

EXHIBIT E
REPORT OF MEASUREMENTS

A. TEST REPORT

The HandyMic 216 MHz transmitter was tested and found to comply with the limits imposed by the FCC "Code of Federal Regulations", Title 47, Part 95 for LPRS transmitters.

The attached test report describes the results of the test in detail.

ELITE ELECTRONIC ENGINEERING COMPANY
1516 CENTRE CIRCLE
DOWNERS GROVE, ILLINOIS 60515-1082

ELITE PROJECT: 26314 DATE COMPLETED: March 6, 1998

TEST PERSONNEL: Daniel E. Crowder

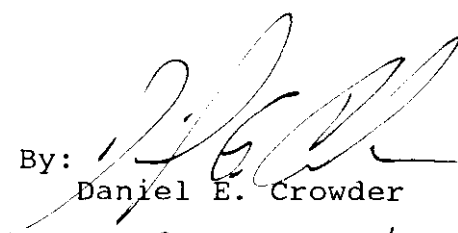
TEST SPECIFICATION: FCC "Code of Federal Regulations" Title 47
Part 95 and Part 2

ENGINEERING TEST REPORT NO. 20415
TYPE ACCEPTANCE MEASUREMENTS FOR
THE MODEL HANDYMIC 216 MHZ TRANSMITTER
FCC ID: KWC004T

FOR: PHONAK, INC.
Naperville, IL

PURCHASE ORDER NO.: 6062

Report By:


Daniel E. Crowder

Approved By:


Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

ENGINEERING TEST REPORT NO. 20415

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: LPRS Transmitter

MODEL NO: HandyMic **SERIAL NO:** None Assigned

MANUFACTURER: Phonak, Inc.

APPLICABLE SPECIFICATIONS: FCC "Code of Federal Regulations"
 Title 47, Part 95 and Part 2,

QUANTITY OF ITEMS TESTED: One (1)

TEST PERFORMED BY: ELITE ELECTRONIC ENGINEERING COMPANY
 1516 Centre Circle
 Downers Grove, Illinois 60515

DATE COMPLETED: March 6, 1998

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):

CUSTOMER: No Phonak, Inc. Personal were present for the testing.
 ELITE ELECTRONIC: Daniel E. Crowder

ELITE JOB NO.: 26314

ABSTRACT: The Model HandyMic 216 MHz Transmitter does meet the RF Power, the modulation characteristics, the occupied bandwidth, the field strength of spurious radiation, and frequency stability of the FCC "Code of Federal Regulations", Title 47, Part 95. See test results and data pages for more details.

ENGINEERING TEST REPORT NO. 20415

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TYPE ACCEPTANCE MEASUREMENTS FOR
A MODEL HANDYMIC 216 MHZ TRANSMITTER**1.0 INTRODUCTION:**

1.1 DESCRIPTION OF TEST ITEM: This report presents the results of a series of radio interference measurements which were performed on a Model HandyMic 216 MHz Transmitter, (hereinafter referred to as the test item). No serial number was assigned to the test item. The test item is powered by a Lithium cell 1.5 volt battery. The tests were performed for Phonak, Inc. of Naperville, Illinois.

1.2 PURPOSE: The test series was performed to determine if the test item meets the type acceptance test requirements of the FCC "Code of Federal Regulations" Title 47, Part 95 for LPRS (auditory assistance).

1.3 APPLICABLE DOCUMENTS: The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 2 and 95, dated 1 October 1997

1.4 SUBCONTRACTOR IDENTIFICATION: This series of tests was performed by the Elite Electronic Engineering Company, radio interference consultants of Downers Grove, Illinois.

2.0 TEST ITEM SETUP AND OPERATION:

The test item is a transmitter for use as an auditory assistance device in the Low Power Radio Service (LPRS) band. A removable external antenna can be connected at the left side near the bottom of the test item. The antenna socket serves also as audio input for an external electrical audio source.

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For radiated tests, the test item was placed on a 0.8 meter high non-conductive stand. The preliminary radiated tests were performed with and without the external antenna. Open Area measurements were performed with the external antenna attached since it represented the worst case emission level.

Since the test item is battery powered, it was ungrounded during the tests.

3.0 TEST EQUIPMENT:

A list of the test equipment used can be found on Table I. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:**4.1 RF POWER OUTPUT:**

4.1.1 REQUIREMENTS: In accordance to Paragraph 95.639(e); the maximum output power that will be authorized for LPRS stations is 100 mW.

4.1.2 PROCEDURES: Since the test item is equipped with an integral antenna, the effective radiated power (ERP) was measured instead of the output power. The measurement equipment was connected to the receiving antenna 3 meters away from the test item. The test item was set to transmit. The level was maximized and recorded.

The ERP into a dipole antenna was calculated from the field intensity levels measured at 3 meters using the equation shown below:

$$P_g = E^2 4\pi d^2 / 120\pi = E^2 d^2 / 30$$

where P = power in watts
 g = arithmetic gain of transmitting antenna over isotropic radiator.
 E = maximum field strength in volts/meter

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d = measurement distance in meter

Using a dipole gain of 1.67 or 2.2 dB and a test distance of 3 meters, this equation reduces to:

$$P(\text{dBm}) = E(\text{dBuV/m}) - 97.2\text{dB}$$

4.1.3 RESULTS OF TESTS: Data page 109 shows the results of the measured ERP. As can be seen from this data page, the maximum ERP at the fundamental was 13.2 dBm or 20.9 mW is well below the 100 milliwatt limit.

4.2 MODULATION CHARACTERISTICS:

4.2.1 REQUIREMENTS: In accordance to Paragraph 2.987, the modulation characteristics shall be determine. These characteristics include the audio response and the maximum frequency deviation.

4.2.2 PROCEDURES:

4.2.2.1 PROCEDURES FOR FREQUENCY RESPONSE OF AUDIO CIRCUIT:

The audio frequency response was measured by establishing a constant sound pressure level at the transmitter's microphone and measuring the FM deviation on the output RF signal.

An acoustic source was setup approximately 65 cm from the input microphone. The sound level was adjusted for a 100% rated FM deviation at 1 kHz. The sound pressure level required to achieve this level was measured using a sound pressure level meter. Next, while maintaining the same sound pressure level, the frequency was varied. The FM deviation was measured and recorded at several frequencies across the frequency range in order to determine the frequency response.

4.2.2.2 PROCEDURES FOR MODULATION LIMITING : With the acoustical source setup as described in 4.2.2.1 above, a measurement

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receiver was connected to a small loop probe antenna which was placed near the test item. The receiver was tuned to the test item's frequency and then set to measure the FM deviation. The audio signal generator frequency was set to 200 Hz. While varying the input level to the acoustical source, the resulting FM deviation was measured and recorded. The sound pressure level (SPL) and resulting FM deviation were recorded. This step was repeated at modulating frequencies of 1000Hz, 3500Hz, and 8000Hz.

4.2.3 RESULTS: The modulation characteristics are shown on data page 101.

The audio response was fairly constant up to 6.0kHz after which the response begins to drop off.

The maximum FM deviation measured 9.1kHz. This deviation was achieved with an input sound pressure level of 95dB at 3500Hz.

Each microphone characteristic was checked. The results were not changed when the microphone characteristic function was changed.

4.3 OCCUPIED BANDWIDTH MEASUREMENTS:

4.3.1 REQUIREMENTS: In accordance with paragraph 95.633(d)(2) and 95.635(c)(1); the channel bandwidth for the standard band is 25 kHz and any emission shall be attenuated below the unmodulated carrier in accordance with the following schedule:

(1) Emissions 12.5 to 22.5 kHz away from the channel center frequency: at least 30 dB.

(2) Emissions more than 22.5 kHz away from the channel center frequency: at least $43 + 10\log(\text{carrier power in watts})$ dB.

4.3.2 PROCEDURES: The measurement equipment was connected to a probe antenna which was placed near the test item. The

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transmitter was modulated by a 2000Hz signal at an audio level set at 16dB higher than the audio level found to produce 50% modulation (2500 Hz). The emissions near the fundamental frequency were plotted. The test was repeated with the transmitter modulated by 3000Hz, 3500Hz, 6250Hz, and 8000Hz signals. Each time the audio level was set at 16dB above the level required to produce 50% modulation.

4.3.3 RESULTS: The plots of the emissions near the fundamental frequency are presented on data pages 102 through 106. As can be seen from this data page, the transmitter met the occupied bandwidth requirements for a 25 kHz channel.

4.4 FIELD STRENGTH OF SPURIOUS EMISSIONS:**4.4.1 PRELIMINARY RADIATED MEASUREMENTS:**

4.4.1.1 REQUIREMENTS: Because emission levels in the open field may be masked by interference from sources other than the test item, preliminary radiated measurements are first performed in the low ambient environment of a shielded enclosure. Radiated emissions from the test item were therefore first measured and automatically plotted using a peak detector. The frequencies with significant emission levels were then manually remeasured in the open field.

4.4.1.2 PROCEDURES: All preliminary tests were performed in a 17ft. x 20ft. x 8ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

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The broadband measuring antennas were positioned at a 1 meter distance from the test item. The entire frequency range from 30MHz to 3GHz was investigated using a peak detector function.

4.4.1.3 RESULTS: The preliminary radiated emissions plots are presented on data pages 107 and 108. This data is only presented for a reference, and is not used as official data. All significant radiated emissions with the test item were subsequently measured at an open area test site.

4.4.2 FINAL RADIATED EMISSIONS:

4.4.2.1 REQUIREMENTS: The test methods of FCC "Code of Federal Regulations", Title 47, Part 2, para. 2.993 regarding field strength of spurious radiation were used in performing these tests with the test item in the transmit mode. According to FCC Part 95, the spurious emissions shall be attenuated by at least $43 + 10\log$ (carrier power in watts) dB which translates to an equivalent power level of -13 dBm into a dipole antenna.

4.4.2.2 PROCEDURES: Final open field measurements were manually performed at Elite's open field test site located in Downers Grove, IL. The open field test site is located in a clear area and is constructed in accordance with ANSI C63.4 1992 requirements. The test site is equipped with a 1/4-inch wire mesh ground plane.

The final open field emission test procedure is as follows:

- a) The test item was placed on a 0.8 meter high non-conductive stand at a 3 meter test distance from the receive antenna.
- b) The external antenna supplied by the manufacturer was used.
- c) The measurement antenna was placed on an adjustable height

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antenna mast 3 meters from the test item.

- d) Detected emissions were maximized at each frequency by rotating the test item and adjusting the receive antenna height and polarization. The maximum meter reading was recorded.

The equivalent power into a dipole antenna was calculated from the field intensity levels measured at 3 meters using the equation shown below:

$$P_g = E^2 4\pi d^2 / 120\pi = E^2 d^2 / 30$$

where P = power in watts
 g = arithmetic gain of transmitting antenna over isotropic radiator.
 E = maximum field strength in volts/meter
 d = measurement distance in meter

Using a dipole gain of 1.67 or 2.2 dB and a test distance of 3 meters, this equation reduces to:

$$P(\text{dBm}) = E(\text{dBuV/m}) - 97.2\text{dB}$$

4.4.2.3 RESULTS OF OPEN FIELD RADIATED TEST: The final open field radiated levels are presented on data page 109. As can be seen from this data, the emissions up through the 10th harmonic met the specification requirements.

4.5 FREQUENCY STABILITY:

4.5.1 REQUIREMENTS: In accordance with Paragraph 95.629(b), an LPRS transmitter operating on the standard band channels must be maintained within a frequency stability of 50 parts per million. The conditions listed in Paragraph 2.995 shall apply.

4.5.2 PROCEDURES: Two separate procedures were performed for each of the two tests which are as follows:

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(a) Frequency Stability vs. Temperature

- (1) The test item was placed in a Thermotron temperature chamber. The test item was powered up.
- (2) The measurement equipment was set to monitor the transmitted frequency.
- (3) The ambient room temperature was recorded and a reference frequency was recorded.
- (4) The temperature was varied from -30 to +50 degrees centigrade in 10 degree increments. The test item was allowed to soak from 30 to 45 minutes at each temperature.
- (5) After this time period, the transmit frequency was recorded.

(b) Frequency Stability vs. Voltage:

- (1) The measurement equipment was set to monitor the transmit frequency.
- (2) The nominal voltage to the test item is 1.2 VDC (Battery). The test item was set to transmit and a reference frequency was recorded.
- (3) With the input voltage was adjusted down to the minimum rated operating voltage (0.96Vdc), the transmit frequency was recorded.
- (4) The input voltage was adjusted up to the maximum rated operating voltage (1.38 Vdc). This frequency was recorded.

4.5.3 RESULTS OF TESTS: The results of the frequency stability tests can be found on data pages 110. As can be seen from the data, the frequency is within the 50 ppm tolerance.

5.0 CONCLUSION:

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It was found that the Phonak Model HandyMic 216 MHz Transmitter, did comply with the requirements of the FCC "Code of Federal Regulations" Title 47, Part 95 as measured per Part 2, para. 2.981.

6.0 CERTIFICATION:

Elite Electronic Engineering Company certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specification.

The data presented in this test report pertains to the test item at the test date.

ENGINEERING TEST REPORT NO. 20415

DATA SHEET

MANUFACTURER : Phonak, Inc.
 TEST ITEM : Transmitter
 MODEL : HandyMic
 SERIAL NUMBER : None Assigned
 TEST PERFORMED : FCC Part 95 Modulation Characteristics
 DATE TESTED : January 13, 1998

AUDIO RESPONSE - FREQUENCY VS. OUTPUT:

Input Level = SPL set @ 65dB

Freq (Hz)	DEV (kHz)	Freq (Hz)	DEV (kHz)	Freq (Hz)	DEV (kHz)	Freq (Hz)	DEV (kHz)
100	6.4	900	4.2	4000	4.8	8000	2.0
200	3.9	1000	5.0	4500	3.4	8500	1.8
300	5.0	1200	4.2	5000	4.4	9000	1.6
400	5.8	1500	4.2	5500	3.6	9500	1.4
500	5.6	2000	5.6	6000	2.6	10000	1.4
600	4.2	2500	3.2	6500	2.4		
700	4.0	3000	3.2	7000	2.2		
800	4.4	3500	4.6	7500	2.8		

MODULATION LIMITING - INPUT VS. FM DEVIATION :

Input	FM Deviation (kHz)			
SPL (dB)	200	1000	3500	8000
50	1.6	1.9	2.0	1.6
55	2.2	2.4	2.6	1.6
60	3.0	3.3	3.2	1.8
65	4.0	5.0	5.0	2.0
70	6.4	6.5	7.0	2.4
75	6.6	7.0	7.4	3.0
80	7.8	7.4	7.8	4.5
85	8.2	8.0	8.2	5.0
90	7.6	8.9	9.0	5.1
95	---	8.9	9.1	5.0

* audio modulation rated 100% when $\Delta f_{DEV} = 5\text{kHz}$ at $f_{mod} = 1\text{kHz}$

Necessary Bandwidth: $2M + 2D = 2(3.5\text{k}) + 2(9.0\text{k}) = 25\text{k}$
 Emission Designator: 25k0F3E

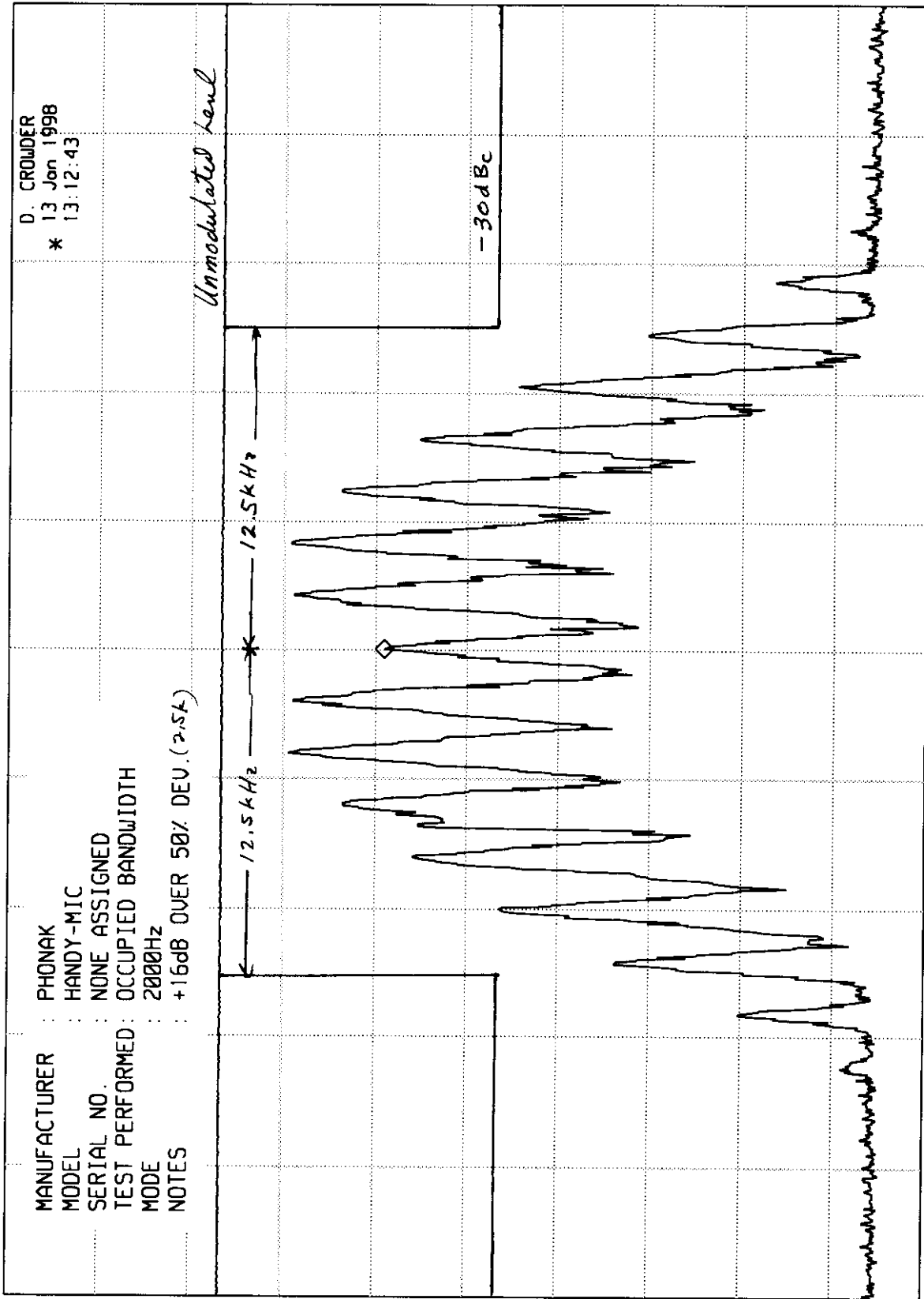
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ELITE ELECTRONIC ENGINEERING CO

MKR 216.213 05 MHz
-41.00 dBm

REF 0.0 dBm ATTN 10 dB

hp
10 dB/



MANUFACTURER : PHONAK
MODEL : HANDY-MIC
SERIAL NO. : NONE ASSIGNED
TEST PERFORMED : OCCUPIED BANDWIDTH
MODE : 2000Hz
NOTES : +16dB OVER 50% DEV. (2.5%)

D. CROWDER
* 13 Jan 1998
13:12:43

SPAN 50.0 kHz
SWP 15.0 sec

VBW 300 Hz

CENTER 216.213 0 MHz
RES BW 100 Hz

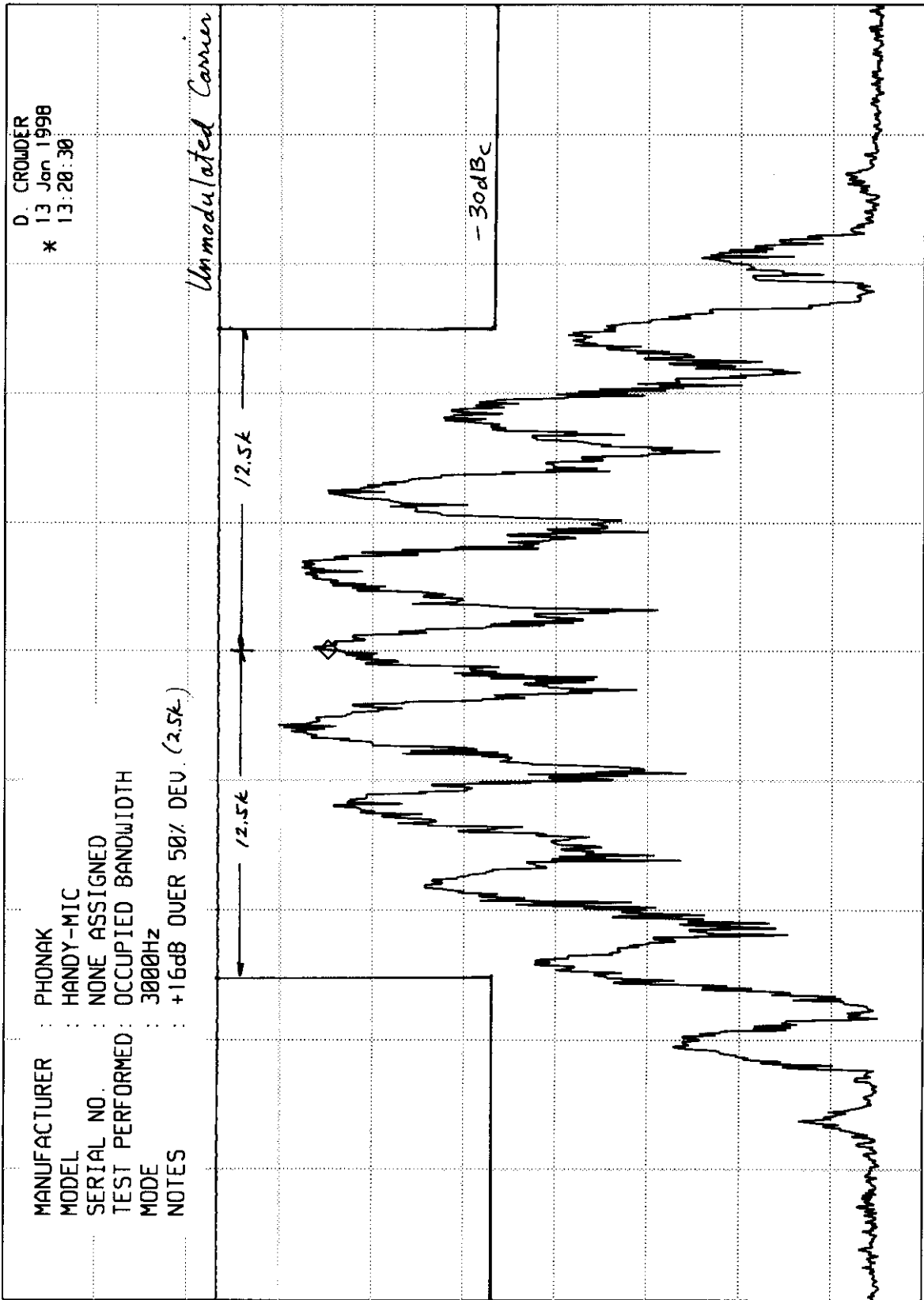
ELITE ELECTRONIC ENGINEERING CO

MKR 216.213 05 MHz
-35.20 dBm

hp

REF 0.0 dBm ATTN 10 dB

10 dB/



SPAN 50.0 kHz
SWP 15.0 sec

VBW 300 Hz

CENTER 216.213 0 MHz
RES BW 100 Hz

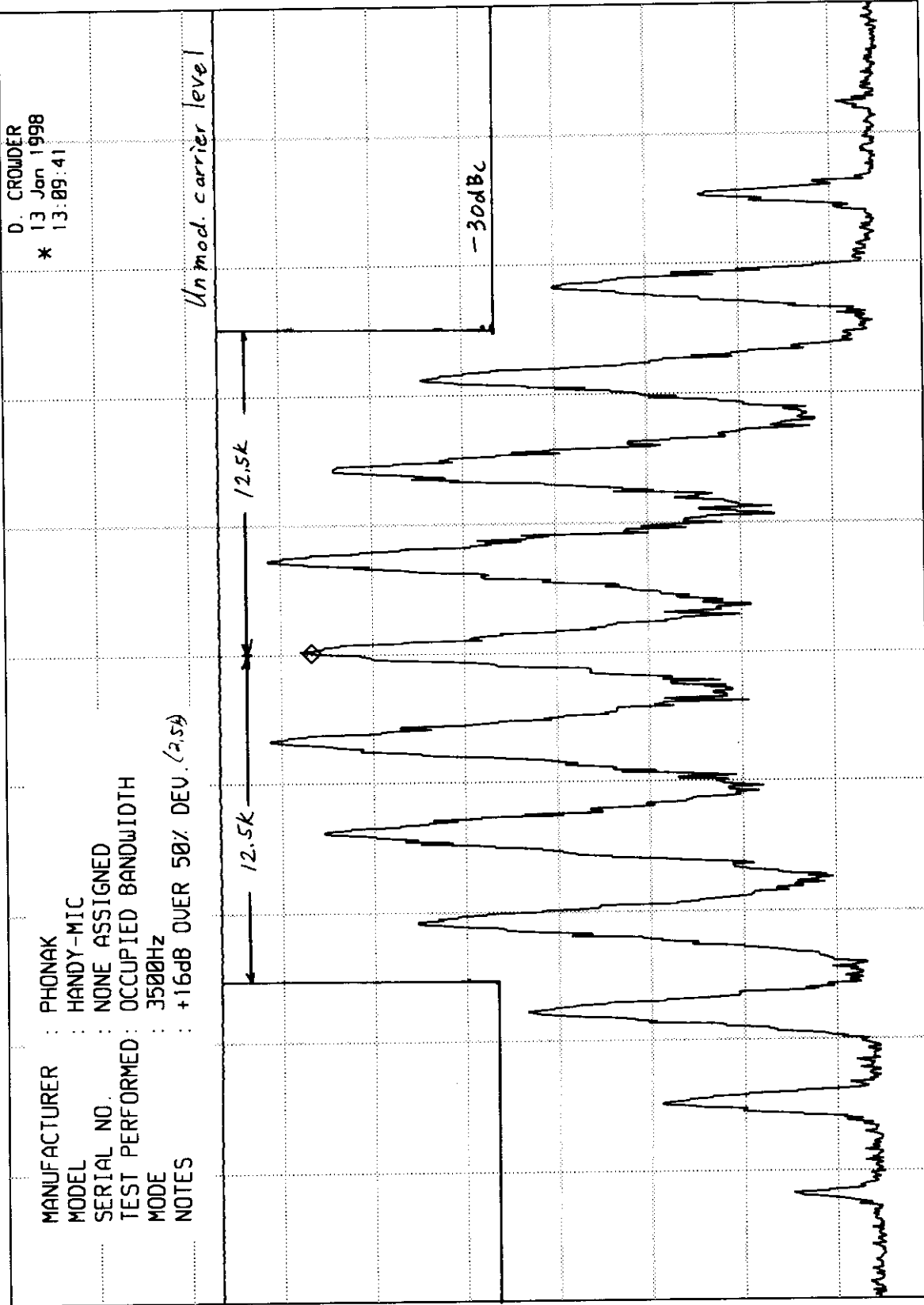
ELITE ELECTRONIC ENGINEERING CO

MKR 216.213 05 MHz
-33.30 dBm

hp

REF 0.0 dBm ATTN 10 dB

10 dB/



CENTER 216.213 0 MHz RES BW 100 Hz VBW 300 Hz SPAN 50.0 kHz SWP 15.0 sec

ELITE ELECTRONIC ENGINEERING CO

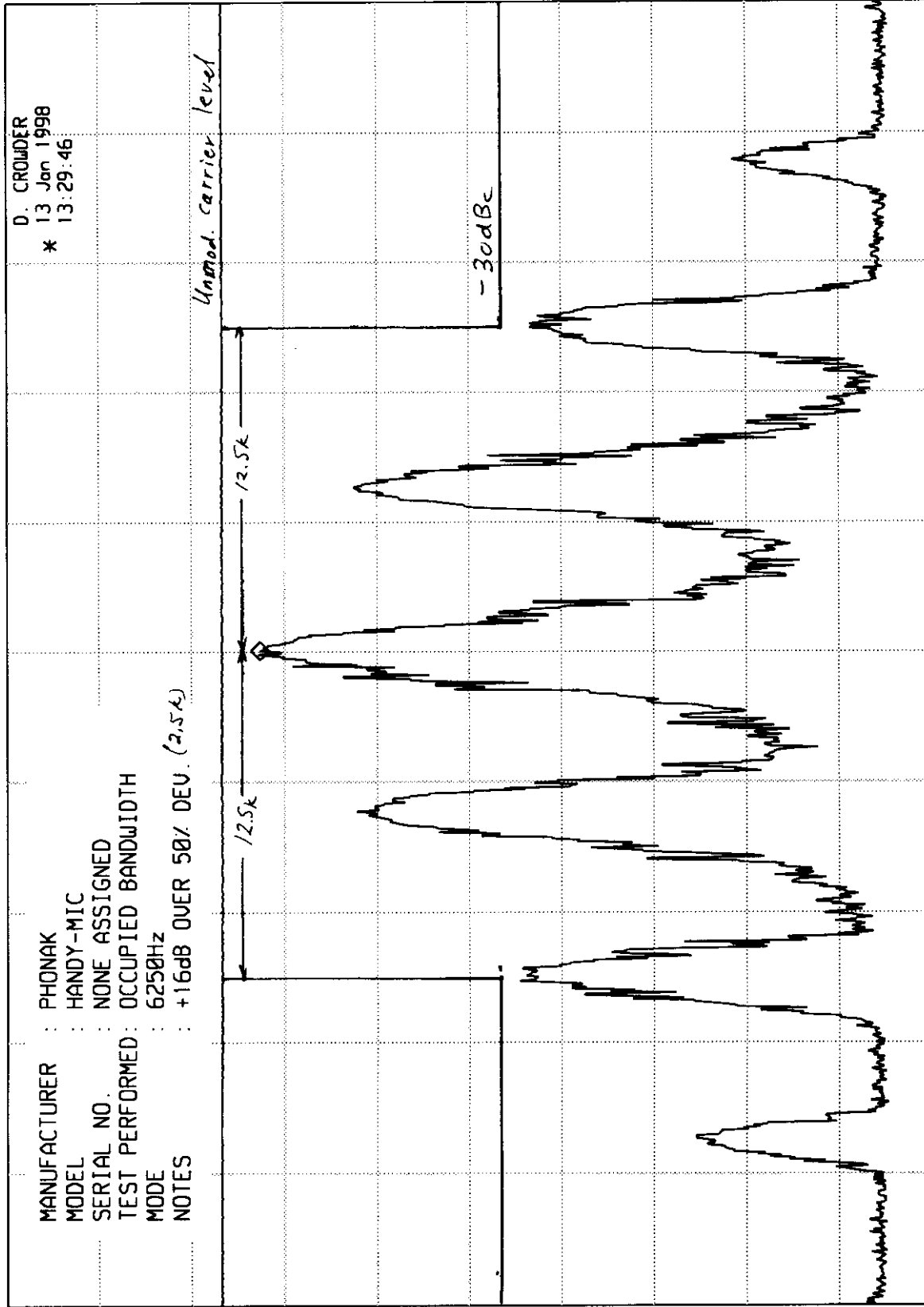
FCC ID: KWC004T

MKR 216.213 05 MHz
-27.40 dBm

hp

REF 0.0 dBm ATTEN 10 dB

10 dB/



SPAN 50.0 kHz
SWP 15.0 sec

VBW 300 Hz

CENTER 216.213 0 MHz
RES BW 100 Hz

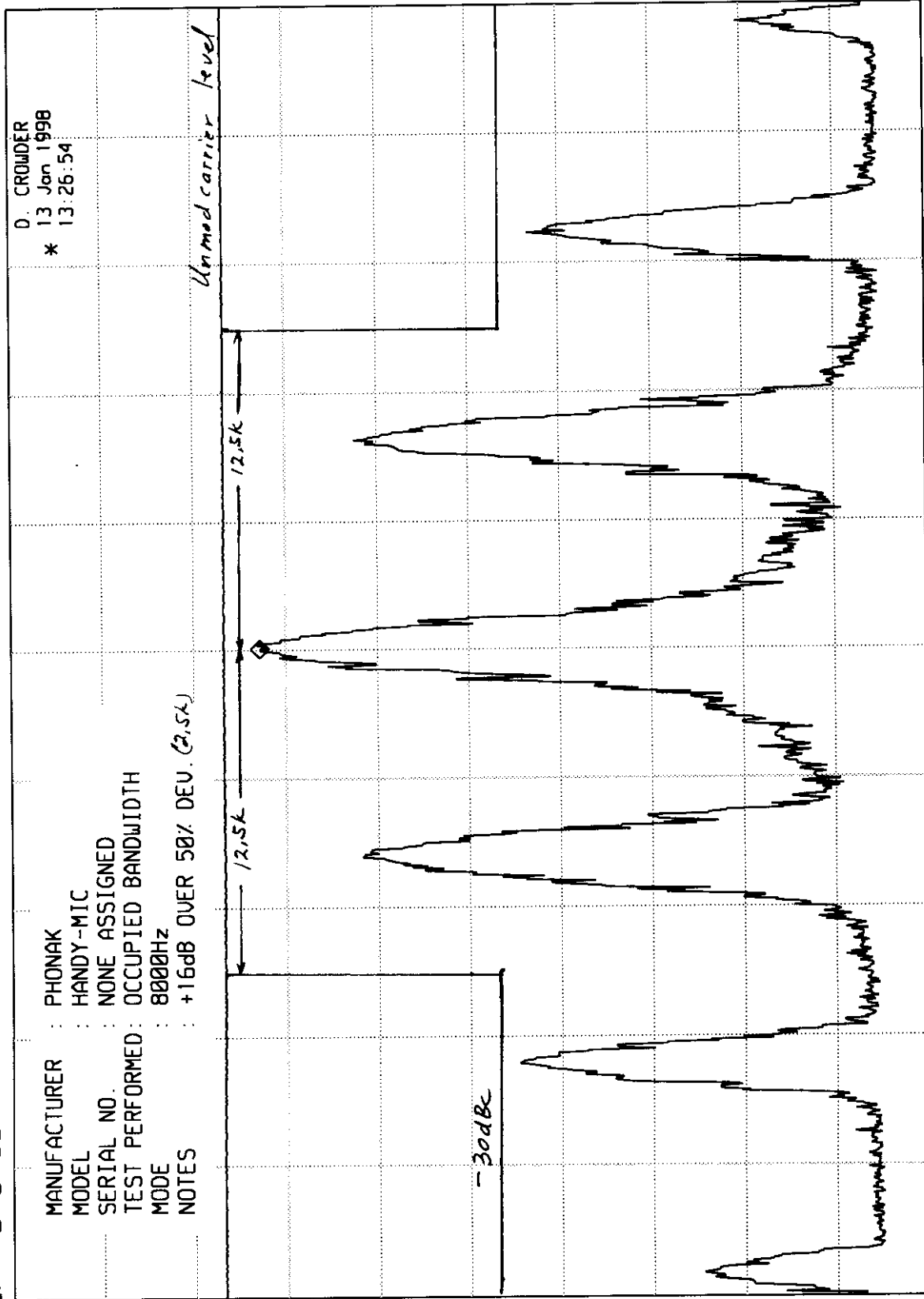
ELITE ELECTRONIC ENGINEERING CO

MKR 216.213 05 MHz
-27.20 dBm

hp

REF 0.0 dBm ATTN 10 dB

10 dB/

SPAN 50.0 kHz
SWP 15.0 sec

VBW 300 Hz

CENTER 216.213 0 MHz
RES BW 100 Hz

ENGINEERING TEST REPORT NO.
ELITE ELECTRONIC ENGINEERING COMPANY

MANUFACTURER : PHONAK, INC.
MODEL : HANDY-MIC
S/N : NONE ASSIGNED
SPECIFICATION : FCC-95 OPEN FIELD SPURIOUS RADIATED EMISSIONS
DATE : MARCH 6, 1998
NOTES : TRANSMIT CW AT 216.04MHz, EXTERNAL ANTENNA

FREQ. (MHz)	ANT POL	MTR RDG (dBuV)	ANT FAC dB	CABLE FAC dB	PRE-AMP GAIN dB	F.I. CORR dB	TOTAL dBm	LIMIT dBm
216.04	H	92.4 100k	16.0	2.0		-97.2	13.2	20
	V	82.9 100k	16.0	2.0		-97.2	3.7	20
432.4	H	13.6 1M	19.5	2.9		-97.2	-61.2	-13
	V	14.8 1M	19.5	2.9		-97.2	-60.0	-13
648.6	H	32.0 1M	24.6	3.6		-97.2	-37.0	-13
	V	28.5 1M	24.6	3.6		-97.2	-40.5	-13
864.8	H	19.5 1M	27.5	4.2		-97.2	-46.0	-13
	V	17.9 1M	27.5	4.2		-97.2	-47.6	-13
1081.0	H	49.0 1M	24.0	1.6	37.3	-97.2	-59.9	-13
	V	51.3 1M	24.0	1.6	37.3	-97.2	-57.6	-13
1297.2	H	54.1 1M	24.9	1.8	36.8	-97.2	-53.2	-13
	V	57.7 1M	24.9	1.8	36.8	-97.2	-49.6	-13
1513.4	H	49.5 1M	25.5	2.0	36.7	-97.2	-56.9	-13
	V	50.5 1M	25.5	2.0	36.7	-97.2	-55.9	-13
1729.6	H	55.8 1M	26.2	2.2	36.4	-97.2	-49.4	-13
	V	51.7 1M	26.2	2.2	36.4	-97.2	-53.5	-13
1945.8	H	54.9 1M	27.1	2.4	36.2	-97.2	-49.0	-13
	V	50.6 1M	27.1	2.4	36.2	-97.2	-53.3	-13
2162.0	H	51.5 1M	27.6	2.6	36.1	-97.2	-51.6	-13
	V	58.1 1M	27.6	2.6	36.1	-97.2	-45.0	-13

CHECKED BY: *RJK*

ENGINEERING TEST REPORT NO. 20415

DATA SHEET

MANUFACTURER : Phonak, Inc.
 TEST ITEM : Transmitter
 MODEL : HandyMic
 SERIAL NUMBER : None Assigned
 TEST PERFORMED : FCC Part 95 Frequency Stability
 DATE TESTED : January 14, 1998
 TEST SPECIFICATION : Tolerance of 50 ppm

vs. Temperature:

Temperature Degrees Centigrade	Frequency MHz	Duration Minutes	Change ppm	Limit ppm
-30	216.212667	30	3	50
-20	216.213340	30	1	50
-10	216.213340	30	2	50
0	216.213879	30	3	50
10	216.213593	30	1	50
20	216.213298	30	1	50
24	216.213305	--	Ref.	---
30	216.213013	30	1	50
40	216.212792	30	3	50
50	216.212721	30	3	50

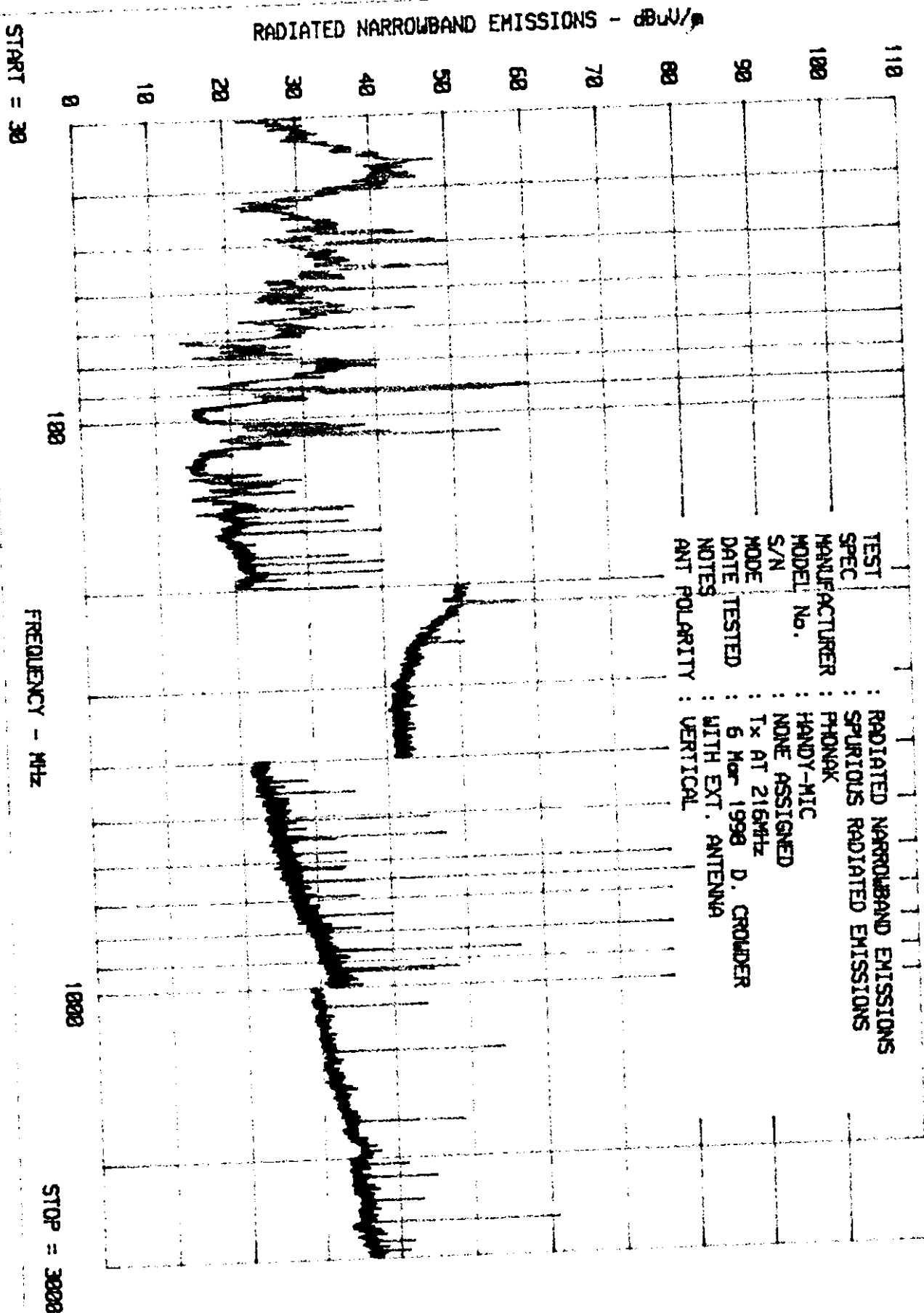
vs. Voltage:

Voltage VDC	Rated Voltage	Frequency MHz	Change ppm	Limit ppm
1.0	Minimum	216.211615	8	50
1.2	Nominal	216.213254	Ref	Ref
1.4	Maximum	216.213275	1	50

Checked By: R. J. K.

ELITE ELECTRONIC ENGINEERING Co.
 Downers Grove, Ill. 60515

TEST SPEC : RADIATED NARROWBAND EMISSIONS
 MANUFACTURER : PHONAK
 MODEL No. :
 S/N :
 MODE :
 DATE TESTED : Tx AT 216MHz
 NOTES : 6 Mar 1998 D. CROUDER
 ANT POLARITY : WITH EXT. ANTENNA
 : VERTICAL





ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Ill. 60515

TEST : RADIATED NARROWBAND EMISSIONS
SPEC : SPURIOUS RADIATED EMISSIONS
MANUFACTURER : PHONAK
MODEL No. : HANDY-MIC
S/N : NONE ASSIGNED
MODE : Tx AT 216MHz
DATE TESTED : 6 Mar 1998 D. CROWDER
NOTES : W/O EXT ANTENNA
ANT POLARITY : VERTICAL

