MEASUREMENT/TECHNICAL REPORT

Company - Model: Hewlett-Packard M3816A
FCC ID: B94M3816A
April 29, 1999

Description: This is a report to support a request for an original grant of equipment authorization.

Equipment Type: Low Power Communications Device Transmitter

Report prepared for: Hewlett-Packard
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Letter of Agency

HEWLETT PACKARD

Cynthia P. Danaher
Vice President and
Group General Manager

January 19, 1999

Curtis-Straus LLC
527 Great Road
Littleton, MA 01460

I am an officer of Hewlett-Packard Company, do hereby authorize, until further notice, Curtis-Straus LLC, of 527 Great Road, Littleton, MA 01460, to act on our behalf in dealings before the Federal Communications Commission with respect to the preparation, submission and filing of applications for equipment authorization under Title 47 of the Code of Federal Regulations for the following Hewlett-Packard products:

M3812A Home Hub
M3813A Home Scale Unit
M3815A Home Blood Pressure Unit
M3816A Home ECG Rhythm Strip Unit

This authorization includes, but is not limited to, the signing of Form 731.

I certify that no party (as defined in 47 CFR § 1.2002) to these applications, including myself, is subject to a denial of federal benefits, including FCC benefits, pursuant to section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C., § 862.

Certified by:

HEWLETT-PACKARD COMPANY

Cynthia P. Danaher
Vice President and General Manager
Medical Products Group

Introduction

This report is an application for Certification of a Transmitter operating pursuant to Part 15.249 of the FCC Rules, Code of Federal Regulations 47. The model number covered by this report is M3816A. This report is designed to demonstrate the compliance of this device with the requirements outlined in Part 15 of CFR 47 using the methods outlined in Part 2 of CFR 47. The revision date, October 1,1997, of each Part has been used for technical requirements.

The confidential information and descriptions included in this application are detailed descriptions of the products, block diagrams, component specifications, and schematic diagrams. We hereby respectfully request under the provision of section 0.457d of the code that the documents listed below be held confidential.

Exhibit 6.1: Block Diagram

Exhibit 6.2: Schematics

Exhibit 6.3: Bill of Materials

Hewlett-Packard is requesting that the Block Diagram, Schematics and Bill of Materials be kept confidential in the FCC application because of the proprietary design developed by Hewlett-Packard that is unique to the industry.

EXHIBIT 1:

1.0 Statement of Conformity

The Hewlett-Packard M3816A has been found to conform with the following parts of the 47 CFR as detailed below:

Part 2	Part 15	Comments
	15.15(b)	The product contains no user accessible controls that increase transmission power above allowable levels.
2.925	15.19	The label is shown in the label exhibit.
	15.21	Information to the user is shown in the instruction manual exhibit.
	15.27	No special accessories are required for compliance.
	15.203	The antenna is permanently attached to the printed circuit board.
	15.205 15.209	The fundamental is not in a Restricted band and the spurious and harmonic emissions in the Restricted bands comply with the general emission limits of 15.209.
	15.207	The unit is battery operated and the line conducted limits are, therefore, not applicable.
	15.249(a)	The unit complies with the field strength limits of the 15.249(a) table including the 20dB peak restriction of 15.35(b) and 15.249(d).
	15.249(c)	The unit complies with the field strength limits of the 15.209(a) table.

EXHIBIT 2

2.0 General Description

2.1 Product Description

The product is a self-contained battery operated home ECG monitor with transmitter. The ECG Monitor takes a 16 sec single-lead EKG waveform of Patients, in their homes. It then transmits its readings to a receiving HUB (916.5MHz) several times per day. The unit is battery operated and has no direct connections, other than the RF link, to any other device.

Unit Tested
Model Number: M3816A
Serial Number: 1059

2.2 Related Submittal(s) Grants

There are no other approvals required for this device.

2.3 Test Methodology

Radiated emission testing was performed according to the procedures in ANSI C63.4 (1992). Radiated testing was performed at an antenna to EUT distance of 3 meters below 1 GHz, and at a distance of 3 or 1 meter(s) above 1 GHz. The actual test distance used is noted in the test data sheets. The device's performance was investigated to 10 times the fundamental frequency. A fresh battery was used for all testing. Although the device does contain voltage regulating circuitry, the emissions in each configuration were maximized and the battery changed in the maximized configuration just prior to the reading being taken to insure that maximum emissions were recorded.

All other performance tests were made in accordance with the procedures outlined in Part 15 of CFR 47. The applicable sections provided under Part 15 are provided in the measurement section of this report, Exhibit 3.

2.4 Test Facility

The open area test sites and conducted measurement facilities used to collect the radiated data are located at 527 Great Road, Littleton, MA 01460. Sites "T" and "F" were used. These test facilities have been fully described in a report submitted to your office, and letters from your office for Site "T" dated August 8, 1997 and Site "F" dated February 28, 1997 verified receipt of these reports and confirmed compliance of these sites. Please reference your file # 31040/SIT 1300F2 should you have any questions regarding the test site construction.

2.5 Test Equipment Used

SPECTRUM ANALYZER(S)

GREEN 8593E 9 kHz-26.5 GHz	HP	S/N:3829A03618	Calibration Due:31-AUG-99
WHITE 8593E 9 kHz-22 GHz	HP	S/N:3547U01252	Calibration Due:05-JAN-00

ANTENNA(S)

RED 3143 Biconilog 30 MHz-1.1 GHz	EMCO	S/N:1270	Calibration Due:28-MAY-99
YELLOW 3115 Horn Antenna	EMCO 1-18 GHz	S/N:9608-4989	Calibration Due:03-MAR-99

PREAMPLIFIER(S)

BLUE ZFL-1000-LN RF Preamplifier 0.05 - 2000 MHz	MiniCircuits		Calibration Due:14-OCT-99
BLACK ZFL-1000-LN RF Preamplifier 0.01 - 2000 MHz	MiniCircuits		Calibration Due:01-MAR-00
WHITE SMC-12A RF Preamplifier 2000 - 18000 MHz	MITEQ	S/N:426643	Calibration Due:30-OCT-99

OPEN AREA TEST SITE(S)

SITE "F"	Calibration Due:18-OCT-99
SITE "T"	Calibration Due:28-MAY-99

Unless otherwise noted the calibration interval is one year. All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

EXHIBIT 3

3.0 Measurement Results

3.1 Operating Frequency

The devices operating frequency is 916.5 MHz.

3.2 Electric Field Strength Radiation Measurements

Data was obtained using the procedures outlined in ANSI C63.4 (1992). All signals from the transmitter within 20 dB of the emission limit are reported in the following data table.

Radiated Emissions Chart — *Curtis-Straus LLC*

Date: 15-Apr-99 **Company:** Hewlett Packard **Distance:** 3 m
Engineer: Michael Buchholz **EUT Desc:** Rhythm Strip Recorder **Table No:** 1
Notes: First ten harmonics of 916.5MHz **Work Order:** 990115

Harmonic Number	Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Distance Factor (dB)	Duty-cycle Factor (dB)	Adjusted Reading (dBµV/m)	FCC Part 15C Sec 249 Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)
1	H	916.3	84.8	21.6	23.7	4.1	0.0	0.0	91.0	93.97	-2.9	Pass
2	H	1832.6	39.5	18.2	28.6	1.2	0.0	6.0	45.1	53.9	-8.8	Pass
3	V	2748.9	33.7	20.2	31.4	1.6	0.0	6.0	40.5	53.9	-13.4	Pass
4	V	3665.2	39.8	19.9	33.3	1.9	0.0	6.0	49.1	53.9	-4.8	Pass
5	H	4581.6	38.4	20.2	35.0	2.3	0.0	6.0	49.5	53.9	-4.4	Pass
6	V	5498.6	39.2	19.9	36.9	2.5	0.0	6.0	52.7	53.9	-1.2	Pass
7	V	6415.6	30.8	18.1	37.0	2.8	0.0	6.0	46.5	53.9	-7.4	Pass
8	noise floor	7332.2	32.1	16.6	38.7	3.1	9.5	6.0	41.8	53.9	-12.1	Pass
9	noise floor	8248.7	33.0	16.8	39.7	3.3	9.5	6.0	43.7	53.9	-10.2	Pass
10	noise floor	9165.2	32.5	18.1	40.8	3.6	9.5	6.0	43.3	53.9	-10.6	Pass

Pre-Amp: Black, White **OATS:** "F" **Cable:** 65', 12' RG8A/U **Analyzer:** Green **Antenna:** Red,Yel

Radiated Emissions Chart

Curtis-Straus LLC

Date: 22-Jan-99 **Company:** Hewlett Packard **Distance:** 3 m
Engineer: Michael Buchholz **EUT Desc:** ECG Recorder **Table No:** 2
Notes: Unintentional emissions 30-10000MHz **Work Order:** 990115

Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBµV/m)	FCC Class B Limit (dBµV/m)	FCC Class B Margin (dB)	FCC Class B Result (Pass/Fail)	FCC Class B Limit (dBµV/m)	FCC Class B Margin (dB)	FCC Class B Result (Pass/Fail)
H	232.8	39.8	22.5	11.8	0.3	29.4	46.0	-16.6	Pass	46.0	-16.6	Pass
H	237.8	31.4	22.5	12.1	0.3	21.3	46.0	-24.7	Pass	46.0	-24.7	Pass
H	362.8	23.5	22.6	15.4	0.4	16.7	46.0	-29.3	Pass	46.0	-29.3	Pass
H	367.4	30.4	22.6	15.5	0.4	23.7	46.0	-22.3	Pass	46.0	-22.3	Pass
H	375.0	25.2	22.6	15.7	0.4	18.7	46.0	-27.3	Pass	46.0	-27.3	Pass
H	391.7	32.2	22.6	16.1	0.4	26.1	46.0	-19.9	Pass	46.0	-19.9	Pass
H	741.3	28.7	22.6	22.8	0.6	29.5	46.0	-16.5	Pass	46.0	-16.5	Pass
H	817.0	41.7	22.5	23.0	0.7	42.9	46.0	-3.1	Pass	46.0	-3.1	Pass
H	812.1	36.3	22.5	22.9	0.7	37.4	46.0	-8.6	Pass	46.0	-8.6	Pass
H	824.1	38.7	22.5	23.0	0.7	39.9	46.0	-6.1	Pass	46.0	-6.1	Pass
H	912.1	41.2	22.4	23.7	0.7	43.2	46.0	-2.8	Pass	46.0	-2.8	Pass
H	921.1	39.1	22.3	23.6	0.7	41.1	46.0	-4.9	Pass	46.0	-4.9	Pass
H	1049.7	31.5	21.8	25.4	0.8	35.9	54.0	-18.1	Pass	54.0	-18.1	Pass
H	1700.8	35.2	19.2	27.4	1.1	44.5	54.0	-9.5	Pass	54.0	-9.5	Pass

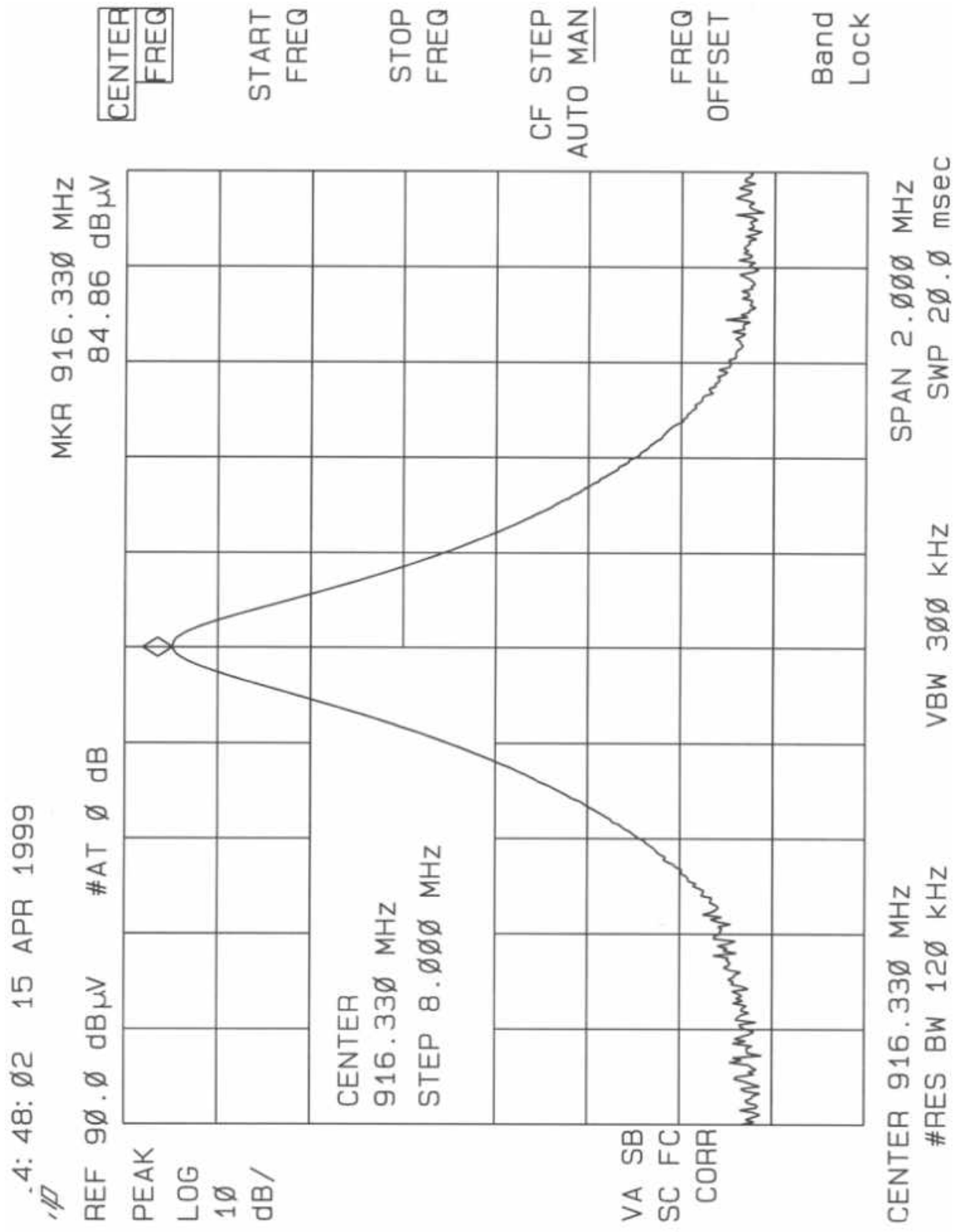
Pre-Amp: Blue **OATS:** "T" **Cable:** 12' RG8A/U **Analyzer:** White **Antenna:** Red, Yellow

3.3 Radiated Test Configuration Photographs:

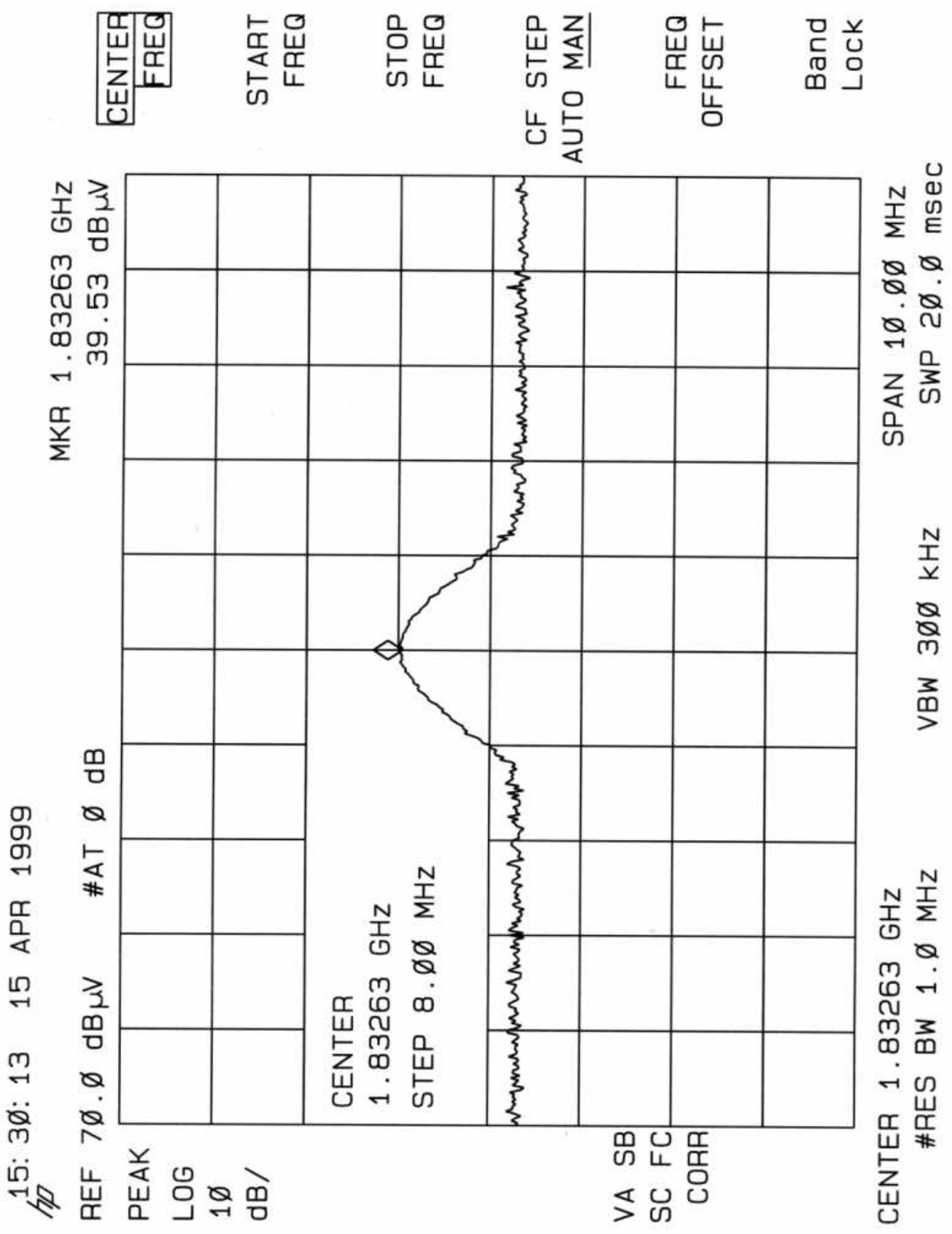
See file "990115 Exhibit 3.3 - Test Setup Photos.PDF"

3.4 Radiated Emissions Plots:

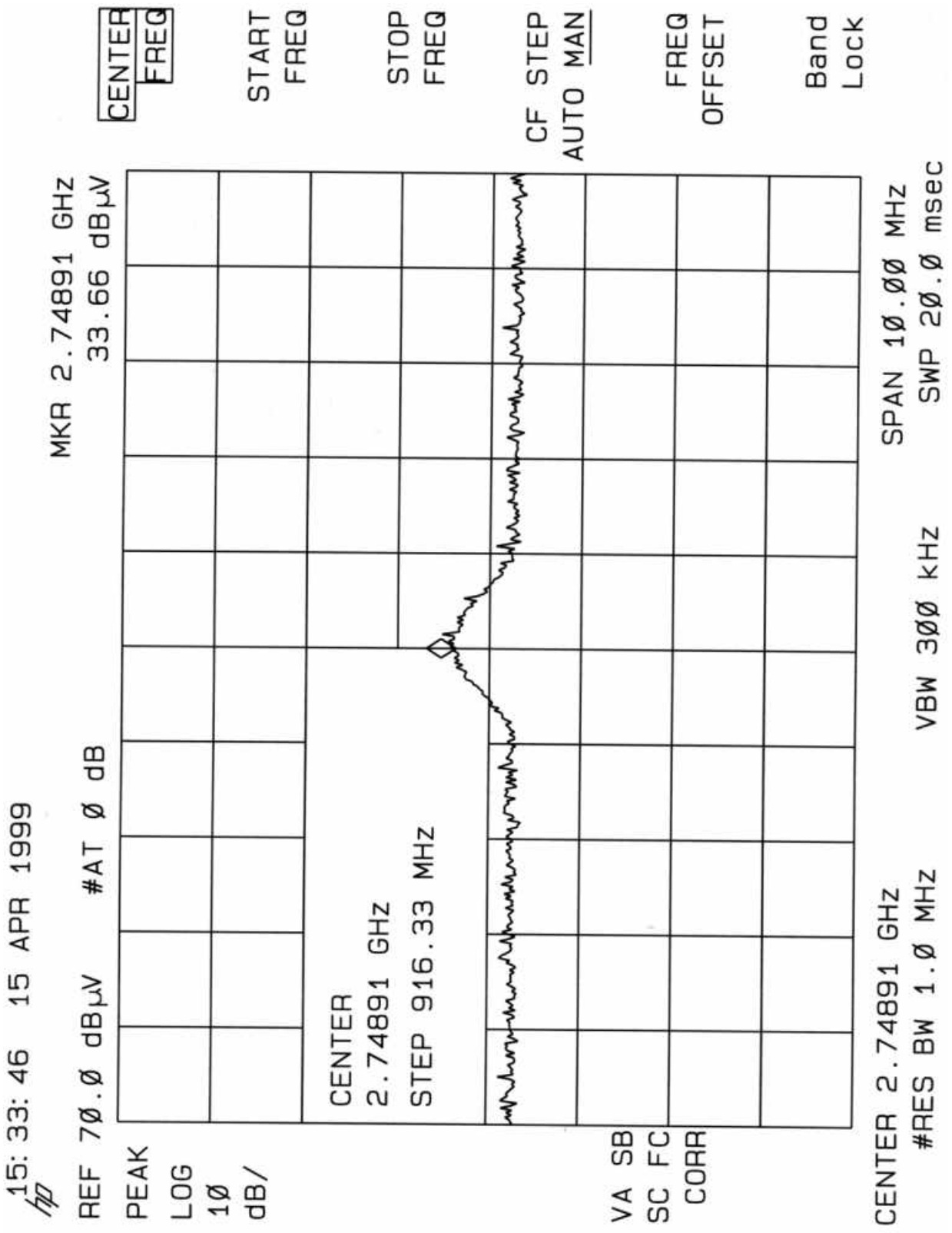
Fundamental



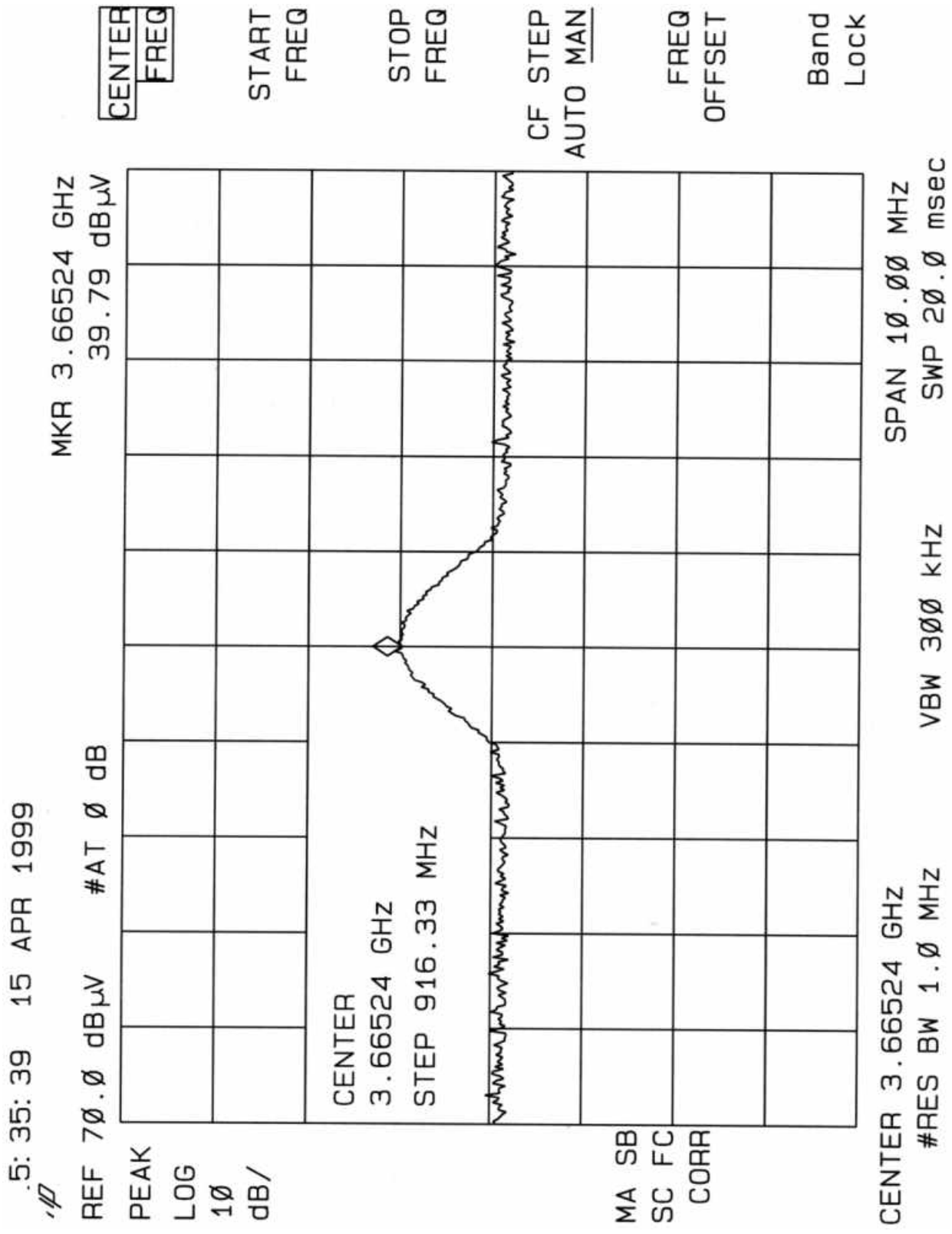
2nd Harmonic



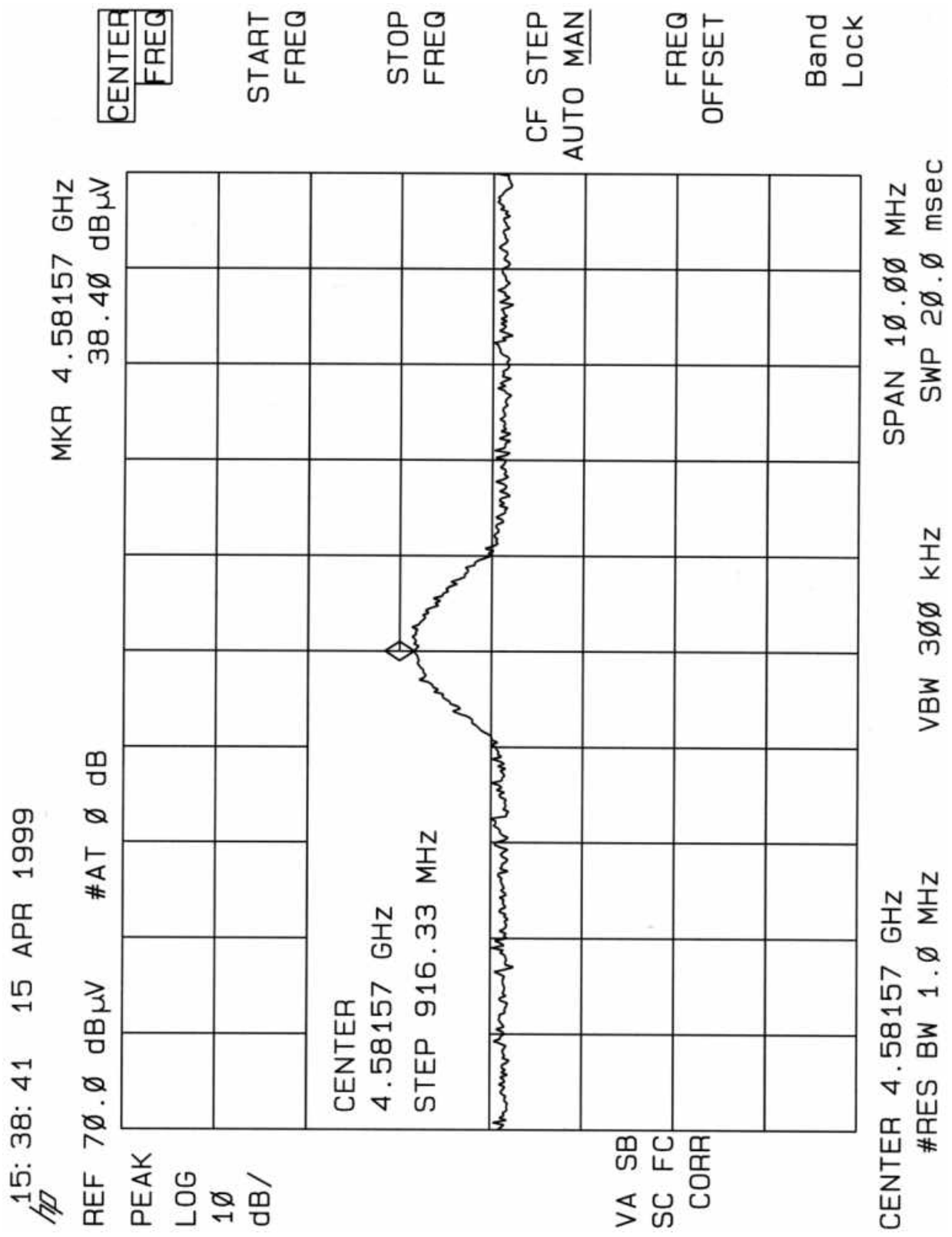
3rd Harmonic



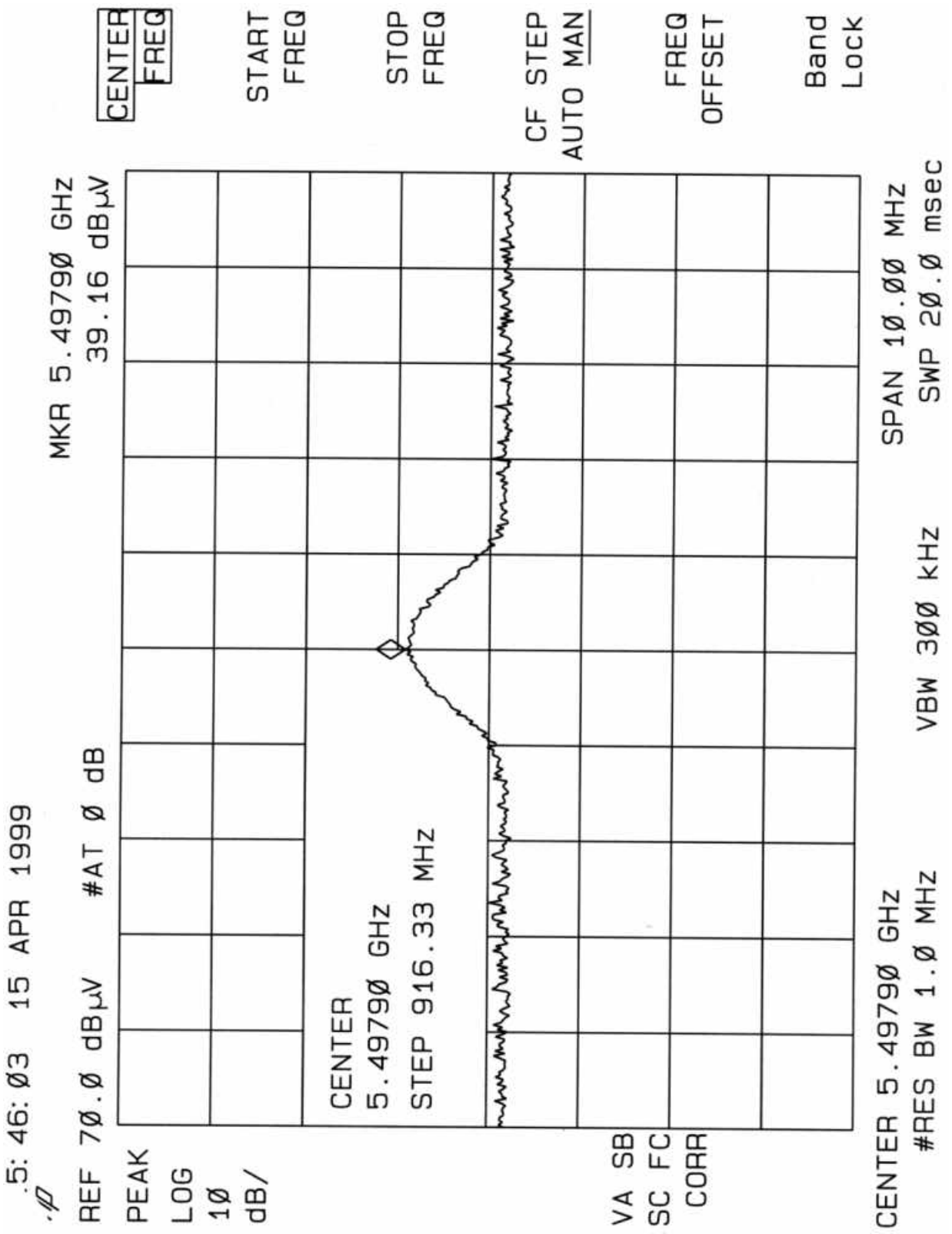
4th Harmonic



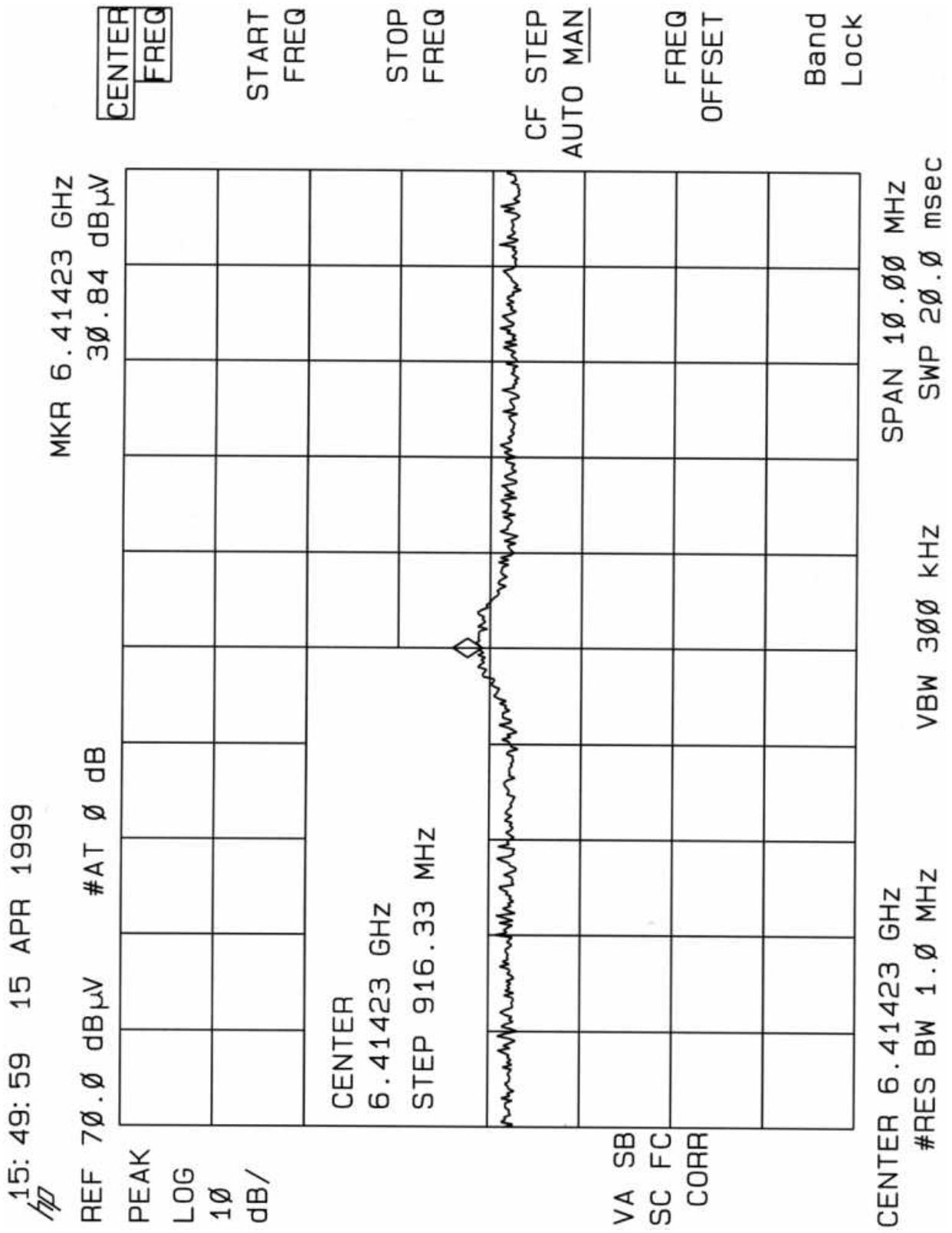
5th Harmonic



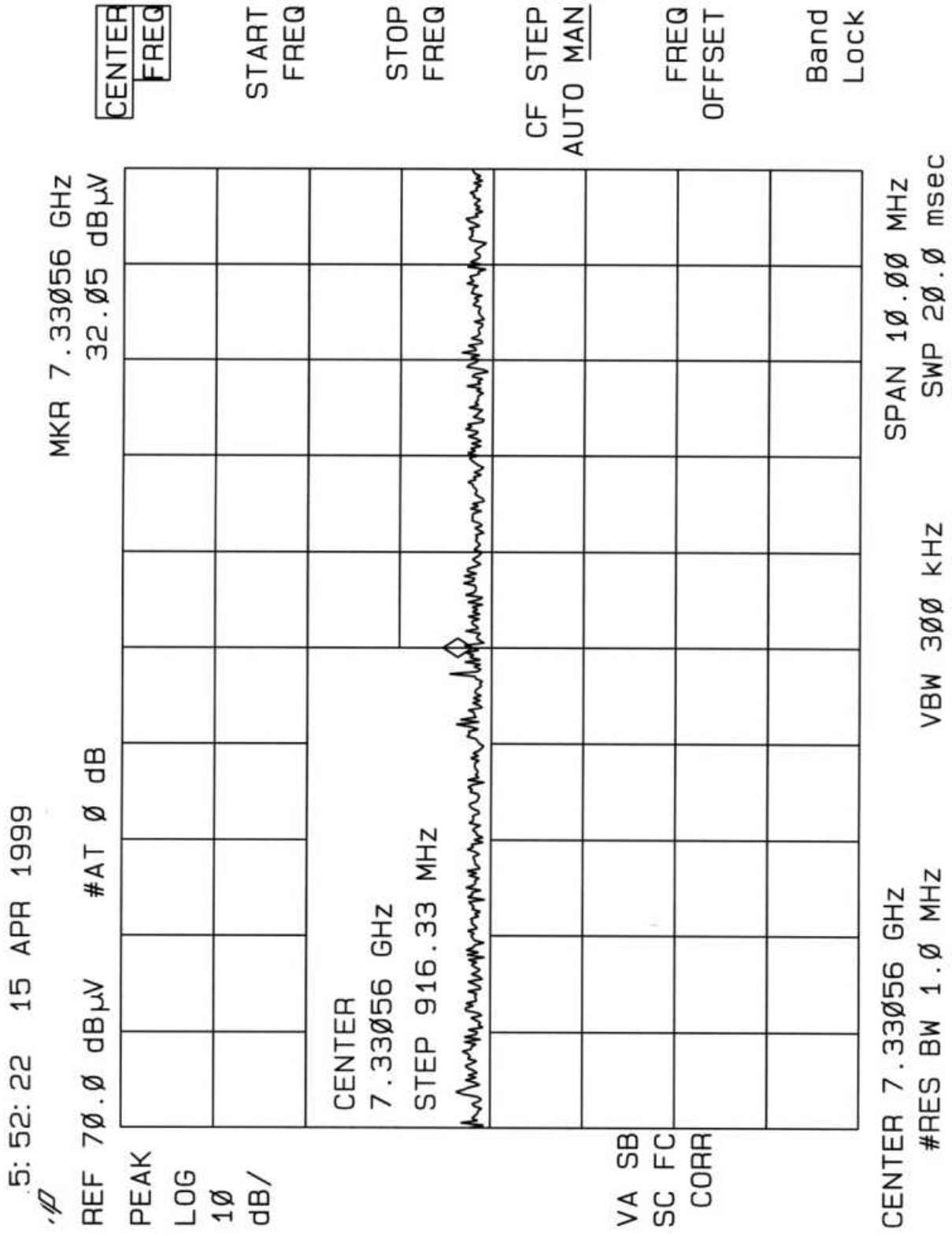
6th Harmonic



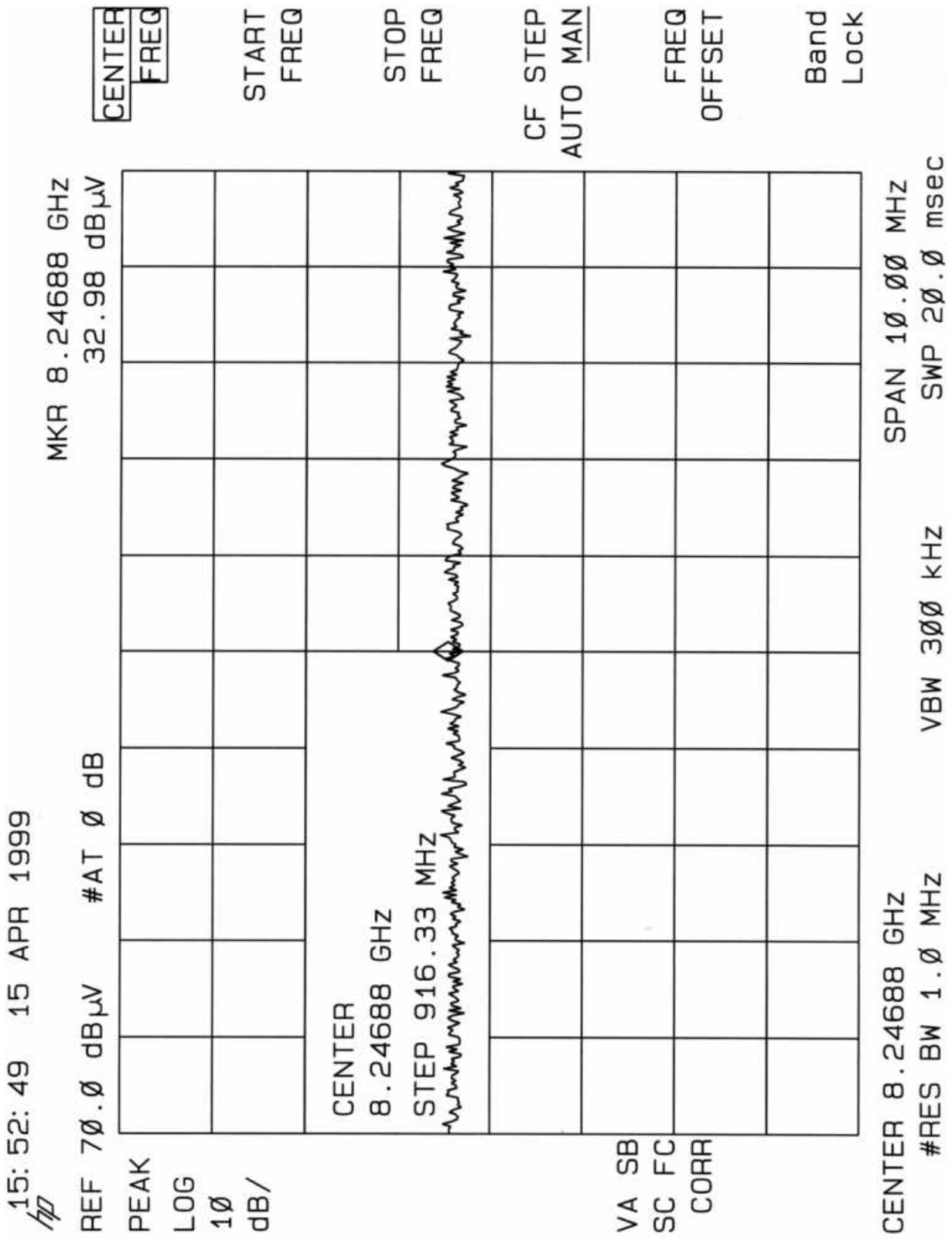
7th Harmonic



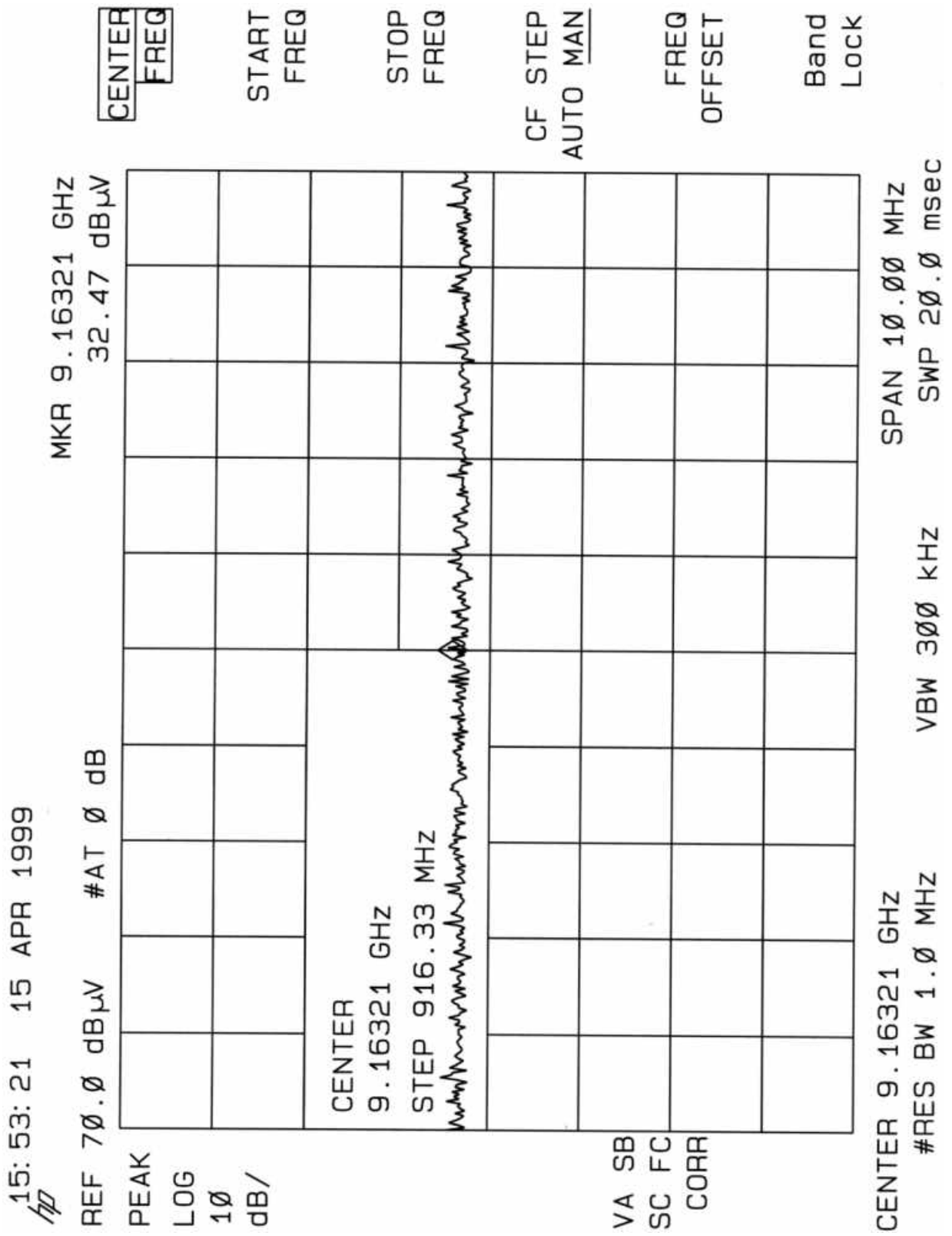
8th Harmonic



9th Harmonic

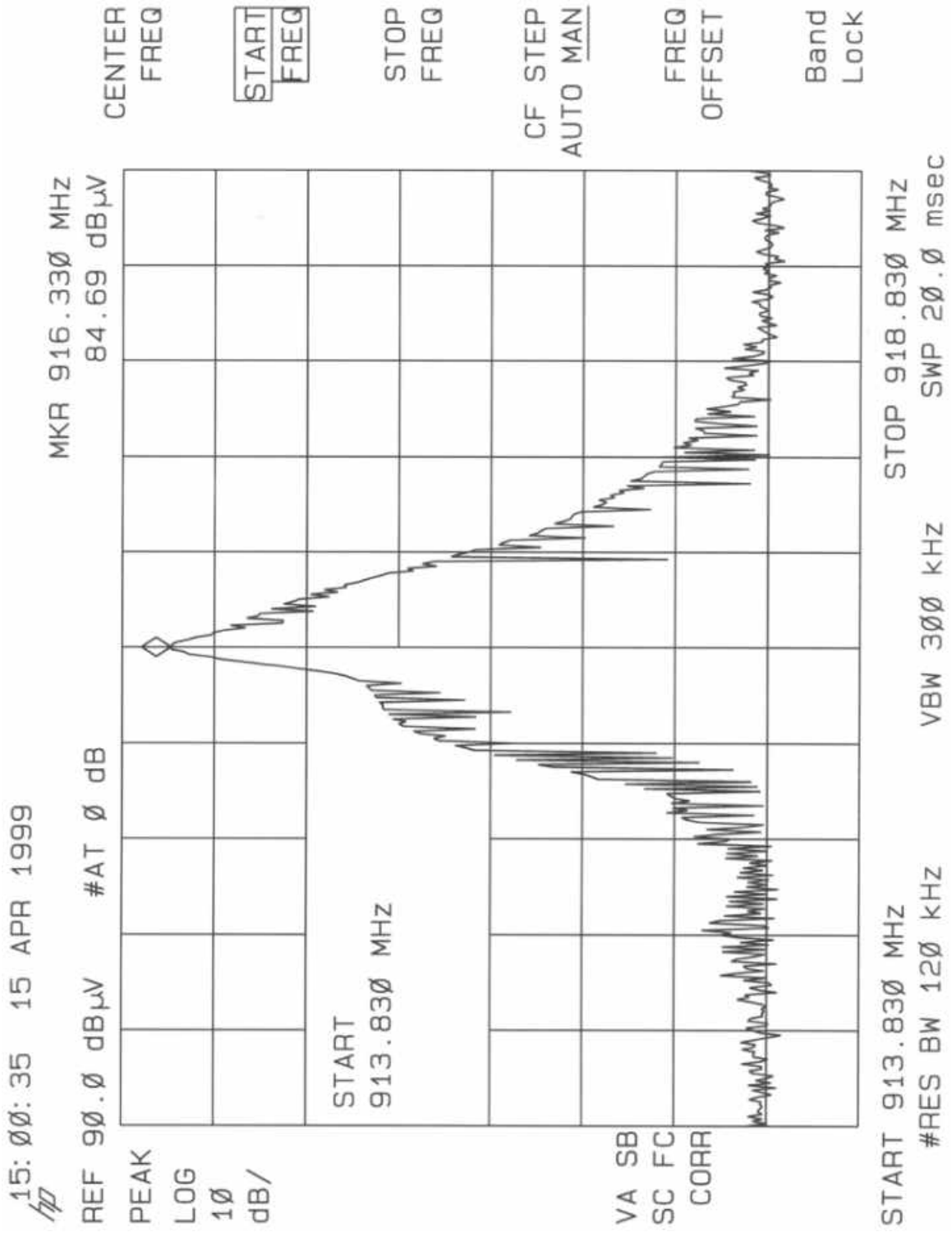


10th Harmonic



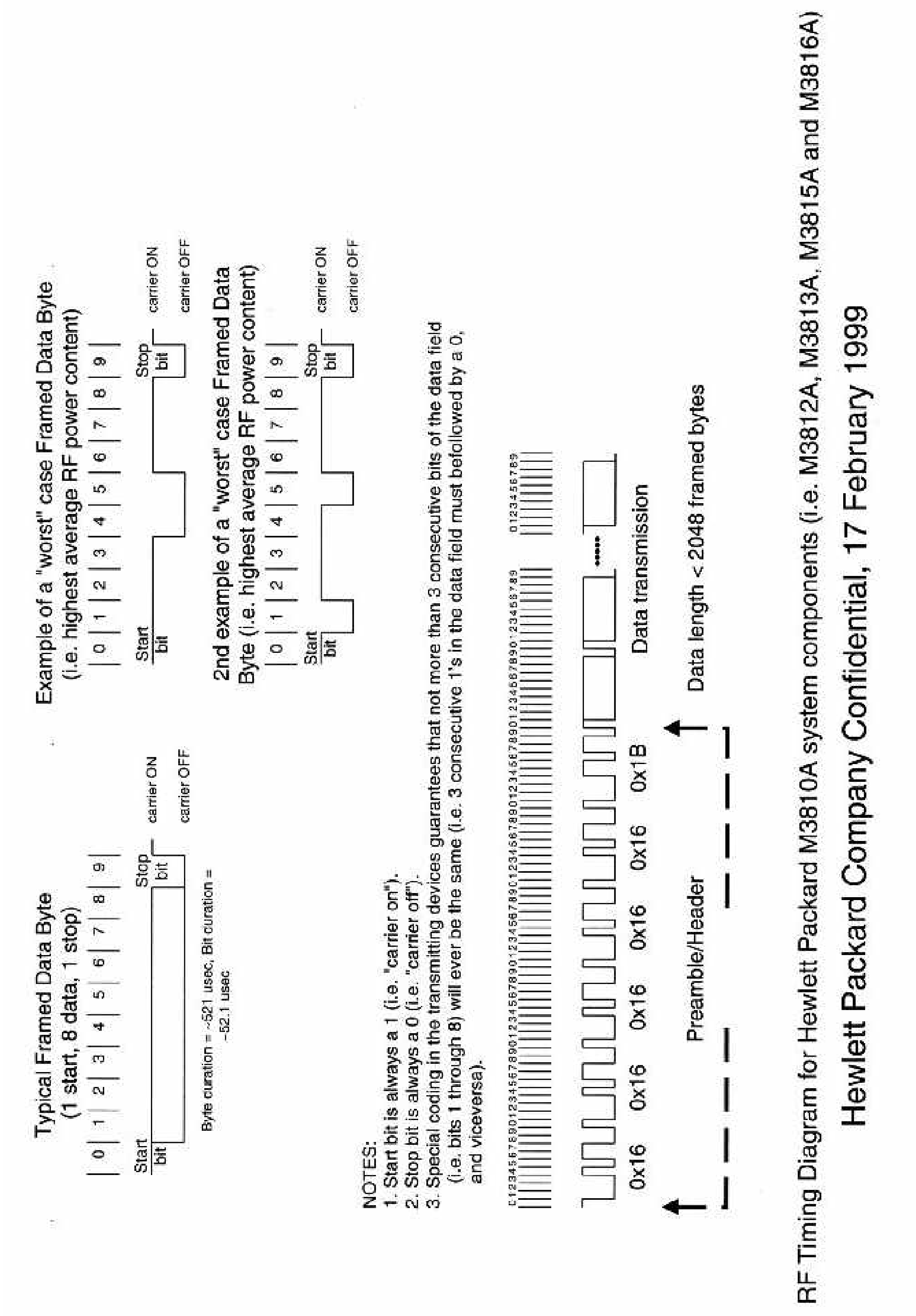
3.5 Occupied Bandwidth Measurements

A plot was obtained with the unit operating with modulation. The bandwidth observed does not extend outside of the operating band 902-928MHz.



3.6 Averaging factor derivation based on worst case 100mS period.

Attached is a discussion of the pulse code modulation scheme employed by the device. As shown on the timing diagram, the worst case 100mS second period results in an averaging factor of 6.0dB.


Typical Framed Data Byte
(1 start, 8 data, 1 stop)
0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
Start bit
Stop bit
carrier ON
carrier OFF
Byte duration = ~521 usec, Bit duration = ~52.1 usec
Example of a "worst" case Framed Data Byte
(i.e. highest average RF power content)
0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
Start bit
Stop bit
carrier ON
carrier OFF
2nd example of a "worst" case Framed Data Byte (i.e. highest average RF power content)
0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
Start bit
Stop bit
carrier ON
carrier OFF
NOTES:
1. Start bit is always a 1 (i.e. "carrier on").
2. Stop bit is always a 0 (i.e. "carrier off").
3. Special coding in the transmitting devices guarantees that not more than 3 consecutive bits of the data field (i.e. bits 1 through 8) will ever be the same (i.e. 3 consecutive 1's in the data field must befollowed by a 0, and viceversa).
0x16 0x16 0x16 0x16 0x16 0x1B
Preamble/Header
Data transmission
Data length < 2048 framed bytes
RF Timing Diagram for Hewlett Packard M3810A system components (i.e. M3812A, M3813A, M3815A and M3816A)
Hewlett Packard Company Confidential, 17 February 1999

M3816A RF Data Encoding Algorithm

RFM Receiver Limitations

The RFM receiver requires a data pattern such that there are no more than 3 bits of the same value (1 or 0) in a row. Ideally, the duty-cycle of any transmission will average 50% so that the receiver threshold is optimized for sensitivity and noise rejection. The receiver can operate reliably when the threshold is between %25 and %75 of the peak-to-peak value of the transmitted signal (hence the 3-bit limitation). This requirement applies to the transmitted bit stream, which in our case includes the "start" and "stop" framing bits inserted by the 16550-compatible UART.

FCC Limitations

We have computed our worst case duty cycle with a program that moved a 0.10-second window over traces of 145,997 and 28,565 bytes of real device data. The duty cycles for these traces were 0.5312 and 0.5307 respectively, resulting in –5.495dB and –5.503dB averaging factors. For FCC certification, we are claiming a less aggressive –5.2dB averaging factor providing an additional 0.3dB of margin beyond the measured values.

We are using a serial data format of 19200 bits/sec with a format of 1 start bit, 8 data bits, and one stop bit. Using this format, 0.1 seconds is equivalent to 192 bytes of data.

RF Data Transmission

Data is transmitted using OOK (On-Off Keying) such that the equivalent of an RS-232 idle line (MARK) is carrier OFF.

For RS232 transmission, a binary data value of '1' is transmitted as a MARK = idle = carrier-OFF value and a binary data value of '0' is transmitted as a SPACE = carrier-ON value. A START bit is a SPACE and can be represented with a binary data value of '0'. A STOP bit is a MARK and can be represented with a binary data value of '1'.

Given this, a binary data value of **'1' is equivalent to carrier OFF**, and a binary value of **'0' is equivalent to carrier ON**. This will be important when calculating the transmitted duty-cycle of a given data byte.

We are framing each 8-bit data byte with 1 start bit, 1 stop bit, and no parity bit. Note that data is always transmitted LSB first. A given byte of data is transmitted as follows:

```
    ------time-------->>>>
    <start> D0 D1 D2 D3 D4 D5 D6 D7 <stop>
or
    0 D0 D1 D2 D3 D4 D5 D6 D7 1
```

When a binary value is written "normally", the MSB is on the left, so the values in the rest of this description are written as:

```
  1 D7 D6 D5 D4 D3 D2 D1 D0 0
```

A hex value of "0x11" becomes a binary "00010001" which, when framed, is "1000100010".

Duty Cycle Calculation

Table 1 shows all of the allowable "data" values that meet this criterion when transmitted using an 8-bit data byte transmitted LSB-first framed with 1 start (logic 0) and 1 stop (logic 1) bit. The duty cycle of the carrier for the given data value is shown in the right-hand column.

The maximum RF duty cycle for any of the allowable codes is 70% and the minimum duty cycle is 30%. Since there are only 137 allowable codes, certain data values must be sent as a two-byte pair ("escaped" or "shifted"). In order to maximize throughput, only 119 values will be escaped.

Since the “shift” character will be a dominant character in the data stream, it should be chosen such that it has a 50% duty cycle. The ASCII “escape” character, 0x1B works nicely for this purpose.

TABLE 1: Allowable data values in ascending order

N.B. ‘1’ = carrier OFF, ‘0’ = carrier ON

==========

11 = 00010001 = 1000100010 (/ 7.0 (+ 7.0 3.0)) 0.70
12 = 00010010 = 1000100100 (/ 7.0 (+ 7.0 3.0)) 0.70
13 = 00010011 = 1000100110 (/ 6.0 (+ 6.0 4.0)) 0.60
14 = 00010100 = 1000101000 (/ 7.0 (+ 7.0 3.0)) 0.70
15 = 00010101 = 1000101010 (/ 6.0 (+ 6.0 4.0)) 0.60
16 = 00010110 = 1000101100 (/ 6.0 (+ 6.0 4.0)) 0.60
17 = 00010111 = 1000101110 (/ 5.0 (+ 5.0 5.0)) 0.50
19 = 00011001 = 1000110010 (/ 6.0 (+ 6.0 4.0)) 0.60
1A = 00011010 = 1000110100 (/ 6.0 (+ 6.0 4.0)) 0.60
1B = 00011011 = 1000110110 (/ 5.0 (+ 5.0 5.0)) 0.50
1C = 00011100 = 1000111000 (/ 6.0 (+ 6.0 4.0)) 0.60
1D = 00011101 = 1000111010 (/ 5.0 (+ 5.0 5.0)) 0.50
22 = 00100010 = 1001000100 (/ 7.0 (+ 7.0 3.0)) 0.70
23 = 00100011 = 1001000110 (/ 6.0 (+ 6.0 4.0)) 0.60
24 = 00100100 = 1001001000 (/ 7.0 (+ 7.0 3.0)) 0.70
25 = 00100101 = 1001001010 (/ 6.0 (+ 6.0 4.0)) 0.60
26 = 00100110 = 1001001100 (/ 6.0 (+ 6.0 4.0)) 0.60
27 = 00100111 = 1001001110 (/ 5.0 (+ 5.0 5.0)) 0.50
29 = 00101001 = 1001010010 (/ 6.0 (+ 6.0 4.0)) 0.60
2A = 00101010 = 1001010100 (/ 6.0 (+ 6.0 4.0)) 0.60
2B = 00101011 = 1001010110 (/ 5.0 (+ 5.0 5.0)) 0.50
2C = 00101100 = 1001011000 (/ 6.0 (+ 6.0 4.0)) 0.60
2D = 00101101 = 1001011010 (/ 5.0 (+ 5.0 5.0)) 0.50
2E = 00101110 = 1001011100 (/ 5.0 (+ 5.0 5.0)) 0.50
31 = 00110001 = 1001100010 (/ 6.0 (+ 6.0 4.0)) 0.60
32 = 00110010 = 1001100100 (/ 6.0 (+ 6.0 4.0)) 0.60
33 = 00110011 = 1001100110 (/ 5.0 (+ 5.0 5.0)) 0.50
34 = 00110100 = 1001101000 (/ 6.0 (+ 6.0 4.0)) 0.60
35 = 00110101 = 1001101010 (/ 5.0 (+ 5.0 5.0)) 0.50
36 = 00110110 = 1001101100 (/ 5.0 (+ 5.0 5.0)) 0.50
37 = 00110111 = 1001101110 (/ 4.0 (+ 4.0 6.0)) 0.40
39 = 00111001 = 1001110010 (/ 5.0 (+ 5.0 5.0)) 0.50
3A = 00111010 = 1001110100 (/ 5.0 (+ 5.0 5.0)) 0.50
3B = 00111011 = 1001110110 (/ 4.0 (+ 4.0 6.0)) 0.40
44 = 01000100 = 1010001000 (/ 7.0 (+ 7.0 3.0)) 0.70
45 = 01000101 = 1010001010 (/ 6.0 (+ 6.0 4.0)) 0.60
46 = 01000110 = 1010001100 (/ 6.0 (+ 6.0 4.0)) 0.60
47 = 01000111 = 1010001110 (/ 5.0 (+ 5.0 5.0)) 0.50
49 = 01001001 = 1010010010 (/ 6.0 (+ 6.0 4.0)) 0.60
4A = 01001010 = 1010010100 (/ 6.0 (+ 6.0 4.0)) 0.60
4B = 01001011 = 1010010110 (/ 5.0 (+ 5.0 5.0)) 0.50

4C = 01001100 = 1010011000 (/ 6.0 (+ 6.0 4.0)) 0.60
4D = 01001101 = 1010011010 (/ 5.0 (+ 5.0 5.0)) 0.50
4E = 01001110 = 1010011100 (/ 5.0 (+ 5.0 5.0)) 0.50
51 = 01010001 = 1010100010 (/ 6.0 (+ 6.0 4.0)) 0.60
52 = 01010010 = 1010100100 (/ 6.0 (+ 6.0 4.0)) 0.60
53 = 01010011 = 1010100110 (/ 5.0 (+ 5.0 5.0)) 0.50
54 = 01010100 = 1010101000 (/ 6.0 (+ 6.0 4.0)) 0.60
55 = 01010101 = 1010101010 (/ 5.0 (+ 5.0 5.0)) 0.50
56 = 01010110 = 1010101100 (/ 5.0 (+ 5.0 5.0)) 0.50
57 = 01010111 = 1010101110 (/ 4.0 (+ 4.0 6.0)) 0.40
59 = 01011001 = 1010110010 (/ 5.0 (+ 5.0 5.0)) 0.50
5A = 01011010 = 1010110100 (/ 5.0 (+ 5.0 5.0)) 0.50
5B = 01011011 = 1010110110 (/ 4.0 (+ 4.0 6.0)) 0.40
5C = 01011100 = 1010111000 (/ 5.0 (+ 5.0 5.0)) 0.50
5D = 01011101 = 1010111010 (/ 4.0 (+ 4.0 6.0)) 0.40
62 = 01100010 = 1011000100 (/ 6.0 (+ 6.0 4.0)) 0.60
63 = 01100011 = 1011000110 (/ 5.0 (+ 5.0 5.0)) 0.50
64 = 01100100 = 1011001000 (/ 6.0 (+ 6.0 4.0)) 0.60
65 = 01100101 = 1011001010 (/ 5.0 (+ 5.0 5.0)) 0.50
66 = 01100110 = 1011001100 (/ 5.0 (+ 5.0 5.0)) 0.50
67 = 01100111 = 1011001110 (/ 4.0 (+ 4.0 6.0)) 0.40
69 = 01101001 = 1011010010 (/ 5.0 (+ 5.0 5.0)) 0.50
6A = 01101010 = 1011010100 (/ 5.0 (+ 5.0 5.0)) 0.50
6B = 01101011 = 1011010110 (/ 4.0 (+ 4.0 6.0)) 0.40
6C = 01101100 = 1011011000 (/ 5.0 (+ 5.0 5.0)) 0.50
6D = 01101101 = 1011011010 (/ 4.0 (+ 4.0 6.0)) 0.40
6E = 01101110 = 1011011100 (/ 4.0 (+ 4.0 6.0)) 0.40
71 = 01110001 = 1011100010 (/ 5.0 (+ 5.0 5.0)) 0.50
72 = 01110010 = 1011100100 (/ 5.0 (+ 5.0 5.0)) 0.50
73 = 01110011 = 1011100110 (/ 4.0 (+ 4.0 6.0)) 0.40
74 = 01110100 = 1011101000 (/ 5.0 (+ 5.0 5.0)) 0.50
75 = 01110101 = 1011101010 (/ 4.0 (+ 4.0 6.0)) 0.40
76 = 01110110 = 1011101100 (/ 4.0 (+ 4.0 6.0)) 0.40
77 = 01110111 = 1011101110 (/ 3.0 (+ 3.0 7.0)) 0.30
89 = 10001001 = 1100010010 (/ 6.0 (+ 6.0 4.0)) 0.60
8A = 10001010 = 1100010100 (/ 6.0 (+ 6.0 4.0)) 0.60
8B = 10001011 = 1100010110 (/ 5.0 (+ 5.0 5.0)) 0.50
8C = 10001100 = 1100011000 (/ 6.0 (+ 6.0 4.0)) 0.60
8D = 10001101 = 1100011010 (/ 5.0 (+ 5.0 5.0)) 0.50
8E = 10001110 = 1100011100 (/ 5.0 (+ 5.0 5.0)) 0.50
91 = 10010001 = 1100100010 (/ 6.0 (+ 6.0 4.0)) 0.60
92 = 10010010 = 1100100100 (/ 6.0 (+ 6.0 4.0)) 0.60
93 = 10010011 = 1100100110 (/ 5.0 (+ 5.0 5.0)) 0.50
94 = 10010100 = 1100101000 (/ 6.0 (+ 6.0 4.0)) 0.60
95 = 10010101 = 1100101010 (/ 5.0 (+ 5.0 5.0)) 0.50
96 = 10010110 = 1100101100 (/ 5.0 (+ 5.0 5.0)) 0.50
97 = 10010111 = 1100101110 (/ 4.0 (+ 4.0 6.0)) 0.40
99 = 10011001 = 1100110010 (/ 5.0 (+ 5.0 5.0)) 0.50
9A = 10011010 = 1100110100 (/ 5.0 (+ 5.0 5.0)) 0.50
9B = 10011011 = 1100110110 (/ 4.0 (+ 4.0 6.0)) 0.40
9C = 10011100 = 1100111000 (/ 5.0 (+ 5.0 5.0)) 0.50
9D = 10011101 = 1100111010 (/ 4.0 (+ 4.0 6.0)) 0.40
A2 = 10100010 = 1101000100 (/ 6.0 (+ 6.0 4.0)) 0.60
A3 = 10100011 = 1101000110 (/ 5.0 (+ 5.0 5.0)) 0.50
A4 = 10100100 = 1101001000 (/ 6.0 (+ 6.0 4.0)) 0.60
A5 = 10100101 = 1101001010 (/ 5.0 (+ 5.0 5.0)) 0.50
A6 = 10100110 = 1101001100 (/ 5.0 (+ 5.0 5.0)) 0.50
A7 = 10100111 = 1101001110 (/ 4.0 (+ 4.0 6.0)) 0.40
A9 = 10101001 = 1101010010 (/ 5.0 (+ 5.0 5.0)) 0.50
AA = 10101010 = 1101010100 (/ 5.0 (+ 5.0 5.0)) 0.50
AB = 10101011 = 1101010110 (/ 4.0 (+ 4.0 6.0)) 0.40
AC = 10101100 = 1101011000 (/ 5.0 (+ 5.0 5.0)) 0.50
AD = 10101101 = 1101011010 (/ 4.0 (+ 4.0 6.0)) 0.40
AE = 10101110 = 1101011100 (/ 4.0 (+ 4.0 6.0)) 0.40

B1 = 10110001 = 1101100010 (/ 5.0 (+ 5.0 5.0)) 0.50
B2 = 10110010 = 1101100100 (/ 5.0 (+ 5.0 5.0)) 0.50
B3 = 10110011 = 1101100110 (/ 4.0 (+ 4.0 6.0)) 0.40
B4 = 10110100 = 1101101000 (/ 5.0 (+ 5.0 5.0)) 0.50
B5 = 10110101 = 1101101010 (/ 4.0 (+ 4.0 6.0)) 0.40
B6 = 10110110 = 1101101100 (/ 4.0 (+ 4.0 6.0)) 0.40
B7 = 10110111 = 1101101110 (/ 3.0 (+ 3.0 7.0)) 0.30
B9 = 10111001 = 1101110010 (/ 4.0 (+ 4.0 6.0)) 0.40
BA = 10111010 = 1101110100 (/ 4.0 (+ 4.0 6.0)) 0.40
BB = 10111011 = 1101110110 (/ 3.0 (+ 3.0 7.0)) 0.30
C4 = 11000100 = 1110001000 (/ 6.0 (+ 6.0 4.0)) 0.60
C5 = 11000101 = 1110001010 (/ 5.0 (+ 5.0 5.0)) 0.50
C6 = 11000110 = 1110001100 (/ 5.0 (+ 5.0 5.0)) 0.50
C7 = 11000111 = 1110001110 (/ 4.0 (+ 4.0 6.0)) 0.40
C9 = 11001001 = 1110010010 (/ 5.0 (+ 5.0 5.0)) 0.50
CA = 11001010 = 1110010100 (/ 5.0 (+ 5.0 5.0)) 0.50
CB = 11001011 = 1110010110 (/ 4.0 (+ 4.0 6.0)) 0.40
CC = 11001100 = 1110011000 (/ 5.0 (+ 5.0 5.0)) 0.50
CD = 11001101 = 1110011010 (/ 4.0 (+ 4.0 6.0)) 0.40
CE = 11001110 = 1110011100 (/ 4.0 (+ 4.0 6.0)) 0.40
D1 = 11010001 = 1110100010 (/ 5.0 (+ 5.0 5.0)) 0.50
D2 = 11010010 = 1110100100 (/ 5.0 (+ 5.0 5.0)) 0.50
D3 = 11010011 = 1110100110 (/ 4.0 (+ 4.0 6.0)) 0.40
D4 = 11010100 = 1110101000 (/ 5.0 (+ 5.0 5.0)) 0.50
D5 = 11010101 = 1110101010 (/ 4.0 (+ 4.0 6.0)) 0.40
D6 = 11010110 = 1110101100 (/ 4.0 (+ 4.0 6.0)) 0.40
D7 = 11010111 = 1110101110 (/ 3.0 (+ 3.0 7.0)) 0.30
D9 = 11011001 = 1110110010 (/ 4.0 (+ 4.0 6.0)) 0.40
DA = 11011010 = 1110110100 (/ 4.0 (+ 4.0 6.0)) 0.40
DB = 11011011 = 1110110110 (/ 3.0 (+ 3.0 7.0)) 0.30
DC = 11011100 = 1110111000 (/ 4.0 (+ 4.0 6.0)) 0.40
DD = 11011101 = 1110111010 (/ 3.0 (+ 3.0 7.0)) 0.30

EXHIBIT 4

4.0 Equipment Photographs

4.1 Internal Photos

See file "990115 Exhibit 4.1 - Internal Photos.PDF"

4.2 External Photos

See file "990115 Exhibit 4.2 - External Photos.PDF"

EXHIBIT 5

5.0 Product Labeling

See file "990115 Exhibit 5 – ID Label Info.PDF"

EXHIBIT 6

6.0 Technical Specifications

6.1 Block Diagram

See file "990115 Exhibit 6.1 – Block Diagram.PDF"

6.2 Schematics

See file "990115 Exhibit 6.2 – Schematics.doc"

6.3 Bill of Materials

See file "990115 Exhibit 6.3 – Parts List.PDF"

EXHIBIT 7

7.0 Instruction Manual

See file "990115 Exhibit 7 – User's Manual.PDF"

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