

FCC Part 15 Subpart E Test Report

Western Multiplex

U-NII Radio

Model: 27900

FCC ID: HZB-U5358-480

Job # J20029334

Number of Pages: 20 pp. + Supporting Data and Documents

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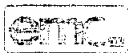


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1.0 Summary of Tests

Western Multiplex, MODEL: 27900 FCC ID: HZB-U5358-480

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 Part	15.209	Pass
Radiated Emission from Receiver L.O.	15.209	Not Applicable
Radiation Exposure Requirement	1.1310	Pass
Antenna Requirement	15.203	Not Applicable

Test Engineer:

Ollie Moyrong
Ollie Moyrong

Date:

11/28/00

EMC Site Manager:

David Chernomordik
David Chernomordik

Date:

11/28/00

2.0 General Description

2.1 Product Description

The EUT Model No.: 27900 is an intentional transmitter used for wireless point-to-point communications operating in the frequency ranges: 5.25 - 5.35 GHz and 5.725 - 5.825 GHz.

A pre-production version of the sample was received on October 22, 2000 in good condition.

Overview of the U-NII 27900 Radio

Applicant	Western Multiplex Corporation
Trade Name & Model No.	27900
FCC Identifier	HZB-U5358-480
Use of Product	Point-to-point fixed wireless interconnect
Manufacturer & Model of Spread Spectrum Module	Western Multiplex, Model 27900
Type of Transmission	QPSK
Rated RF Output (dBm)	≤ 2.3 dBm * (5.25-5.35 GHz) ≤ 18.4 dBm * (5.725-5.825 GHz)
Frequency Range (MHz)	5.25-5.35 GHz, 5.725-5.825 GHz
Number of Channel(s)	2
Antenna(s) & Gain, dBi	2' Parabolic Antenna, 28.4 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	Western Multiplex Corporation 1196 Borregas Avenue Sunnyvale, California 94089

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

2.2 Related Submittal(s) Grants

None.

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 "Data Sheet" of this Application. All other measurements were made in accordance with the procedures in part 2 of CFR 47.

2.4 Test Facility

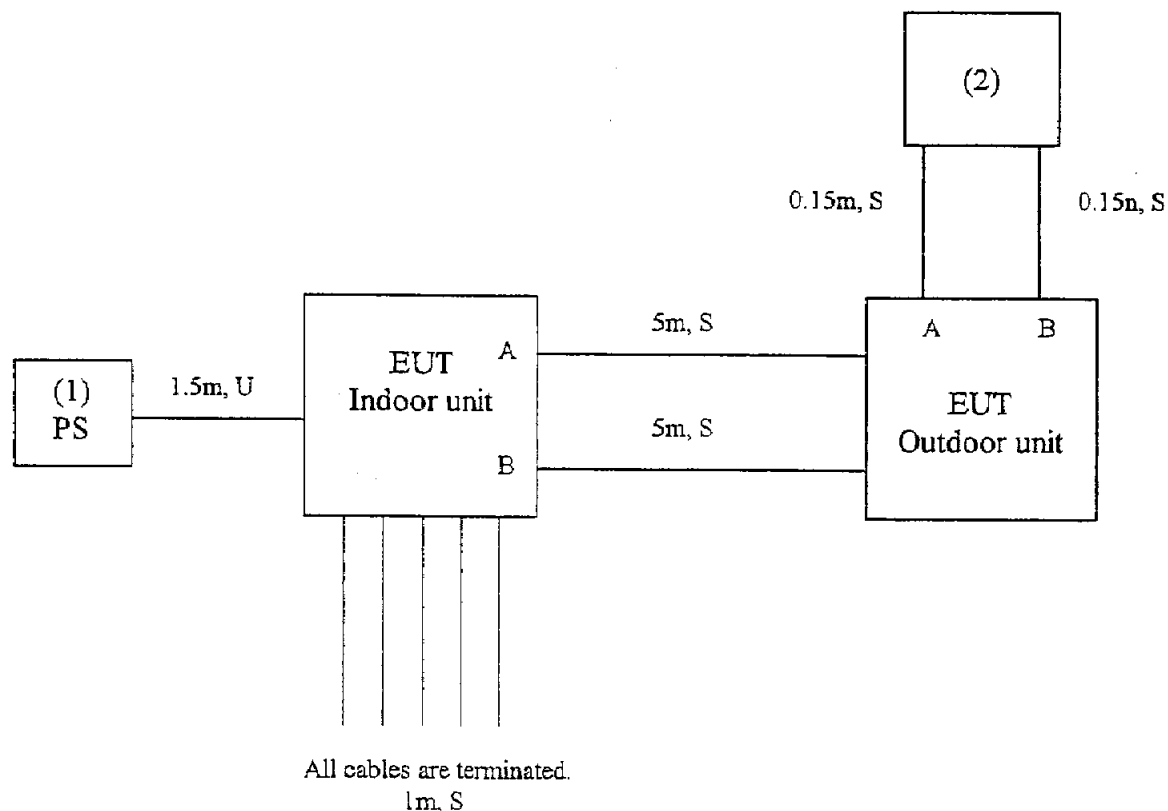
The open area test site and conducted measurement facility used to collect the radiated data is site 2. This test facility and site measurement data have been fully placed on file with the FCC and NVLAP accredited.

3.0 System Test Configuration

3.1 Support Equipment and description

Item #	Description	Model No.	Serial No.
1	GW DC Power Supply	GPR-6030	8690196
2	Gabriel Electronics Plane-Dual Polarized Antenna	SSD2-52	N/A

3.2 Block Diagram of Test Setup



m: Length
S: Shielded
U: Unshielded

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.

For radiated emission measurements, the EUT is attached to a cardboard box (if necessary) and placed on the wooden turntable. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). The EUT is wired to transmit full power.

The signal is maximized through rotation and placement in the three orthogonal axes. 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.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use. For emissions testing, the units were setup to transmit continuously to simplify the measurement methodology. 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 Western Multiplex prior to compliance testing):

No modifications were made to the EUT by Intertek Testing Services.

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 Watt (30 dBm) or $17 \text{ dBm} + 10\text{Log}(B)$, where B is the 26dB emission bandwidth in MHz (for antenna gain up to 23 dBi). For devices operating in 5.25-5.35 GHz band, the peak transmit power shall not exceed the lesser of 250 mW (24 dBm) or $11 \text{ dBm} + 10\text{Log}(B)$, 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	EIRP Limit, dBm	Maximum allowed antenna gain, dBi
Low Channel: 5300	1.7	2.3	30.0	27.7
High Channel: 5775	69.0	18.4	53.0	34.6

Note:

1. The EUT Output Power was set to maximum to produce the worse case test result. In real application, when using an antenna with 28.4 dBi gain, the Output Power will have to be reduced by 0.7 dB.
2. When a higher gain antenna is used, the Output Power will be reduced further.

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
5300	86.3
5775	80.4

Refer to the following plots for 26 dB bandwidth:

Plot 1a: Low Channel 26 dB Bandwidth

Plot 1b: High Channel 26 dB Bandwidth

BW Mkr Δ 86.3 MHz

Δ 26.00 dB

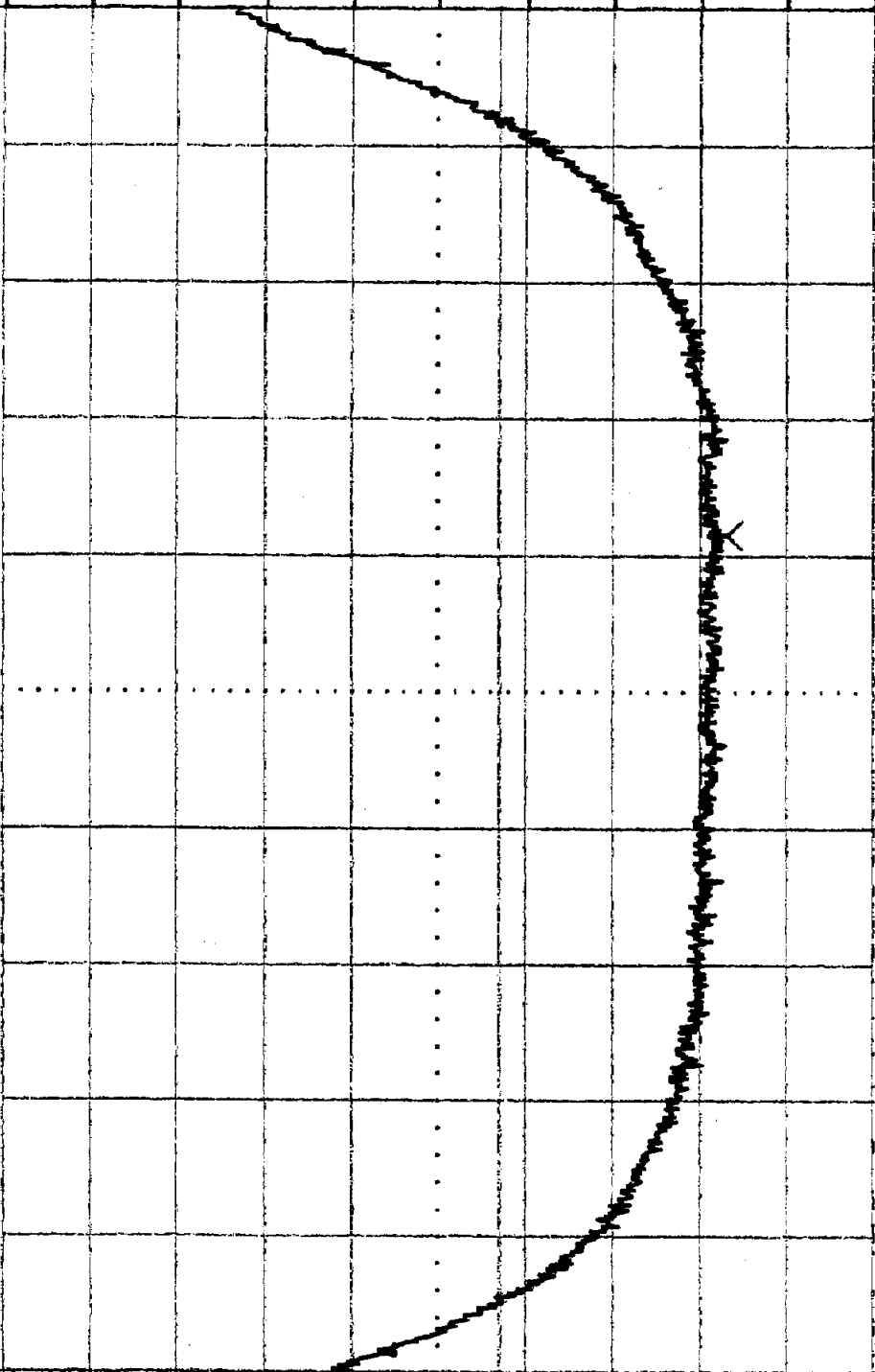
Tek

Ref Lvl 3.0 dBm

10 dB /

Atten 10 dB

3.0
-7.0
-17.0
-27.0
-37.0
-47.0
-57.0
-67.0
-77.0
-87.0



5.250 MHz

to

5.350 MHz

Res BW 100 kHz

Video BW 100 kHz

SWP 57 ms

LEVEL

SPAN

Mkr

5.288 MHz

Knob 2

Knob 1

Keypad

Tektronix

2784

BWMr-Δ 80.4MHz

Δ26.00dB

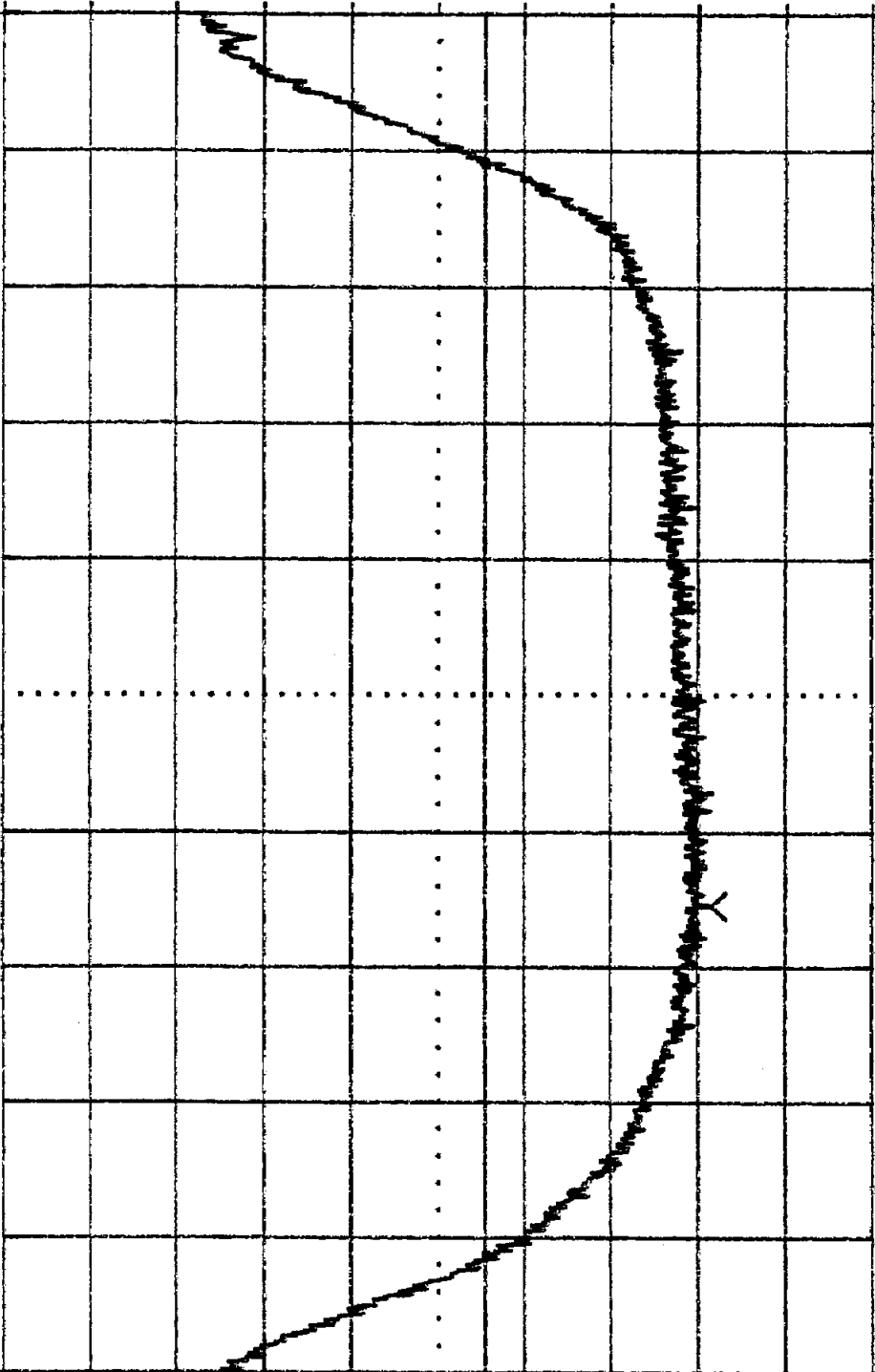
Tek

Ref Lvl 3.0dBm

10dB/

Atten 10dB

3.0
-7.0
-17.0
-27.0
-37.0
-47.0
-57.0
-67.0
-77.0
-87.0



Plot 1b

5.725 0GHz

to

5.825 0GHz

ResBW 100kHz

ViDBW 100kHz

SWP 57ms

LEVEL

SPAN

TRIG

0 %

Knob 2

Knob 1

Keypad

Tektronix

2784

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

Requirement:

For transmitters operating in the 5.25-5.35 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz. Devices operating in the 5.25-5.35 GHz band that generate emissions in the 5.15-5.25 GHz band must meet all applicable technical requirements for operation in the 5.15-5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of -27 dBm/MHz in the 5.15-5.25 GHz band.

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.

Procedure:

Spectrum Analyzer was connected to the output of the EUT. For measurements above 1 GHz, the Resolution Bandwidth was set to 1 MHz; for measurements below 1 GHz, the Resolution Bandwidth was set 100 kHz, and the Video Bandwidth was set to 30 kHz. Several plots were made in the frequency range from 5715 to 5835 MHz.

In addition, plots were made in the frequency range from 1 MHz to 40 GHz.

Result:

Refer to the following plots and data tables (on the next page) for out-of-band conducted emissions data:

Plot 4.a1 – 4.a10: Low Channel Emissions

Plot 4.b1 – 4.b10: High Channel Emissions

The antenna used for this application has the gain equals 28.4 dBi, therefore the EUT pass the test with a margin of 3.2 dB without reducing the output power.

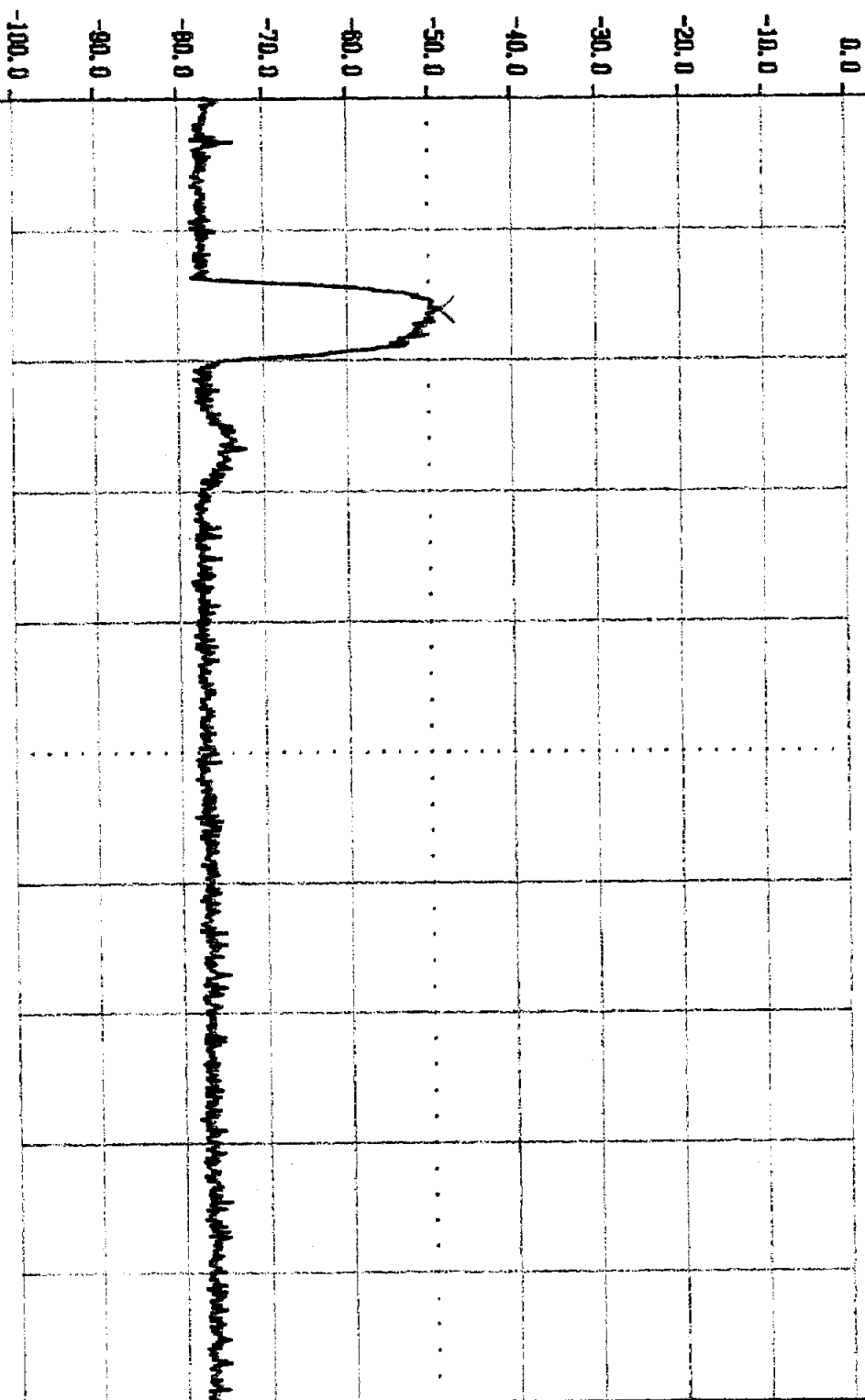
Operating frequency	Frequency, MHz	Level, dBm	Limit, dBm/MHz	Maximum allowed antenna gain,* dBi
5300 MHz	5150	-67.8 from plot 4.a5	-27.0	40.8
	5350	-59.3 from plot 4.a7	-27.0	32.3

Operating frequency	Frequency, MHz	Level, dBm	Limit, dBm/MHz	Maximum allowed antenna gain,* dBi
5775 MHz	5715	-58.6 from plot 4.b4	-27.0	31.6
	5725	-57.0 from plot 4.b5	-17.0	40.0
	5825	-56.2 from plot 3.b6	-17.0	39.2
	5835	-58.6 from plot 3.b7	-27.0	31.6

* Maximum antenna gain without reducing the Output Power.

Mkr 186.2MHz -48.90dBm Tek

Ref Lvl 0.0dBm 10dB/ Atten 10dB

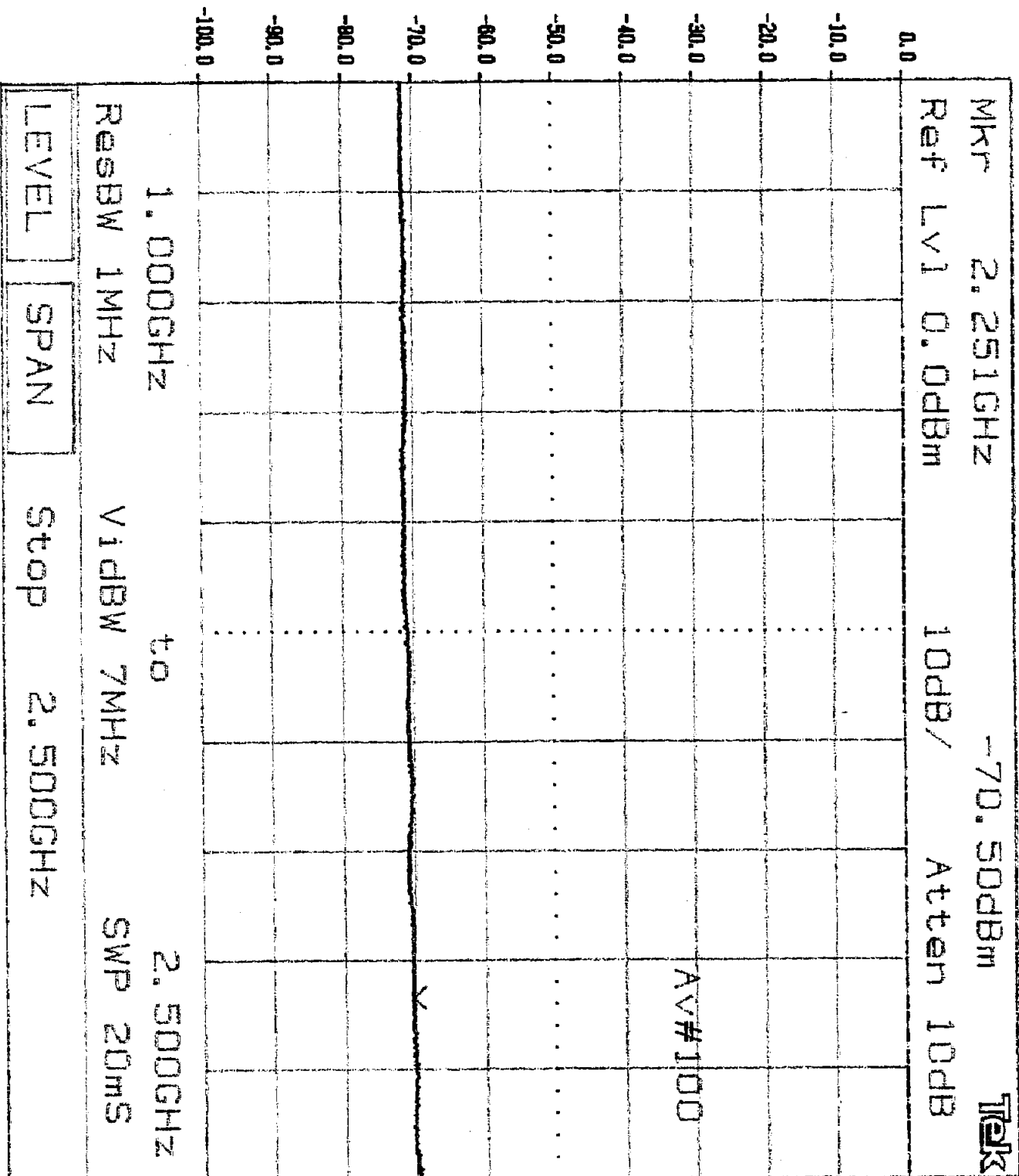


30.0MHz to 1.000 GHz

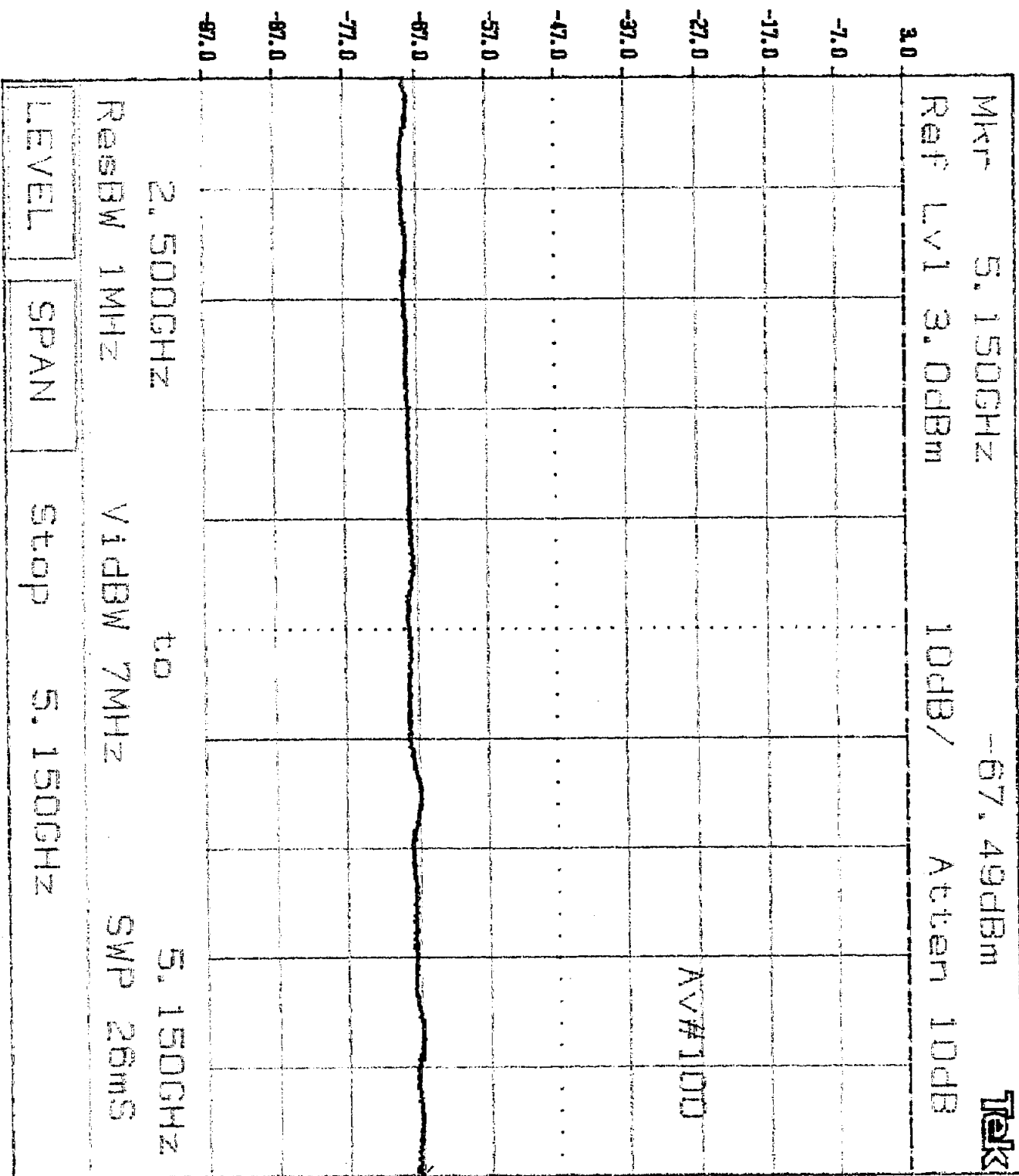
ResBW 100kHz VidBW 7MHz SWP 550ms

LEVEL SPAN ResBW 100kHz

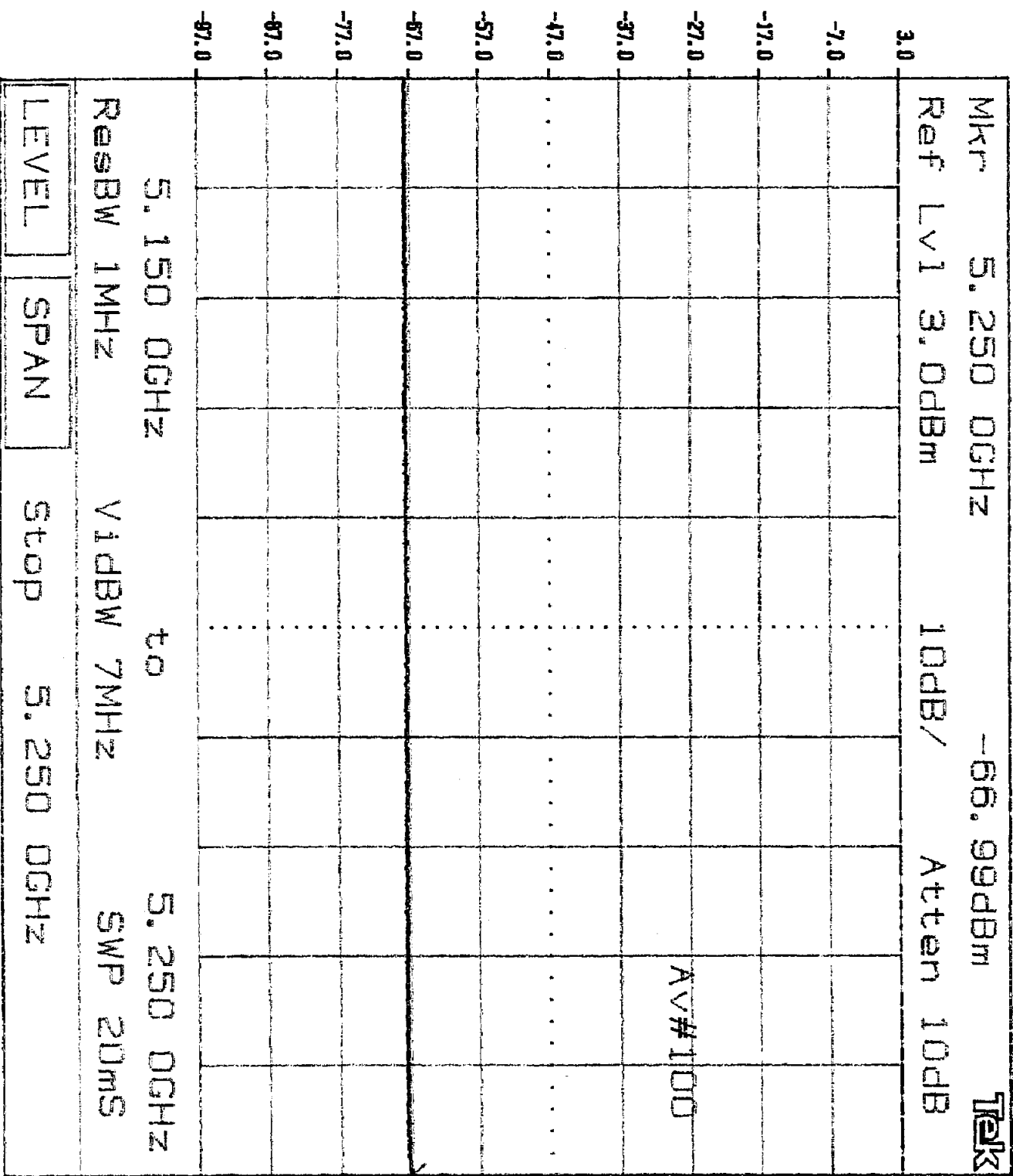
KN0B 2 KN0B 1 KEYPAD Tektronix 2784



Plot 4.a2



Plot 4.83



Plot 4.24

4.3 Power Density FCC Rule 15.407(a)(3)

Requirement:

For fixed point-to-point U-NII devices operating in 5.725-5.825 GHz band the peak power spectral density shall not exceed 17 dBm in any 1 MHz band (for antenna gain up to 23 dBi).

For devices operating in 5.25-5.35 GHz band peak power spectral density shall not exceed 11 dBm in any 1 MHz band (for antenna gain up to 6 dBi).

Procedure:

Antenna output of the EUT was coupled directly to spectrum analyzer; if an external attenuator and/or cable was used, these losses are compensated for with the analyzer OFFSET function.

The spectrum analyzer Resolution Bandwidth was set to 1 MHz and Video Bandwidth was set to 7 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:

Frequency MHz	Power Density dBm	EIRP Limit dBm	Maximum Allowed Antenna Gain dBi
5300	-10.8	17.0	27.8
5775	2.3	40.0	37.7

Refer to the following plots for power density data:

Plot 2a: Low Channel Power Density

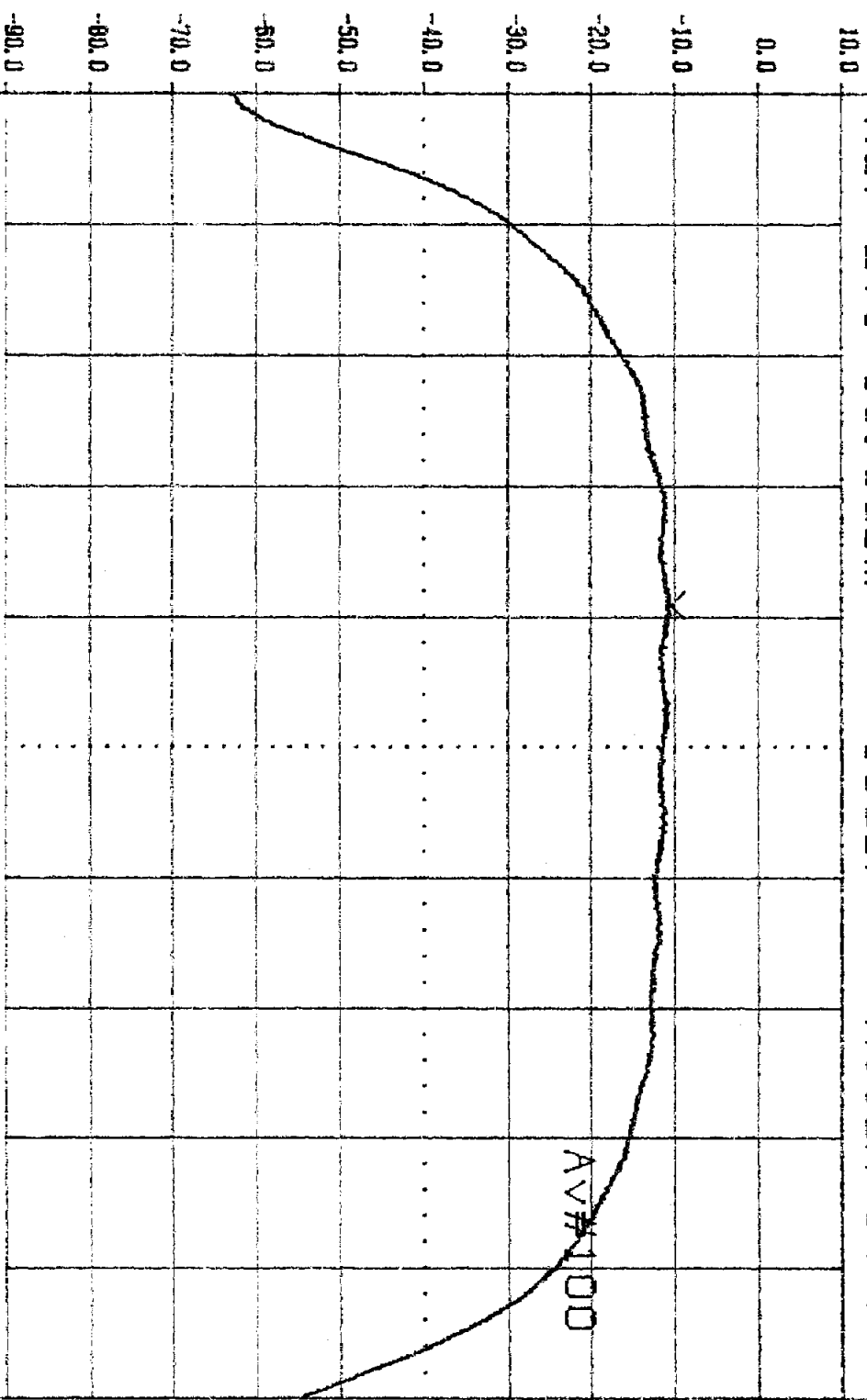
Plot 2b: High Channel Power Density

Note:

1. As it is written in section 4.1, the Output Power should be reduced by 0.7 dB to meet the EIRP requirement with antenna gain 28.4 dBi. In this case, the Power Density will reduce on the same scale, so it will be in compliance with EIRP Power Density Limit.
2. When a higher gain antenna is used, the Output Power will be reduced further and, as a result, further down the Power Density.

Mkr 5.289 1GHz -10.80dBm Tek

Ref Lvl 10.0dBm 10dB/ Atten 10dB



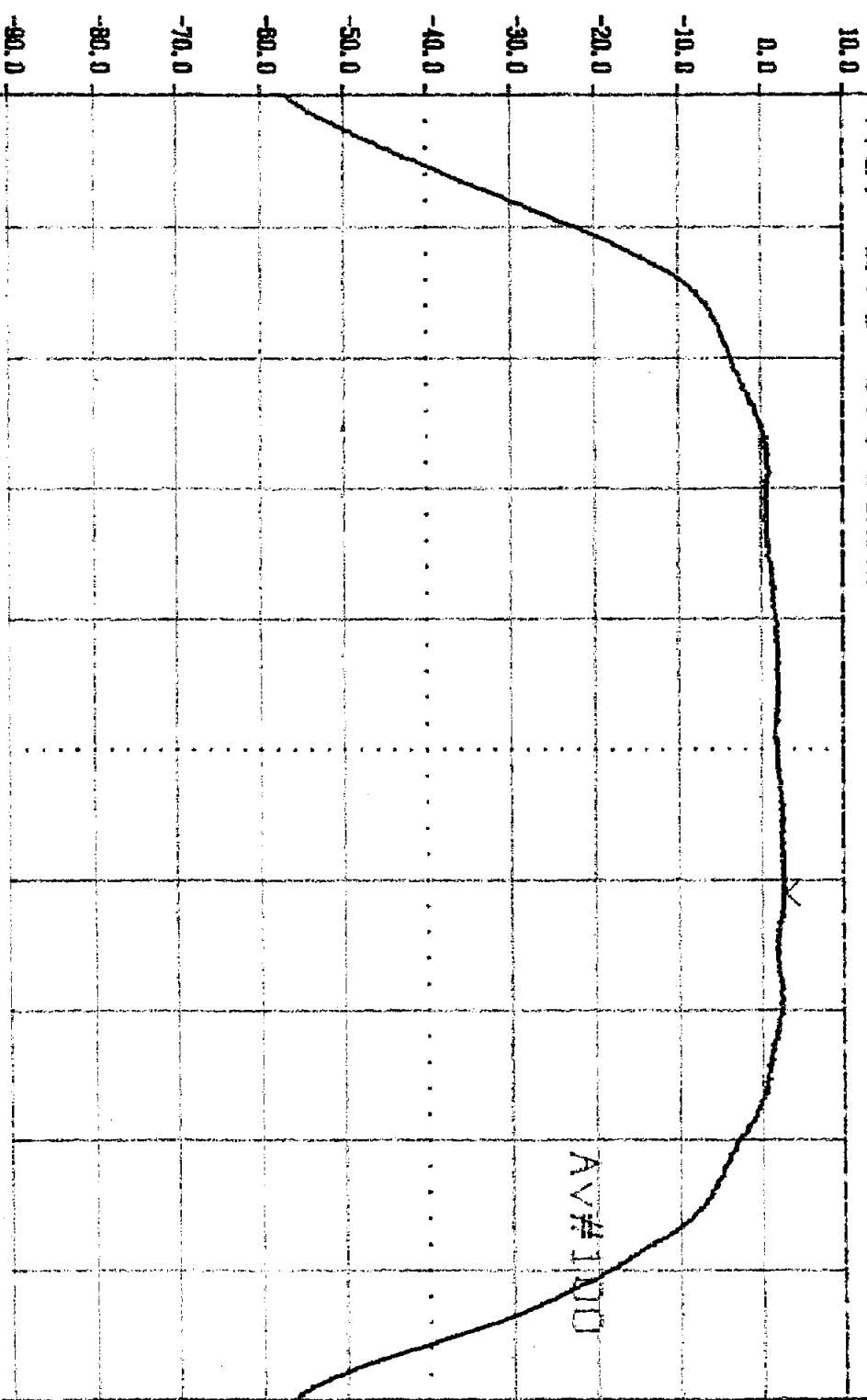
Plot 2.2

5.250 0GHz to 5.350 0GHz
ResBW 1MHz VidBW 7MHz SWP 20ms

LEVEL SPAN TRIG 0 %

Mkr 5.786 0GHz 2.30dBm Tek

Ref Lvl 10.0dBm 10dB/ Atten 20dB



Plot 26

5.725 0GHz to 5.825 0GHz
ResBW 1MHz VidBW 7MHz SWP 20ms

LEVEL SPAN Stop 5.825 0GHz

KNOB 2 KNOB 1 KEYPAD Tektronix 2784

- 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.

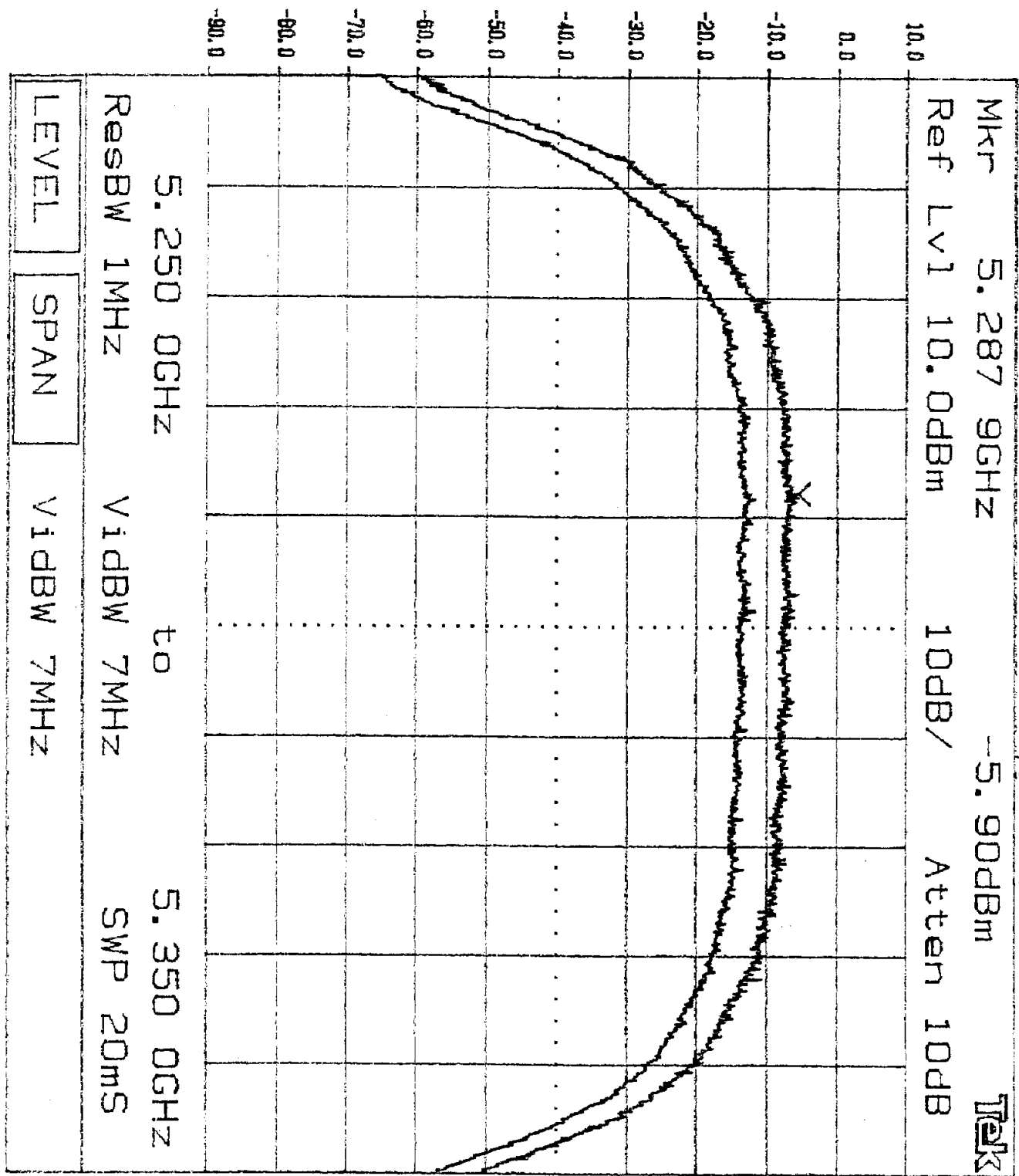
Procedure:

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 7 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 7.0 dB

Plot 3a1

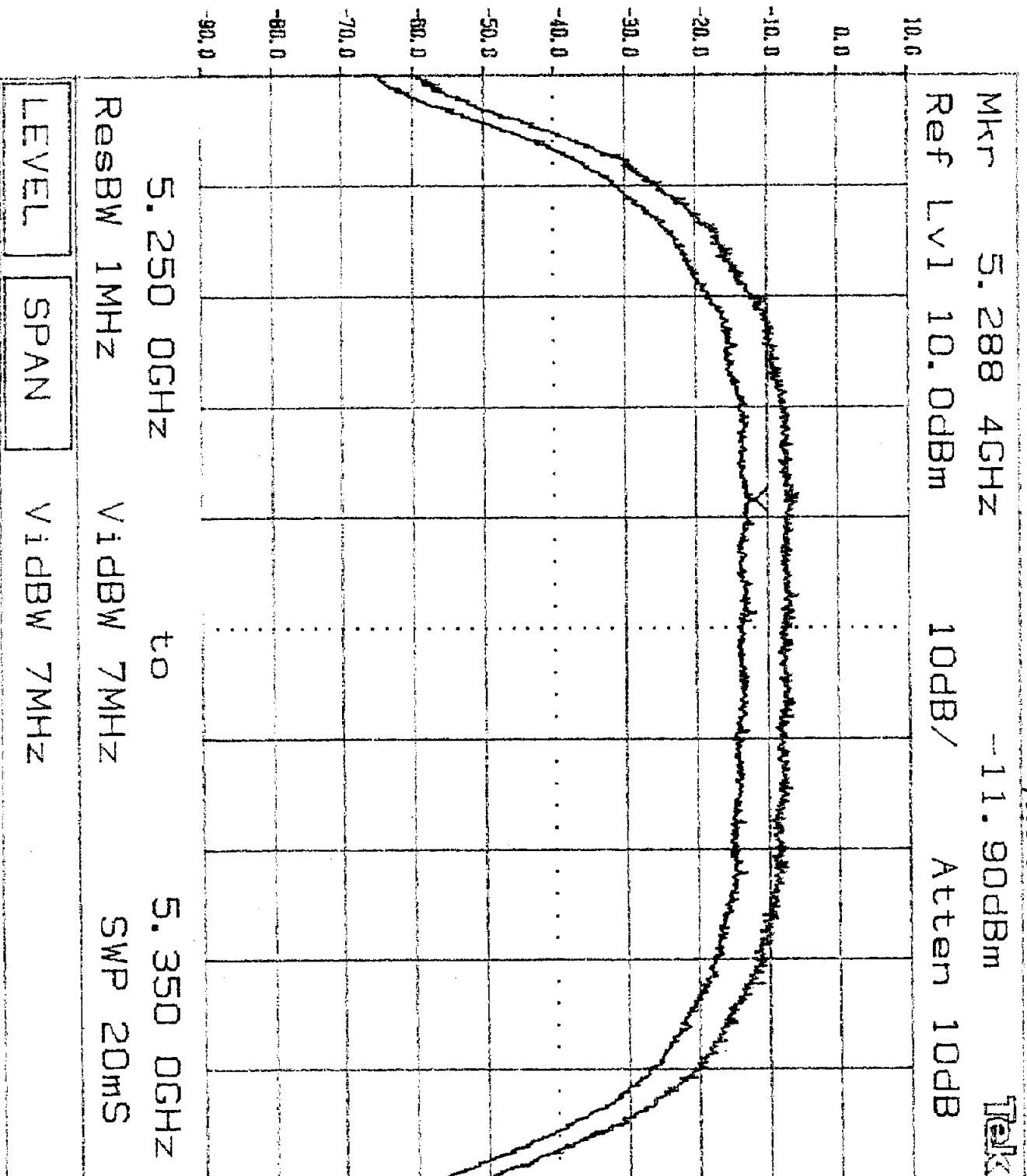


WAVEFORM A.
Atten 10dB
Freq 5.300 0GHz
Ref Lvl 10.0dBm
ResBW 1MHz
Span 100MHz
SWP 20ms
10dB/
VIDBW 7MHz

WAVEFORM B.
Atten 10dB
Freq 5.300 0GHz
Ref Lvl 10.0dBm
ResBW 1MHz
Span 100MHz
SWP 20ms
10dB/
VIDBW 30kHz

LEVEL SPAN ViDBW 7MHz
KNOB 2 KNOB 1 KEYPAD Tektronix 2784

Plot 3.22



KN08 2 KN08 1 KEYPAD Tektronix 2784

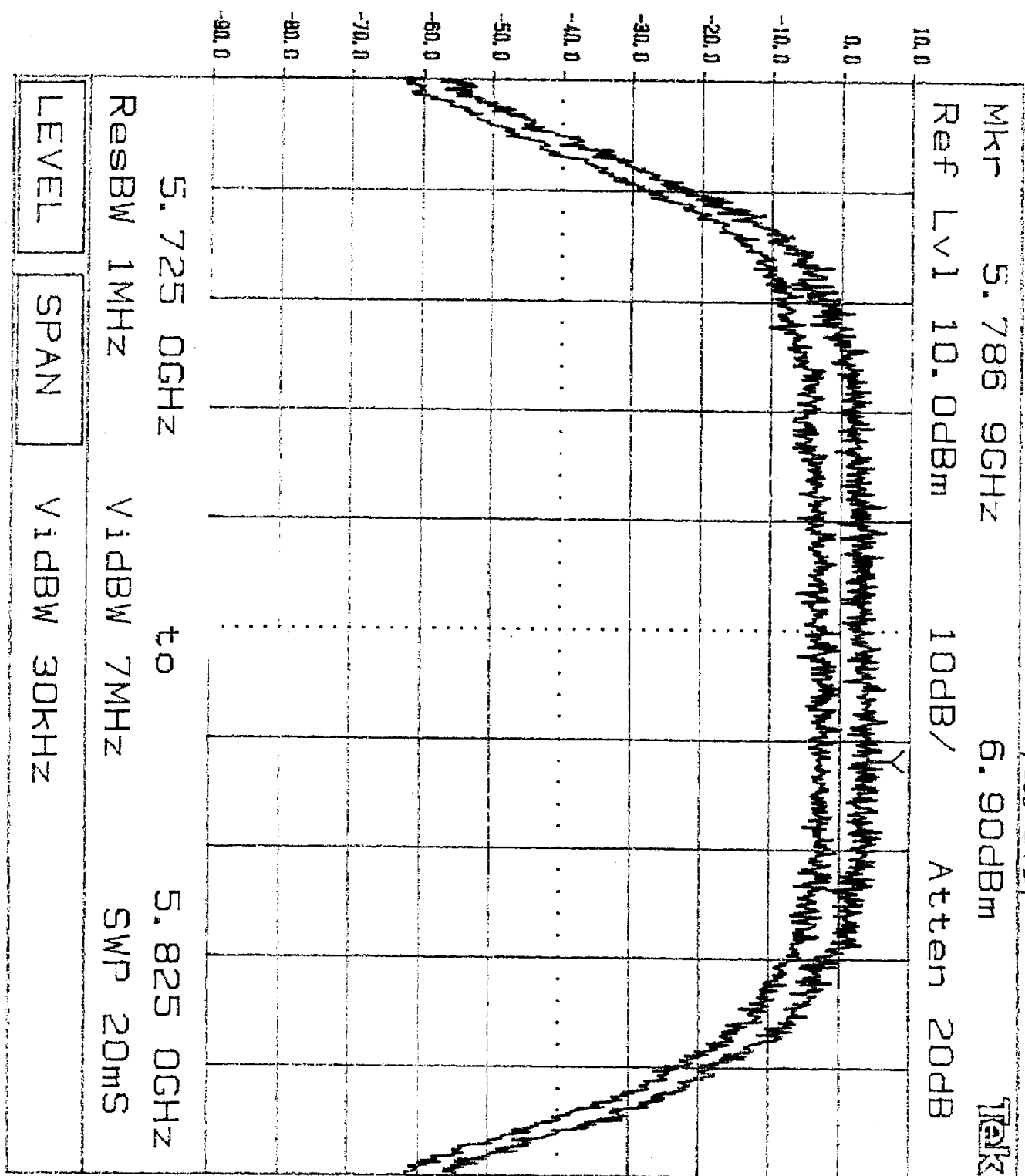
WAVEFORM A:

Atten 10dB
Freq 5.300 0GHz
Ref Lvl 10.0dBm
ResBW 1MHz
Span 100MHz
SWP 20ms
10dB/
VidBW 7MHz

WAVEFORM B:

Atten 10dB
Freq 5.300 0GHz
Ref Lvl 10.0dBm
ResBW 1MHz
Span 100MHz
SWP 20ms
10dB/
VidBW 30kHz

Plot 3.61



KN0B 2 KN0B 1 KEYPAD Tektronix 2784

WAVEFORM A:

Atten 20dB
Freq 5.775 GHz
Ref Lvl 10.0dBm
ResBW 1MHz
Span 100MHz
SWP 20ms
10dB/
VIDBW 7MHz

WAVEFORM B:

Atten 20dB
Freq 5.775 GHz
Ref Lvl 10.0dBm
ResBW 1MHz
Span 100MHz
SWP 20ms
10dB/
VIDBW 30kHz

Plot 3.62

Mkr 5.784 0GHz

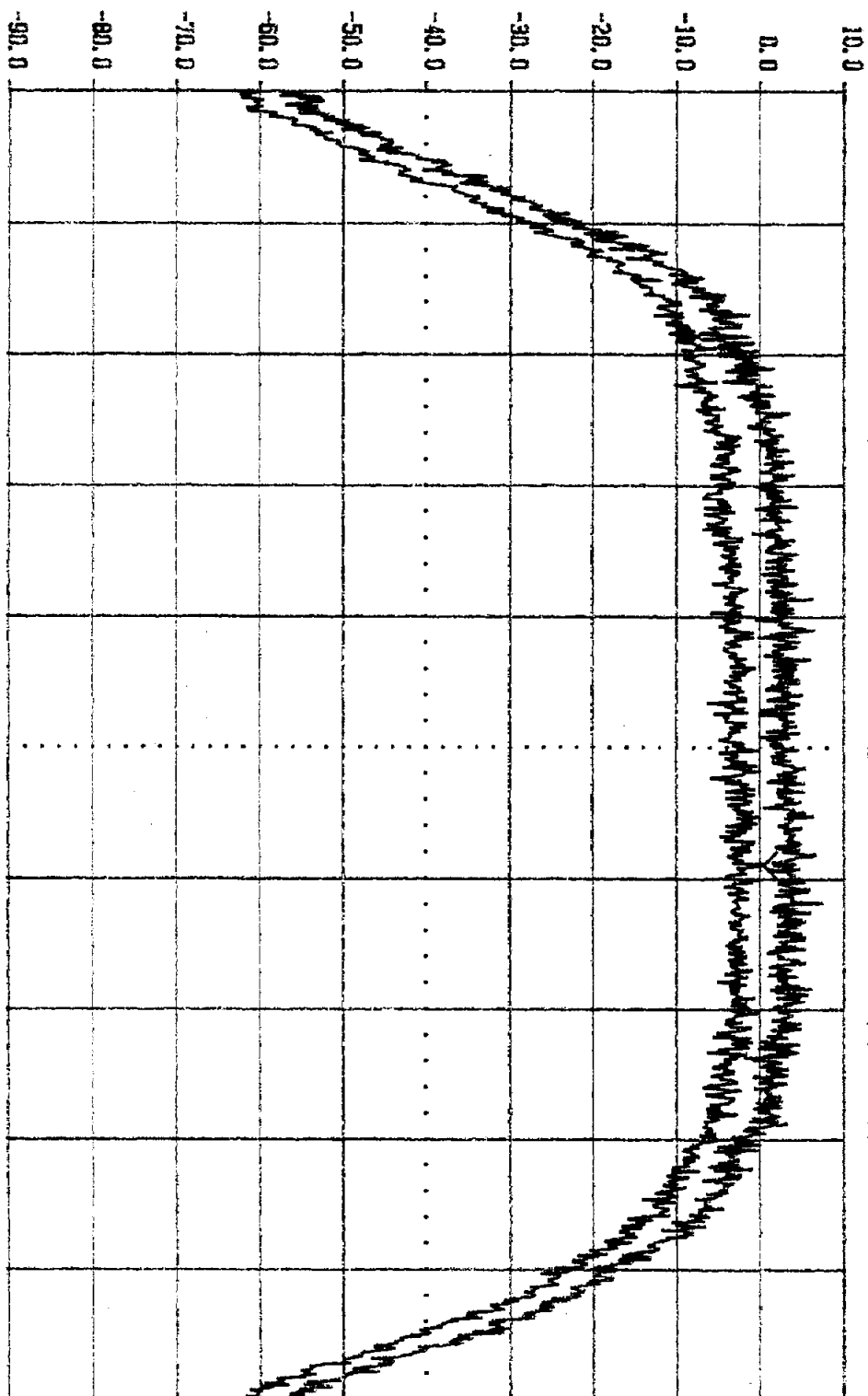
-0.10dBm

TEK WAVEFORM A.

Ref Lvl 10.0dBm

10dB/

Atten 20dB



Atten 20dB

Freq 5.775 0GHz

Ref Lvl 10.0dBm

ResBW 1MHz

Span 100MHz

SWP 20ms

10dB/

VidBW 7MHz

Atten 20dB

Freq 5.775 0GHz

Ref Lvl 10.0dBm

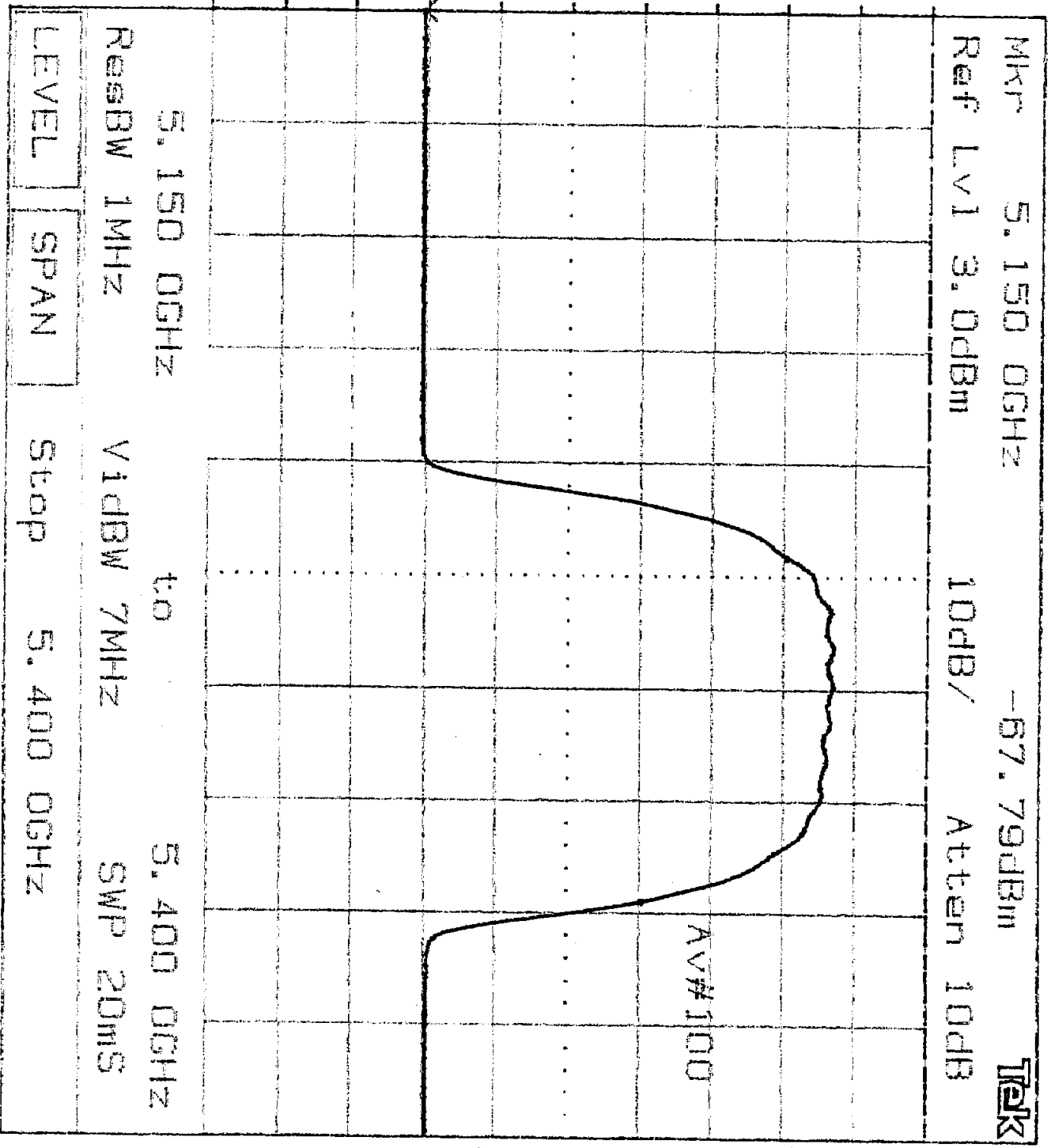
ResBW 1MHz

Span 100MHz

SWP 20ms

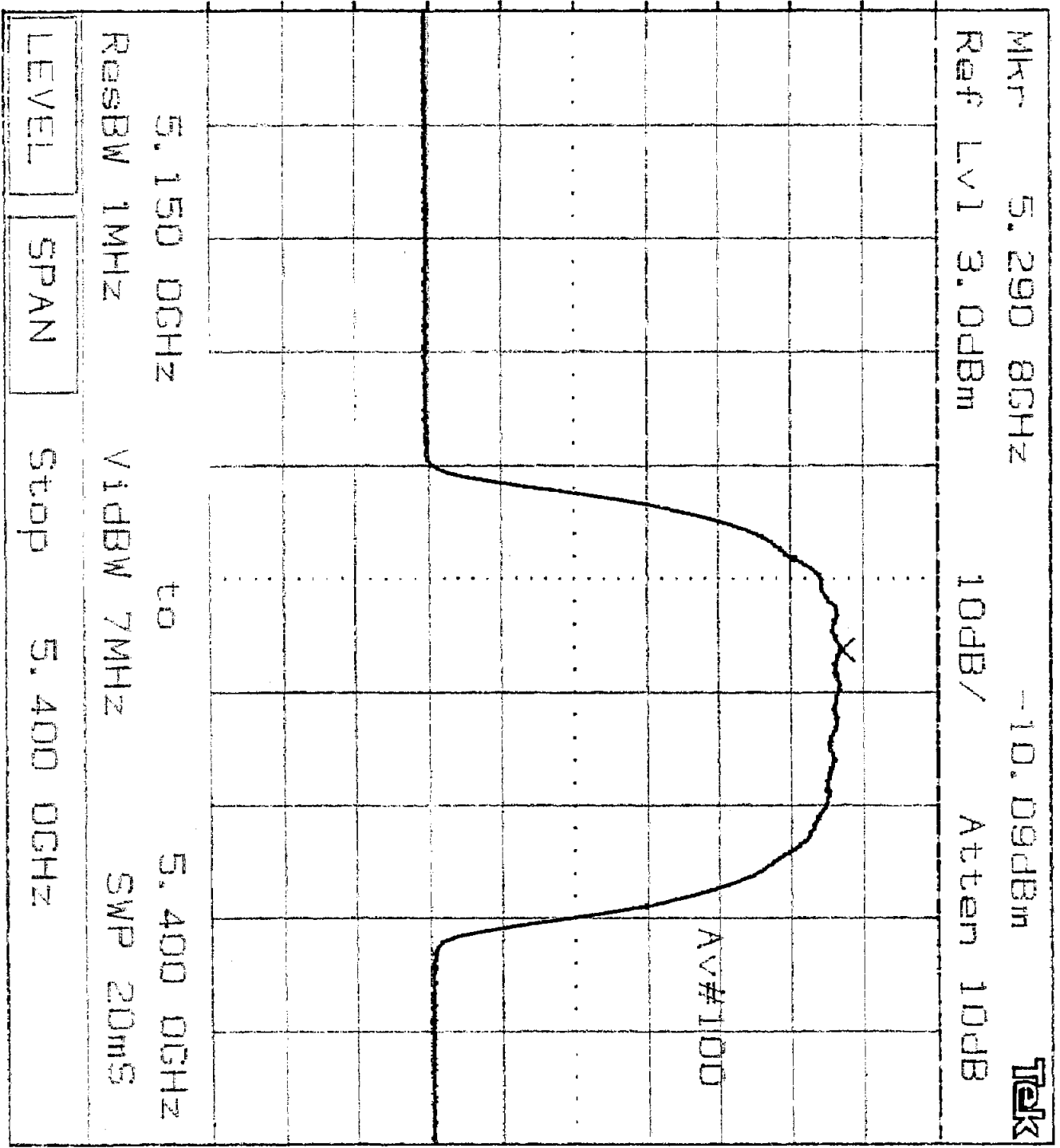
10dB/

VidBW 30kHz

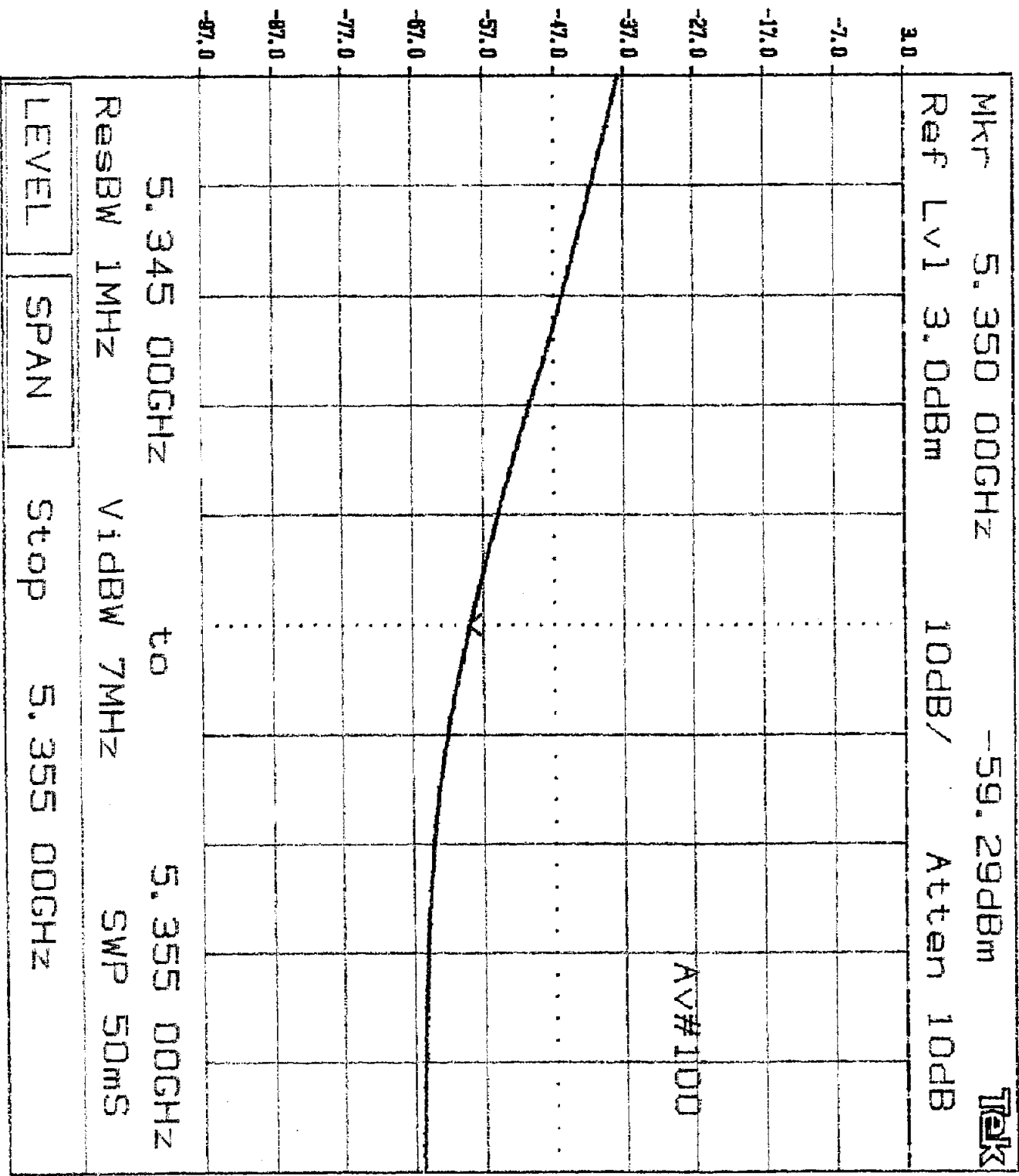


Plot 4.25

Knob 2 Knob 1 Keypad Tektronix 2784



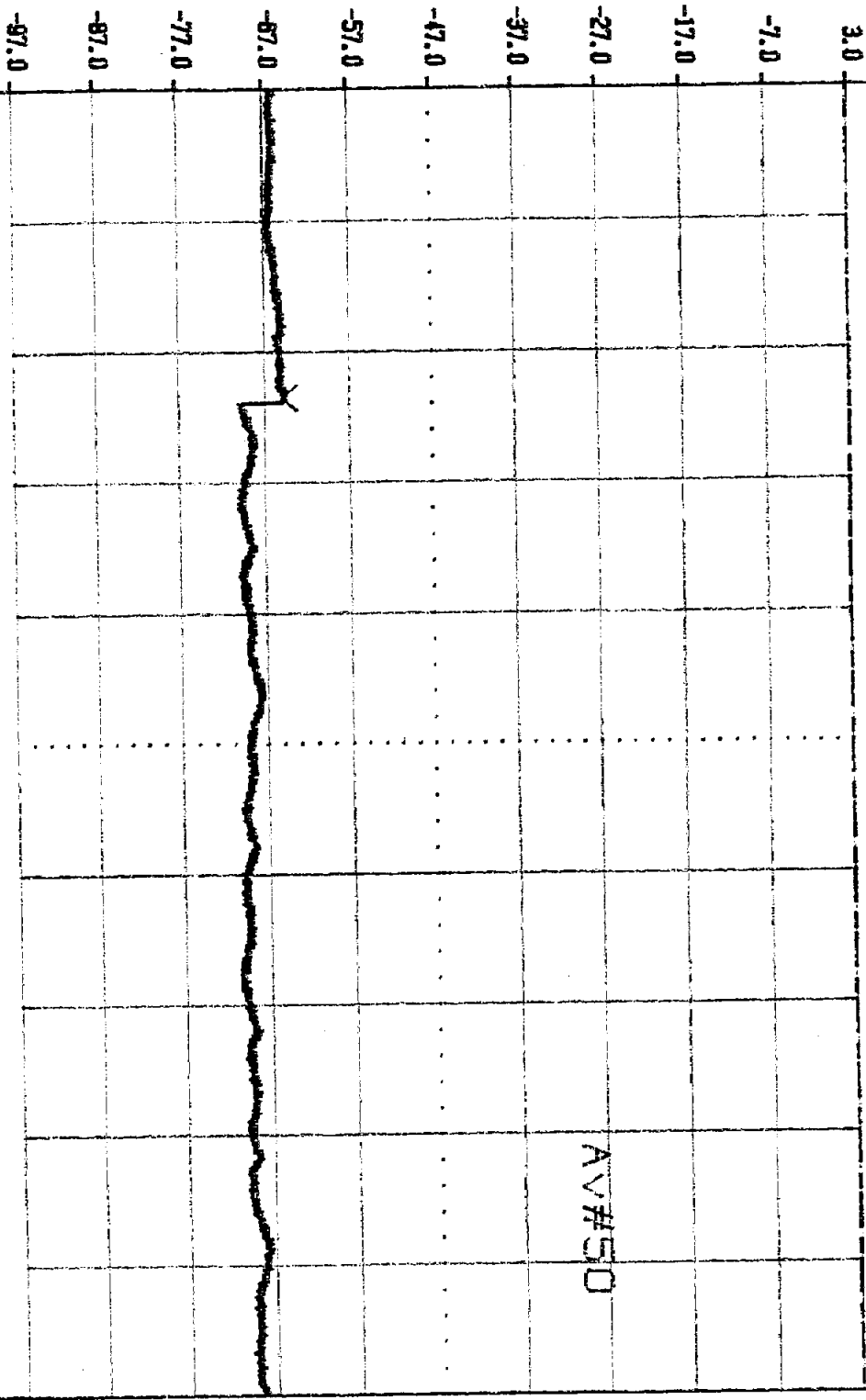
Plot 4.26



Plot 4.27

Mkr 6.481GHz -64.89dBm **Tek**

Ref Lvl 3.0dBm 10dB/ Atten 10dB



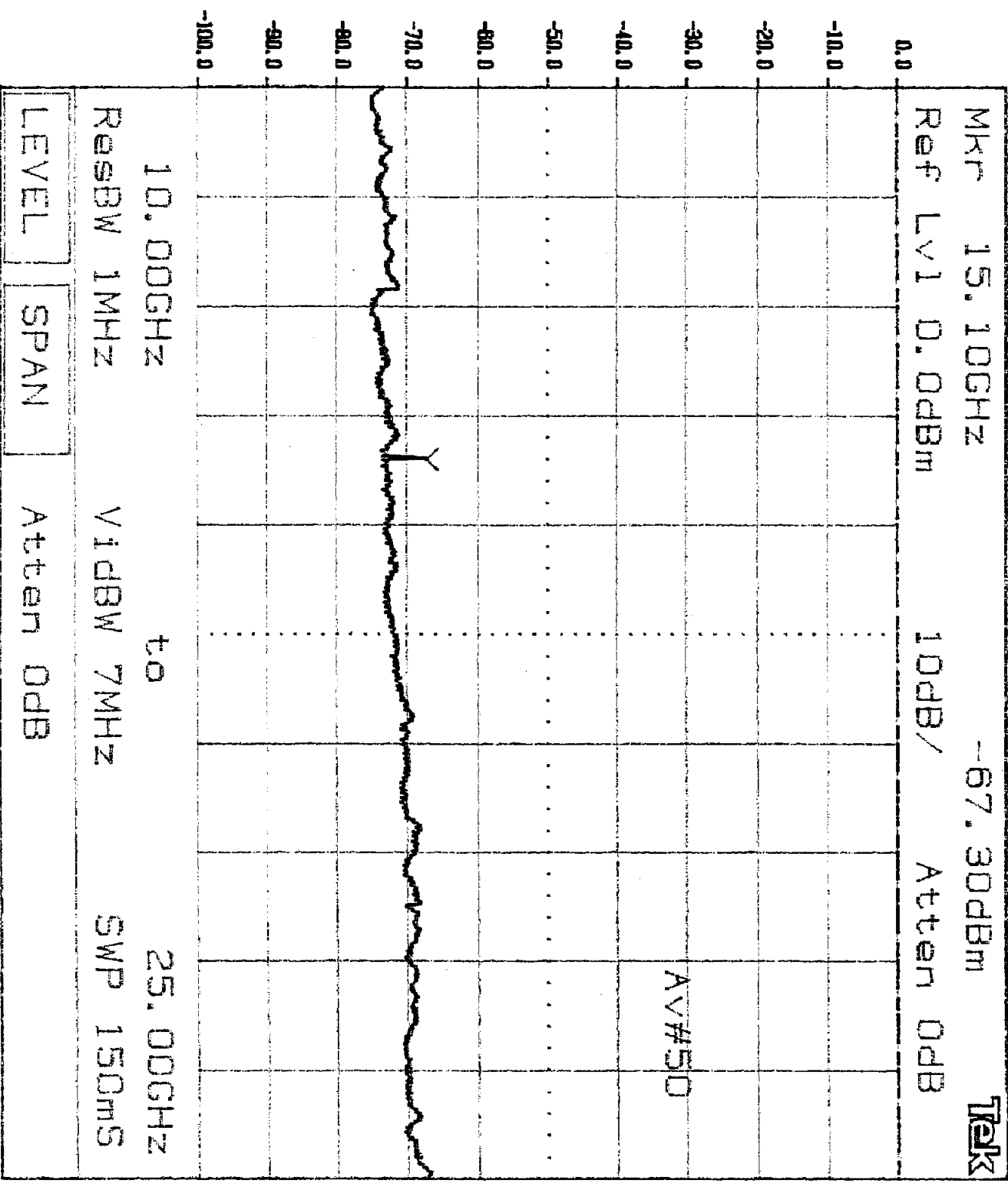
5.400GHz to 10.000GHz

ResBW 1MHz VidBW 7MHz SWP 65ms

LEVEL SPAN Stop 10.000GHz

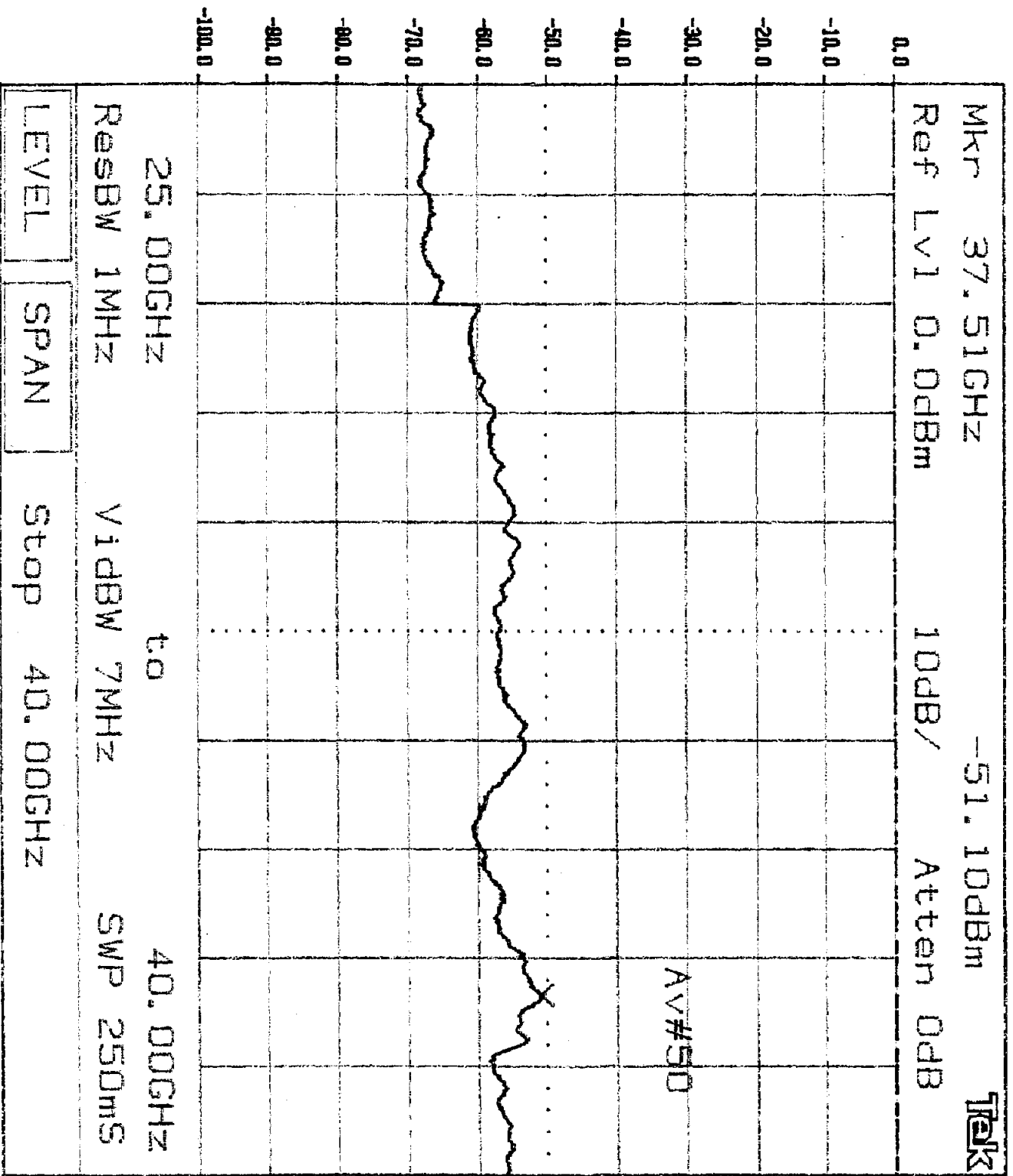
KN0B 2 KN0B 1 KEYPAD Taktronix 2784

Plot 4.28



Knob 2 Knob 1 Keypad Tektronix 2784

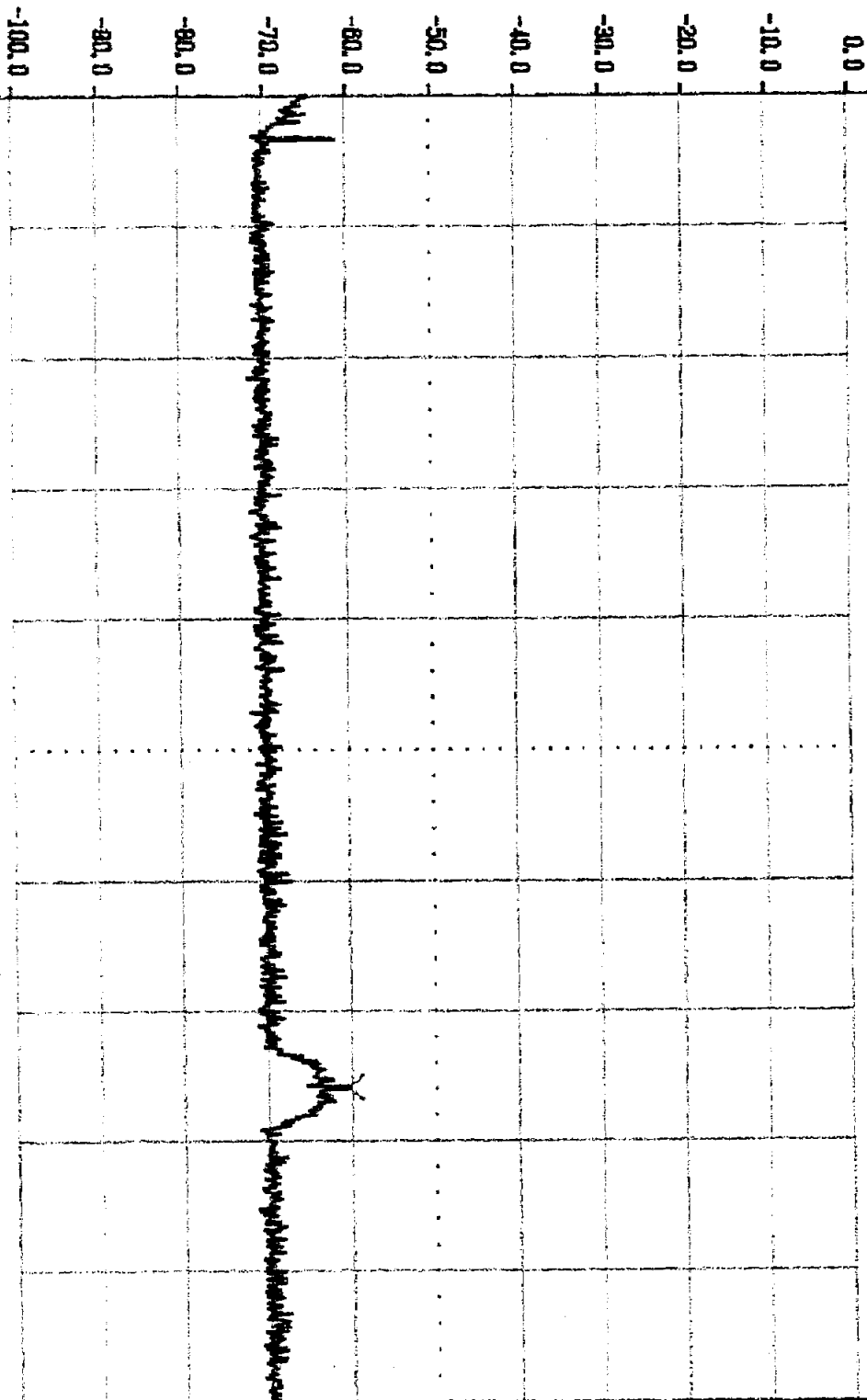
Plot 4.28



Pict 4.210

Mkr 766.2MHz -60.50dBm Tek

Ref Lvl 0.0dBm 10dB/ Atten 20dB

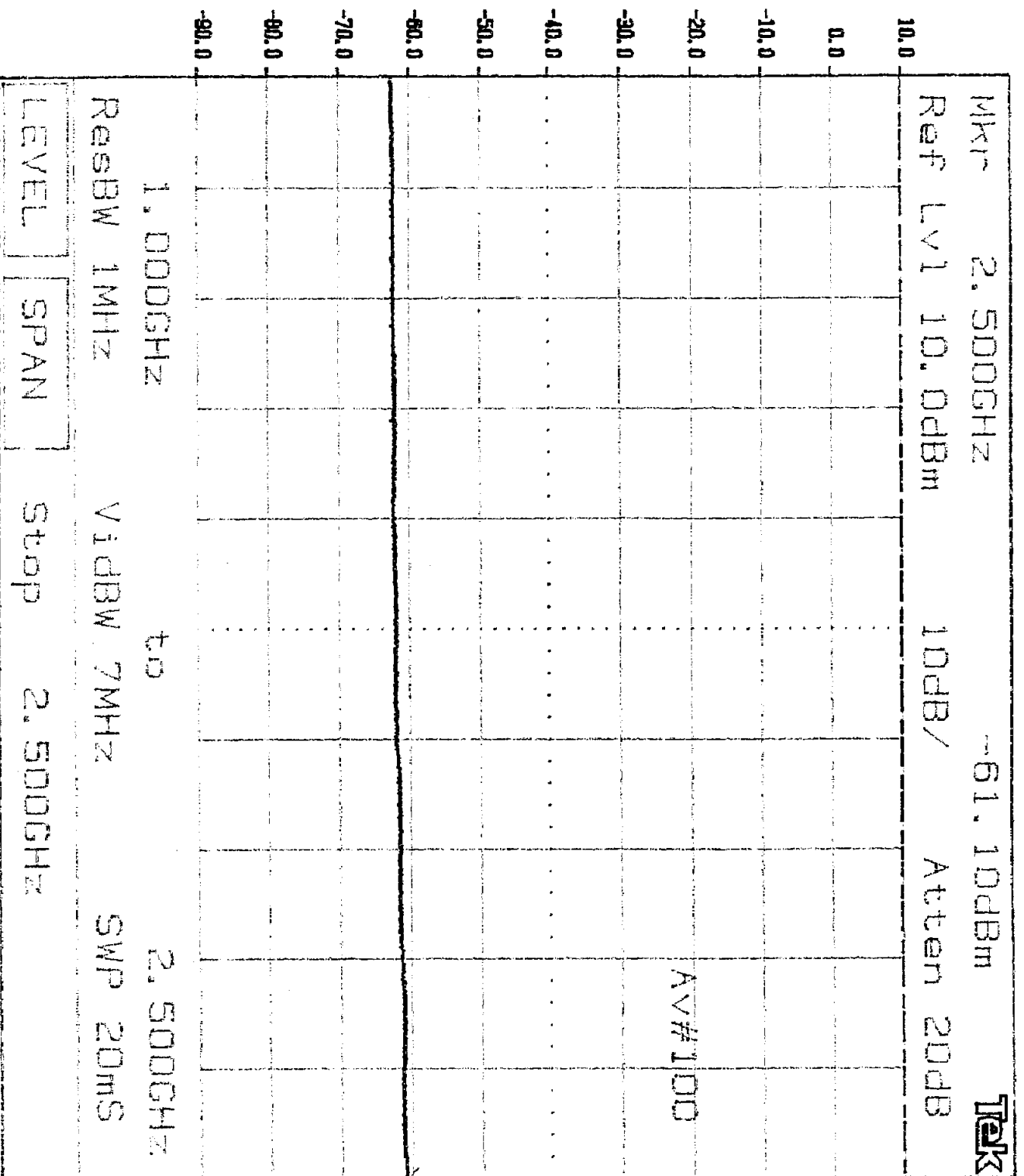


30.0MHz to 1.000 GHz

ResBW 100kHz VidBW 100kHz SWP 550ms

LEVEL	SPAN	Atten 20dB
-------	------	------------

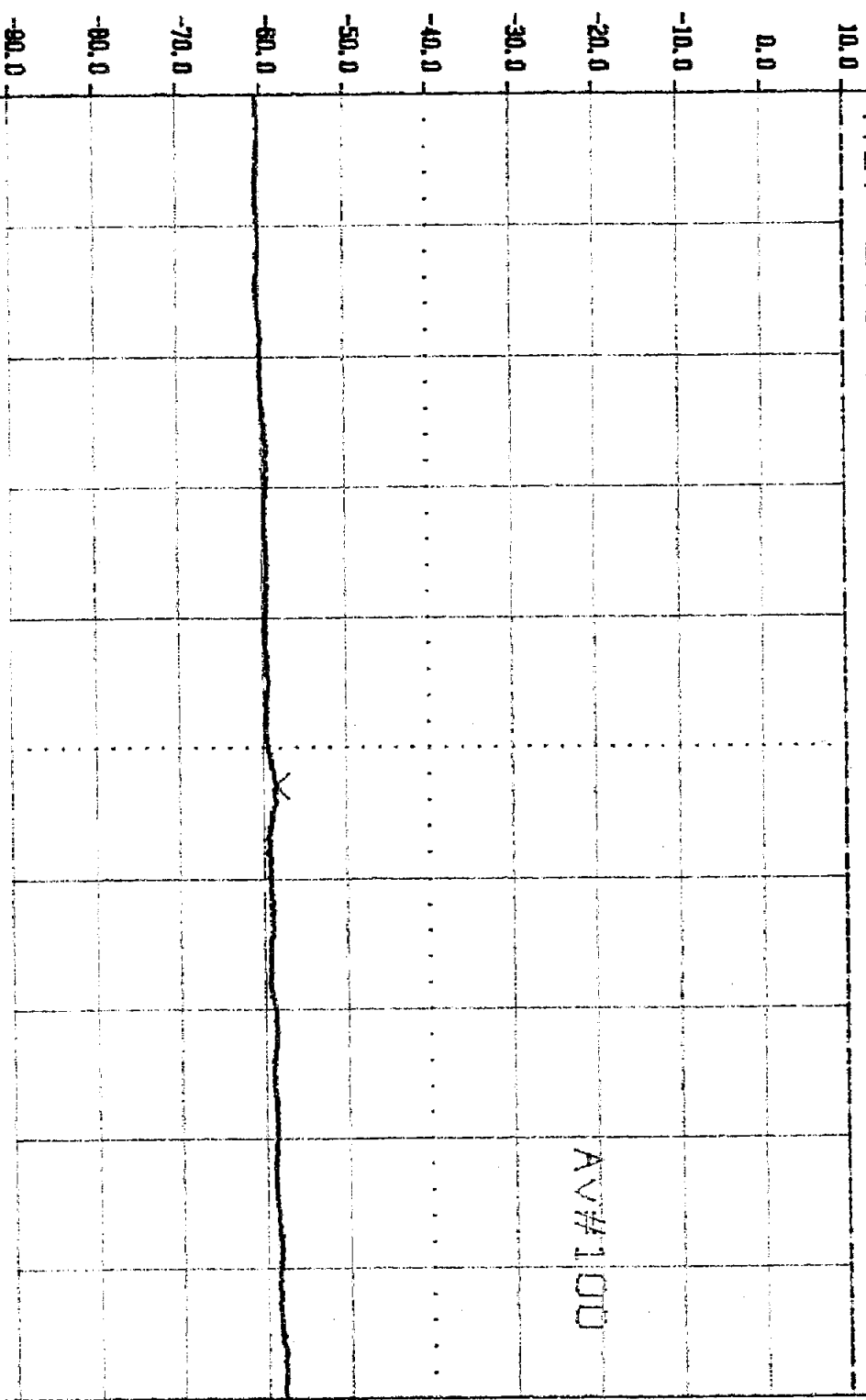
Plot 4.61



Plot 4.62

Mkr 4.201GHz -58.60dBm **Tek**

Ref Lvl 10.0dBm 10dB/ Atten 20dB



2.500GHz to 5.715GHz

RESBW 1MHz VIDBW 7MHz SWP 32ms

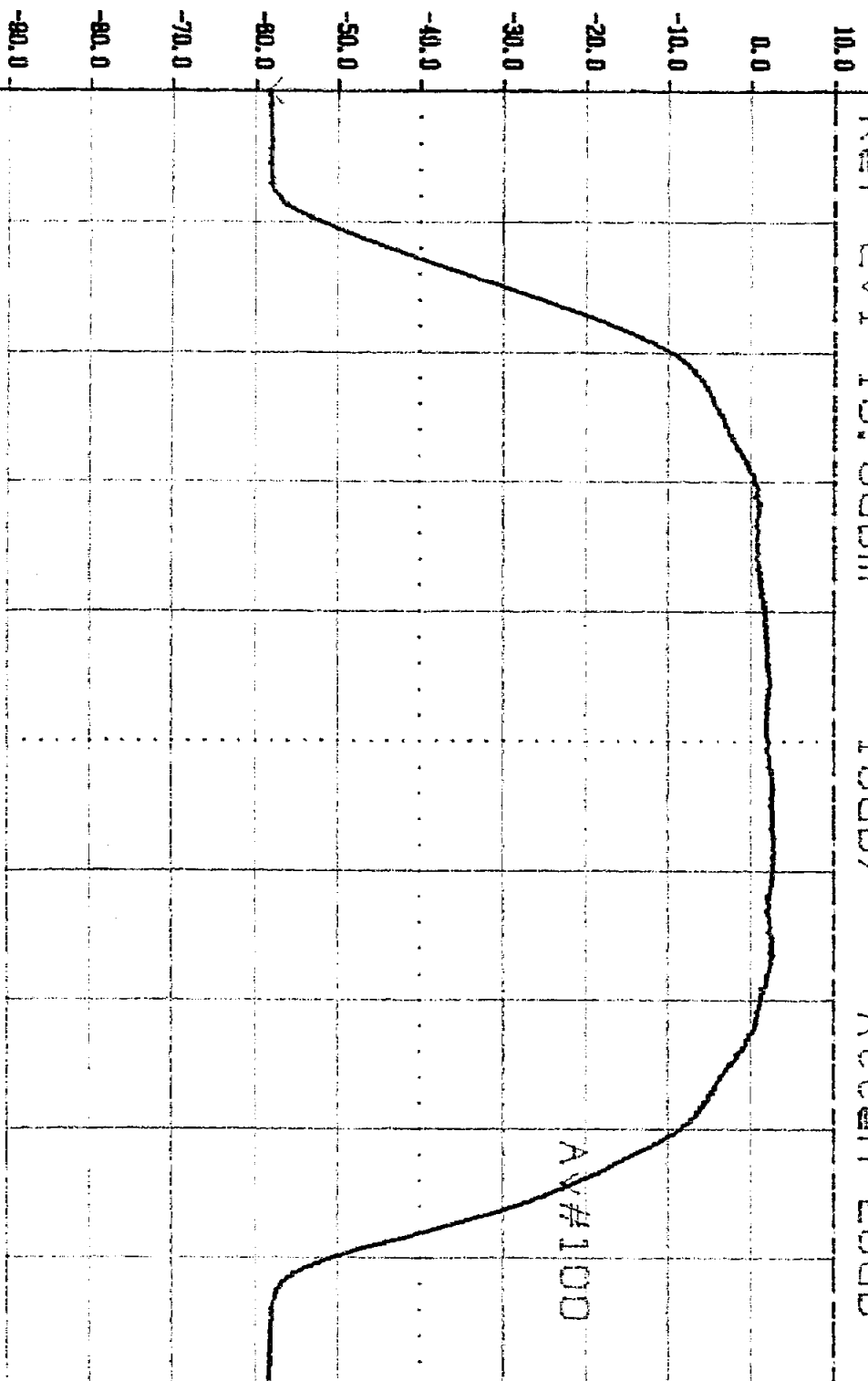
LEVEL SPAN Stop 5.715GHz

KN08 2 KN08 1 KEYPAD Tektronix 2784

Plot 4.63

Mkr 5.715 GHz -58.60dBm **Tek**

Ref Lvl 10.0dBm 10dB/ Attenu 20dB

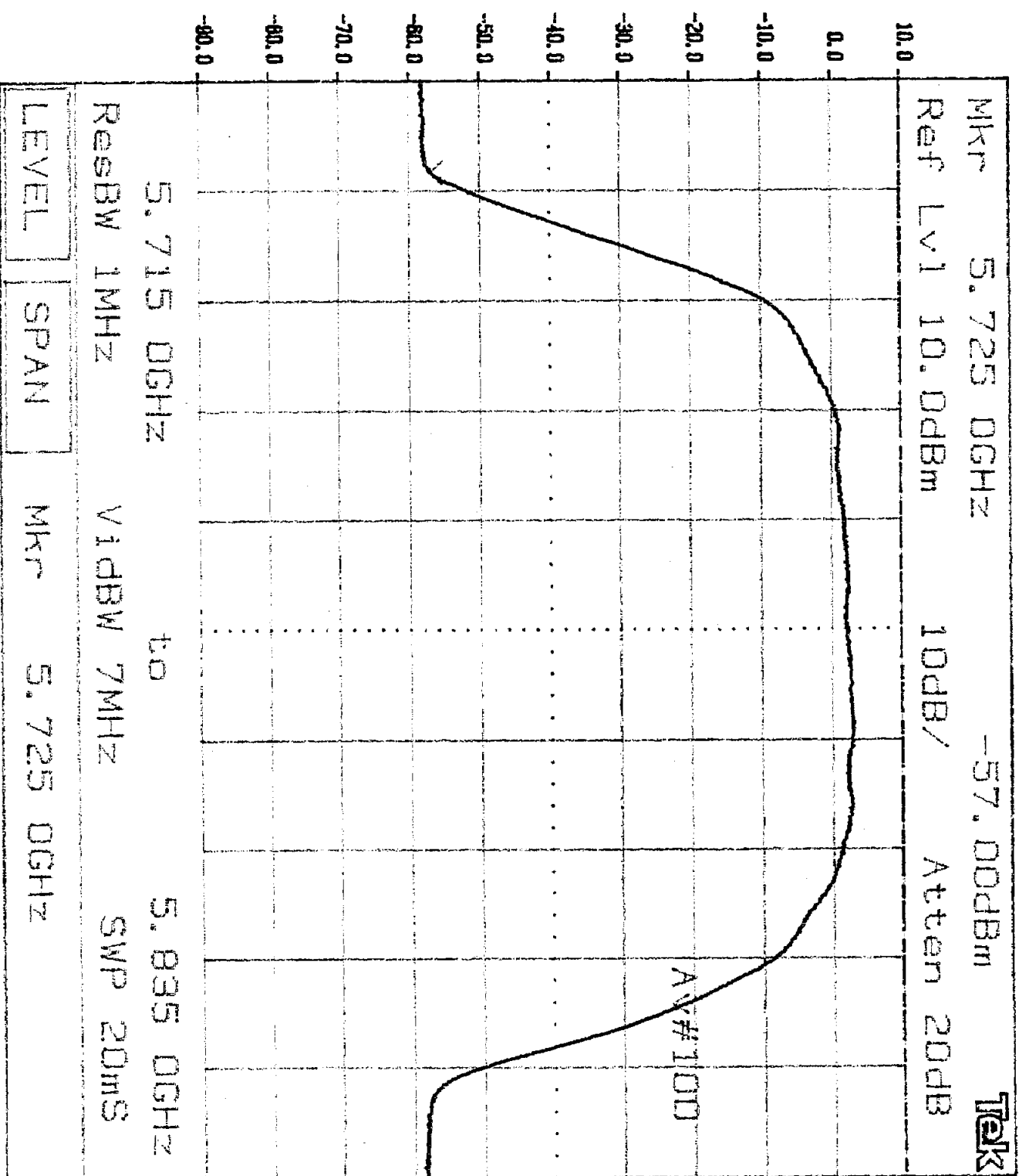


Plot 4.64

5.715 GHz to 5.835 GHz
ResBW 1MHz VidBW 7MHz SWP 20ms

LEVEL SPAN Stop 5.835 GHz

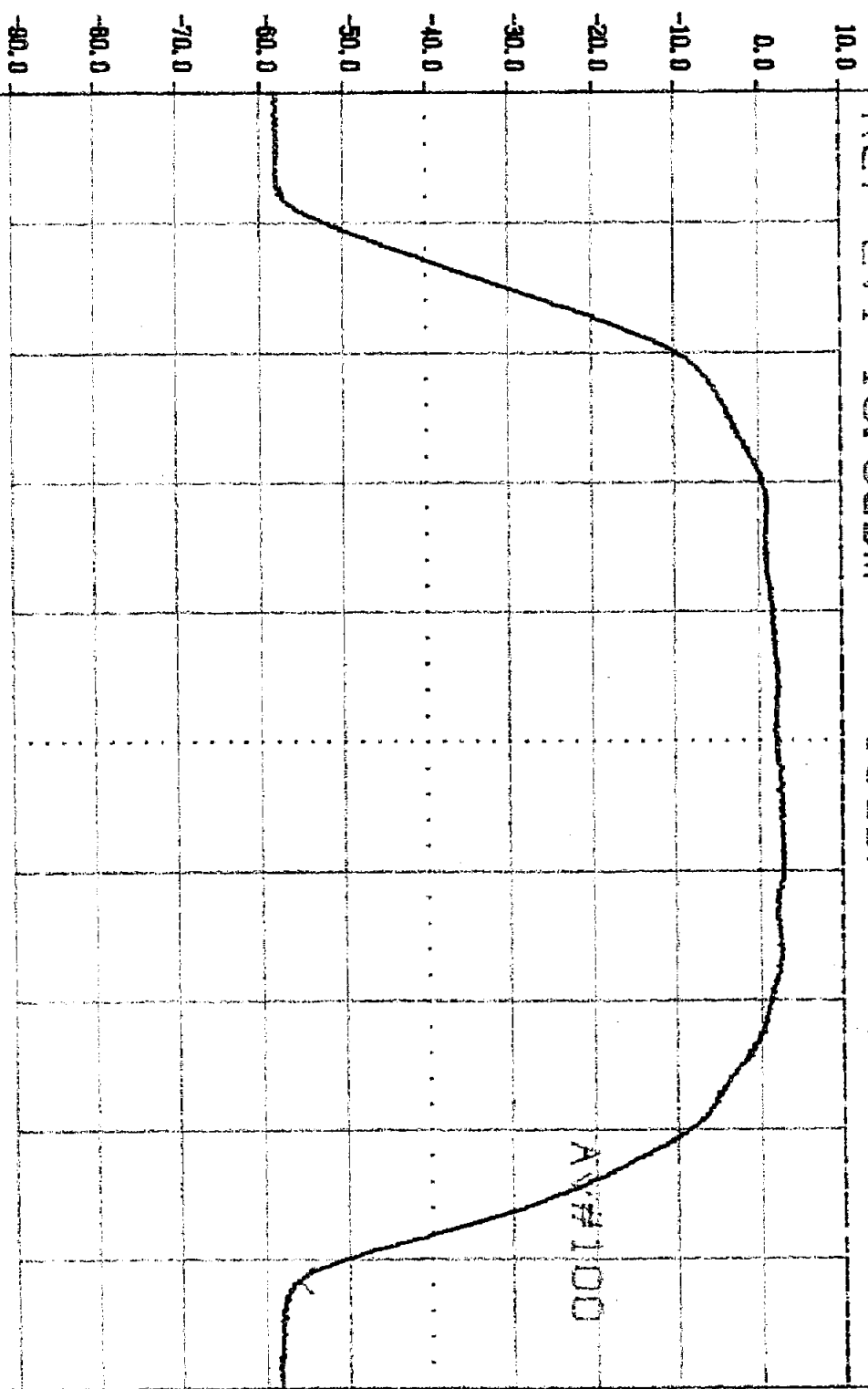
KNOB 2 KNOB 1 KEYPAD Tektronix 2784



Plot 4.65

Mkr 5.825 0GHz -56.20dBm Tek

Ref Lvl 10.0dBm 10dB/ Atten 20dB



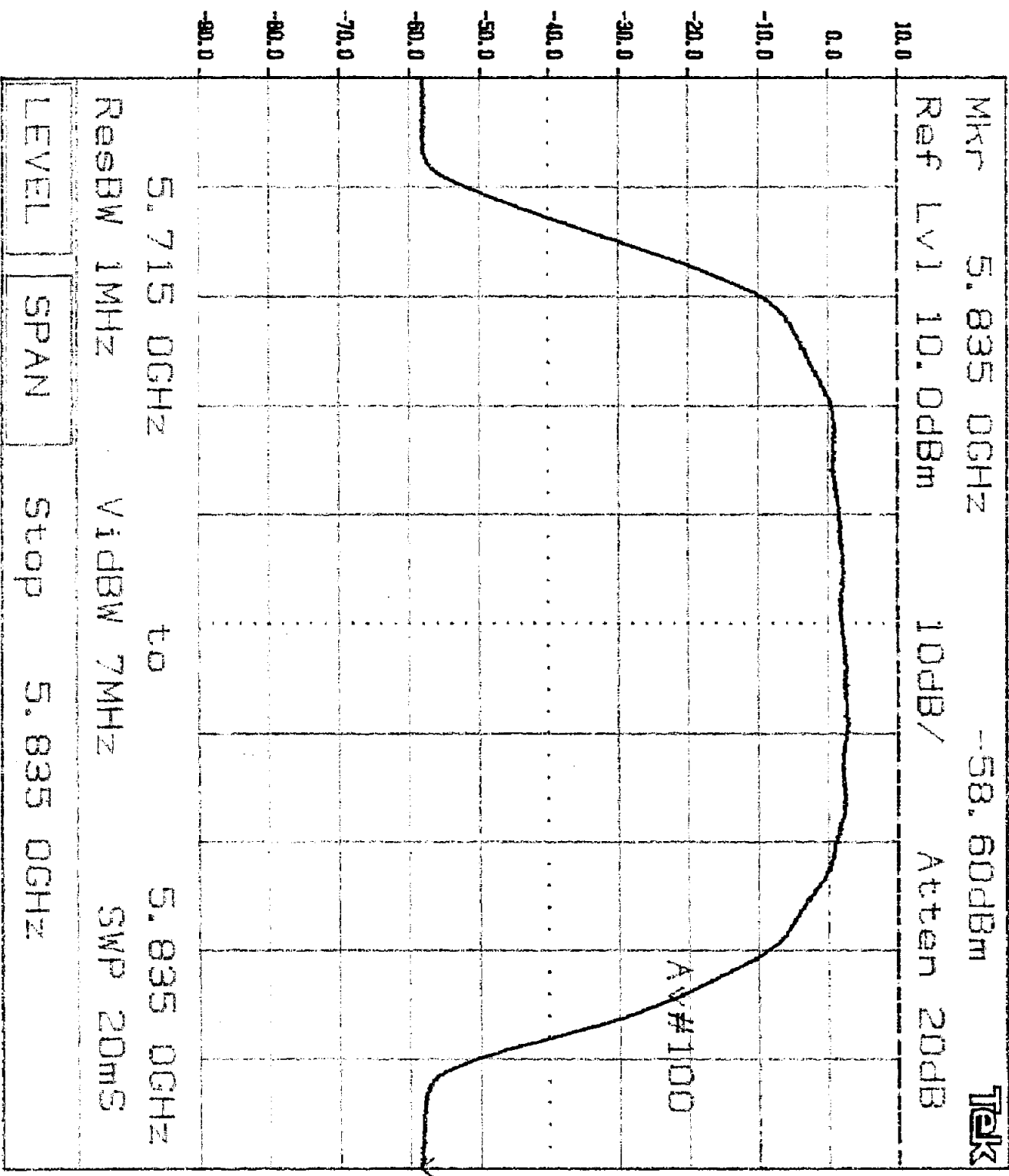
5.715 0GHz to 5.835 0GHz

ResBW 1MHz VidBW 7MHz SWP 20ms

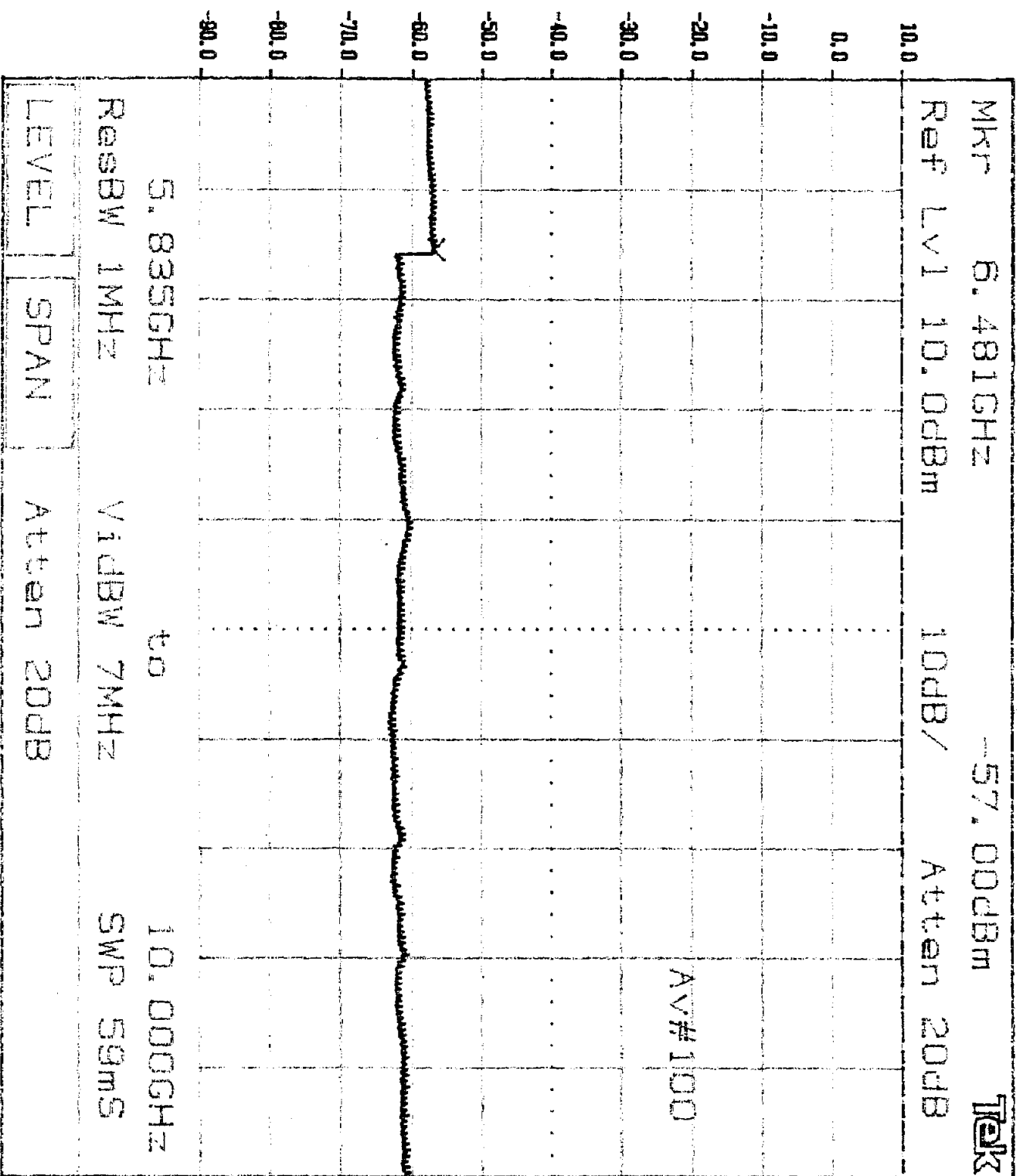
LEVEL SPAN Mkr 5.825 0GHz

KN08 2 KN08 1 KEYPAD Tektronix 2784

Plot 4.66



Plot 9.67



KN0B 2

KN0B 1

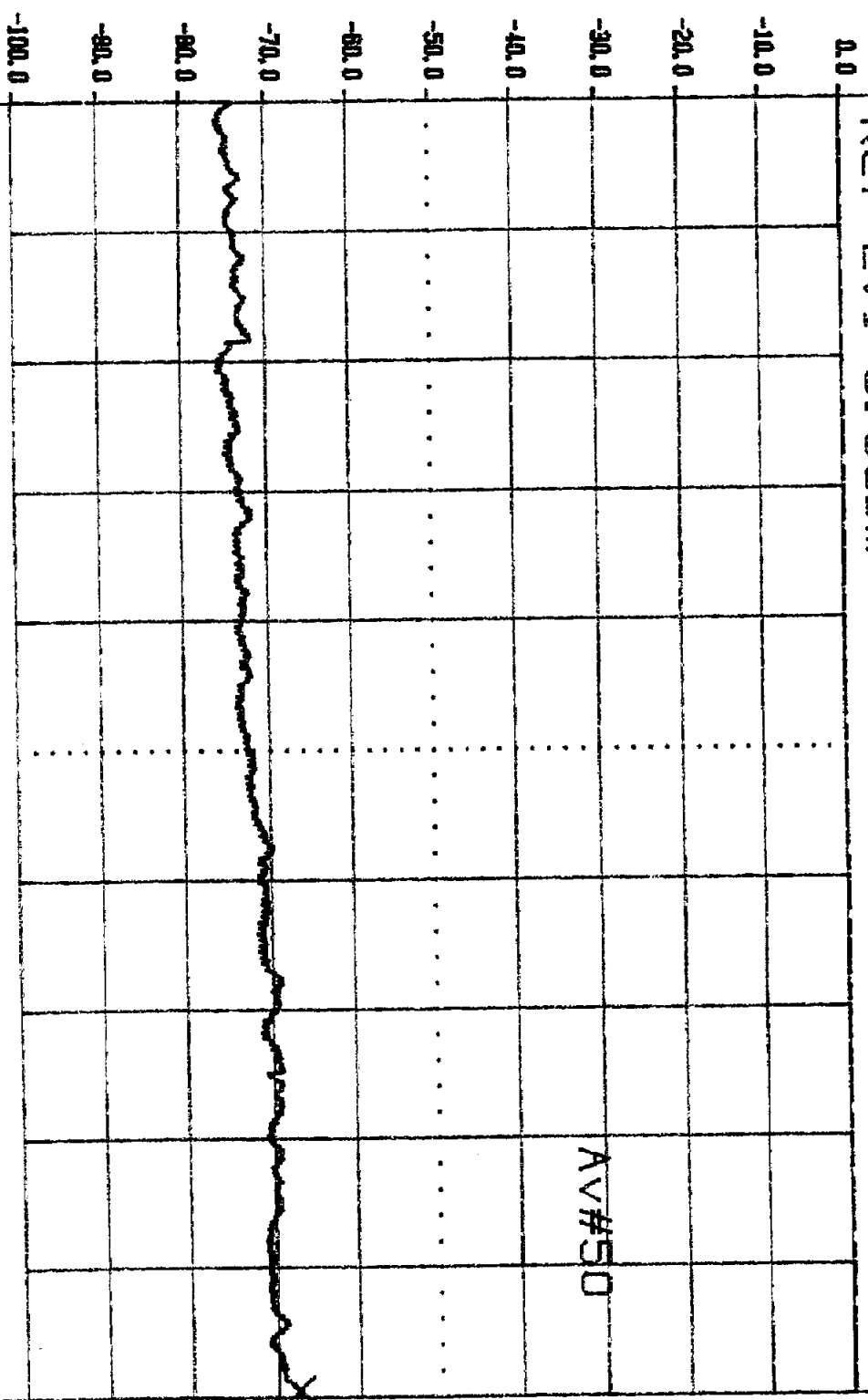
KEYPAD

Tektronix

2784

Mkr 24.91GHz -67.50dBm Tek

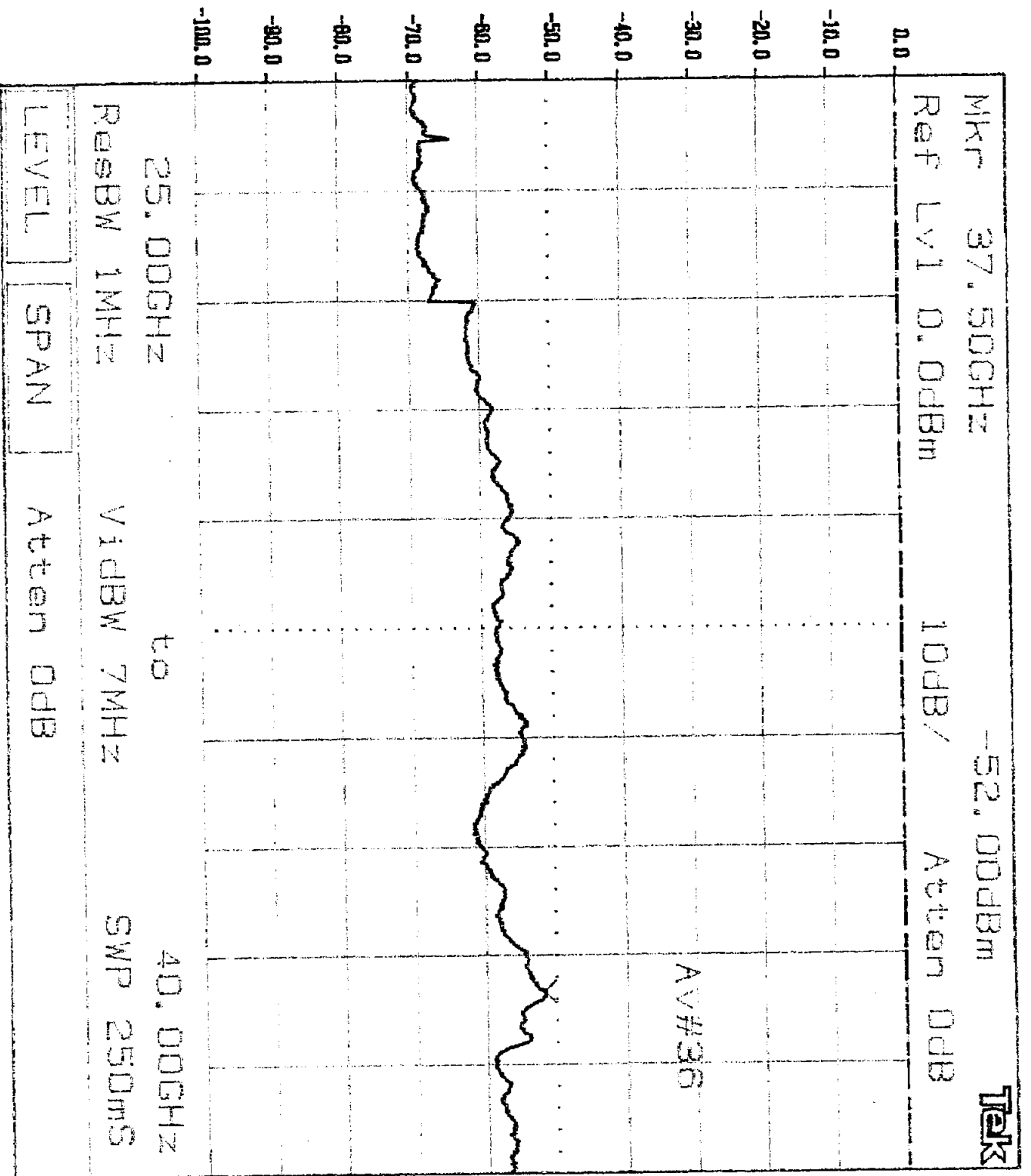
Ref Lvl 0.0dBm 10dB/ Atten 0dB



10.00GHz to 25.00GHz
ResBW 1MHz VidBW 7MHz SWP 150ms

LEVEL SPAN Stop 25.00GHz

KN08 2 KN08 1 KEYPAD Tektronix 2784



Plot 4.610

4.6 Transmitter Radiated Emissions in Restricted Bands FCC Rule 15.205

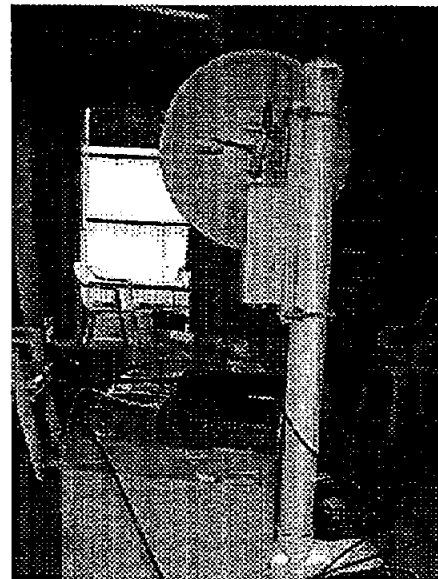
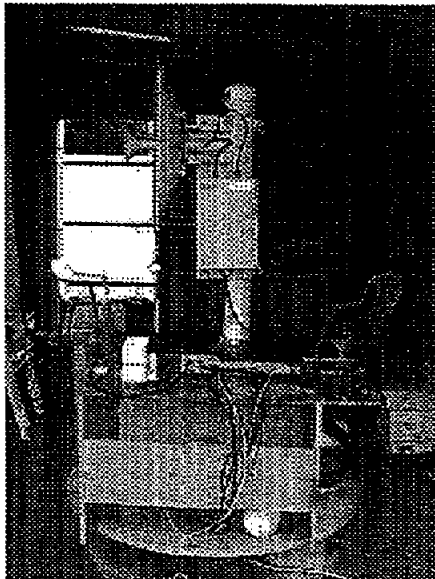
Radiated emission measurements were performed from 30 MHz to 40,000 MHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz - for frequencies above 1000 MHz.

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.

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included. All measurements were performed with peak detection unless otherwise specified.

Configuration Photograph



Test Result

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.



Radiated Emissions Test Data

Company:	Western Multiplex Corporation	Model #:		Standard_	FCC § 15.407 (R.B.)
EUT:	Tsunami UNNI 480GHz Radio	S/N #:		Limits	11
Project #:	J20029334	Test Date:	November 1, 2000	Test Distance_	3 meters
Test Mode:	Tx @ 5.3 GHz	Engineer:	Xi-Ming Y.	Duty Relaxation	0 dB

	Antenna Used			Pre-Amp Used			Cable Used			Transducer Used
Number:	14	21	22	10	13	0	12	0	0	0
Model:	EMCO 3115	3150-9	3160-10	AFT15865	ACO1400	None	NPS366	None	None	None

[illegible]

Notes:

- a) D.C.F.:Distance Correction Factor
b) Insert. Loss (dB) = Cable A + Cable B + Cable C.
c) Net (dB) = Reading + Antenna Factor - Pre-amp + Insert. Loss. - Transducer Loss - Duty Relaxation (transmitter only).
d) Negative signs (-) in Margin column signify levels below the limits.
e) All other emissions not reported are below the equipment noise floor which is at least 20 dB below the limits.
f) Frequency above 19 GHz was made at 1m distance



Radiated Emissions Test Data

Company:	Western Multiplex Corporation	Model #:	Standard	FCC § 15.407 (R.B.)
EUT:	Tsunami UNNI 480GHz Radio	S/N #:	Limits	11
Project #:	J20029334	Test Date:	Test Distance	3 meters
Test Mode:	Tx @ 5.775 GHz	Engineer:	Duty Relaxation	0 dB

	Antenna Used			Pre-Amp Used			Cable Used			Transducer Used
Number:	14	21	22	10	13	0	12	0	0	0
Model:	EMCO 3115	3153-9	3160-10	AFT16865	ACC1400	None	NFS366	None	None	None

[illegible]

Notes

- a) D.C.F.:Distance Correction Factor
b) Insert. Loss (dB) = Cable A + Cable B + Cable C.
c) Net (dB) = Reading + Antenna Factor - Pre-amp + Insert. Loss. - Transducer Loss - Duty Relaxation (transmitter only).
d) Negative signs (-) in Margin column signify levels below the limits.
e) All other emissions not reported are below the equipment noise floor which is at least 20 dB below the limits.
f) Frequency above 19 GHz was made at 1m distance

4.7 AC Line Conducted Emission
FCC Rule 15.207

See FCC Part 15 Subpart B Emission Test Report number: 20533091

**4.8 Radiated Emissions from Digital Section
FCC Rule 15.109**

See FCC Part 15 Subpart B Emission Test Report number: 20533091

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

Not required - EUT operation above 960 MHz only

4.10 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.

4.0

List of Test Equipment

Equipment	Manufacturer	Model	Serial #	Cal. Int.	Cal. Due	Used
Biconical Antenna	EMCO	3104	3789	12	4/10/01	X
Log Periodic Antenna	EMCO	EM LPA-25	1079	12	4/10/01	X
Double-ridged Horn Antenna	EMCO	3115	9107-3712	12	6/25/01	X
Horn Antenna	EMCO	3160-9	N/A	#	#	X
Pre-amplifier	ComPower	CPPA-102	1256	12	4/28/01	X
Pre-amplifier	CDI	P1000	N/A	12	10/14/00	X
Pre-amplifier	Avantek	AFT18855	8723H705	12	10/14/00	X
Pre-amplifier	CTT	ACO/400	47526	12	10/14/00	X
Spectrum Analyzer w/8650 QP Adapter	Hewlett Packard	HP 8566B	2416A00317 2521A01021	6	2/03/01	X
Spectrum Analyzer	Tektronix	2784	B3020108	12	8/4/01	X
Peak Power Meter	Hewlett Packard	8900D	3607U00673	12	7/31/01	X
Peak Power Sensor	Hewlett Packard	84811A	3318A05091	12	12/7/99	X

Calibration is not required