Nucomm - FCC Certification Report

ChannelMaster TX1 Dual Band (2/7 GHz)

Portable Microwave Transmitter

2/7CMTX1-L5E1.5-326-A2C2

(Per CFR TITLE 47, PART 2, SUB-PART J)

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PROPRIETARY INFORMATION

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Specifications are subject to change in order to allow for the introduction of design improvements

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Table 1: Revision History

Date	Revision	Changed by	Reason for Change
8/2//06	1.0	John Odell	Initial release
11/4/06	1.1	John Odell	Removed section 8 system architecture (confidential material).
11/25/06	1.2	George Williamson	Fold in formatting changes an file references
3/3/07	2.0	George Williamson	Updated data, addendum references and dates.
3/26/07	2.1	George Williamson	Corrected FCC ID from 15 Characters to 14. ”I4U27CMT1-L5-E1P5” removed the “X” and updated Model number (A2C2K to A2C2). Modified Table 2 to correct nominal and minimum power.

Nucomm - FCC Certification Report

~CMTX1~

(Per CFR TITLE 47, PART 2, SUB-PART J)

1 Applicants full name and address (1)

Full name and mailing address of the manufacturer of the device and the applicant for certification:

Name of Manufacturer/Applicant: Nucomm, Inc.

Address of Manufacturer/Applicant: 101 Bilby Road
Hackettstown, NJ 07840

2 FCC Identifier (2)

Equipment Identification: **FCC ID: I4U27CMT1-L5-E1P5**

3 Installation and operating instructions to be furnished by the user (3)

A copy of the Installation and operating instruction are provided under separate cover with the title of

4 Emission (4), Frequency range (5), & Range of operating power (6)

Values or specific operating power levels, and description of any means provided for variation of operating power.

For the 1990 to 2550 MHz band, the range of operating power is between 1.5 to 12 Watts, with two selectable power output levels called “Low” and “High” and two operational modes called “Digital” and “Analog.”
For the 6425-7125 MHz band, the range of operating power is between 0.5 to 5 Watts, again with two selectable power output levels called “Low” and “High” and two operational modes called “Digital” and “Analog.” The following table (Table 2) outlines the respective power levels.

Table 2: Analog and Digital Power Levels

Mode	Nominal Power (Watts)	Minimum Power (Watts)
2 GHz Analog High Power	12.0	10.0
2 GHz Analog Low Power	3.0	2.0
2 GHz Digital High Power	5.0	4.0
2 GHz Digital Low Power	1.25	1.0
7 GHz Analog High Power	5.0	4.0
7 GHz Analog Low Power	1.25	1.0
7 GHz Digital High Power	1.5	1.0
7 GHz Digital Low Power	0.4	.3

5 Maximum power rating as defined in the applicable part(s) of the rules (7)

The maximum power rating of 12 Watts is requested for service in Part 74, Subpart F, Television Auxiliary Broadcast Stations, Section 74.636 under the heading Power Limitations.

6 DC Voltages & Currents (8)

The maximum DC voltage and DC currents into the last two stages of the driver and final amplifier for the maximum output are outlined in the Table 3. For both the Digital and Analog modes of operation the bias conditions on the amplifier are identical therefore only “High” and “Low” power conditions are shown.

1990 MHz to 2550 MHz

Table 3a: Maximum DC voltage and currents

Mode	Driver Stages	Final Stage
High Power	+11V @ 0.72A	+11V @ 4.4A
Low Power	+11V @ 0.72A	+11V @ 4.4A

6425 MHz to 7125 MHz

Table 4b: Maximum DC voltage and currents

Mode	Driver Stages	Final Stage
High Power	+11V @ 0.75A	+11V @ 2.5A
Low Power	+11V @ 0.75A	+11V @ 2.5A

7 Tune-up procedure over the power range, or at specific operating power levels (9)

The 2/7CMTX1-L5E1.5-326-A2C2 requires no tune-up over its operating range.

8 Equipment Identification (11)

The following photograph figure (Figure 1: FCC Equipment Identification Plate) shows the FCC label which identifies the FCC ID, Manufactures name, part number, unit serial number and week of manufacture.

Figure 1: FCC Equipment Identification Plate

9 Photographs (8X10 inch) of the equipment (12).

Supply photographs of the equipment of sufficient clarity to reveal equipment construction and layout, including meters, if any, and labels for controls and meters and sufficient views of the internal construction to define component placement and chassis assembly. Refer to addendum 4 (I4U27CMT1-L5-E1P5_External_Photos.pdf) for external photographs and addendum 5 (I4U27CMT1-L5-E1P5_Internal_Photos.pdf) for internal photographs which are contained in a separate file associated with this report.

10 Digital modulation techniques (13)

A detailed description of the modulation system to be used, including the response characteristics (frequency, phase and amplitude) of any filters provided, and a description of the modulating wave train, shall be submitted for the maximum rated conditions under which the equipment will be operated.
The transmitter supports 2 forms of digital modulation VSB and COFDM (Coded Orthogonal Frequency Division Multiplexing). The VSB mode supports 2VSB, 4VSB, 8VSB, 8VSB with Trellis and 16VSB. These modes conform to the ATSC document A\53. The COFDM modulation conforms to DVB-T EN 300 744.

11 Data required by §§2.1046 through 2.1057, inclusive, measured in accordance with the

procedures set out in *§2.1041* (14).

The following table (Table 5: Test Equipment Used) identifies the equipment used to perform testing including the manufacturer, model number, serial number, calibration dates, frequency and thermo ranges. Images of the test equipment and set up are located in Addendum 1 section 1.2 (FCC Test Equipment Images).

Table 5: Test Equipment Used

Manufacturer	Model #	Serial #	Calibration	Ranges
1. *Output Power Tests*				
Hp/Agilent	437B	31254U11528	10-19-05 due 10-19-06	Power Meter
Hp/Agilent	8481A	2349A43226	12/12/05 due 12/12/06	Power Sensor 10 Mhz to 18 Ghz
Aeroflex Wienschel	46-30-34	BT6325	1/11/06 due 1/11/07	DC-18 Ghz, 25Watt, 30 dB Attenuator
2. *Occupied Bandwidth Tests*				
Agilent	E4407B	MY45102094	6/1/06 due 6/1/07	Spectrum Analyzer 9Khz to 26.5 Ghz
Hp/Agilent	8481A	2349A43226	12/12/05 due 12/12/06	Microwave Power Sensor 10 Mhz to 18 GHz
Aeroflex Wienschel	46-30-34	BT6325	1/11/06 due 1/11/07	DC-18 GHz, 25Watt, 30 dB Attenuator
Narda	4226-20		N/A	20 dB Directional Coupler .5-18 GHz
3. *Frequency Stability Tests*				
Hewlett Packard	5342A	2542A 10570	10/24/05 due 10/24/06	Microwave Frequency Counter ,10 Hz to 18 Ghz
Tenney	BTL	23867-08.	N/A	Temperature Chamber
Fluke	54 II	90510039	3/29/06 due 3/29/07	Thermometer -200 C º to 1372 C º
4. *Video and Audio Modulation Tests*				
Tektronics	TG700	B011060	8/10/06 due 8/10/07	TV Signal Generator Platform, DC-10 MHz
Tektronics	VM700A	B021027	2/15/06 due 2/14/07	Video Measurement Set, DC-10 MHz
Audio Precision	ATS-2	11277	12/19/05 due 12/20/06	Audio Test Set System DC-100Khz
Hewlett Packard	8496B	3308A71159	N/A	Attenuator/110 dB DC-18 GHz
Hewlett Packard	8494B	2812A19146	N/A	Attenuator/11 dB DC-18 GHz

11.1 RF Power Output (2.1046)

The transmitter was terminated through a 50 Ohm 30-dB pad. The data was measured on a 436A Hewlett-Packard power meter as shown in Figure 2.

Figure 2: RF Power Output test set up

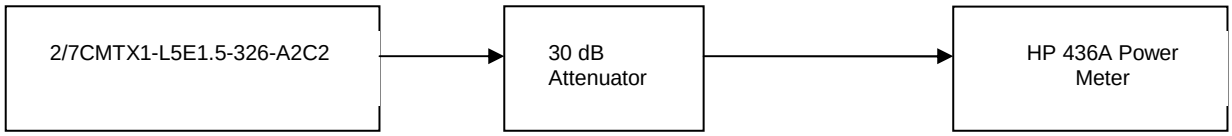


Table 6: Power Output: 1990-2500 MHz (current freqs)

		Analog Mode (Watts)		Digital Mode (Watts)	
Channel	Frequency (MHz)	High	Low	High	Low
1	1999.0	11.78	3.50	4.82	1.32
4	2050.5	12.02	3.48	4.82	1.31
7	2101.5	12.22	3.44	4.84	1.33
9	2475.5	11.97	3.22	4.51	1.25
10	2492.5	11.83	3.23	4.45	1.25

Table 7: Power Output: 2031.5-2500 MHz (BAS relo freqs)

		Analog Mode (Watts)		Digital Mode (Watts)	
Channel	Frequency (MHz)	High	Low	High	Low
1	2031.5	11.91	3.37	4.76	1.30
3	2055.5	11.99	3.39	4.78	1.31
5	2079.5	12.08	3.40	4.82	1.31
7	2103.5	12.11	3.42	4.85	1.32
10	2492.5	11.80	3.21	4.43	1.24

Table 8: Power Output: 6425-7125Mhz

		Analog Mode (Watts)		Digital Mode (Watts)	
Channel	Frequency (MHz)	High	Low	High	Low
1	6887.5	5.11	1.37	1.68	0.44
4	6962.5	5.11	1.37	1.69	0.44
7	7037.5	5.11	1.37	1.68	0.44
10	7112.5	5.20	1.38	1.70	0.45
14	6512.5	5.26	1.40	1.73	0.46

11.2 Modulation Characteristics (2.1047)

11.2.1 Video Modulation:

Standard test signals were fed into the video input of 2/7CMTX1-L5E1.5-326-A2C2 Transmitter from the Tektronix 1410 NTSC signal generator. The output of the transmitter was attenuated and then connected to a receiver. The video output of the receiver was connected to a Tektronix VM 700A Video Measurement Test Set. A block diagram of the test setup is shown below

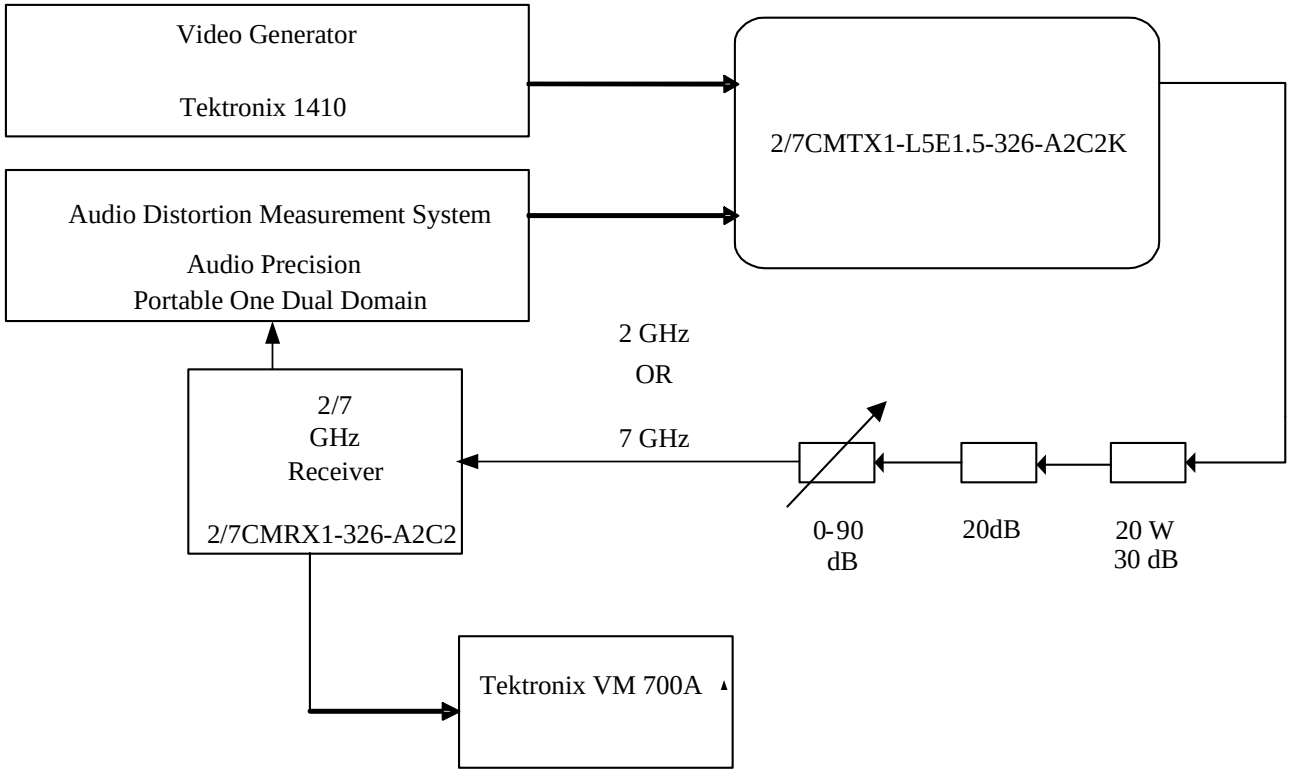


Figure 3: Video and Audio Modulation test setup

Results:

Since the modulation circuitry is common for all channels and the data was identical, only one set of data is given below. The Linearity waveform, as listed in the table below, demonstrates a substantially linear transfer function through the transmitter and the receiver.

Table 9: 17 MHz channel spacing with +/- 4 MHz FM deviation

Band (GHz)	Freq. (MHz)	Fig. No. Demod Waveform	Fig. No. Diff. Gain	Diff. Gain	Fig. No. Diff. Phase	Diff. Phase (Deg)

Band (GHz)	Freq. (MHz)	Fig. No. Demod Waveform	Fig. No. Diff. Gain	Diff. Gain	Fig. No. Diff. Phase	Diff. Phase (Deg)
2	2101.5	1	2	2.77%	3	1.14

Table 10: 12 MHz channel spacing with +/- 3 MHz FM deviation (BAS relo frequencies)

Band (GHz)	Freq. (MHz)	Fig. No. Demod Waveform	Fig. No. Diff. Gain	Diff. Gain	Fig. No. Diff. Phase	Diff. Phase (Deg)
2	2031.5	4	5	1.83%	6	0.97

Table 11: 25 MHz channel spacing with +/-4 MHz FM deviation (7 GHz BAND)

Band (GHz)	Freq. (MHz)	Fig. No. Demod Waveform	Fig. No. Diff. Gain	Diff. Gain	Fig. No. Diff. Phase	Diff. Phase (Deg)
7	7112.5	7	8	0.61%	9	0.91

11.2.2 Video Frequency Response

The frequency is represented by the demodulated multi-burst waveform, as listed and tabulated in the table. Since the modulation circuitry is common to each band and the data was identical, only one set of data is given below. Measurements were made to a tolerance of ±1/4 IRE (±0.025 dB).

Table 12: 17 MHz channel spacing with +/- 4 MHz FM deviation

			Relative Response (MHz) in IRE units					
Band (GHz)	Freq. (MHz)	Fig. No.	0.5	1.25	2	3	3.58	4.1
2	2101.5	10,11	99.97	99.90	99.88	99.79	99.60	99.44

Table 13: 12 MHz channel spacing with +/- 3 MHz FM deviation (BAS relo frequencies)

			Relative Response (MHz) in IRE units					
Band (GHz)	Freq. (MHz)	Fig. No.	0.5	1.25	2	3	3.58	4.1
2	2031.5	12,13	99.97	99.92	99.82	99.76	99.65	99.55

Table 14: 25 MHz channel spacing with +/- 4 MHz FM deviation (7GHz BAND)

			Relative Response (MHz) in IRE units					
Band (GHz)	**Freq. (MHz)**	**Fig. No.**	**0.5**	**1.25**	**2**	**3**	**3.58**	**4.1**
7	7112.5	14,15	99.99	99.92	99.85	99.79	99.74	99.64

The video pre-emphasis circuit is designed in accordance with CCIR recommendation 405-1 (New Delhi, 1970) and has the insertion loss characteristic shown in Figure 7: video response.

11.2.3 Audio Modulation

The audio frequency response of the 2/7CMTX1-L5E1.5-326-A2C2 was measured with the setup shown in Figure 3. The audio pre-emphasis circuit has the insertion loss characteristics as shown in figure 6: Audio response

Results:

The results are presented in the following table. These results were measured and found to be identical for all channels. Since the modulation circuitry is common to each channel and the data was identical, only one set of data is given below.

Audio Frequency Response:

Table 15: 17 MHz channel spacing with +/- 4 MHz FM deviation

Frequency (Hz)	**Demodulated Relative Response (dB)**	**Measured Distortion**
50	0.29	0.16%
100	0.28	0.17%
400	0.27	0.16%
1000	0.20	0.14%
5000	0.14	0.13%
10000	-0.22	0.27%
12000	-0.33	0.29%
15000	-2.30	0.28%
20000	-5.40	0.69%
30000	-60	x

Table 16: 12 MHz channel spacing with +/- 3 MHz FM deviation (BAS relo frequencies)

Frequency (Hz)	Demodulated Relative Response (dB)	Measured Distortion
50	0.11	0.17%
100	0.14	0.12%
400	0.15	0.25%
1000	0.06	0.28%
5000	0.02	0.30%
10000	-0.92	0.38%
12000	-1.50	0.36%
15000	-2.34	0.45%
20000	-6.37	01.9%
30000	-60	x

Table 17: MHz channel spacing with +/- 4 MHz FM deviation (7 GHz BAND)

Frequency (Hz)	Demodulated Relative Response (dB)	Measured Distortion
50	0.23	0.14%
100	0.23	0.15%
400	0.25	0.14%
1000	0.23	0.13%
5000	0.19	0.16%
10000	-0.17	0.24%
12000	-0.22	0.30%
15000	-4.84	0.42%
20000	-5.72	1.40%
30000	-60	x

See separate e-file named I4U27CMT1-L5-E1P5_Modulation_Characterics.pdf.

11.3 Occupied bandwidth (2.1049)

The Occupied Bandwidth is defined in Section 2.1049 as the frequency bandwidth, where the mean power radiated below its lower and above its upper frequency limits are each equal to 0.5 percent of the total mean radiated power. In other words, the Occupied Bandwidth contains 99% of the total mean radiated power.

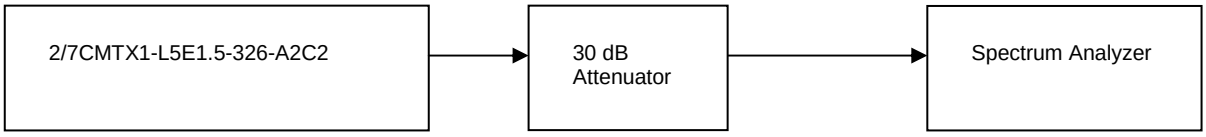
Color bar signals along with two sub-carriers of 4.83 MHz and 6.2 MHz were used as baseband input. For both analog and digital mode, 2/7CMTX1-L5E1.5-326-A2C2 was set in the normal operational mode with maximum output power.

The spectrum analyzer parameters for the measurement of Digital Signal Bandwidth were as follows:

- Resolution BW 3KHz
- Video BW 3KHz
- Span 30MHz
- Sweep 4.295sec

In the case of Analog Signals, the spectrum changes substantially during the vertical interval and line by line through the picture. The display on the analyzer is the vector sum of these components that fall within the band pass of the analyzer as it sweeps across the band. The accuracy of bandwidth measurement improves if the spectrum analyzer bandwidth is effectively narrow and effectively averaged. Also, several analyzer sweeps should be averaged to allow many TV fields to pass by for effective averaging of the changing sideband components. Taking these points into consideration, the spectrum analyzer was set to a resolution bandwidth of 100 kHz and swept slowly at the rate of 1 second across a 50 MHz span centered on the channel. The analyzer video bandwidth was set to 100 kHz and 20 averages were taken to effectively average the display. The vertical scale was set to a logarithmic factor of 10 dB per division thus providing a power scale.
The Occupied Bandwidth measurement was done using an Agilent E4407B Spectrum analyzer, which has standard built-in bandwidth calculator. The test set up is shown in Figure 4.

Figure 4: Occupied Bandwidth test set up



The table below shows the bandwidth occupied by Analog and Digital Signal for the current 17 MHz channel spacing (Table 18) and the new 12 MHz channel spacing BAS relo frequencies (Table 19).

Table 18: Occupied Bandwidth Figure Reference (17 MHz spacing)

Occupied Bandwidth MHz				Frequency GHz
Figure No.	Digital (COFDM)	Figure No.	Analog (FM)	
1	7.548	5	12.201	1.999
2	7.537	6	13.319	2050.5
3	7.541	7	12.282	2084.5
4	7.572	8	13.136	2492.5

See separate e-file named I4U27CMT1-L5-E1P5_Occbw_17Mhz_channels.pdf.

Table 19: Occupied Bandwidth figure reference (12 MHz spacing)

Occupied Bandwidth MHz			Frequency GHz

Figure No.	Digital (COFDM)	Figure No.	Analog (FM)	
1	7.553	5	11.019	2031.5
2	7.523	6	11.410	2043.5
3	7.539	7	11.224	2091.5
4	7.543	8	10.208	2103.5

See separate e-file named I4U27CMT1-L5-E1P5_Occbw_BAS_relo_freq.pdf.

Table 20: Occupied Bandwidth figure reference (25 MHz spacing 7GHz Band)

Occupied Bandwidth MHz				Frequency GHz
Figure No.	Digital (COFDM)	Figure No.	Analog (FM)	
1	7.567	6	12.756	6887.5
2	7.547	7	13.260	6962.5
3	7.531	8	12.857	7037.5
4	7.561	9	12.306	7112.5
5	7.538	10	11.438	6512.5

See separate e-file named I4U27CMT1-L5-E1P5_Occbw_7GHz_freq.pdf.

11.4 Spurious Emission at Antenna Terminals (2.1051)

To be provided by Retlif Testing Laboratory.

11.5 Field strength of spurious radiation (2.1053)

To be provided by Retlif Testing Laboratory.

11.6 Frequency stability (2.1055)

The transmitter was installed in a temperature test chamber per Figure 5 below.

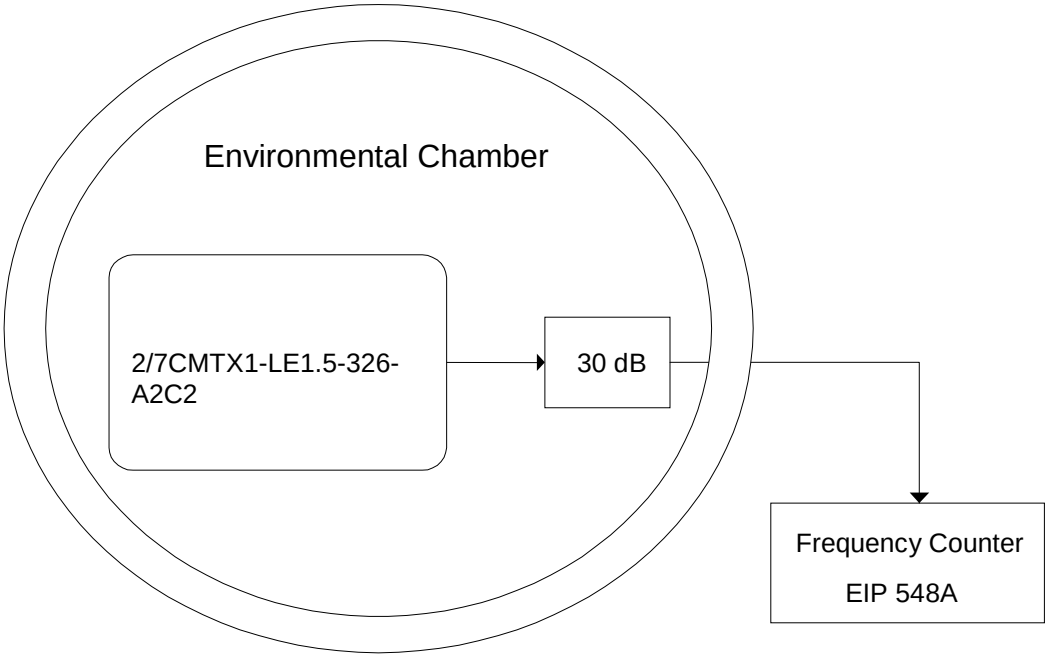


Figure 5: Frequency stability test set-up

The output frequencies were measured at intervals of 10 ºC from +60 ºC to –30 ºC using the HP 5342A Frequency Counter. Table 21 and Table 22 summarize the measured frequency vs. temperature.

Table 21: Frequency vs. Temp: 1990-2055 GHz (current freqs)

Channel	1	4	7	10
Temp ºC		Frequency Hz		
60	1,999,000,029	2,050,500,026	2,101,500,022	2,492,499,982
50	1,999,000,294	2,050,500,298	2,101,500,315	2,492,500,320
40	1,999,000,299	2,050,500,309	2,101,500,321	2,492,500,348
30	1,999,000,440	2,050,500,459	2,101,500,467	2,492,500,533
20	1,999,000,475	2,050,500,485	2,101,500,498	2,492,500,565
10	1,999,000,706	2,050,500,705	2,101,500,711	2,492,500,791
0	1,999,000,814	2,050,500,843	2,101,500,866	2,492,500,995
-10	1,999,000,950	2,050,500,969	2,101,500,985	2,492,501,112
-20	1,999,000,807	2,050,500,810	2,101,500,802	2,492,500,896
-30	1,999,000,221	2,050,500,223	2,101,500,225	2,492,500,240

Max Dev.	950	969	985	1112
Max Dev. %	0.000047%	0.000047%	0.000046%	0.000045%

The maximum observed deviation was 1112 Hz, with carrier on Ch10.

Table 22: Frequency vs. Temp 2031.5-2492.5 GHz (BAS freqs)

Channel	1	3	5	7
Temp ºC		Frequency Hz		
60	2031,500,036	2055,500,040	2079,500,042	2103,500,039
50	2031,500,263	2055,500,286	2079,500,296	2103,500,308
40	2031,500,364	2055,500,362	2079,500,353	2103,500,345
30	2031,500,531	2055,500,530	2079,500,525	2103,500,513
20	2031,500,522	2055,500,521	2079,500,518	2103,500,512
10	2031,500,616	2055,500,655	2079,500,686	2103,500,781
0	2031,500,875	2055,500,879	2079,500,886	2103,500,887
-10	2031,500,904	2055,500,908	2079,500,932	2103,500,955
-20	2031,500,673	2055,500,694	2079,500,721	2103,500,745
-30	2031,500,261	2055,500,271	2079,500,274	2103,500,270

Max Dev.	904	908	932	955
% Max Dev.	0.000047%	0.000044%	0.000045%	0.000045%

The maximum observed deviation was 955 Hz, with carrier on Ch 7.

Table 23: Frequency vs. Temp 6512.5-7112.5 GHz (7 GHz freqs)

Channel	1	4	7	10	14
Temp ºC		Frequency Hz			
60	6887,499,547	6962,499,487	7037,499,461	7112,499,471	6512,499,587
50	6887,500,233	6962,500,218	7037,500,194	7112,500,158	6512,500,132
40	6887,500,725	6962,500,723	7037,500,746	7112,500,776	6512,500,786
30	6887,501,312	6962,501,334	7037,501,349	7112,501,337	6512,501,212
20	6887,501,265	6962,501,269	7037,501,248	7112,501,241	6512,501,159
10	6887,501,436	6962,501,422	7037,501,415	7112,501,404	6512,501,273
0	6887,502,498	6962,502,506	7037,502,504	7112,502,515	6512,502,310
-10	6887,502,554	6962,502,575	7037,502,591	7112,502,603	6512,502,387
-20	6887,501,729	6962,501,708	7037,501,743	7112,501,807	6512,501,731
-30	6887,500,293	6962,500,279	7037,500,291	7112,500,324	6512,500,346

Max Dev.	2554	2575	2591	2603	2387
% Max Dev.	0.000037%	0.000037%	0.0000037	0.000037%	0.000037%

The maximum observed deviation was 2603 Hz, with carrier on Ch 10.

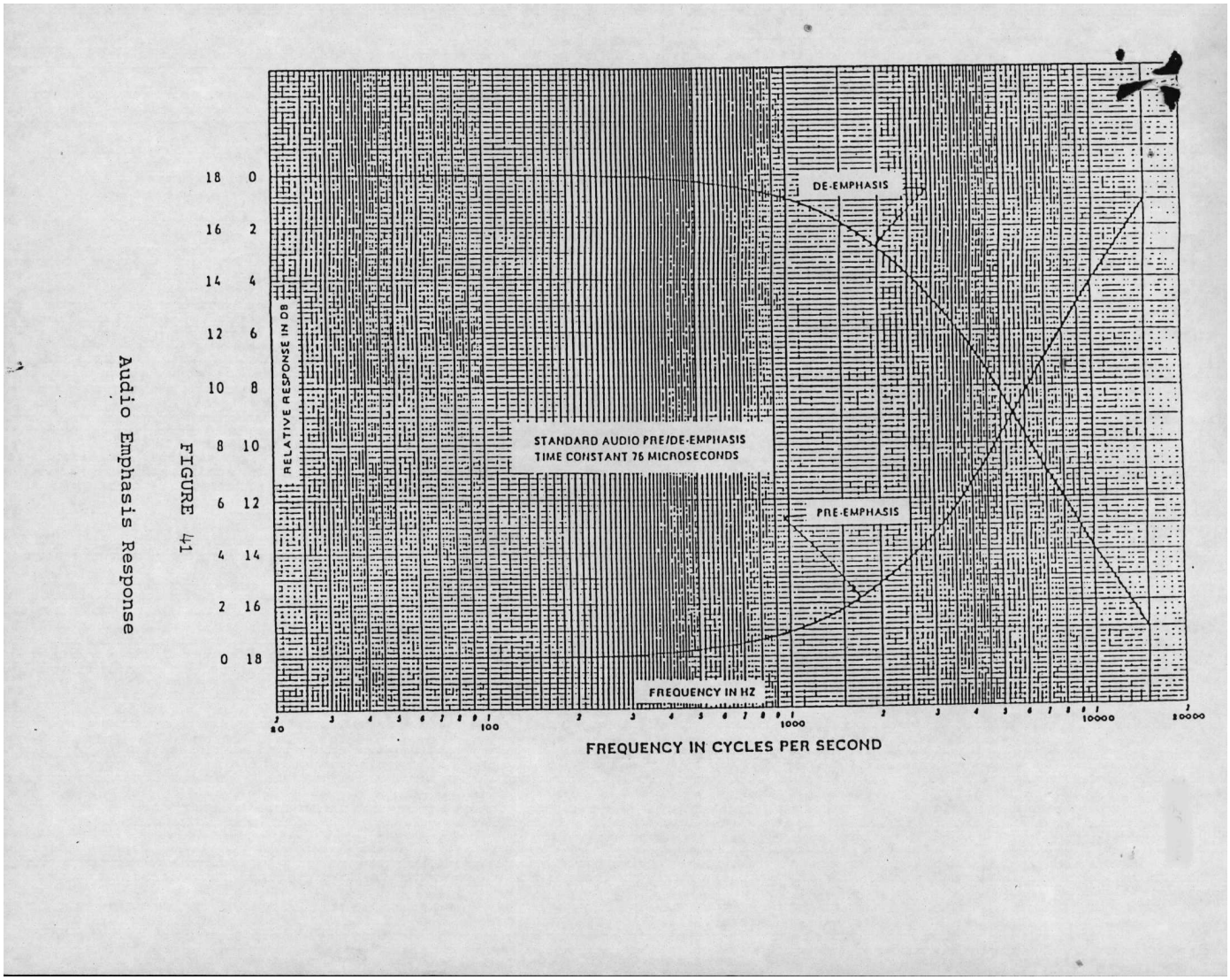


Figure 6: Audio Emphasis Response

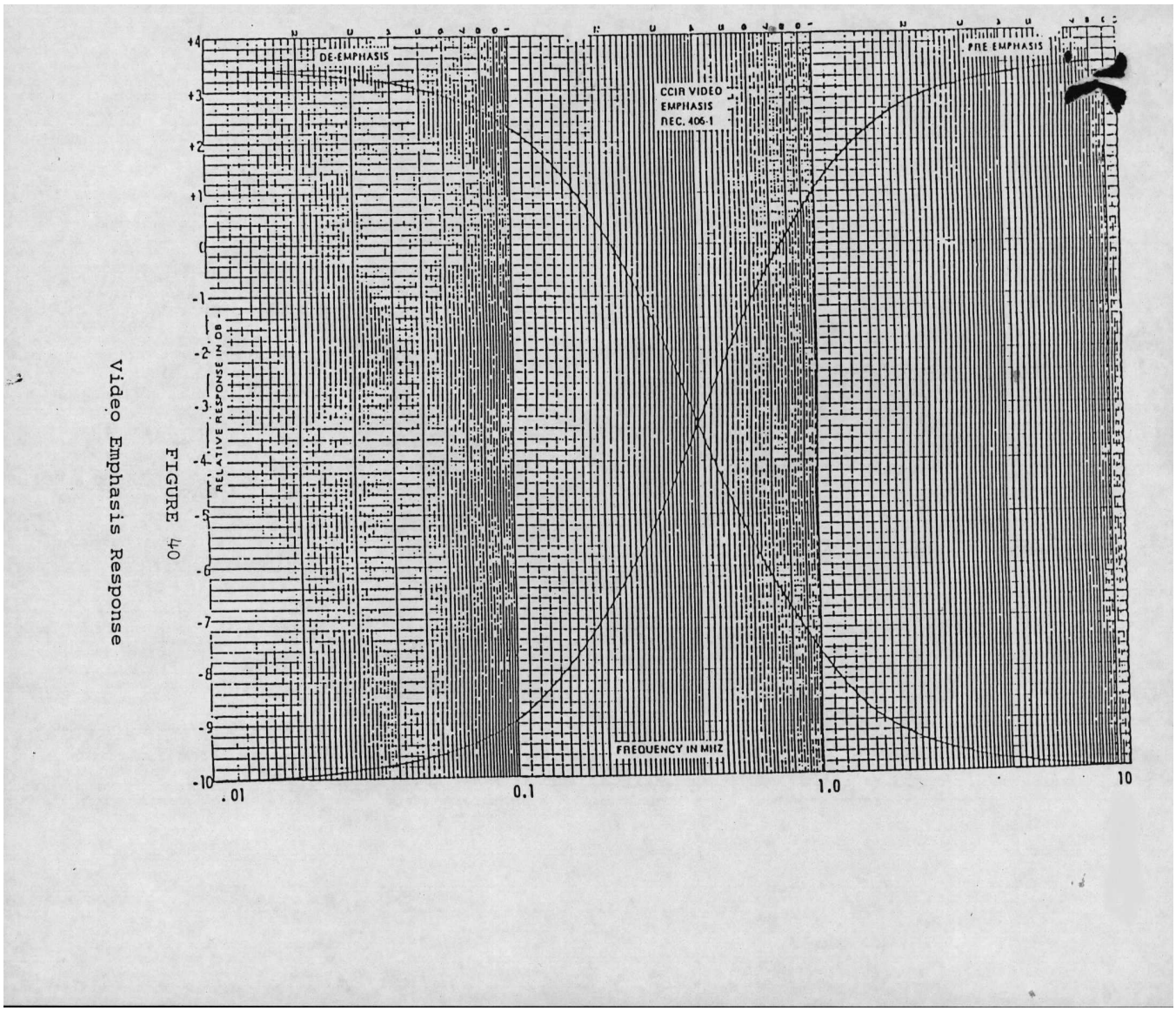


Figure 7: Video Emphasis Response