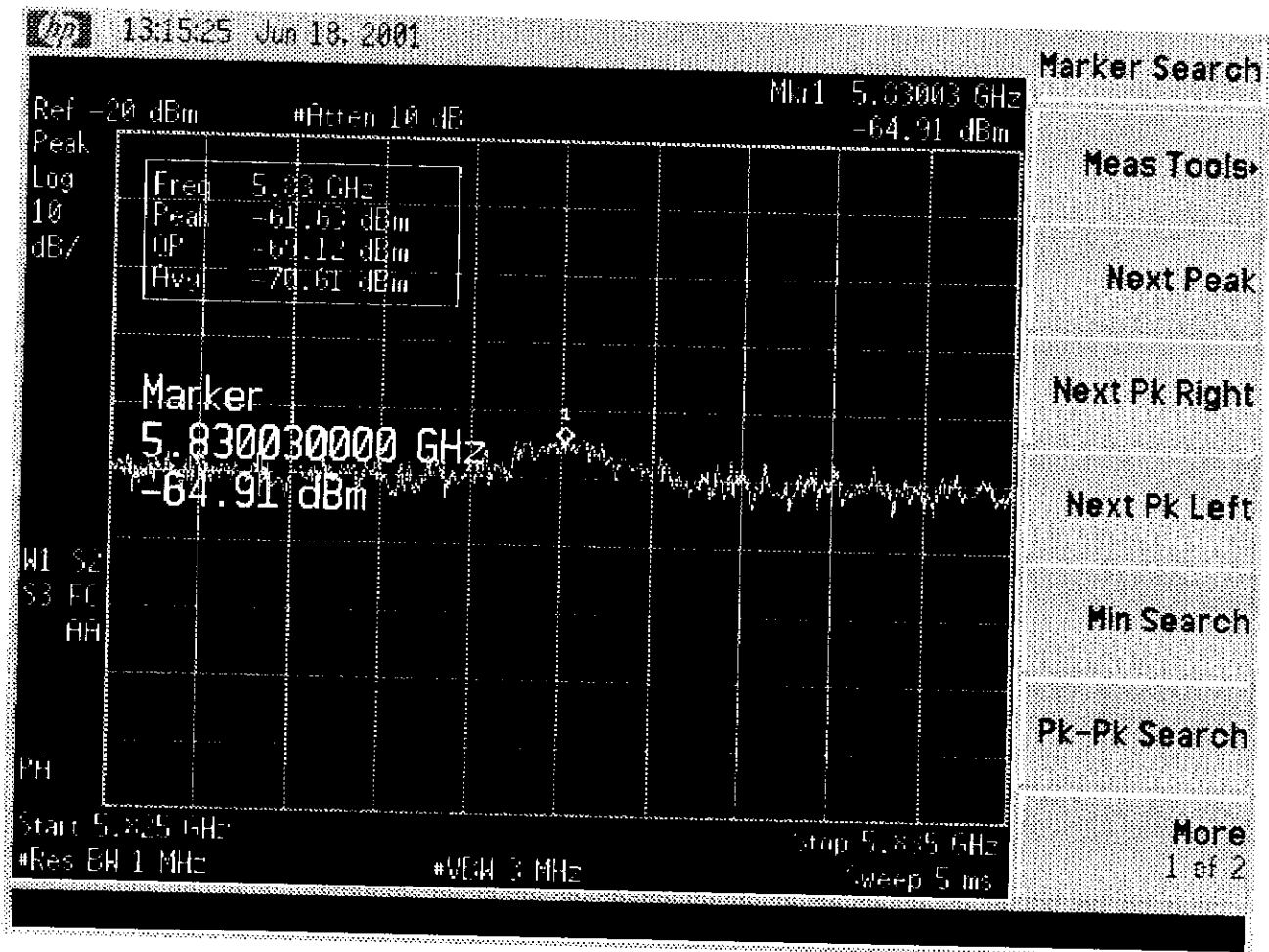
4e7

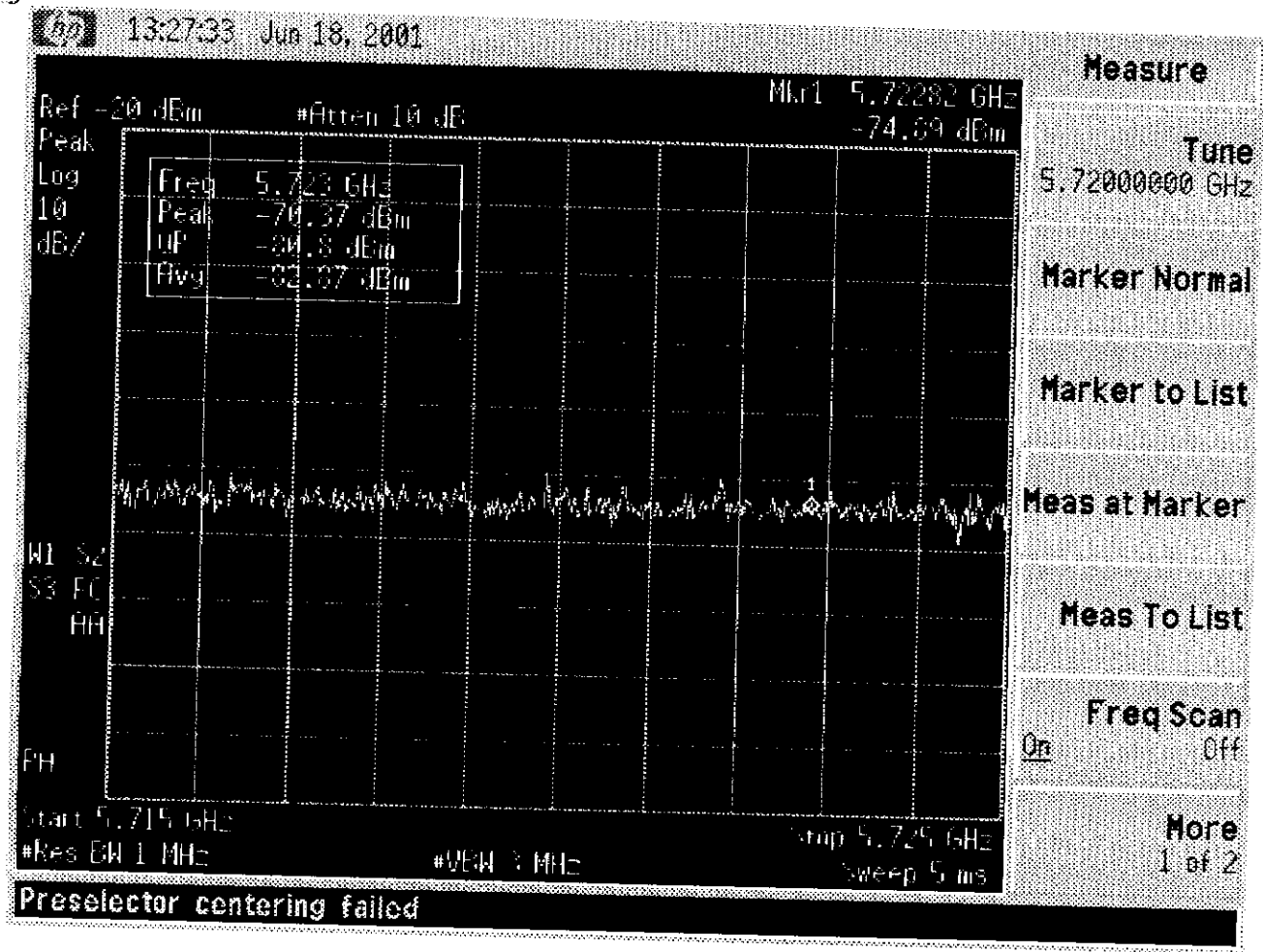


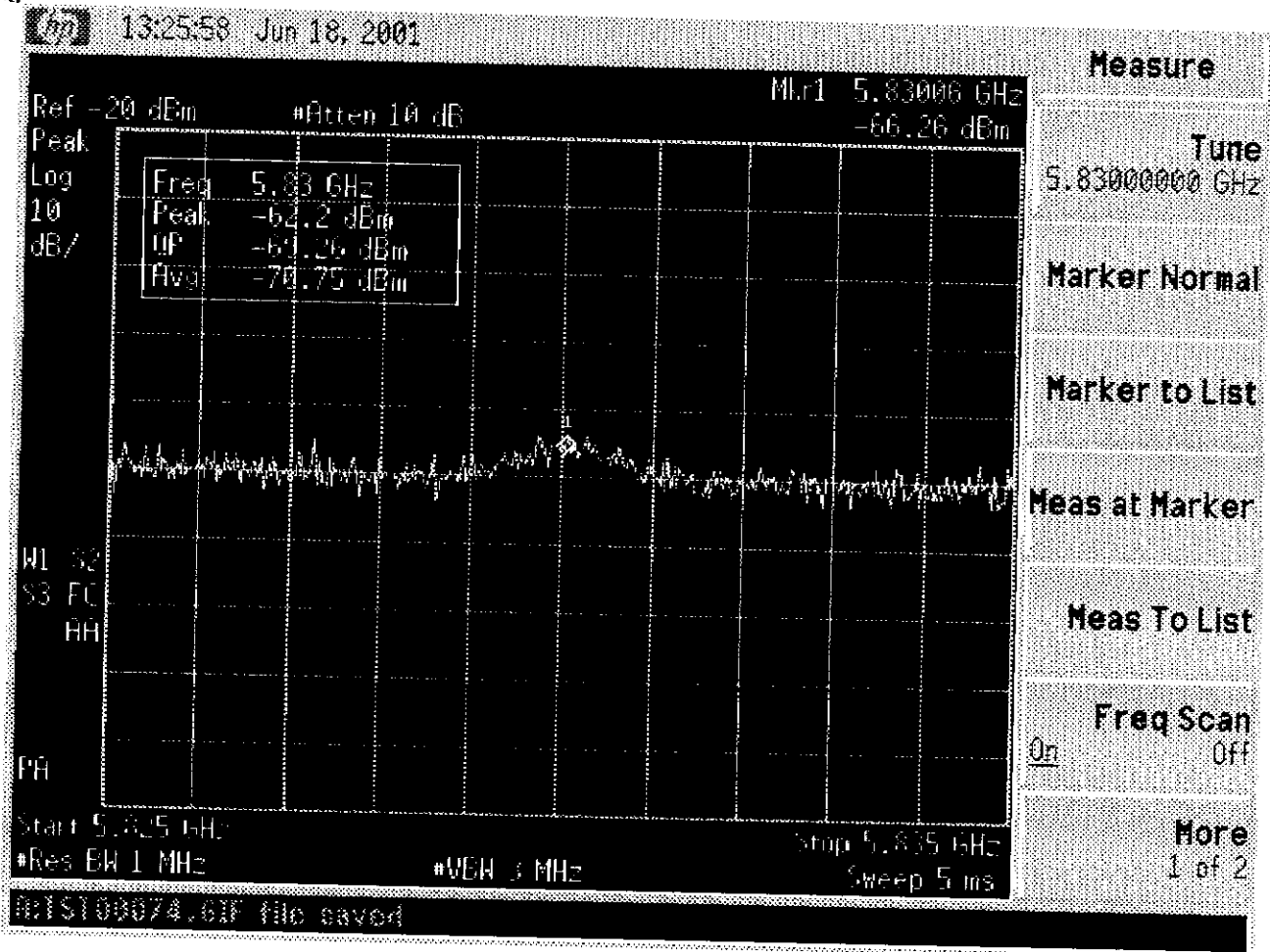
4e8

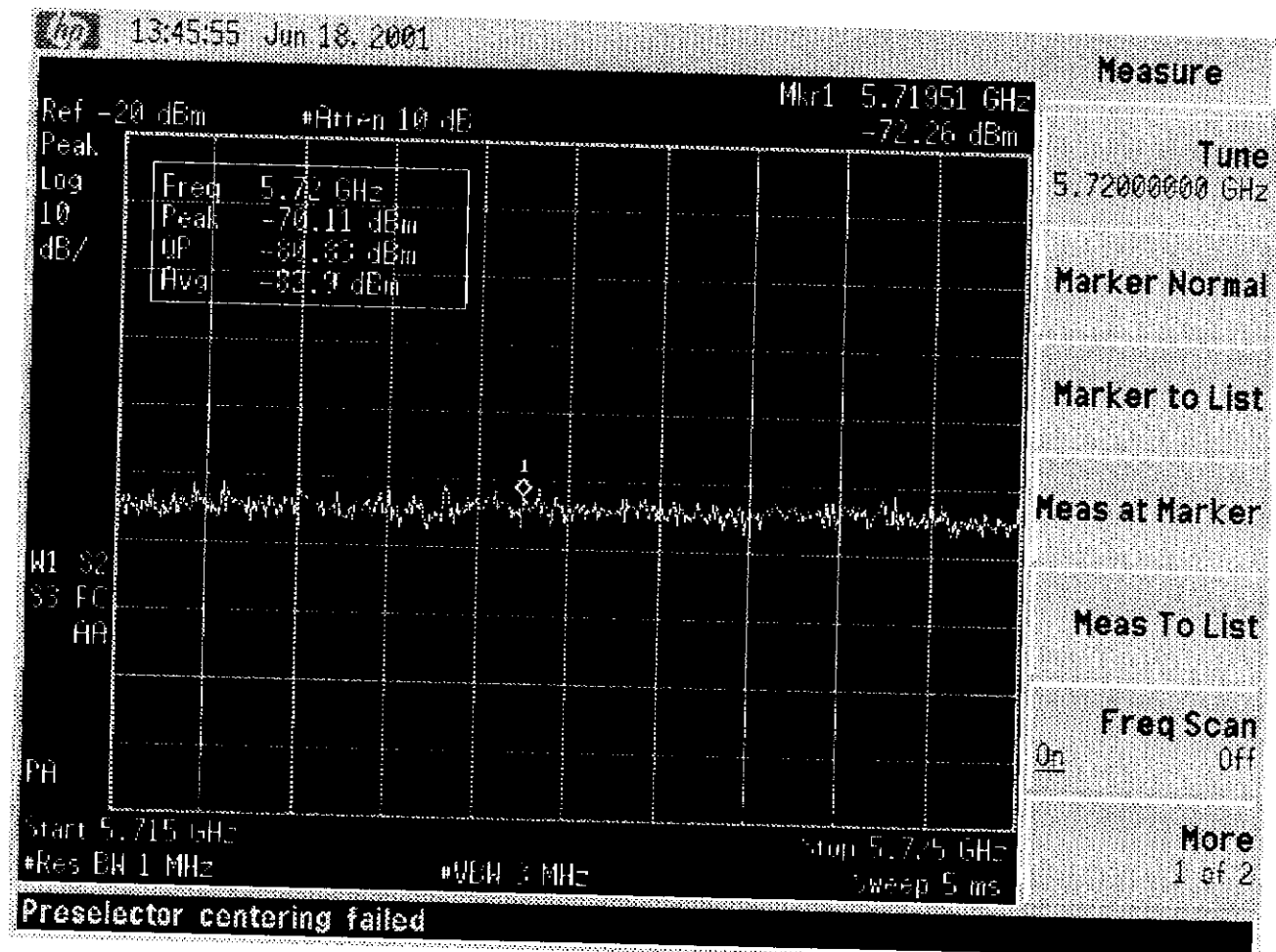


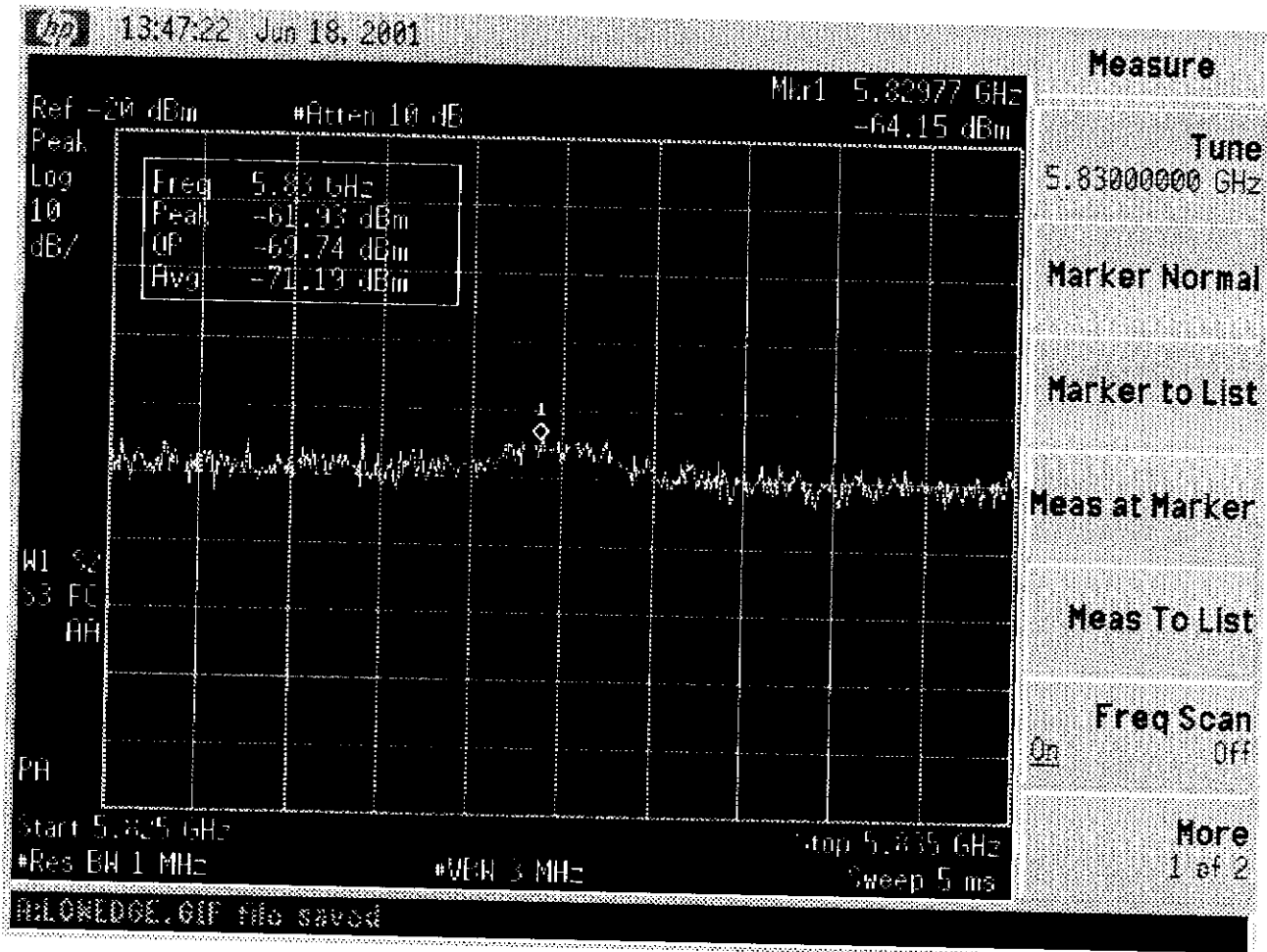






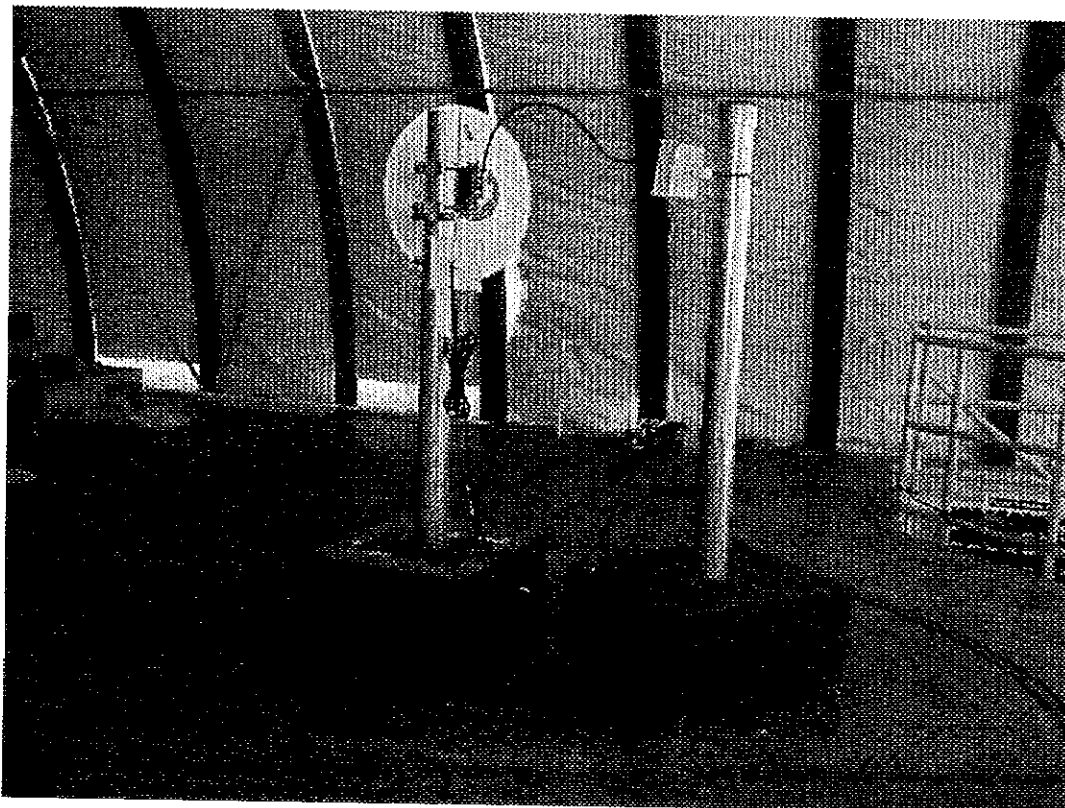
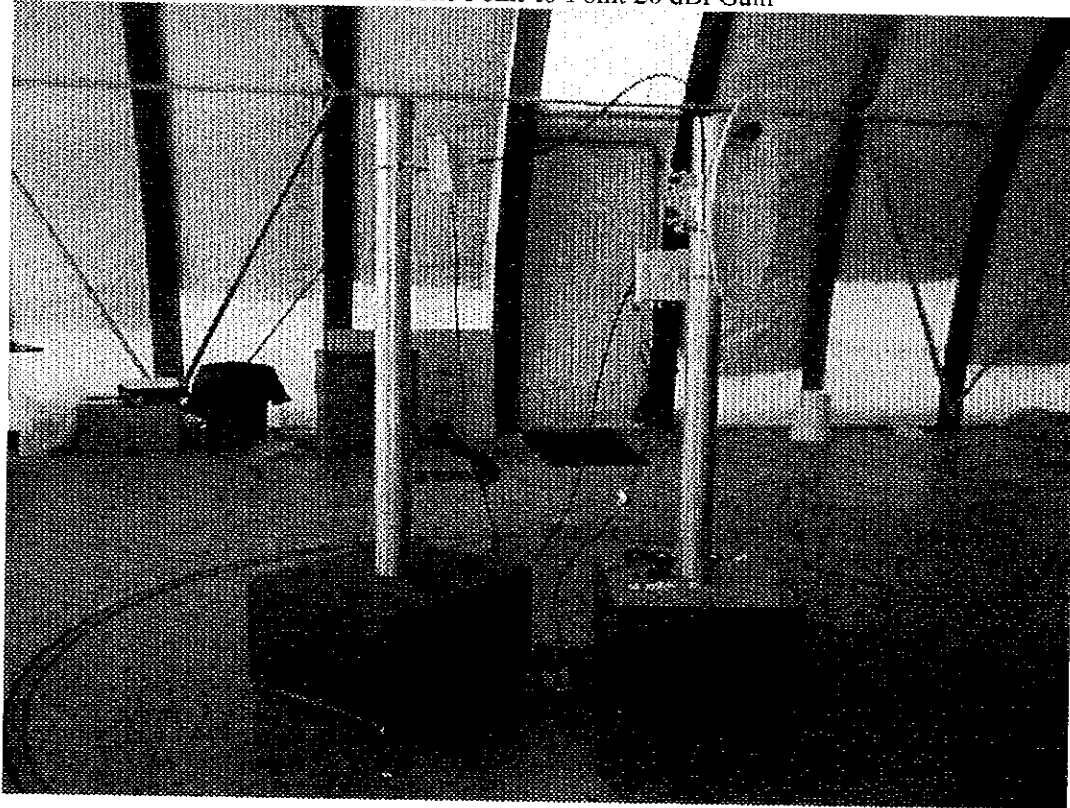






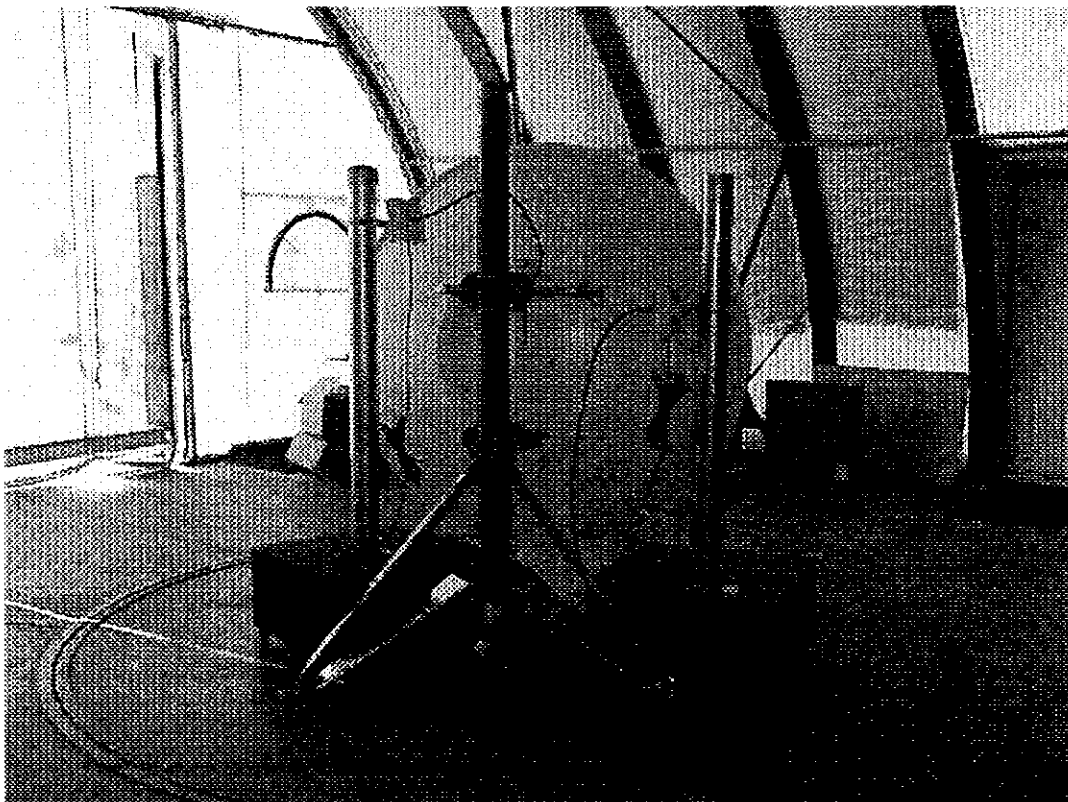
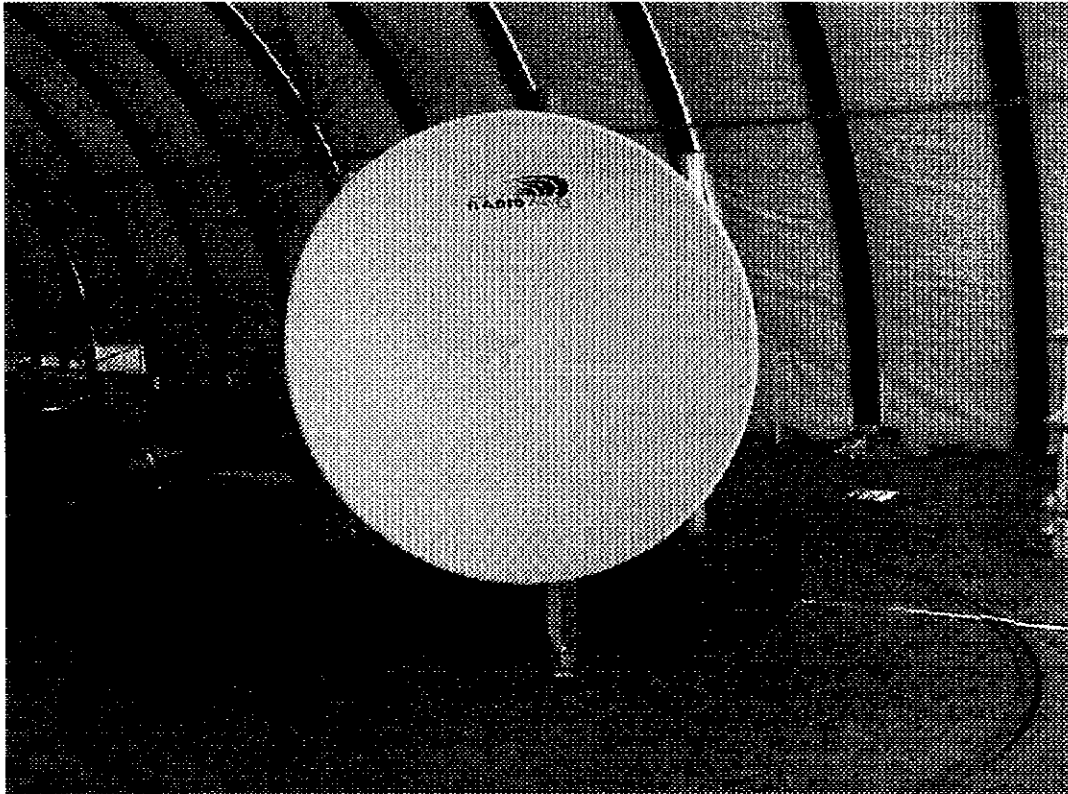
Configuration Photograph

2' Parabolic Point-to-Point 28 dBi Gain



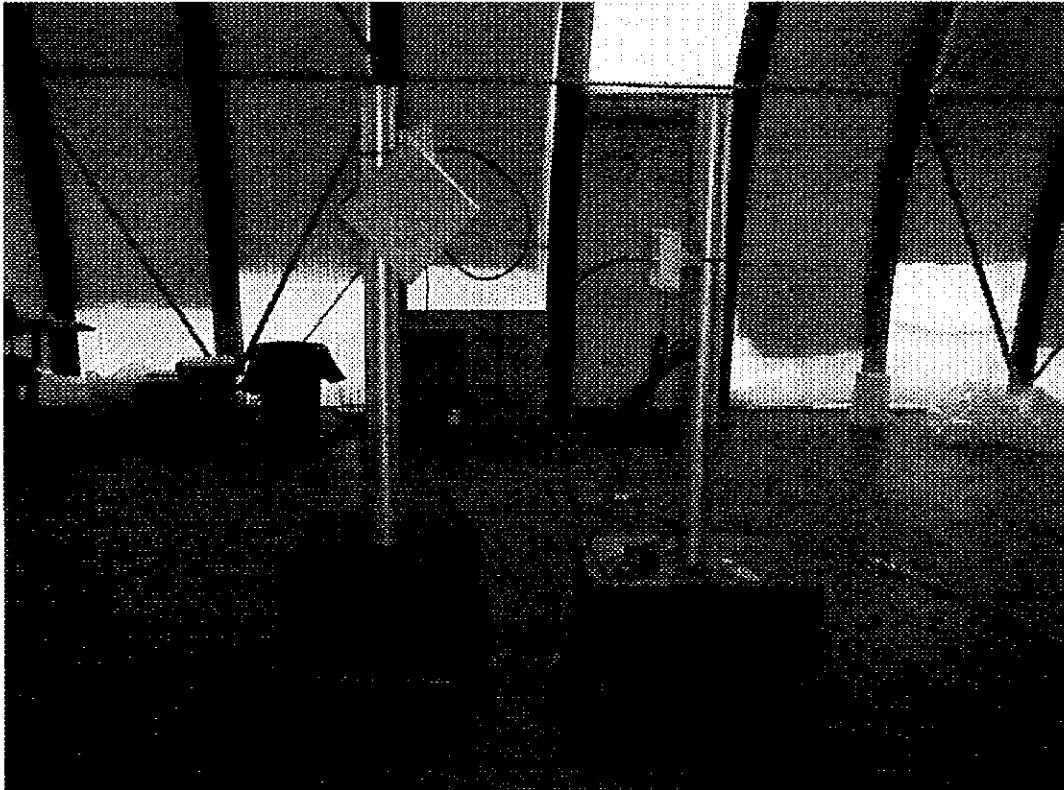
Configuration Photograph (Continued)

6' Parabolic Point-to-Point 37.6 dBi Gain



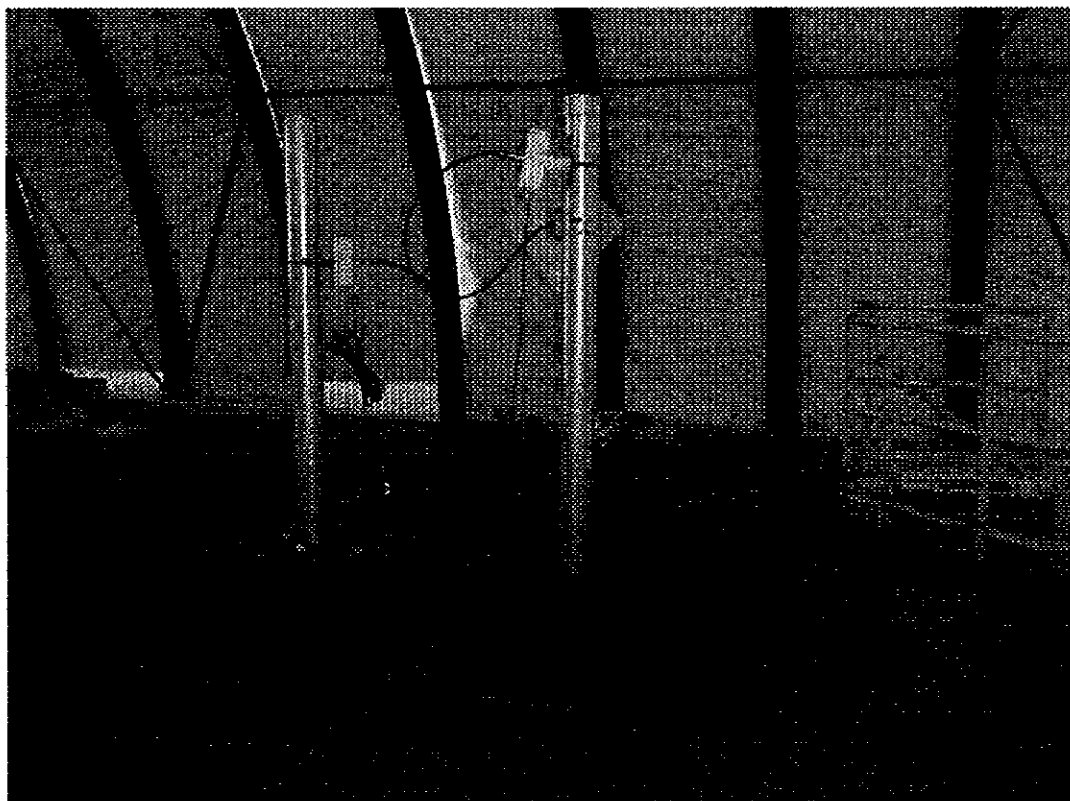
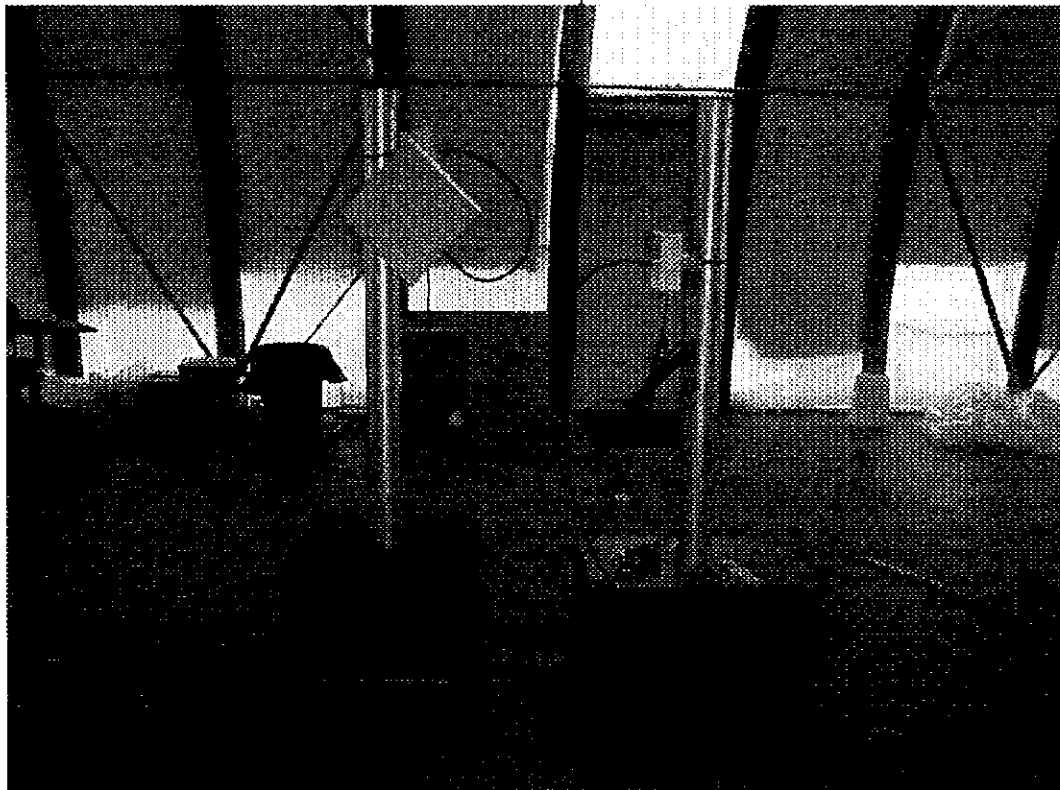
Configuration Photograph (Continued)

Flat Panel Point-to-Point 23 dBi Gain



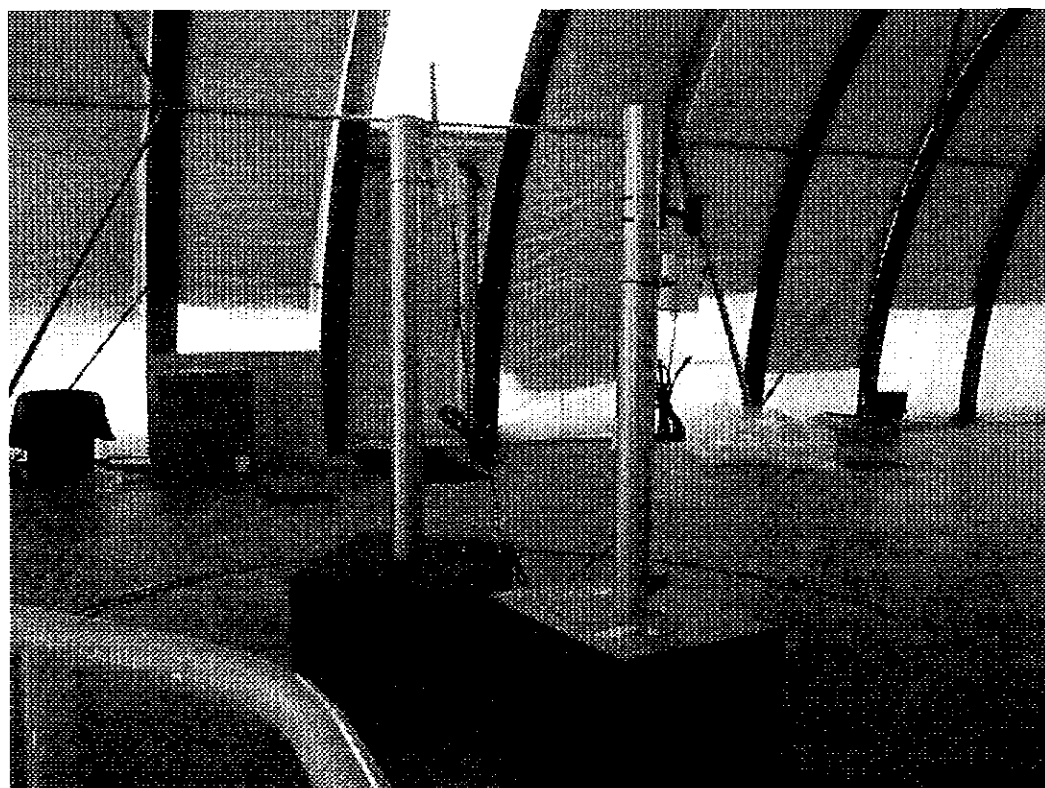
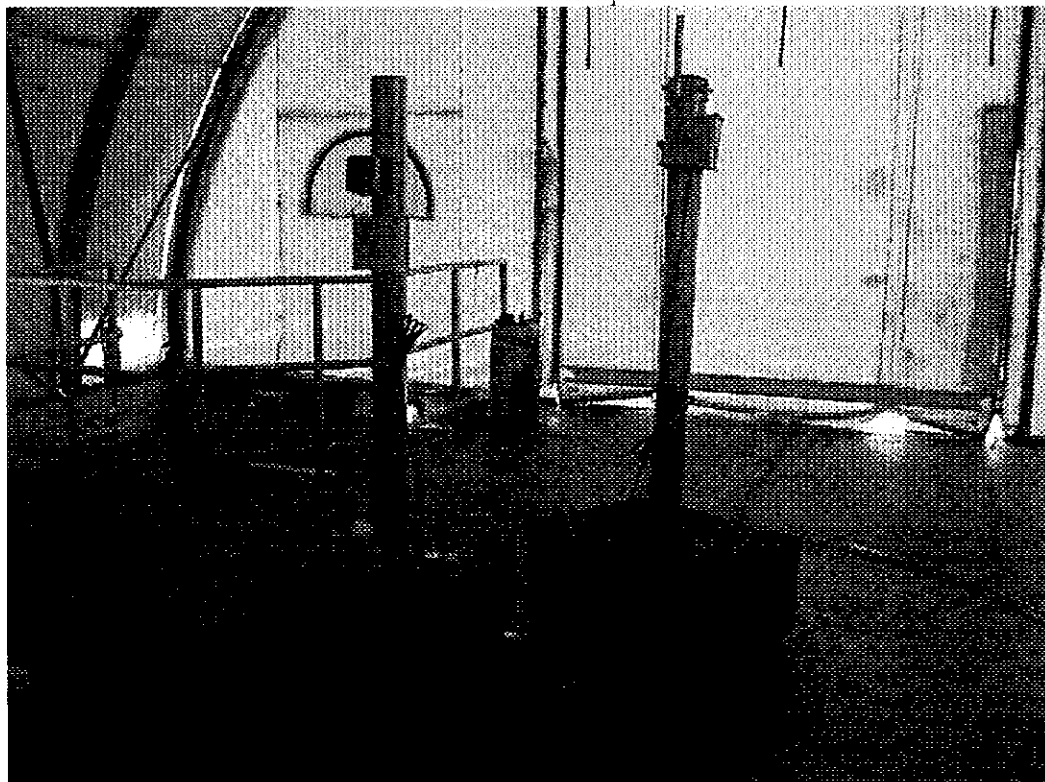
Configuration Photograph (Continued)

Flat Panel Point-to-Multipoint 23 dBi Gain



Configuration Photograph (Continued)

Omni-Directional Point-to-Multipoint 7.5 dBi 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 $\mu$ V/m

RA = Receiver Amplitude (including preamplifier) in dB $\mu$ 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 $\mu$ V/m

RR = RA - AG in dB $\mu$ V

LF = CF + AF in dB

Assume a receiver reading of 52.0 dB $\mu$ 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 $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ 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<br>(MHz) | Class B<br>( $\mu$ V) | Class B<br>(dB $\mu$ 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 $\mu$ V), and microvolts ( $\mu$ V). To convert between them, use the following formulas:  $20 \text{ LOG}_{10}(\mu V) = \text{dB}\mu V$ ,  $\text{dBm} = \text{dB}\mu V - 107$ .*

**Test Result**

See Table F.  
The EUT passed the test

# Intertek Testing Services

## Conducted Emissions / Interference

Table: F

Company: Wireless Bypass

Model: DL-5800H24

Job No.: J20046196

Date: 06/12/01

Standard: FCC15E

Class: A Group: None

Notes: LISN10, CBL110E, AGL001, DS25A

System Loss: Includes the Cable and LISN loss.

Tested by: Nicholas Abbondante

Location: Site 1C

Detector: Agilent E7405A

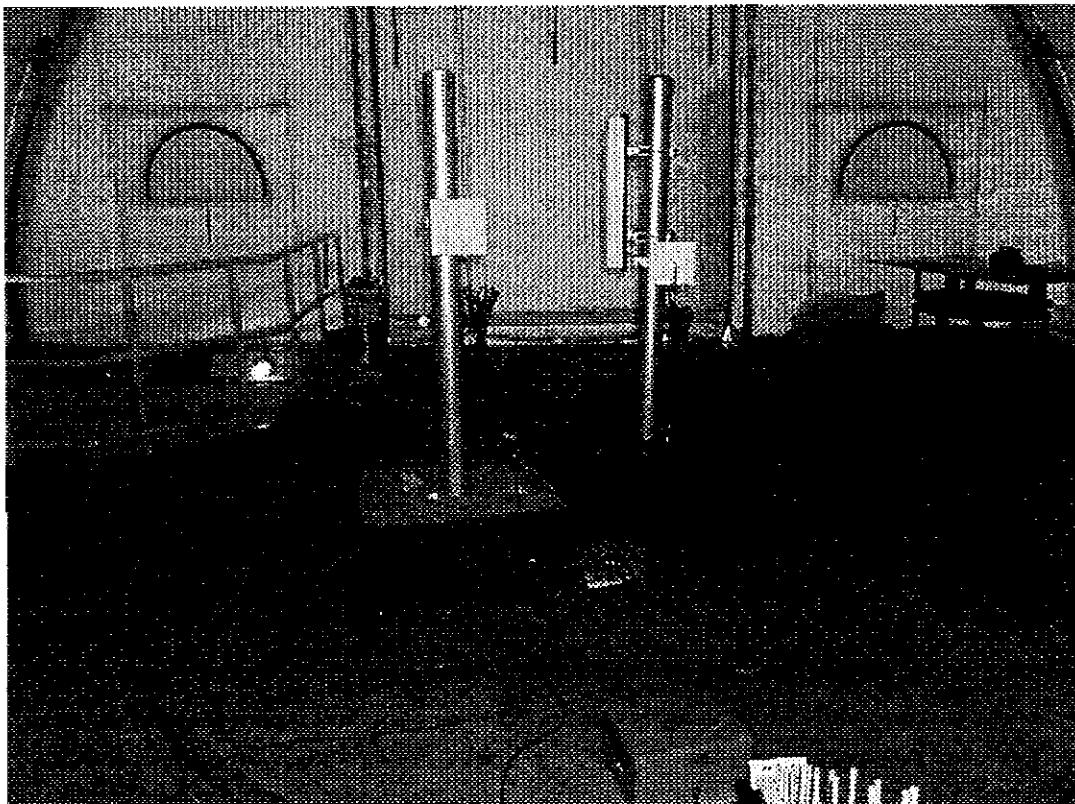
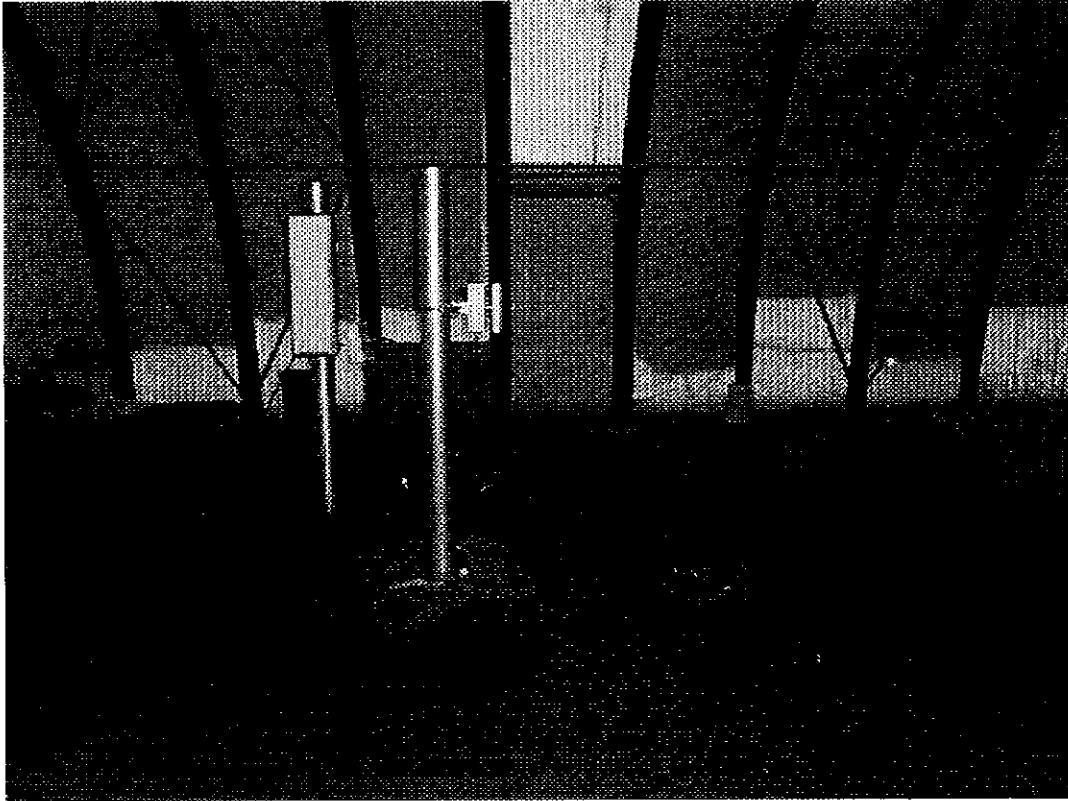
Cable(s): 1C, CBL11

Limiter: no

| Frequency<br>MHz | Reading<br>Side A<br>dB | Reading<br>Side B<br>dB | Attenuator<br>Factor<br>dB | System<br>Loss<br>dB | Quasi-Peak          |                       |              |
|------------------|-------------------------|-------------------------|----------------------------|----------------------|---------------------|-----------------------|--------------|
|                  |                         |                         |                            |                      | Net<br>dB( $\mu$ V) | Limit<br>dB( $\mu$ V) | Margin<br>dB |
| 0.513            | 12.3                    | -0.9                    | 20.0                       | 1.3                  | 33.6                | 48.0                  | -14.4        |
| 0.617            | 13.1                    | -0.3                    | 20.0                       | 1.3                  | 34.4                | 48.0                  | -13.6        |
| 1.131            | 19.5                    | 4.2                     | 20.0                       | 0.5                  | 40.0                | 48.0                  | -8.0         |
| 2.055            | 8.0                     | 4.1                     | 20.0                       | 0.4                  | 28.4                | 48.0                  | -19.6        |
| 6.473            | 12.8                    | 11.8                    | 20.0                       | 0.7                  | 33.5                | 48.0                  | -14.5        |
| 16.860           | 18.5                    | 18.7                    | 20.0                       | 0.8                  | 39.5                | 48.0                  | -8.5         |
| 20.660           | 18.3                    | 18.5                    | 20.0                       | 0.9                  | 39.4                | 48.0                  | -8.6         |
| 27.040           | 14.8                    | 14.5                    | 20.0                       | 1.1                  | 35.9                | 48.0                  | -12.1        |

Configuration Photograph

Line-conducted emissions, HUB



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.                                                |

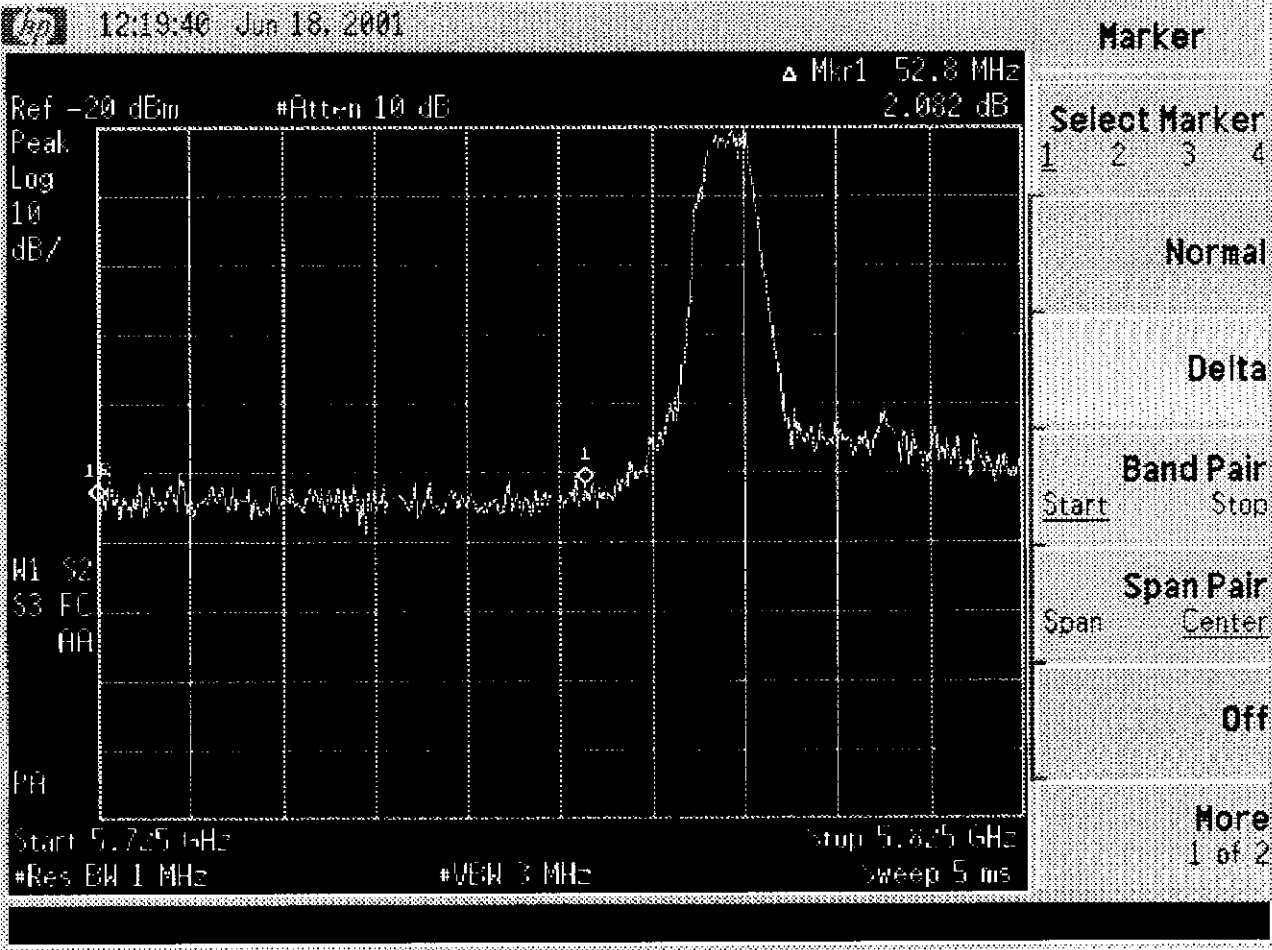
4.12 Frequency Stability  
FCC Rule 15.407(g)

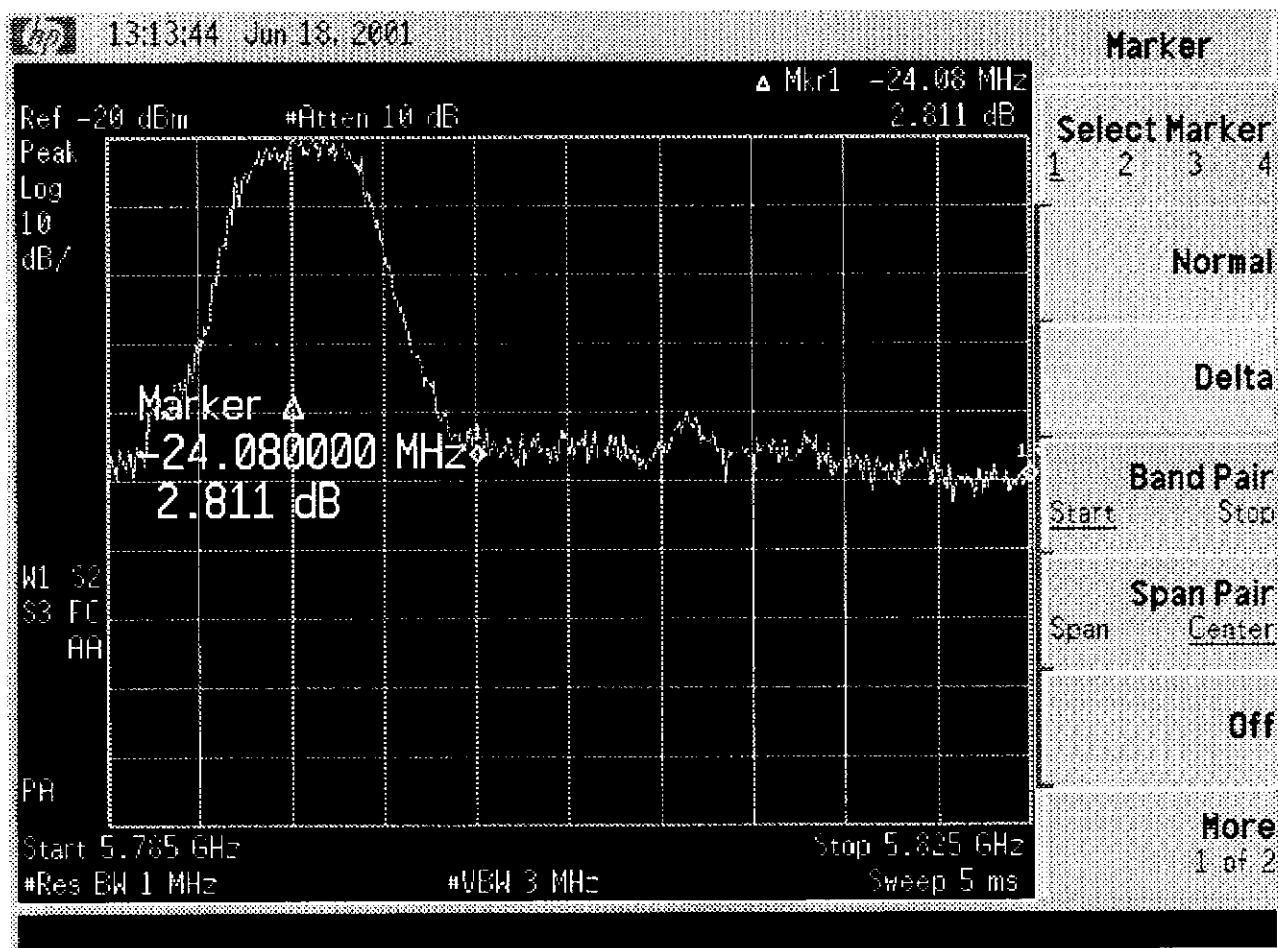
The EUT antenna output was connected directly to the input of the spectrum analyzer via a 30 dB attenuation pad and a high frequency cable with 5.7 dB of loss. Measurements were made from the 26dBc bandwidth point, or lower, of the fundamental frequency to the nearest band edge for both the high and 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.

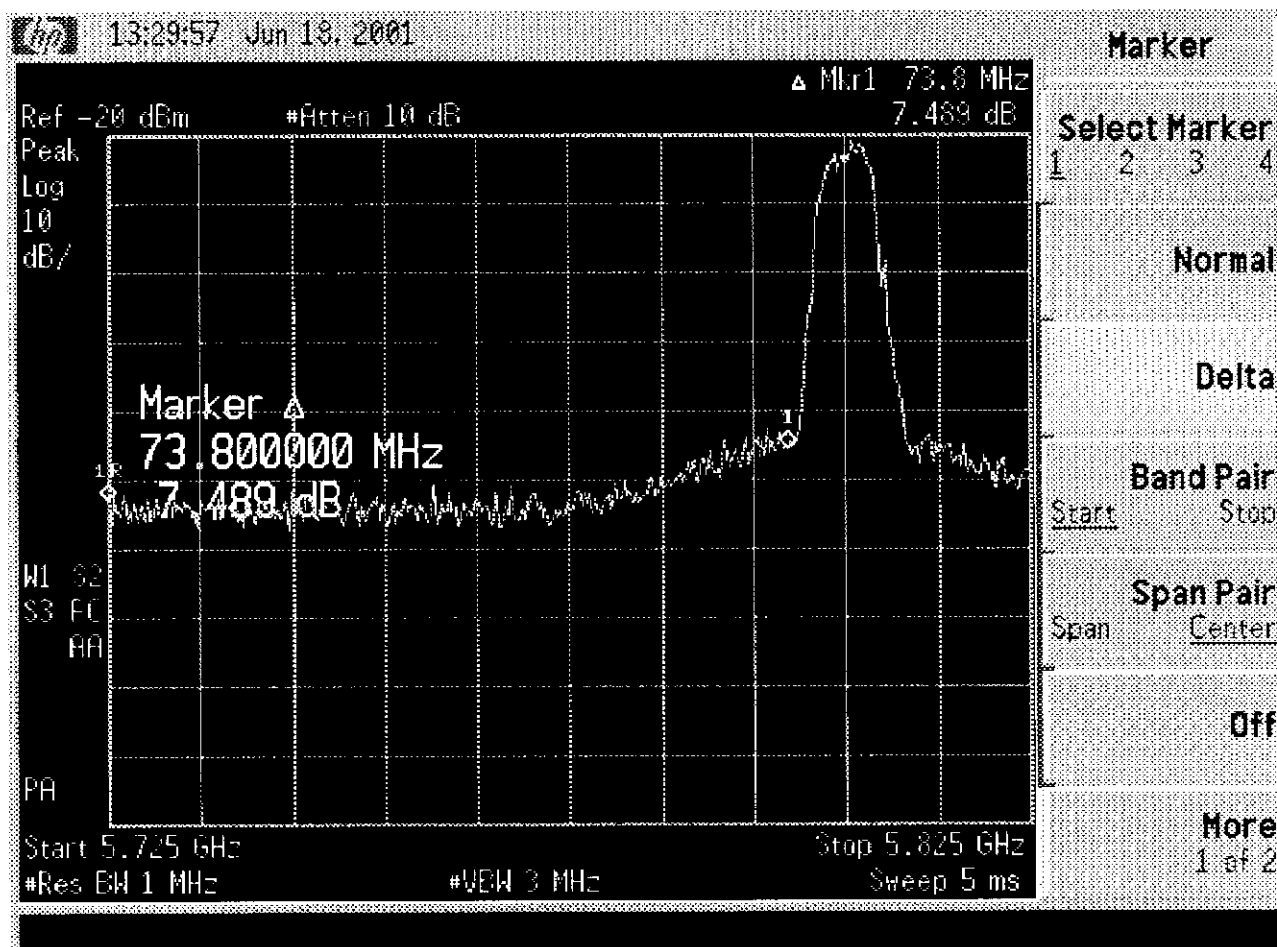
Refer to Exhibit A for a discussion of the worst case frequency stability of the EUT. Refer to the following plots for supporting data:

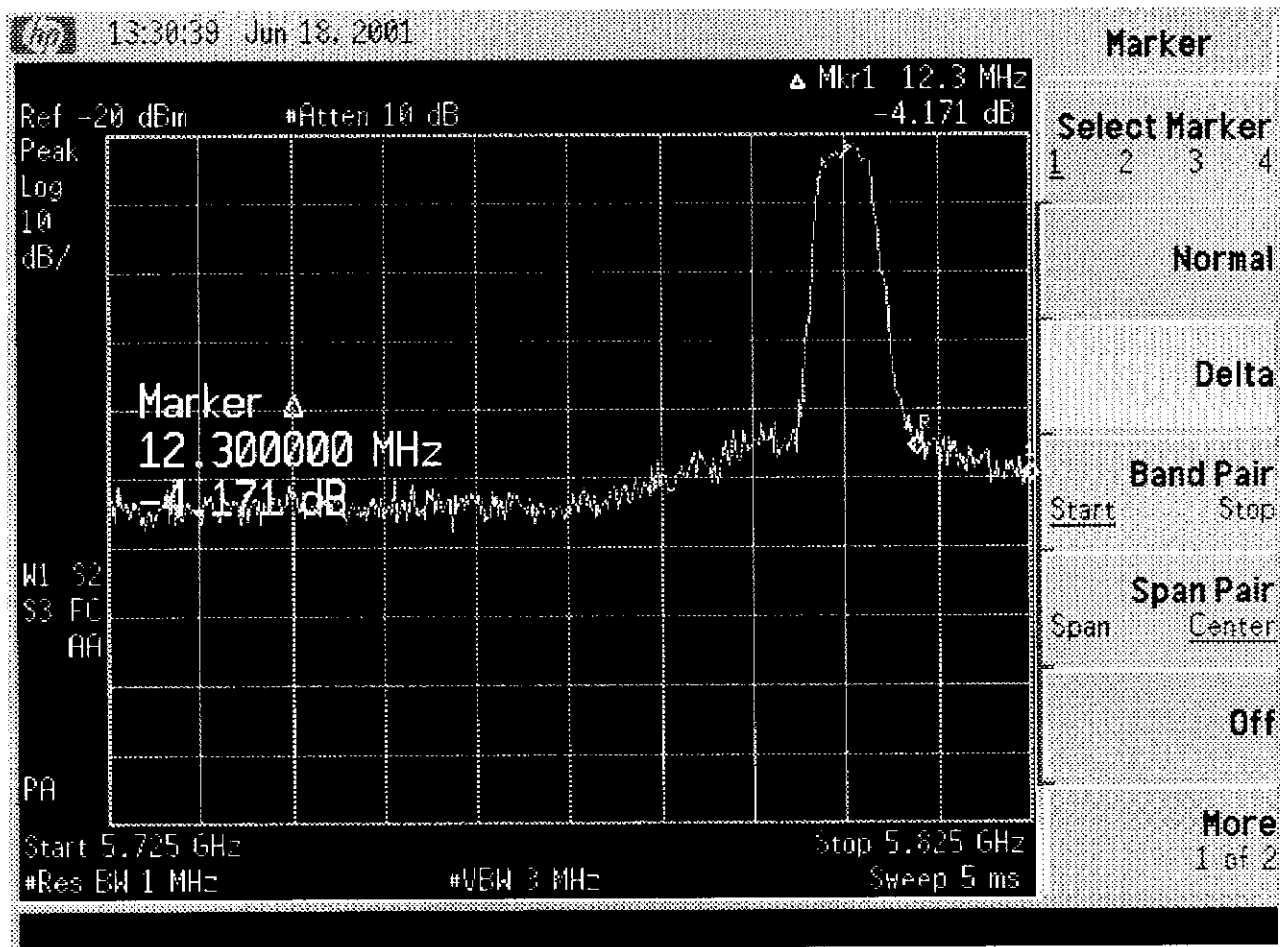
Plot 5.a1-5.a2: Frequency Stability Margin Low Channel  
Plot 5.b1-5.b2: Frequency Stability Margin Mid Channel  
Plot 5.c1-5.c2: Frequency Stability Margin High Channel

5a1

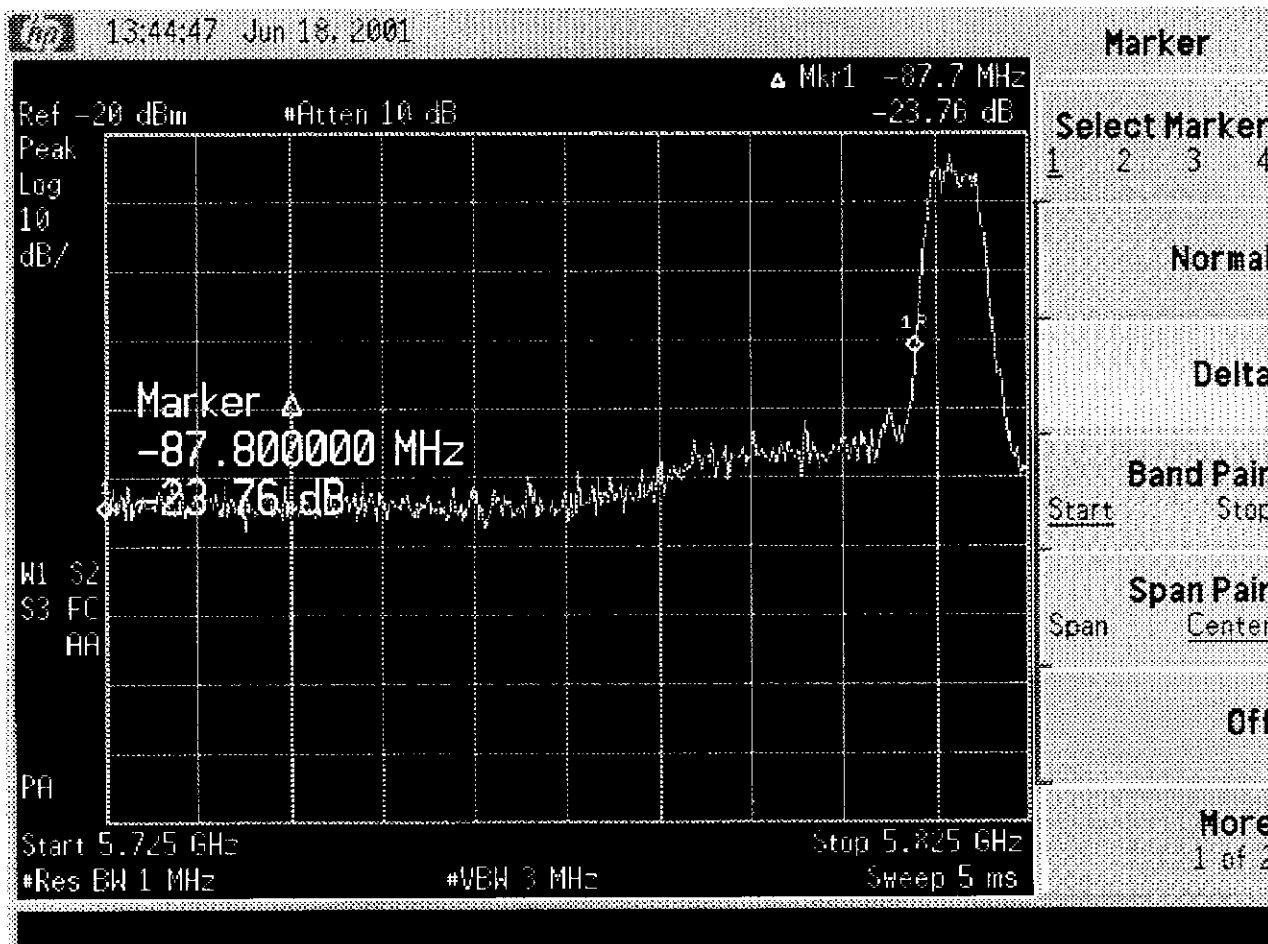




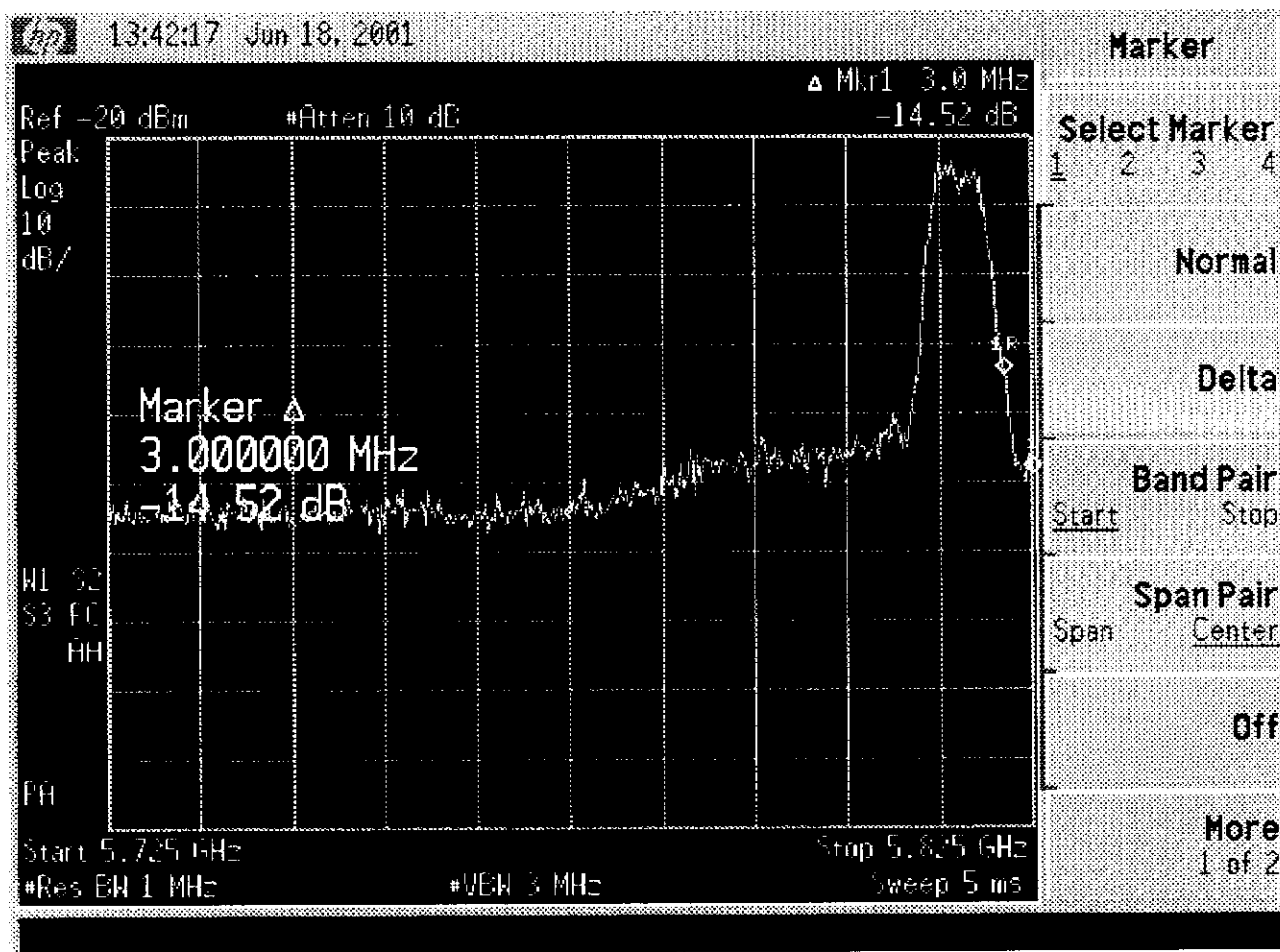




5c1



5c2





# 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 +/- 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 +/- 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

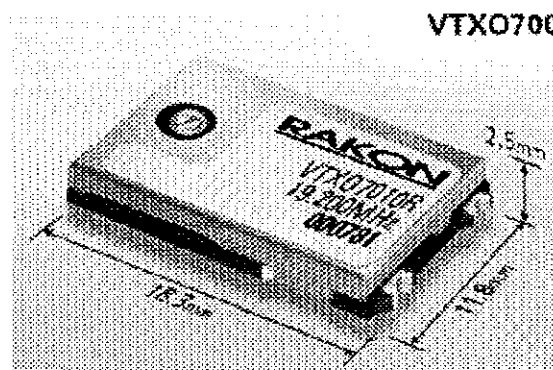
**Voltage Controlled Temperature Compensated Crystal Oscillators**  
 Low profile surface mountable VTCXO available in custom frequencies from 8.2MHz to 32MHz with a clipped sinewave output

### 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  | <b>Static temperature hysteresis</b> | Frequency change after reciprocal temperature ramped over the operating range. Frequency measured before and after at 25 deg C     | 0.4 | +/-ppm |  |
| 2.8  | <b>Supply voltage stability</b>      | 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  | <b>Load sensitivity</b>              | +/-10% load change                                                                                                                 | 0.2 | -/-ppm |  |
| 2.10 | <b>Root Allan Variance</b>           | 1 second Tau. (Note 1)                                                                                                             | 1.0 | ppb    |  |
| 2.11 | <b>Long term stability</b>           | Frequency drift over 1 year (Note 1)                                                                                               | 1.0 | +/-ppm |  |
| 2.12 | <b>G Sensitivity</b>                 | Gamma vector of all three axes from 30Hz to 1500Hz (Note 1)                                                                        | 1.0 | ppb/G  |  |
| 2.13 | <b>Trimmer adjustment</b>            | Manual adjustment using trimmer tool                                                                                               | 3.0 | +/-ppm |  |

### 3.0 POWER SUPPLY

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

### 4.0 CONTROL VOLTAGE

| Line | Parameter                         | Test Condition                                                                                                      | Min.  | Max. | Units  |
|------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------|-------|------|--------|
| 4.1  | <b>Control voltage range</b>      | 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  | <b>Frequency tuning</b>           | Frequency shift from Min. to Max. control voltages (Note 6)                                                         | 6.0   |      | ppm    |
| 4.3  | <b>Frequency tuning linearity</b> | Deviation from straight line curve fit (Note 1)                                                                     |       | 20.0 | %      |
| 4.4  | <b>Port input impedance</b>       |                                                                                                                     | 100.0 |      | K Ohms |

### 5.0 OSCILLATOR OUTPUT

| Line | Parameter                     | Test Condition         | Min. | Max. | Units  |
|------|-------------------------------|------------------------|------|------|--------|
| 5.1  | <b>Output waveform</b>        | Clipped sinewave       |      |      |        |
| 5.2  | <b>Output voltage level</b>   | At min. supply voltage | 1.0  |      | V      |
| 5.3  | <b>Output load resistance</b> | 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

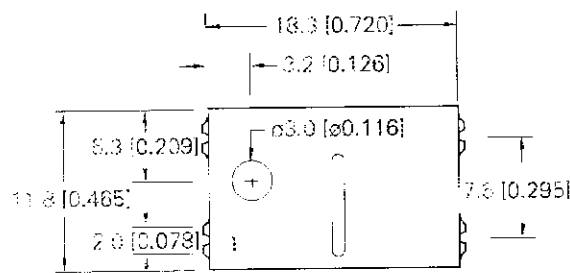
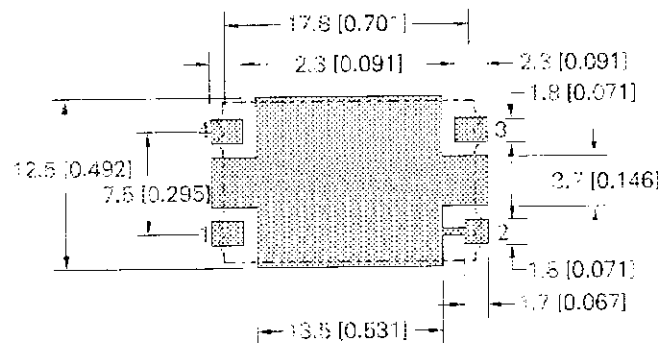
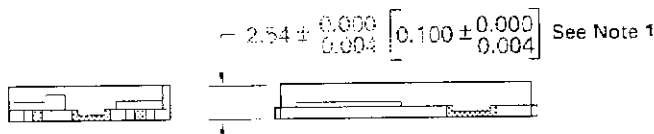
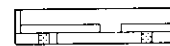
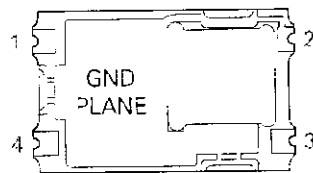
|     |        |                                                                                                                      |
|-----|--------|----------------------------------------------------------------------------------------------------------------------|
| 8.1 | Type   | Engrave                                                                                                              |
| 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 | <b>Reflow and washing</b>    | Able to withstand normal solder reflow processes but not aqueous washing due to presence of trimmer with open dielectric exposure. |
| 9.2 | <b>Packaging description</b> | Tape and reel                                                                                                                      |

## 10.0 SPECIFICATION NOTES

- |      |               |                                                                                                                                                                                                                                                                                |
|------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.1 | <b>Note 1</b> | The Max. value is the specification. A Min. value, if present, indicates the tightest specification available.                                                                                                                                                                 |
| 10.2 | <b>Note 2</b> | A max. frequency stability over the temperature is required to be specified. For this model, values between to $\pm 1$ ppm and $\pm 10$ ppm are available. Standard options are $\pm 1$ ppm, $\pm 1.5$ ppm, $\pm 2$ ppm and $\pm 2.5$ ppm.                                     |
| 10.3 | <b>Note 3</b> | 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 $\pm 1.5$ ppm. |
| 10.4 | <b>Note 4</b> | Standard power supply options are 2.7V, 3V, 3.3V, 4V or 5V, but any value between Min. & Max. is available.                                                                                                                                                                    |
| 10.5 | <b>Note 5</b> | 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 | <b>Note 6</b> | 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

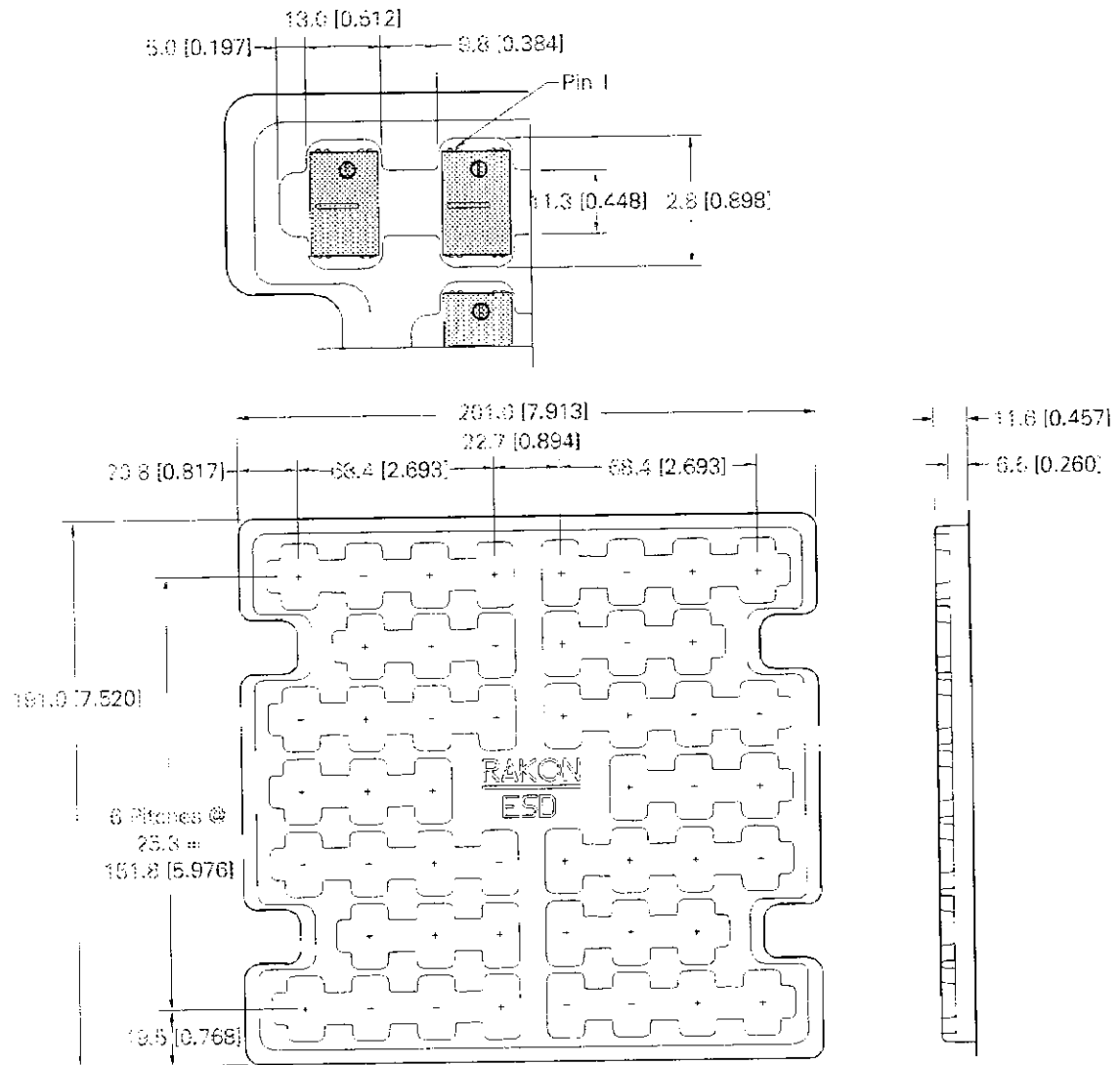
Millimetres [inch]

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

©1998 Rakon Limited



**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)

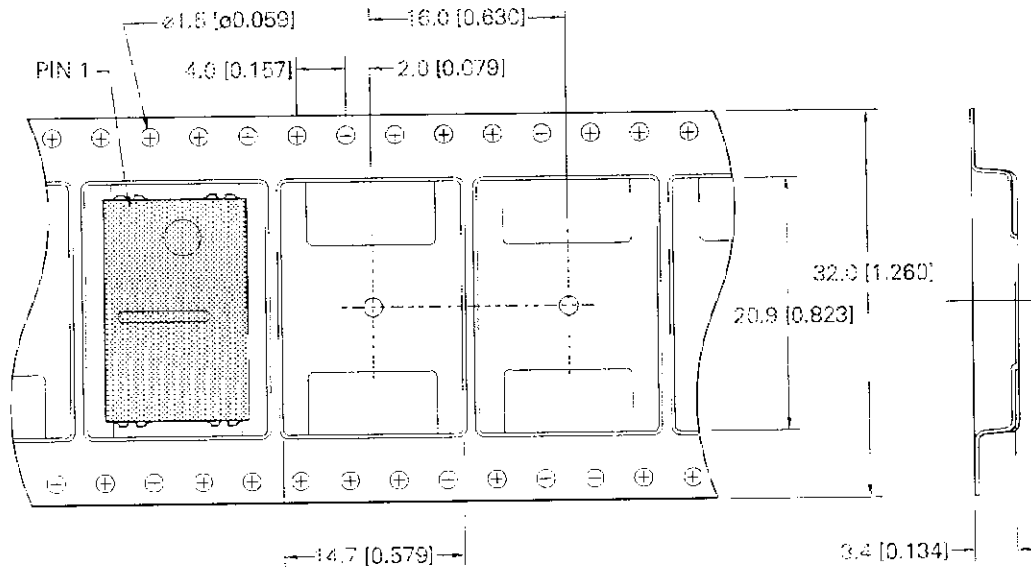
DATE: 24 JULY 98

SCALE: 1:1

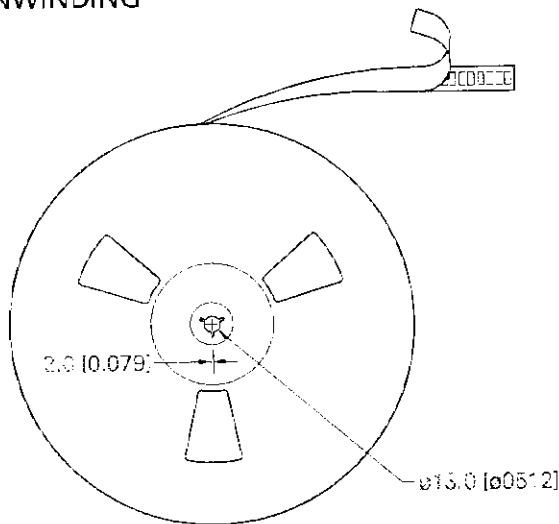
Millimetres [inch]

**RAKON**  
 PRECISION QUARTZ CRYSTALS

©1998 Rakon Limited



UNWINDING



REEL DETAIL  
SCALE 1:5

TITLE: 700 TAPE & REEL

FILENAME: CAT098

REVISION: A

RELATED DRAWINGS: TXO700 VTXO700

DATE: 16 DEC 98

SCALE: 2:1 1:5

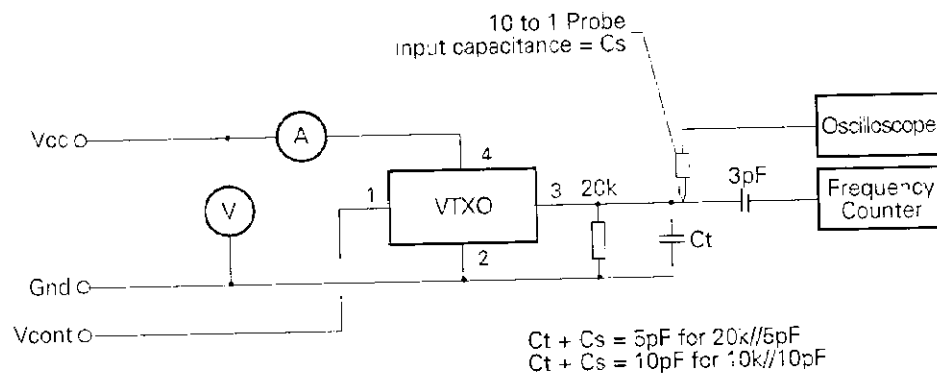
Millimetres [inch]

Tolerances:

XX =  $\pm 0.5$   
X.X =  $\pm 0.10$   
X.XX =  $\pm 0.05$   
X.XXX =  $\pm 0.05$   
X<sup>c</sup> =  $\pm 1.0^\circ$   
Hole =  $\pm 0.10$

**RAKON**  
PRECISION QUARTZ CRYSTALS

©1998 Rakon Limited



TITLE: VT XO CLIPPED SINEWAVE TEST CIRCUIT FILENAME: CAT135

REVISION: A

RELATED DRAWINGS: VT XO400 VT XO500  
 VT XO4080 VT XO700  
 VT XO4080S

DATE: 3 SEPT 98

SCALE: NTS

Millimetres [inch]

**RAKON**  
PRECISION QUARTZ CRYSTALS

©1998 Rakon Limited

## 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