E. F. JOHNSON COMPANY

WASECA, MINNESOTA 56093

Test report for FCC Type Acceptance of the Johnson 242-2008-132 Repeater. All measurements made per TIA/EIA-603 unless otherwise noted.

TRADE NAME:	SUMMIT QX
MODEL NUMBER:	242-2008-132
MANUFACTURER:	E. F. Johnson Company, Waseca, MN 56093
FCC ID NUMBER:	FCC ID: ATH2422008 Transmitter
FCC RULES AND REGS:	FCC Part (s) 90
FREQUENCY RANGE:	Frequency 851-869 MHz
SERIAL NUMBER (S):	FEP #304

DATE: 5-27-93

TEST PERFORMED BY:

William M. Junge
Certified Technologist II

Douglas A. Knoll
Engineer III

APPROVED BY:

Neil Hovelsrud
Engineering Manager

AFFIDAVIT

The technical data included in this report has been accumulated through tests that were performed by me or by engineers under my direction. To the best of my knowledge, all the data is true and correct.

Neil Hovelsrud
Engineering Manager

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QUALIFICATIONS OF ENGINEERING PERSONNEL

NAME:	William M. Junge
TITLE:	Certified Technologist II
TECHNICAL EDUCATION:	Associate Arts Degree in Electronics Rochester Community College, Mankato State University, Esectronic Communication Course, Spring of 1987
TECHNICAL EXPERIENCE:	12 years in design and development of airborne, repeater, mobile, telemetry, and two-way radios

NAME:	Douglas A. Knoll
TITLE:	Engineer III
TECHNICAL EDUCATION:	Milwaukee School of Engineering Graduate BSEET 1986. Marquette University Graduate, Masters of Science in Engineering 1990.
TECHNICAL EXPERIENCE:	4 years Bench Technician Wisconsin Cable and Radio Co. 4 years Microwave Engineering National Biomedical ESR Center, Milwaukee County Medical Center. 3 years in design and development of repeater and mobile radios at E.F. Johnson Co.

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GENERAL INFORMATION

Rule Part No.: 2.983 (d)

TRANSMITTER

TYPE OF EMISSION:	16KOF3E, 16KOF3D, 16K0F1D 14KOF3E, 14KOF3D, 14K0F1D
FREQUENCY RANGE:	851.0125–869.9875 MHz
MINIMUM POWER RATING:	25.0 Watts
MAXIMUM POWER RATING:	85.0 Watts
NUMBER OF CHANNELS:	1 of 840 channels
INPUT IMPEDANCE:	50 ohms, nominal
VOLTAGE REQUIREMENTS:	110 VAC @ 4 Amps Multiple Voltage Switching Power Supply, Tectrol Inc. TC47S–1047 26.5 Vdc, 15.0 Vdc, 5.0 Vdc, and –5.0 Vdc.

DESCRIPTION OF CIRCUITRY

1.0 EXCITER

1.1 SYNTHESIZER

The synthesizer inputs/outputs are shown in Figure 1 and the exciter block diagram in Figure 2. The synthesizer output signal is the transmit frequency. This signal is produced by a VCO (voltage–controller oscillator). The frequency of this oscillator is controlled by a DC voltage produced by synthesizer chip U403.

Frequencies are selected by programming counters in U403 to divide by a certain number. This programming is provided through J201, pins 12, 19 and 20. The frequency stability of the synthesizer is established by the ±1.0 PPM stability of TCXO Y401. This oscillator is stable from −30° C to +60° C (−22° F to +140° F).

The VCO frequency of A007 is controlled by a DC voltage produced by the phase detector in U403. The phase detector senses the phase and frequency of the two input signals and causes the VCO control voltage to increase or decrease if they are not the same. When the frequencies are the same, the VCO is then "locked" on frequency.

One signal is the reference frequency (f_R). This frequency is the 17.500 MHz TCXO frequency divided by the reference counter to be half the channel spacing or 12.5 kHz.

The other signal (fv) is from the VCO frequency divided by the "N" counter in U403. This counter is programmed through the synthesizer data line on J401, pin 20. Each channel is programmed by a divide number so that the phase detector input is identical to the reference frequency when the VCO is locked on the correct frequency.

The synthesizer contains the R (reference), N, and A counters, phase and lock detectors and counter programming circuitry.

Frequencies are selected by programming the three counters in U403 to divide by an assigned number. The programming of these counters is performed by circuitry in the Main Processor Card (MPC), buffered and latched through the Interface Alarm Card (IAC) and fed in to the synthesizer on J401, pin 20 to Data input port U403, pin 19.

Data is loaded into U403 serially on the Data input port U403, pin 19. Data is clocked into the shift registers a bit at a time by a low to high transition on the Clock input port U403, pin 18. The Clock pulses come from the MPC via the IAC to J401, pin 19. Data is first loaded into the 1–bit shift register and then into the 7–, 10–, and 14–bit registers. The last bit loaded is present in the 1–bit register and determines which counters will be programmed. If this bit is a 1, the data is latched into the "R" counter when the Enable input port U403, pin 17 goes low. If this bit is a 0, data is latched into only the "A" and "N" counters.

As previously stated, the counter divide numbers are chosen so that when the VCO is operating on the correct frequency, the VCO–derived input to the phase detector (fv) is the same frequency as the TCXO–derived input (f_R).

The f_R input is produced by dividing the 17.500 MHz TCXO frequency by 1187. This produces a reference frequency (f_R) of 12.5 kHz. Since the VCO is on frequency and no multiplication is used, the frequencies are changed in 12.5 kHz steps. The reference frequency is 12.5 kHz for all frequencies selected by this exciter.

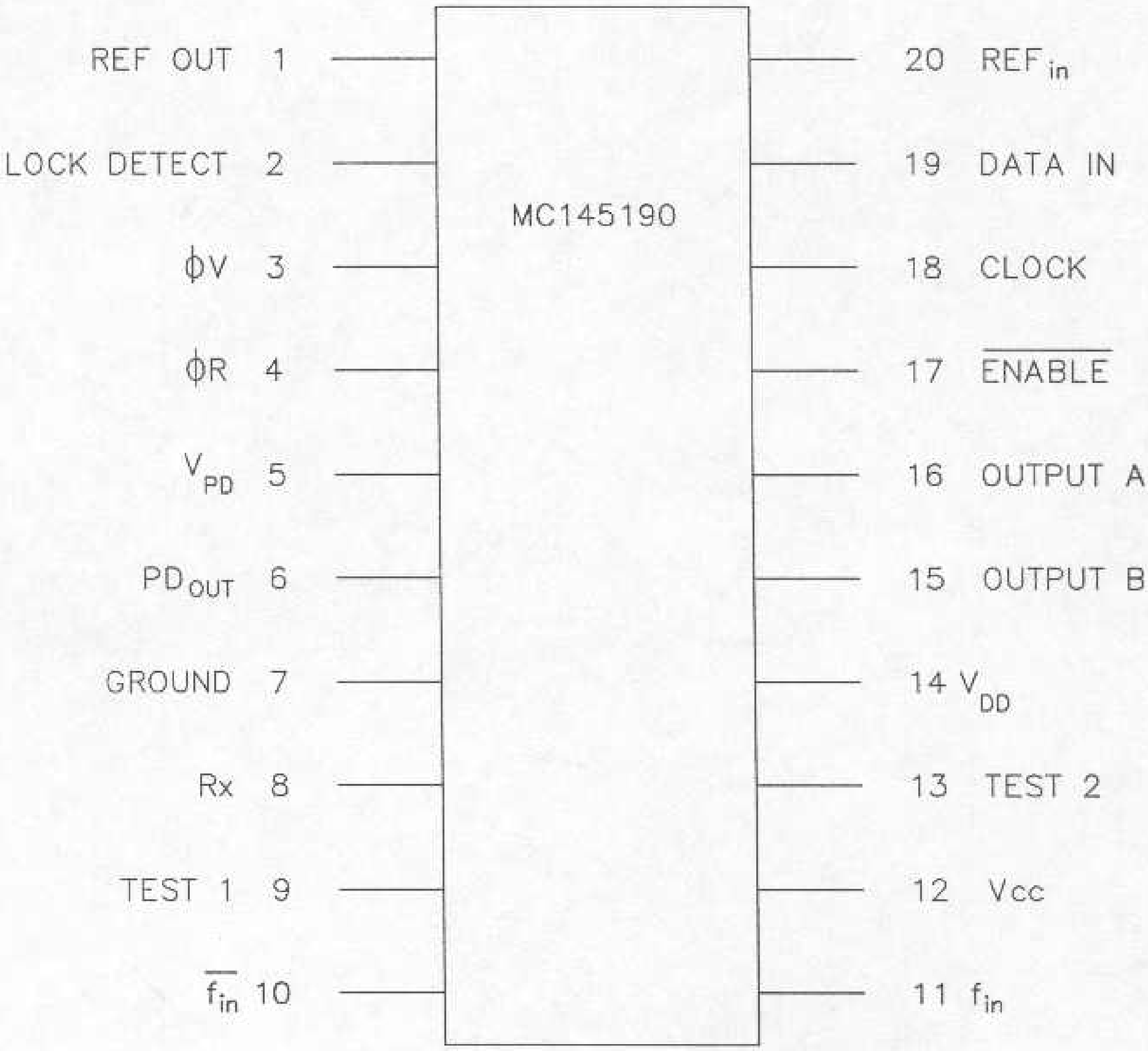

MC145190
REF OUT 1
LOCK DETECT 2
ϕV 3
ϕR 4
V_{PD} 5
PD_{OUT} 6
GROUND 7
Rx 8
TEST 1 9
$\overline{f_{in}}$ 10
20 REF_{in}
19 DATA IN
18 CLOCK
17 $\overline{ENABLE}$
16 OUTPUT A
15 OUTPUT B
14 V_{DD}
13 TEST 2
12 Vcc
11 f_{in}

Figure 1

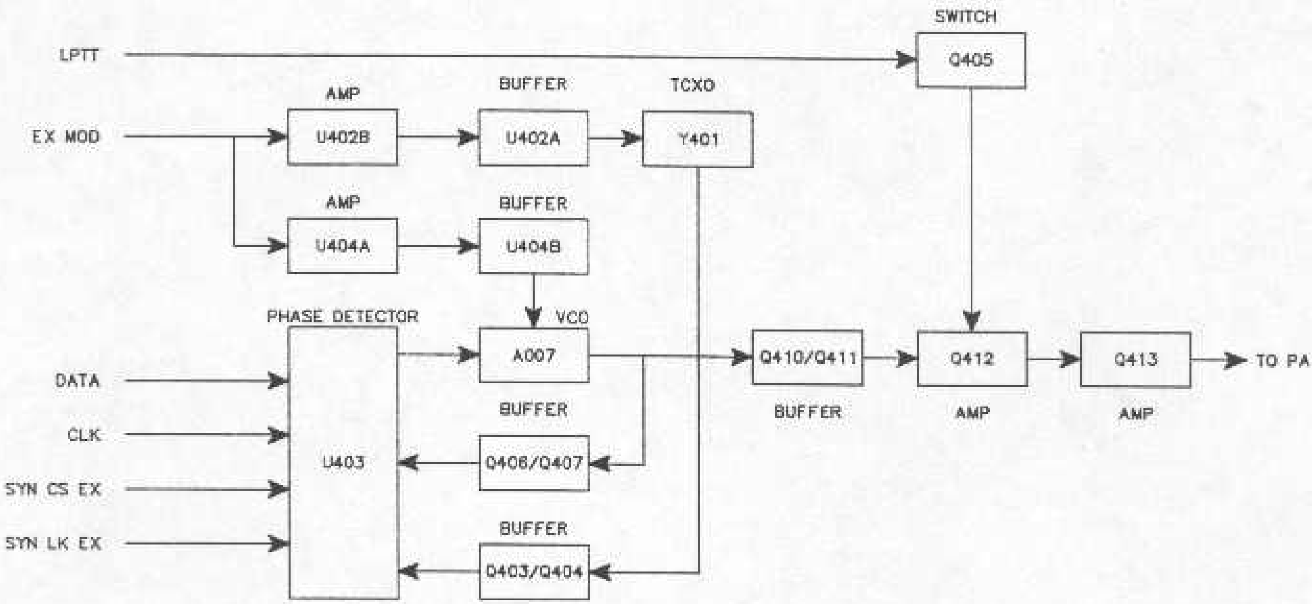


Figure 2

The fv input is produced by dividing the VCO frequency using the prescaler and N counter in U403. The prescaler divides by 64 or 65. The divide number of the prescaler is controlled by the N and A counters in U403. The N and A counters function as follows:

Both the N and A counters begin counting down from their programmed number. When the A counter reaches zero, it halts until the N counter reaches zero. Both counters then reset and the cycle repeats. The A counter is always programmed with a smaller number than the N counter. While the A counter is counting down, the prescaler divides by 65. Then when the A counter is halted, the prescaler divides by 64.

Example: To illustrate the operation of these counters, assume a transmit frequency of 859.500 MHz. Since the VCO is on-frequency for transmit this frequency is used. To produce this frequency, the N and A counters are programmed as follows:

N = 1074 A = 24

To determine the overall divide number of the prescaler and N counter, the number of VCO output pulses required to produce one N counter output pulse can be counted. In this example, the prescaler divides by 65 for 65 x 24 or 1560 input pulses. It then divides by 64 for 64 x (1074 - 24) or 67,200 input pulses. The overall divide number K is therefore (67,200 + 1560) or 68,760. The VCO frequency of 859.500 MHz divided by 68,760 equals 12.5 kHz which is the f_R input to the phase detector. The overall divide number K can alsobe determined by the following formula: **K = 64N + A**

Where,

N = N counter divide number and
A = A counter divide number.

1.2 LOCK DETECT

When the synthesizer is locked on frequency, the Lock Detect output on U403, pin 2 is basically a high voltage because only narrow negative-going pulses are present. When the synthesizer is unlocked, the negative-going pulses are much wider.

The locked or unlocked condition of the synthesizer is filtered by R440 and C423 and applied to J401, pin 16 and sent to the RF Interface J102, pin 16 for detection.

1.3 VCO AND TCXO FREQUENCY MODULATION

Both the VCO and TCXO are modulated in order to achieve the required frequency response. If only the VCO was modulated, the phase detector in U403 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change at the lower audio frequencies. If only the TCXO frequency was modulated, the VCO frequency would not change fast enough at the higher audio frequencies. However, by modulating both the VCO and TCXO, the two phase detector inputs remain in phase and no frequency shift is sensed. This produces a flat audio response. Potentiometers R425 and R448 balance the modulating signals.

1.4 BUFFER AMPLIFIER (Q410, Q411)

A cascode amplifier formed by Q410 and Q411 provides amplification and also isolation between the VCO and exciter RF stages. A cascode amplifier is used because it provides high gain, high isolation and consumes only a small amount of power. The input signal to this amplifier is tapped from VCO A007 on pin 6. C441 provides DC blocking. Bias for the amplifier is provided by R484, R485, R486, R487 and R468. L408 is a RF choke and R483 lowers the Q of the coil. RF bypass is provided by C434, C442, C445, C443, C444 and C480. The output of Q410/Q411 is matched to the exciter RF stages by C448, R460 and two sections of microstrip.

1.5 RF AMPLIFIERS (Q412, Q413)

RF amplifier Q412 is biased by R469, R470 and R472. AC ground is provided by C450. C448 provides RF bypass from the DC line and R471 provides supply voltage isolation. A section of microstrip on the collector acts as an RF choke to the supply line. Q410 is matched to Q411 by C449, C451 and two sections of microstrip.

RF amplifier/buffer Q413 is similar in design to Q412. The collector and base voltage of Q413 is switched by Q405. The Logic Push-To-Talk (LPTT) on J401, pin 11 turns on Q405 and conducts the 15V supply to the collector of Q405 and to Q413. The output of Q413 is matched to 50 ohms by two sections of microstrip and C485 provides DC blocking. The RF output of the exciter is on coaxial connector J402 to the power amplifier.

2.0 POWER AMPLIFIER

2.1 AMPLIFIER/PREDRIVER (U501)

The PA block diagram is shown in Figure 3. RF input to the PA from the Exciter is through a coaxial cable and connector to WO511. C501 couples the RF to 50 ohm microstrip that matches the input to U501. U501 is a 6W amplifier/ pre-driver operating in the 851-869 MHz range.

Power control is connected to WO505 from the RF Interface board (RFI). RF is filtered from the control voltage line by various capacitors and inductors to U501, pin 2. This control voltage regulates the RF output of the amplifier on U501, pin 4 to approximately 4W.

2.2 DRIVER (Q501)

The output of U501 passes through several sections of 50 ohm microstrip and bypass filter capacitors to the emitter of Q501. Driver Q501 is a common base amplifier with an output of approximately 22W. Supply voltage is RF bypassed by various capacitors and microstrip. C521 matches the output of the driver on J501 to the input impedance of the combiner to the final amplifiers.

2.3 FINAL AMPLIFIERS (Q502, Q503)

Q502 and Q503 are parallel 60W amplifiers. The 22W RF input from J501 on the output of the driver Q501 is applied to WO514 through a coaxial cable and connector. A 50 ohm microstrip connects the RF to a 70.7 ohm quarter-wave combiner and to the emitter of each common-base amplifier. The outputs on the collectors of the amplifiers are combined using another combiner for an output of approximately 120W. The output of the combiner is matched to 50 ohms by a section of microstrip and fed from WO513 directly to the low-pass filter via a jumper.

2.4 POWER DETECTORS (U504A, U502B)

Inductive coupling is used to detect the output of each final amplifier. The detected RF is then fed to a rectifier to create a voltage output indication of the power output. The outputs of U504A and U502B are monitored by the RF Interface board and the repeater software. If a final amplifier fails, the software will reduce the output power to prevent overdriving the remaining final amplifier.

2.5 THERMAL SENSOR (U503)

Thermal protection is provided by temperature sensor U503. The operating range of the sensor is from 0 to 100° C (32° F to 212° F). CR505 is used to reference U503 above ground to allow the sensor to read below 0° C. Amplifier U502A sends the output of U503 to WO509 and to the RF Interface board. The RF Interface board reduces the power amplifier to half power if the temperature reading is too high and also uses the reading to turn on and off the fan. The fan for the RF Interface board is turned on at approximately 50° C and off again at approximately 45° C.

2.6 FORWARD/REVERSE POWER DETECT, ISOLATOR, LOW-PASS FILTER

The power amplifier output is directly coupled to the forward/reverse power detect board via a jumper. The output then enters the isolator and exits to the low-pass filter board to the antenna jack for a nominal power output of 75W. If an antenna is not connected to the low-pass filter, the isolator connects the output power to the no antenna load R685.

Forward and reverse power are inductively coupled from the input and output of the isolator. R663 and R680 set the threshold for the forward and reverse sense levels. The sensed levels are coupled to the RF Interface board and software.

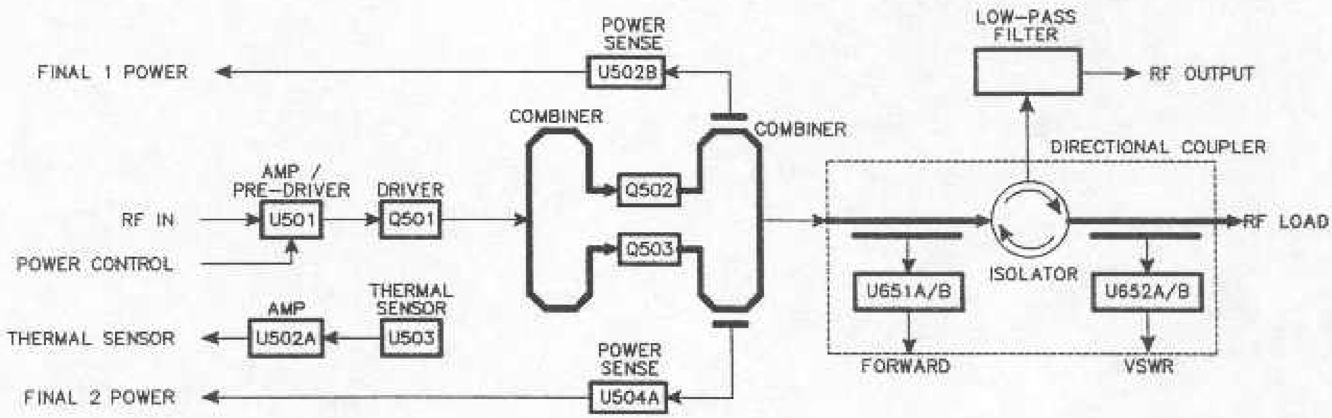

POWER
SENSE
U502B
FINAL 1 POWER
LOW-PASS
FILTER
RF OUTPUT
COMBINER
COMBINER
DIRECTIONAL COUPLER
AMP /
PRE-DRIVER
DRIVER
RF IN
U501
Q501
Q502
Q503
RF LOAD
POWER CONTROL
ISOLATOR
U651A/B
U652A/B
THERMAL
SENSOR
AMP
THERMAL SENSOR
U502A
U503
FORWARD
VSWR
POWER
SENSE
FINAL 2 POWER
U504A

Figure 3

TRANSMITTER
TRANSISTOR, DIODE, AND IC FUNCTIONS

Designator	Part Number	Function	JEDEC or Vendor Type
PA			
CR501	523-1504-016	Hot Carrier Diode	MMBD501
CR504	523-1504-016	Hot Carrier Diode	MMBD501
CR505	523-1504-023	Voltage Reference Diodes	MBAV99
U502	544-2019-004	Buffer Amplifier	LM2904
U503	544-2032-003	Temperature Sensor	LM35DM
U504	544-2019-004	Buffer Amplifier	LM2904
U505	544-2603-039	Voltage Regulator	MC78LO5ACM
A011	023-2008-600	800 MHz Low Pass Filter	EFJ0232008600
PA010	023-2008-660	FWD/REV PWR Detector	EFJ0232008660
U501	544-4001-045	Pre-Driver	MHW806AZ
Q501	576-0004-821	RF Driver	MRF894
Q502	576-0004-820	RF Final	MRF898
Q503	576-0004-820	RF Final	MRF898
Exciter			
Q412	576-0003-628	Exciter Driver	NE85633-T1B
Q413	576-0004-098	Exciter Final	MRF8372-R1
SYNTHESIZER AND VCO			
U403	544-3954-026	Synthesizer/Prescaler	MC145190F
Q410	576-0003-628	Buffer	NE85633-T1B
Q411	576-0003-628	Buffer	NE85633-T1B
Q801	576-0001-300	Capacitance Multiplier	MMBT5089LT1
Q802	576-0003-628	V.C.O.	NE85633-T1B
CR801	523-1504-015	Modulation Varactor	MMBV105G
CR802	523-1504-002	VCO Varactor	MV1204-04
TCXO			
Y401	518-7117-500	1.0 PPM TCXO	EFJ 17.5MHz TCXO
Q403	576-0003-658	Buffer	MMBT3904L-T1
Q404	576-0003-658	Buffer	MMBT3904L-T1

TRANSMITTER TUNE UP PROCEDURE

1.0 Preset C521 on the PA Board to mid-range and R663 on F/R Power Detect Board fully clockwise.

2.0 Use and ohmmeter to verify all feedthru capacitors are not shorted to ground except for the feedthru that is ground.

2.1 Inspect the Power Amplifier. Make sure that the RF power transistors are properly soldered and that all components/connections from the final collectors to the circulators are properly soldered.

3.0 Connect an attenuator and power meter to J501.

3.1 Connect the power supply Ground lead to P105, the 15.0 Vdc lead to P103, the 26.5 Vdc lead to P101, and the 36 pin cable to J101 on the RFIB.

4.0 Run PC Test Software and set the power level to #140.

5.0 Set the RF Signal Generator to +15 dBm +/- 0.1 db @ 870 MHz.

6.0 Key up the PA and set R116 on the RFIB for 22 Watts +/- 0.2 db (+/- 1 Watt).

7.0 Tune C521 for Maximum power.

8.0 Re-set R116 for 22 Watts +/- 0.2 db (+/- 1 Watt).

8.1 Re-peak C521. Unkey the Power Amplifier.

9.0 Set the RF Signal Generator to +15 dBm +/- 0.1 db @ 860 MHz and key the Power Amplifier.

10.0 Adjust R116 for 46 Watts +/- 0.2 db (+/- 2 Watts). Unkey the Power Amplifier.

11.0 Set the RF Signal Generator to +15 dBm +/- 0.1 db @ 850 MHz and key the Power Amplifier.

12.0 Re-adjust R116 for 46 Watts +/- 0.2 db (+/- 2 Watts) only if the power exceeds 46 Watts. Unkey the Power Amplifier.

13.0 Remove 26.5 Vdc from P101.

14.0 Disconnect the attenuator and power meter from J502 and Connect to A8, the Transmit Antenna Connector.

15.0 Connect A501 to J501 making sure to position the cable midway between the driver collector feed and the adjacent input Wilkinson combiner traces on the printed circuit board.

15.1 Re-set R663 fully counterclockwise.

15.2 Re-connect 26.5 Vdc to P101.

16.0 Set the RF Signal Generator to +15 dBm +/- 0.1 db @ 860 MHz and key the Power Amplifier.

17.0 Adjust Forward Power Calibration Pot R663 to yield 85 Watts +/- 0.1 db (+/-2 Watts).

17.1 Check that the Power Output at 850 MHz and 870 MHz is within 0.25 db (+/- 5 Watts).

17.2 Verify from the test computer that Output 1 is within 20% of Output 2.

18.0 Unkey the Power Amplifier.

18.1 Remove load cable from A8, the Transmit Antenna Connector. Key the Power Amplifier.

19.0 Adjust Reverse Power Calibration Pot R680 for equal voltages on W126 and W121 or by setting Forward Power and Reverse Power equal on the test computer. Unkey the Power Amplifier.

20.0 Apply "glyptol" to R663, R680, and R116.

21.0 Momentarily short R171 on the RFIB. The PA fan should turn on.

22.0 Measure the temperature detector voltage @ W127 on the RFIB. Normal output at 25C ambient is approximately 2.1 Vdc.

Tx Power: 25 Watts Minimum 85 Watts Maximum

Tx Current: 10.0 A Maximum

NAME OF TEST: Transmitter Rated Power Output

RULE PART NUMBER: 2.985 (a)

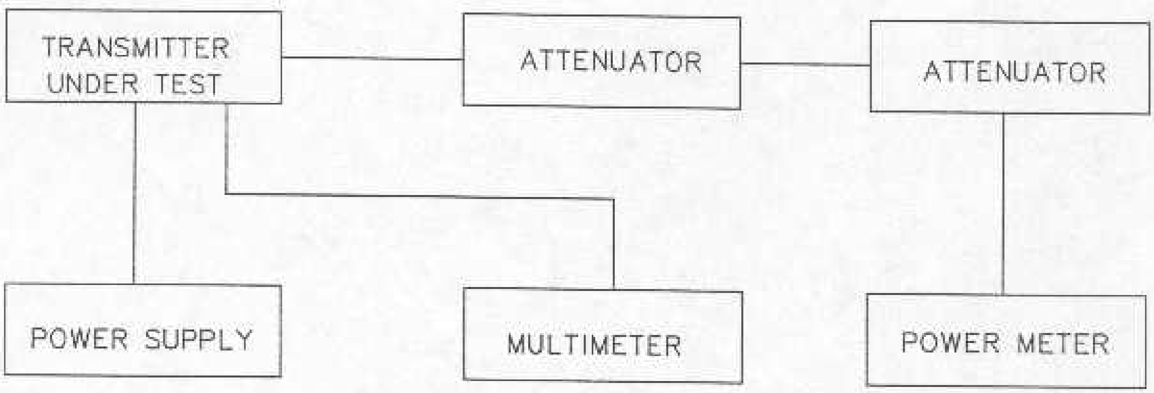
TEST RESULTS: See results below.

TEST CONDITIONS: Standard Test Conditions.
Multiple Voltage Switching Power Supply, Tectrol Inc. TC47S-1047

TEST EQUIPMENT:
Attenuator, Tenuline Model 8323
Attenuator, Tenuline Model 8340-200
Power Meter, HP436A
Power Supply, Tectrol Inc. TC47S-1047
Multimeter, Model 8012A Fluke

PERFORMED BY: William M. Junge DATE: 5-27-93

TEST SET-UP:



TEST SET-UP

MEASUREMENTS TAKEN:

DC Voltage at Final	DC Current Into Final	DC Power Into Final	Power Output
26.5 VDC	7.0 Amps	185.5 Watts	85 W

NAME OF TEST: Frequency Response of Transmitter Audio Modulating Circuit

RULE PART NO.: 2.987 (a)

TEST RESULTS: See curve on following page.

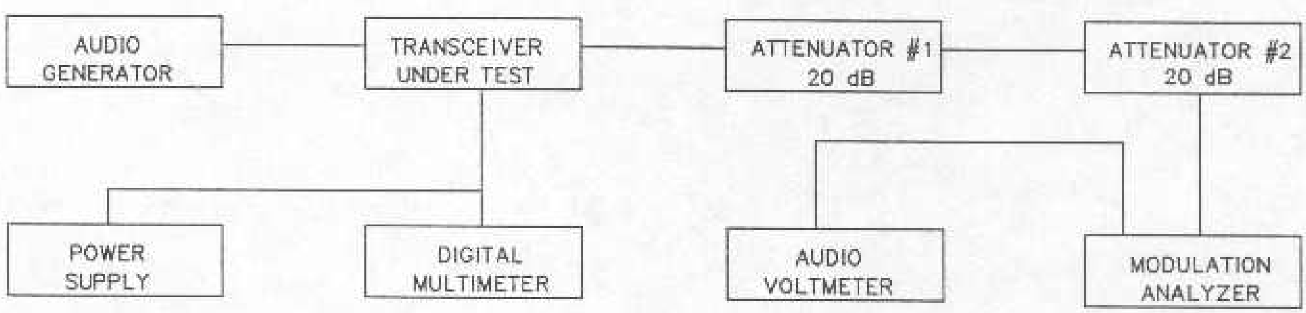
TEST CONDITIONS: Prevailing room and conditions, temperature 26 C
Multiple Voltage Switching Power Supply, Tectrol Inc. TC47S-1047

TEST EQUIPMENT:

Attenuator, Tenuline Model 8340-200
Attenuator, Tenuline Model 8323
Modulation Analyzer, Model HP 8901A
Multimeter, Model 8012A Fluke
Audio Generator, Model HP-8903A
Audio Voltmeter, Model HP-8903A
Power Supply, Tectrol Inc. TC47S-1047
Modulation Analyzer, Model HP 8901A

PERFORMED BY: William M. Junge DATE: 5-27-93

TEST SET-UP:



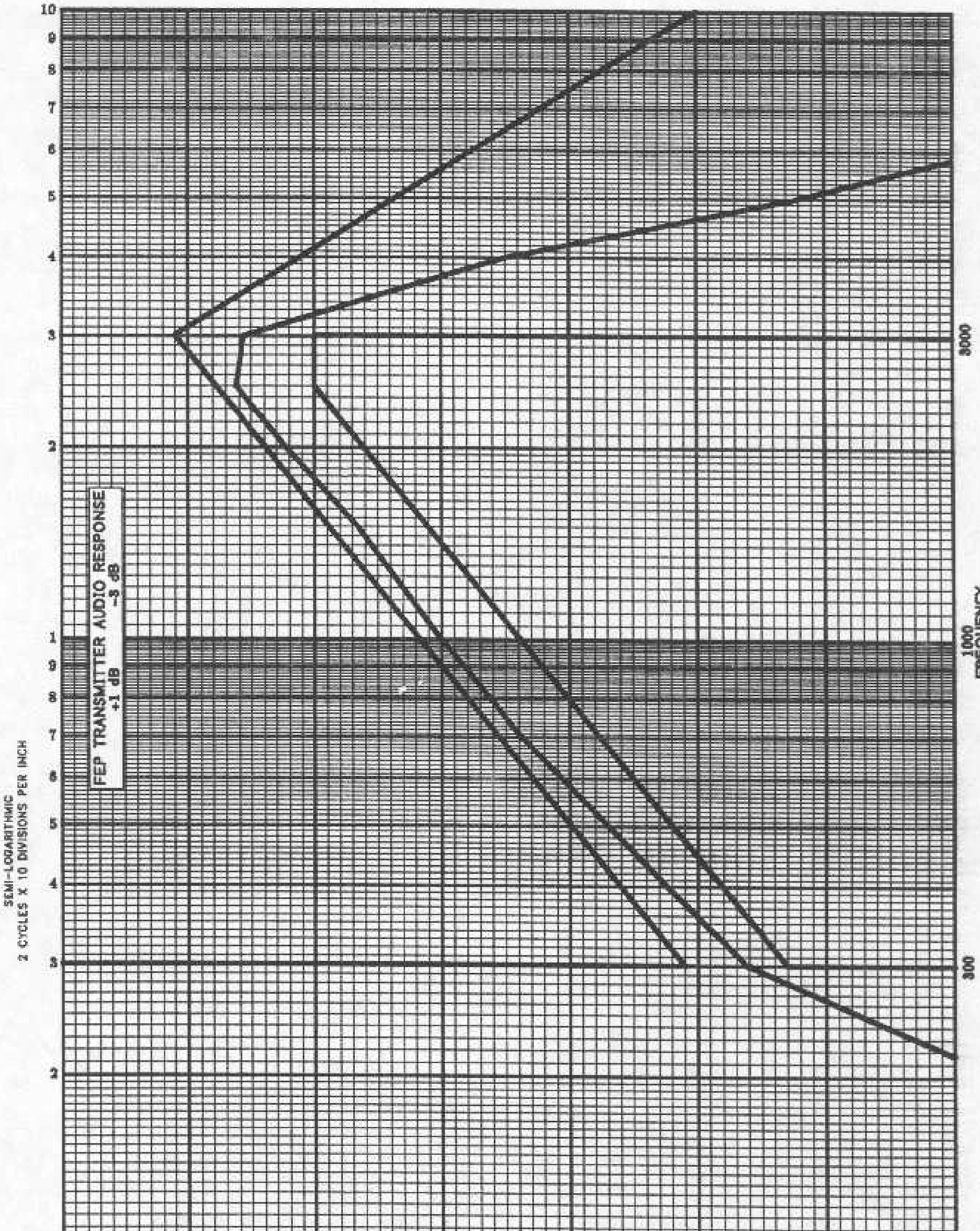
TEST SET-UP

(Test Data on next page)

MEASUREMENTS TAKEN: Zero level = 0.50 kHz deviation at 1000 Hz. Mic input.

Frequency	Level	Frequency	Level
100 Hz	-28	1500 Hz	+3.40
150 Hz	-25	2000 Hz	+6.10
200 Hz	-23	2500 Hz	+8.10
300 Hz	-12	3000 Hz	+7.70
400 Hz	-8.7	4000 Hz	-2.50
700 Hz	-3.1	5000 Hz	-13.9
900 Hz	-.90	6000 Hz	-22.5
1000 Hz	0		

These responses are for a constant deviation of 0.50 kHz.



TRANSMIT AUDIO RESPONSE

NAME OF TEST: Audio Response of Audio Filter

RULE PART NO.: 90.211 (d)

MINIMUM STANDARDS: 60 log10 (f/3), 3 kHz < f < 20 kHz; (f in kHz), 50 dB above 20 kHz.

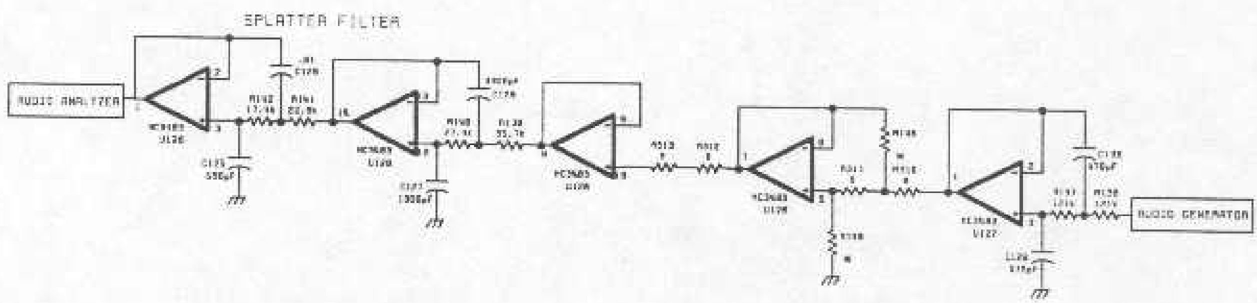
TEST RESULTS: Meets minimum standards

TEST CONDITIONS: Temperature 26 C

TEST EQUIPMENT: Audio Generator, Model HP-8903A
Audio Analyzer, Model HP-8903A

PERFORMED BY: William M. Junge DATE: 5-27-93

TEST SET-UP:

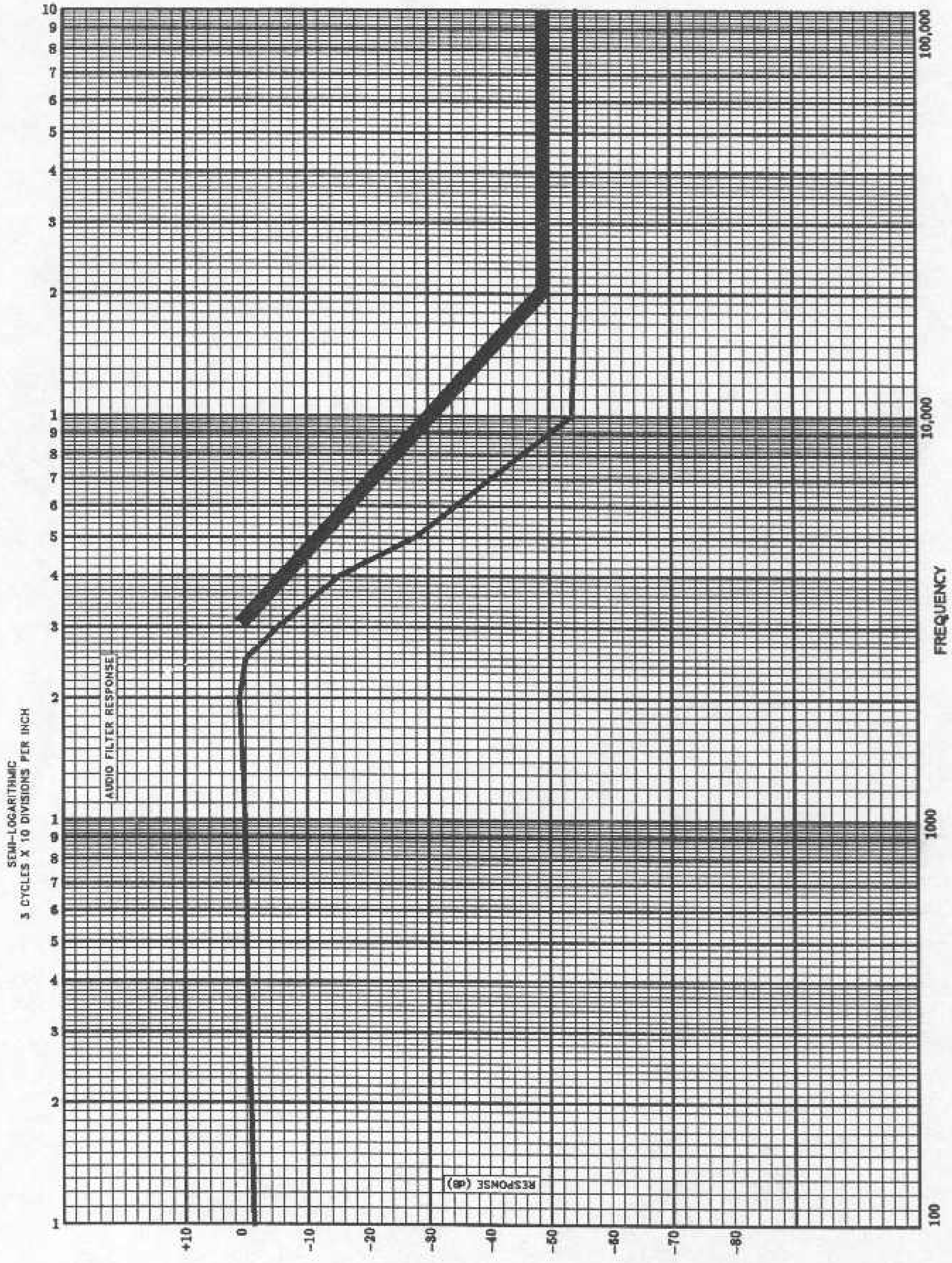


TRANSMIT AUDIO SPLATTER FILTER

NAME OF TEST: Audio Response of Audio Filter

TEST RESULTS: Reference: 1000 Hz, 0 dB

Frequency, Hz	Relative Level, dB
100	−.43
200	−.39
300	−.36
500	−.26
700	−.12
1,000	0
2,000	+.44
2,500	+0
3,000	−.44
4,000	−9.12
5,000	−17.0
10,000	−53.8
20,000	−54.3
30,000	−62.3
40,000	−61.5
50,000	−54.5
70,000	−54.4
100,000	−54.5



TRANSMIT AUDIO SPLATTER FILTER RESPONSE

NAME OF TEST: Percentage Modulation Versus Input Voltage

RULE PART NO.: 2.987 (b)

MINIMUM STANDARD: Shall not exceed 5 kHz deviation from 300 Hz to 3 kHz.

TEST RESULTS: Does not exceed 5.0 kHz.

TEST CONDITIONS: Standard Test Conditions
Standard Room Conditions
Multiple Voltage Switching Power Supply, Tectrol Inc.
TC47S-1047

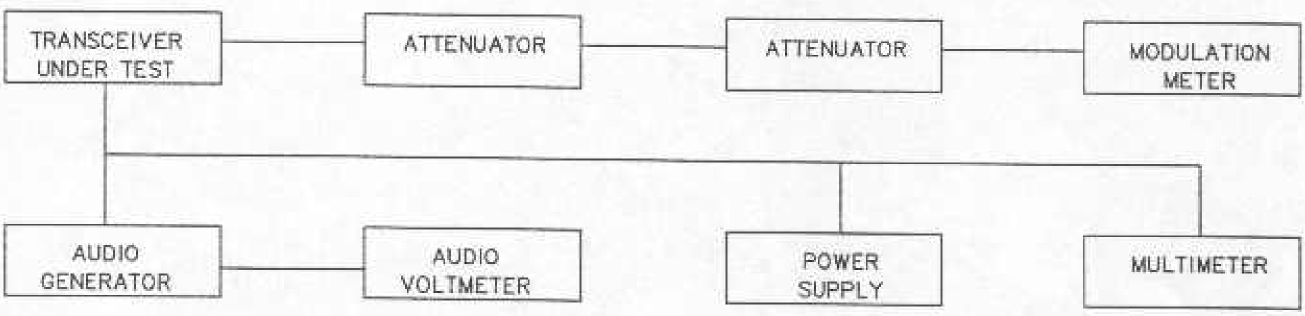
TEST EQUIPMENT:

Attenuator, Tenuline Model 8340-200
Attenuator, Tenuline Model 8323
Modulation Analyzer, Model HP 8901A
Multimeter, Model 8012A Fluke
Audio Generator, Model HP-8903A
Audio Voltmeter, Model HP-8903A
Power Supply, Tectrol Inc. TC47S-1047
Modulation Analyzer, Model HP 8901A

TEST PROCEDURE: The measurements were made according to TIA/EIA 603 standard Section 2.2.3. The transmitter was adjusted for (rated-guard band) kHz deviation at 1 kHz per the alignment instructions. The audio input was adjusted for 60% of rated deviation at 300 Hz, 1kHz, 3kHz and increased 20 dB for each. Then the deviation was measured over the 300 Hz to 5 kHz frequency range for each. The deviation was also measured as a function of input voltage at 300 Hz, 1 kHz, and 3 kHz.

PERFORMED BY: William M. Junge DATE: 5-27-93

TEST SET-UP:

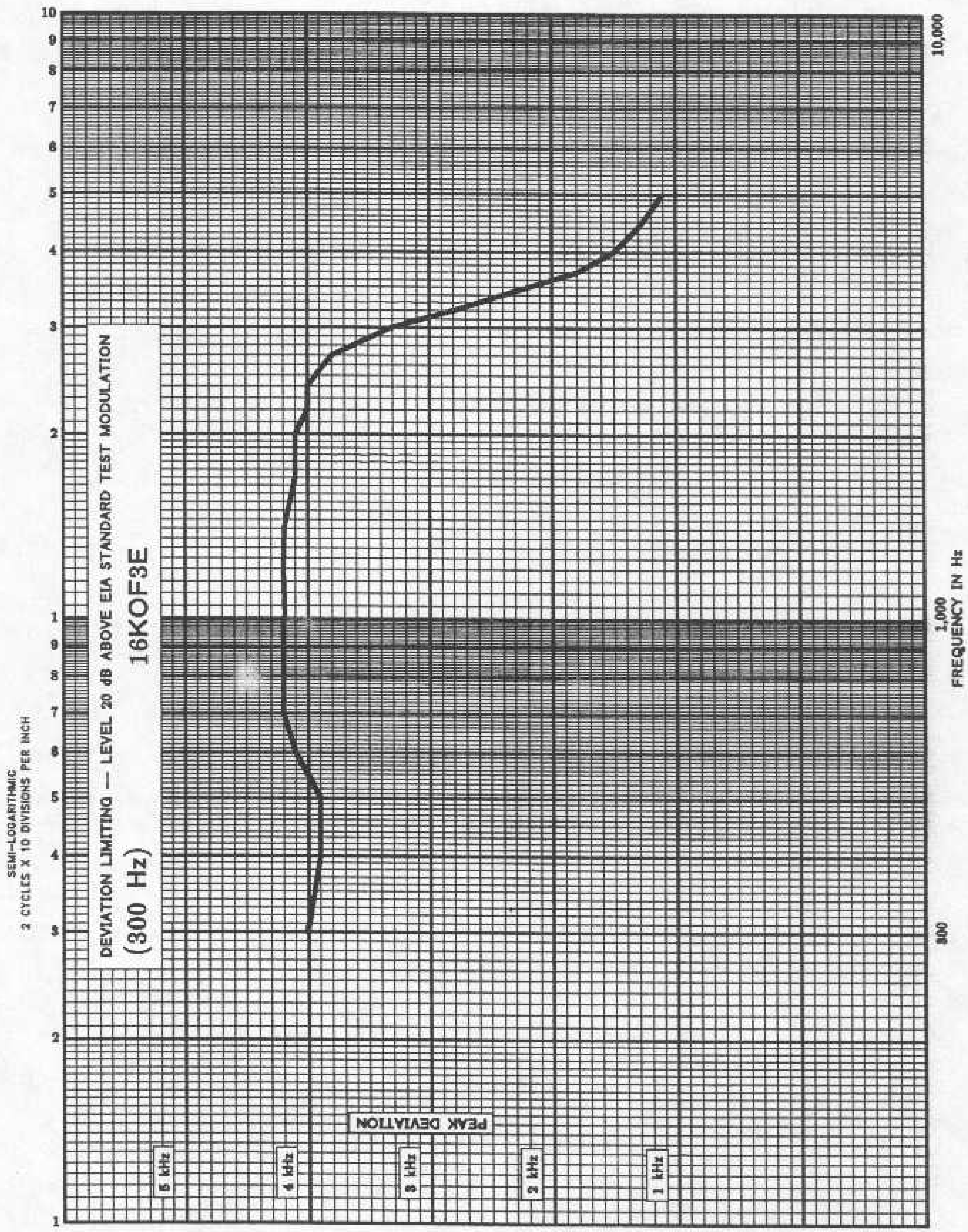


TEST SET-UP

DEVIATION LIMITING WITH INPUT VOLTAGE
20 dB ABOVE 60% RATED DEVIATION AT 300 Hz

16KOF3E

Frequency (Hz)	Deviation
300	4.0
400	3.9
500	3.9
600	4.1
700	4.2
800	4.2
1,000	4.2
1,200	4.2
1,400	4.2
1,700	4.1
2,000	4.1
2,200	4.0
2,400	4.0
2,700	3.8
3,000	3.3
3,200	2.8
3,400	2.4
3,700	1.8
4,000	1.5
4,200	1.4
4,400	1.3
4,700	1.2
5,000	1.1

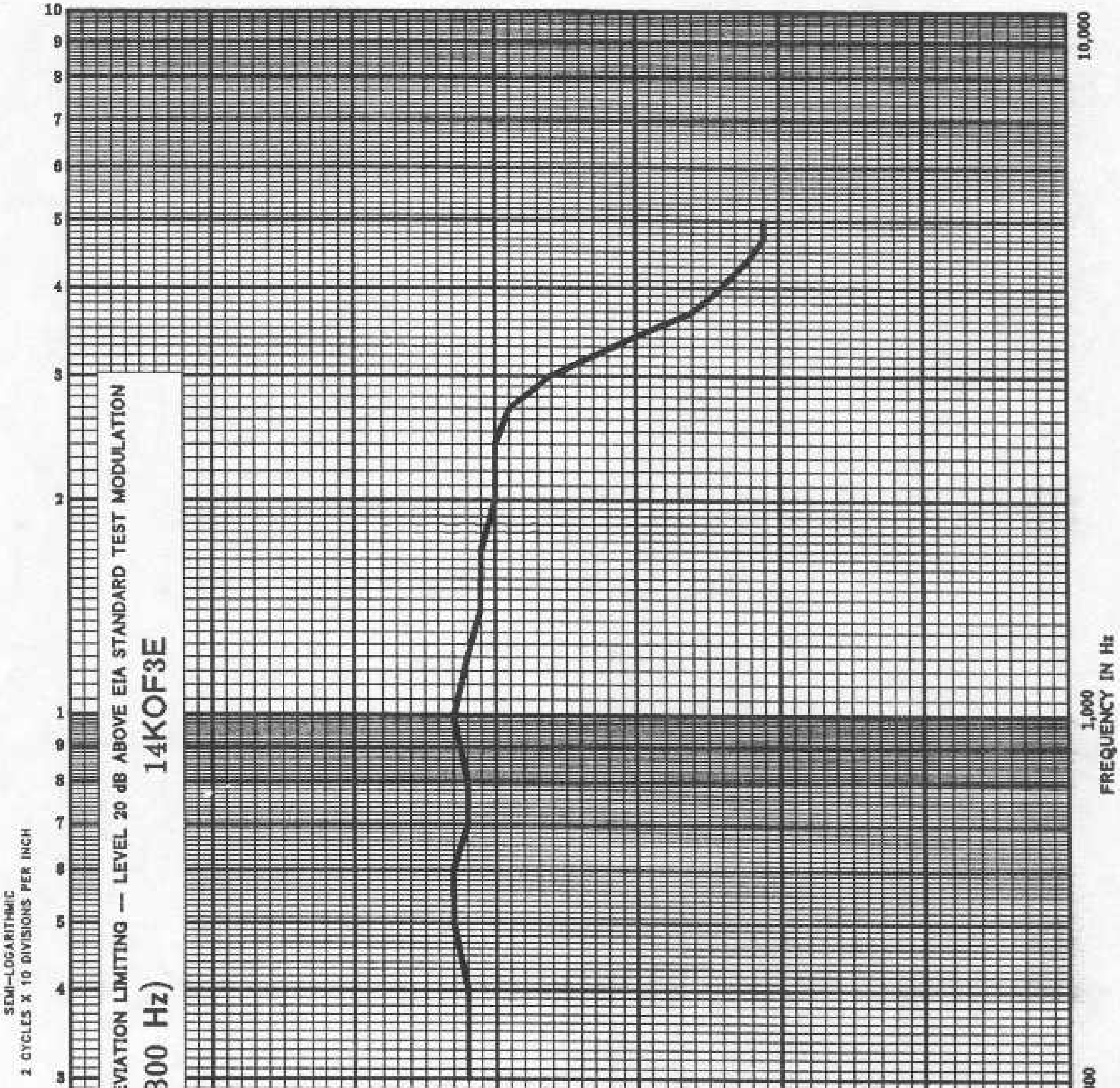


DEVIATION LIMITING (300 Hz) 16KOF3E

DEVIATION LIMITING WITH INPUT VOLTAGE 20 dB ABOVE 60% RATED DEVIATION AT 300 Hz

14KOF3E

Frequency (Hz)	Deviation
300	3.2
400	3.2
500	3.3
600	3.3
700	3.2
800	3.2
1,000	3.3
1,200	3.2
1,400	3.1
1,700	3.1
2,000	3.0
2,200	3.0
2,400	3.0
2,700	2.9
3,000	2.6
3,200	2.3
3,400	2.0
3,700	1.6
4,000	1.4
4,200	1.3
4,400	1.2
4,700	1.1
5,000	1.1

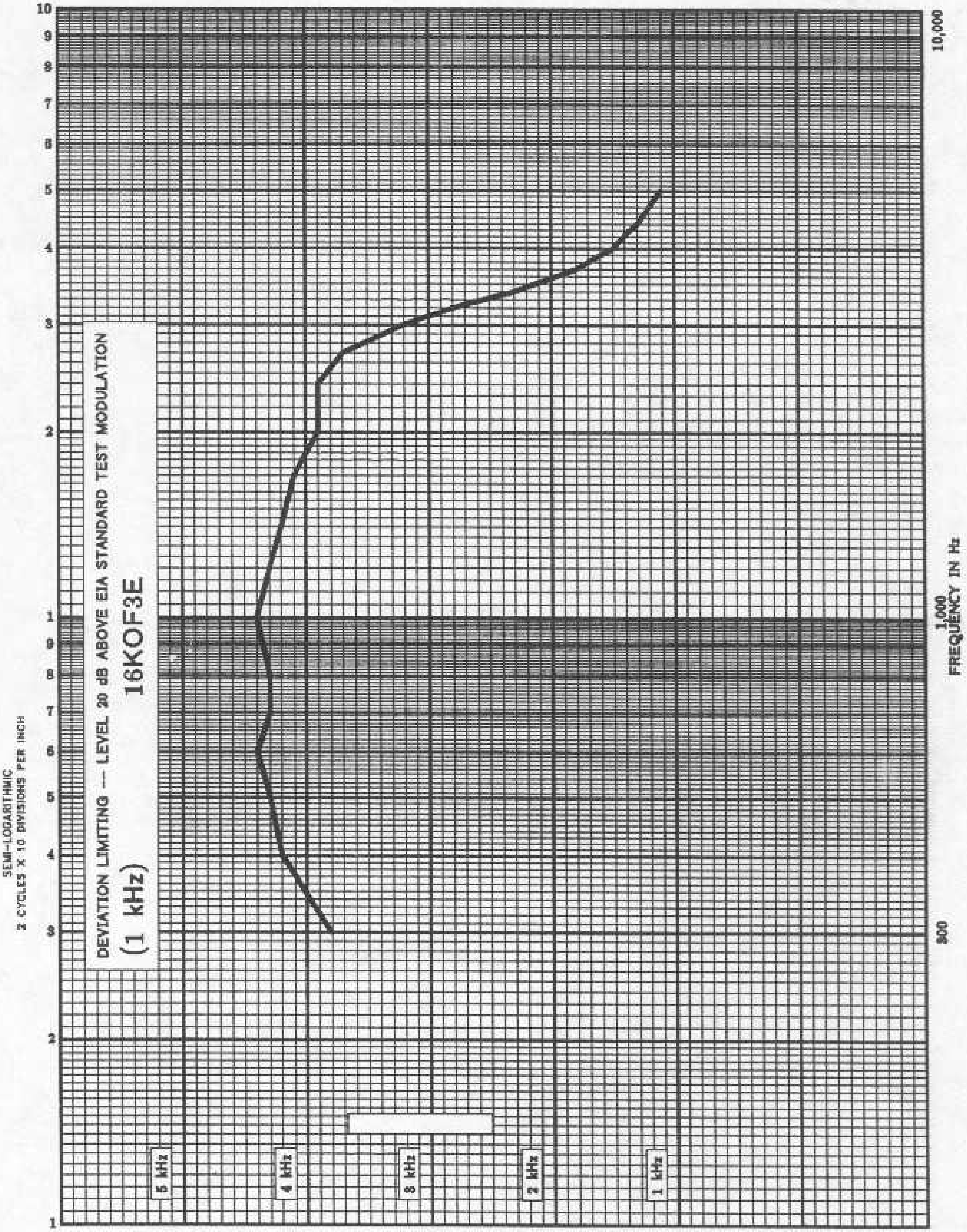


DEVIATION LIMITING (300 Hz) 14KOF3E

DEVIATION LIMITING WITH INPUT VOLTAGE 20 dB ABOVE 60% RATED DEVIATION AT 1.0 kHz

16KOF3E

Frequency (Hz)	Deviation
300	3.8
400	4.2
500	4.3
600	4.4
700	4.3
800	4.3
1,000	4.4
1,200	4.3
1,400	4.2
1,700	4.1
2,000	3.9
2,200	3.9
2,400	3.9
2,700	3.7
3,000	3.2
3,200	2.8
3,400	2.3
3,700	1.8
4,000	1.5
4,200	1.4
4,400	1.3
4,700	1.2
5,000	1.1

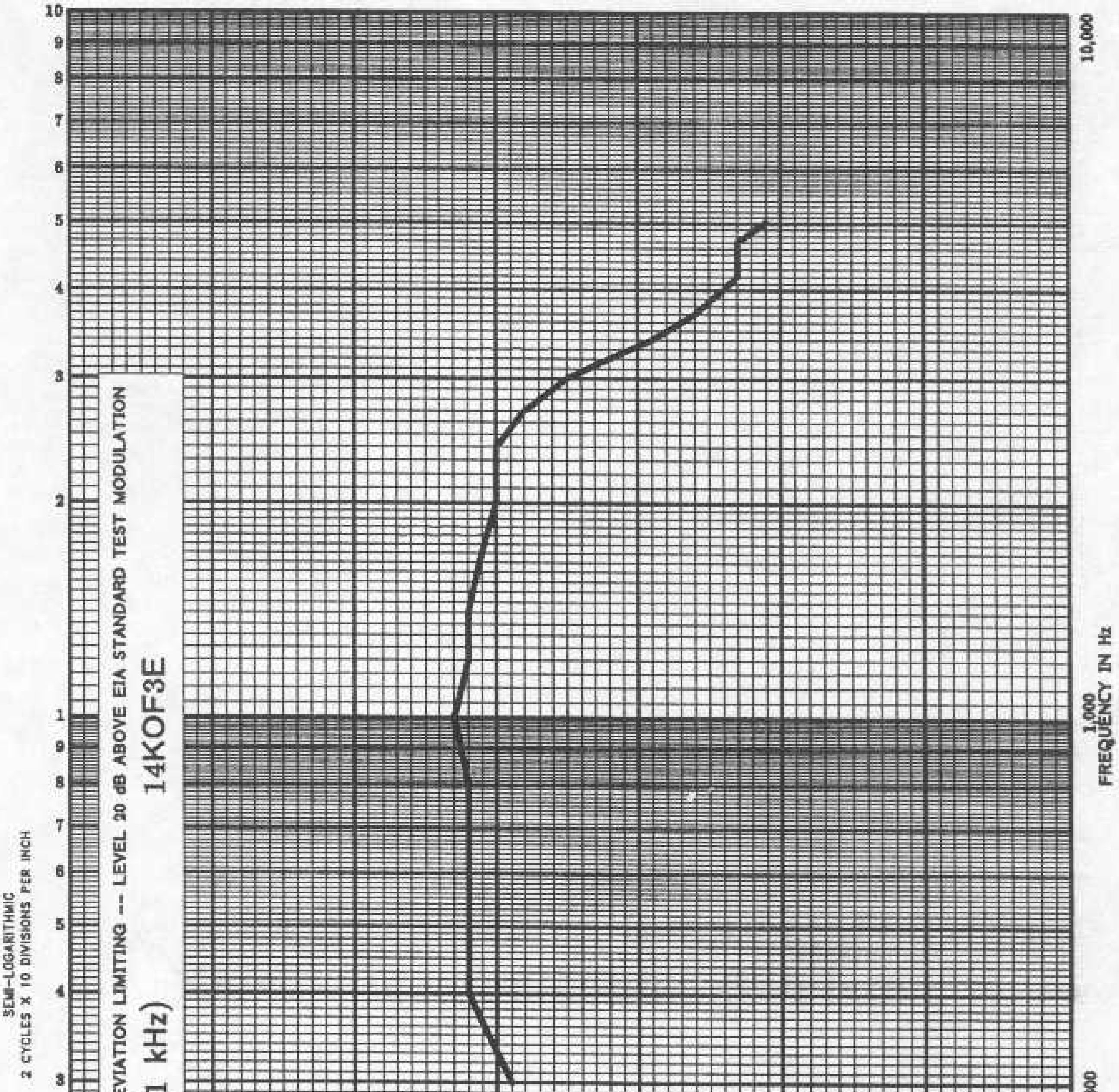


DEVIATION LIMITING (1 kHz) 16KOF3E

DEVIATION LIMITING WITH INPUT VOLTAGE 20 dB ABOVE 60% RATED DEVIATION AT 1.0 kHz

14KOF3E

Frequency (Hz)	Deviation
300	2.9
400	3.2
500	3.2
600	3.2
700	3.2
800	3.2
1,000	3.3
1,200	3.2
1,400	3.2
1,700	3.1
2,000	3.0
2,200	3.0
2,400	3.0
2,700	2.8
3,000	2.5
3,200	2.2
3,400	1.9
3,700	1.6
4,000	1.4
4,200	1.3
4,400	1.2
4,700	1.2
5,000	1.1

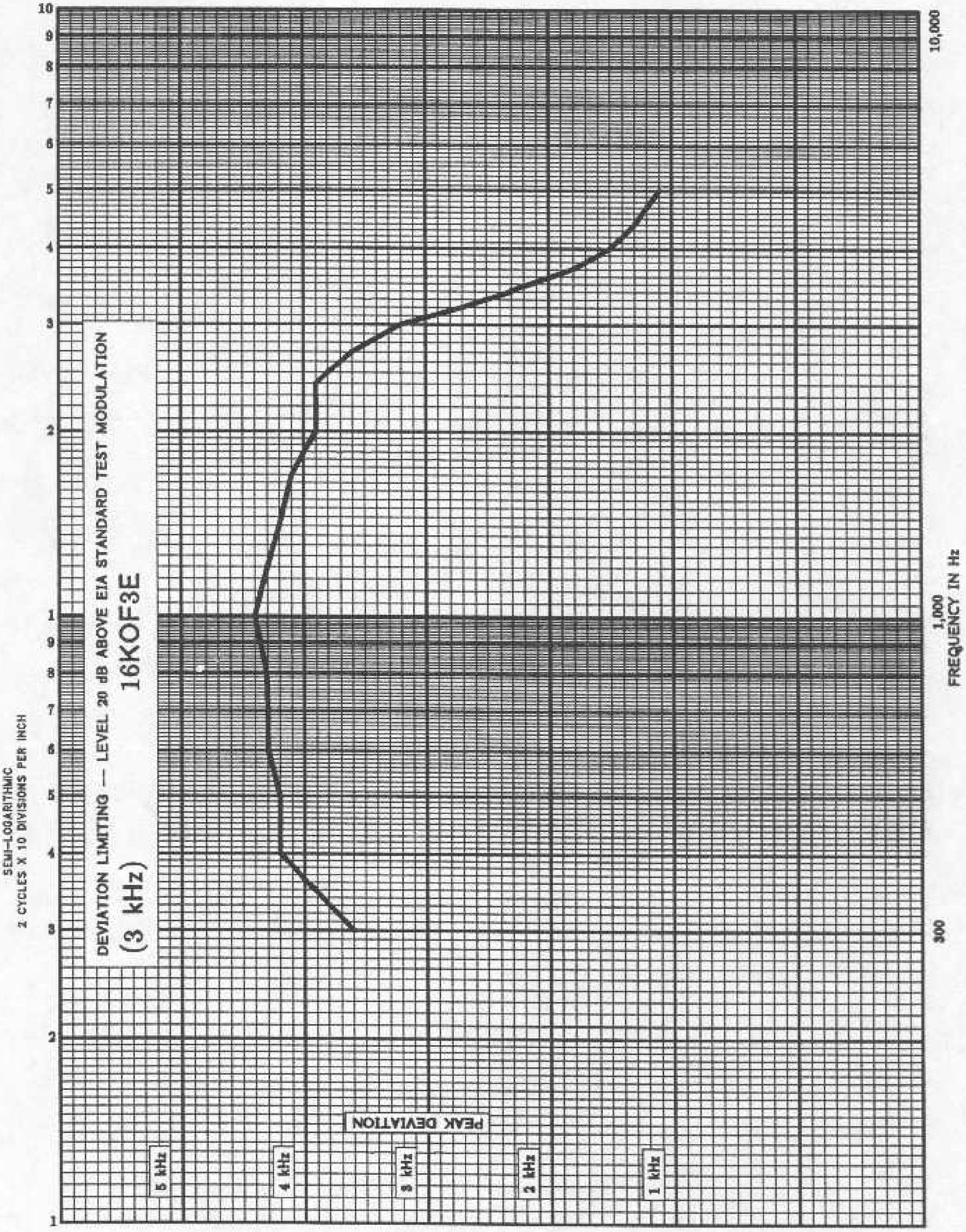


DEVIATION LIMITING (1 kHz) 14KOF3E

DEVIATION LIMITING WITH INPUT VOLTAGE
20 dB ABOVE 60% RATED DEVIATION AT 3 kHz

16KOF3E

Frequency (Hz)	Deviation
300	3.6
400	4.2
500	4.2
600	4.3
700	4.3
800	4.3
1,000	4.4
1,200	4.3
1,400	4.2
1,700	4.1
2,000	3.9
2,200	3.9
2,400	3.9
2,700	3.6
3,000	3.2
3,200	2.7
3,400	2.3
3,700	1.8
4,000	1.5
4,200	1.4
4,400	1.3
4,700	1.2
5,000	1.1

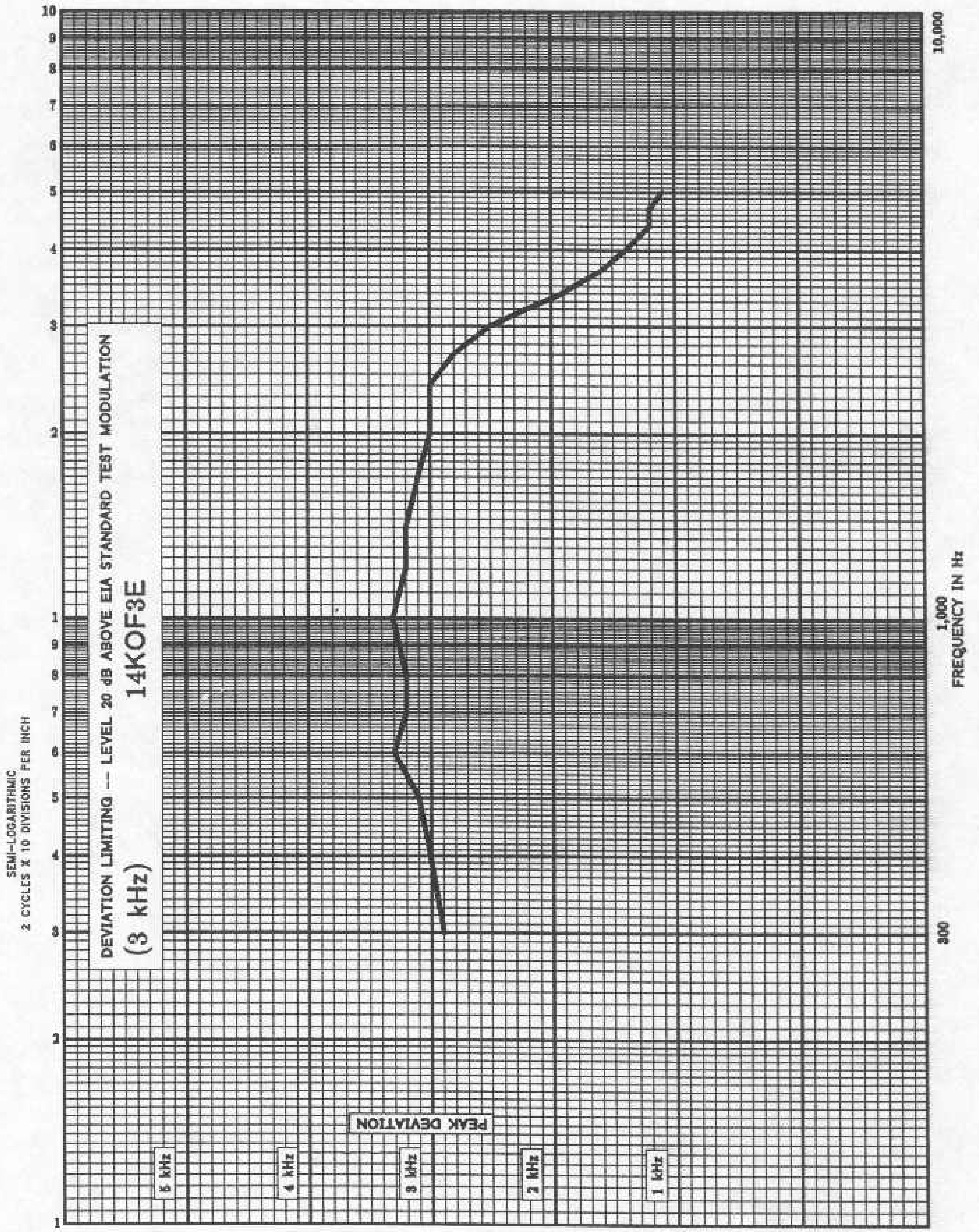


DEVIATION LIMITING (3 kHz) 16KOF3E

DEVIATION LIMITING WITH INPUT VOLTAGE
20 dB ABOVE 60% RATED DEVIATION AT 3 kHz

14KOF3E

Frequency (Hz)	Deviation
300	2.9
400	3.0
500	3.1
600	3.3
700	3.2
800	3.2
1,000	3.3
1,200	3.2
1,400	3.2
1,700	3.1
2,000	3.0
2,200	3.0
2,400	3.0
2,700	2.8
3,000	2.5
3,200	2.2
3,400	1.9
3,700	1.6
4,000	1.4
4,200	1.3
4,400	1.2
4,700	1.2
5,000	1.1



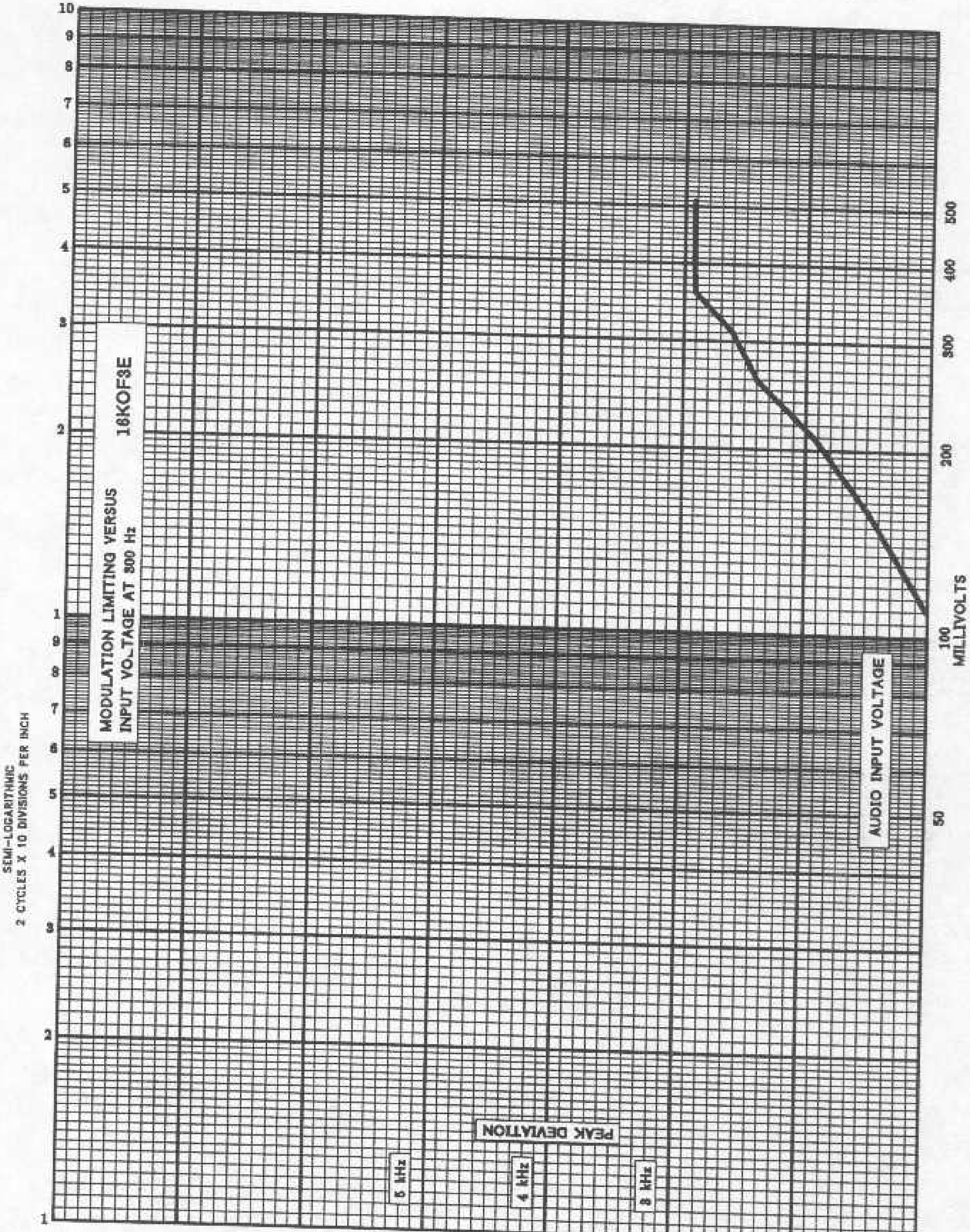
DEVIATION LIMITING (3kHz) 14KOF3E

NAME OF TEST: Percentage Modulation Versus Input Voltage at 300 Hz

16KOF3E

TEST DATA:

Input Voltage (mV)	Deviation (kHZ)
110	1.04
160	1.50
210	1.93
260	2.40
310	2.60
360	2.90
410	2.92
460	2.92
510	2.92



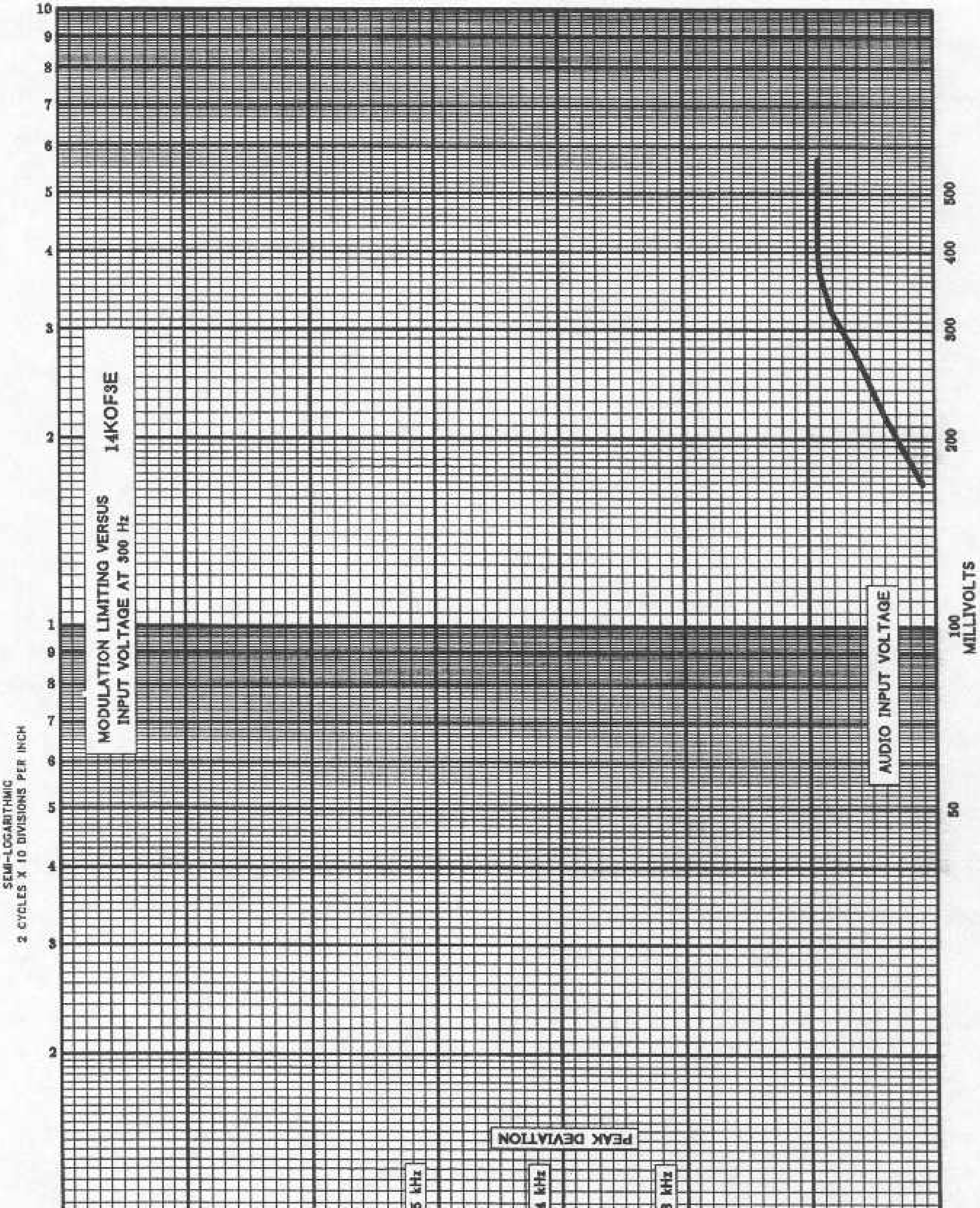
MODULATION LIMITING (300 Hz) 16KOF3E

NAME OF TEST: Percentage Modulation Versus Input Voltage at 300 Hz

14KOF3E

TEST DATA:

Input Voltage (mV)	Deviation (kHZ)
170	1.10
220	1.40
270	1.60
320	1.80
370	1.90
420	1.92
470	1.92
520	1.92
570	1.92



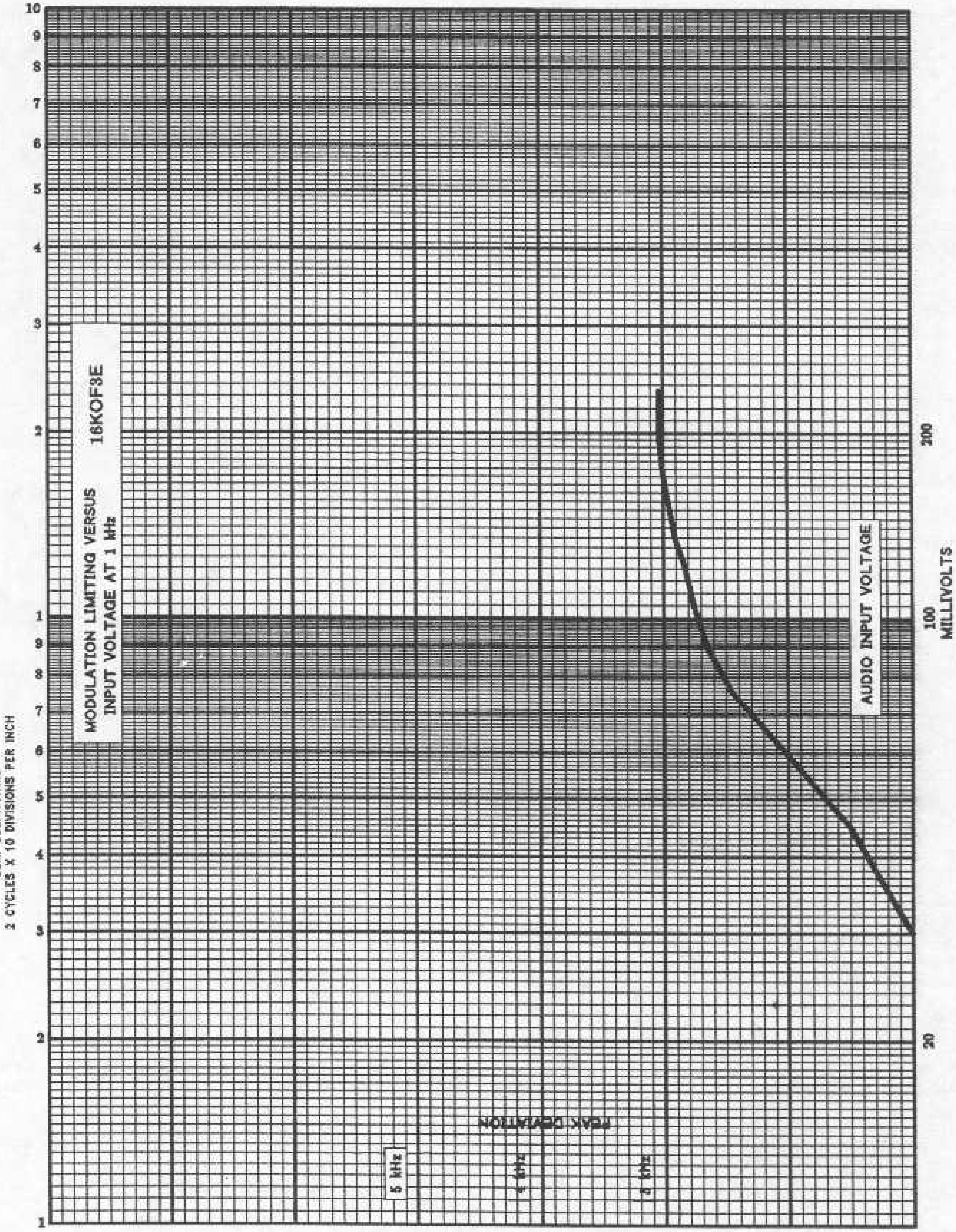
MODUDATION LIMITING (300 Hz) 14KOF3E

NAME OF TEST: Percentage Modulation Versus Input Voltage at 1 kHz

16KOF3E

TEST DATA:

Input Voltage (mV)	Deviation (kHZ)
30	1.00
45	1.52
60	2.02
75	2.45
90	2.65
105	2.75
120	2.83
135	2.90
150	2.95
165	2.99
180	3.01
195	3.03
210	3.06
235	3.06



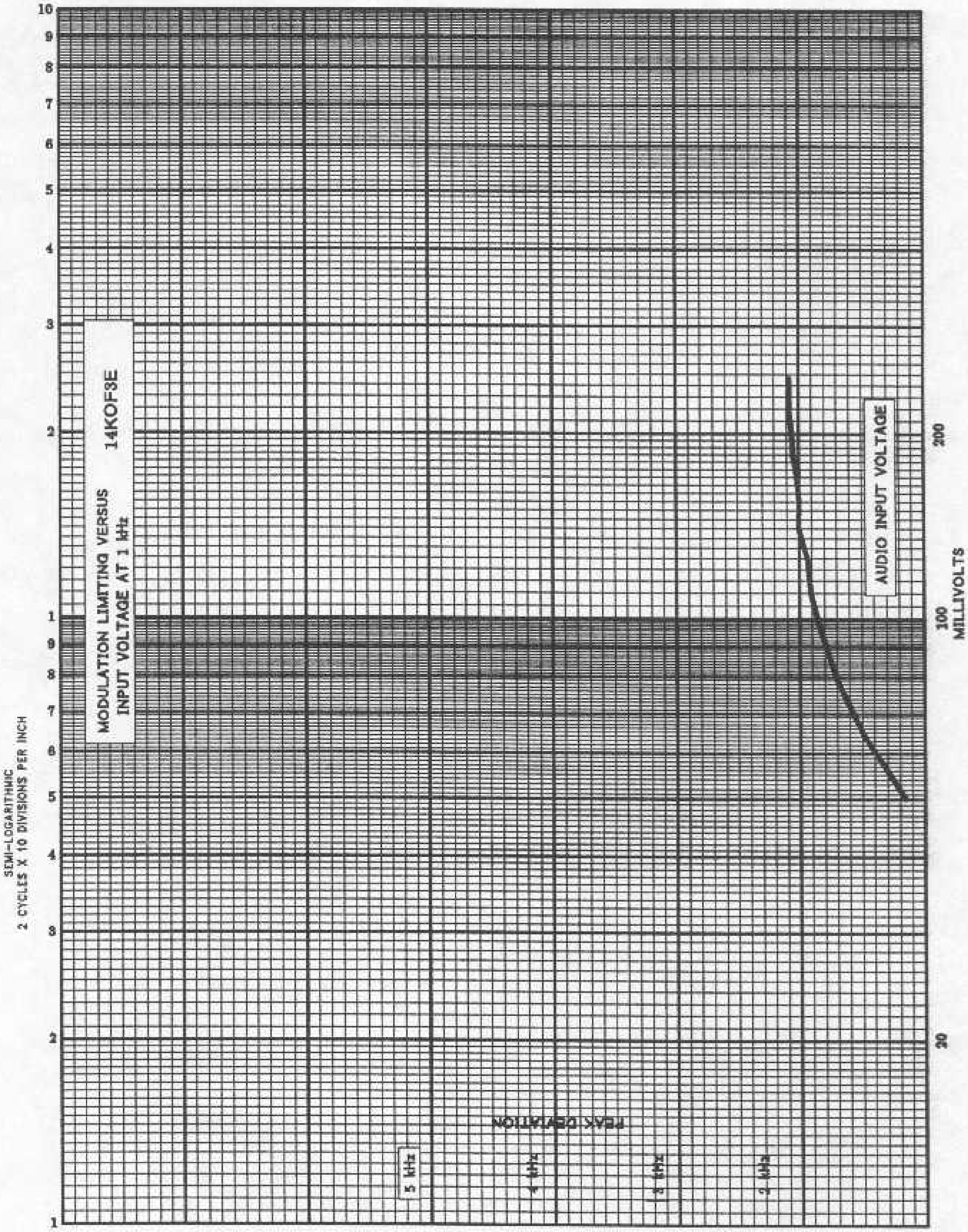
MODULATION LIMITING (1 kHz) 16KOF3E

NAME OF TEST: Percentage Modulation Versus Input Voltage at 1 kHz

14KOF3E

TEST DATA:

Input Voltage (mV)	Deviation (kHZ)
50	1.15
65	1.48
80	1.72
95	1.84
110	1.90
125	1.93
140	1.99
155	2.00
170	2.04
185	2.06
200	2.07
215	2.09
230	2.09
245	2.09



MODULATION LIMITING (1 kHz) 14KOF3E