ENVELOPE DELAY CHARACTERISTICS OF 384- AND 385-TYPE EQUALIZERS

1. GENERAL

1.01 This section describes the Delay Equalizing Circuit per J99292C used to provide envelope and attenuation equalization for various voice-frequency facilities in the 300-3000 cycle range. The circuit was primarily designed for the transmission of data at 2400 bits per second over multi-link connections in switched services networks. It can also be used to meet the envelope delay requirements of various private line data channels.

1.02 Included in the section are curves and tables describing the absolute and relative envelope delay characteristics and the attenuation-frequency characteristics of the various plug-in equalizers.

2. DESCRIPTION OF EQUALIZER MOUNTING SHELF

2.01 The equalizer mounting shelf per J99292C provides for delay and attenuation equalization in one direction of transmission. The other direction of transmission can be equipped with a pad for level adjustment on an optional basis.

2.02 The shelf accepts up to four plug-in 384- or 385-type equalizers, a plug-in 227C amplifier, two plug-in 359-type equalizers, a fixed 12 db pad, a 1C pad socket and transmission access jacks. When a full complement of equalizers is not required for a given application, dummy units must be used. The dummy for the 384- or 385-type equalizer is the 433A plug; the dummy for the 359G equalizer is the 359E; and the dummy for the 359H equalizer is the 359C.

2.03 An equalizer mounting shelf is 5 inches high and designed to mount on a 23-inch bay. Two bays combining both equalizers and SF signaling units have been developed. The first, J98617A, provides for 10 circuits with equalization in both directions of transmission (20 equalizer shelves). The second, J98617B provides for 17 circuits with equalization in one direction only. Optional wiring options will permit cross-connection to echo suppressors or other transmission equipment.

2.04 Fig. 1 shows the equalizer mounting shelf with four open positions for the 384 or 385 plug-in units.

2.05 Fig. 2 shows the equalizer mounting shelf equipped with plug-in equalizers and dummy.

2.06 Fig. 3 shows a line drawing of the circuit for the equalizer mounting shelf.

2.07 The optional 1C pad provided for level control is located under the cover plate on the right side of the equipment. It must be equipped with an 89-type resistor for through transmission.

2.08 The 600-ohm transformer is used to couple the input line to the unbalanced equalizers. The 12 db pad improves the termination presented to the incoming line and to the equalizers. The 227C amplifier is used to couple the equalizers to the outgoing line and to compensate for the flat loss of the transformer, pad and equalizers. The 227C amplifier is similar to the 227B with the exception that the low frequency response and envelope delay has been improved substantially.

2.09 The four mounting positions within the equalizing mounting shelf are connected in series and must be filled with delay equalizers or 433A dummy plugs.

2.10 Since the equalizer mounting shelf contains a 227C amplifier, its envelope delay must be included in computation. The characteristics are given in Table I.

TABLE I

ENVELOPE DELAY — MICROSECONDS
227C AMPLIFIER

FREQ	10DB	20DB	30DB
500	45	40	40
1000	25	25	25
2500	20	20	20

3. DESCRIPTION OF DELAY EQUALIZERS

3.01 Table II lists each equalizer available for use with the equalizing mounting shelf and the type of voice frequency section it is designed to equalize.

TABLE II

BASIC FIXED EQUALIZER	
384A	1 Pr. of A Channel Banks
384B	3/4 (minimum) Pr A Channel Bank
384C	1 PR N2 Carrier Terminal
384D	Average LMX-1 LL Group Connector in Ch. 1
384E	Average LMX-1 LL Group Connector in Ch. 12
384F	Average LMX-2 LL Group Connector in Ch. 1
384G	Average LMX-2 LL Group Connector in Ch. 12
ADJUSTABLE EQUALIZER	
385A	Low Frequency Adjustable in Four Steps
385B	High Frequency Adjustable in Six Steps

3.02 Following are descriptions for the use of each equalizer:

(a) ***384A Delay Equalizer***

Provides delay equalization for a single section using "A"- type channel banks. Typical carrier systems are K, L and J.

(b) ***384B Delay Equalizer***

Provides delay equalization for 3/4 of a typical single section of "A"-type channel banks. Used in conjunction with 385A and B adjustable equalizer or where measurements on a particular pair of "A"-type channel banks indicate.

(c) ***384C Delay Equalizer***

Provides delay equalization for an average pair of N2 terminals. It can also be used with T1 carrier equipped with E&M channel units.

(d) ***384D Delay Equalizer***

Provides delay equalization for average LMX-1 LL Group Connector in Channel 1.

(e) ***384E Delay Equalizer***

Provides delay equalization for average LMX-1 LL Group Connector in Channel 12. It can also be used for H44 and other types of cable facilities when the envelope delay approximates a straight line across the frequency band.

(f) ***384F Delay Equalizer***

Provides delay equalization for average LMX-2 LL Group Connector in Channel 1.

(g) ***384G Delay Equalizer***

Provides delay equalization for average LMX-2 LL Group Connector in Channel 12. It can also be used for H44 and other types of cable facilities where the envelope delay approximates a straight line across the frequency band.

(h) ***433A Dummy***

The 433A dummy is a shorting plug that is used whenever less than four delay equalizers are required. As all four equalizer mountings are wired in series, either an equalizer or 433A dummy must be inserted in each socket to maintain continuity.

3.03 Table III gives the attenuation-frequency characteristics of the equalizers. Table IV gives the envelope delay characteristics of the equalizers. Suggested applications of the equalizers can be found in Table V.

3.04 Figures 4-12 show the delay characteristics for the individual equalizers.

3.05 Settings for the attenuation equalizers, 359G and 359H can continue to be obtained from Section 314-016-125.

TABLE III

ATTENUATION-FREQUENCY RESPONSE
NOMINAL LOSS IN DB

FREQUENCY (Cycles)	384A	384B	384C	384D	384E	384F	384G
300	1.70	1.28	0.63	1.73	1.19	1.39	1.01
400	1.85	1.38	0.65	1.76	1.19	1.43	1.04
600	2.01	1.56	0.70	1.79	1.17	1.48	1.10
800	2.16	1.79	0.74	1.82	1.15	1.49	1.12
1000	2.35	1.90	0.75	1.81	1.15	1.45	1.13
1200	2.41	1.89	0.73	1.75	1.16	1.42	1.13
1400	2.36	1.86	0.71	1.73	1.16	1.42	1.12
1600	2.23	1.79	0.70	1.76	1.17	1.43	1.11
1800	2.14	1.76	0.71	1.78	1.17	1.45	1.11
2000	2.17	1.79	0.71	1.77	1.18	1.46	1.12
2200	2.28	1.86	0.71	1.76	1.19	1.48	1.12
2400	2.34	1.92	0.72	1.76	1.20	1.49	1.12
2600	2.23	1.85	0.72	1.77	1.19	1.49	1.12
2800	2.09	1.68	0.72	1.79	1.11	1.49	1.10
3000	1.97	1.44	0.70	1.80	0.98	1.49	1.04

TABLE III (Cont)

ATTENUATION-FREQUENCY RESPONSE
NOMINAL LOSS IN DB

			385A	
FREQUENCY (Cycles)	STEP 1	STEP 2	STEP 3	STEP 4
300	0	0.48	0.93	1.41
400	0	0.79	0.99	1.78
600	0	0.85	1.11	1.96
800	0	0.91	1.18	2.09
1000	0	0.93	1.14	2.07
1200	0	0.91	1.08	1.99
1400	0	0.87	1.04	1.91
1600	0	0.84	1.03	1.87
1800	0	0.85	1.04	1.89
2000	0	0.87	1.05	1.92
2200	0	0.88	1.06	1.94
2400	0	0.89	1.07	1.96
2600	0	0.90	1.08	1.98
2800	0	0.91	1.08	1.99
3000	0	0.93	1.09	2.02

TABLE III (Cont)

ATTENUATION-FREQUENCY RESPONSE
NOMINAL LOSS IN DB

FREQUENCY (Cycles)	STEP 1	STEP 2	STEP 3	385B STEP 4	STEP 5	STEP 6
300	0	0.50	0.66	1.16	1.32	1.81
400	0	0.50	0.66	1.16	1.32	1.81
600	0	0.50	0.67	1.17	1.34	1.83
800	0	0.51	0.68	1.19	1.36	1.86
1000	0	0.51	0.69	1.20	1.38	1.88
1200	0	0.50	0.69	1.19	1.38	1.87
1400	0	0.50	0.70	1.20	1.40	1.89
1600	0	0.51	0.72	1.23	1.44	1.94
1800	0	0.51	0.73	1.24	1.46	1.96
2000	0	0.51	0.75	1.26	1.50	2.00
2200	0	0.52	0.76	1.27	1.52	2.02
2400	0	0.51	0.76	1.27	1.52	2.02
2600	0	0.50	0.74	1.24	1.48	1.97
2800	0	0.47	0.69	1.16	1.38	1.84
3000	0	0.44	0.63	1.16	1.26	1.78

TABLE IV

Relative Envelope Delay in Microseconds

FREQ. IN CPS	384A EQUALIZER	384B EQUALIZER	384C EQUALIZER	384D EQUALIZER	384E EQUALIZER	384F EQUALIZER	384G EQUALIZER
400	−985	−634	−120	−647	152	−443	90
600	−526	−420	− 68	−481	142	−309	84
800	−313	−225	− 21	−298	120	−198	71
1000	−164	−130	4	−173	98	−137	57
1200	− 98	− 76	8	−124	81	− 84	48
1400	− 53	− 32	3	− 87	58	− 48	32
1600	− 14	− 22	2	− 40	34	− 23	15
1800	0	0	0	0	0	0	0
2000	− 3	− 6	− 10	22	− 37	22	− 18
2200	− 36	− 32	− 29	35	− 81	38	− 49
2400	− 72	− 60	− 49	51	−133	55	− 83
2600	−137	−118	− 67	75	−214	64	−124
2800	−257	−192	− 93	98	−349	72	−181
3000	−430	−355	−141	97	−527	76	−260
Envelope Delay at 1800 cps	384A	384B	384C	384D	384E	384F	384G
in Microseconds	2,471	1,482	721	1,672	1,502	1,430	941

TABLE IV (Cont)

385 Type Equalizers

Relative Envelope Delay in Microseconds

FREQ. cps	385A				385B					
Step	*1*	*2*	*3*	*4*	*Step*	*1*	*2*	*3*	*4*	*5*	*6*
400	0	−165	−407	−572	0	− 3	1	− 2	2	− 1
600	0	−124	−266	−390	0	− 2	3	1	6	4
800	0	− 78	−140	−218	0	− 1	2	1	4	3
1000	0	− 40	− 78	−118	0	− 1	− 1	− 2	− 2	− 3
1200	0	16	− 48	− 64	0	− 1	− 2	− 3	− 4	− 5
1400	0	− 9	− 19	− 28	0	− 2	− 1	− 3	− 2	− 4
1600	0	− 7	− 6	− 13	0	0	0	0	0	0
1800	0	0	0	0	0	0	0	0	0	0
2000	0	6	7	13	0	− 1	− 3	− 4	− 6	− 7
2200	0	5	4	9	0	− 6	− 15	− 21	− 30	− 36
2400	0	2	5	7	0	− 18	− 38	− 56	− 76	− 94
2600	0	0	6	6	0	− 41	− 77	−118	−154	−195
2800	0	5	5	10	0	− 70	−137	−207	−274	−344
3000	0	7	2	9	0	−105	−204	−309	−408	−513
Loss at 1.8 kc in db		0.85	1.04	1.89		0.51	0.73	1.24	1.46	1.96
Envelope Delay at 1.8 kc in microseconds		655	1,260	1,920		420	695	1,120	1,390	1,810

TABLE V

Selection of Plug-in Delay Equalizers

	FACILITY MAKEUP NL OR H44 LOADED CABLE (Note 1)							PLUG-IN EQUALIZERS						
	A5	L-L CONN	T1 N2	0-5Mi.	5-15Mi.	15-30Mi.	30-50Mi.	384A (Note 2) 1A	384B 3/4A	384C N2	384D-G (Note 3) L-L CONN	385A LF ADJUST-ABLE	385B HF ADJUST-ABLE	CABLE EQUAL
1.	x			x				x						
2.	x	x		x					x		x	x	x	
3.	x	x			x				x		x	x	x	
4.	x	x	x	x					x		x	x	x	
5.	x				x			x					x	
6.	x					x			x			x	x	384G
7.	x						x		x			x	x	384E
8.	x		x	x				x		x				
9.	x		x		x				x			x	x	384G
10.			x	x						x				
11.			x		x					x			x	
12.			x			x				x			x	384G
13.			x				x					x	x	384E
14.					x								x	
15.						x							x	384G
16.							x					x	x	384E

Notes:

1. NL Cable not to exceed 18 kilofeet.
2. Use of the 384A equalizer should be adequate in most cases. However, it may be necessary in a few cases to replace 384A by 384B + 385A + 385B.
3. The choice of the appropriate equalizer is made according to the type of group connector and channel number: LMX1, Ch 1-384D; LMX1, Ch 12-384E; LMX2, Ch 1-384F; LMX2, Ch 12-384G. Channels 2 through 11 do not require an equalizer in this position.

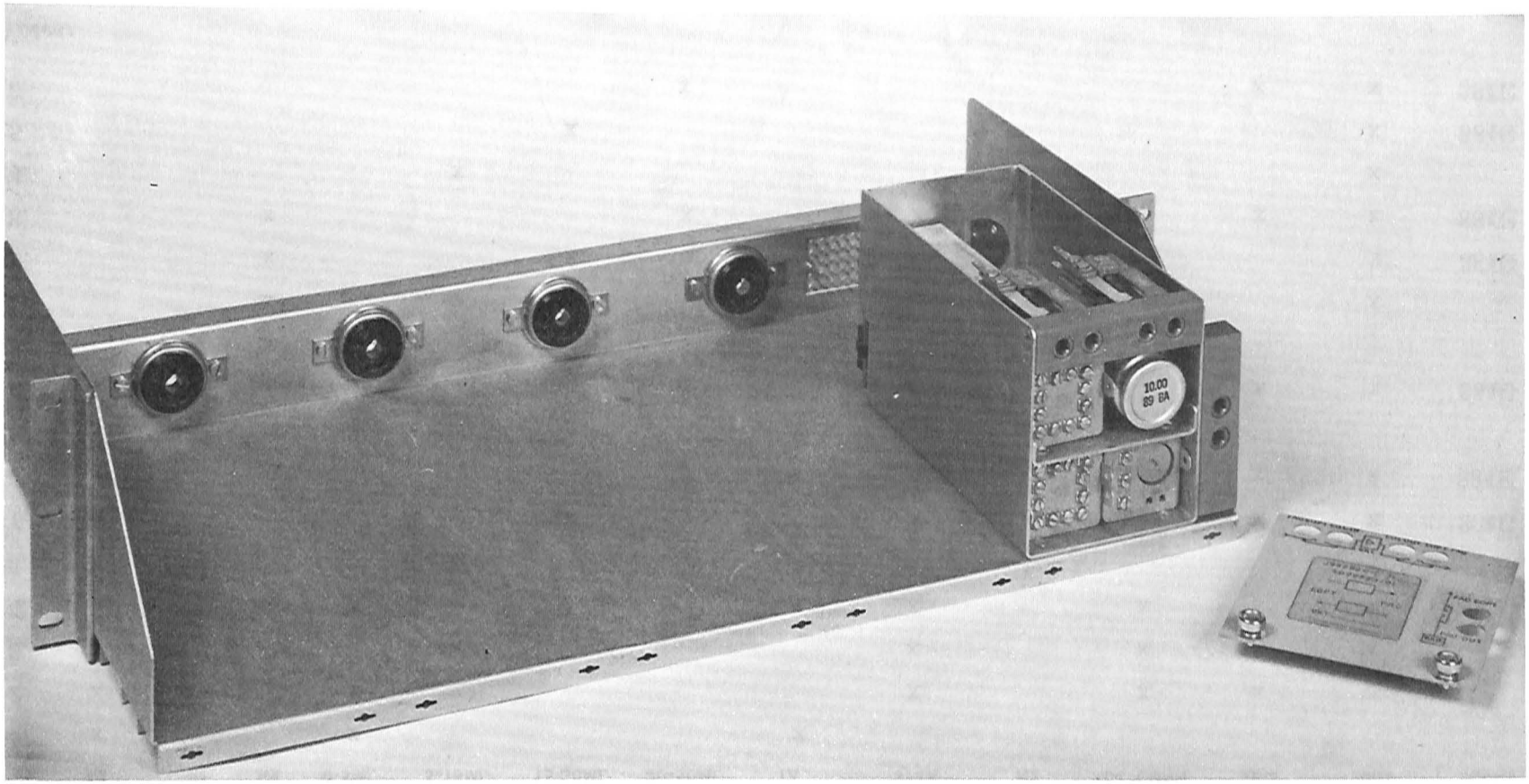

Fig. 1 – Equalizer Mounting Shelf With Four Open Positions

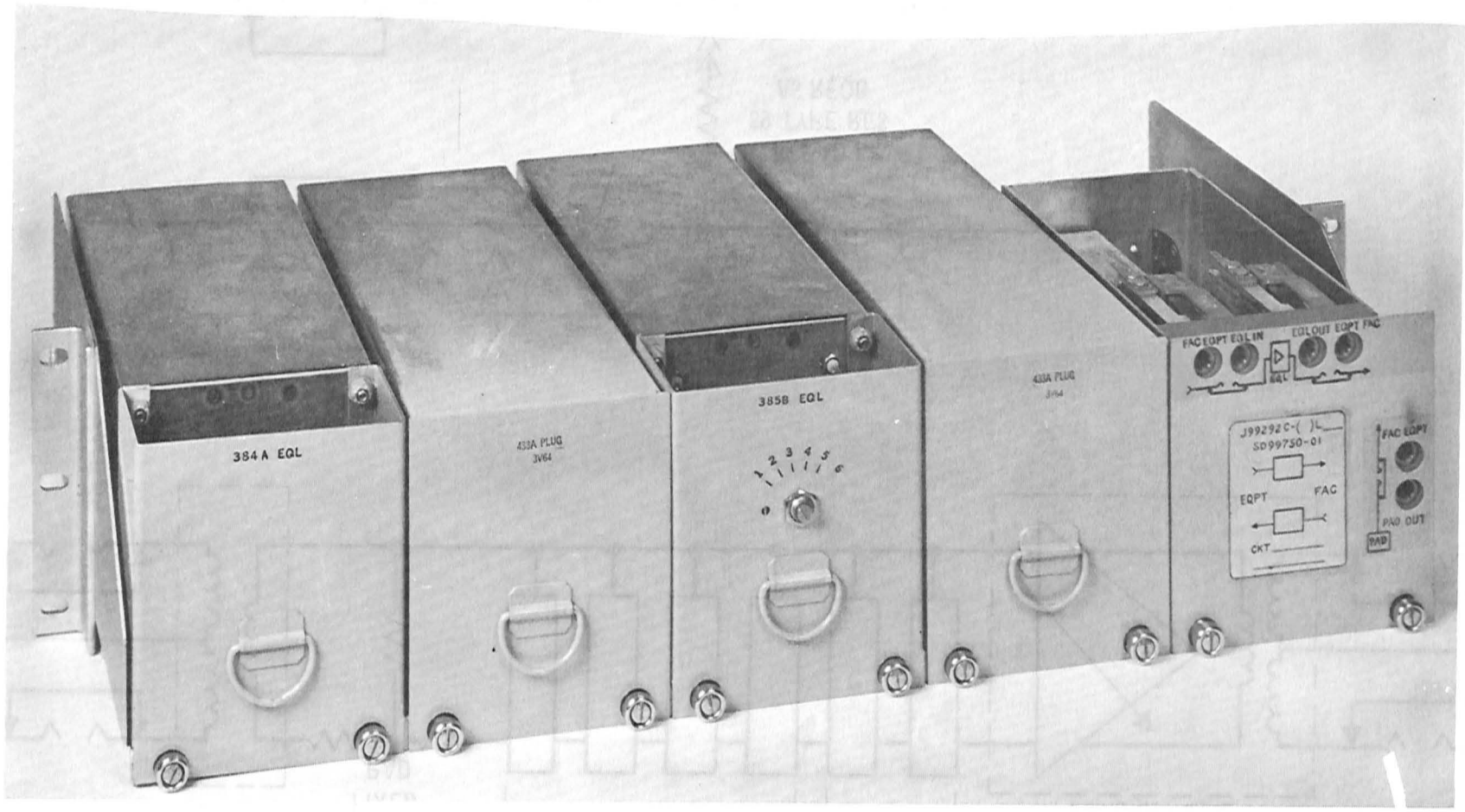

Fig. 2 – Equalizer Mounting Shelf With Plug-in Equalizers and Dummy

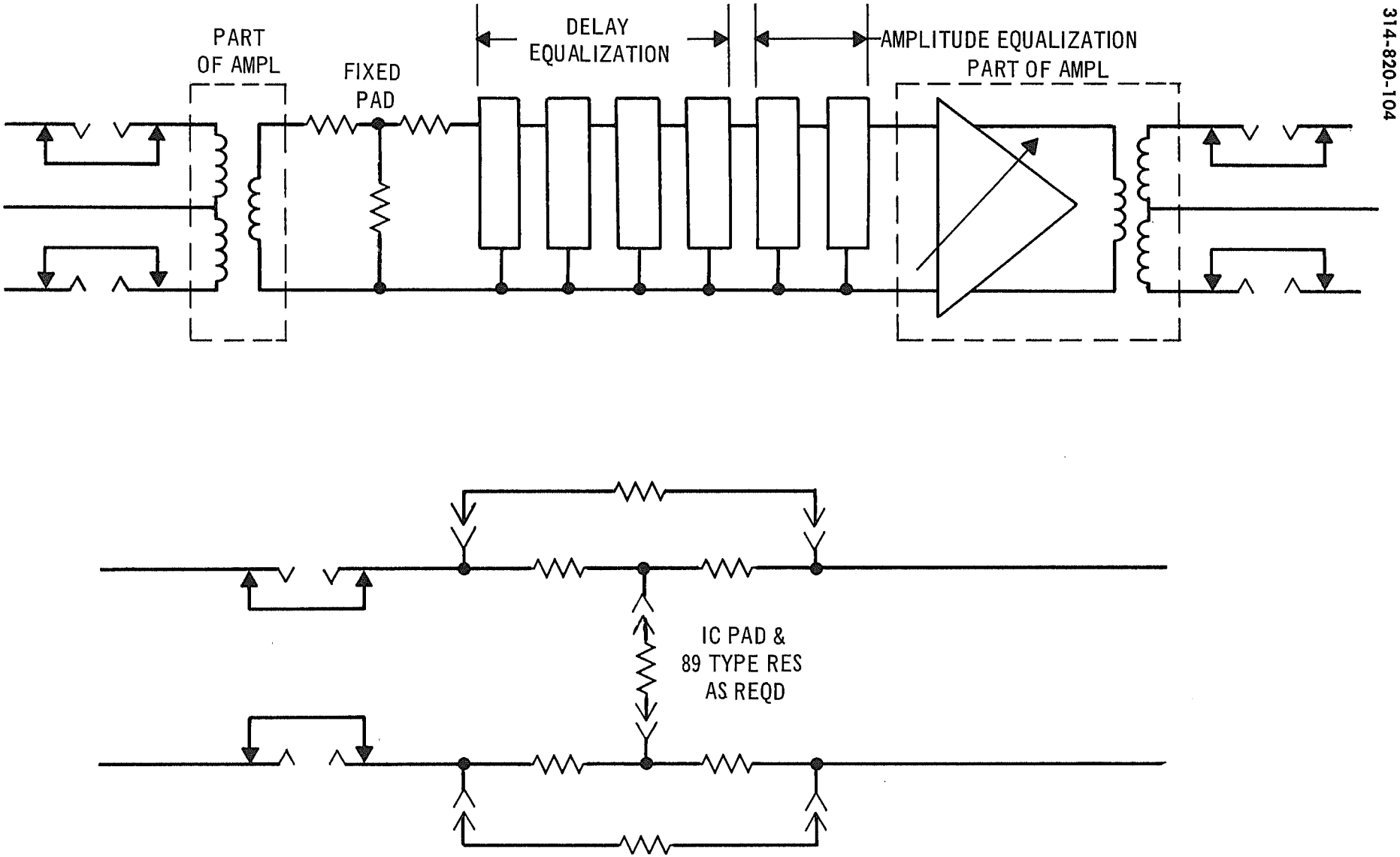

Fig. 3 – Block Schematic of the Equalizer Mounting Shelf

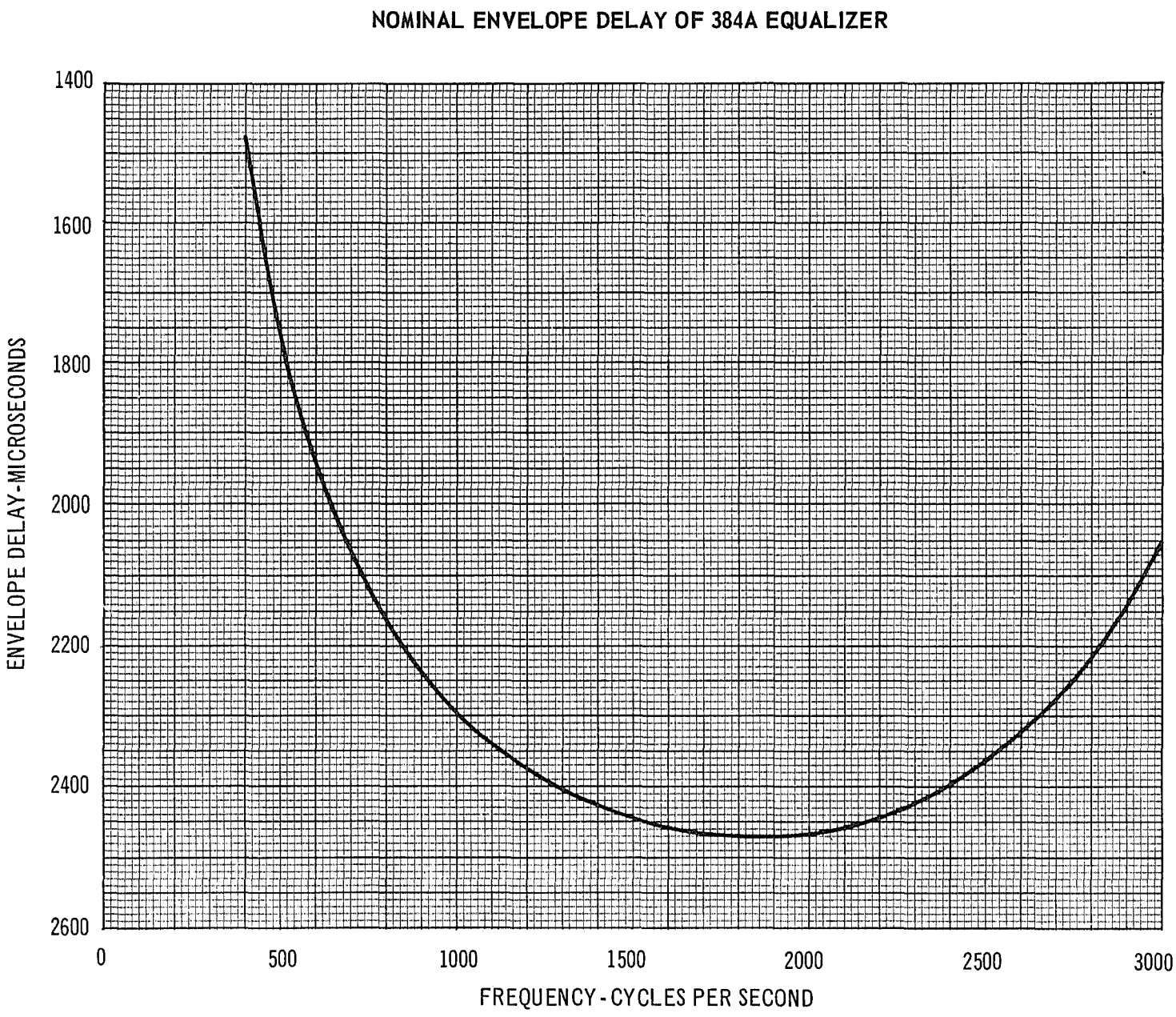

Fig. 4 – Nominal Envelope Delay of 384A Equalizer

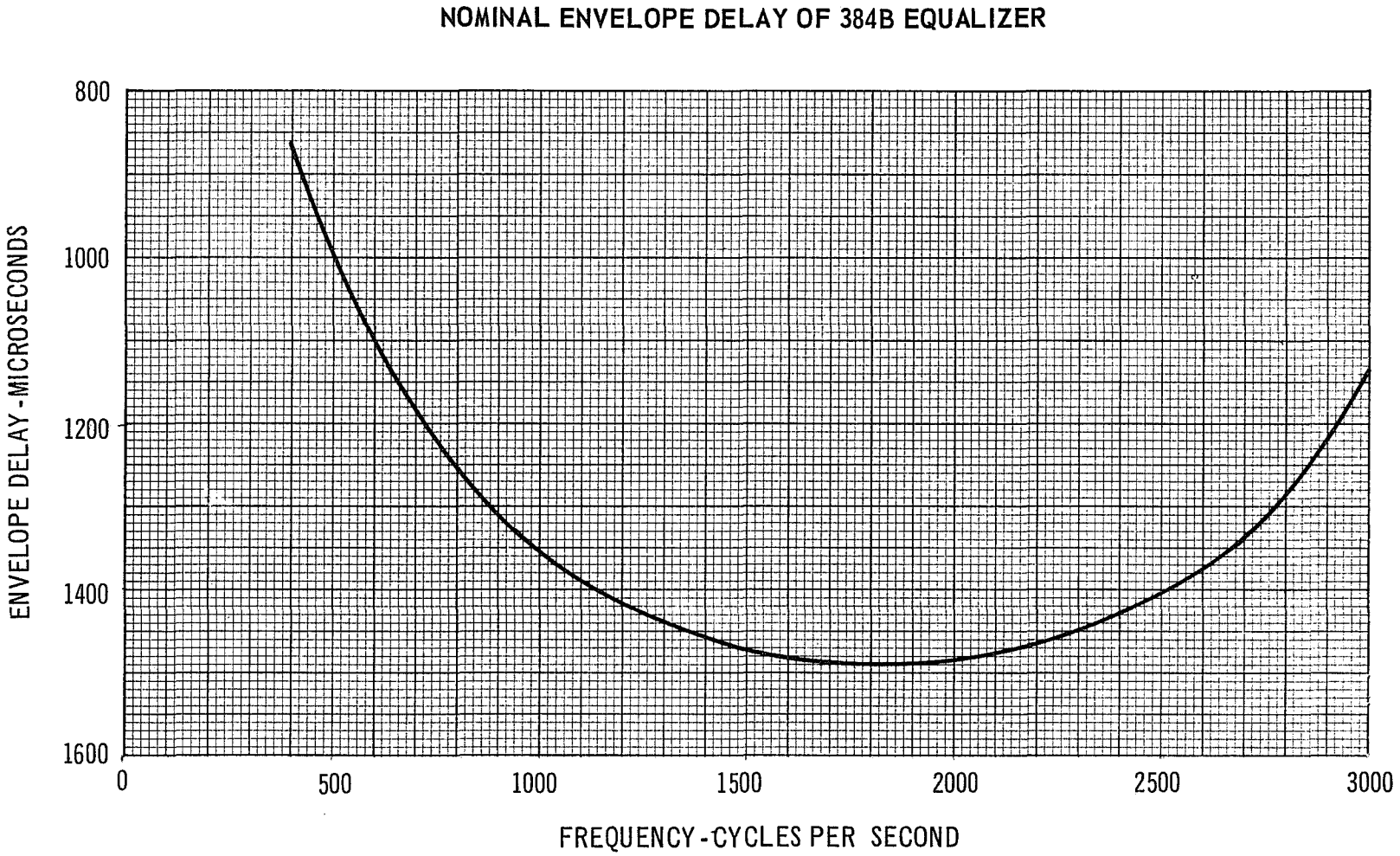

Fig. 5 – Nominal Envelope Delay of 384B Equalizer

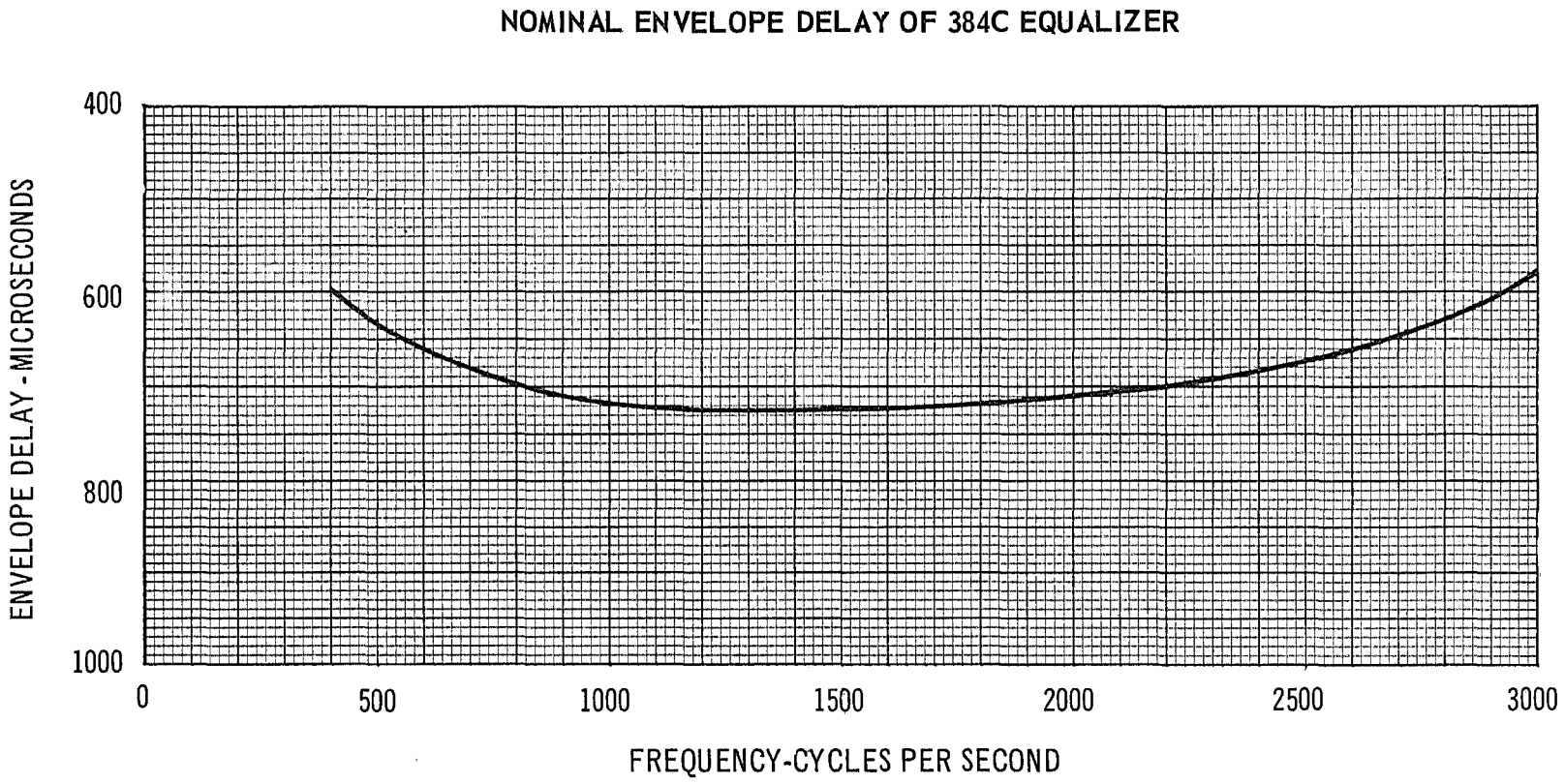

Fig. 6 – Nominal Envelope Delay of 384C Equalizer

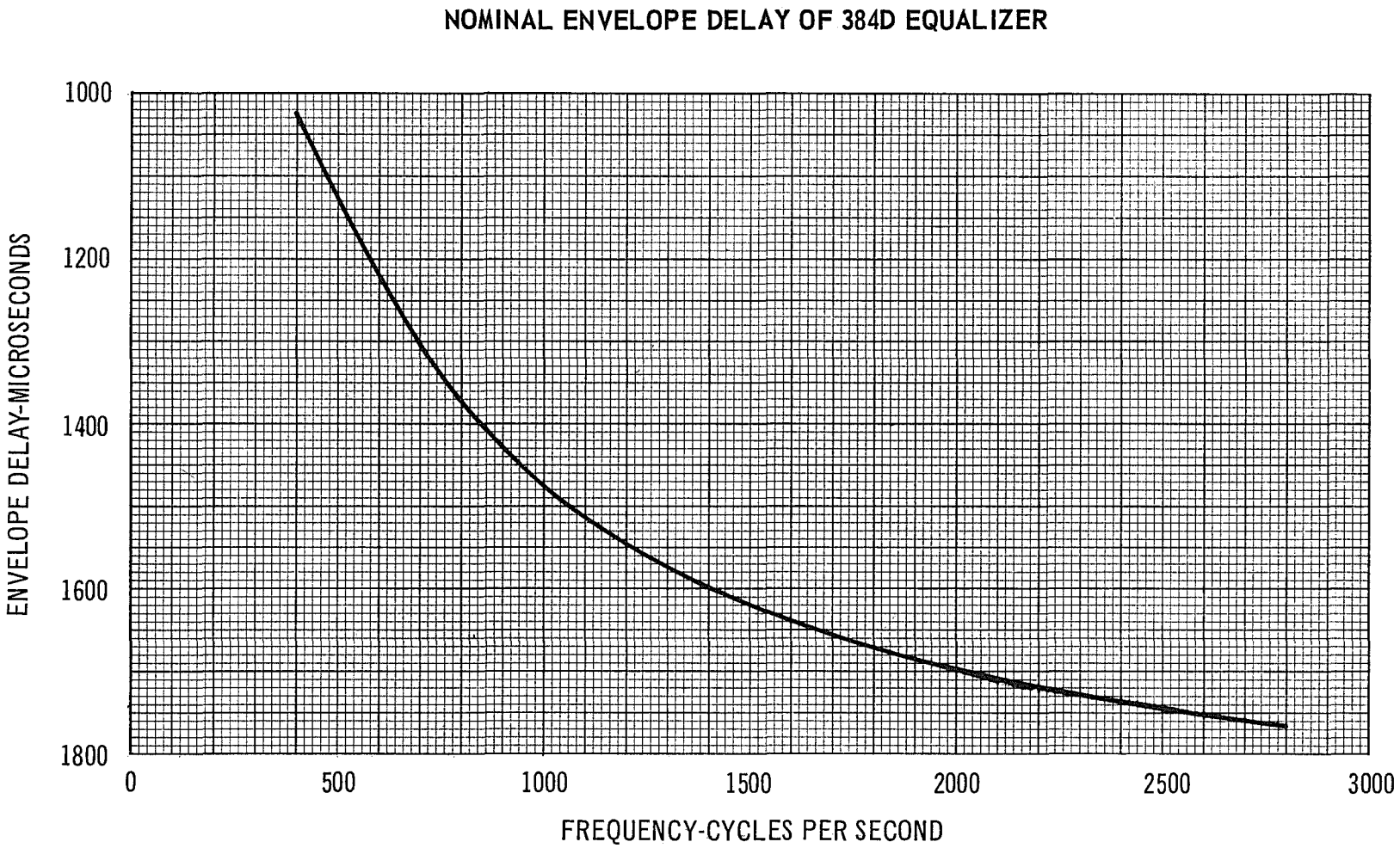

Fig. 7 – Nominal Envelope Delay of 384D Equalizer

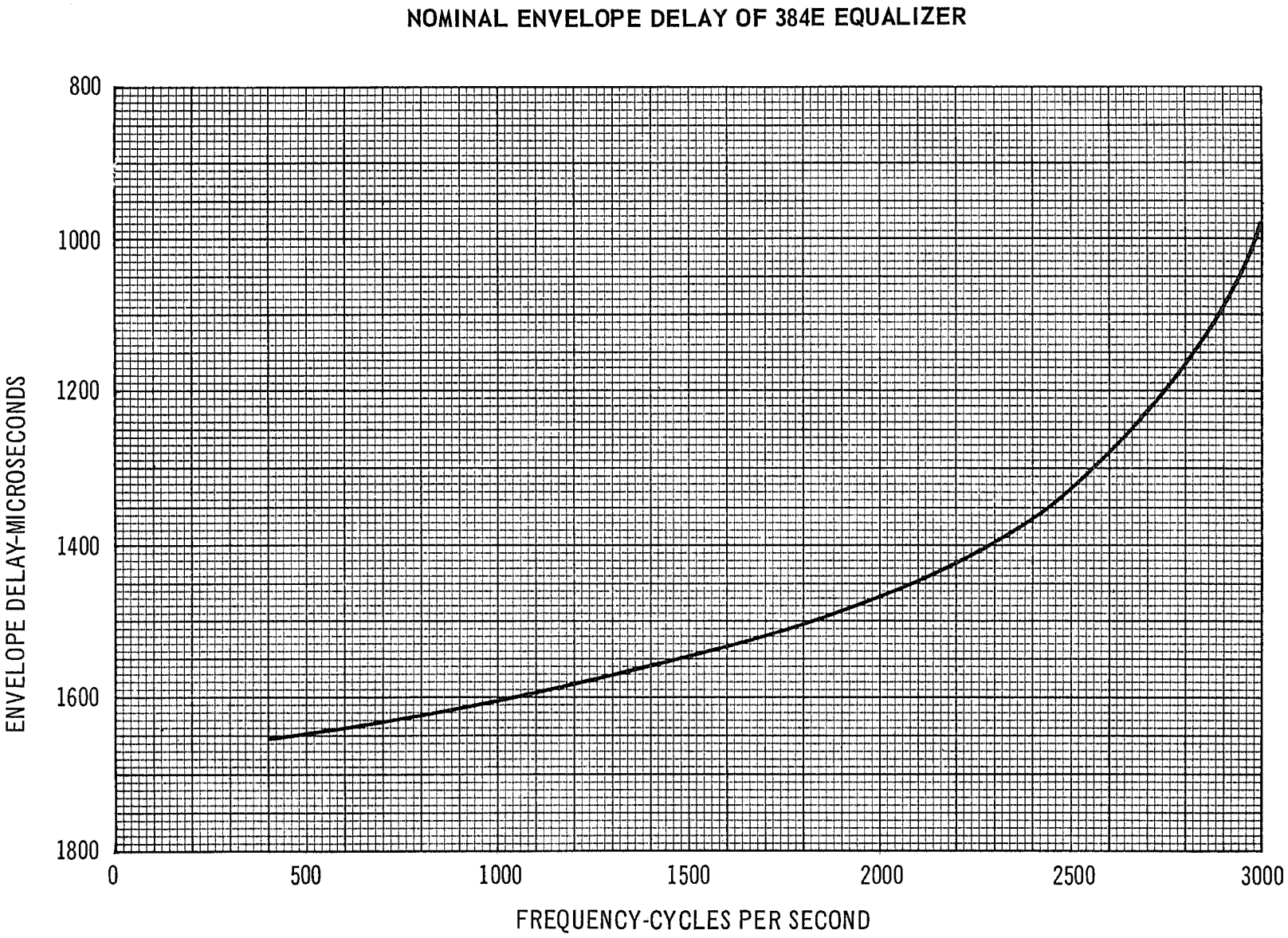

Fig. 8 – Nominal Envelope Delay of 384E Equalizer

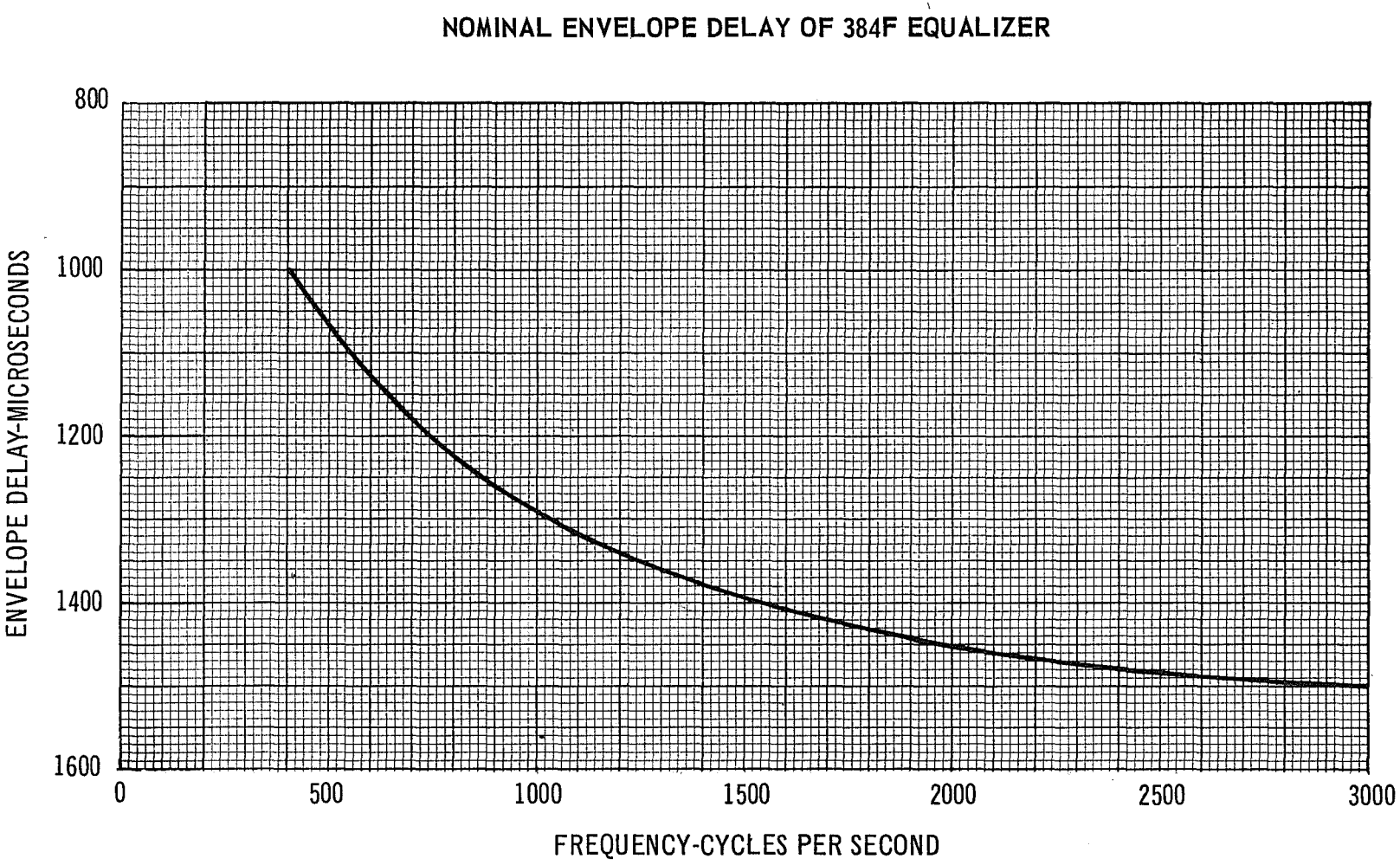

Fig. 9 – Nominal Envelope Delay of 384F Equalizer

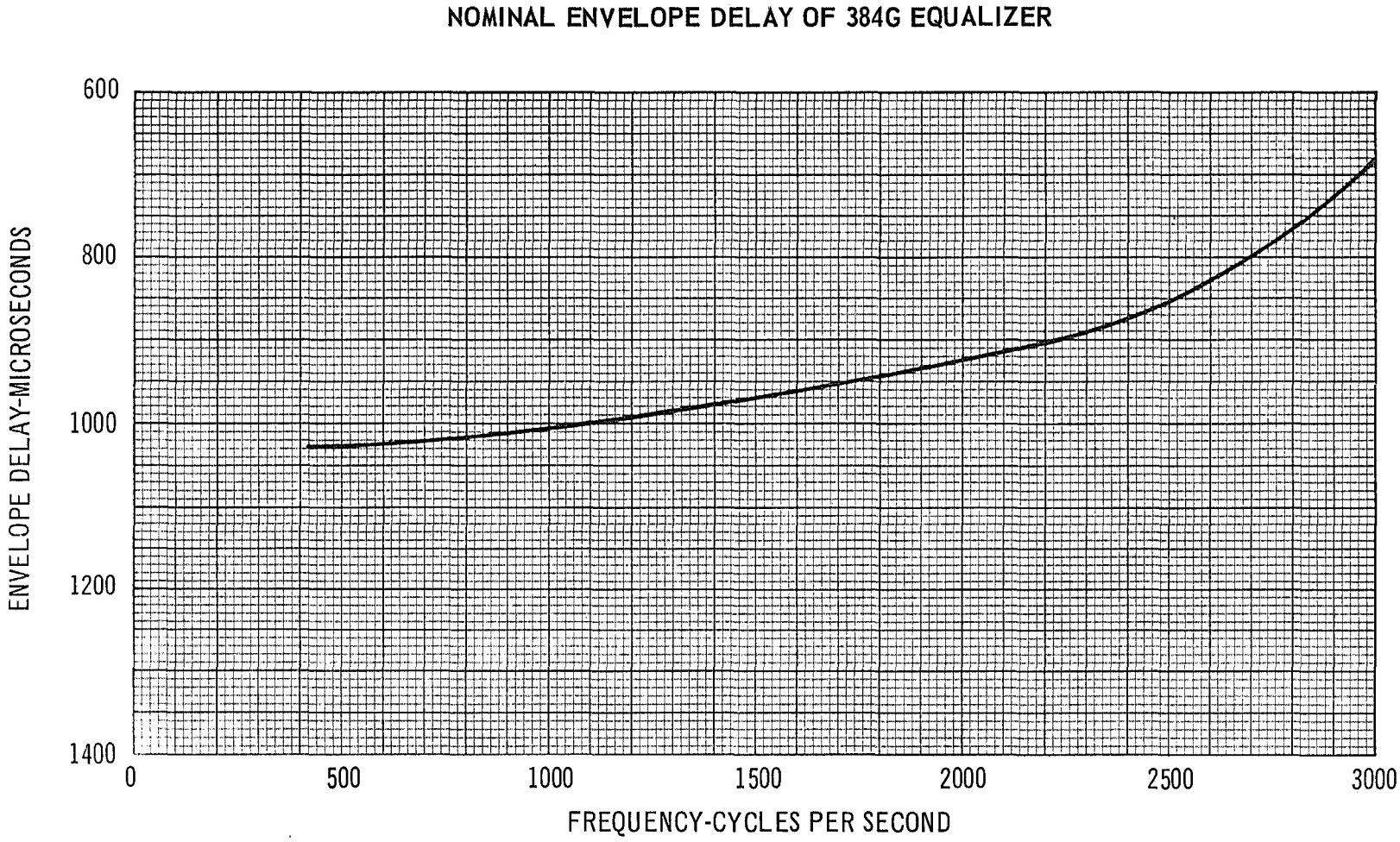

Fig. 10 – Nominal Envelope Delay of 384G Equalizer

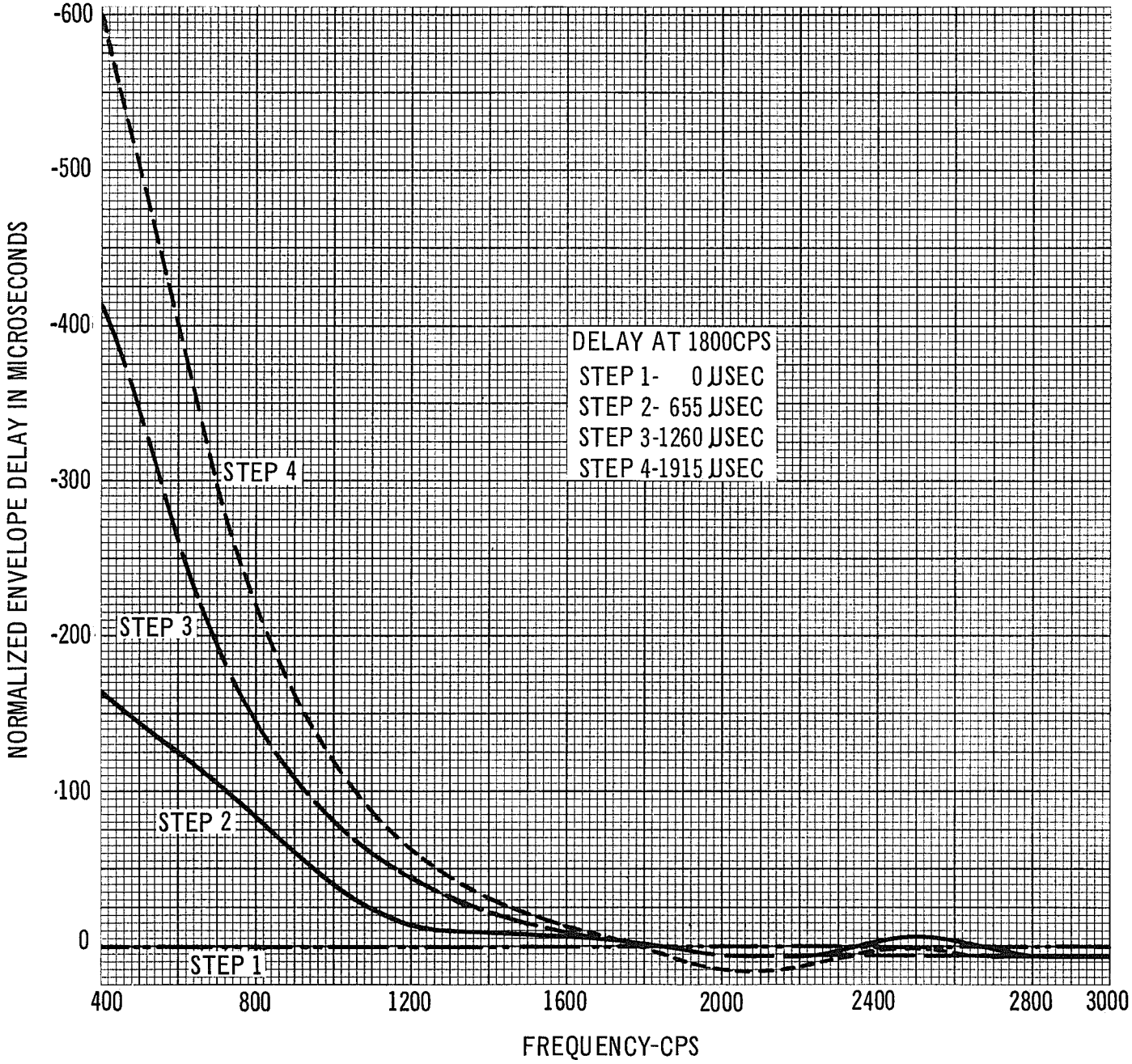

Fig. 11 – Nominal Envelope Delay of 385A Equalizer

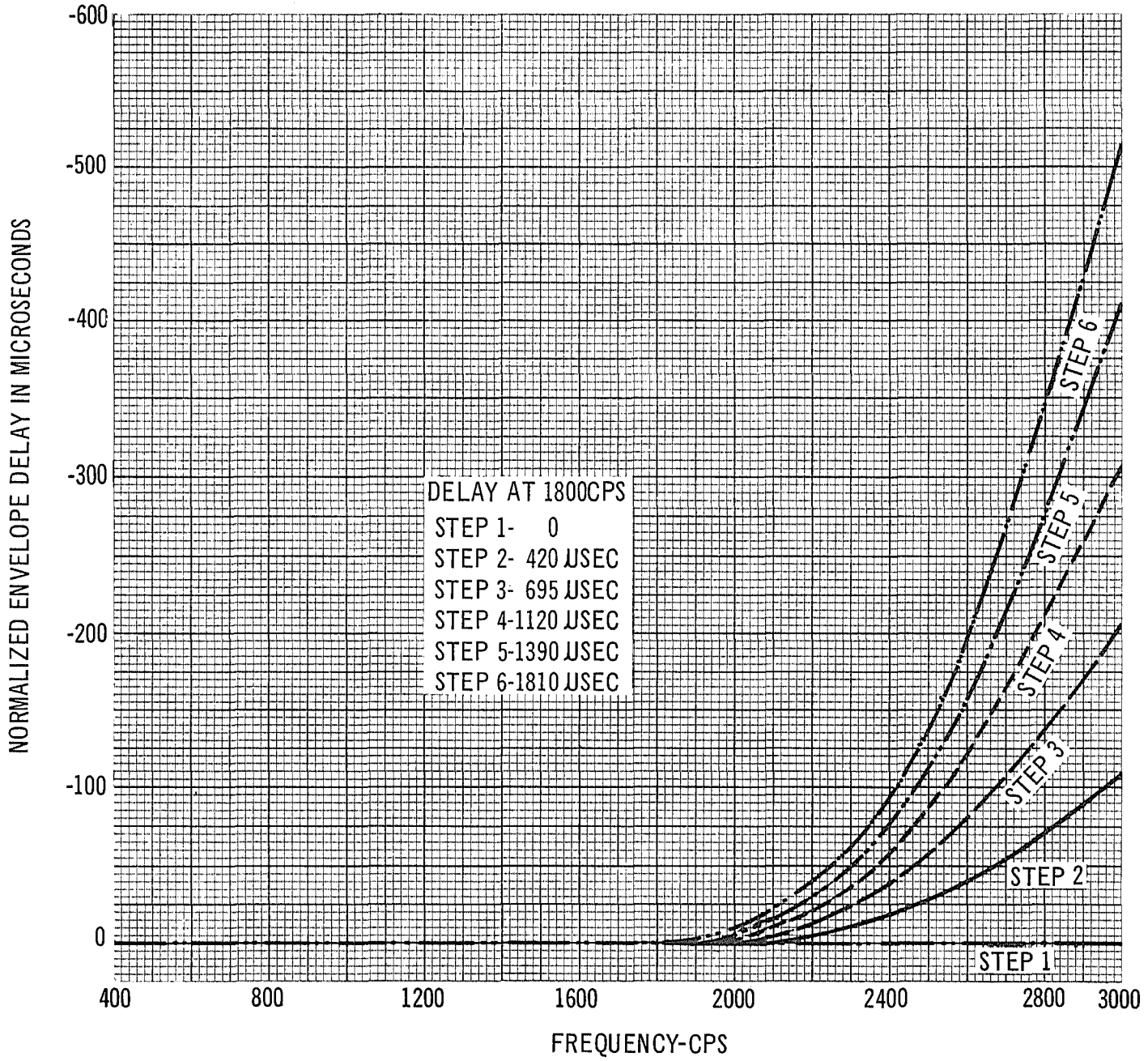

Fig. 12 – Nominal Envelope Delay of 385B Equalizer