ITS Intertek Testing Services
ETL SEMKO

FCC Part 15.247
Direct Sequence Test Report
for
Symbol Technologies
on the
WLAN PC Card
Model: LA-4131
FCC ID: H9PLA4131P

Test Report #: 2036369E3
Date of Report: May 25, 2001

Job #: J20036369E
Date of Test: April 1 to May 24, 2001

Total No of Pages Contained in this Report: 51 + Data Sheets

NVLAP®

NVLAP Laboratory Code: 200201-0

	Suresh Kondapalli, Test Engineer
David Chernomordik	David Chernomordik, Ph.D., EMC Site Manager

Review Date: 5/30/01

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Table of Contents

1.0 Summary of Tests

MODEL: Model: LA-4131
FCC ID: H9PLA4131P

TEST	REFERENCE	RESULTS
Output power	15.247(b)	Passed
6 dB Bandwidth	15.247(a)(2)	Passed
Power Density	15.247(d)	Passed
Out-of-band Antenna Conducted Emission	15.247(c)	Passed
Out-of-band Radiated Emission (except emissions in restricted bands)	15.247(c)	Not Applicable. The EUT passed out-of-band antenna conducted emission
Radiated Emission in Restricted Bands	15.35(b)(c)	Passed
AC Line-conducted Emission	15.207	Passed
Radiated Emission from Digital Part	15.109	Passed, see separate DoC report
Radiated Emission from Receiver L.O.	15.109	Not Applicable. The operating frequency is above 960 MHz
Processing Gain	15.247(e)	Passed, see exhibit "Processing Gain"
RF Exposure Requirement	2.1091	Passed, see exhibit "RF Exposure"
Antenna Requirement	15.203	Passed

Test Engineer: _____ Date: 5/30/01
Suresh Kondapalli

EMC Site Manager: David Chernomordik Date: 5/30/01
David Chernomordik, Ph.D.
EMC Site Manager

2.0 General Description

2.1 Product Description

The Symbol Technologies model LA-4131 is a 2.4 GHz Direct Sequence Spread Spectrum radio in the form of a PC Card that is used for wireless communication from a laptop or other remote device to a LAN.

This extended PC Card is used in a portable configuration that uses two built in antennas for diversity and is typically installed in a laptop for wireless connectivity to a LAN. These antennas are printed symmetrical in construction for diversity. The antennas may be less than 20 cm from a persons body.

A connectorized version is also available for future custom internal terminal antennas. The connector used is a MMCX series coaxial connector that satisfies the FCC unique connector requirements.

Overview of WLAN PC Card
Model: LA-4131

Applicant	Symbol Technologies
Trade Name & Model No.	Symbol Technologies, LA-4131
FCC Identifier	H9PLA4131P
Use of Product	Wireless LAN communications
Manufacturer & Model of Spread Spectrum Module	Symbol Technologies
Type of Transmission	Direct Sequence Spread Spectrum
Rated RF Output	60 mW
Frequency Range	2412 - 2462
Number of Channel(s)	11
Antenna(s) & Gain,	Integrated antenna, IEC T2, gain 0 dBi
Antenna Requirement	[X] 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	Symbol Technologies 6480 Via Del Oro San Jose, CA 95119-1208

2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

Radiated emissions measurements were performed according to the procedures in ANSI C63.4 (1992). Radiated tests were performed at an antenna to LA-4131 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

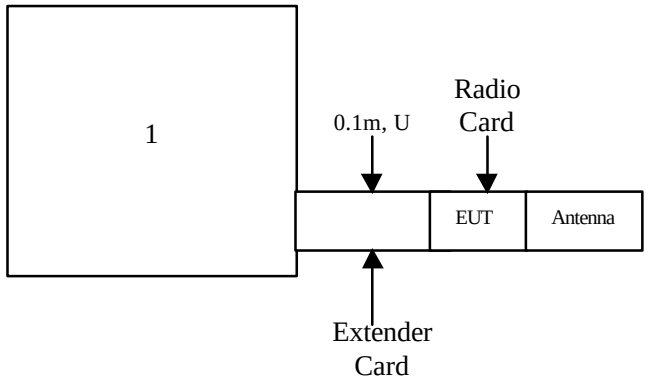
The open area test site and conducted measurement facility used to collect the radiated data is site 2 located in Menlo Park, California. This test facility and site measurement data have been fully placed on file with the FCC.

3.0 System Test Configuration

3.1 Support Equipment and description

Item #	Description	Model No.	Serial No.	FCC ID
1	Compaq Laptop	Armada	3882B400	N/A

3.2 Block Diagram of Test Setup



m: Length in meters
U: Unshielded
S: Shielded

3.3 Justification

For radiated emission measurements the LA-4131 is placed on the wooden turntable. The LA-4131 is attached to peripherals and they are connected and operational (as typical as possible). The LA-4131 is wired to transmit full power. During testing, all cables were manipulated to produce worst case emissions.

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 LA-4131 exercise program used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use.

3.5 Mode of Operation during Test

For emissions testing, the units were setup to transmit continuously at the low, middle, and high frequencies.

3.6 Modifications Required for Compliance

No modifications were installed by Intertek Testing Services during compliance testing in order to bring the product into compliance (Please note that this does not include changes made specifically by Symbol Technologies prior to compliance testing).

4.0 Measurement Results

4.1 Conducted Output Power at Antenna Terminals
FCC Rules 15.247(b):

Requirements

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt (+30 dBm).
For antennas with gains greater than 6 dBi, transmitter output level must be decreased by an amount equal to (GAIN - 6) dBm.

Procedure

The antenna port of the LA-4131 was connected to the input of a power meter. Power was read directly and cable loss correction was added to the reading to obtain power at the LA-4131 antenna terminal.

Test Results

Frequency (MHz)	Output in dBm	Output in mWatt
2412	17.8	60
2437	16.0	40
2462	16.3	43

The maximum EIRP (with antenna gain 0 dBi) is 17.8 dBm.

4.2 6 dB RF Bandwidth
FCC Rule 15.247(a)(2):

Requirements

The minimum 6 dB bandwidth shall be at least 500 kHz

Procedure

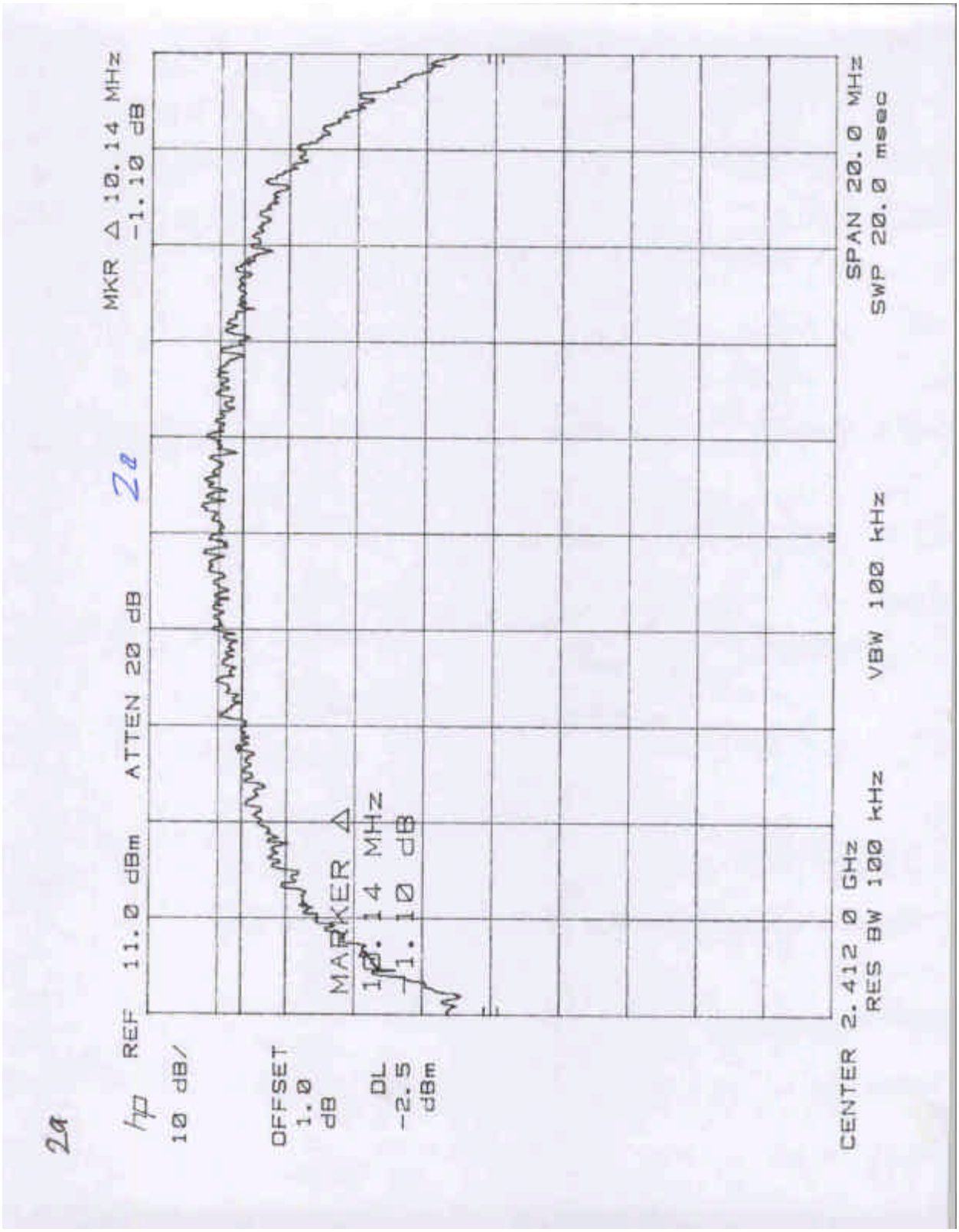
The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RES BW was set to 100 kHz. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A PEAK output reading was taken, a DISPLAY line was drawn 6 dB lower than PEAK level. The 6 dB bandwidth was determined from where the channel output spectrum intersected the display line.

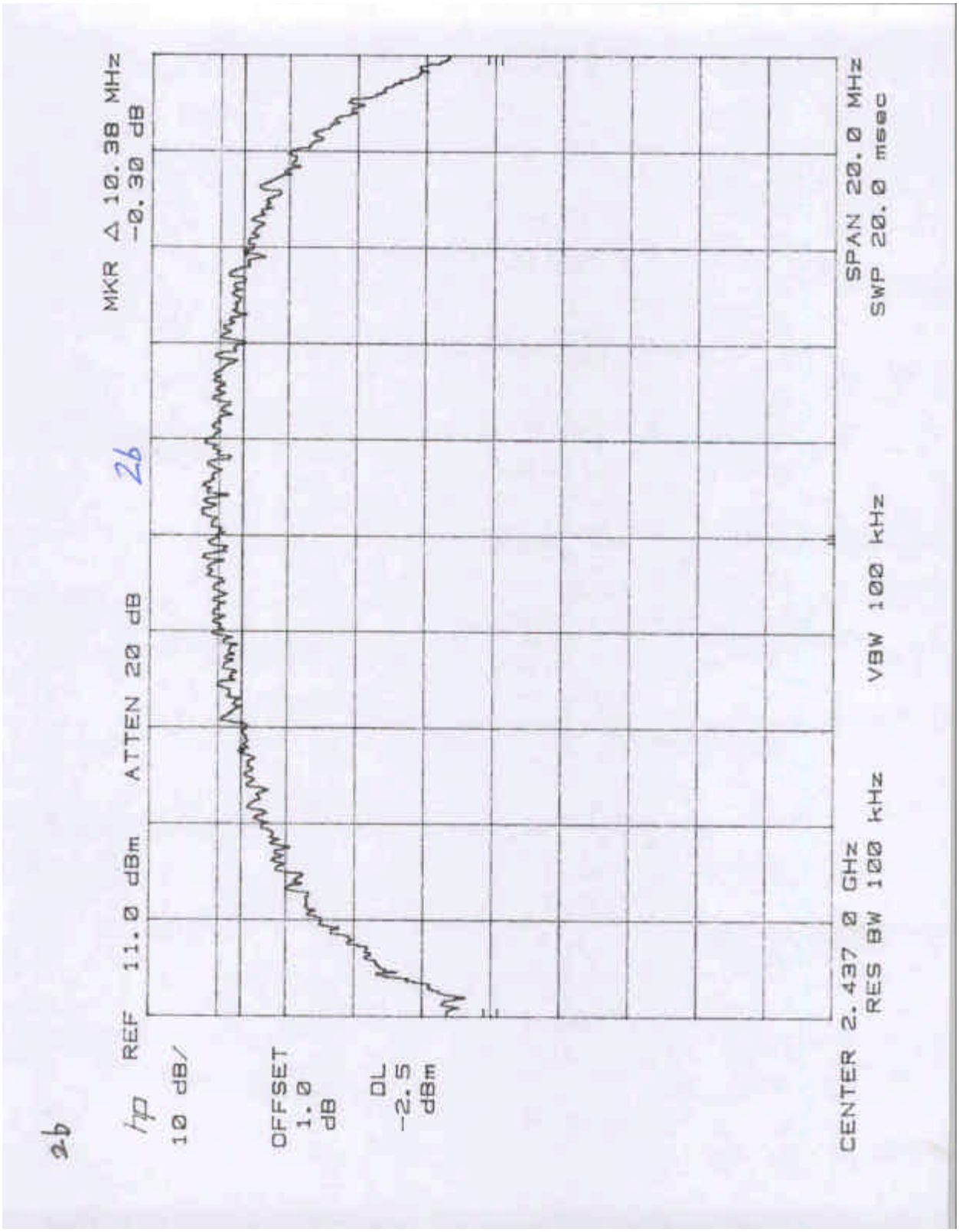
Test Result

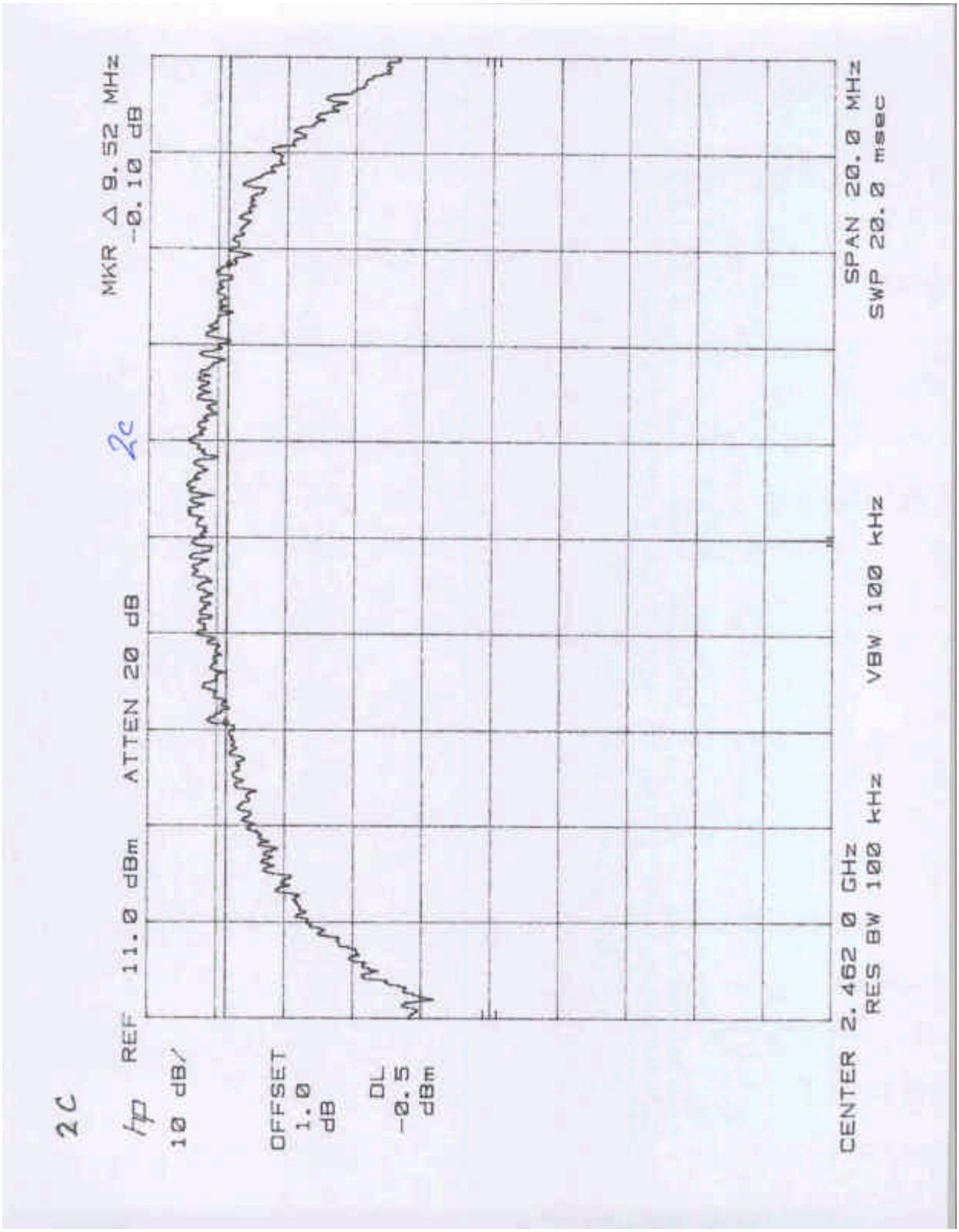
Frequency (MHz)	6 dB Bandwidth
2412	10.14 MHz
2437	10.38 MHz
2462	9.52 MHz

Refer to the following plots for 6 dB bandwidth:

Plot 2a: Low Channel 6 dB RF Bandwidth
Plot 2b: Middle Channel 6 dB RF Bandwidth
Plot 2c: High Channel 6 dB RF Bandwidth


2a
hp
REF 11.0 dBm
10 dB/
ATTEN 20 dB
OFFSET
1.0
dB
DL
-2.5
dBm
MARKER Δ
10.14 MHz
-1.10 dB
MKR Δ 10.14 MHz
-1.10 dB
CENTER 2.412 0 GHz
RES BW 100 kHz
VBW 100 kHz
SPAN 20.0 MHz
SWP 20.0 msec


MKR Δ 10.38 MHz
-0.30 dB
SPAN 20.0 MHz
SWP 20.0 msec
2b
hp REF 11.0 dBm ATTEN 20 dB
10 dB/
OFFSET
1.0
dB
DL
-2.5
dBm
VBW 100 kHz
CENTER 2.437 0 GHz
RES BW 100 kHz
2b


2C
hp
REF 11.0 dBm
10 dB/
ATTEN 20 dB
OFFSET
1.0
dB
DL
-0.5
dBm
MKR Δ 9.52 MHz
-0.10 dB
2c
CENTER 2.462 0 GHz
RES BW 100 kHz
VBW 100 kHz
SPAN 20.0 MHz
SWP 20.0 msec

4.3 Power Density
FCC Rule 15.247(d):

Requirements

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Procedure

The spectrum analyzer RES BW was set to 3 kHz. The START and STOP frequencies were set to the band edges of the maximum output passband. If there is no clear maximum amplitude in any given portion of the band, it may be necessary to make measurements at a number of bands defined by several START and STOP frequency pairs. Total SWEEP TIME is calculated as follows:

SWEEP TIME (SEC) = (Fstop, kHz - Fstart, kHz)/3 kHz

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.

Test Result

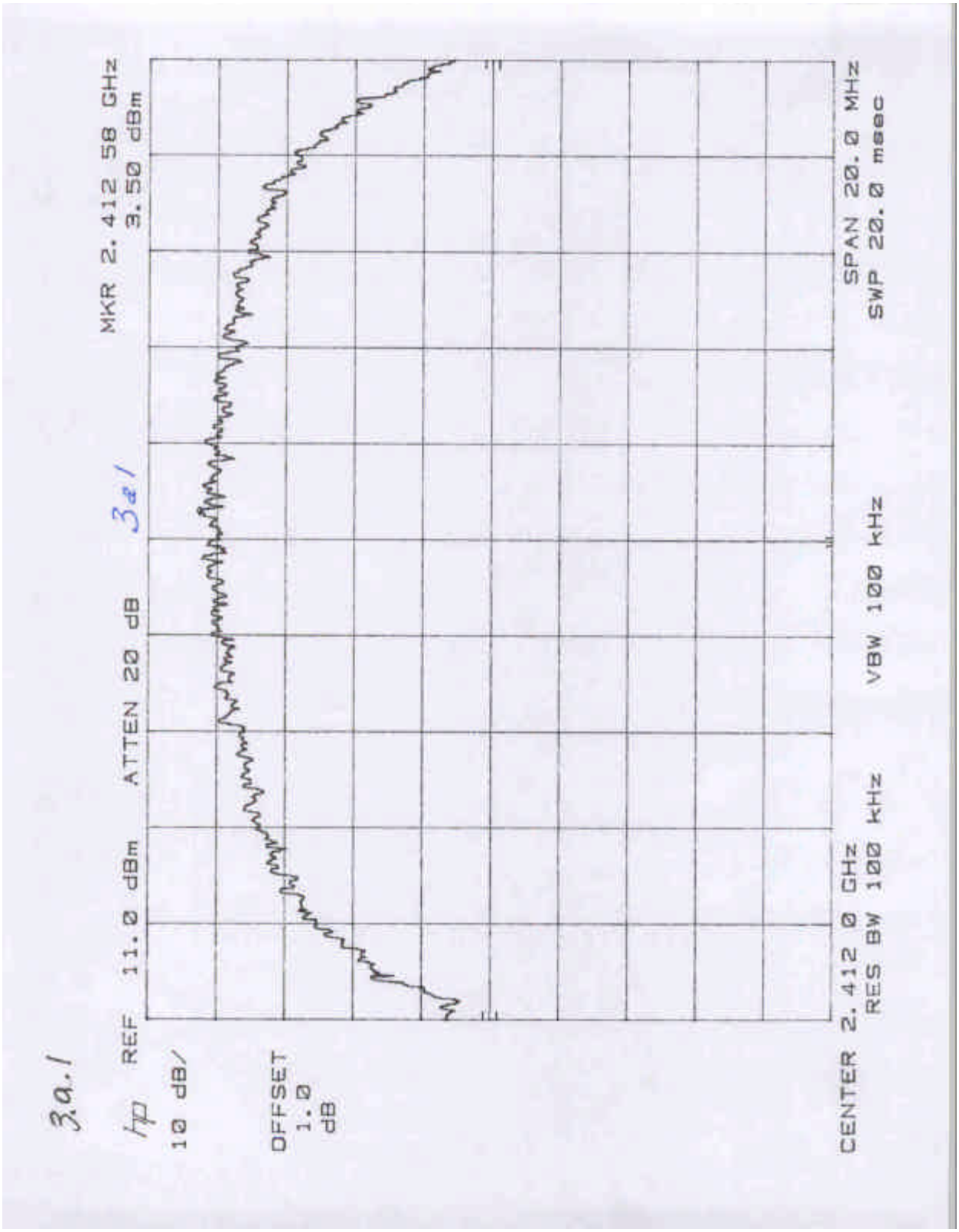
Frequency (MHz)	Power Density (dBm)
2412	-9.6

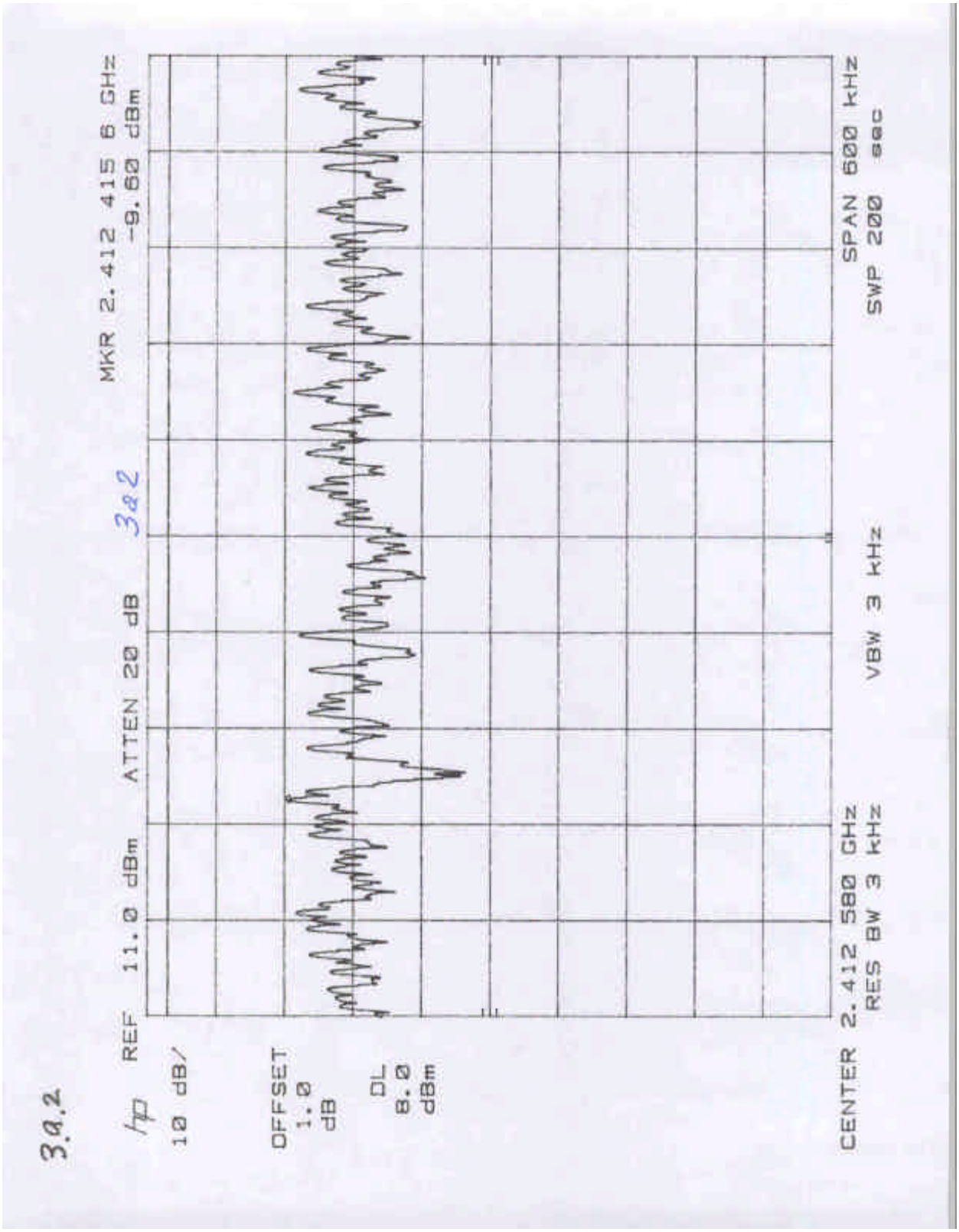
Frequency Span = 600 kHz

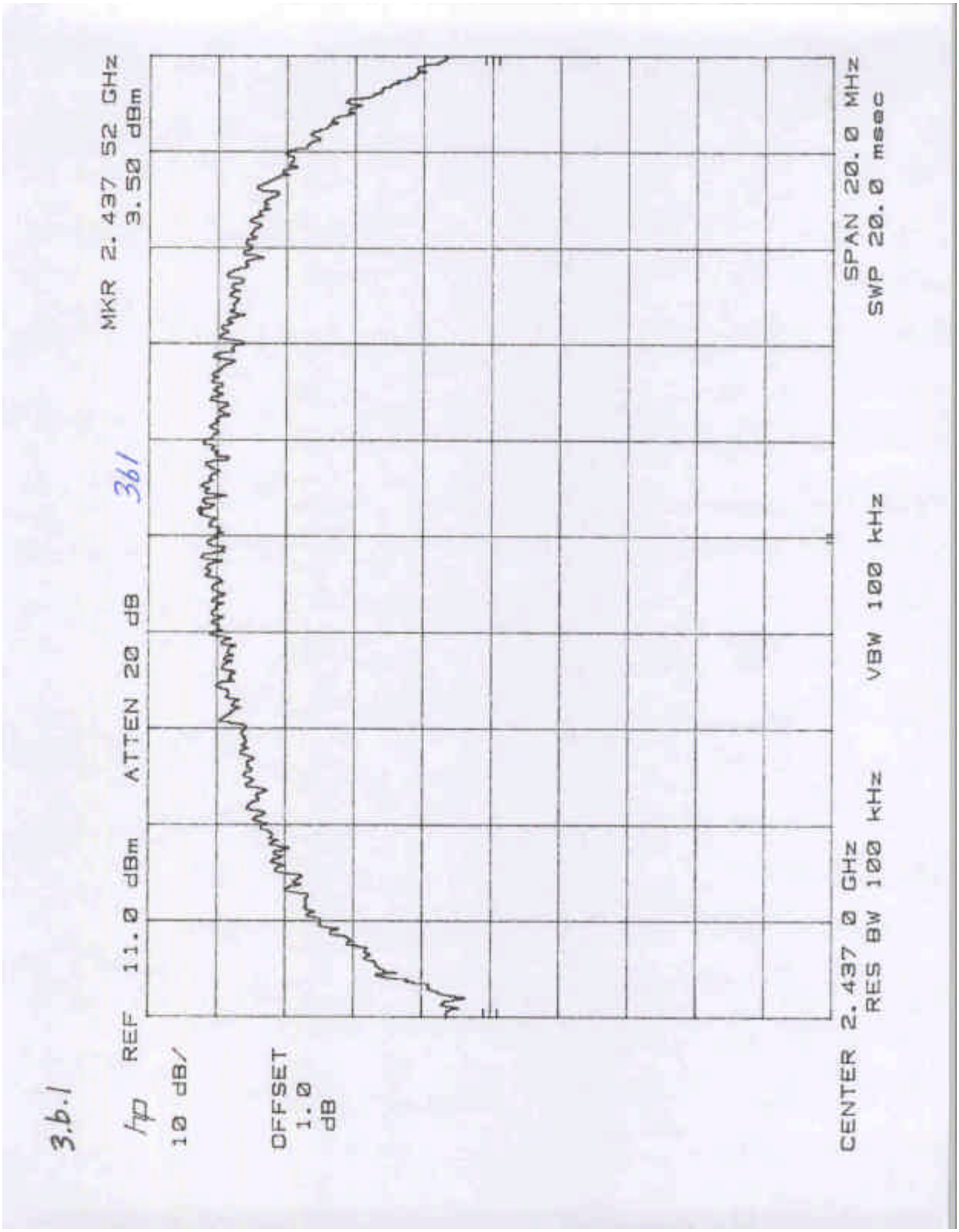
Sweep Time = Frequency Span/3 kHz
= 200 Seconds

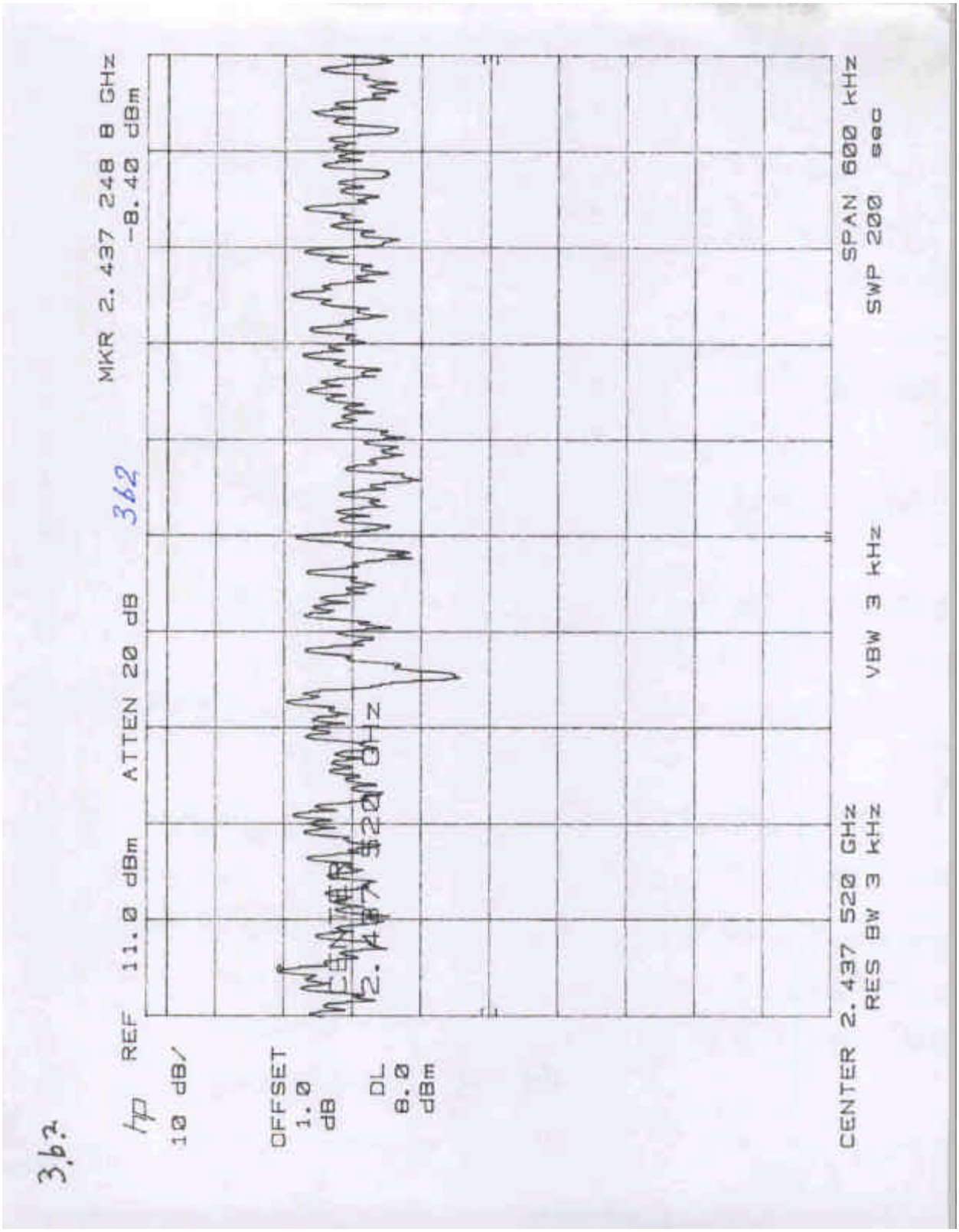
Refer to the following plots for power density data:

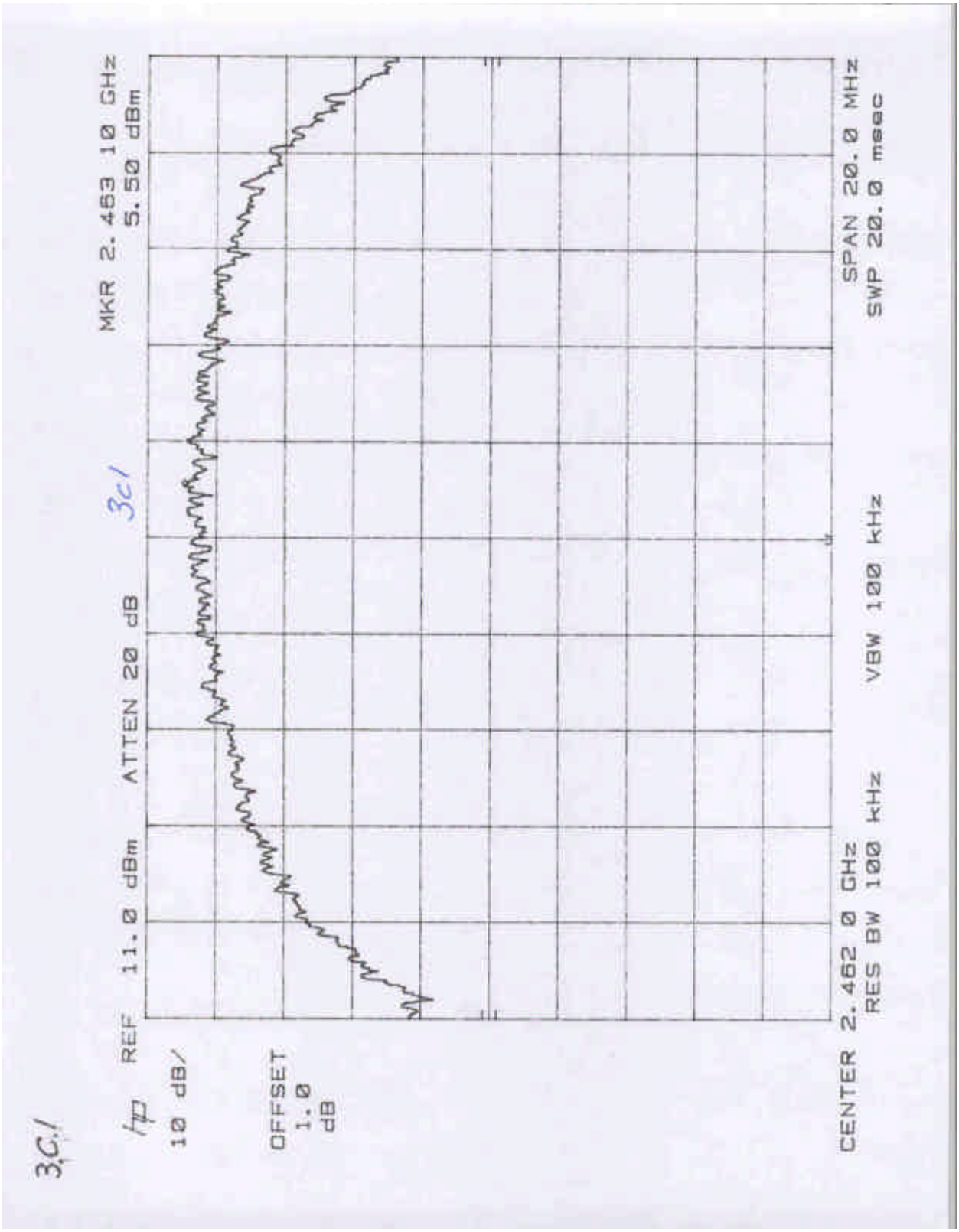
Plot 3a1 – 3a2: Low Channel Power Density
Plot 3b1 – 3b2: Middle Channel Power Density
Plot 3c1 – 3c2: High Channel Power Density

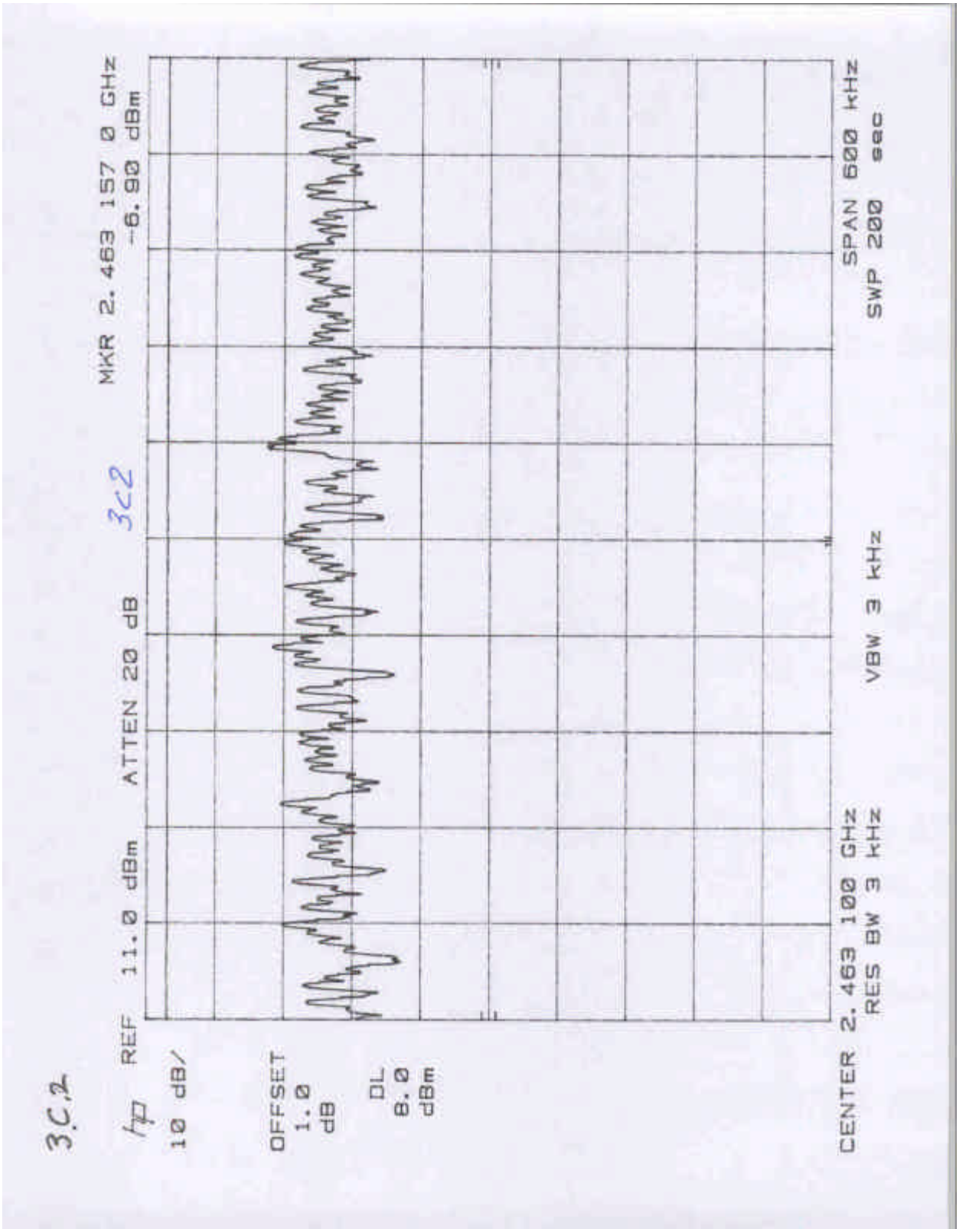

3a.1
hp
REF 11.0 dBm
10 dB/
OFFSET
1.0
dB
ATTEN 20 dB
3a1
MKR 2.412 58 GHz
3.50 dBm
CENTER 2.412 0 GHz
RES BW 100 kHz
VBW 100 kHz
SPAN 20.0 MHz
SWP 20.0 msec


3.4.2
MKR 2.412 415 6 GHz
-9.60 dBm
3&2
REF 11.0 dBm
ATTEN 20 dB
10 dB/
OFFSET
1.0
dB
DL
8.0
dBm
CENTER 2.412 580 GHz
RES BW 3 kHz
VBW 3 kHz
SPAN 600 kHz
SWP 200 sec


MKR 2.437 52 GHz
3.50 dBm
SPAN 20.0 MHz
SWP 20.0 msec
361
REF 11.0 dBm
ATTEN 20 dB
VBW 100 kHz
10 dB/
OFFSET
1.0
dB
CENTER 2.437 0 GHz
RES BW 100 kHz
3.b.1


MKR 2.437 248 8 GHz
-8.40 dBm
SPAN 600 kHz
SWP 200 sec
362
REF 11.0 dBm
ATTEN 20 dB
VBW 3 kHz
10 dB/
OFFSET
1.0
dB
DL
8.0
dBm
CENTER 2.437 520 GHz
RES BW 3 kHz
3.b.2.


MKR 2.463 10 GHz
5.50 dBm
SPAN 20.0 MHz
SWP 20.0 msec
3c1
REF 11.0 dBm
ATTEN 20 dB
VBW 100 kHz
10 dB/
OFFSET
1.0
dB
CENTER 2.462 0 GHz
RES BW 100 kHz
3C.1


MKR 2.463 157 0 GHz
-6.90 dBm
3c2
SPAN 600 kHz
SWP 200 sec
REF 11.0 dBm
ATTEN 20 dB
VBW 3 kHz
10 dB/
OFFSET
1.0
dB
DL
8.0
dBm
CENTER 2.463 100 GHz
RES BW 3 kHz
3.C.2

4.4 Out-of-Band Conducted Emissions
FCC Rule 15.247(c):

Requirements

In any 100 kHz bandwidth outside the EUT passband, the RF power shall be at least 20 dB below that of the maximum in-band 100 kHz emission.

Test Result

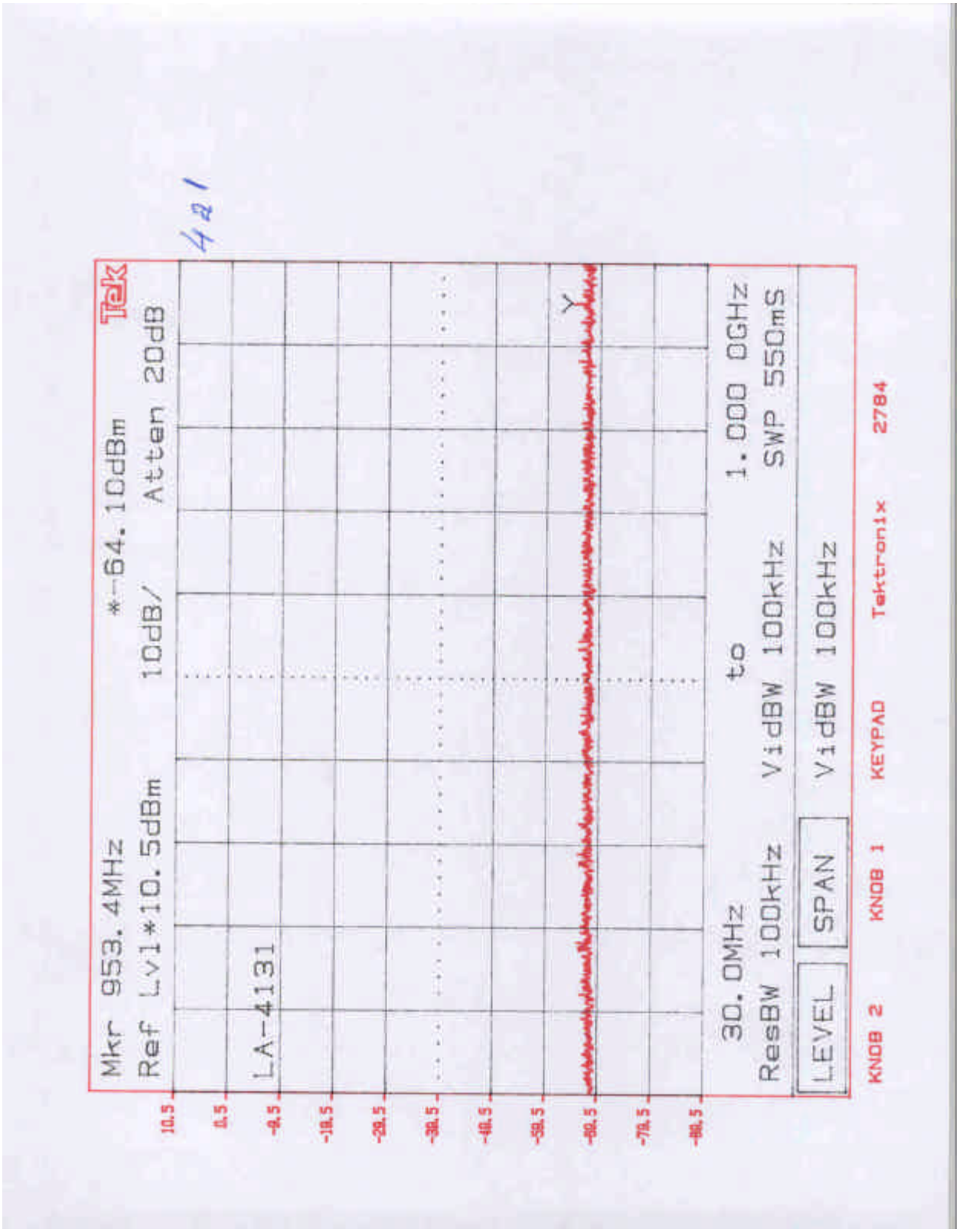
Refer to the following plots for out of band conducted emissions data:

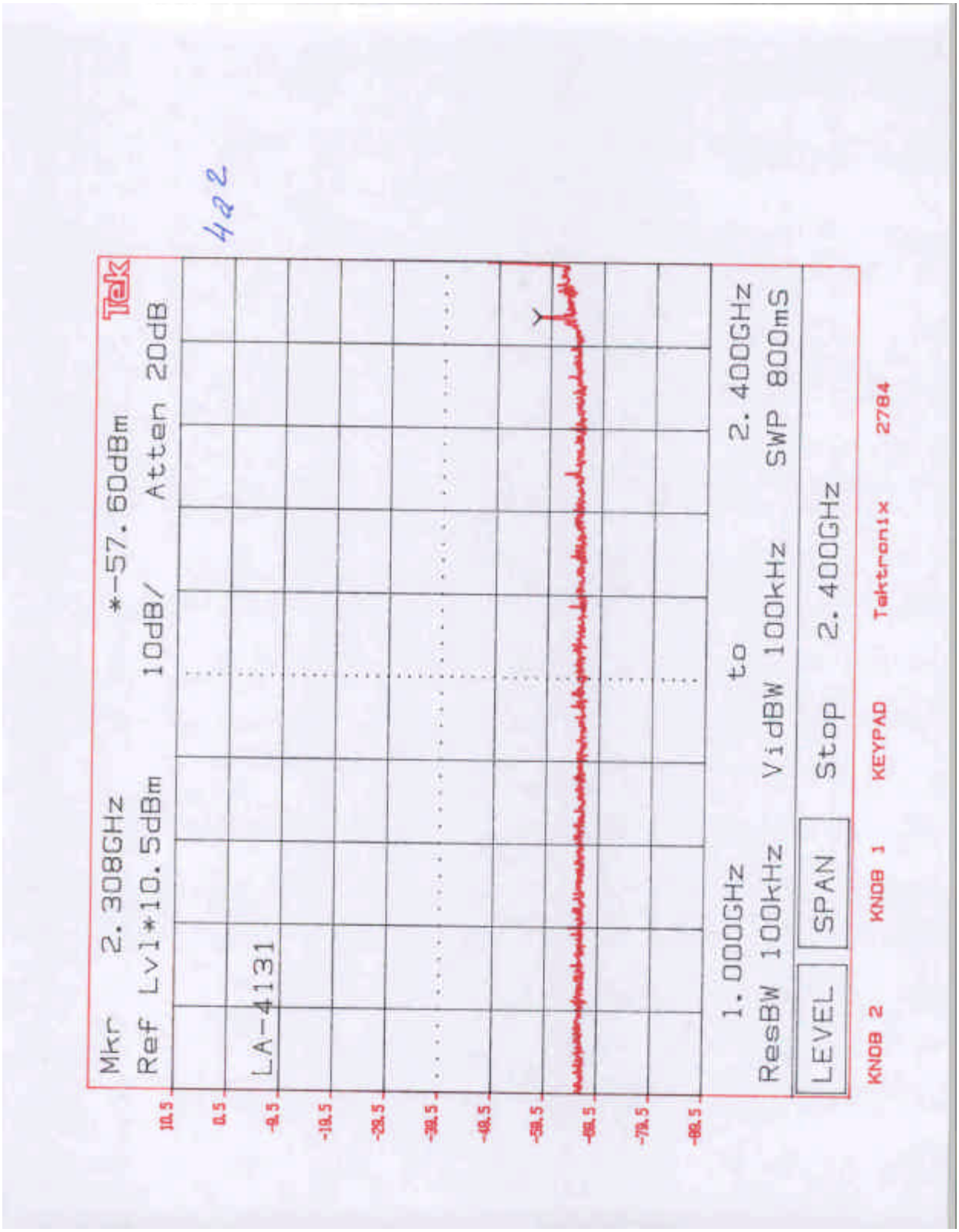
Plot 4a1 - 4a5: Low Channel Emissions
Plot 4b1 - 4b5: Middle Channel Emissions
Plot 4c1 - 4c5: High Channel Emissions

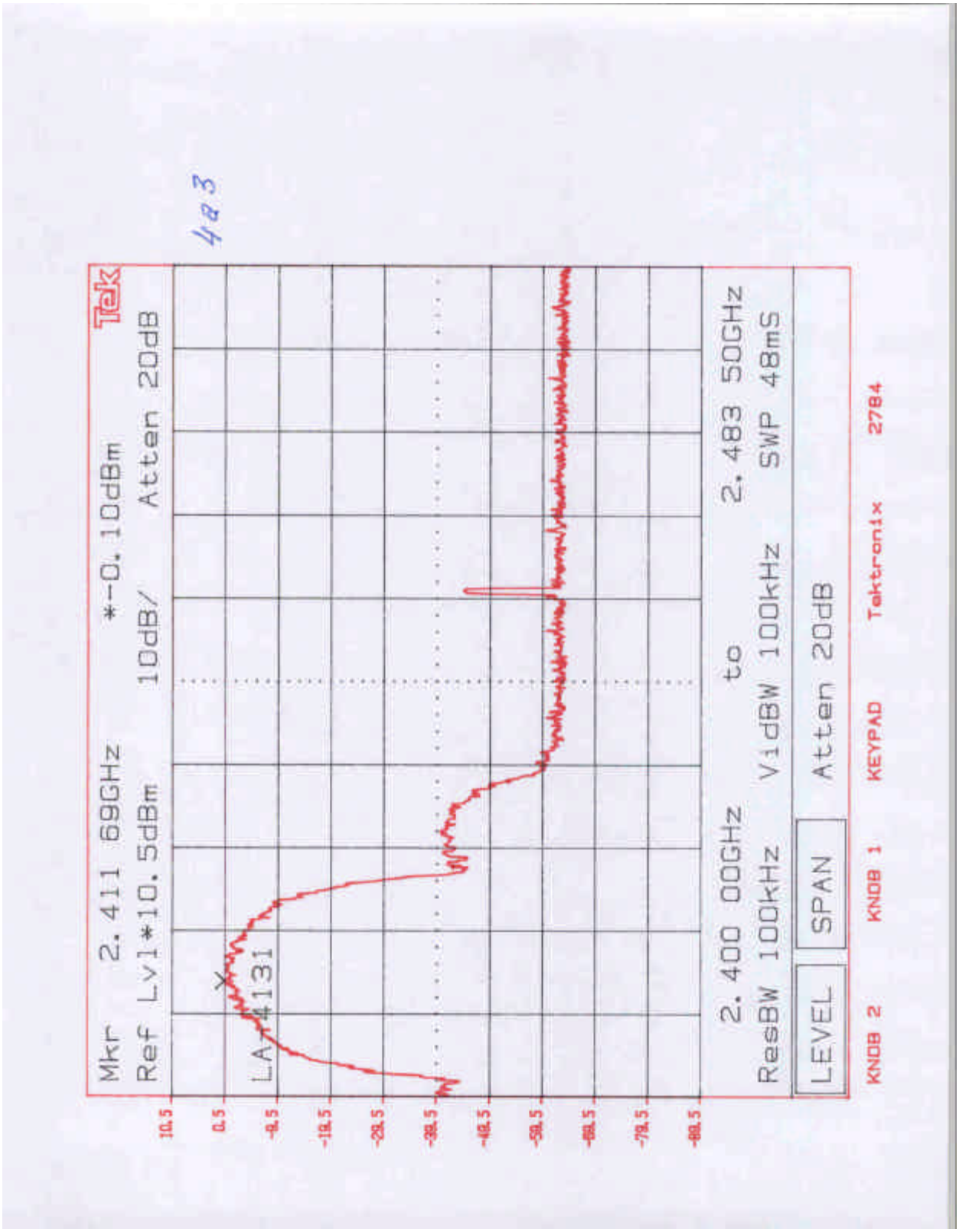
4.5 Out-of-Band Radiated Emissions
FCC Rule 15.247(c):

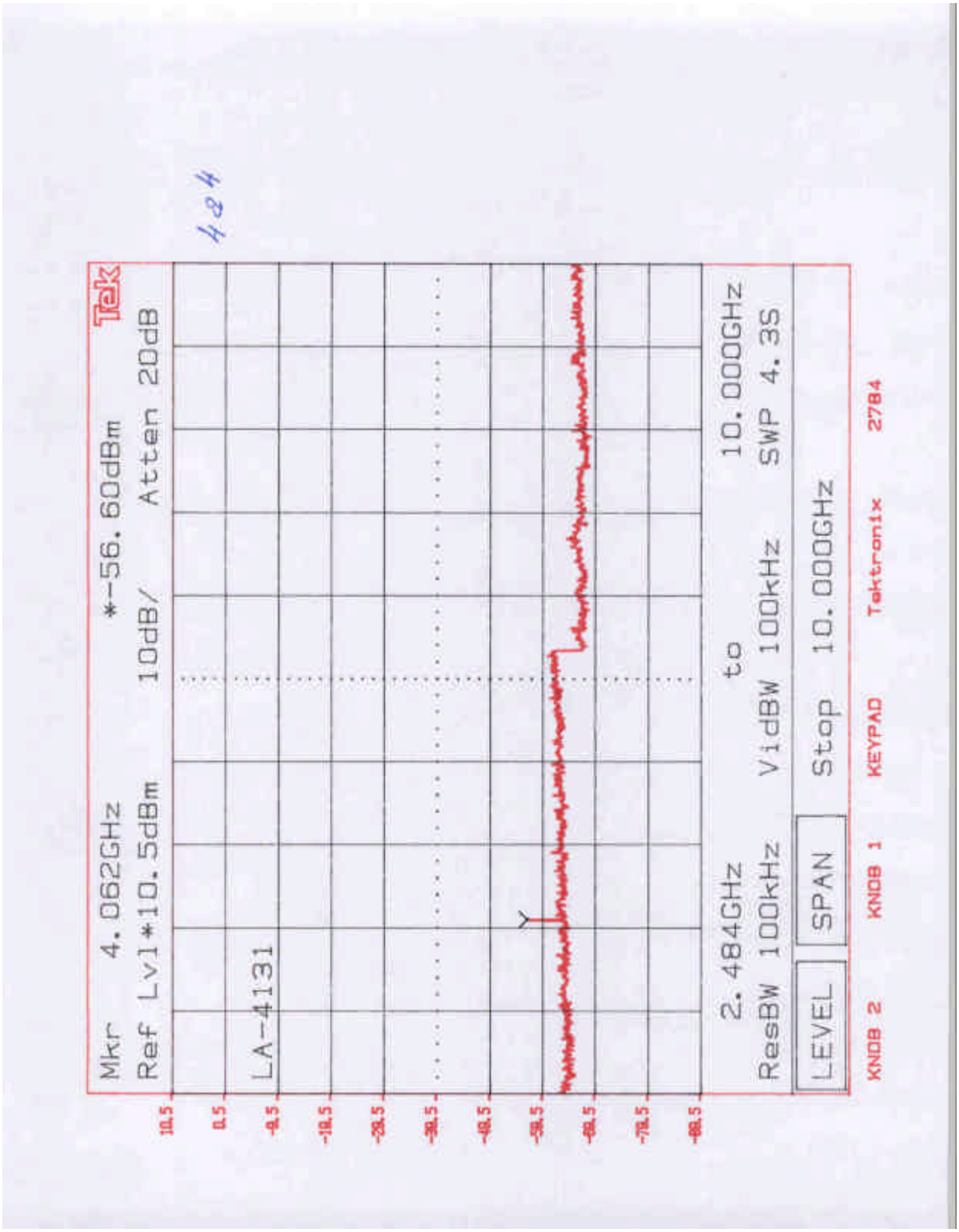
For out-of-band emissions that are close to or less than the 20 dB attenuation requirement described in the section 4.4, radiated measurements were performed at a 3 m separation distance to determine whether these emissions complied with the 20 dB attenuation.

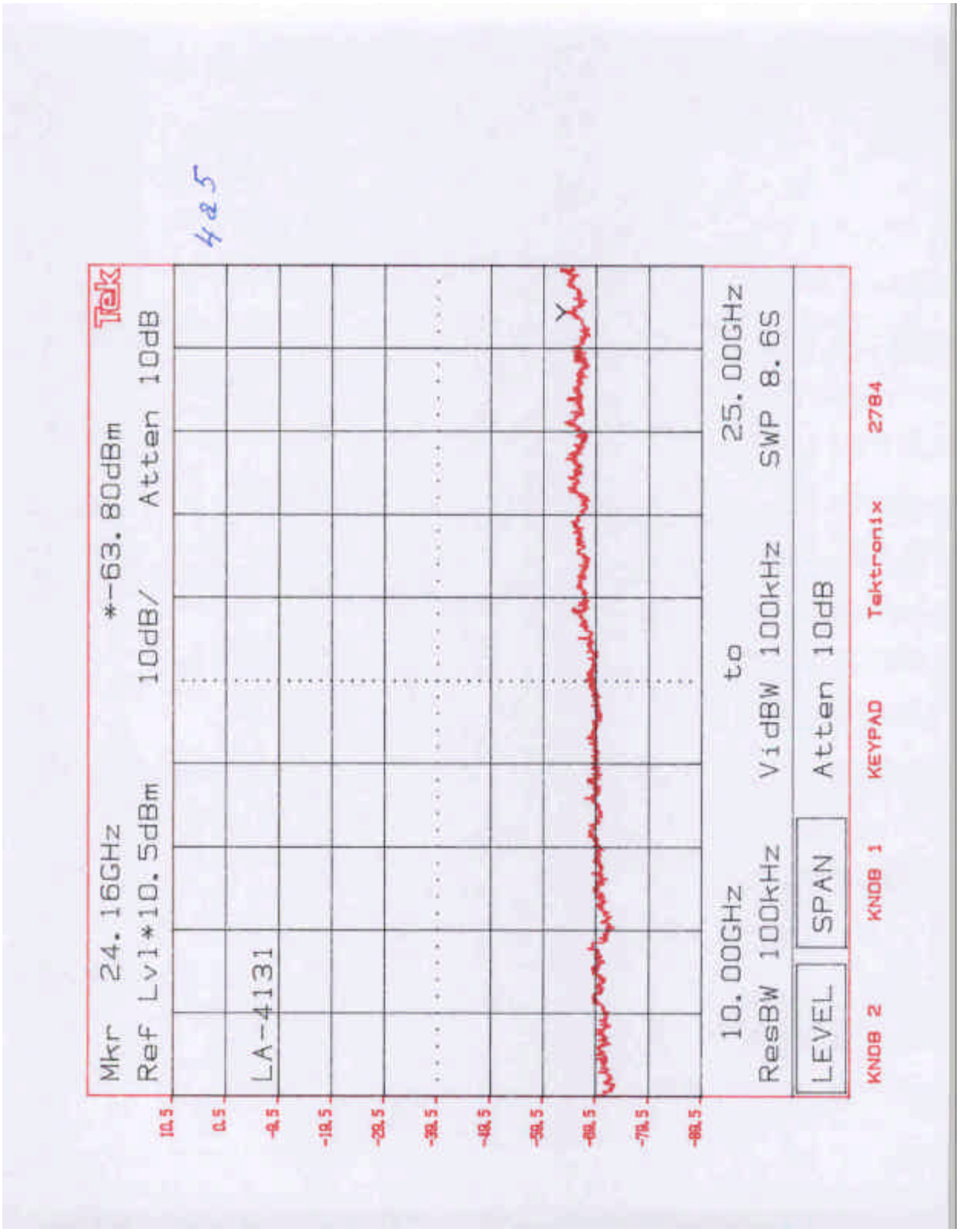
Not required, all conducted emissions more than 20 dB below fundamental.

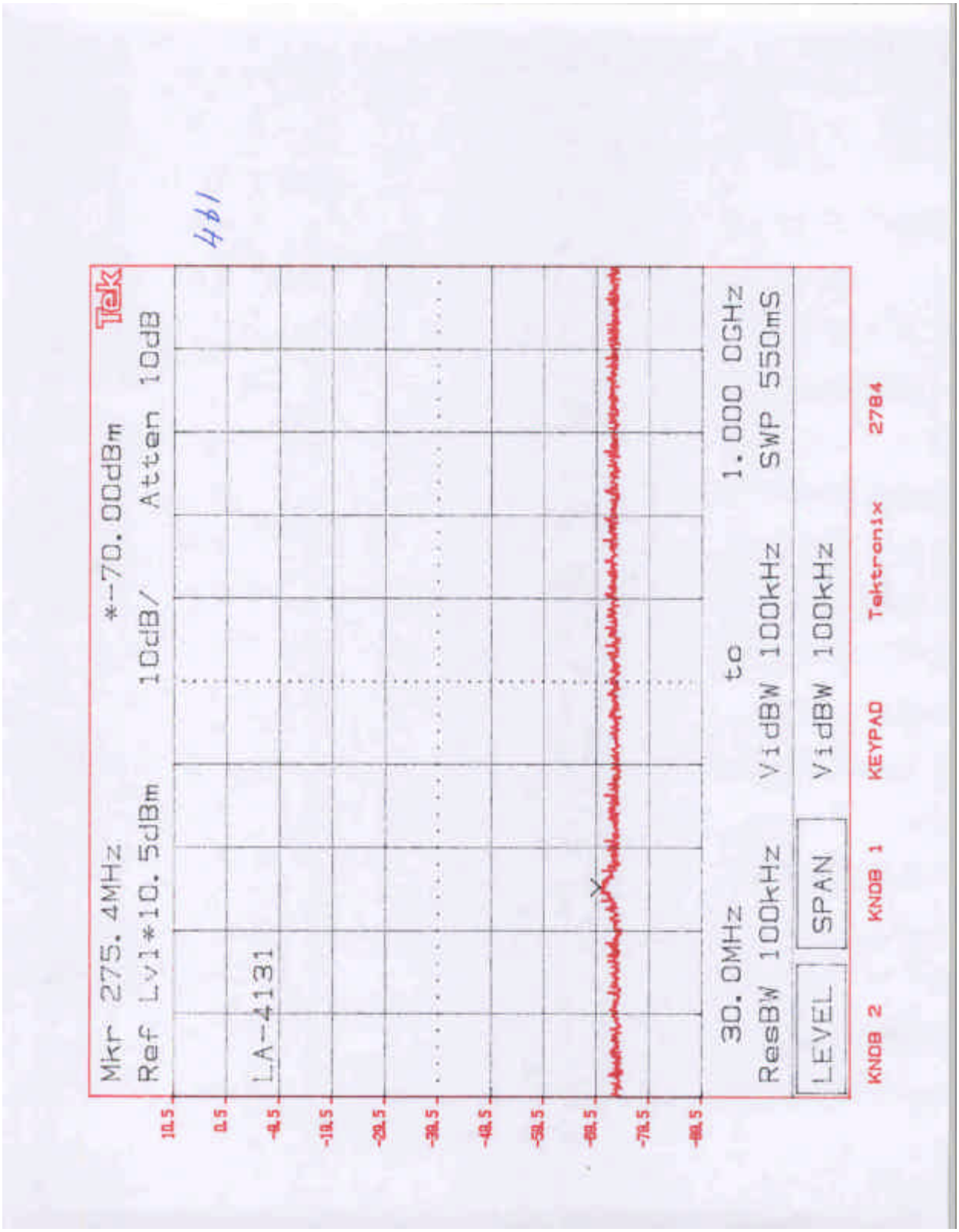

Mkr 953.4MHz
*-64.10dBm
Ref Lvl*10.5dBm
10dB/
Atten 20dB
LA-4131
30.0MHz
to
1.000 0GHz
ResBW 100kHz
VidBW 100kHz
SWP 550mS
LEVEL
SPAN
VidBW 100kHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784
Tek
421

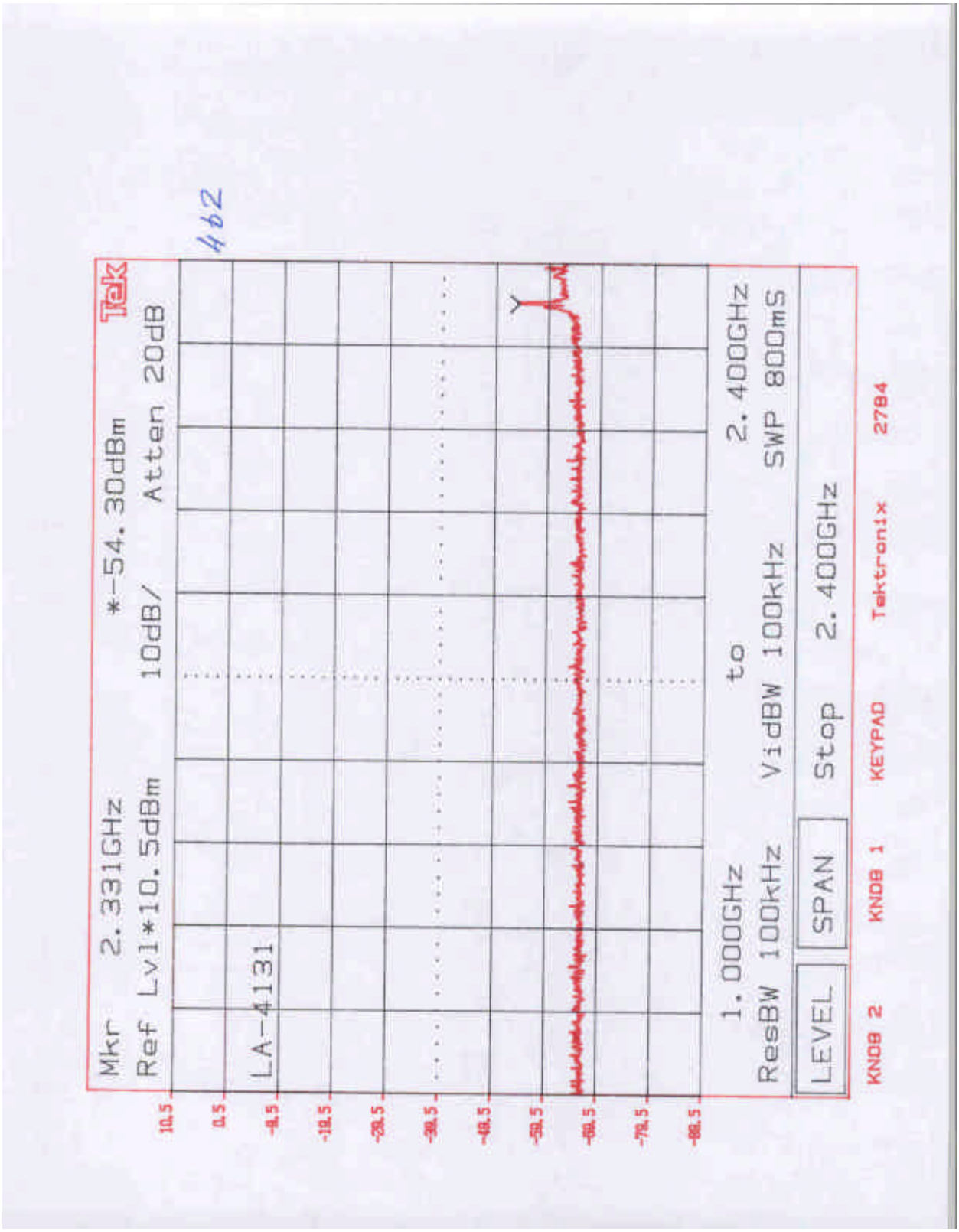

422
Tek
Mkr 2.308GHz
Ref Lvl*10.5dBm
*-57.60dBm
10dB/ Atten 20dB
LA-4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
1.000GHz
ResBW 100kHz
to
2.400GHz
VidBW 100kHz
SWP 800mS
LEVEL
SPAN
Stop
2.400GHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784


483
Tek
Mkr 2.411 69GHz *-0.10dBm
Ref Lvl*10.5dBm 10dB/ Atten 20dB
LA4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
2.400 00GHz to 2.483 50GHz
ResBW 100kHz VidBW 100kHz SWP 48mS
LEVEL SPAN Atten 20dB
KNOB 2 KNOB 1 KEYPAD Tektronix 2784

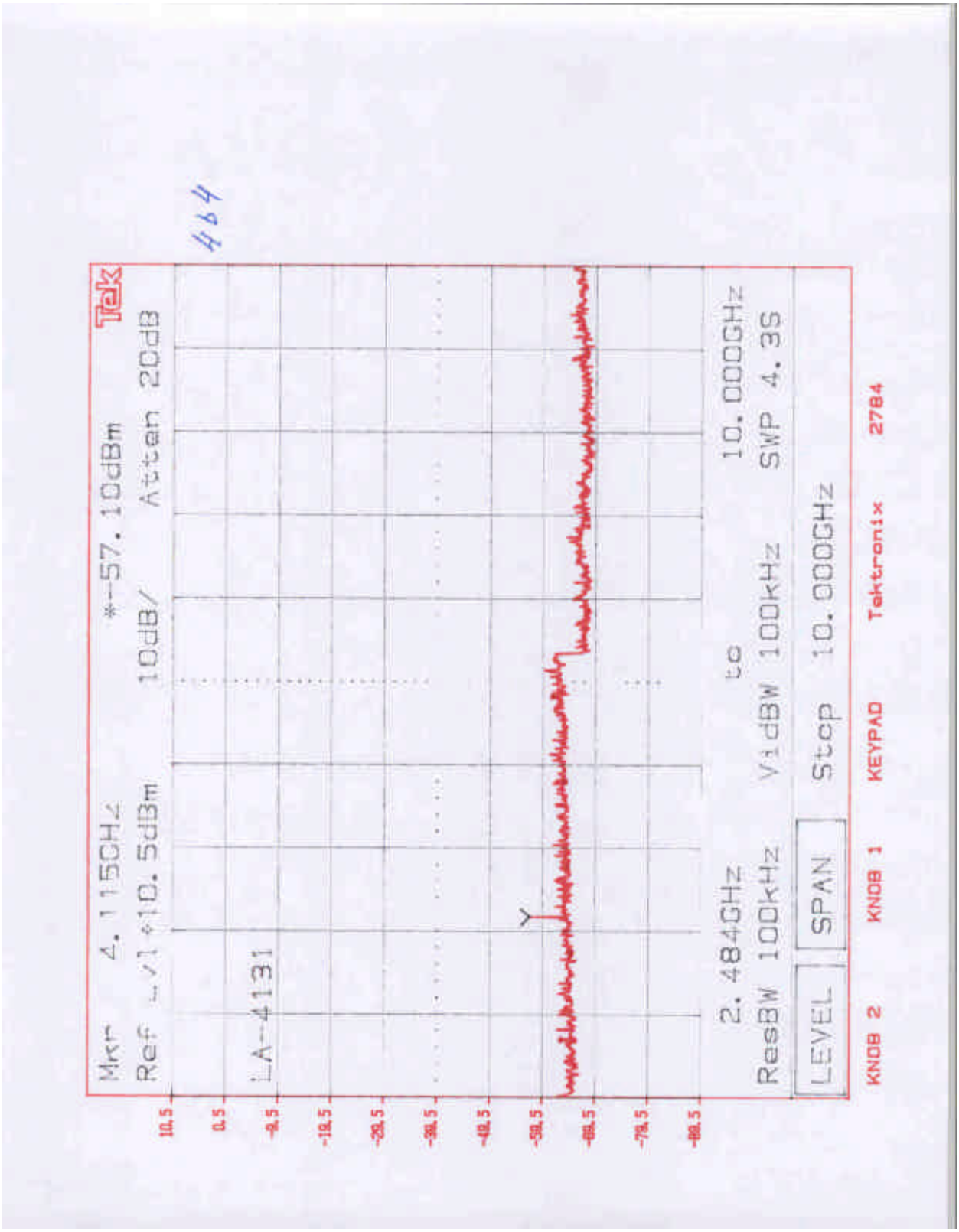

4 & 4
Tek
Mkr 4.062GHz
Ref Lvl *10.5dBm
*-56.60dBm
10dB/
Atten 20dB
LA-4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
2.484GHz
ResBW 100kHz
to
VidBW 100kHz
10.000GHz
SWP 4.3S
LEVEL
SPAN
Stop 10.000GHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784

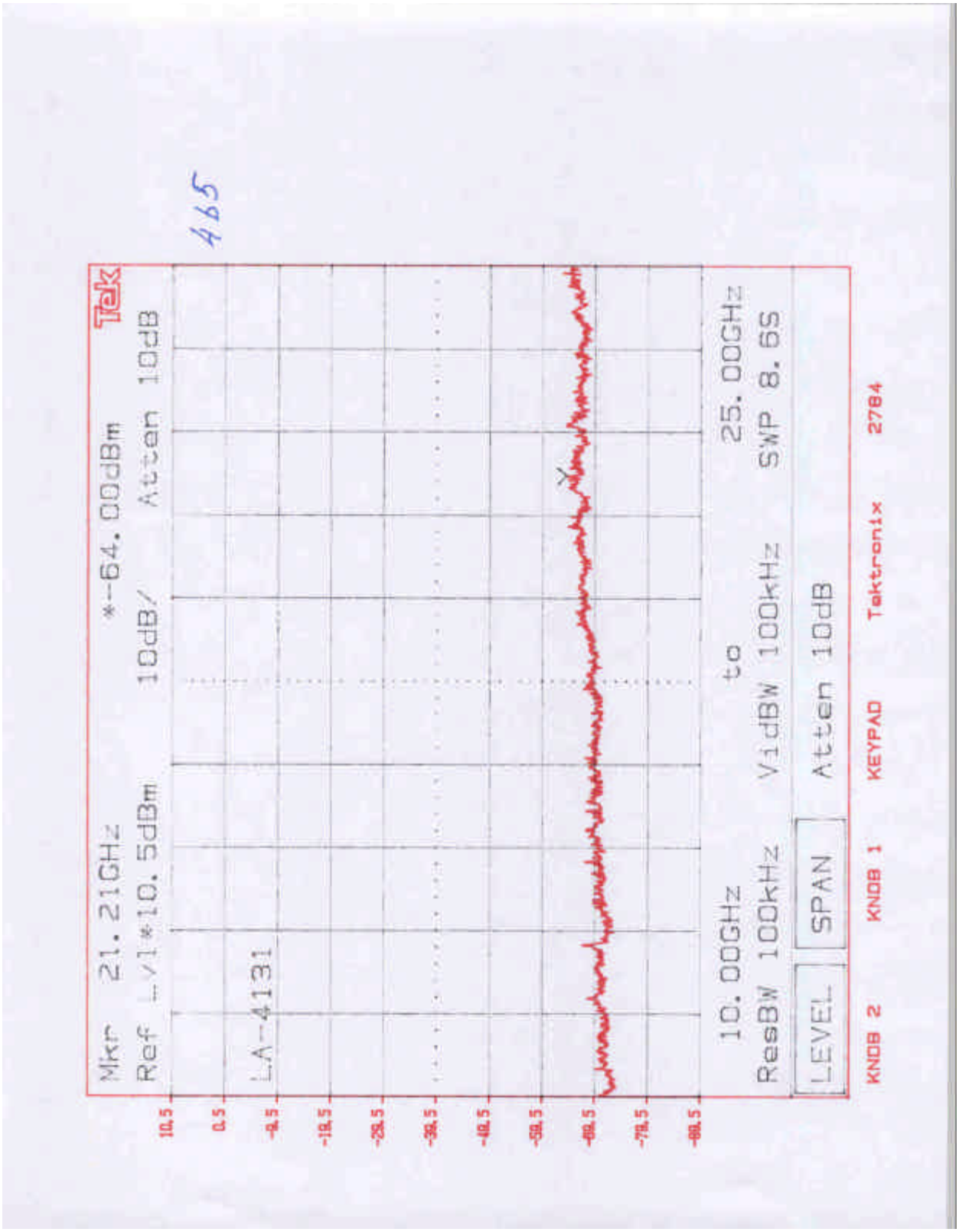

Tek
Mkr 24.16GHz
*-63.80dBm
Ref Lvl*10.5dBm
10dB/
Atten 10dB
LA-4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
10.00GHz
to
25.00GHz
ResBW 100kHz
VidBW 100kHz
SWP 8.6S
LEVEL
SPAN
Atten 10dB
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784

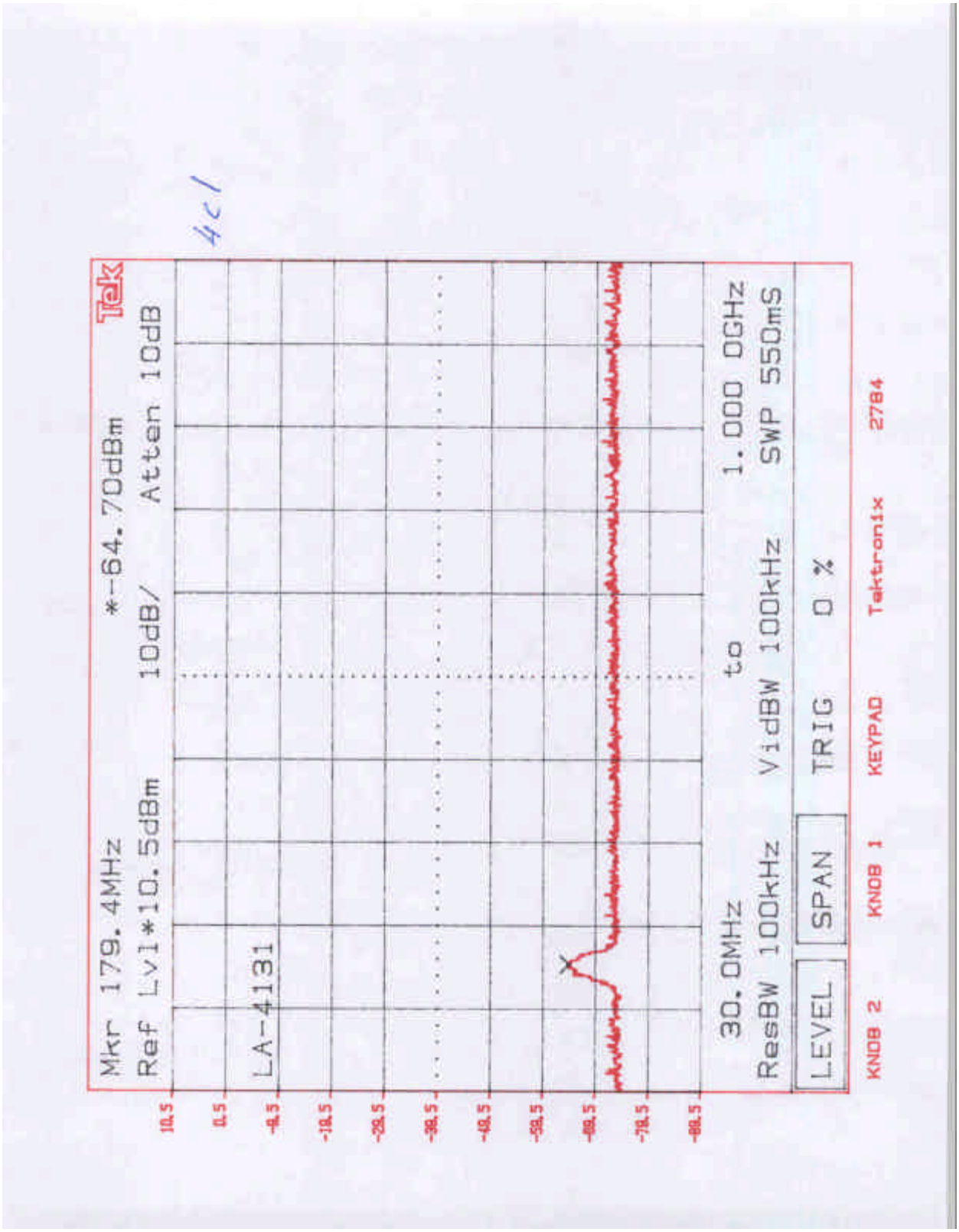

Mkr 275.4MHz
*-70.00dBm
Ref Lvl*10.5dBm
10dB/
Atten 10dB
LA-4131
30.0MHz
to
1.000 0GHz
ResBW 100kHz
VidBW 100kHz
SWP 550mS
LEVEL
SPAN
VidBW 100kHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784

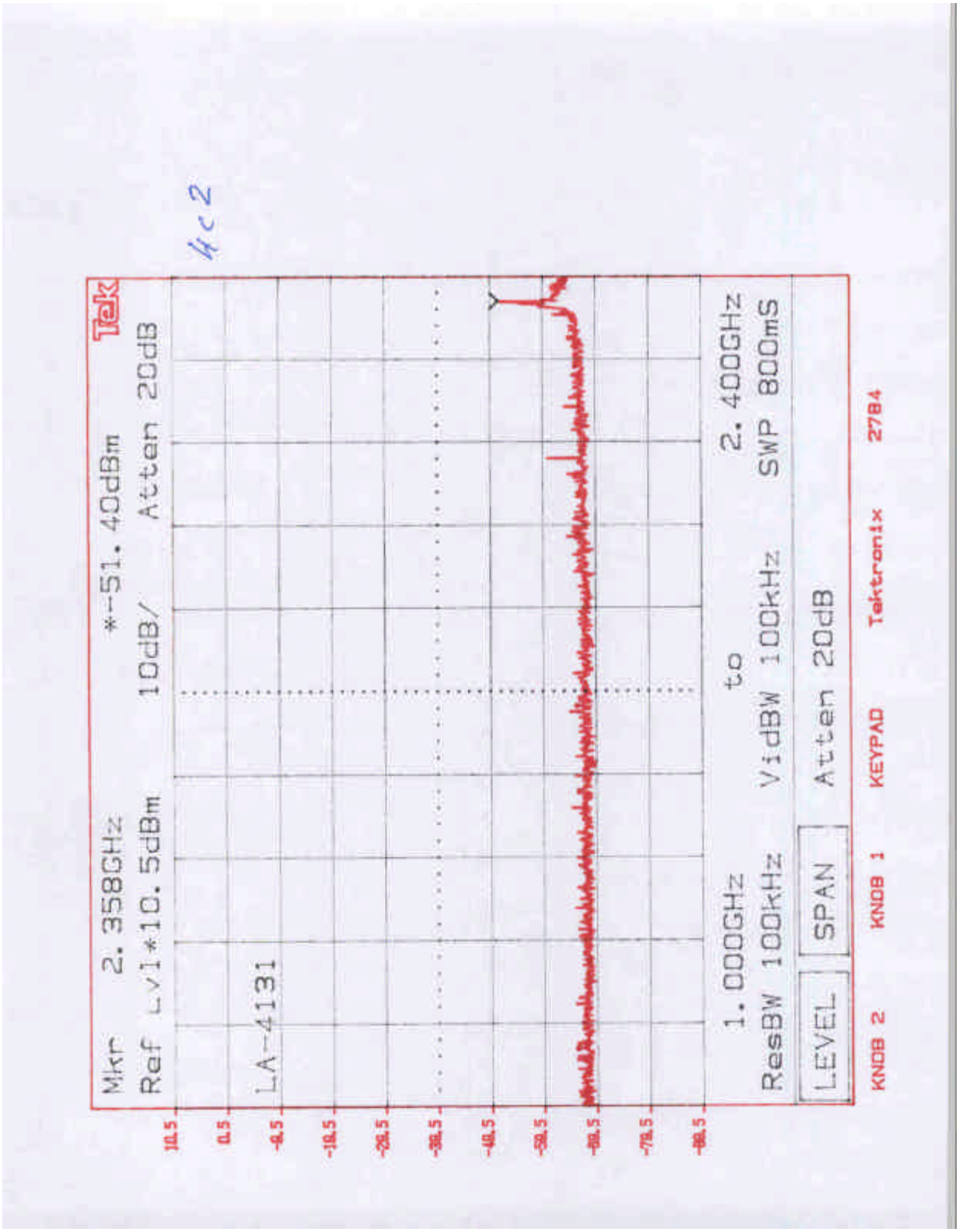

4b2
Tek
Mkr 2.331GHz
Ref Lvl*10.5dBm
*-54.30dBm
10dB/
Atten 20dB
LA-4131
1.000GHz
to
2.400GHz
ResBW 100kHz
VidBW 100kHz
SWP 800mS
LEVEL
SPAN
Stop 2.400GHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784

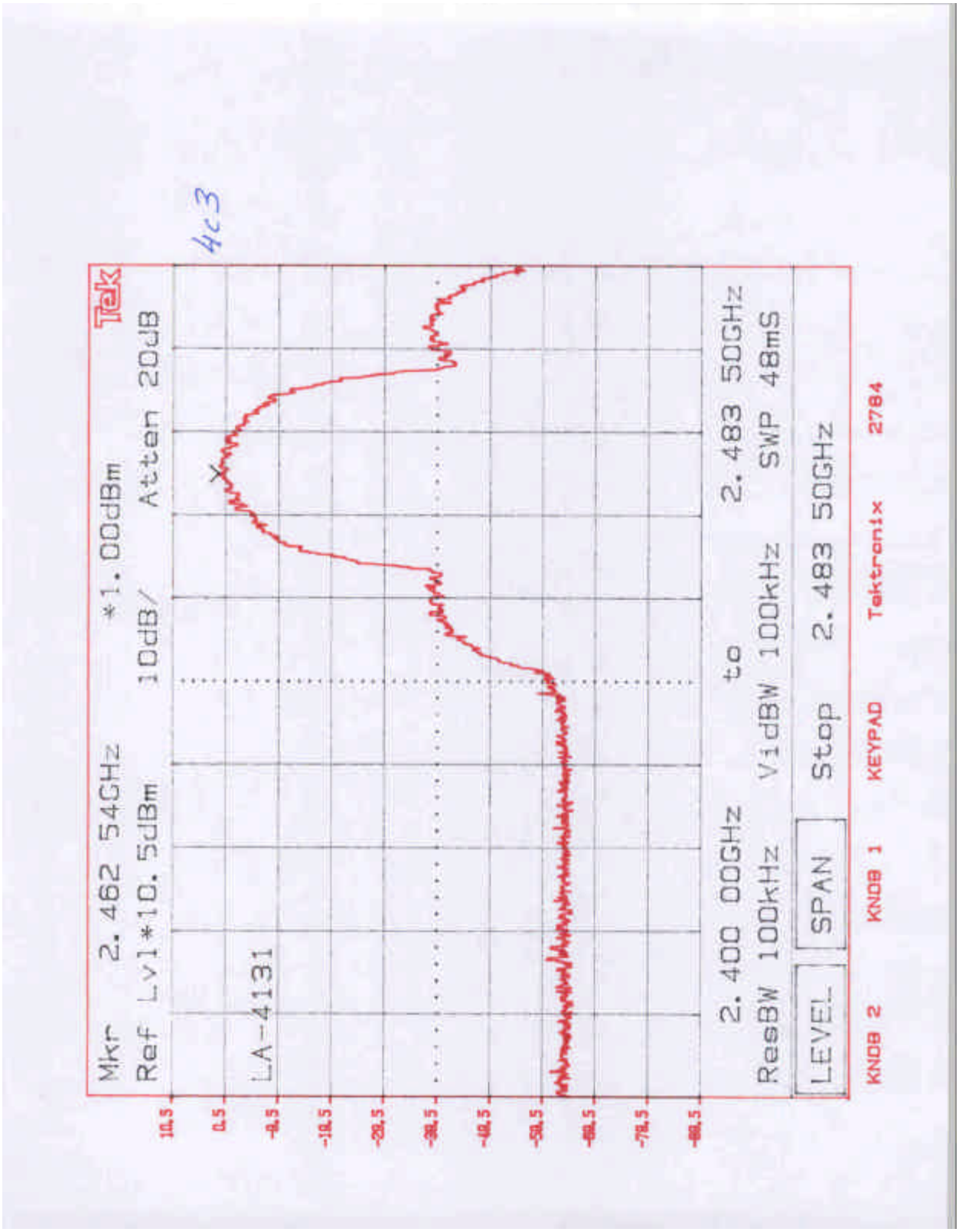

463
Tek
Mkr 2.437 32GHz *0.00dBm
Ref Lvl*10.5dBm 10dB/ Atten 20dB
LA-4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
2.400 00GHz to 2.483 50GHz
ResBW 100kHz VidBW 100kHz SWP 48mS
LEVEL SPAN Stop 2.483 50GHz
KNOB 2 KNOB 1 KEYPAD Tektronix 2784

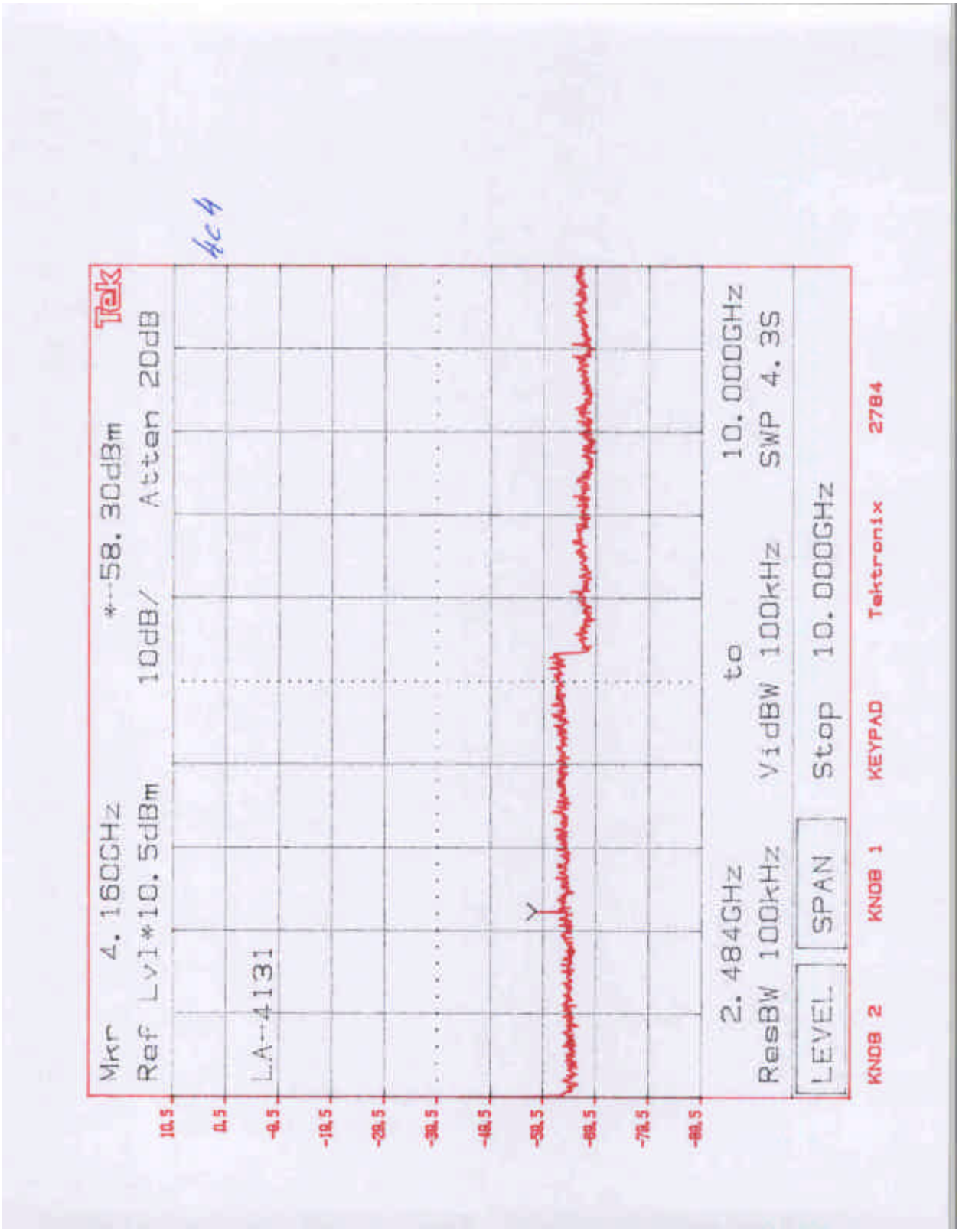

Mkr 4.115GHz
*-57.10dBm
Ref Lvl +10.5dBm
10dB/
Atten 20dB
LA-4131
2.484GHz
ResBW 100kHz
VidBW 100kHz
Stop 10.000GHz
10.000GHz
SWP 4.3S
LEVEL
SPAN
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784
Tek
464

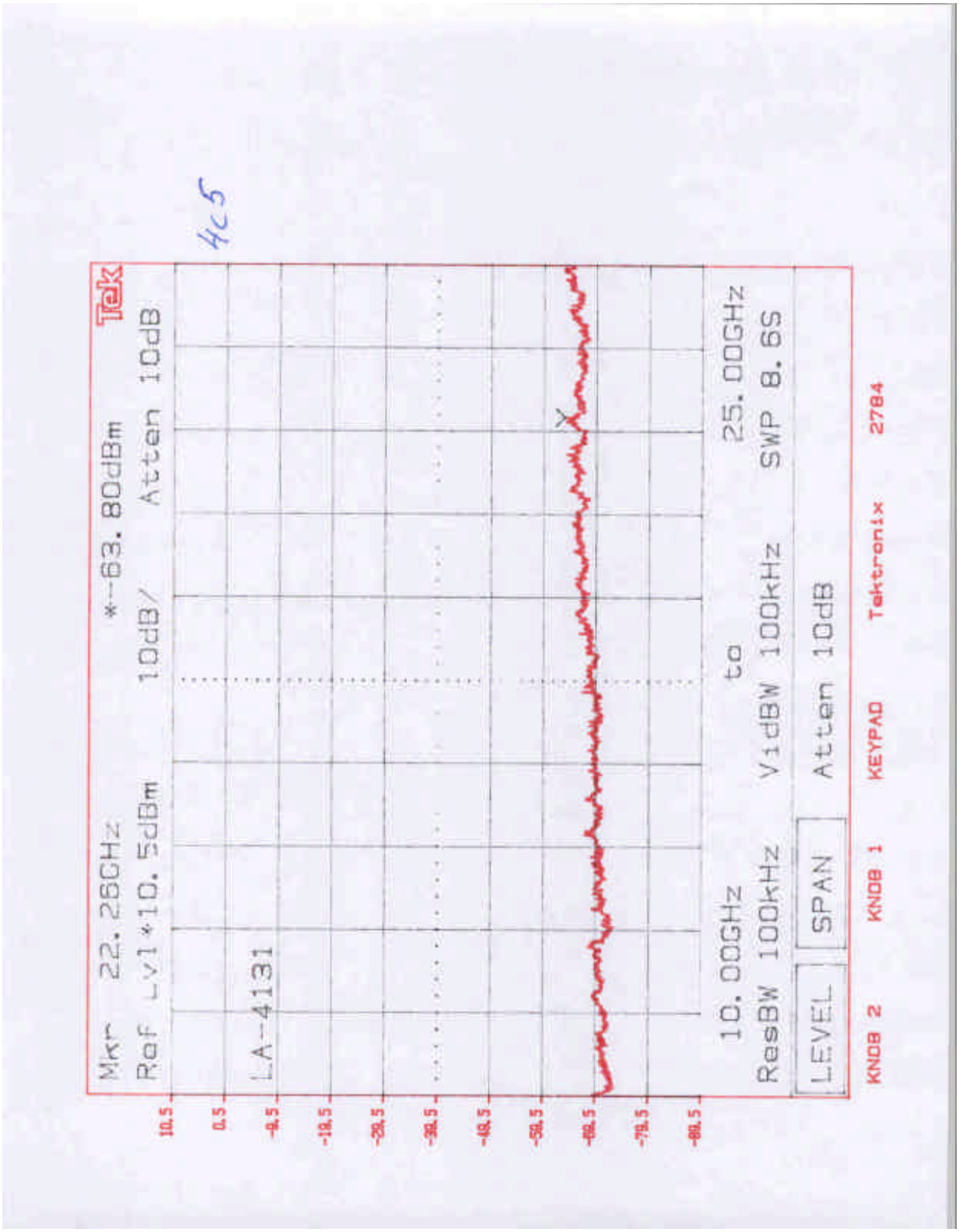

485
Tek
Mkr 21.21GHz
*-64.00dBm
Ref Lvl*10.5dBm
10dB/
Atten 10dB
LA-4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
10.00GHz
ResBW 100kHz
to
25.00GHz
VidBW 100kHz
SWP 8.6S
LEVEL
SPAN
Atten 10dB
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784


4c1
Tek
Mkr 179.4MHz
Ref Lvl*10.5dBm
*-64.70dBm
10dB/
Atten 10dB
LA-4131
30.0MHz
ResBW 100kHz
to
1.000 0GHz
VidBW 100kHz
SWP 550mS
LEVEL
SPAN
TRIG
0 %
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5


4 c 2
Tek
Mkr 2.358GHz
Ref Lvl*10.5dBm
*-51.40dBm
10dB/
Atten 20dB
LA-4131
1.000GHz
to
2.400GHz
ResBW 100kHz
VidBW 100kHz
SWP 800mS
LEVEL
SPAN
Atten 20dB
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784


4c3
Tek
Mkr 2.462 54GHz *1.00dBm
Ref Lvl*10.5dBm 10dB/ Atten 20dB
LA-4131
2.400 00GHz to 2.483 50GHz
ResBW 100kHz VidBW 100kHz SWP 48mS
LEVEL SPAN Stop 2.483 50GHz
KNOB 2 KNOB 1 KEYPAD Tektronix 2784
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5


Tek
Mkr 4.160GHz
Ref Lvl*10.5dBm
*-58.30dBm
10dB/ Atten 20dB
LA-4131
4c 4
2.484GHz
ResBW 100kHz
to
10.000GHz
VidBW 100kHz
SWP 4.3S
LEVEL
SPAN
Stop 10.000GHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784


4c5
Tek
Mkr 22.280Hz
*-63.80dBm
Ref Lvl *10.5dBm 10dB/ Atten 10dB
LA-4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
10.00GHz
ResBW 100kHz
to
25.00GHz
VidBW 100kHz SWP 8.6S
LEVEL
SPAN
Atten 10dB
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784

4.6 Transmitter Radiated Emissions in Restricted Bands
FCC Rules: 15.247 (c), 15.205, 15.209, 15.35

Radiated emission measurements were performed from 30 MHz to 25000 MHz.

For radiated emission tests, the analyzer setting was as followings:

	RES BW	VID BW	
Frequency <1 GHz	100 kHz	100 kHz	
Frequency ≥1 GHz	1 MHz	1 MHz	(Peak measurements)
	1 MHz	10 Hz	(Average measurements)
	or 1 MHz	≥ 1 MHz with sampling	(Average measurements)

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels).

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

The field strength at the band-edge frequencies was calculated as $E_F = E_o - \Delta$.

Where:

E_F = Field Strength at bandedge frequency, dBuV/m
E_O = Field Strength at fundamental frequency , dBuV/m
Δ = Delta between output power at fundamental frequency and at band-edge frequency.

Refer to following data sheets and plots 6.1 – 6.7 for details.

Fundamental Frequency, MHz	Average FS at fundamental frequency, dBuV/m	Minimum Delta, dB	Calculated Average FS in restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz, dBuV/m *	Average FS Limit in restricted bands, dBuV/m	Plot number
2412	101.4	65.0	36.4	54.0	6.1
2437	103.4	59.3	44.1	54.0	6.4
2462	104.0	57.8	46.2	54.0	6.5

* Worst case calculated
FS – Field Strength

Radiated Emissions Test Data

Company:	Symbol	**Model #:**	LA4131	**Standard**	**FCC § 15.247 (R.B.)**
EUT:	LA4131 with IEC T2 antenna	**FCC ID**	H9PLA4131P	**Limits**	11
Project #:	J20036369	**Test Date:**	May 15, 2001	**Test Distance**	3 meters
Test Mode:	Tx @ 2412 MHz	**Engineer:**	Suresh K.	**Duty Relaxation**	0 dB

	Antenna Used			Pre-Amp Used			Cable Used			Transducer Used
Number:	2	21	8	10	8	13	12	0	0	0
Model:	EMCO 3143	3160-9	EMCO 3115	AFT18855	CDI_P1000	ACO/400	green	None	None	None

Frequency	Reading	Detector	Ant.	Amp.	Ant. Pol.	Ant. Factor	Pre-Amp	Insert. Loss	D. C. F.	Net	Limit @3m	Margin
MHz	dB(µV)	P/A/Q	#	#	H/V	dB(1/m)	dB	dB	dB	dB(µV/m)	dB(µV/m)	dB
2412.0	79.2	Peak	8	0	V	29.1	0.0	2.3	0.0	110.6	-	-
2412.0	70.0	Ave.	8	0	V	29.1	0.0	2.3	0.0	101.4	-	-
4824.1	41.1	Peak	8	8	V	34.0	28.1	3.2	0.0	50.2	74.0	-23.8
4824.1	34.3	Ave.	8	8	V	34.0	28.1	3.2	0.0	43.4	54.0	-10.6
7235.0	36.2	Peak	8	8	V	37.0	28.0	4.3	0.0	49.5	74.0	-24.5
7235.0	27.0	Ave.	8	8	V	37.0	28.0	4.3	0.0	40.3	54.0	-13.7
9647.9	33.7	Peak	8	8	V	38.5	27.3	5.0	0.0	49.9	74.0	-24.1
9647.9	23.6	Ave.	8	10	V	38.5	27.3	5.0	0.0	39.8	54.0	-14.2
12060	43.1	Peak	8	10	V	41.6	39.1	5.9	0.0	51.5	74.0	-22.5
12060	33.0	Ave.	8	10	V	41.6	39.1	5.9	0.0	41.4	54.0	-12.6
14472	38.8	Peak	8	10	V	40.7	37.8	6.5	0.0	48.2	74.0	-25.8
14472	27.4	Ave.	8	10	V	40.7	37.8	6.5	0.0	36.8	54.0	-17.2
16884	38.9	Peak	8	10	V	40.8	39.4	7.2	0.0	47.5	74.0	-26.5
16884	27.7	Ave.	8	10	V	40.8	39.4	7.2	0.0	36.3	54.0	-17.7
19296	32.9	Peak	21	13	V	40.2	23.3	7.0	-9.5	47.3	74.0	-26.7
19296	23.0	Ave.	21	13	V	40.2	23.3	7.0	-9.5	37.4	54.0	-16.6
21708	38.6	Peak	21	13	V	40.3	23.3	7.2	-9.5	53.3	74.0	-20.7
21708	29.0	Ave.	21	13	V	40.3	23.3	7.2	-9.5	43.7	54.0	-10.3
24120	39.7	Peak	21	13	V	40.4	24.2	7.7	-9.5	54.1	74.0	-19.9
24120	30.0	Ave.	21	13	V	40.4	24.2	7.7	-9.5	44.4	54.0	-9.6

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 10 dB below the limits.
	f) All emissions above 18 GHz were measured at 1 m distance.

Radiated Emissions Test Data

Company:	Symbol	**Model #:**	LA4131	**Standard**	**FCC § 15.247 (R.B.)**
EUT:	LA4131 with IEC T2 antenna	**FCC ID**	H9PLA4131P	**Limits**	11
Project #:	J20036369	**Test Date:**	May 15. 2001	**Test Distance**	3 meters
Test Mode:	Tx @ 2437 MHz	**Engineer:**	Suresh K.	**Duty Relaxation**	0 dB

	Antenna Used			Pre-Amp Used			Cable Used			Transducer Used
Number:	2	21	8	10	8	13	12	0	0	0
Model:	EMCO 3143	3160-9	EMCO 3115	AFT18855	CDI_P1000	ACO/400	NPS366	None	None	None

Frequency	Reading	Detector	Ant	Amp.	Ant. Pol.	Ant. Factor	Pre-Amp	Insert. Loss	D. C. F.	Net	Limit @3m	Margin
MHz	dB(µV)	P/A/Q	#	#	H/V	dB(1/m)	dB	dB	dB	dB(µV/m)	dB(µV/m)	dB
2437.0	80.6	Peak	14	0	V	30.1	0.0	2.3	0.0	113.0	-	-
2437.0	71.0	Avg	14	0	V	30.1	0.0	2.3	0.0	103.4	-	-
4874.0	44.9	Peak	14	8	V	33.9	28.1	3.2	0.0	53.9	74.0	-20.1
4874.0	34.6	Ave.	14	8	V	33.9	28.1	3.2	0.0	43.6	54.0	-10.4
7311.0	35.1	Peak	14	8	V	38.0	28.0	4.3	0.0	49.4	74.0	-24.6
7311.0	25.6	Ave.	14	8	V	38.0	28.0	4.3	0.0	39.9	54.0	-14.1
9748.0	33.2	Peak	14	8	V	38.3	27.3	5.0	0.0	49.2	74.0	-24.8
9748.0	21.1	Ave.	14	8	V	38.3	27.3	5.0	0.0	37.1	54.0	-16.9
12185	40.3	Peak	14	10	V	42.3	39.1	5.9	0.0	49.4	74.0	-24.6
12185	28.7	Ave.	14	10	V	42.3	39.1	5.9	0.0	37.8	54.0	-16.2
14622	37.5	Peak	14	10	V	41.1	37.4	6.8	0.0	48.0	74.0	-26.0
14622	26.5	Ave.	14	10	V	41.1	37.4	6.8	0.0	37.0	54.0	-17.0
17059	38.8	Peak	14	10	V	42.2	38.8	7.5	0.0	49.7	74.0	-24.3
17059	27.5	Ave.	14	10	V	42.2	38.8	7.5	0.0	38.4	54.0	-15.6
19496	32.9	Peak	21	13	V	40.3	23.3	7.0	-9.5	47.4	74.0	-26.6
19496	23.1	Ave.	21	13	V	40.3	23.3	7.0	-9.5	37.6	54.0	-16.4
21933	38.6	Peak	21	13	V	40.3	23.3	7.2	-9.5	53.3	74.0	-20.7
21933	29.3	Ave.	21	13	V	40.3	23.3	7.2	-9.5	44.0	54.0	-10.0
24370	39.7	Peak	21	13	V	40.4	24.2	7.7	-9.5	54.1	74.0	-19.9
24370	30.0	Ave.	21	13	V	40.4	24.2	7.7	-9.5	44.4	54.0	-9.6

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 10 dB below the limits.
	f) All emissions above 18 GHz were measured at 1 m distance.

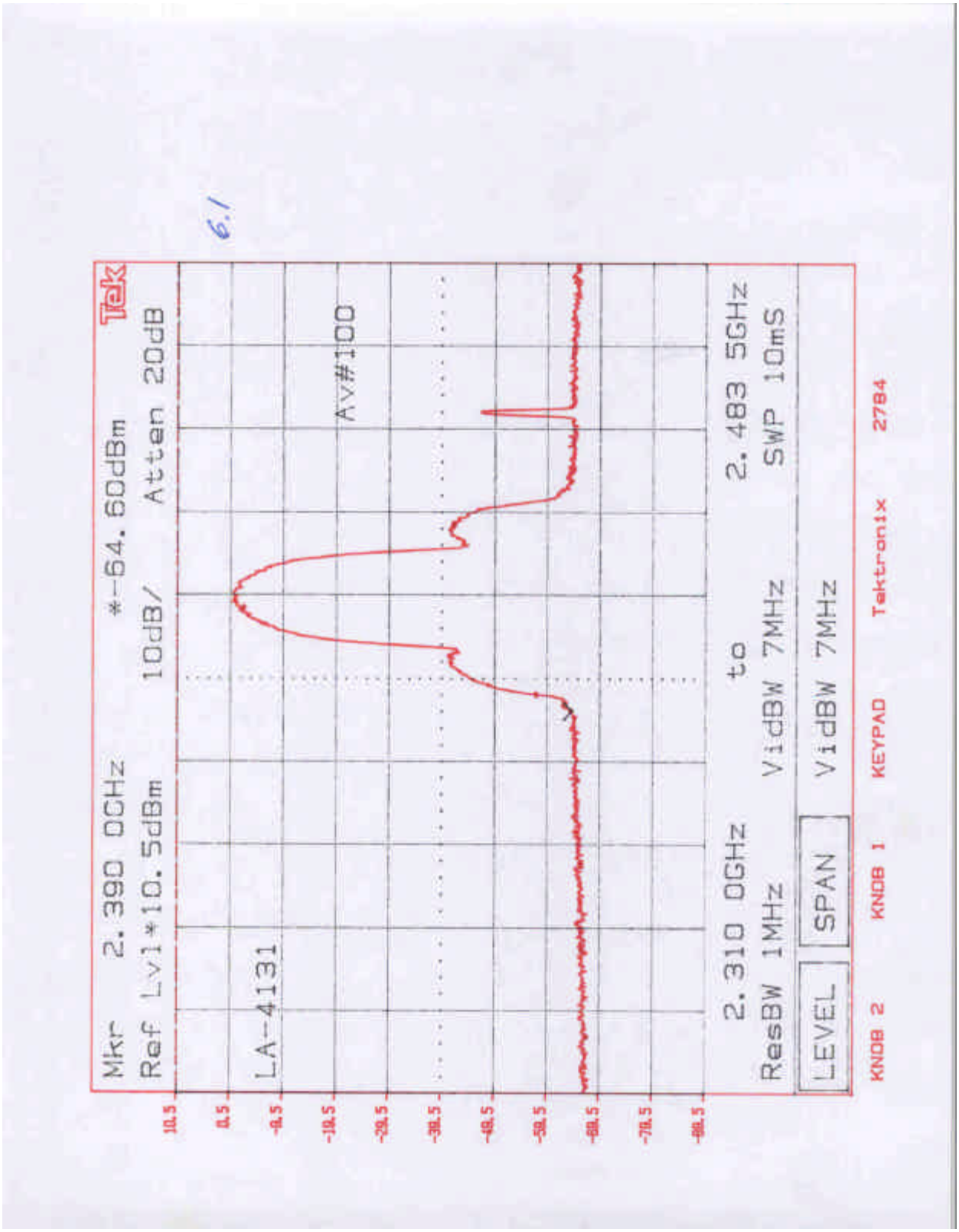
Radiated Emissions Test Data

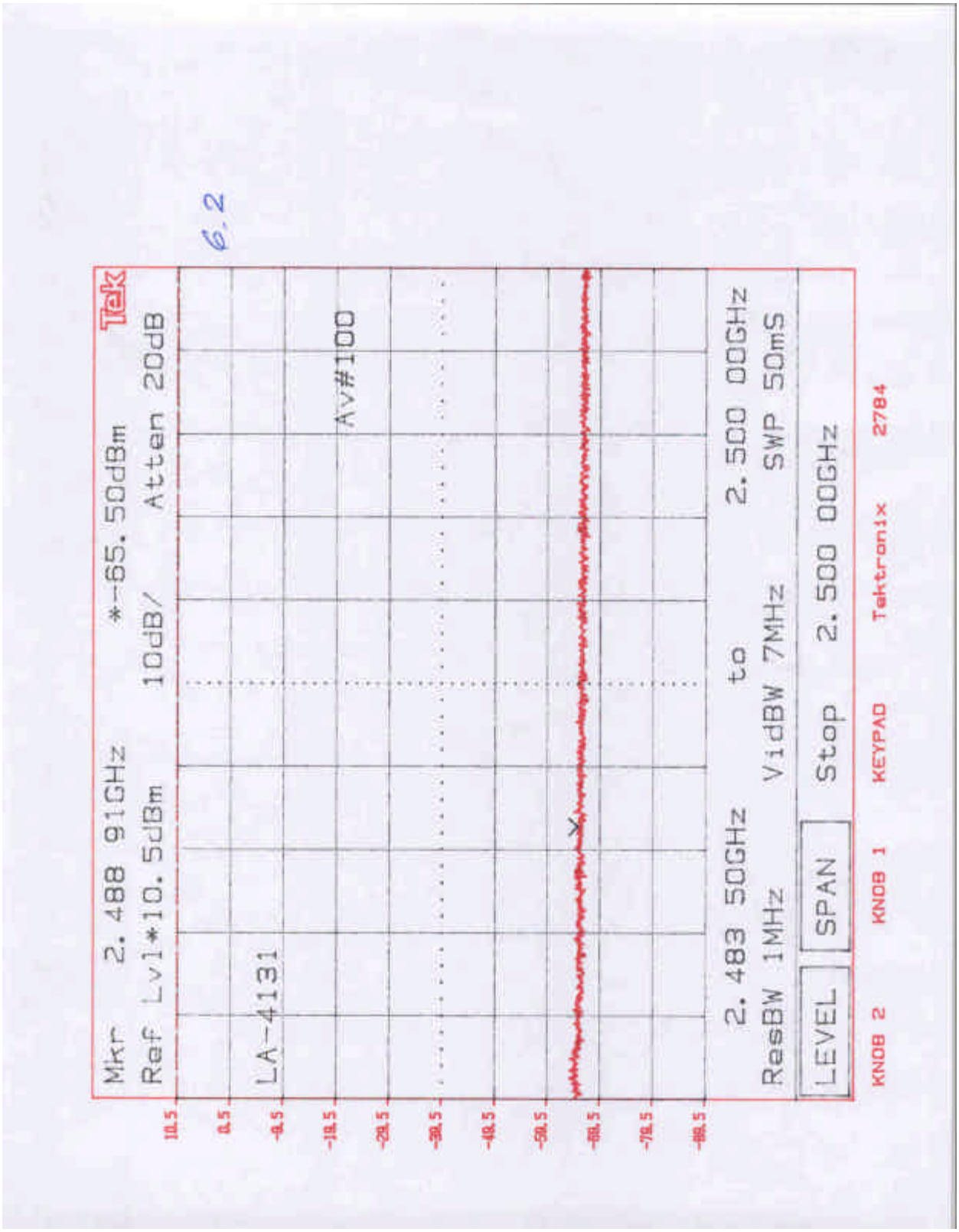
Company:	Symbol	**Model #:**	LA4131	**Standard**	**FCC § 15.247 (R.B.)**
EUT:	LA4131 with IEC T2 antenna	**FCC ID**	H9PLA4131P	**Limits**	11
Project #:	J20036369	**Test Date:**	May, 15, 2001	**Test Distance**	3 meters
Test Mode:	Tx @ 2462 MHz	**Engineer:**	Suresh K.	**Duty Relaxation**	0 dB

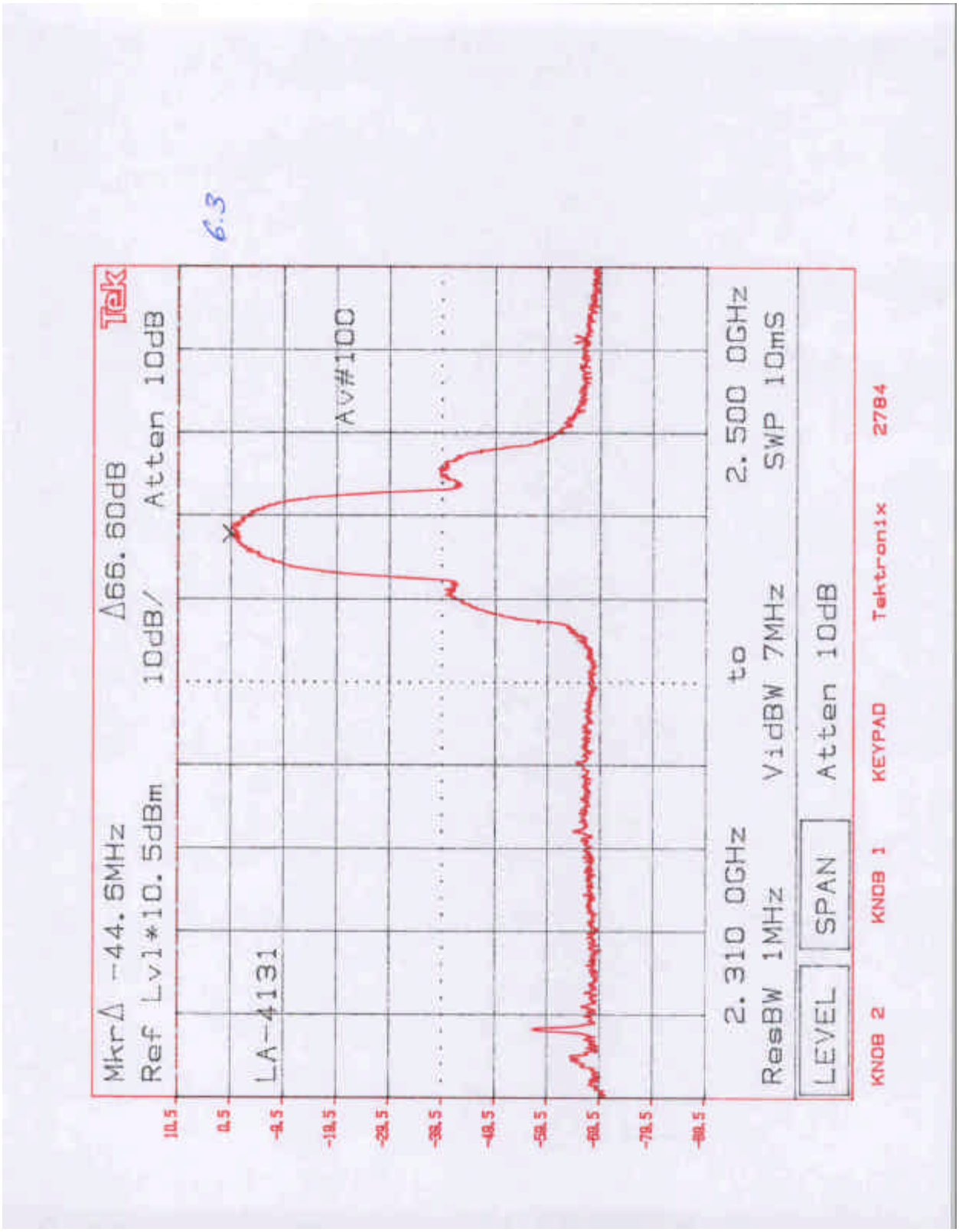
	Antenna Used			Pre-Amp Used			Cable Used			Transducer Used
Number:	2	21	8	10	8	13	12	0	0	0
Model:	EMCO 3143	3160-9	EMCO 3115	AFT18855	CDI_P1000	ACO/400	NPS366	None	None	None

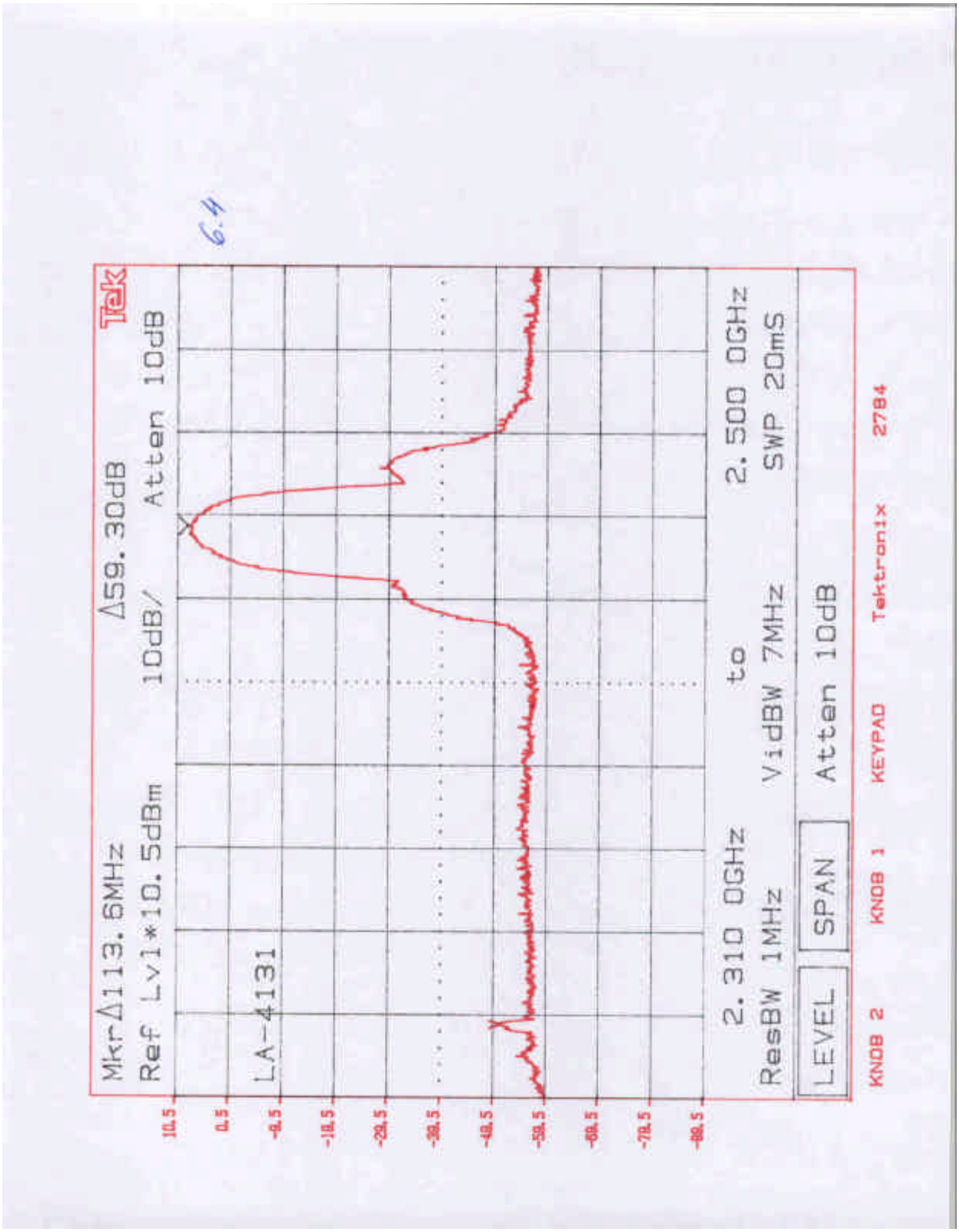
Frequency	Reading	Detector	Ant	Amp.	Ant. Pol.	Ant. Factor	Pre-Amp	Insert. Loss	D. C. F.	Net	Limit @3m	Margin
MHz	dB(µV)	P/A/Q	#	#	H/V	dB(1/m)	dB	dB	dB	dB(µV/m)	dB(µV/m)	dB
2462.0	80.6	Peak	14	0	V	30.1	0.0	2.3	0.0	113.0	-	-
2462.0	72.2	Ave	14	0	V	30.1	0.0	2.3	0.0	104.0	-	-
4924.0	40.6	Peak	14	8	V	33.9	28.1	3.2	0.0	49.6	74.0	-24.4
4924.0	32.6	Ave.	14	8	V	33.9	28.1	3.2	0.0	41.6	54.0	-12.4
7386.0	32.3	Peak	14	8	V	38.0	28.0	4.3	0.0	46.6	74.0	-27.4
7386.0	21.1	Ave.	14	8	V	38.0	28.0	4.3	0.0	35.4	54.0	-18.6
9848.0	32.3	Peak	14	8	V	38.3	27.6	5.0	0.0	48.0	74.0	-26.0
9848.0	21.0	Ave.	14	8	V	38.3	27.6	5.0	0.0	36.7	54.0	-17.3
12310	41.2	Peak	14	10	V	42.3	39.1	5.9	0.0	50.3	74.0	-23.7
12310	29.4	Ave.	14	10	V	42.3	39.1	5.9	0.0	38.5	54.0	-15.5
14772	39.4	Peak	14	10	V	41.1	37.4	6.8	0.0	49.9	74.0	-24.1
14772	27.3	Ave.	14	10	V	41.1	37.4	6.8	0.0	37.8	54.0	-16.2
17234	38.6	Peak	14	10	V	42.2	38.8	7.5	0.0	49.5	74.0	-24.5
17234	27.5	Ave.	14	10	V	42.2	38.8	7.5	0.0	38.4	54.0	-15.6
19696	32.9	Peak	21	13	H	40.3	23.3	7.0	-9.5	47.4	74.0	-26.6
19696	23.0	Ave.	21	13	H	40.3	23.3	7.0	-9.5	37.5	54.0	-16.5
22158	38.6	Peak	21	13	V	40.3	23.3	7.2	-9.5	53.3	74.0	-20.7
22158	29.0	Ave.	21	13	V	40.3	23.3	7.2	-9.5	43.7	54.0	-10.3
24620	39.7	Peak	21	13	H	40.4	24.2	7.7	-9.5	54.1	74.0	-19.9
24620	30.0	Ave.	21	13	H	40.4	24.2	7.7	-9.5	44.4	54.0	-9.6

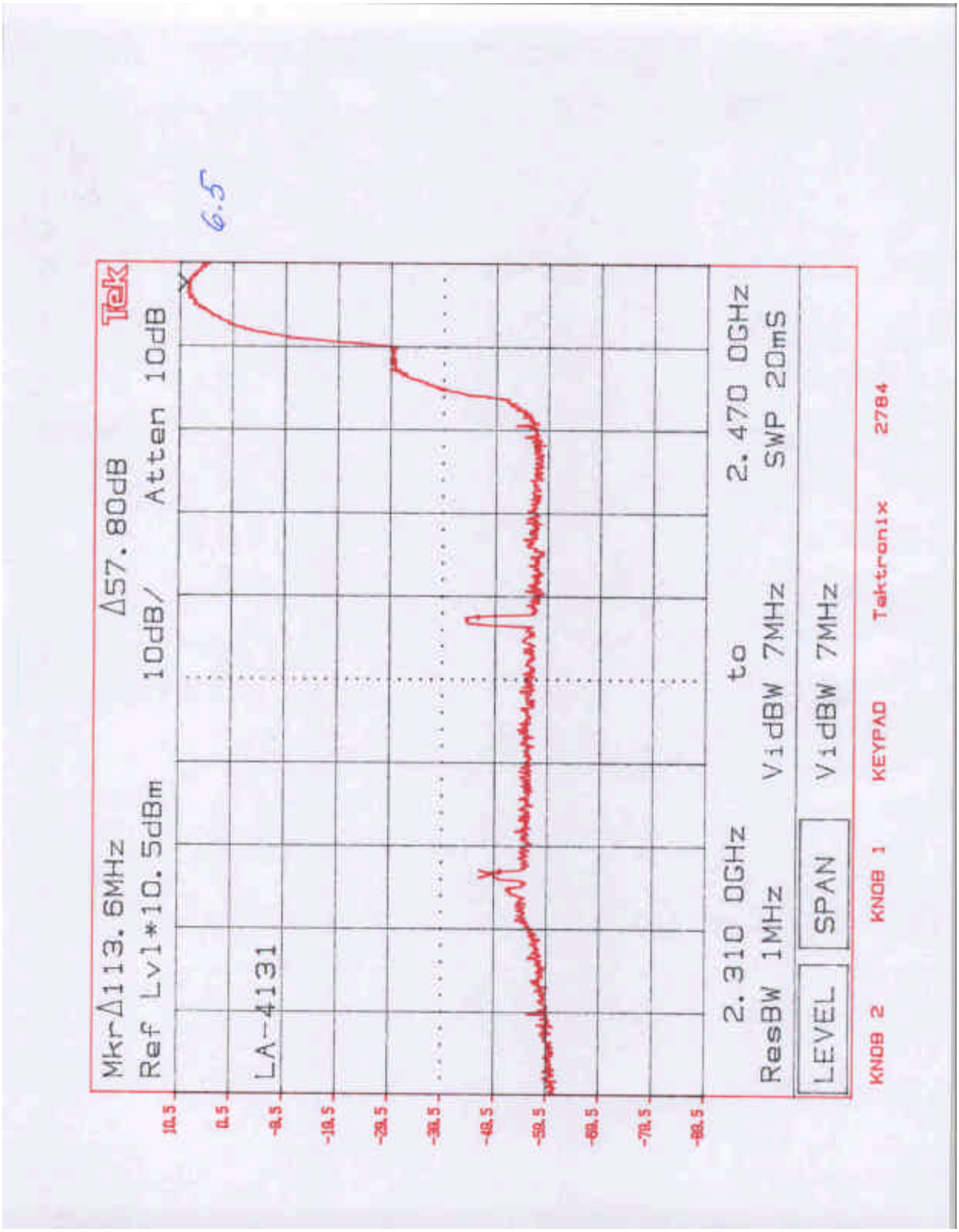
Notes:	
	a) D.C.F.:Distance Correction Factor
	b) Insert. Loss (dB) = Cable A + Cable B + Cable C .
	c) Net (dB) = Reading + Antenna Factor - Pre-amp + Insert. Loss. - Transducer Loss - Duty Relaxation (transmitter only).
	d) Negative signs (-) in Margin column signify levels below the limits.
	e) All other emissions not reported are below the equipment noise floor which is at least 10 dB below the limits.
	f) All emissions above 18 GHz were measured at 1 m distance.

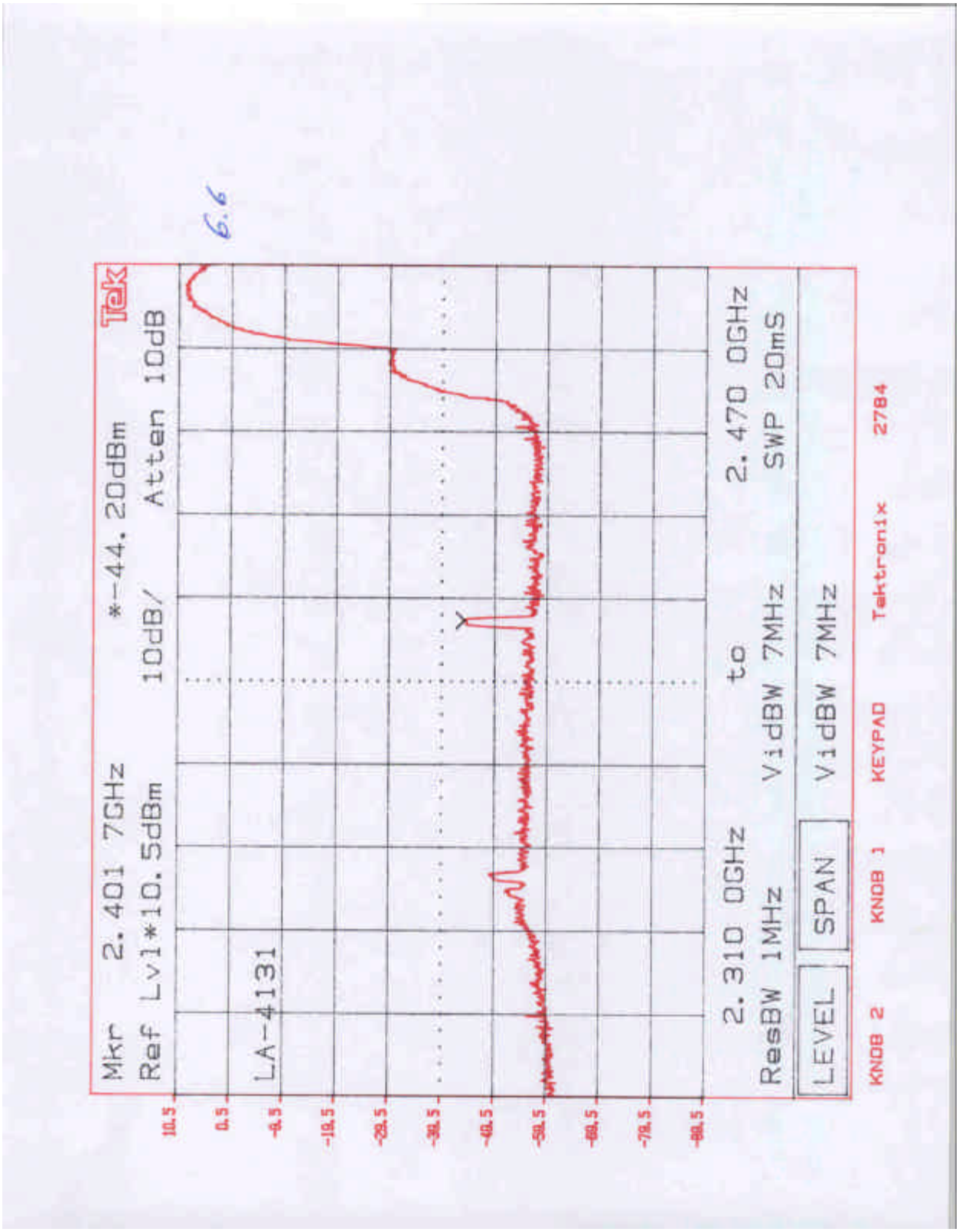

6.1
Tek
Mkr 2.390 00GHz
Ref Lvl *10.5dBm
*-64.60dBm
10dB/ Atten 20dB
AV#100
LA-4131
2.310 0GHz
ResBW 1MHz
to
2.483 5GHz
VidBW 7MHz
SWP 10mS
VidBW 7MHz
LEVEL
SPAN
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784

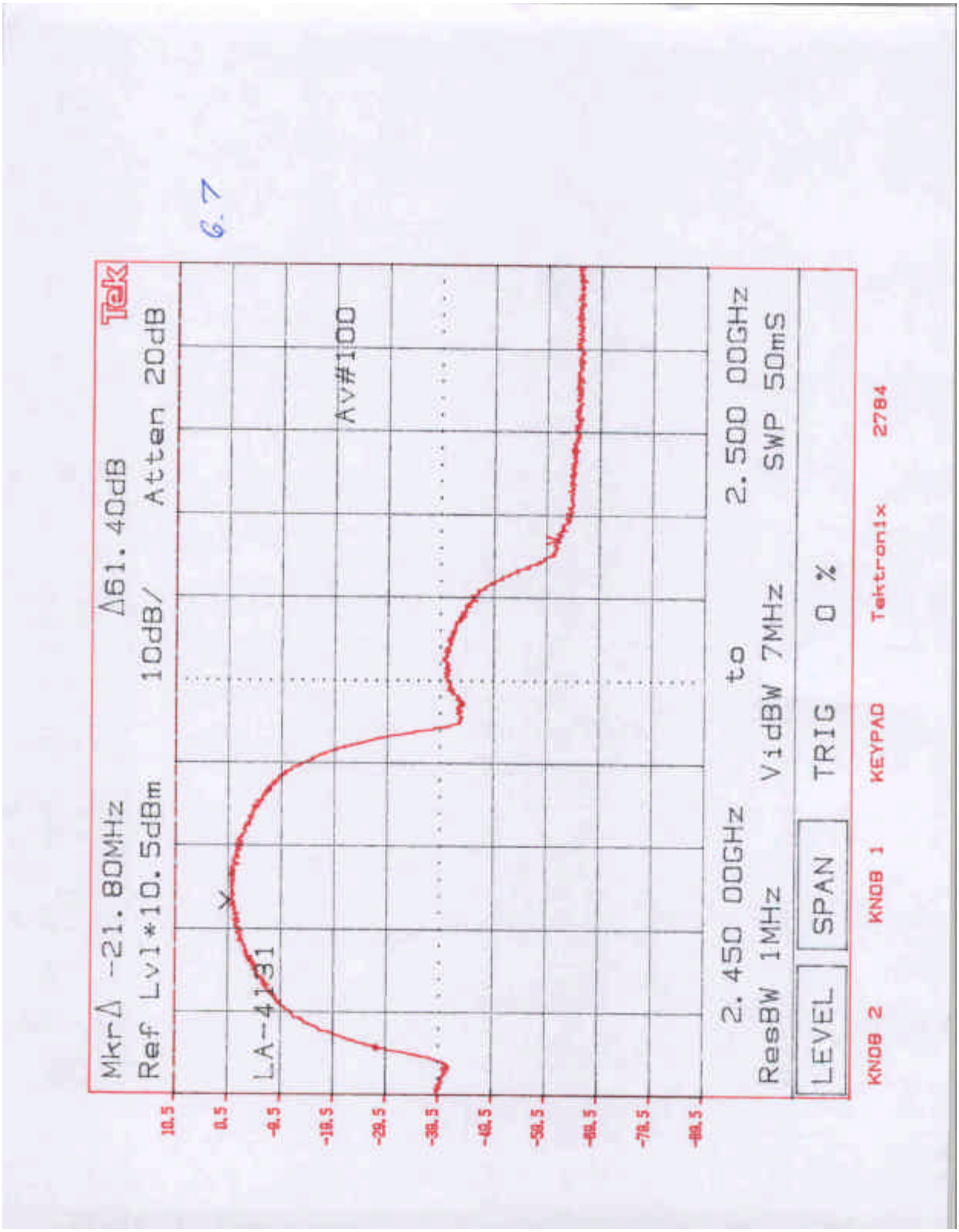

6.2
Tek
Mkr 2.488 91GHz
Ref Lvl*10.5dBm
*-65.50dBm
10dB/ Atten 20dB
LA-4131
Av#100
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
2.483 50GHz
ResBW 1MHz
to
VidBW 7MHz
2.500 00GHz
SWP 50mS
LEVEL
SPAN
Stop 2.500 00GHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784


6.3
Tek
MkrΔ -44.6MHz
Ref Lvl*10.5dBm
Δ66.60dB
10dB/
Atten 10dB
LA-4131
Av#100
2.310 0GHz
ResBW 1MHz
to
2.500 0GHz
VidBW 7MHz
SWP 10mS
LEVEL
SPAN
Atten 10dB
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5


6.4
Tek
Mkr Δ113.6MHz
Ref Lvl *10.5dBm
Δ59.30dB
10dB/
Atten 10dB
LA-4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
2.310 0GHz
ResBW 1MHz
to
2.500 0GHz
VidBW 7MHz
SWP 20mS
LEVEL
SPAN
Atten 10dB
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784


6.5
Tek
Mkr-Δ113.6MHz
Ref Lvl*10.5dBm
Δ57.80dB
10dB/
Atten 10dB
LA-4131
2.310 0GHz
ResBW 1MHz
to
2.470 0GHz
VidBW 7MHz
SWP 20mS
VidBW 7MHz
LEVEL
SPAN
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5

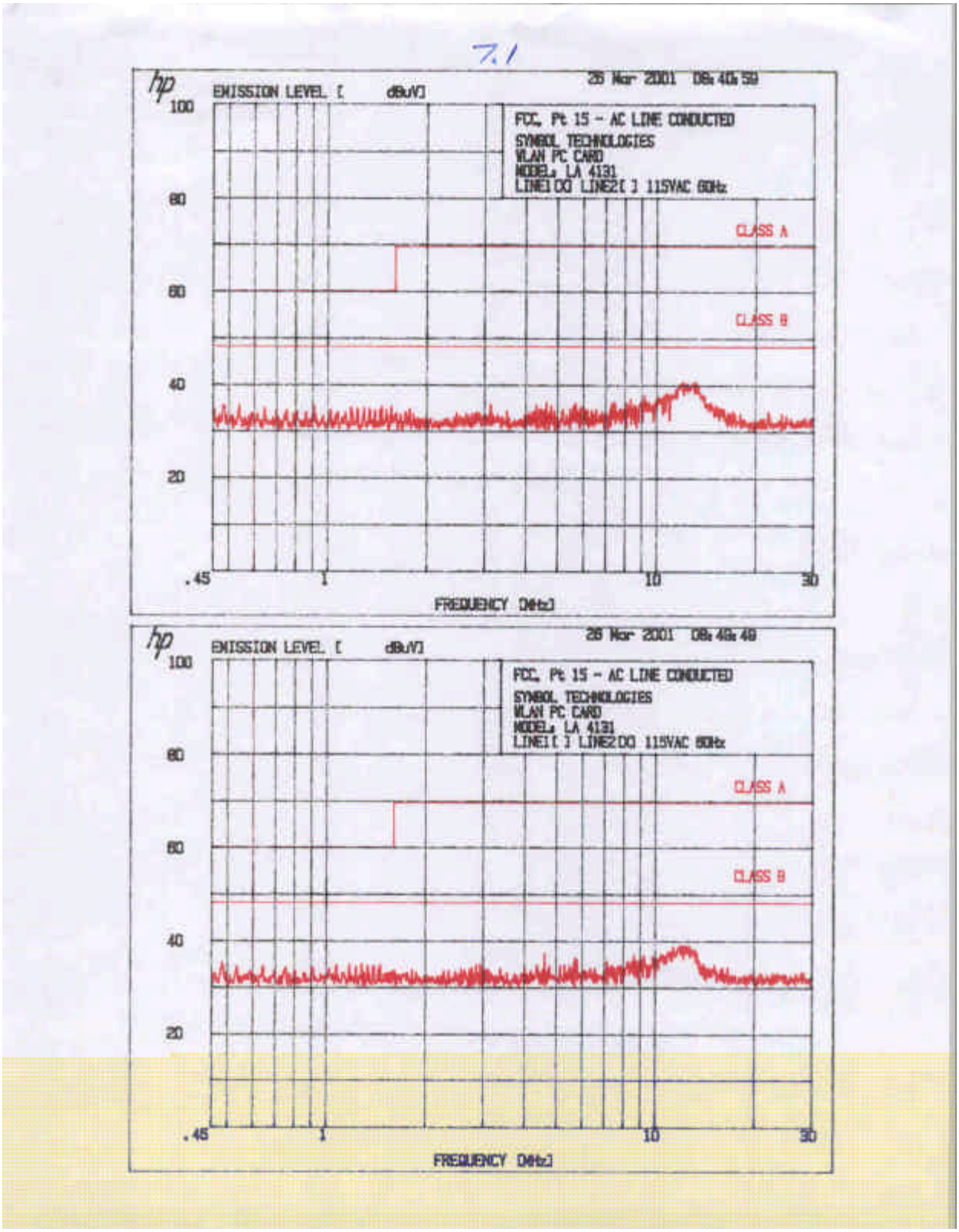

6.6
Tek
Mkr 2.401 7GHz
Ref Lvl*10.5dBm
*-44.20dBm
10dB/
Atten 10dB
LA-4131
10.5
0.5
-9.5
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-79.5
-89.5
2.310 0GHz
ResBW 1MHz
to
VidBW 7MHz
2.470 0GHz
SWP 20mS
LEVEL
SPAN
VidBW 7MHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784


6.7
Tek
Mkr-Δ -21.80MHz
Ref Lvl*10.5dBm
Δ61.40dB
10dB/
Atten 20dB
AV#100
LA-4131
2.450 00GHz
ResBW 1MHz
to
2.500 00GHz
VidBW 7MHz
SWP 50mS
LEVEL
SPAN
TRIG
0 %
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784

4.7 AC Line Conducted Emission
FCC Rule 15.207:

AC line conducted emission test was performed according the ANSI C63.4 standard. The EUT was connected to AC Line through the LISNs.

For the test result, see attached plot 7.1.


7.1
hp
EMISSION LEVEL [dBuV]
26 Mar 2001 08:40:59
FCC, Pt 15 - AC LINE CONDUCTED
SYMBOL TECHNOLOGIES
WLAN PC CARD
MODEL: LA 4131
LINE1:DO LINE2:[ ] 115VAC 60Hz
CLASS A
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]
hp
EMISSION LEVEL [dBuV]
26 Mar 2001 08:48:49
FCC, Pt 15 - AC LINE CONDUCTED
SYMBOL TECHNOLOGIES
WLAN PC CARD
MODEL: LA 4131
LINE1:[ ] LINE2:DO 115VAC 60Hz
CLASS A
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

4.8 Radiated Emissions from Digital Section of Transceiver (Transmitter)
FCC Ref: 15.109

See separate DoC report.

4.9 Radiated Emissions from Receiver Section of Transceiver (L.O. Radiation)
FCC Ref: 15.109, 15.111

Not required - EUT operation above 960 MHz only.

5.0 List of test Equipment

EQUIPMENT	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CAL. INTERVAL	CAL. DUE
Spectrum Analyzer w/85650 QP Adapter	Hewlett Packard	8566B	2416A00317 2043A00251	12	4/6/02
Spectrum Analyzer w/85650 QP Adapter	Hewlett Packard	8568B	1912A0053 2521A01021	12	2/23/02
Spectrum Analyzer	Tektronix	2784	B3020108	12	8/4/01
Double-ridged Horn Antenna	EMCO	3115	9107-3712	12	3/17/02
Horn Antenna	EMCO	3160-09	-	#	#
Pre-Amplifier	CDI	P950	ITS009	12	10/6/01
Pre-Amplifier	CDI	P1000	N/A	12	10/06/01
Pre-Amplifier	Avantek	AFT-18855	8723H705	12	10/5/01
Pre-amplifier	CTT	ACO/400	47526	12	10/5/01
Power Meter	Hewlett Packard	8900D	3607U00673	12	7/31/01

No calibration required

6.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / J20036369E	SS	May 25, 2001	Original document

Processing Gain Calculation
Symbol Technologies LA-4131
WLAN PC Card

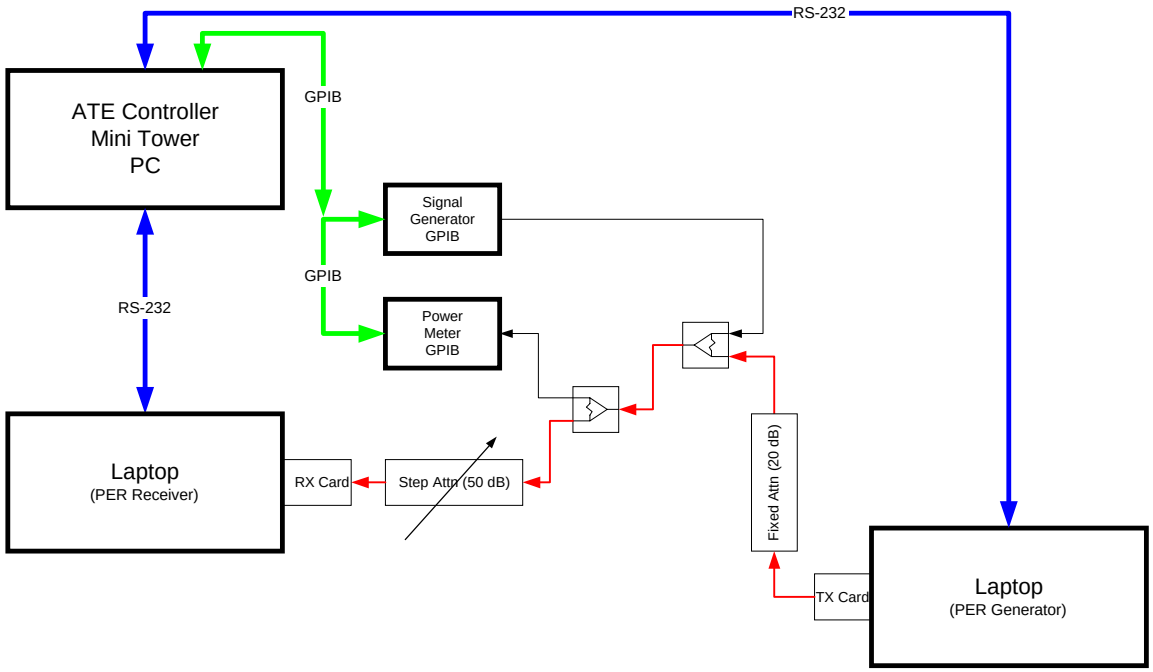
Norman H. Nelson, Sr. EMC Engineer
June 18, 2001

Symbol calculated the processing gain from the jamming margin of the LA-4121 transceiver as specified in 15.247 (e)(2).

Test Setup

The purpose of the jamming test is to determine how effective the modulation, coding and decoding is at rejecting the corrupting influence of a CW jammer signal. Where as most setups us a BER to generate data and count errors because the modulator chip architecture prevents injecting data after chipping, Symbol chose to use another LA-4121 as the transmitter and data generator. A link between the transmitter and receiver is made and path loss adjusted so that the BER is 10E-5. The path loss is then reduced by 10 dB so that the BER approaches zero. Finally a jamming signal is combined with the transmitted signal to degrade the system performance. The jamming signal amplitude is then adjusted to the point that the BER is degraded to 10E-5.

The relationship between PER and BER is as follows. In order to get a good packet we need 8 x 1024 good bits. Stated mathematically. $1\text{-PER} = (1\text{-BER})^{(8*24)}$. Or $\text{BER}=1-(1-\text{PER})^{(1/(8*1024))}$.



Jamming Margin Test Setup

The major blocks of the jamming margin test are a transmitter, a receiver, and a jammer. The TX card formats and transmits packets of data consisting of 1024 bytes

each. The RX card then attempts to read each packet. The Signal Generator provides the jamming signal. The splitters combine the TX and jammer signals and provide a port to measure the power levels within the RF link. The PER Generator Laptop controls the transmit card and the PER receiver laptop controls the receiver. The ATE PC automates the test by controlling the two laptops, the Signal Generator, and the power meter.

Software blocks

The key to this test is three software programs Packet Generator (PG), Packet Counter (PC), and Jam Margin Controller (JMC). The first to work together to form the PER measurement system and the last to control the jammer, the power meter, and the other two software blocks.

Packet Generator runs on the PG Laptop and controls the transmit card. A trigger on the serial port line commands the TX card to generate and transmit 1000 packets of 1024 bytes at a specified data rate.

Packet Counter runs on the PER receiver laptop and queries the RX card for the number of packets it has received. A trigger on the serial port causes the Packet Counter to report the number of packets to the ATE Controller and reset the Packet Counter to zero. The Packet counter automatically detects the data rate of the incoming packet stream.

The other Jamming Margin Controller (JMC) runs on the ATE PC and controls the Signal Generator, the Power Meter, and PGAC running on the Dual Slot laptop.

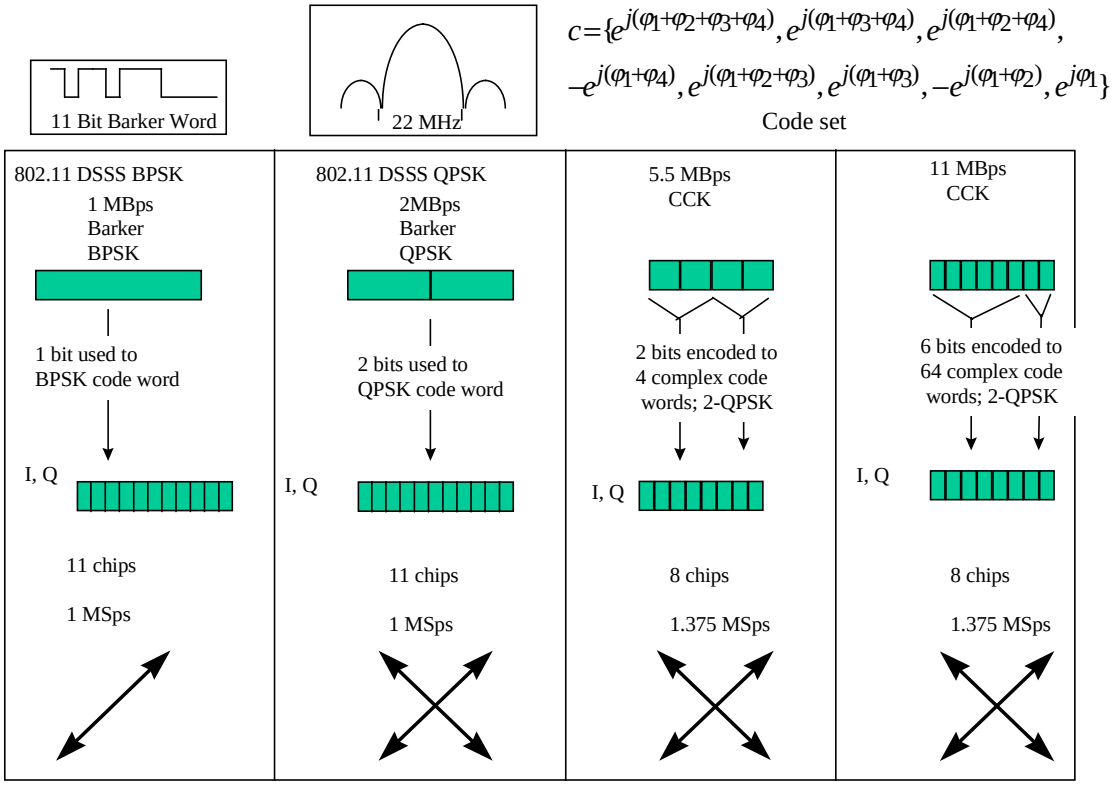
PG commands the TX card to transmit a set of 1000 packets of 1024 bytes of data. The RX card receives the packets and PC sends the number of good packets received to the serial port. The functional purpose is the same as a BER meter. A new set is run every time a new trigger is received on the serial port from JMC.

JMC controls the jammer, the power meter, and the Dual Slot program. JMC sets the frequency and level of the signal generator that acts as a jammer. JMC then sends a trigger to PG. The trigger causes PG to run another set of packets and PC reports the number of good packets back to JMC. The packet error rate is then converted to BER and JMC adjusts the Jammer level appropriately. A search algorithm is built into JMC to have the jammer converge to the right level for a 10E-5 BER. The jammer resolution is .1 dB.

When the jammer level causes a BER of 10E-5, the JMC program turns off the TX card and commands the power meter to read the jammer power level. JMC then turns off the jammer, turns on the TX card, and measures its power. Then S is offset for duty cycle and J/S is calculated from the two power measurements and recorded to disk. In this way as the test progresses and the TX card warms up power fluctuations due to temperature are referenced out.

The test is then repeated at the next jammer frequency. In this instance the test is conducted across the band of a single channel at 50KHz steps.

Data Rate and Modulation Description



Mode	Chip/Symbol
1 MBps	**11/1**
2 MBps	**11/2**
5.5 MBps	**8/2**
11 MBps	**8/8**

Gp Calculation from J/S data

Gp = E_b/ N_0 + J/S + L_{sys} Where L_{sys} <= 2 dB

Mbps	E_b/ N_0 (dB)	Gp = J/S +
1	10.6	12.6
2	10.6	12.6
5.5	15.6	17.6
11	16.6	18.6

Test Results

Attached are four plots of J/S and Gp vs F in MHz for 1, 2, 5.5 and 11 Mbps

The lower line shows the J/S as taken from the power ratios measured with the power meter. The upper line shows the processing gain G_p as calculated from the Jamming Margin data. Note that the lowest 20% of the data points were discarded as specified in 15.247 (e)(2).

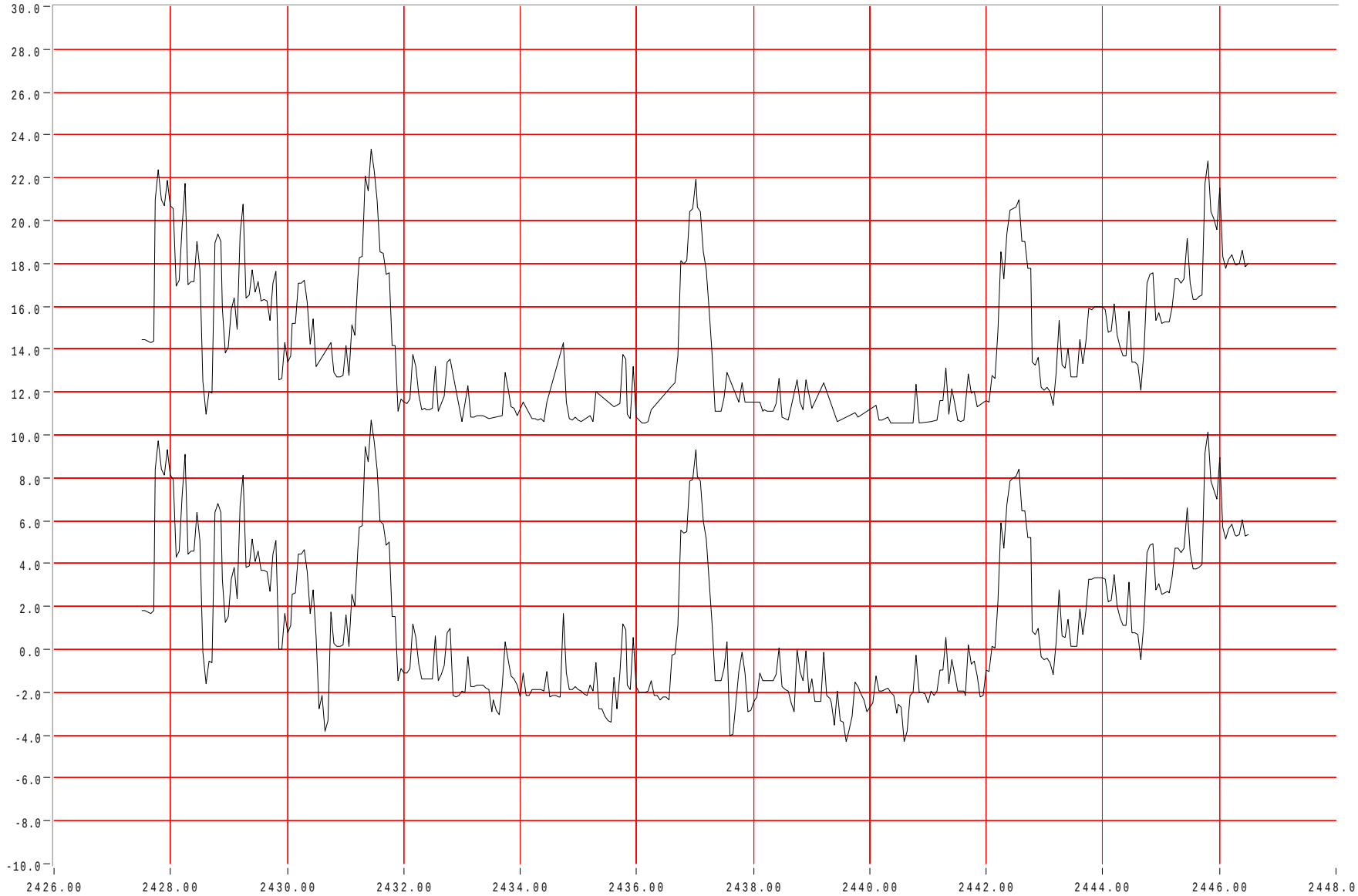
Results Table

Mode (Mbps)	Gp (dB)
1	10.56
2	10.32
5.5	11.87
11	10.68

Read from JS File.vi
G:\LabView\Project\Jamming\Read from JS File.vi
Last modified on 3/23/01 at 4:04 PM
Printed on 3/23/01 at 4:04 PM

File LA4131 1 Mbps.dat

LA-4131 Processing Gain Plot: 1 Mbps



	MHz	Gp
min value	2436.15	10.56

Raw J/S
Gp

Gp Offset 12.60

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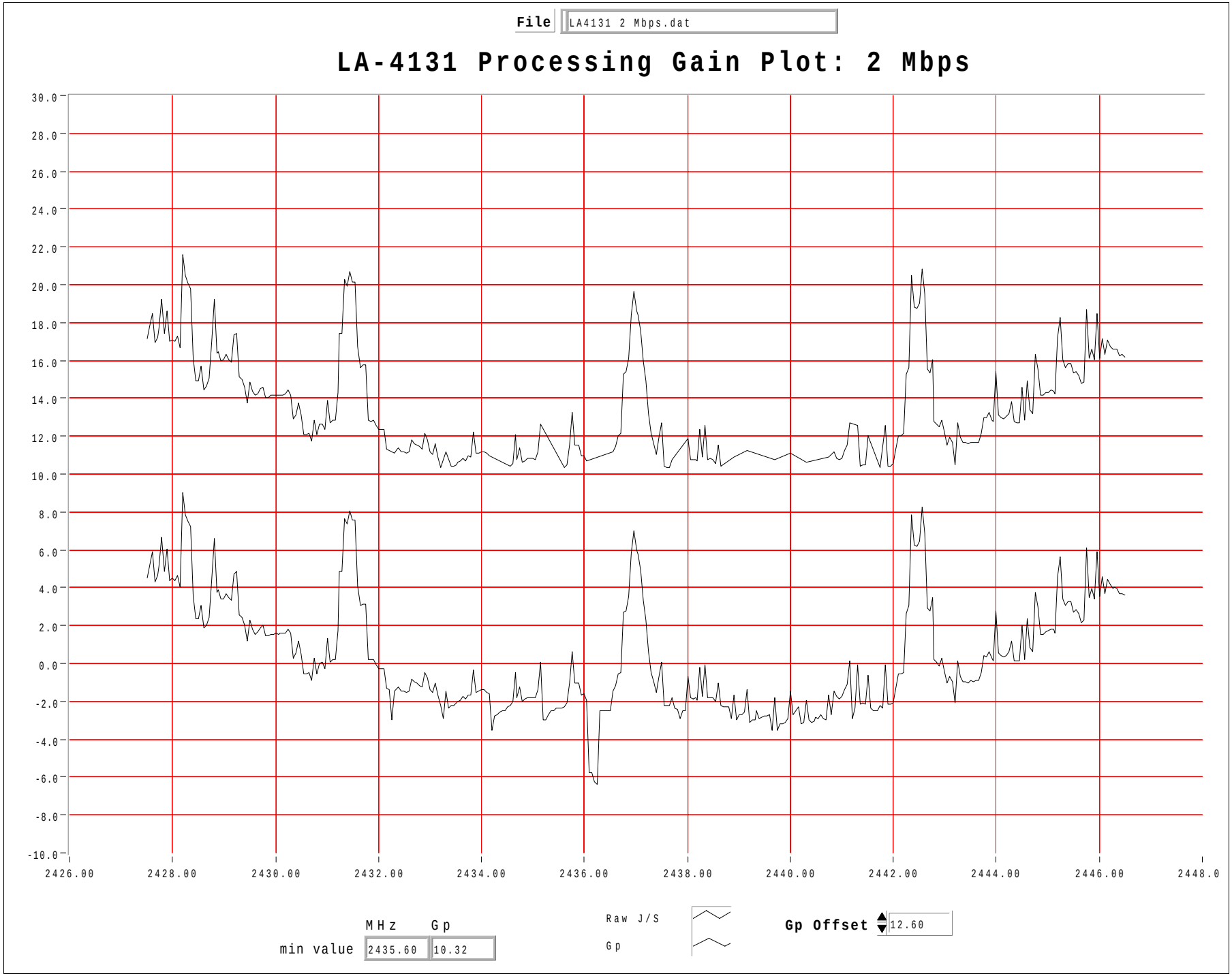

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Last modified on 3/23/01 at 4:04 PM
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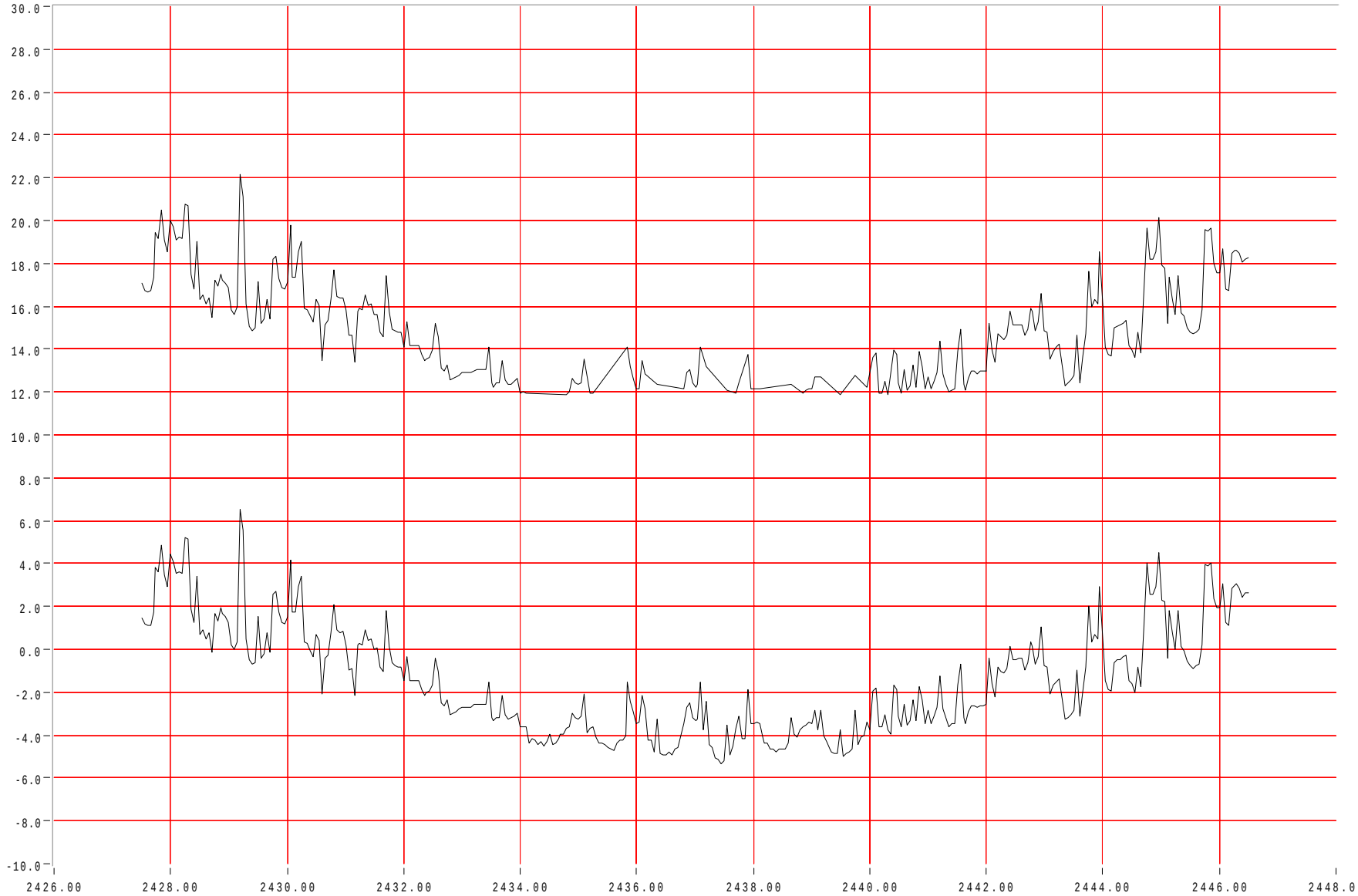
File LA4131 5.5 Mbps.dat

LA-4131 Processing Gain Plot: 5.5 Mbps



	MHz	Gp
min value	2440.30	11.87

Raw J/S
Gp

Gp Offset 15.60

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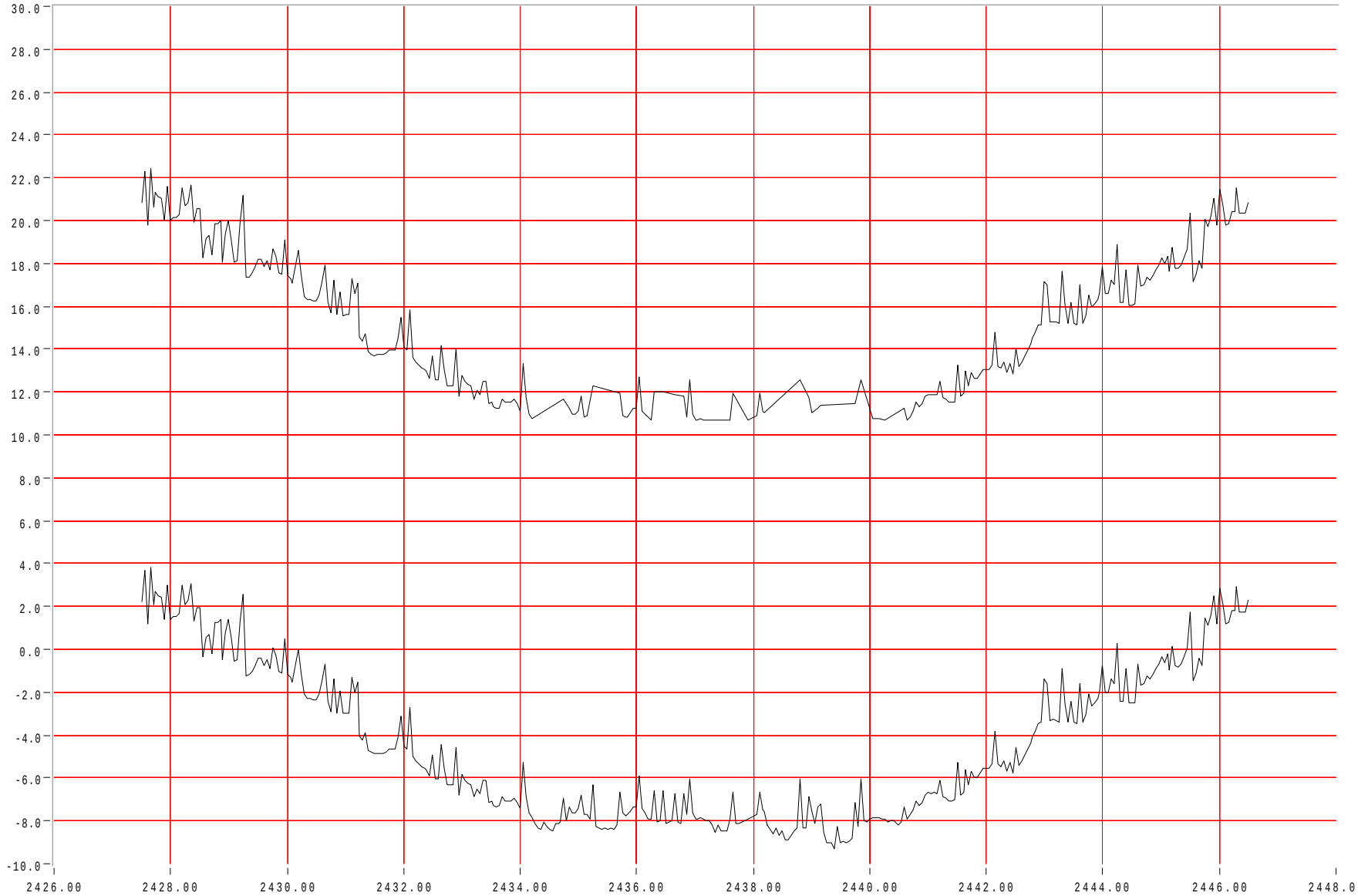
File LA4131 11 Mbps.dat

LA-4131 Processing Gain Plot: 11 Mbps



	MHz	Gp
min value	2437.90	10.68

Raw J/S
Gp

Gp Offset 18.60