

# PRELIMINARY

Bell System PICTUREPHONE<sup>®</sup> and Voice Communications  
TECHNICAL REFERENCE

---

---

PICTUREPHONE<sup>®</sup>  
Connecting  
Arrangement

PVF

Interface  
Specification

---

---

September 1970

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS



NOTICE

This Technical Reference is published by American Telephone and Telegraph Company as a guide for consultants, designers, and manufacturers of customer-provided systems and equipment which connect with Bell System communications systems or equipment. American Telephone and Telegraph Company reserves the right to revise this Technical Reference for any reason, including, but not limited to, conformity with standards promulgated by ANSI, EIA, CCITT, or similar agencies, utilization of new advances in the state of the technical arts, or to reflect changes in the design of equipment or services described therein. The limits of responsibility and liability of the Bell System with respect to the use of customer-provided equipment and systems are set forth in the appropriate Tariff regulations.

If further information is required, please contact:

Engineering Director - Customer Telephone Systems

American Telephone and Telegraph Company

195 Broadway

New York, New York 10007

## TABLE OF CONTENTS

	<u>PAGE</u>
PART I - GENERAL	
1. INTRODUCTION	1
2. PURPOSE	2
3. ORDERING AND IDENTIFICATION	3
PART II - DESCRIPTION	
1. FUNCTIONS	4
2. PHYSICAL DESCRIPTION	4
3. INTERFACE LEADS	5
3.1 Lead Identification	5
3.2 Lead Description	6
PART III - OPERATION	
1. IDLE CONDITION	8
2. PLACING OR RECEIVING A VOICE-ONLY CALL	8
3. PLACING A VIDEO CALL	9
4. RECEIVING A VIDEO CALL	11
5. OPERATION DURING CUSTOMER POWER FAILURE CONDITION	12
6. DISTANT PARTY ANSWER AND DISCONNECT	13
PART IV - ELECTRICAL CHARACTERISTICS	
1. GENERAL	14
2. VOICE TRANSMISSION	14
2.1 Voice Transmission Protective Criteria	14
2.2 Voice Signal Limiter	15
2.3 DC Voltage	16
3. VOICE CIRCUIT CONTROL	16
3.1 Nonlocking Voice Circuit Control	16
3.2 Locking Voice Circuit Control	17
3.3 Electrical and Circuit Parameters	18
4. VIDEO TRANSMISSION	18
4.1 Video Transmission Path	18
4.2 Video Transmission Protective Criteria	19
4.3 Video Signal Limiter	20
4.4 Electrical and Circuit Parameters	21
5. POWER FAILURE INDICATION	22
6. VIDEO CALL SIGNALING	22
7. GROUNDING	24
8. AC POWER	24

TABLE OF CONTENTS

- 2 -

	<u>PAGE</u>
 PART V - SPECIFIC DESIGN CONSIDERATIONS  	
1. VOICE TRANSMISSION PATH	25
1.1 Impedance	25
1.2 Average Power at the Central Office	25
1.3 Maximum Available Power	25
1.4 Measuring Maximum Available Power	26
1.5 Out-of-Band Limits	27
1.6 Signaling Considerations	27
2. VIDEO TRANSMISSION PATH	28
2.1 Impedance	28
2.2 Maximum Video Power	29
2.3 Measuring Maximum Video Power	30
3. PICTUREPHONE SIGNAL CHARACTERISTICS	42
3.1 General	42
3.2 Output Video Signal	42
3.3 Input Video Signal	43
 PART VI - GENERAL TECHNICAL CONSIDERATIONS  	
1. GENERAL	45
2. VOICE TRANSMISSION	45
2.1 Transmission Parameters	45
2.2 End-to-End Electrical Loss	45
2.3 Bandwidth and Frequency Response	46
2.4 Nonlinearities	46
3. VIDEO TRANSMISSION	47
3.1 Network Configuration	47
3.2 Transmission Variables	48
4. FOREIGN AND SURGE VOLTAGE PROTECTION	54
5. GENERAL VOLTAGE LIMITATIONS	55
 PART VII - SERVICE and MAINTENANCE CONSIDERATIONS  	
1. RESPONSIBILITY OF THE CUSTOMER	57
2. RESPONSIBILITY OF THE TELEPHONE COMPANY	58
3. TROUBLE REPORTING PROCEEDURE	59
 Appendix A - REFERENCES Appendix B - GLOSSARY FIGURES 1-20	

PRELIMINARY

PART I - GENERAL

1. INTRODUCTION

Tariffs filed by the Bell System provide for the direct connection of customer-provided voice transmitting and receiving terminal equipment and communications systems to the Bell System telecommunications network and provide for the direct connection of customer-provided video transmitting and receiving terminal equipment to the associated PICTUREPHONE® network. Direct electrical connection is made through a PICTUREPHONE connecting arrangement furnished, installed, and maintained by the Telephone Company.

In addition, the Telephone Company retains responsibility for network control signaling (this includes the switchhook, dialing and control functions), as well as responsibility for the protective functions of voice and video signal limiting and protection against hazardous voltages from the customer-provided equipment.

This Technical Reference is intended to provide information for customer-provided video (face-to-face and graphic signals) applications. PICTUREPHONE facilities will also be used for computer access service and wideband data service. Computer access service involves interaction with a customer's computer to display alphanumeric and graphic information at the PICTUREPHONE station. Wideband data service involves, initially, transmission of customer data over PICTUREPHONE facilities at the rate of 460.8 Kb/s. Questions concerning these data services should be addressed to:

Engineering Director - Data Communications  
American Telephone and Telegraph Company  
195 Broadway, New York, New York 10007

## 2. PURPOSE

The PICTUREPHONE Connecting Arrangement PVF provides a means for connecting customer-provided video/audio terminal equipment to the Bell System telecommunications network and associated PICTUREPHONE network. This arrangement handles voice-only or voice and video telephone calls in both directions. This connecting arrangement is associated with a Telephone Company-provided 12-button TOUCH-TONE® telephone set which is used to originate and receive both telephone and PICTUREPHONE calls. For installations with a Telephone Company-provided Key Telephone System, the normal pick-up, hold, and lamp illumination features can be provided plus distinctive (red) lamp supervision for indicating PICTUREPHONE calls.

A hands-free audio feature can be provided using either a Bell System Speakerphone, to be associated with the telephone set, or the customer may provide audio equipment and connect it to the connecting arrangement. The voice circuit in the connecting arrangement is suitable only for the transmission of speech signals and is not intended for the transmission of data.

The video circuits in this connecting arrangement are intended for use with signals similar to those used by the Bell System in PICTUREPHONE service. Control leads are provided in the connecting arrangement to permit the customer's equipment to detect an incoming PICTUREPHONE call, to answer either a telephone or PICTUREPHONE call, to make use of customer-provided audio equipment, and to accept a signal for customer equipment power failure.

3. ORDERING AND IDENTIFICATION

The connection service described in this Technical Reference is identified by the Bell System as PICTUREPHONE® Connecting Arrangement PVF and should be ordered as such. Contact the local Telephone Company business office or Marketing representative for information regarding rates for, and the availability of this connecting arrangement.



PRELIMINARY

PART II - DESCRIPTION

- 4 -

1. FUNCTIONS

The major functions of PICTUREPHONE Connecting Arrangement PVF are:

- (a) To isolate hazardous voltages and currents for the protection of Telephone Company personnel and equipment.
- (b) To limit abnormally high voice and video signal voltages.
- (c) To provide network control signaling to the network.
- (d) To provide longitudinal impedance balance both on the telephone line and on video receive and transmit pairs.
- (e) To provide voice and video signal access to and from the telecommunications network.
- (f) To provide for accepting supervisory signals from the customer-provided equipment.
- (g) To provide video call ringing indication to customer-provided equipment.
- (h) To provide indication of video call in progress to customer-provided equipment.

2. PHYSICAL DESCRIPTION

PICTUREPHONE Connecting Arrangement PVF consists of a connecting unit, incorporating both a voice coupler circuit and a video coupler circuit, and is associated with a Telephone Company-provided TOUCH-TONE telephone set used for network control signaling for PICTUREPHONE connections as well as for telephone calls. The connecting unit (see Fig. 1) measures approximately 6 by 7-1/2 by 12 inches and weighs approximately 12 pounds. The unit is to be mounted in an appropriate location by the

Telephone Company in close proximity to a customer-provided 117 volt ac outlet not under control of a wall switch (see Part IV Section 8). The unit dissipates a maximum of 25 watts and may be located in a service area remote from the customer-provided equipment. (See Part IV for distance limitations.) This unit will function satisfactorily within an ambient temperature range of 0° to 55°C and a humidity range continuous from 5 to 95 percent. The interface leads of the connecting arrangement are terminated in a multi-pin connector (Interface Connector) attached to the terminating unit for ease of connection to the customer's equipment and to permit testing, maintenance and trouble isolation. The mating connector and associated cable to the customer-provided equipment is to be provided as part of the customer's equipment. (See Part II, Section 3 for connector type and connections.)

### 3. INTERFACE LEADS

#### 3.1 Lead Identification

The leads from PICTUREPHONE Connecting Arrangement PVF are terminated in a female connector which is openly accessible for connection by the customer (see Fig. 1). The mating connector, and the conductors outgoing from this connector to the customer-provided equipment, must be provided and installed by the customer. The conductors to be connected to terminals in the customer's connector are designated (See Fig. 2) as follows:

- 6 -

<u>Lead Designation</u>	<u>Connector* Terminal Designation</u>	<u>Function</u>
CVOT	1	customer's video outgoing transmission
CVOR	26	
CVIT	2	customer's video incoming transmission
CVIR	27	
CPF**	6	customer power failure indication
CVCR**	7	video call ringing
CVCC**	8	video call connect
CK1	9	voice circuit connect
CK2	34	
CT	4	voice transmission
CR	29	
CK3	10	voice circuit control leads
CK4	11	
CK5	12	
COM1	3	control and signal common leads (ground)
COM2	5	
COM3	28	
COM4	30	

### 3.2 Lead Description

Eighteen interface leads are provided from PICTUREPHONE Connecting Arrangement PVF to an Interface Connector (see Figs. 1 and 2) for the customer's use. Technical information pertaining to these leads is discussed in Part IV. Seven leads are associated with the video functions, seven with the voice functions associated with customer-provided microphone-loudspeaker equipment operation where such equipment is provided, and four leads are multipled to obtain a low impedance for control and

---

\* Connector, part of customer-provided equipment, is: Amphenol Mfg. Co. No. 57-10500-7 or Cinch Mfg. Co. No. 222-32-50-023 or equivalent.

\*\* Unbalanced signaling to control and signal common leads (terminals 3, 5, 28, 30).

signal common ground. The leads associated with the video functions include two pairs for transmission of the video signal, that is, a pair designated CVOT and CVOR for the transmitted signal and another designated CVIR and CVIT for the received signal. A lead designated CVCR provides an alerting indication (interrupted at the normal ringing rate) that 20 Hz ringing is being received on an incoming VIDEO call, and a lead designated CVCC provides an alert that transmission on the video pairs to the serving Central Office has been enabled. A lead designated CPF provides for the function of indicating an inoperative condition in the customer's equipment due to power failure and is used to prevent completion of a PICTURE-PHONE call during this period.

The leads associated with the voice functions include a pair, designated CT and CR, which provide the two-way voice transmission path from the connecting arrangement to the customer's microphone-loudspeaker equipment. Leads designated CK3, CK4 and CK5 are used to provide the function of a request for two-way voice transmission to the telephone line. An alert indication that the two-way voice transmission path has been established is provided by means of an isolated circuit closure between leads designated CK1 and CK2.

PRELIMINARY

PART III - OPERATION

- 8 -

1. IDLE CONDITION

During idle conditions, the VIDEO TRANSMIT leads (CVOT and CVOR) and the VIDEO RECEIVE leads (CVIT and CVIR) are disconnected from resistance terminations within the connecting unit (see Fig. 2). The VIDEO TRANSMIT leads are looped back on the VIDEO RECEIVE leads by normally closed contacts connecting lead CVOT to lead CVIT and lead CVOR to lead CVIR. The voltage on the VIDEO CALL RINGING lead (CVCR) and VIDEO CALL CONNECT lead (CVCC) is at logic level LOW (see Part IV, Section 6). The VOICE CIRCUIT CONNECT leads (CK1 and CK2) are open and the VOICE TRANSMISSION leads (CT and CR) are disconnected from the telephone line.

2. PLACING OR RECEIVING A VOICE-ONLY CALL

A voice-only call using the PICTUREPHONE connecting arrangement is placed in a manner similar to a regular telephone call. To initiate a call, the customer lifts the handset of the associated telephone set, assures that dial tone is being received and dials the desired number. In the event that the customer's equipment is provided with a voice transmitting and receiving (microphone and loudspeaker) capability, the call may be placed without the use of the telephone handset if desired. For operation with the customer's microphone and loudspeaker equipment, the call is initiated with the handset on-hook by a momentary closure between the VOICE CIRCUIT CONTROL leads (CK3 and CK5) to operate the K relay. Indication of the K relay being operated is provided by an isolated circuit closure between VOICE CIRCUIT CONNECT leads (CK1 and CK2). The K relay is locked operated under control of the VOICE CIRCUIT

- 9 -

CONTROL leads (CK3 and CK4) and the switchhook of the associated telephone set. This establishes a two-way voice connection from the telephone line to leads CT and CR. When dial tone has been received at the customer's loudspeaker over leads CT and CR, the desired number may be dialed using the associated Telephone Company-provided telephone set with the handset on-hook.

A voice-only call placed to a customer with a PICTUREPHONE connecting arrangement is received in a manner similar to a regular telephone call. When the associated telephone set rings, the call may be answered either by lifting the handset or, if provided, by operating the customer's microphone-loudspeaker equipment.

A Telephone Company-provided Speakerphone associated with the telephone set may also be used in a similar manner to provide hands-free voice service.

### 3. PLACING A VIDEO CALL

A video call using the PICTUREPHONE connecting arrangement is placed in a manner similar to a regular voice-only call. To initiate a video call, the customer proceeds as in a voice-only call but prefixes the telephone number to be dialed by pressing the "#" button on the TOUCH-TONE dial. At the completion of dialing, the serving Central Office performs automatic testing, including a continuity test, of the video transmission loops of the calling station. This test consists of sending a test signal from the Central Office to the station on the receive video pair and detecting its return to the Central Office on the station transmit video pair. This loop-around transmission path and its

- 10 -

control is provided by Telephone Company circuits associated with the video loops; the signal does not appear at the Interface Connector. Failure of the loop-around continuity test results in dial tone or some other positive indication being returned to the customer placing the call (see Trouble Reporting, Part VII, Section 3).

After successfully completing the loop-around continuity test, the Central Office sends a video supervisory signal (VSS) which causes the following action at the connecting arrangement:

- (a) The voltage on the VIDEO CALL CONNECT lead (CVCC) changes to the logic level HIGH (see Part IV, Section 6) state and remains HIGH as long as the PICTUREPHONE connecting arrangement is off-hook on the telephone line.
- (b) The loopback connection between leads CVOT and CVOR and leads CVIT and CVIR is removed, causing these leads to be connected to their resistance terminations, and video transmission to and from the Central Office is enabled.
- (c) For installations in a Telephone Company-provided Key Telephone System, a lamp illuminating the line pick-up key can be provided which will change from white to red indicating a video call.

When the call has been completed, by placing the telephone handset on-hook or by turning the customer's microphone-loudspeaker equipment OFF, the connecting arrangement is restored to the idle condition (see Part III, Section 1).

4. RECEIVING A VIDEO CALL

When a video call is to be completed to a customer with a PICTUREPHONE connecting arrangement, the serving Central Office performs automatic testing that includes a continuity test of the video transmission loops of the called station. This test is performed in a similar manner to that described for placing a video call. Failure of the loop-around continuity test results in abandoning the attempt by the Central Office to complete the call and, typically, a reorder tone is returned to the originating station. If the loop-around continuity test is successful, the following action occurs at the connecting arrangement:

- (a) The ringer of the associated telephone set rings in the conventional manner. For installations in a Telephone Company-provided Key Telephone System, this ringer can be disabled by the Telephone Company if the customer desires to provide a separate distinctive signal only.
- (b) The voltage on the VIDEO CALL RINGING lead (CVCR), normally in the logic level LOW state, will fluctuate from logic LOW to logic HIGH following the individual cycles of the 20 Hz ringing signal (see Part IV, Section 6).
- (c) For installations in a Telephone Company-provided Key Telephone System, a lamp illuminating the line pick-up key can be provided that will flash red on an incoming call during the interval prior to answer.

The call may be answered either by lifting the handset of the associated telephone set or by turning ON the customer's microphone-loudspeaker equipment, if provided. The loopback connection between

- 12 -

the VIDEO TRANSMIT and VIDEO RECEIVE leads is removed and these leads are connected through for transmission to and from the Central Office. At the same time, the voltage on lead CVCC changes to the logic level HIGH state and remains in the HIGH state as long as the connecting arrangement is off-hook on the telephone line. At the termination of the call, with the telephone line in the on-hook condition, the connecting arrangement restores to the idle condition.

5. OPERATION DURING CUSTOMER POWER FAILURE CONDITION

PICTUREPHONE Connecting Arrangement PVF provides for the capability of inhibiting the placing and receiving of video calls during a condition of power failure in the customer-provided equipment. This function is under the control of the CUSTOMER POWER FAILURE indication lead (CPF, see Fig. 2), which is normally connected to the CONTROL AND SIGNAL COMMON leads (COM 1-4) in the customer-provided equipment. Placing and receiving video calls will be prevented by action of the PICTUREPHONE connecting arrangement during the interval in which lead CPF is open in the customer-provided equipment. An attempt at placing a video call from a PICTUREPHONE connecting arrangement, when lead CPF is open in the customer-provided equipment, will result in the return of dial tone or some other positive indication at the completion of dialing; the same indication results from the loss of commercial 117 volt ac power to the connecting arrangement. A video call placed to a PICTUREPHONE connecting arrangement with its lead CPF open in the associated customer-provided equipment will typically result in the return of reorder tone to the calling customer.

6. DISTANT PARTY ANSWER AND DISCONNECT

PICTUREPHONE Connecting Arrangement PVF is not equipped to detect, or to indicate to the customer's equipment, distant party answer or disconnect.

PRELIMINARY

PART IV - ELECTRICAL CHARACTERISTICS

- 14 -

1. GENERAL

PICTUREPHONE Connecting Arrangement PVF provides both a voice connecting arrangement and a video connecting arrangement in a combined unit. An associated Telephone Company-provided TOUCH-TONE telephone set provides for network control signaling on both PICTUREPHONE and regular voice-only telephone calls.

The insertion loss of the voice connecting circuit is approximately one (1) dB over the voice frequency range of 300 to 3000 Hz for both directions of transmission. No voice signal amplification is provided by this arrangement. This circuit is not suitable for the transmission of data or customer-provided tone address signals.

The video connecting circuits are designed to present a 0 dB PICTUREPHONE Transmission Level Point (0 PTLP) at the Interface Connector for both the TRANSMIT VIDEO signal and the RECEIVE VIDEO signal. The term 0 PTLP means, in this instance, that the received signal on leads CVIT and CVIR at a PICTUREPHONE connecting arrangement at one end of a connection is nominally at the same level as it was transmitted on leads CVOT and CVOR of another PICTUREPHONE connecting arrangement at the other end of that connection. The video signal on leads CVIR and CVIT is of the same polarity (referenced to ground) as transmitted on lead CVOR and CVOT respectively.

2. VOICE TRANSMISSION

2.1 Voice Transmission Protective Criteria

The voice connecting circuit of PICTUREPHONE Connecting Arrangement PVF provides about a one-to-one impedance transformation. The

input impedance is a function of the impedance of the connecting arrangement and the impedance of the loop to the Central Office. For design purposes, the impedance of this arrangement should be considered to be 600 ohms and, therefore, the impedance of the customer-provided equipment should also be 600 ohms. The voice signal levels must comply with the applicable Tariffs. The Tariffs permitting electrical connection of customer-provided voice terminal equipment state the following:

"To prevent excessive noise and crosstalk in the network, it is necessary that the power of the signal at the Central Office not exceed 12 dB below one milliwatt when averaged over any three second interval. To insure that this limit is not exceeded, the power of the signal which may be applied by the customer-provided equipment to the Telephone Company interface located on the customer's premises will be specified for each type of connecting arrangement, but in no case shall it exceed one milliwatt."

For PICTUREPHONE Connecting Arrangement PVF the maximum permissible voice signal power at the Interface Connector on leads CT and CR is -8 dBm when averaged over any 3-second interval. (See Part V, Paragraph 1.4 for testing methods.)

## 2.2 Voice Signal Limiter

A voice signal limiter is incorporated in the transmission path to protect the Bell System telecommunications network from application of abnormally high signal levels. This limiter has no effect on normal voice signal levels.

This limiter does not remove the customer's responsibility to meet the network protection criteria as prescribed in the Tariffs and as outlined in Part V, Section 1 of this Technical Reference.

### 2.3 DC Voltages

The peak voltage (dc, ac, or surge) across leads CT and CR or from ground to CT or CR measured at the Interface Connector, shall not exceed 30 volts. The dc signals from the customer-provided equipment are blocked by a capacitor in the connecting arrangement.

### 3. VOICE CIRCUIT CONTROL

This control circuit, which involves the leads CK3, CK4, and CK5, provides the means for enabling two-way speech transmission between the customer-provided microphone-loudspeaker equipment and the telephone line by way of leads CT and CR. This circuit may be arranged for operation with either one of two types of voice circuit control in the customer-provided equipment. That is, the customer's controls may be arranged for momentary (or nonlocking) operation of the functions indicated as OFF and ON (see Fig. 2) or may be arranged for continuous (or locking) operation using only the ON function. The operation for either option is defined by the schematic in Fig. 2, and is described in the following paragraphs.

#### 3.1 Nonlocking Voice Circuit Control

For nonlocking operation of the ON and OFF customer-provided control functions, a momentary closure between leads CK3 and CK5 (with the handset of the associated telephone set on-hook) causes the K relay to operate. The K relay closes a holding path between leads CK3 and CK4

which includes the customer-provided OFF function. Operation of the K relay, indicated by an isolated circuit closure between leads CK1 and CK2, enables two-way voice signal transmission between the telephone line and leads CT and CR. When the K relay operates, the customer-provided closure between leads CK3 and CK5 may be opened and the K relay is held operated under control of the customer-provided closure (OFF function) between leads CK3 and CK4. This two-way voice transmission connection may be released in either one of two ways, that is, by opening the closure between leads CK3 and CK4 (OFF function) or by lifting the handset of the associated telephone set. Opening of the closure between leads CK3 and CK4 terminates the call, while lifting the handset results in transfer of the voice path from the customer's equipment to the telephone set. Transfer of the voice path from the customer's microphone-loudspeaker to the telephone set and vice versa may be accomplished at any time during a call. However, when transferring from the telephone set to the customer's equipment, care must be exercised that the closure between leads CK3 and CK5 (customer's ON function) is established before the handset is placed on-hook so as not to terminate the call as the result of an interruption on the telephone line (which may be recognized as a handset hang-up by the Central Office).

### 3.2 Locking Voice Circuit Control

Continuous (or locking) VOICE CIRCUIT CONTROL operation of the connecting arrangement may be provided in the customer's equipment by means of a closure between leads CK3 and CK5 (customer's ON function). Lead CK4 shall not be used in the customer's equipment for this mode of

VOICE CIRCUIT CONTROL. A closure between leads CK3 and CK5 in the customer's equipment will operate the K relay (with the telephone handset on-hook) to establish the voice transmission path between leads CT and CR and the telephone line; operation of the K relay will be indicated by an isolated circuit closure between leads CK1 and CK2. This connection will remain (as long as the telephone handset is on-hook) until leads CK3 and CK5 are opened.

### 3.3 Electrical and Circuit Parameters

The CK3 lead has a maximum of 45 volts dc (positive polarity referenced to ground), through 1000 ohms (winding of the K relay) and will load the customer's VOICE CIRCUIT CONTROL switch with .045 ampere maximum inductive load. Arc suppression is provided in the connecting unit across the winding of the K relay such that the peak voltage will not exceed the 45 volt maximum. The minimum open circuit insulation resistance between any pair combination of leads CK3, CK4, and CK5 and from any of these leads to ground will be 100,000 ohms.

The maximum external loop (a loop is established by a closure in the customer's equipment) resistance from lead CK3 to lead CK4 and from lead CK3 to lead CK5 measured at the Interface Connector towards the customer is 50 ohms. The customer's equipment load on leads CK1 and CK2 shall not exceed a peak value of .25 ampere, and the maximum peak voltage across leads CK1 and CK2 shall not exceed 50 volts.

## 4. VIDEO TRANSMISSION

### 4.1 Video Transmission Path

Ordinary insulated wire pairs in telephone cables are utilized for loop transmission between PICTUREPHONE Connecting Arrangement PVF and

the serving Central Office. Equalization and amplification are required in the video transmission paths of the connecting arrangement in order to obtain a flat 0 dB PICTUREPHONE Transmission Level Point at the interface with the customer-provided equipment.

#### 4.2 Video Transmission Protective Criteria

To protect the services furnished to the general public by the Telephone Company from harmful effects, the customer-provided terminal equipment must comply with the following minimum network protection criteria:

- (a) To prevent excessive noise and crosstalk in the network it is necessary that the power of the signal which is applied by the customer-provided equipment to the interface located on the customer's premises be limited so that the sum of the products of the weighting factors below times the signal power in the corresponding 100 kilohertz band does not exceed 100 milliwatts when averaged over any 50-millisecond interval. The appropriate weighting factors when the power in each 100 kilohertz band is measured in milliwatts are as follows:

<u>Frequency Band</u>	<u>Weighting Factor</u>
0- 100 kHz	60
100- 200 kHz	120
200- 300 kHz	100
300- 400 kHz	70
400- 500 kHz	50
500- 600 kHz	30
600- 700 kHz	10
700- 800 kHz	5
800- 900 kHz	2
900-1000 kHz	1

- 20 -

- (b) To protect other services from excessive interference it is necessary that the signal power in narrowbands which is applied by the customer-provided equipment to the interface located on the customer's premises be limited so that the power in any 200 Hz band within the frequency ranges listed below is not greater than the indicated permissible power when averaged over any 3-second interval:

<u>Frequency Range</u>	<u>Largest Permissible Power When Averaged Over Any 3-Second Interval In Any 200 Hz Frequency Band</u>
Below 25 kHz	8 dB below one milliwatt
25 kHz to 35 kHz	16 dB below one milliwatt
35 kHz to 160 kHz	8 dB below one milliwatt
160 kHz to 270 kHz	16 dB below one milliwatt
270 kHz to 1070 kHz	8 dB below one milliwatt
1070 kHz to 1120 kHz	30 dB below one milliwatt
1.12 MHz to 100 MHz	$[8 + 40 \log_{10} f]$ dB below one milliwatt where $f$ is the center frequency in megahertz of the 200 Hz band.

#### 4.3 Video Signal Limiter

A video signal limiter is incorporated in the transmission path to protect the telecommunications network from applications of abnormally high signal levels. This has no effect on normal video signal levels.

This limiter does not remove the customer's responsibility to meet the network protection criteria as prescribed in the Tariffs and as outlined in Part V, Section 2 of this Technical Reference.

#### 4.4 Electrical and Circuit Parameters

With a video call connected at a PICTUREPHONE Connecting Arrangement PVF, the signal delivered to a 100 ohm resistance termination at the Interface Connector on leads CVIT and CVIR represents a flat transmission response and is nominally at the same level as presented on leads CVOT and CVOR at the Interface Connector of another PICTUREPHONE Connecting Arrangement PVF. Any equalization, or shaped gain desired to compensate for loss encountered in the TRANSMIT VIDEO and RECEIVE VIDEO leads from the Interface Connector to the customer-provided equipment must be provided by the customer's equipment.

No direct connection shall be made between lead CVIT or lead CVIR and any voltage source in the customer-provided equipment. Since the output of an amplifier in the connecting unit is dc coupled to the customer-provided equipment on leads CVIT and CVIR, a DC voltage referenced to ground of 0 to maximum 5 volts negative will be present on leads CVIT and CVIR when a video call is connected. The VIDEO RECEIVE signal will be superimposed on this dc voltage. The voltage applied by the customer's equipment on the TRANSMIT VIDEO leads CVOT and CVIR at the Interface Connector shall not exceed a peak value (dc voltage with superimposed peak signal voltage) of 8 volts maximum, of either positive or negative polarity referenced to ground.

The center tapped connection of the 100 ohm terminations in the connecting unit on both the RECEIVE VIDEO and TRANSMIT VIDEO leads is connected to ground. (See Part IV, Section 7.)

5. POWER FAILURE INDICATION

The CUSTOMER POWER FAILURE lead (CPF) provides the means for indicating, by the customer-provided equipment, an inoperative condition in the customer's equipment, as for example, a power failure. Automatic testing is performed by the serving Central Office when an attempt is made to place or receive a video call. An indication of POWER FAILURE at the video station will be detected by this automatic testing and the Central Office will not permit the call to be completed (see Part III, Section 5). In the case of a connecting arrangement served from a Telephone Company-provided Key Telephone System with more than one video station access to the same lines, placing and receiving calls will be prevented as a result of automatic Central Office testing only if a POWER FAILURE indication is received from every associated video station on that given line.

A CUSTOMER POWER FAILURE condition is indicated from the customer's equipment by a resistance of 100,000 ohms or greater at the Interface Connector between lead CPF and leads COM 1-4. For indication of normal operation from the customer's equipment the maximum loop resistance at the Interface Connector between lead CPF and leads COM 1-4 shall be 100 ohms or less. The CPF lead will load the control contacts in the customer's equipment with a maximum of 45 volts dc, positive polarity referenced to ground, through approximately 12,000 ohms resistance.

6. VIDEO CALL SIGNALING

These leads, designated CVCR and CVCC, perform the function of alerting the customer's equipment during a video call by means of

unbalanced logic signals of positive polarity referenced to CONTROL AND SIGNAL COMMON leads COM 1-4 (ground). A logic level HIGH state is defined as a dc voltage of 20 volts minimum to 45 volts maximum through a resistance of 12,000 ohms at the Interface Connector. The dc voltage is zero (0) for a logic level LOW state. In the LOW state, the resistance is a minimum of 50,000 ohms to common ground for voltages of positive polarity applied by the customer's equipment at the Interface Connector and is 2000 ohms minimum resistance for voltages of negative polarity.

VIDEO CALL RINGING on lead CVCR alerts the customer's equipment, on video calls only, that 20 Hz ringing current is being received at the connecting arrangement. The signal consists of alternating HIGH and LOW logic level indications, following the individual cycles of the 20 Hz ringing current. When no ringing is being received, lead CVCR presents a logic level LOW state. The duration of the pulses represented by the logic level HIGH state will be 15% minimum (unbalanced rectangular wave) to 50% maximum (square wave) of each cycle period. Lead CVCR does not alert for ringing received on voice-only calls.

VIDEO CALL CONNECT on lead CVCC alerts the customer's equipment that a video call has been answered at the connecting arrangement, as indicated by a logic level HIGH state, and that the VIDEO TRANSMIT and VIDEO RECEIVE leads have been connected for video transmission to and from the serving Central Office.

The peak voltage applied to leads CVCR and CVCC by the detection circuits in the customer's equipment at the Interface Connector shall

- 24 -

be a maximum 35 volts of either polarity referenced to CONTROL AND SIGNAL COMMON leads (COM 1-4).

7. GROUNDING

It is expected that the customer's equipment, if powered from commercial power, shall be grounded in accordance with applicable electrical codes (NEC) and should be bonded to the same ground electrode to which the telephone protector is grounded (when available). Self-powered or passive customer's equipment need not be grounded.

PICTUREPHONE Connecting Arrangement PVF is provided with a common signal ground (a metallic cold water pipe or other ground approved by the NEC) which is always bonded to the electric power ground and telephone protector ground, where present. The customer's signal ground is obtained from this ground through the CONTROL AND SIGNAL COMMON leads (COM 1-4). Provisions should be made within the customer's equipment for connecting together all internal signal grounds and bonding them to one side of the secondary circuit of his power supply. This connection shall be isolated from both the grounding (green) conductor run with the power supply primary conductors and the chassis or frame of the customer-provided equipment. The customer's power supply shall comply with all provisions of NEC Article 725 for Class 2 Systems.

8. AC POWER

Each PICTUREPHONE Connecting Arrangement PVF requires connection to a customer furnished nominal 117 volt (130 volt maximum), 15 ampere, 60 Hz, 3-wire (U-blade) grounded outlet. This ac circuit, which must be separately fused, should not be under the control of a wall switch. Each connecting arrangement dissipates a maximum of 25 watts. The power cord for the connecting arrangement will be furnished and installed by the Telephone Company.



PRELIMINARY

PART V - SPECIFIC DESIGN CONSIDERATIONS

- 25 -

1. VOICE TRANSMISSION PATH

1.1 Impedance

The internal impedance of the customer's microphone-loudspeaker equipment as presented to leads CT and CR, should be approximately 600 ohms resistive for an audio frequency range of 200 to 5000 Hz. (See Part V, Paragraph 2.1 for video circuit internal impedance.)

1.2 Average Power at the Central Office

The average power (in any 3-second interval) delivered at the Central Office should not exceed -12 dBm. The limitations described in Paragraph 1.3, on power at the customer's location have been established so that, when all business telephone loops in the Bell System are considered, the limit of -12 dBm will be met. (see Section IV, Paragraph 2.1)

1.3 Maximum Available Power

The Central Office power criterion, in Paragraph 1.2, can be satisfied by limiting the maximum available power\* from a customer-provided 600 ohm source to -8 dBm when averaged over any 3-second interval. The customer-provided equipment should be so designed that the average power over any 3-second interval applied to the Interface Connector associated with PICTUREPHONE Connecting Arrangement PVF does not exceed -8 dBm. The recommended procedure for estimating the power is given in Paragraph 1.4.

\* The available power of a source is the maximum power a source can deliver to a load. Maximum power transfer occurs when the load and source impedances are matched.

1.4 Measuring Maximum Available Power

The following measuring method is satisfactory for estimating the maximum power averaged over a 3-second interval to determine that the inband criterion is being met:

Operate the customer-provided equipment into a 600 ohm load (this assumes that the customer-provided equipment has a 600 ohm impedance as recommended) bridged by a Hewlett-Packard Transmission and Noise Measuring Set - Model 3555B or a Western Electric 3-Type Noise Measuring Set, or the equivalent.\* While these meters are nearly equivalent, the arrangement of control switches differ. To insure a proper measurement technique, the control settings on these meters should be as follows:

<u>WESTERN ELECTRIC 3-TYPE NOISE MEASURING SET</u>		<u>HEWLETT-PACKARD TRANSMISSION AND NOISE MEASURING SET MODEL 3555B</u>	
<u>Control</u>	<u>Setting</u>	<u>Control</u>	<u>Setting</u>
FUNCTION (Switch)	BRDG	INPUT (Switch)	NOISE/BRDG
NORM/DAMP (Switch)	DAMP	FUNCTION (Pushbutton)	VF/Nm-600BAL
WTG (Plug-In Network)	3Kc FLAT	NOISE WTG (Switch)	3kHz FLAT
		NORM/DAMP (Switch)	DAMP

In almost all cases the speech power averaged over any 3-second interval will not exceed -8 dBm if the maximum meter swing does not exceed 85 dBrn.

The accuracy of this method can be somewhat improved by increasing the size of the damping capacitance in the Western Electric 3-Type Noise Measuring Set by 150 microfarads. To do this connect the negative lead of a 150 microfarad capacitor to either terminal of the NORM/DAMP switch and connect the positive lead to ground. This allows the meter to more

\* These meters do not have a 3-second averaging time, but when used on speech they give a reliable estimate of a 3-second average.

- 27 -

nearly approximate a 3-second averaging meter. (NOTE: This modification does not necessarily hold for noise meters other than the Western Electric 3-Type.) With the additional damping, the power averaged over any 3-second interval will not exceed -8 dBm if the maximum meter swing does not exceed 83 dBm. The use of meters with shorter time constants, such as a VU meter or a standard voltmeter, is not recommended.

#### 1.5 Out-of-Band Limits

To protect other services it is necessary that the signal applied by the customer-provided equipment to the Telephone Company interface located on the customer's premises meet the following limits:

- (a) The power in the band from 3995 Hz to 4005 Hz shall be at least 18 dB below the power of the signal as specified in Paragraph 1.3, i.e., -26 dB below one milliwatt.
- (b) The power in the band from 4000 Hz to 10,000 Hz shall not exceed 16 dB below one milliwatt.
- (c) The power in the band from 10,000 Hz to 25,000 Hz shall not exceed 24 dB below one milliwatt.
- (d) The power in the band from 25,000 Hz to 40,000 Hz shall not exceed 36 dB below one milliwatt.
- (e) The power in the band above 40,000 Hz shall not exceed 50 dB below one milliwatt.

#### 1.6 Signaling Considerations

The telecommunications network incorporates tone signaling devices that are used for network control functions. These devices, connected at all times to the telephone voice circuit, are designed to be sensitive

to single frequency tones at 2600 Hz. They are, however, relatively insensitive to energy at this frequency if sufficient energy is present at the same time at other frequencies in the voiceband.

In order to prevent the interruption or disconnection of a call, or interference with network control signaling, it is necessary that the audio signal applied by the customer-provided equipment to the PICTURE-PHONE connecting arrangement voice transmission path at no time have energy solely in the 2450 to 2750 Hz band. If signal power is in the 2450 to 2750 Hz band, it must not exceed the power present at the same time in the 800 to 2450 Hz band.

## 2. VIDEO TRANSMISSION PATH

### 2.1 Impedance

To provide the flat response wideband transmission required for video signals, interfacing with the customer-provided equipment on the VIDEO RECEIVE pair is done with dc coupling. The circuit which transmits from the connecting arrangement to the customer's equipment on leads CVIT and CVIR consists of the high impedance balanced output of a differential amplifier terminated in a fixed center tapped 100 ohm resistance. Typically, the input network to the customer's equipment for the VIDEO RECEIVE pair would consist of a fixed center tapped 100 ohm resistive termination capacitively coupled to the high impedance balanced input of a differential amplifier. The circuit connecting to the customer's VIDEO TRANSMIT pair is similar in that it involves the customer's equipment transmitting into a fixed center tapped 100 ohm resistive termination in the connecting unit. The circuit is then capacitively coupled into the high impedance balanced input of a differential amplifier in the connecting unit.

## 2.2 Maximum Video Power

The protective criteria for PICTUREPHONE facilities is divided into two parts: (1) maximum permissible weighted signal power; and (2) maximum permissible signal power in narrowbands. Measurement of signals for conformance with the criteria will be discussed separately for each portion.

The customer-provided equipment should be terminated in 100 ohms and the video signal checked for compliance with the protective criteria before the signal is applied to the VIDEO TRANSMIT leads CVOT and CVOR. The signal must comply with the protective criteria in Part IV, Paragraph 4.2 whenever it is connected to the VIDEO TRANSMIT leads.

The protective criteria have been constructed with the objective of covering a wide variety of applied signals while preserving reasonable simplicity. Where the signal is known, this a priori information may be used to identify the characteristics that will be critical with respect to compliance. For instance, if the signal contains frequency components of nearly equal amplitude spaced closer than 200 Hz, the weighted power portion of the criteria will be controlling. On the other hand, if a few sinusoids dominate the signal, the narrowband limits are likely to control the permissible signal level. Similarly, it is unlikely that the weighted power portion of the criteria will be violated if the total signal power is less than a milliwatt. If the signal is repetitive and its amplitude as a function of time is known, a Fourier analysis of the waveform may be made and compliance with the protective

criteria computed. For computational purposes the weighted signal power averaged over 50 milliseconds may be formulated as follows:

$$P_{50\text{ms}} = \frac{\sum_{f=1}^{10} 20 W_f}{R} \int_{t-(1/20)}^t V_f^2(t) dt$$

where:  $P_{50\text{ms}}$  = 50 millisecond average weighted power

$f$  = index of 100 kHz frequency band:  $1 \leq f \leq 10$

$W_f$  = weighting factor for frequency band  $f$  (see protection criteria)

$R$  = circuit resistance = 100 ohms

$V_f(t)$  = sum of those components of the signal falling in frequency band  $f$ .

### 2.3 Measuring Maximum Video Power

#### 2.3.1 Measuring Weighted Signal Power

The weighted signal power may be measured with the arrangement shown in Fig. 3. A single bridging amplifier and a frequency weighting network is assumed because of its apparent simplicity; however, a parallel bank of 10 amplifier-bandpass filter combinations (Fig. 4) is acceptable. The amplifier-weighting network combination should have the following response:

<u>Frequency</u>	<u>Gain Power Ratio</u>	<u>dB</u>
50 kHz	60	17.8
150 kHz	120	20.8
250 kHz	100	20.0
350 kHz	70	18.4
450 kHz	50	17.0
550 kHz	30	14.8
650 kHz	10	10.0
750 kHz	5	7.0
850 kHz	2	3.0
950 kHz	1	0.0

- 31 -

A practical realization of this combination consists of a bridged-T, constant-resistance network in tandem with a flat gain amplifier. The amplifier should have a high impedance, balanced input and provide about 23 dB of insertion gain when terminated in 100 ohm resistance. Fig. 5 shows the weighting network with its approximate insertion loss between 100 ohm impedances. The amplifier-weighting network combination should be adjusted to provide the above insertion gains with both input and output terminated in 100 ohms.

If the output signal of the customer-provided equipment is balanced with respect to ground, the 100 ohm resistor may be replaced with two 50 ohm resistors in series with their mid-point grounded. An unbalanced bridging amplifier may be connected across one of these 50 ohm resistors. If this option is elected, the gain through the amplifier-weighting network combination,

$$20 \log_{10} \frac{V_{\text{weighted}}}{V_{50 \text{ ohms}}},$$

should be increased 6 dB above the values shown in the table on page 30. Also, conformance with the protective criteria should be verified individually for the signal on both CVOT and CVOR.

The maximum (highest) average power over any 50 millisecond interval delivered to the 100 ohm resistor at the output of the weighting network must not exceed 100 milliwatts. The average power over a 50 millisecond interval is the mean square voltage for that interval divided by the resistance. An ideal voltmeter for measuring the voltage

across the 100 ohm resistor at the output of the weighting network would provide a measure of the running 50 millisecond average of the square of the voltage.

Before examining the 50 millisecond averaging time it is appropriate to note that three types of ac voltmeters are in common use, they are:

1. average responding
2. peak responding
3. true rms

Examples of some of the commercially available VTVM's are:\*

Average Ballantine Model 303; Hewlett-Packard Models 400D, 400E, 400H, and 400L.

Peak Micro Instrument Co. Precision Memory Voltmeter Model 5201B; Hewlett-Packard Model 410B

True RMS Ballantine Model 323, Fluke Model 931A, Hewlett-Packard 3400A

Each of these voltmeters may be calibrated in rms volts. When so calibrated the meter scale shows the correct rms value of an applied sinusoid. For other than sinusoidal waveforms the three types of instruments will usually have different readings.

An average responding ac voltmeter calibrated in rms volts for a sinusoid actually reads  $(\pi/2\sqrt{2})$  times the average value of the full-wave rectified signal. A peak responding ac voltmeter calibrated in rms volts has a meter indication  $(1/\sqrt{2})$  times the peak signal voltage.

\* A more complete listing is provided in November 22, 1969 issue of ELECTRONIC DESIGN.

- 33 -

True rms meters usually measure the effective value of the signal with a thermocouple and provide a reading truly related to the root-mean-square value of the signal. Unfortunately, the response times of these meters are long (response times of a few seconds); therefore, they measure the rms value of the signal over a considerably longer time interval than 50 milliseconds.\*

Because rms voltmeters measuring rms values over intervals as short as 50 milliseconds are not readily available, measurement of an approximation to the 50 millisecond rms voltage will generally be the practical solution. The following equation gives a satisfactory estimate of the rms voltage over 50 milliseconds:

$$V_{50\text{ms rms}} = \left[ V_{50\text{ms avg}}^2 + (V_{\text{peak}} \cdot V_{50\text{ms avg}})^{1/2} \right] / 2$$

where:  $V_{50\text{ms rms}}$  = rms voltage over 50 milliseconds

$V_{50\text{ms avg}}$  = average of full wave rectified voltage over 50 milliseconds

$V_{\text{peak}}$  = peak voltage

Since average responding voltmeters with fast response times are easier to construct than fast rms meters, making the two measurements required by this equation will generally be easier than making a 50 millisecond rms measurement. However, as will be pointed out later, for certain types of signals the rms voltage over a long period is a good estimate of the rms voltage over 50 milliseconds. When the signal meets these

\* Gene Ochs and Peter Richman, "Curve Fitter Aids the Measure of RMS by Overruling Square-Law Slowdowns," ELECTRONICS, September 29, 1969.

conditions, measurements with a commercial true rms meter are acceptable indications of conformance with the protective criteria. Of course, sampling, A/D conversion, and computer technology offer a means of obtaining the true mean square voltage over a 50 millisecond interval.

The peak and average voltages for substitution in the above equation may be measured by commercial instruments or by the circuit arrangements in Fig. 6. If the commercial peak responding voltmeter is calibrated in rms volts for a sinusoid,  $V_{\text{peak}} = \sqrt{2} V_{\text{rms}}$ . Similarly, if the average responding voltmeter is calibrated in rms volts for a sinusoid,  $V_{\text{avg}} = (2 \sqrt{2} V_{\text{rms}}) / \pi$ . The response time of the average responding voltmeter should be checked by the procedure outlined below.

The calibration procedure for a 50-millisecond average responding voltmeter (see Fig. 6) is as follows:

- (a) Set R at approximately 500 K
- (b) Apply 200 kHz sinusoid to input and measure  $V_{\text{dc}}$  versus  $V_{\text{ac avg}}$  for  $V_{\text{ac avg}}$  from .4 volts to 4 volts

$$(V_{\text{ac avg}} = 2 \sqrt{2} (V_{\text{rms}}) / \pi)$$

- (c) Determine slope of line:  $V_{\text{ac avg}} = m V_{\text{dc}}$

This rule of m should be used in determining  $V_{\text{ac avg}}$  from  $V_{\text{dc}}$  in future measurements.

With a constant amplitude sinusoid applied, a steady dc voltage appears across the .5 Mfd capacitor, this voltage may be measured with a high impedance voltmeter but in general the voltage across the capacitor varies

- 35 -

with time. The dc will vary as the 50 millisecond average of the ac input varies and should be viewed with a direct coupled oscilloscope. The oscilloscope beam deflection corresponds to the deflection of a regular dc meter movement that is fast enough to follow the variations in  $V_{ac\ avg}$ . Therefore, the oscilloscope deflection should be calibrated and the oscilloscope used to measure  $V_{dc}$  for determining  $V_{ac\ avg}$  of a time varying signal.

The verification of averaging time of commercial instrument or adjustment of resistor R in circuit of Fig. 6 is as follows:

- (a) Apply gated 200 kHz sinusoid with continuous amplitude of 3 volts rms with 20 bursts per second of 50 percent duty cycle.
- (b) An average responding voltmeter will read approximately
$$\frac{1}{2} \left( \frac{2\sqrt{2}}{\pi} \right) 3 = 1.9 \text{ volts}$$
- (c) For a 50 millisecond averaging time the maximum and minimum  $V_{ac\ avg}$  (pointer movement or beam deflection on oscilloscope) should not exceed the bounds 1.8 and 2.0 volts. If these limits are exceeded, the averaging time is shorter than 50 milliseconds. Increase the averaging time of the circuit in Fig. 8 by increasing R and repeating previous steps. It may be possible to damp commercial instruments by adding capacitance across the meter movement.
- (d) Reduce pulse rate to 5 pulses per second.
- (e) The maximum  $V_{ac\ avg}$  should exceed 2.4 volts and the minimum  $V_{ac\ avg}$  should be less than 1.4 volts. If these readings

are not exceeded, the averaging time is longer than 50 milliseconds. Decrease the averaging time of the circuit in Fig. 6 by reducing R and repeat the previous steps. The response time of some commercial instruments can be decreased by reducing the capacitance shunting the meter movement.

In testing for conformance with the protective criteria it is the highest rms voltage in a 50 millisecond interval that is critical; therefore, the highest 50 millisecond average voltage should be substituted into the equation for estimating the rms voltage. The desired  $V_{50 \text{ ms avg}}$  is  $n$  times the largest  $V_{dc}$  across the .5 Mfd capacitor in the average responding voltmeter circuit of Fig. 6. The peak responding voltmeter circuit of Fig. 6 may be used to measure this maximum value of  $V_{dc}$ . Similarly, if another arrangement is being used to measure  $V_{50 \text{ ms avg}}$ , it is the highest or peak indication that should be used in evaluating  $V_{50 \text{ ms rms}}$  for checking conformance with the protective criteria.

If one or more of the following conditions are satisfied by the signal, the long term rms voltage is an acceptable approximation of the 50 millisecond rms voltage and a true rms responding ac voltmeter may be used in lieu of the above procedure for checking conformance with the weighted power portion of the protective criteria:

1. signal has a small peak to rms ratio
2. signal is repetitive with period less than 50 milliseconds
3. signal characteristics do not vary significantly between 50 millisecond intervals.

- 37 -

The peak signal voltage and the long term rms voltage are bounds on the highest 50 millisecond rms voltage. Regardless of the characteristics of the signal, the signal conforms with the weighted power portion of the protective criteria if the peak voltage across the 100 ohm resistor at the output of a properly adjusted weighting network does not exceed 3.16 volts (a reading of  $3.16/\sqrt{2} = 2.23$  volts on a peak responding meter calibrated in rms volts for a sinusoid). Conversely, the signal does not conform if the long term rms voltage exceeds 3.16 volts. If the peak-to-rms ratio is less than 1.1 these bounds on the highest 50-millisecond rms voltage are tight and either the peak or rms voltage become acceptable measures of the 50-millisecond rms voltage.

If the signal is repetitive with a period shorter than 50 milliseconds, the long term rms voltage is an acceptable estimator of the maximum rms voltage over 50 milliseconds. The rms voltage over one period of a repetitive signal is equal to the rms voltage over any integral number of periods; therefore, the long term rms voltage is nearly equal to the rms voltage over a signal period.

Strict periodicity is not required to make the rms voltage over 50 milliseconds approach the long term rms voltage. All that is required is for the amplitude distribution over any 50 millisecond interval to be similar to the long term amplitude distribution. Stated another way, the signal must not contain "bursts" with concentrations of power in particular 50 millisecond intervals. The average voltmeter (mean of the amplitude distribution of the full wave rectified signal) provides a good measure of the amplitude distribution. Thus, if the 50 millisecond

average voltage does not vary with time, it is reasonable to assume that the 50 millisecond rms voltage does not vary either and that the long term rms voltage is a good approximation of the 50 millisecond rms voltage. Variations larger than +5 percent in the 50 millisecond average voltage during 5 seconds (the approximate response time of many true rms responding meters), indicate "bursts" and offer the opportunity for disturbing interference during the "burst". For these "bursty" signals, the long term rms voltage may not be a good estimator of the highest 50 millisecond rms voltage.

In summary, the signal from customer-provided equipment may be checked for conformance with the weighted power portion of the protective criteria by constructing the amplifier-weighting network configuration in Figures 3 and 5 and measuring the average output power over 50 millisecond intervals. The signal conforms with the weighted power portion of the protective criteria if the rms voltage at the output of the weighting network does not exceed 3.16 volts in any 50 millisecond interval. The following equation provides an acceptable estimate of the rms voltage over 50 milliseconds:

$$V_{50 \text{ ms rms}} = \left[ V_{50 \text{ ms avg}} + (V_{\text{peak}} \cdot V_{50 \text{ ms avg}})^{1/2} \right] / 2$$

The peak voltage and the highest 50 millisecond average voltage may be measured with the circuits in Fig. 6 or by appropriate commercial instruments.

If the weighted signal satisfies one or more of the following conditions, the long term rms voltage as measured with true rms responding

commercial instruments is an acceptable approximation of the 50 millisecond rms voltage for the purpose of evaluating the conformance of a signal with the weighted power portion of the protective criteria:

1. The weighted signal has a peak to rms ratio of less than 1.1.
2. The signal is repetitive with period less than 50 milliseconds.
3. The running 50 millisecond average voltage does not vary more than +5 percent during any 5-second interval.

### 2.32 Measuring Signal Power in Narrowbands

Ideally a wave analyzer provides a tunable window of finite bandwidth through which the frequency components of an electrical signal may be viewed as the window is moved across the frequency spectrum. This is the concept envisaged in the portion of the protective criteria limiting the permissible power in narrowbands. A highly selective bandpass filter 200 Hz in width (the window) is to be very slowly moved across the frequency spectrum while observing the power passing through the filter.

The important characteristics of the wave analyzers to be used in measuring the conformance of signals to the protective criteria are:

1. Frequency range
2. Selectivity
3. Detector averaging time

Unless it is known positively that the signal is bandlimited to a smaller frequency range, the wave analyzers should cover the frequency range from 20 Hz to 100 MHz. It may be necessary to employ two or more analyzers.

The analyzers should have constant width passbands rather than a constant percentage of the center frequency of the band. The width of the bandpass should be approximately 200 Hz at the 3 dB down points and no wider than 600 Hz at the 60 dB down points. Audio wave analyzers for the low portion of the frequency range are likely to have smaller bandwidths. If the signal is known to be repetitive with period less than 5 milliseconds, the frequency spectra will consist of discrete components spaced more than 200 Hz apart. The power in these discrete components as measured with a narrower bandpass filter will be the same as would have been measured with a 200 Hz bandpass filter. If the signal has a period greater than 5 milliseconds a wave analyzer with less than a 200 Hz bandpass will not measure all of the power present in a 200 Hz band. An estimate of the power in a 200 Hz band may be made from the readings of an analyzer with a passband of B Hz by adding the power in  $200/B$  contiguous frequency bands spaced at B Hz intervals.

If the frequency components of the signal, as measured through a wider bandpass filter than 200 Hz, do not exceed the permissible power in 200 Hz bands, the signal complies with the narrowband portion of the criteria.

Although its amplitude may vary considerably with time, the output of a 200 Hz or narrower bandpass filter centered at frequencies well above 200 Hz will appear nearly sinusoidal. Therefore, the basic parameter measured by the detector and assumed to be proportional to power is not very critical as long as the instrument is properly calibrated

- 41 -

for sinusoids. Consequently, the averaging time of the detector is of greater importance than the basis for the power measurements (an average voltage, peak voltage, true rms, or quasi rms). Most commercial instruments will average over shorter intervals than 3 seconds.

For the purposes of measuring conformance to the protective criteria an analyzer may be considered to have an averaging time of 3 seconds if the peak-to-peak variation in meter reading is less than 1 dB when a gated sinusoid with 1.5 seconds of tone and 1.5 seconds of silence is applied at the input and the peak-to-peak variation is greater than 4 dB for a gated sinusoid with 6 seconds on and 6 seconds off. The averaging time is less than 3 seconds if the variation exceeds the 1 dB limit.

If an analyzer with averaging time shorter than 3 seconds is used and the measured power never exceeds the levels specified in the protective criteria, the signal complies with the criteria. On the other hand, if the power always exceeds the permissible level, the signal does not comply with the criteria.

Those signals producing time varying meter indications, on analyzers with less than 3-second averaging time may or may not comply with the criteria. Signals with long time average readings below the permissible power levels, but with occasional peaks above the permissible power level may not be adequately measured in this manner. In these situations, the use of a long time constant meter such as a thermocouple vacuum tube voltmeter connected to the wave analyzer may better approximate a 3-second averaging time.

### 3. PICTUREPHONE SIGNAL CHARACTERISTICS

#### 3.1 General

The video signal associated with a Bell System PICTUREPHONE station can be characterized for the 0 PICTUREPHONE Transmission Level Point (0 PTLP) represented by the VIDEO TRANSMIT and VIDEO RECEIVE leads at the Interface Connector. The output signal level is defined as the voltage balanced-to-ground between the VIDEO TRANSMIT leads CVOT and CVOR, with a video call connected. The input signal level is defined as the voltage balanced to ground between the VIDEO RECEIVE leads CVIT and CVIR with a video call connected and with these leads terminated in a 100 ohm resistance at the Interface Connector.

#### 3.2 Output Video Signal

A typical composite video output signal for a Bell System PICTUREPHONE station, characterized as it would appear on VIDEO TRANSMIT leads CVOT and CVOR at the Interface Connector, is shown in Fig. 7. The important signal parameters are summarized in Table 1 Part V, Section 3. Accuracy of the timing information is  $\pm 100$  parts per million.

The amplitude of the horizontal and vertical synchronization pulses is  $0.20 \pm 0.02$  volts and the rise time from 10% to 90% of final value is less than .5 microsecond with no overshoot. The synchronization pulses are negative going on lead CVOT with reference to ground.

The luminance information, or video portion of the signal, is pre-emphasized by a frequency shaping characteristic  $P(f)$  defined in Table 1 (page 44) and plotted in Fig. 8 (expressed in dB as  $10 \log P(f)$ ). It should

- 43 -

be noted that the synchronization pulses are not pre-emphasized. The nominal black-to-white amplitude of the video signal, prior to pre-emphasis, is three times as great as the nominal amplitude of the synchronization pulses. Black level is nominally established at the porch level.

### 3.3 Input Video Signal

The input video signal from a Bell System PICTUREPHONE station being received at a PICTUREPHONE Connecting Arrangement PVF on VIDEO RECEIVE leads CVIT and CVIR will be the output signal (see Paragraph 3.2) modified by the transmission network characteristics. (See Part VI, Section 3) This signal should be restored to its normal frequency weighting by a de-emphasis network whose transfer function is  $D(f) = 1/P(f)$ . (See Table 1, page 44).

## PRELIMINARY

- 44 -

## PART V - Section 3

TABLE I

## Video Signal Parameters

Used in Bell System PICTUREPHONE® Service

Fields/Frame	2 Interlaced
Field Rate	59.93 Hz*
Line Rate	8 kHz
Number of Active Lines/Frame	251
Active Horizontal Scanning Time/Line	105.5 sec
Vertical Blanking/Field	8 lines
Pre-emphasis Characteristic** (Video Only)	$P(f) = 10(jf + 10^5)/(jf + 10^6)$
De-emphasized Video to Sync Ratio	3
Sync Pulse Size	0.2 volts
Front Porch of Sync Pulse	2.93 $\mu$ sec
Back Porch of Sync Pulse	7.78 $\mu$ sec
Peak Video Signal	1.5 V peak above average
Bandwidth	1 MHz

\* The timing information is derived from a crystal controlled oscillator and has an accuracy of  $\pm 100$  ppm.

\*\* f is frequency expressed in Hertz. This expression characterizes both the magnitude and phase of P(f).

PRELIMINARY

PART VI - GENERAL TECHNICAL CONSIDERATIONS

- 45 -

1. GENERAL

This section discusses general technical considerations which are applicable to voice connecting arrangements as well as to PICTUREPHONE connecting arrangements. These considerations include the general characteristics of the telecommunications network and PICTUREPHONE network.

2. VOICE TRANSMISSION

2.1 Transmission Parameters

Information describing the component parts and operating characteristics of the Bell System telecommunications network has been published. Various articles have discussed statistical information on talker volumes, end-office losses and noise, loop characteristics, and other characteristics. These articles are listed in Appendix A. In addition, several general information texts are listed.

2.2 End-to-End Electrical Loss

The end-to-end electrical loss of a connection is a function of the impedances of both end terminations, the losses of the loops at both ends, and the end-office loss. The information given in the REFERENCES may be used to determine statistical loss distributions for different types of calling patterns on the telephone network.

The 1000 Hz insertion loss for the voice part of this connecting arrangement (with a customer's communication device having a 600 ohm source impedance) and its associated loop will average about 4 dB with a standard deviation of about 1 dB.

It should be noted, however, that the audio plan for PICTUREPHONE service differs considerably from that of the Bell System telecommunications network. Principally, it is a fixed loss plan nominally providing 6 dB of end-office to end-office loss on a toll call independent of the length of the connection. This plan is predicated on the digital multiplexing of audio and broadband signals on all toll trunks with no two-wire audio switching above the end-office level. Therefore, the present noise and loss characteristics of the switched telecommunications network are not directly applicable to PICTUREPHONE service; published reference material on the characteristics of the PICTUREPHONE plan are not presently available.

### 2.3 Bandwidth and Frequency Response

The nominal voice frequency bandwidth of the telecommunications network extends from about 300 to about 3000 Hz. This connecting arrangement does not limit this bandwidth. In general, an end-to-end connection may be expected to have a loss characteristic which rolls off outside this bandwidth.

### 2.4 Nonlinearities

Nonlinearities such as compression, clipping, and harmonic distortion can exist on the telecommunications network. Nominally, these are low enough to be ignored. It is expected that total harmonic distortions no greater than about 5 percent of the fundamental will normally be encountered.

### 3. VIDEO TRANSMISSION

The Bell System PICTUREPHONE network is a complex arrangement of transmission, switching, maintenance and terminal equipment. Although designed primarily with PICTUREPHONE face-to-face signals in mind, the Bell System intends to take fullest advantage of the communications capability of the video portion of the PICTUREPHONE network by using it to transmit other types of signals. For example, the initial service offering will include graphics mode signals, computer access signals and high-speed data signals as well as face-to-face signals.

Specific questions dealing with transmission parameters of the PICTUREPHONE network not covered in this Technical Reference should be addressed to:

Engineering Director - Transmission  
American Telephone and Telegraph Company  
195 Broadway  
New York, New York 10007

#### 3.1 Network Configuration

The hierarchial structure for switching and transmission, shown in Fig. 9, is planned for the early years of the PICTUREPHONE network. Fig. 10 defines the "loop" of Fig. 9 in terms of the connecting arrangement available for connecting customer-provided equipment to the PICTUREPHONE network.

Conversion of a signal from analog-to-digital form and vice versa is performed by devices called codecs (coder plus decoder). The network is structured so that only a single encoding-decoding is allowed on any one call.

### 3.2 Transmission Variables

For the purpose of this Technical Reference, PICTUREPHONE network transmission variables are divided into three categories:

1. Codec Variables,
2. Gain and Phase Variables,
3. Interference Variables.

Unless stated otherwise, the values presented for these variables are based on the network model shown in Fig. 11, i.e., they are the total values for an end-to-end connection from one connecting arrangement to another connecting arrangement.

#### 3.21 Codec Considerations

A simplified representation of the coding portion of the codec being used in the early years of PICTUREPHONE service is shown in Fig. 12. The gain versus frequency characteristic of the Thomson Filter is given in Fig. 13. The purpose of this low-pass filter is to attenuate frequency components above 1 MHz in the input signal. Such components may produce coding fluctuation noise in the signal during the coding process. This codec possesses two modes, i.e., the general purpose mode and the video mode.

The quiescent state of the codec is the general purpose mode, i.e., unless the input signal activates the codec to switch to the video mode, the signal will be encoded and decoded in the general purpose mode. The general purpose mode is used to accommodate the Bell System 460.8 kb/sec synchronous data service.\*

The codec switches to the video mode when it detects, in the signal at its input, a sync pulse train matching the video format. The codec accepts a horizontal frequency range of  $\pm 100$  ppm about 8 kHz in the video mode. Thus, this mode accommodates Bell System PICTUREPHONE video signals# (face-to-face and graphics mode) and Display Data Set\* signals. The AGC circuit for the video mode compensates the composite video and sync signal for as much as 6 dB of voltage variation during analog transmission. The correction is accomplished by detecting deviations in the amplitude of the sync pulses of the video format signal from their nominal .2 volts base-to-peak value referenced to 0 PTLP. If the sync pulses of the input signal differ from .2 volts base-to-peak by more than 6 dB, excessive quantizing or slope overload noise may be induced into the signal during the coding process.

\* For information on this and other PICTUREPHONE data services please contact:

Engineering Director - Data Communications  
American Telephone and Telegraph Company  
195 Broadway  
New York, New York 10007

# See Part V, Section 3, Table 1

After the AGC circuit, the video signal is passed on to a shaping network prior to digital coding. The gain versus frequency characteristic of this shaping network is given in Fig. 14.

The following Table lists the significant coding parameters for the PICTUREPHONE network codec:

Code	8 level nonlinear differential step encoding, 3 bit words at 6.048 Mb/sec (bit stream is pulse stuffed to 6.312 Mb/sec for transmission)	
Sampling Frequency	<u>Video Mode</u>	<u>General Purpose Mode</u>
	2.016 MHz, phase locked to exact 252 multiples of 8 kHz video line scanning rate	2.016 MHz, free running
Differential Step Quantizing Levels in m Volts	15, 45, 105, 225	12, 36, 83, 178
Transition Time	2.48 $\mu$ sec (Black-to-white)	1.98 $\mu$ sec (Logic 0 to 1)

In the video mode, samples are phase locked to exact multiples of the line scanning rate so that encoding samples are taken at the same exact positions on a line for all frames. This technique minimizes edge business distortion.

Signal transmission through the codec is governed by two phenomena: 1) fold-over distortion (aliasing) and 2) slope overload noise. The sampling theorem states that if  $f_m$  is the highest frequency component in the signal, then at least  $2f_m$  uniformly spaced samples are needed in order eventually to reproduce the signal without (fold-over) distortion. Thus the effective transmission bandwidth of the codec is 1 MHz. The

- 51 -

low-pass Thomson filter at the input of the codec restricts all signals to a 1 MHz or less bandwidth. This does not mean, however, that all signals band-limited to 1 MHz or less can be successfully transmitted through the codec without impairment. Signals with very rapid changes (exceeding  $358 \frac{mv}{\mu sec}$  in the general purpose mode and  $300 \frac{mv}{\mu sec}$  in the video mode) will have slope overload distortion added to them. The performance of the codec is, therefore, very much oriented to the characteristics of the signal.

A simplified representation of the decoding portion of the codec being used in the early years of PICTUREPHONE service is shown in Fig. 15. After decoding, a video signal is shaped and its sync pulses are clamped in order to remove coding fluctuation noise on the sync pulse tips. The gain versus frequency characteristic of the shaping network in the video mode of the output portion of the codec is given in Fig. 16.

### 3.22 Gain and Phase Variables

As discussed in Paragraph 3.21, the transfer characteristic of the codec is very much signal dependent. It is thus difficult to discuss the overall end-to-end gain versus frequency and phase versus frequency PICTUREPHONE network transmission variables for anything except particular signals. However, it is possible to discuss these variables in general for the analog portion of the network. The scope of the remainder of Section 3 is therefore concerned with the analog portion of the PICTUREPHONE network consisting of analog loops, analog trunks, analog switches and the analog portion of the codec.

The nominal end-to-end gain of the analog portion of the PICTUREPHONE network is 0 dB flat and 3 dB down at 150 Hz and 1.1 MHz. However, because the network contains many circuits that contribute gains and losses, the gain will deviate from its nominal value. Some of these contributions are independent and random (trunk regulating repeaters, paths through switching offices) while others are consistent or nonrandom (temperature effects on cable loss). Deviation of the gain from its nominal value is divided into two components:

1. flat gain variation,
2. deviation-from-flatness.

An example of gain deviation with the deviation's two components is given in Fig. 17. The allowable flat gain variation objective for an end-to-end analog PICTUREPHONE network connection is  $\pm 5$  dB. Fig. 18 presents the nominal maximum deviation-from-flatness permitted at a given frequency.

PICTUREPHONE network equalizer signal handling capability is nominally 1.5 volts peak above average referenced to 0 PTLP. Signals at the input of the equalizer exceeding this limit may be clipped. Due to equalizer gain variations signals of less than 1.5 volts peak above average may be clipped; a .843 volt peak above average signal should not be clipped by the equalizers.

The degradation of a signal caused by the low frequency roll-off of the PICTUREPHONE network is characterized in terms of tilt. Tilt is found by measuring the drop in amplitude of a step waveform, over a 100  $\mu$ sec interval, as a percentage of the original amplitude. The current end-to-end analog PICTUREPHONE network tilt objective is 10 percent.

The phase characteristic of the PICTUREPHONE network is ideally linear. However, the phase may deviate from being linear due to nonlinear phase characteristics of loop and trunk cable facilities. The actual phase deviation from linearity is directly related to the particular gain deviations encountered.

The current design objectives for gain and phase related analog PICTUREPHONE network end-to-end transmission variables are summarized below:

Nominal Gain	0 dB flat, 3 dB down at 150 Hz and 1.1 MHz
Allowable Gain Deviations:	
Flat Gain Variation	+5 dB
Deviation-from-Flatness	Figure 10
Nominal Phase	Linear
Nominal Signal Capability	1.5 volts peak above average referenced to 0 PTLP at input (cus- tomer interface) of PVF
Low Frequency Roll-Off (Tilt)	10%

### 3.23 Interference Variables

Single frequency interference results from the coupling of energy into the PICTUREPHONE network from sources such as radio transmitters.

Power hum is the noise at 60 Hz and its harmonics that is coupled into the PICTUREPHONE network from ac power equipment and cables.

Impulse noise is generated by switching systems in the local offices. Transient voltages are induced into voice pairs when current is

interrupted by the opening of contacts. These transient voltages may be coupled to adjacent PICTUREPHONE network pairs in office cabling. Impulse noise can also be picked up by loops and trunks from sources external to the switching office such as machinery or nearby telegraph lines.

Random noise includes all sources of noise such as coding noise, single frequency interference, impulse noise and crosstalk interference but does not include power hum.

The PICTUREPHONE network design objectives for interference transmission variables are as follows:

Single Frequency Interference, RMS	Figure 19
Power Hum, RMS	
60 Hz	-35 dBV at 0 PTLP
120 Hz	-41 dBV at 0 PTLP
180 Hz	-44 dBV at 0 PTLP
Weighted* Impulse Noise (Probability of Base-to-Peak Noise Exceeding -33 dBV)	$1.6 \times 10^{-5}$
Weighted Random RMS Noise: PICTUREPHONE network with Codec (for PICTUREPHONE Format Signal)	-54 dBV at 0 PTLP
Analog Portion of PICTUREPHONE Network	-58 dBV at 0 PTLP

#### 4. FOREIGN AND SURGE VOLTAGE PROTECTION

Where telephone and PICTUREPHONE lines are exposed to lightning, power circuit contact, or induction, there are protective devices located at the Central Office and on the customer's premises that will provide a path to ground for foreign voltages that exceed approximately 600 volts

\* See Weighting Curve, Fig. 20.

peak. Since the customer's equipment is connected to the telephone and PICTUREPHONE lines through the PICTUREPHONE connecting arrangement, the customer's equipment is protected from longitudinal lightning surges. The maximum surge between conductors CT and CR, CVOT and CVOR, and CVIT and CVIR (see Fig. 2) due to foreign potential that the customer's equipment will encounter is 30 volts. The surge potentials on the other conductors of the PICTUREPHONE connecting arrangement will be within the voltage limits specified in Part IV for the individual conductors.

The customer is responsible for providing protection, internal to his equipment and facilities, against foreign and surge voltages from his equipment and facilities being applied to the connecting arrangement. The surge potential on the conductors CT and CR is expected to be limited to 30 volts. The surge potential on the other conductors shall be limited to the peak voltage specified in Section 5 below and in Part IV for the individual conductors.

5. GENERAL VOLTAGE LIMITATIONS

When it is necessary for the customer to apply an operational voltage to conductors interconnected with telephone and PICTUREPHONE facilities, certain voltage limitations shall be observed. These limitations are for the purpose of providing adequate protection to personnel and plant facilities, and unless otherwise specified in Part IV of this Technical Reference, steady-state voltages applied by the customer-provided equipment to conductors connected to PICTUREPHONE Connecting

Arrangement PVF should not exceed the following:

	<u>dc</u>	<u>ac (RMS)</u>
Maximum voltage, any conductor to ground	135	50
Maximum voltage, conductor to conductor	(135 (270*	( 50 (100*

The power supplies and wiring methods used in the customer-provided equipment shall meet the provisions of the National Electric Code (NEC), Article 725, for Class 2 remote control and signal circuits.

\* Permitted only if voltage source is center-tapped to ground.

PRELIMINARY

PART VII - SERVICE and MAINTENANCE CONSIDERATIONS

- 57 -

1. RESPONSIBILITY OF THE CUSTOMER

The tariffs permitting direct electrical connection of customer-provided terminal equipment require that:

Where long distance message telecommunications service (including PICTUREPHONE service) is available under this Tariff for use in connection with customer-provided terminal equipment, the operating characteristics of such equipment shall be such as not to interfere with any of the services offered by the Telephone Company. Such use is subject to the further provisions that the customer-provided equipment does not endanger the safety of Telephone Company employees or the public; damage, require change in or alternation of, the equipment or other facilities of the Telephone Company; interfere with the proper functioning of such equipment or facilities; impair the operation of the telecommunications system (and associated PICTUREPHONE system) or otherwise injure the public in its use of the Telephone Company's services. Upon notice from the Telephone Company that the customer-provided equipment is causing, or is likely to cause such hazard or interference, the customer shall make such change as shall be necessary to remove or prevent such hazard or interference.

2. RESPONSIBILITY OF THE TELEPHONE COMPANY

The Tariffs permitting direct electrical connection of customer-provided terminal equipment require that:

The Telephone Company shall not be responsible for the installation, operation or maintenance of any customer-provided terminal equipment. Long distance message telecommunications service (including PICTUREPHONE service) is not represented as adapted to the use of customer-provided equipment and where such equipment is connected to Telephone Company facilities the responsibility of the Telephone Company shall be limited to the furnishing of facilities suitable for long distance message telecommunications service (including PICTUREPHONE service) and to the maintenance and operation of such facilities in a manner proper for such telecommunications service; subject to this responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by the customer-provided equipment or for the quality of, or defect in, such transmission, or (ii) the reception of signals by customer-provided equipment. The Telephone Company shall not be responsible to the customer or otherwise if changes in minimum network protection criteria contained in the Tariffs and in this Technical Reference, or in any of the facilities, operations or procedures

of the Telephone Company, render any customer-provided equipment obsolete or require modification or alteration of such equipment or otherwise affect its use or performance.

3. TROUBLE REPORTING PROCEDURE

When trouble is experienced with this service, the customer should perform the necessary testing, e.g., utilization of the idle condition loopback feature (see Part III, Section 1) of this connecting arrangement, to determine whether the service impairment is in the customer-provided equipment or in the equipment provided by the Telephone Company. If the tests indicate that the trouble is in the Telephone Company-provided equipment, it should be promptly reported to the Telephone Company. Trouble reports should be called in to the listed "Repair Service" number, which can be found in the front of the telephone directory or, where available, to a PICTUREPHONE Repair service number. The repair attendant should be given:

- (a) Customer's name.
- (b) Customer's address.
- (c) Listed PICTUREPHONE number.
- (d) Description of the trouble.
- (e) Customer's contact for additional information.



REFERENCES

Some references describing various transmission characteristics of the telecommunications network are listed below:

- (a) McAdoo, K. L., "Speech Volumes on Bell System Message Circuits - 1960 Survey," Bell System Technical Journal (BSTJ), Vol. 42, No. 5 (September 1963), p. 1999.
- (b) Nasell, I., "The 1962 Survey of Noise and Loss on Toll Connections," BSTJ, Vol. 43, No. 2 (March 1964), p. 697.
- (c) Nasell, I., "Some Transmission Characteristics of Bell System Toll Connections," BSTJ, Vol. 47, No. 6 (July-August 1968), p. 1001.
- (d) Nasell, I.; Ellison, C. R.; and Homstrom, R., "The Transmission Performance of Bell System Intertoll Trunks," BSTJ, Vol. 47, No. 8 (October 1968), p. 1561.
- (e) Gresh, P. A., "Physical and Transmission Characteristics of Customer Loop Plant," BSTJ, Vol. 48, No. 10 (December 1969), p. 3337.
- (f) Alexander, A. A.; Gryb, R. M.; and Nast, D. W., "Capabilities of the Telephone Network for Data Transmission," BSTJ, Vol. 39, No. 3 (May 1960), p. 431.
- \*(g) "Notes on Transmission Engineering," by United States Independent Telephone Association, Washington, D. C.
- \*(h) "Transmission Systems for Communications," by Bell Telephone Laboratories.

\* Available through Graybar Electric Company

Additional references describing various characteristics of PICTUREPHONE service are listed below.

- (1) Bell Laboratories RECORD, May/June 1969, Vol. 47, No. 5  
(8 PICTUREPHONE articles).
- (2) H. E. Brown, "Network Planning for PICTUREPHONE Service,"  
Proceedings of the National Electronics Conference, Vol. 25,  
1969.
- (3) Raymond W. Ralston, "PICTUREPHONE Service, A New Era in  
Communications," Proceedings of the National Electronics  
Conference, Vol. 25, 1969.
- (4) R. C. Boyd and S. D. Hathaway, "Long Distance Video Trans-  
mission for PICTUREPHONE Service," Proceedings of the  
National Electronics Conference, Vol. 25, 1969.
- (5) F. W. Mounts, "Conditional Replenishment: A Promising Tech-  
nique for Video Transmission," Bell Laboratories Record,  
April 1970.
- (6) Earl F. Brown, "Better Pictures Through Better Coding," Bell  
Laboratories Record, April 1970.
- (7) H. A. Wheeler, "The Interpretation of Amplitude and Phase  
Distortion in Terms of Paired Echoes," Proc. IRE, June 1939.
- (8) A. D. Fowler and H. N. Christopher, "Effective Sum of Multiple  
Echoes in Television," Journal of the Society of Motion Picture  
and Television Engineers, Vol. 58, June 1952.
- (9) J. M. Brown and J. W. Lechleider, "Baseband Video Transmission  
for Commercial PICTUREPHONE Service," Proceedings of the  
National Electronics Conference, Vol. 25, 1969.

GLOSSARY\*

COMMUNICATIONS SYSTEMS - denotes channels and other facilities which are capable when not connected to the Long Distance Message Telecommunications Service, of communications between customer-provided terminal equipment or Telephone Company stations.

CONNECTING ARRANGEMENT - The PICTUREPHONE<sup>®</sup> Connecting Arrangement PVF provided by the Telephone Company to accomplish the direct electrical connection of customer-provided terminal equipment with the facilities of the Telephone Company and to connect the transmission paths from the customer-provided equipment to the telecommunications network.

CUSTOMER-PROVIDED TERMINAL EQUIPMENT - denotes devices or apparatus, and their associated wiring, provided by a customer, which do not constitute a communications system and which, when connected to the communications path of the telecommunications network, are so connected either electrically, acoustically or inductively.

END-OFFICE - the last serving Central Office in the switching hierarchy of the telecommunication network.

INTERFACE CONNECTOR - the Telephone Company furnished connecting point to which the customer brings and connects the lead of his equipment.

PICTUREPHONE NETWORK - the Bell System switching equipment, associated interconnecting transmission facilities and PICTUREPHONE station equipment which is associated with the Bell System telecommunications network in providing PICTUREPHONE service.

\* May differ in letter from exact wording as used in the Tariffs.

NETWORK CONTROL SIGNALING - the transmission of signals used in the telecommunications network which perform functions such as supervision (control, status, and charging signals), address signaling (dialing), calling and called number identification, audible tone signals (call progress signals indicating re-order or busy conditions, alerting, coin denominations, coin collect and coin return tones) to control the operation of switching machines in the telecommunications network.

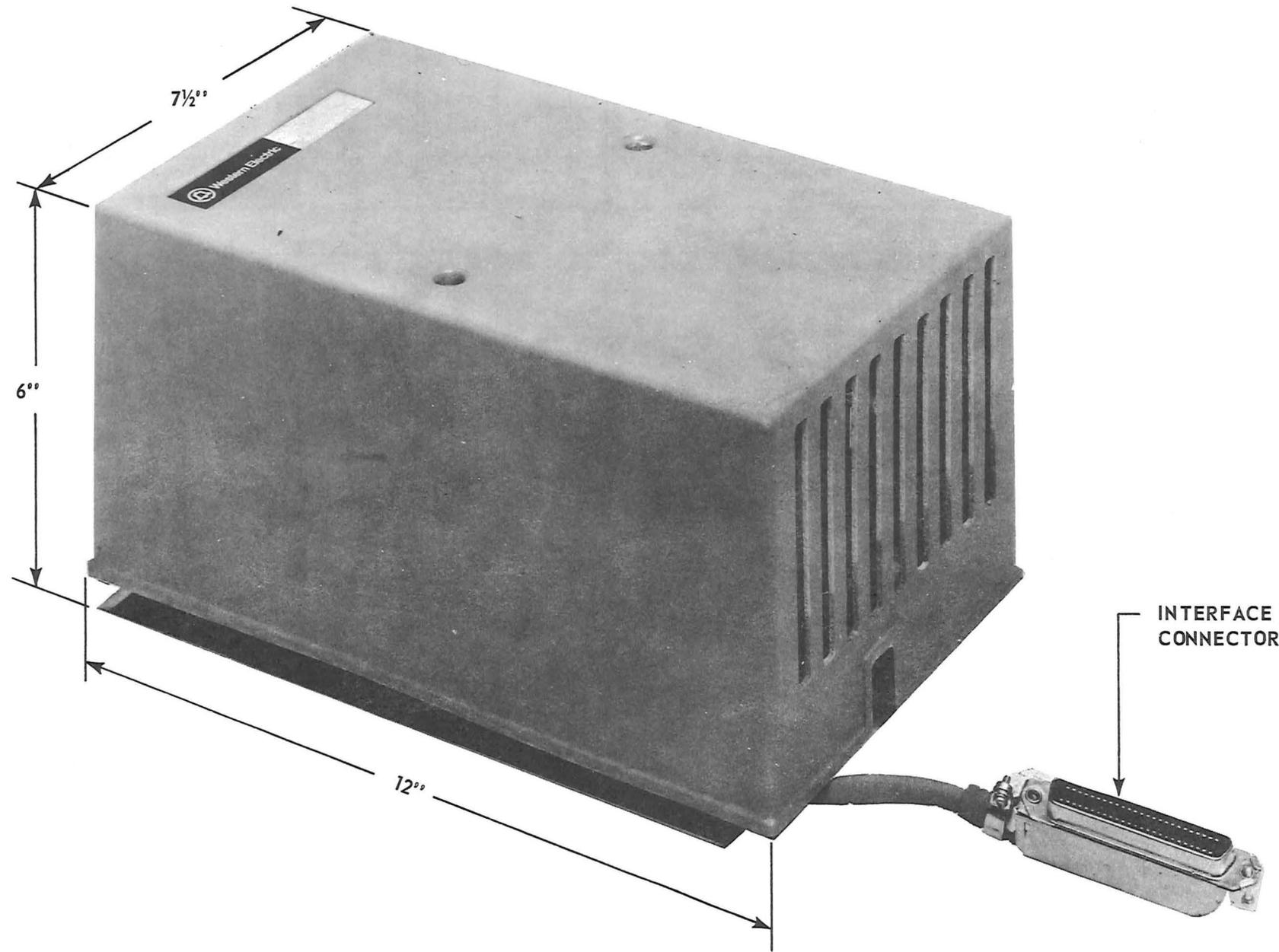
NETWORK CONTROL SIGNALING UNIT - the Bell System TOUCH-TONE® telephone set (furnished, installed and maintained by the Telephone Company for the provision of network control signaling) used with the PICTUREPHONE Connecting Arrangement PVF.

TELECOMMUNICATIONS NETWORK - the Bell System message switching equipment, associated interconnecting facilities and station equipment which connects its customers together.

TELEPHONE COMPANY - denotes the American Telephone and Telegraph Company, Long Lines Department, its concurring carriers and its connecting carriers, either individually or collectively.

VOICE COUPLER - that portion of PICTUREPHONE Connecting Arrangement PVF which connects the voice transmission path from the customer-provided voice equipment to the telecommunications network.

VIDEO COUPLER - that portion of PICTUREPHONE Connecting Arrangement PVF which connects the video transmission paths from the customer-provided video equipment to the PICTUREPHONE facilities.



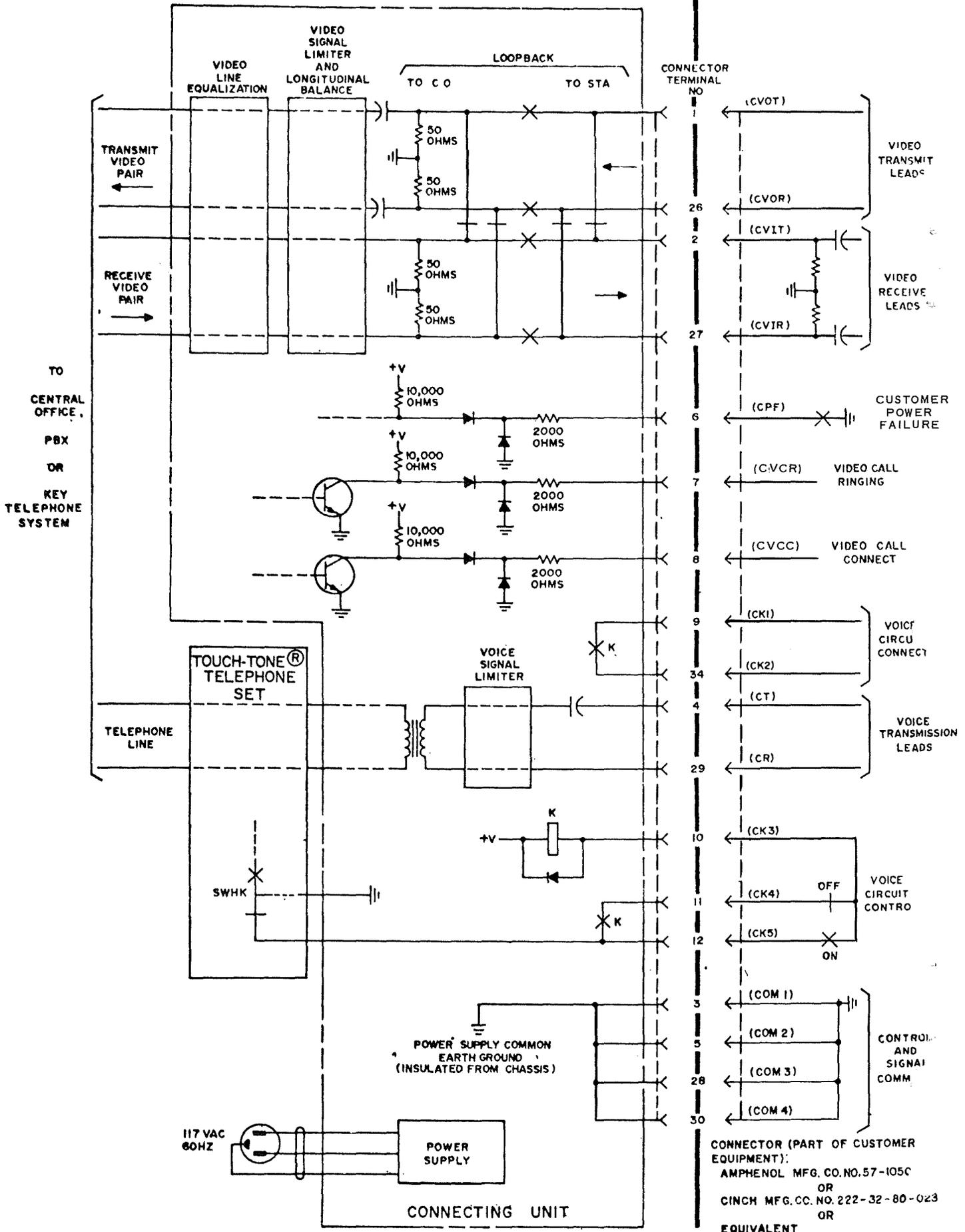
CONNECTING UNIT  
FIG. 1

INTERFACE  
CONNECTOR

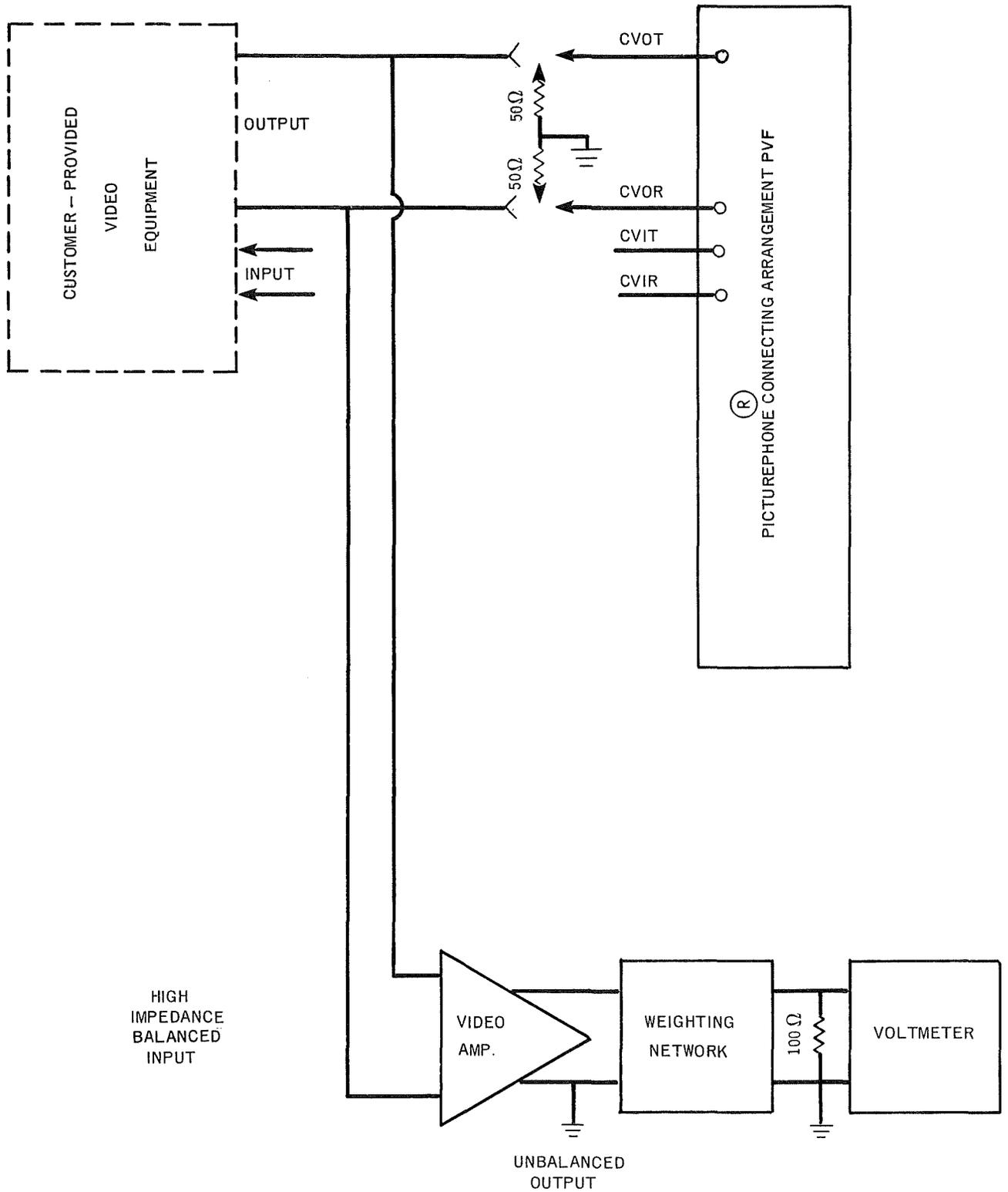
PRELIMINARY

BELL SYSTEM SIDE PRELIMINARY

INTERFACE CUSTOMER SIDE

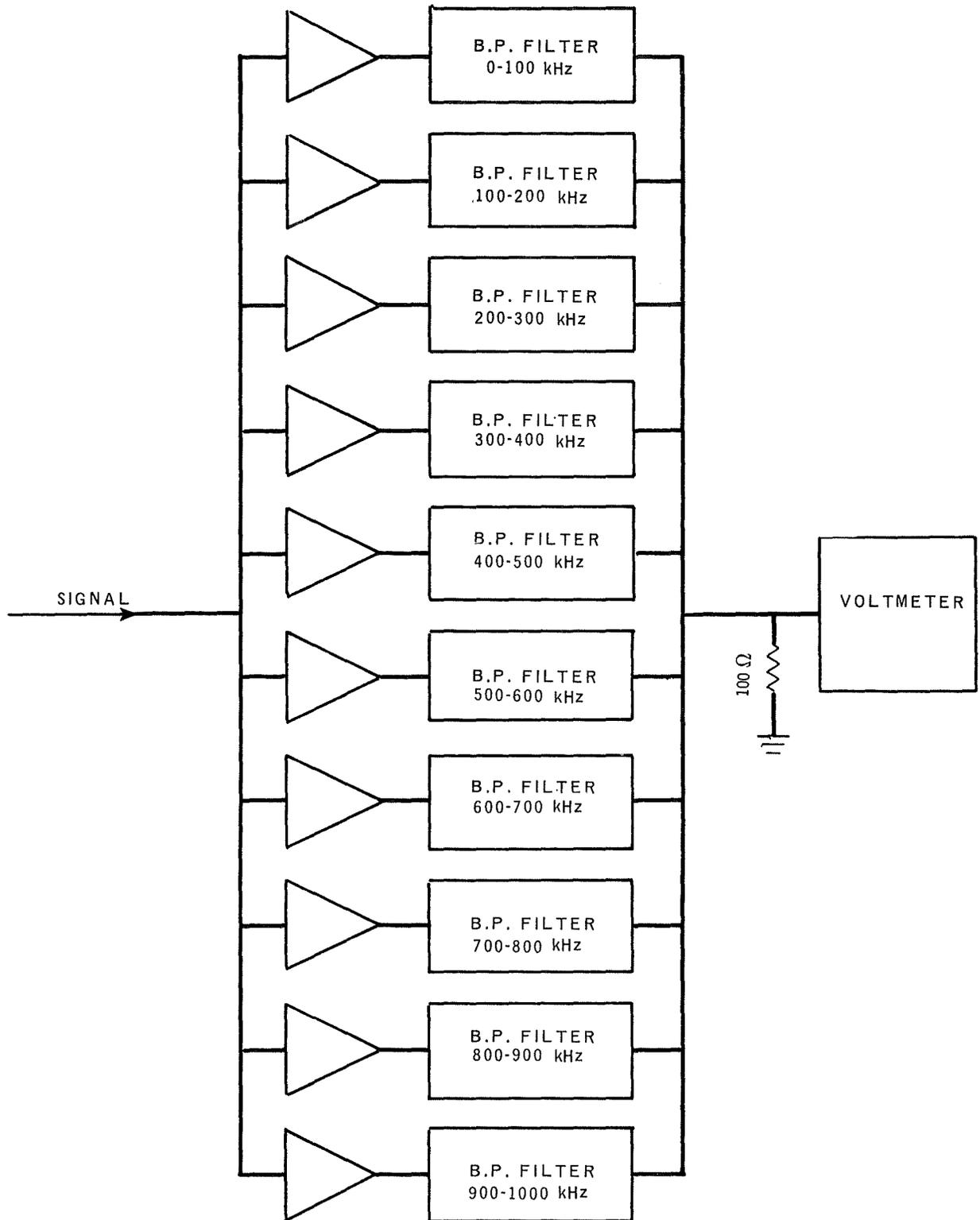


PICTUREPHONE<sup>®</sup> CONNECTING ARRANGEMENT PVF  
 FIG. 2

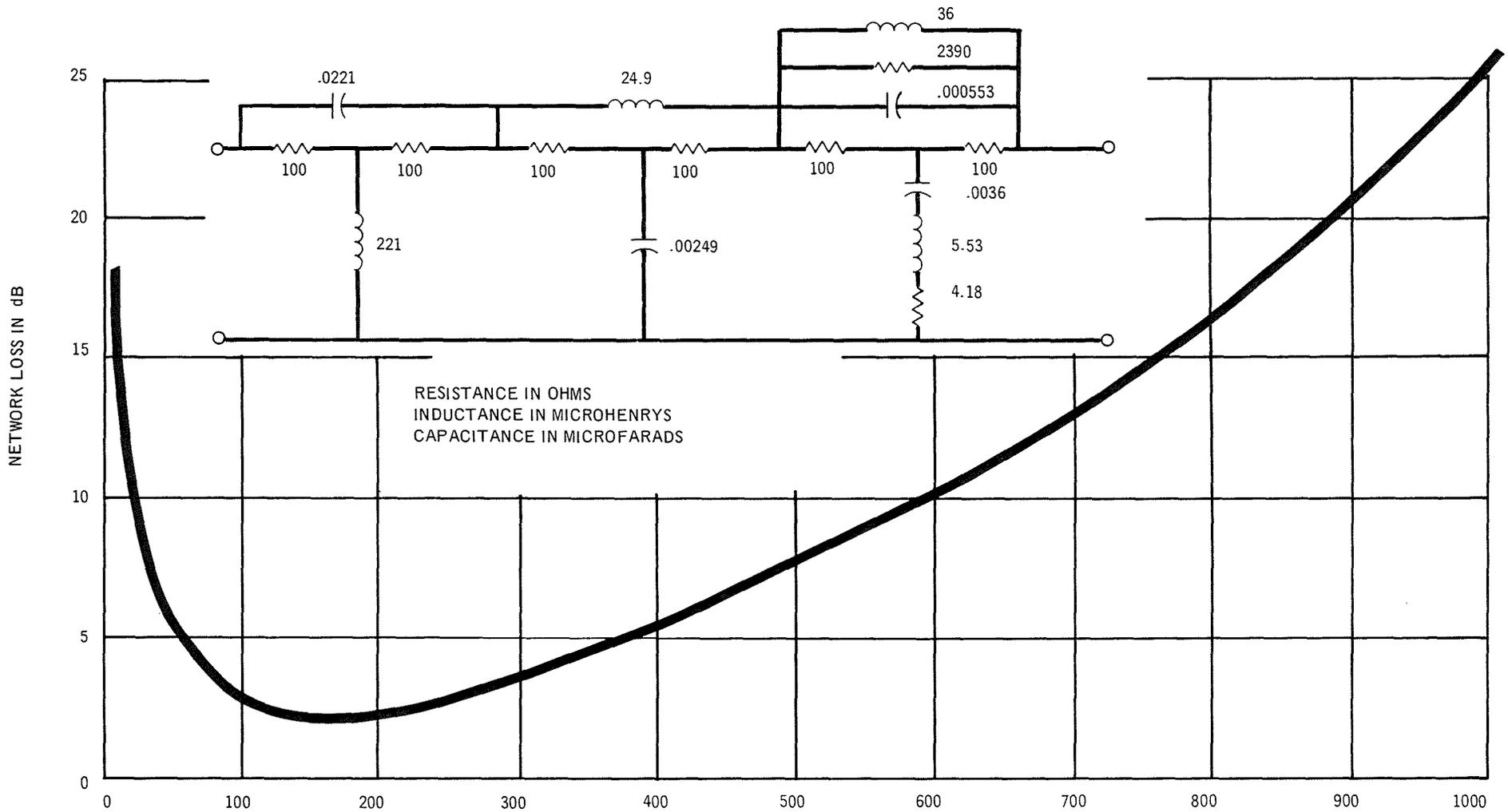


ARRANGEMENT FOR MEASURING  
WEIGHTED VIDEO SIGNAL POWER  
FIG. 3

PRELIMINARY

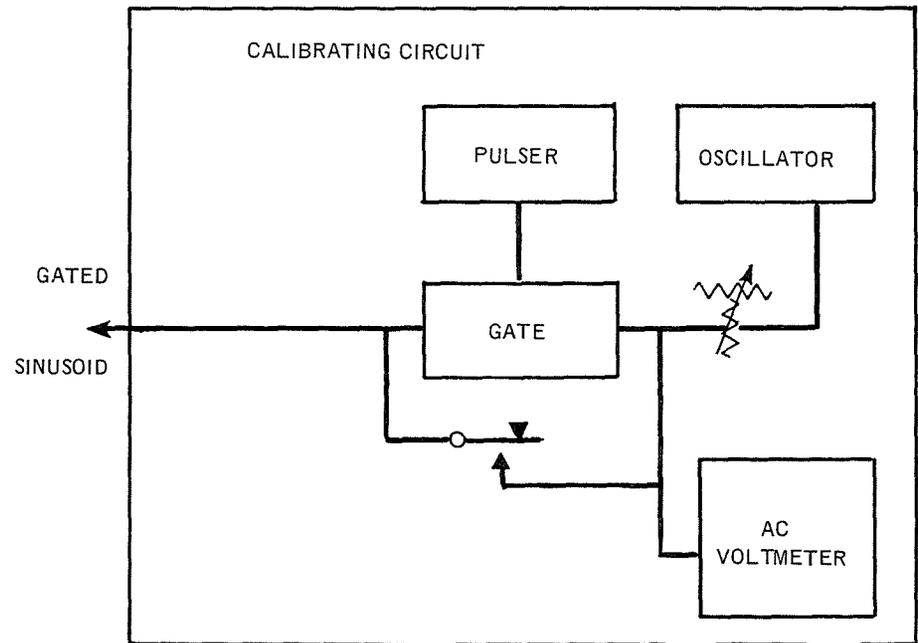
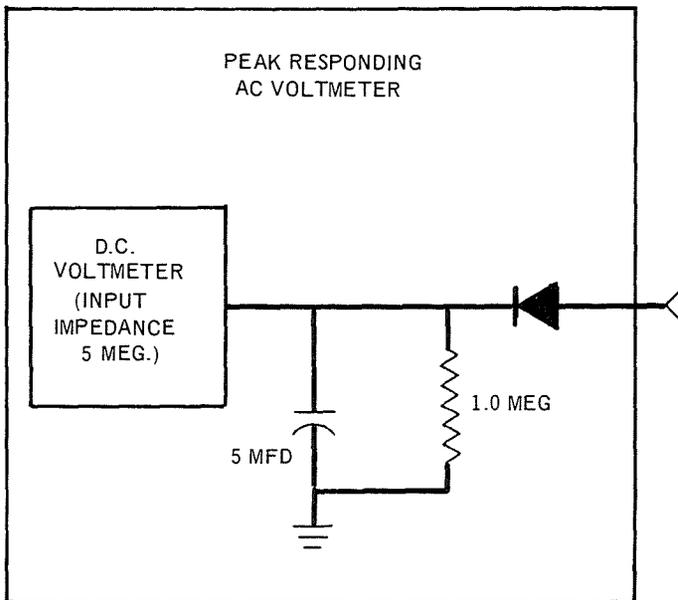
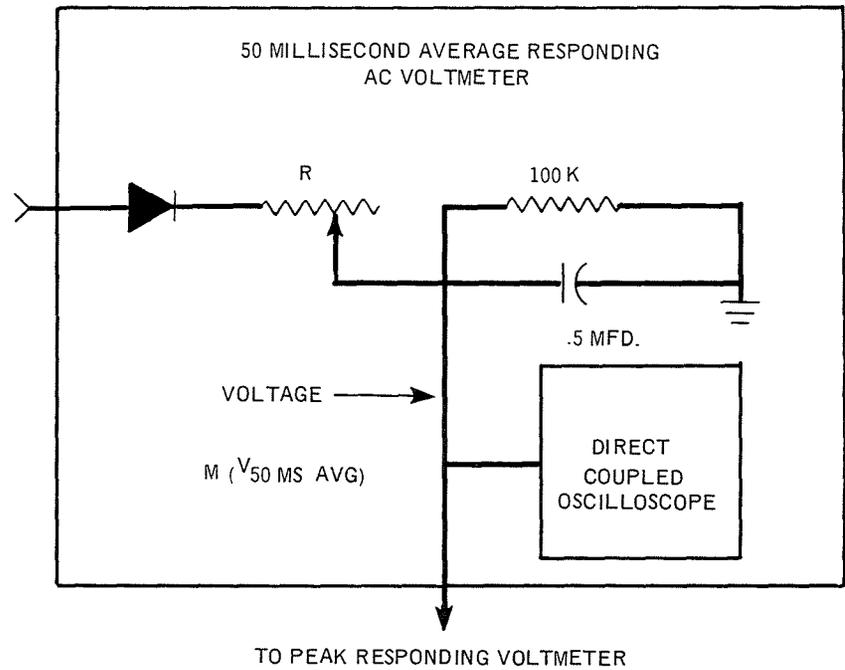
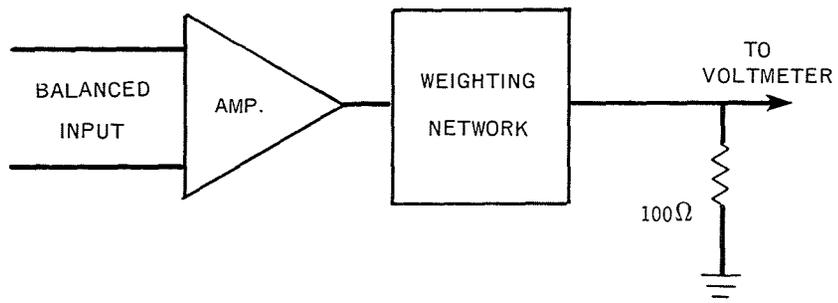


ALTERNATIVE ARRANGEMENT FOR  
MEASURING WEIGHTED VIDEO SIGNAL POWER  
FIG. 4



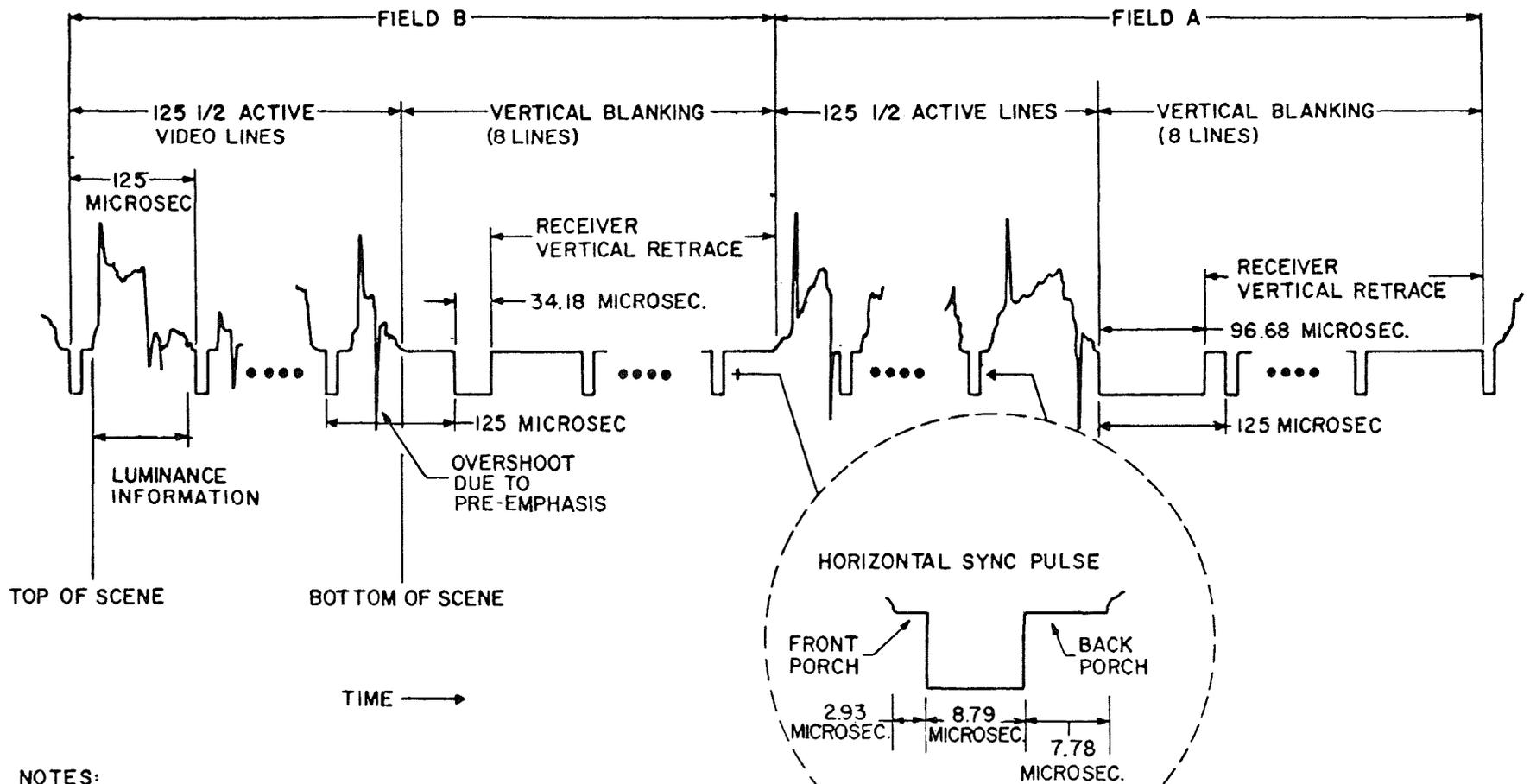
WEIGHTING NETWORK REPOSE  
FIG. 5

PRELIMINARY



POWER MEASUREMENT ARRANGEMENTS  
FIG. 6

PRELIMINARY



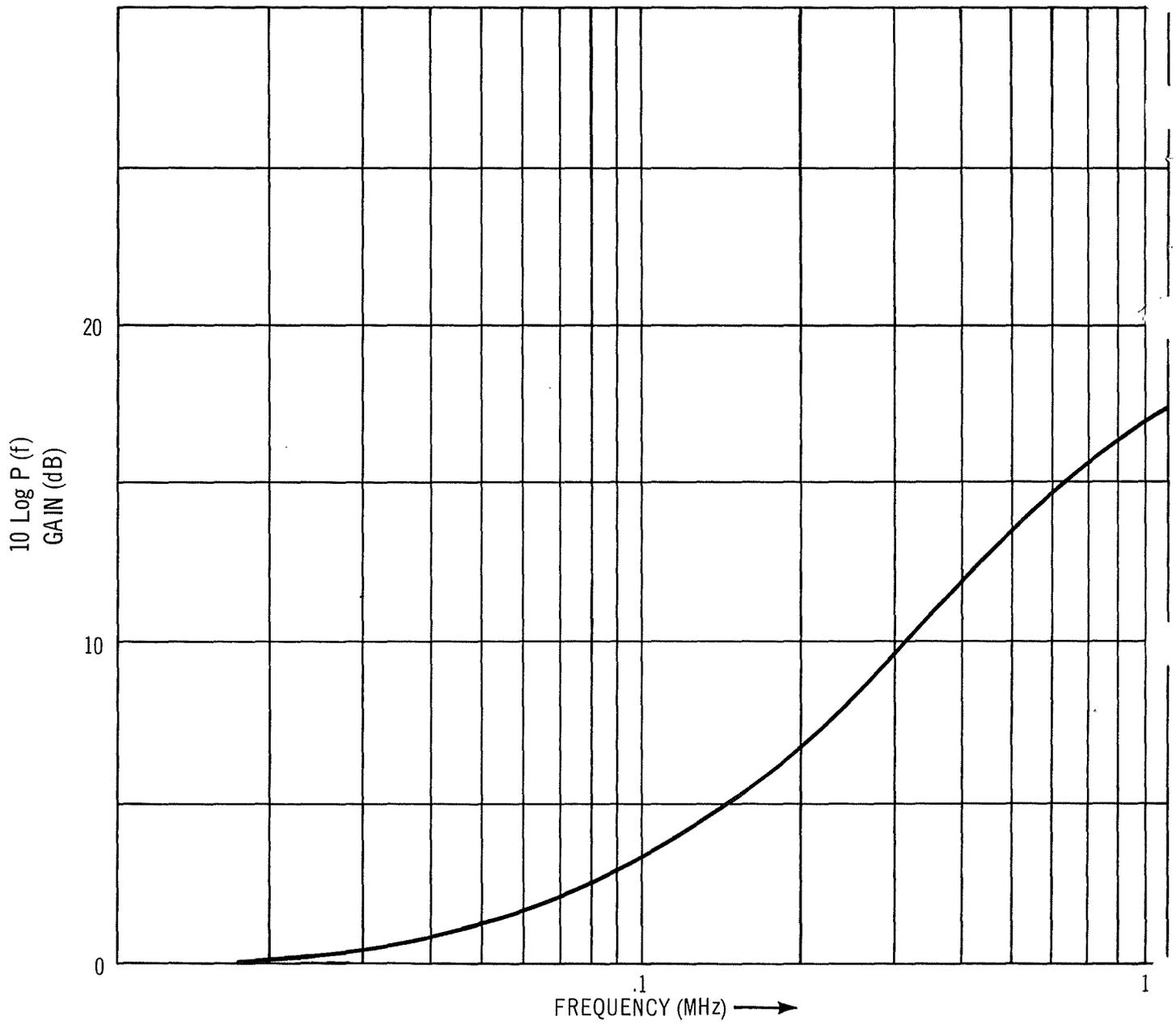
PRELIMINARY

NOTES:

- ONLY VIDEO (NOT SYNC PULSES) IS PRE-EMPHASIZED
- LINE RATE : 8 kHz
- FIELD RATE: 59.93 Hz
- VIDEO POSITIVE ON TIP (AS SHOWN)

COMPOSITE VIDEO SIGNAL USED IN BELL SYSTEM PICTUREPHONE SERVICE<sup>®</sup>  
 FIG. 7

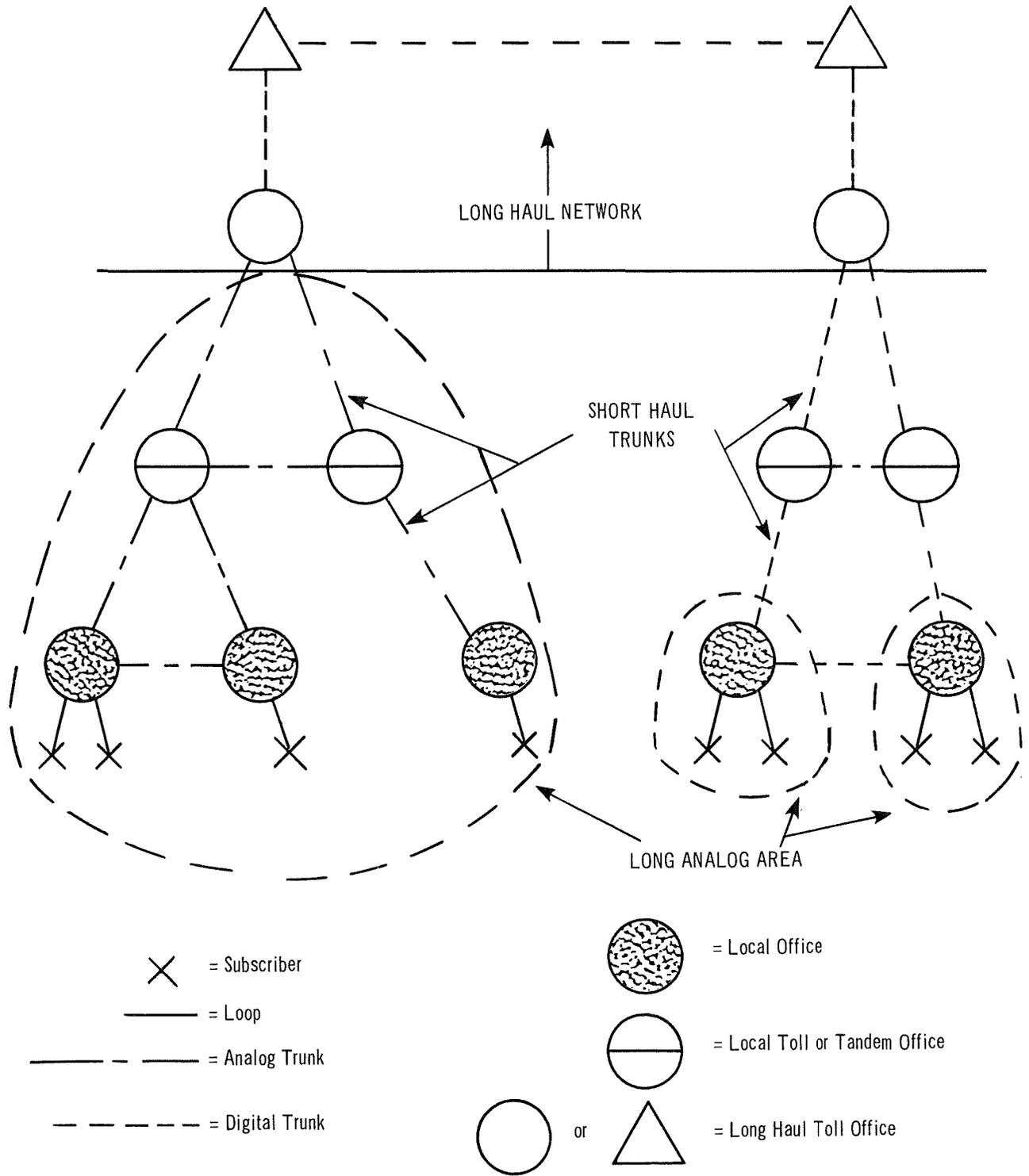
PRELIMINARY



VIDEO PRE-EMPHASIS CHARACTERISTICS  
USED IN BELL SYSTEM PICTUREPHONE<sup>®</sup> SERVICE

FIG. 8

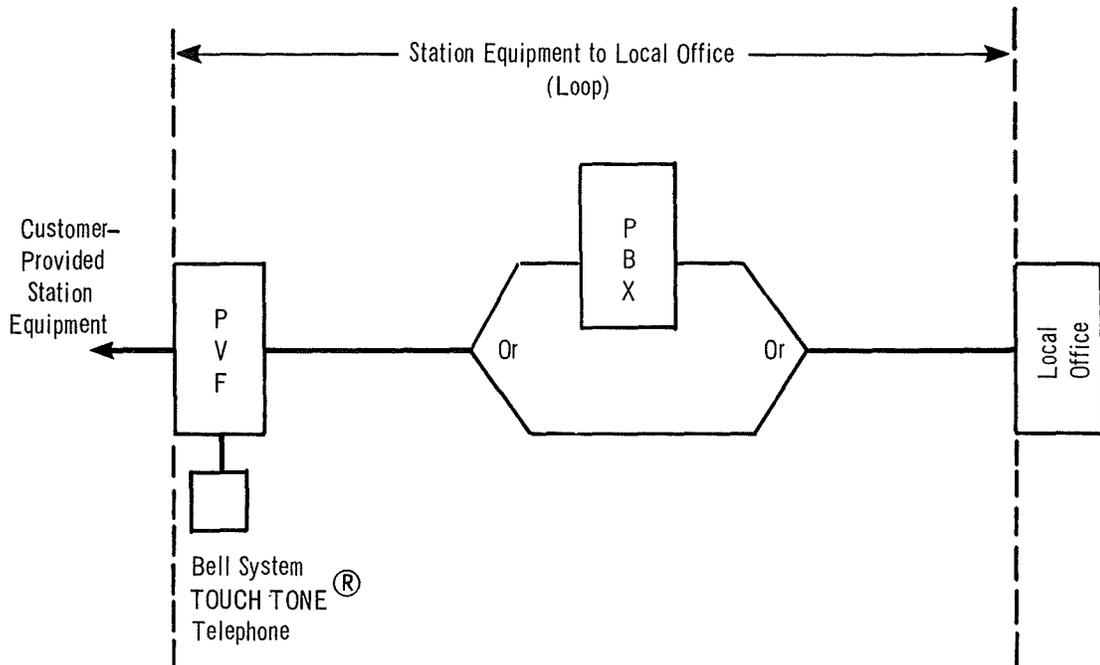
PRELIMINARY



PICTUREPHONE<sup>®</sup> NETWORK HIERARCHY

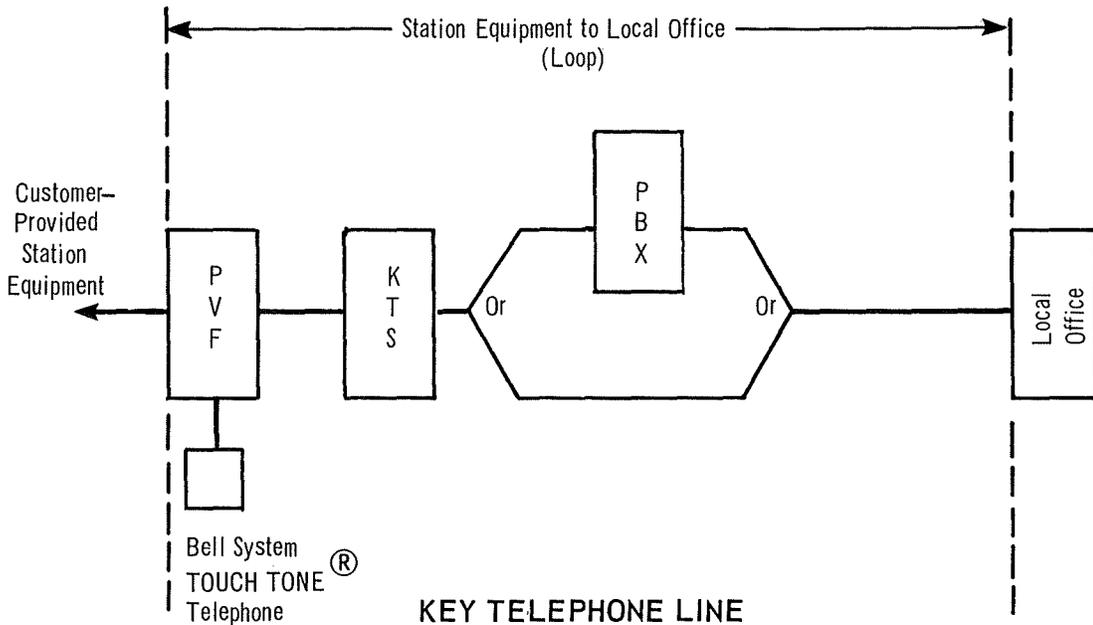
FIG. 9

PRELIMINARY



SINGLE LINE

FIG. 10A



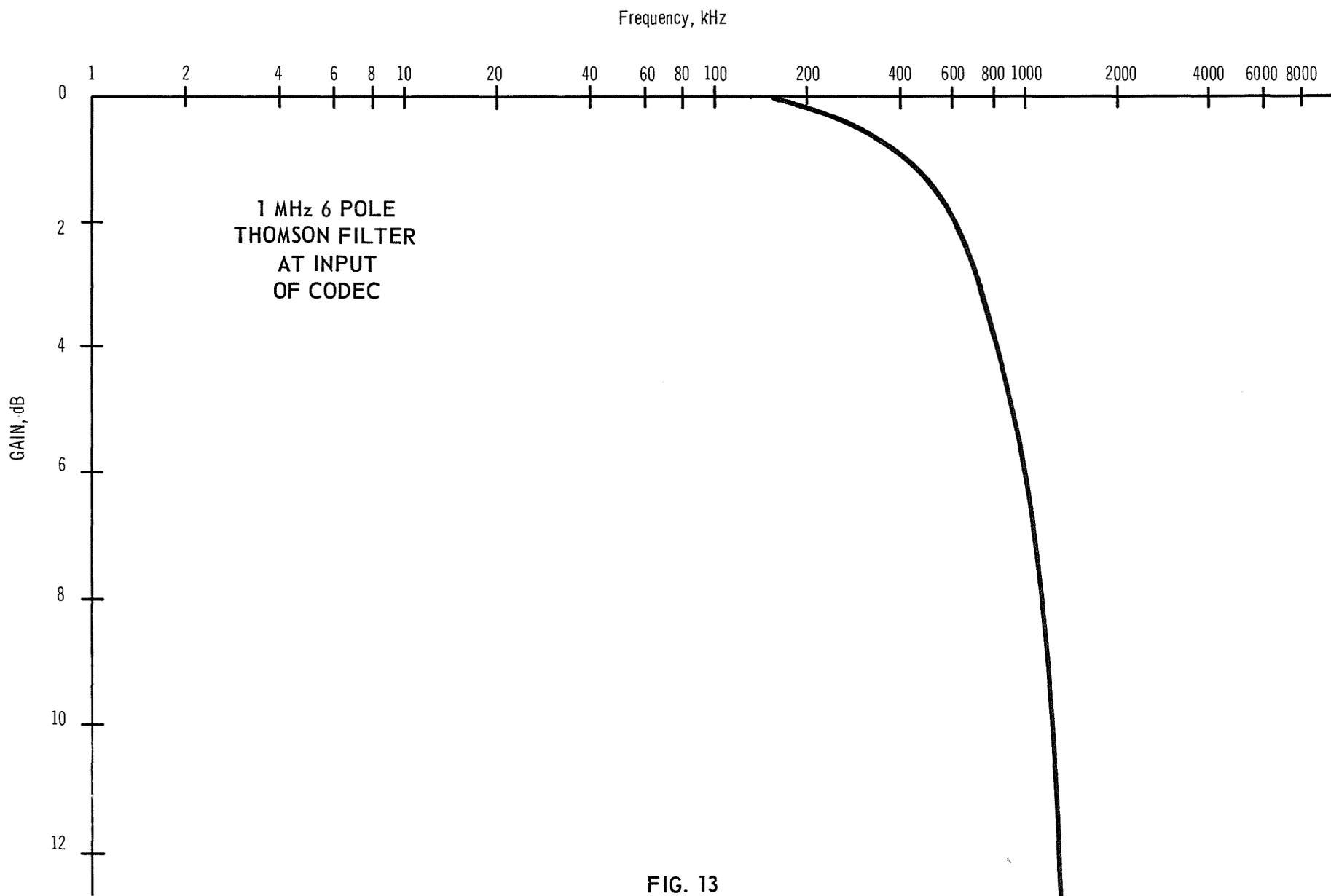
KEY TELEPHONE LINE

FIG. 10B

<sup>®</sup> PICTUREPHONE NETWORK LOOP

FIG. 10

<sup>®</sup> PVF = PICTUREPHONE Connecting Arrangement PVF  
 KTS = Bell System Key Telephone System  
 PBX = Bell System Private Branch Exchange



PRELIMINARY

FIG. 13

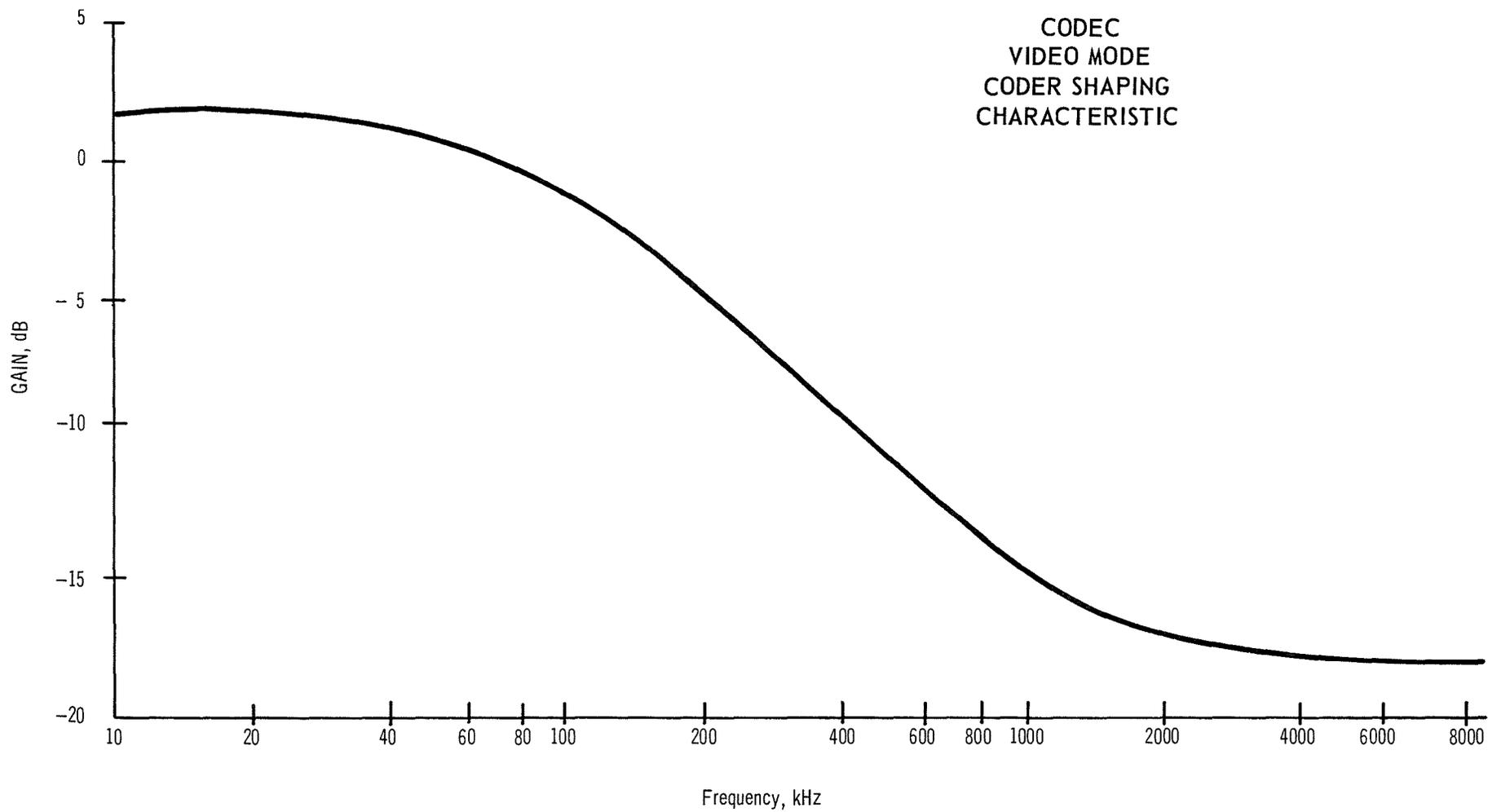
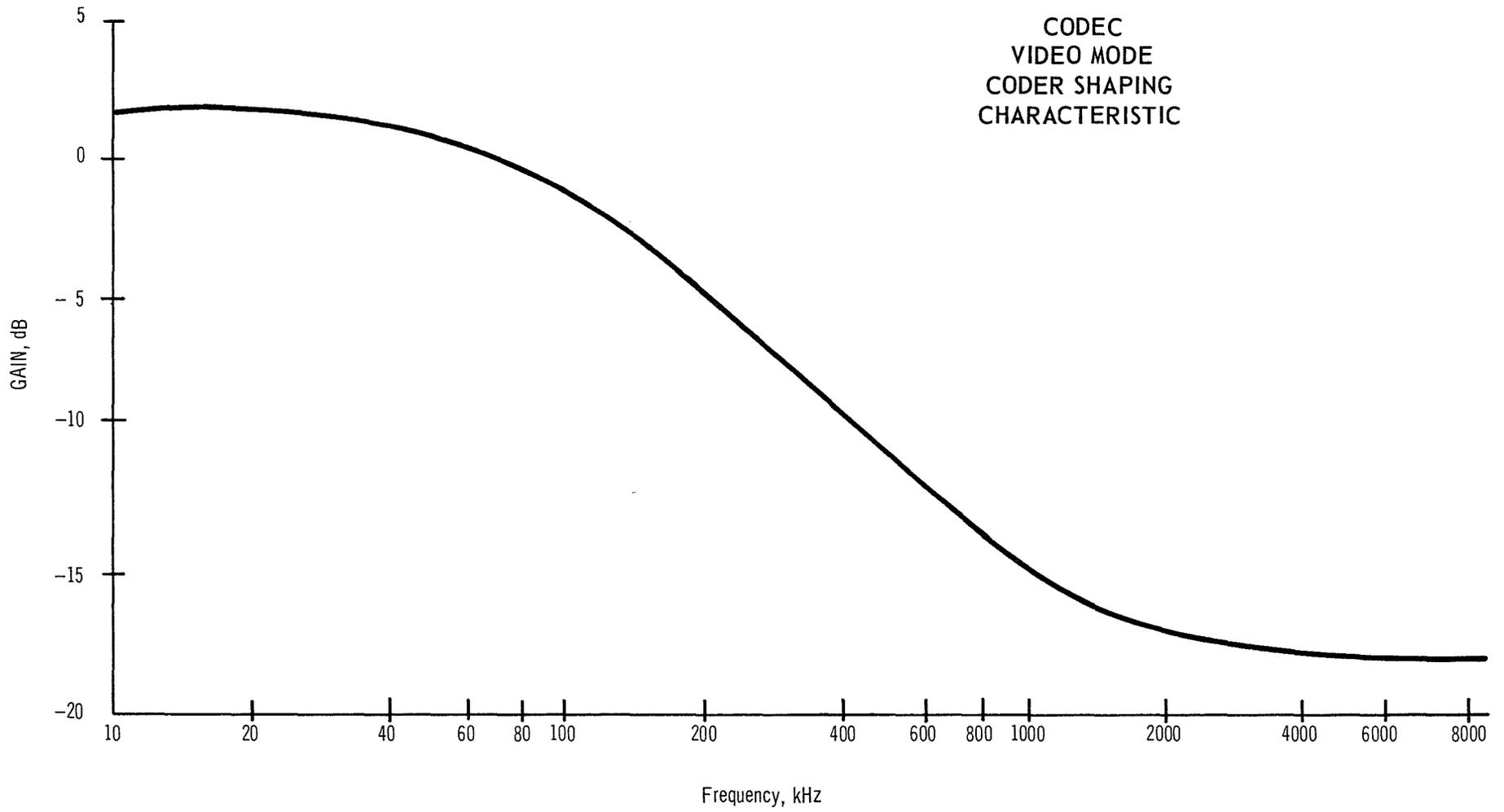


FIG. 14

PRELIMINARY



PRELIMINARY

FIG. 14

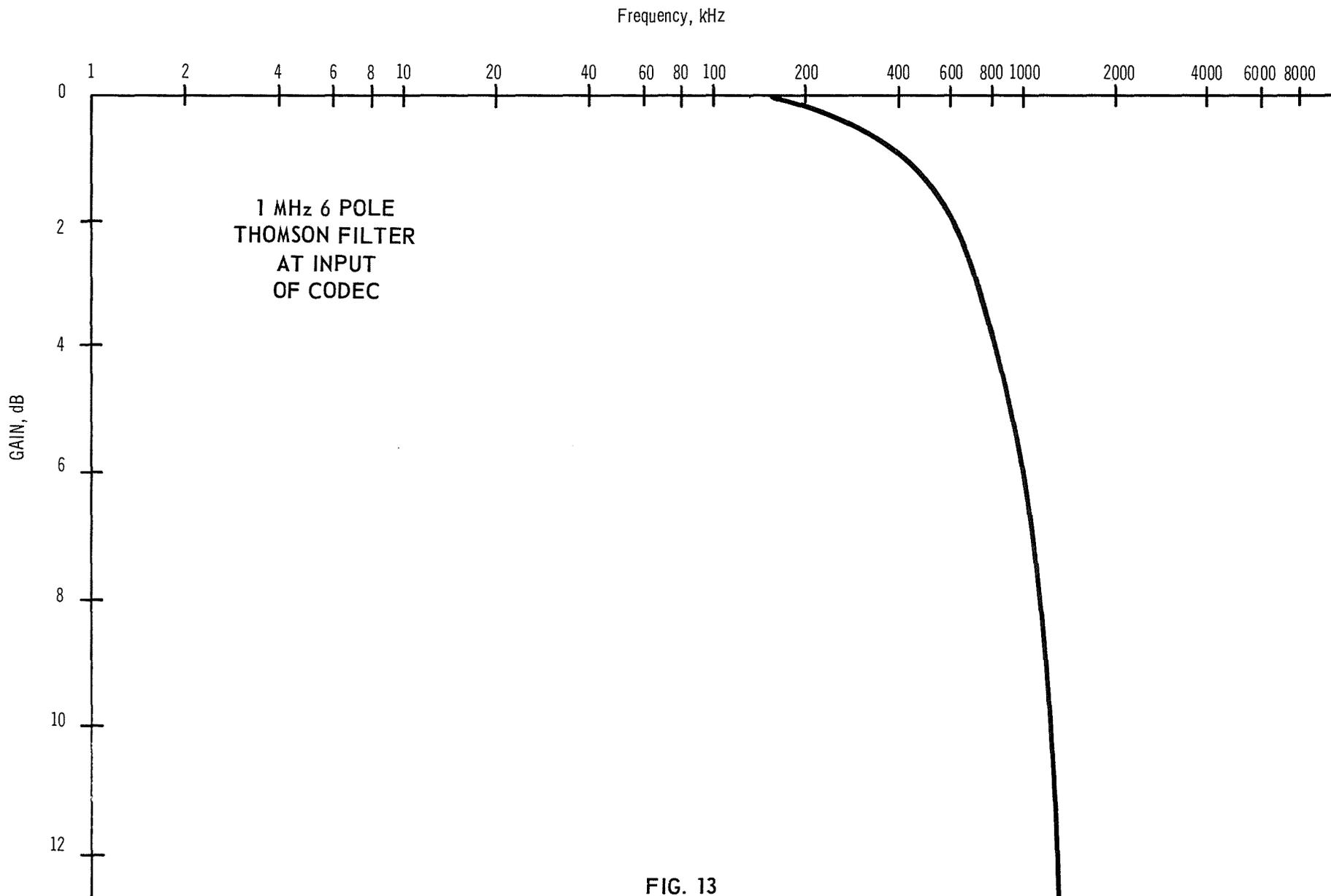
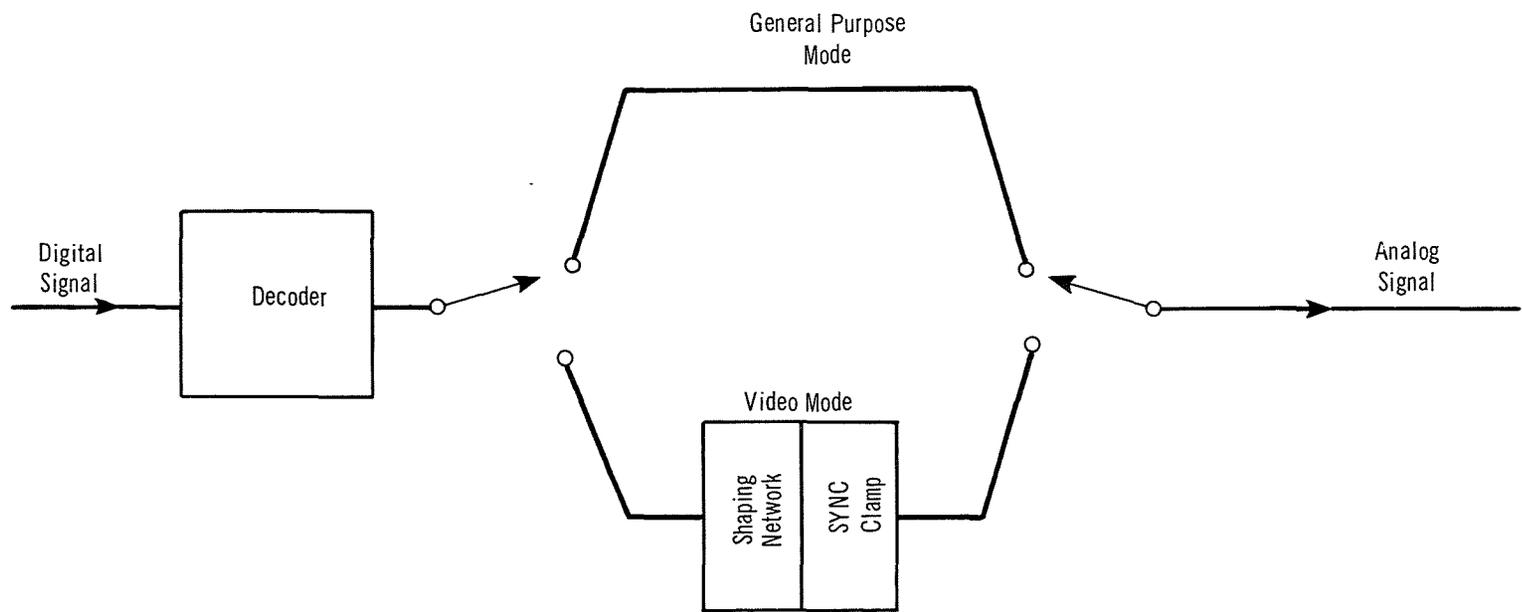


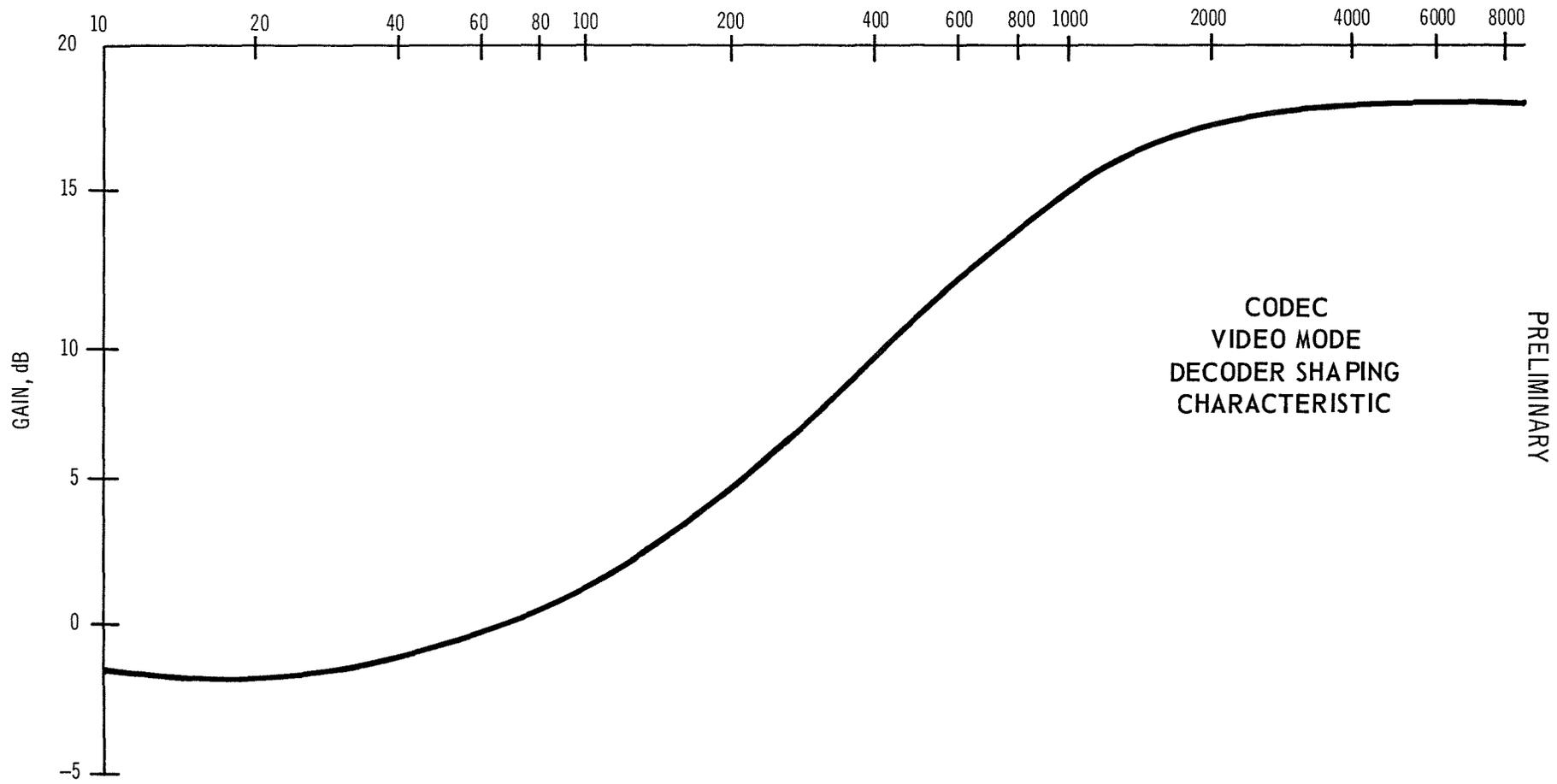
FIG. 13



PRELIMINARY

REPRESENTATION OF DECODING PORTION OF CODEC

FIG. 15

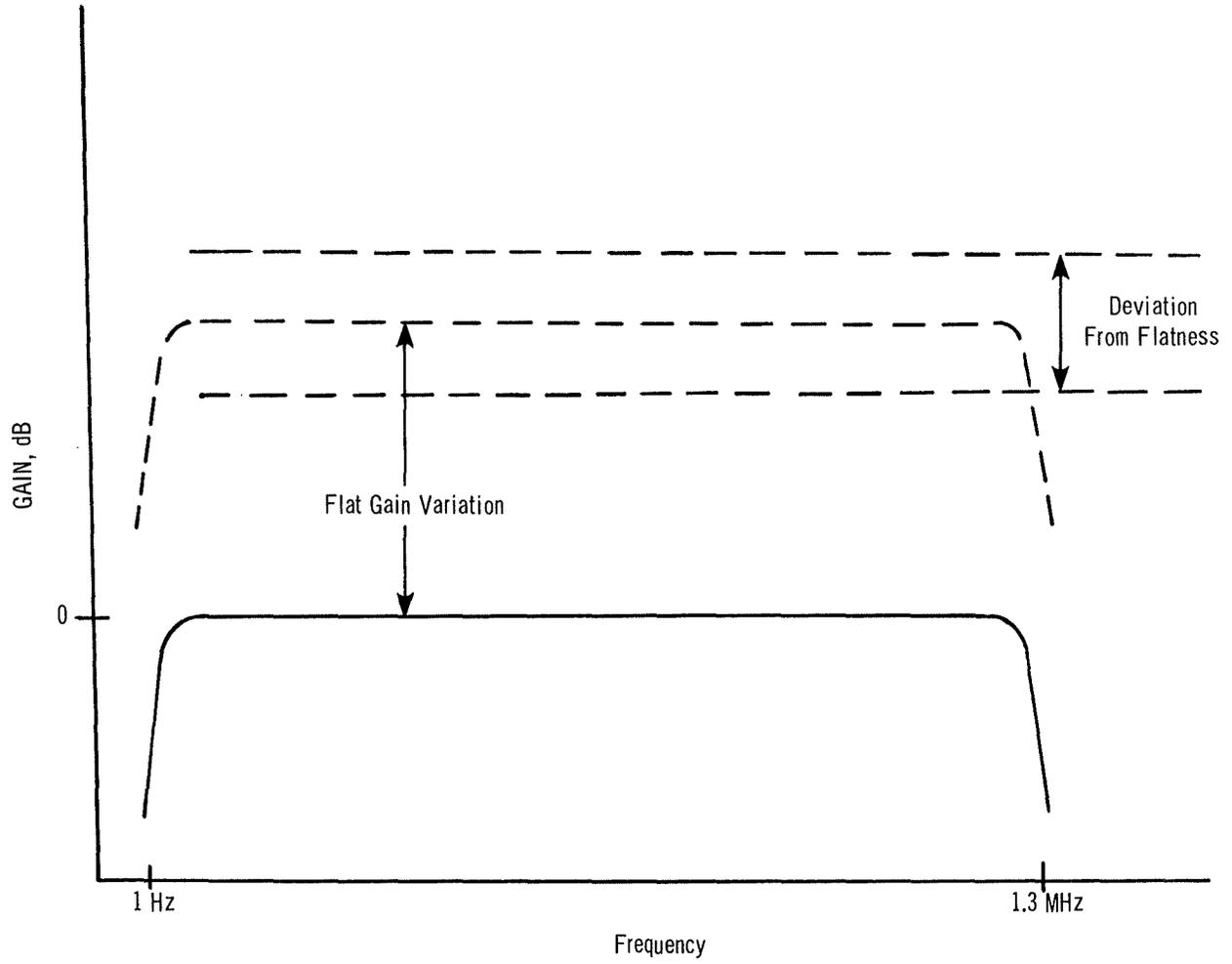


CODEC  
VIDEO MODE  
DECODER SHAPING  
CHARACTERISTIC

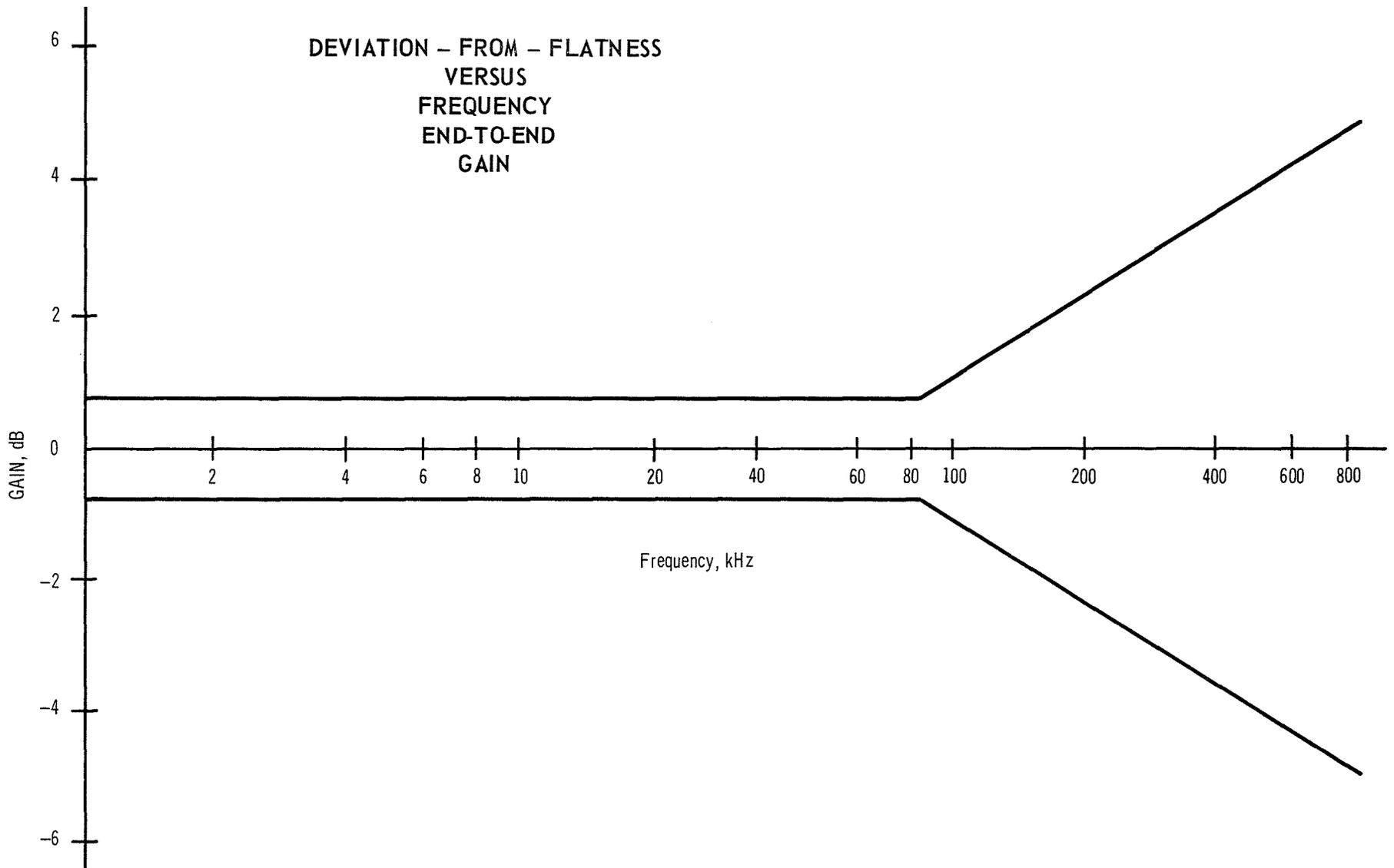
PRELIMINARY

FIG. 16

PRELIMINARY

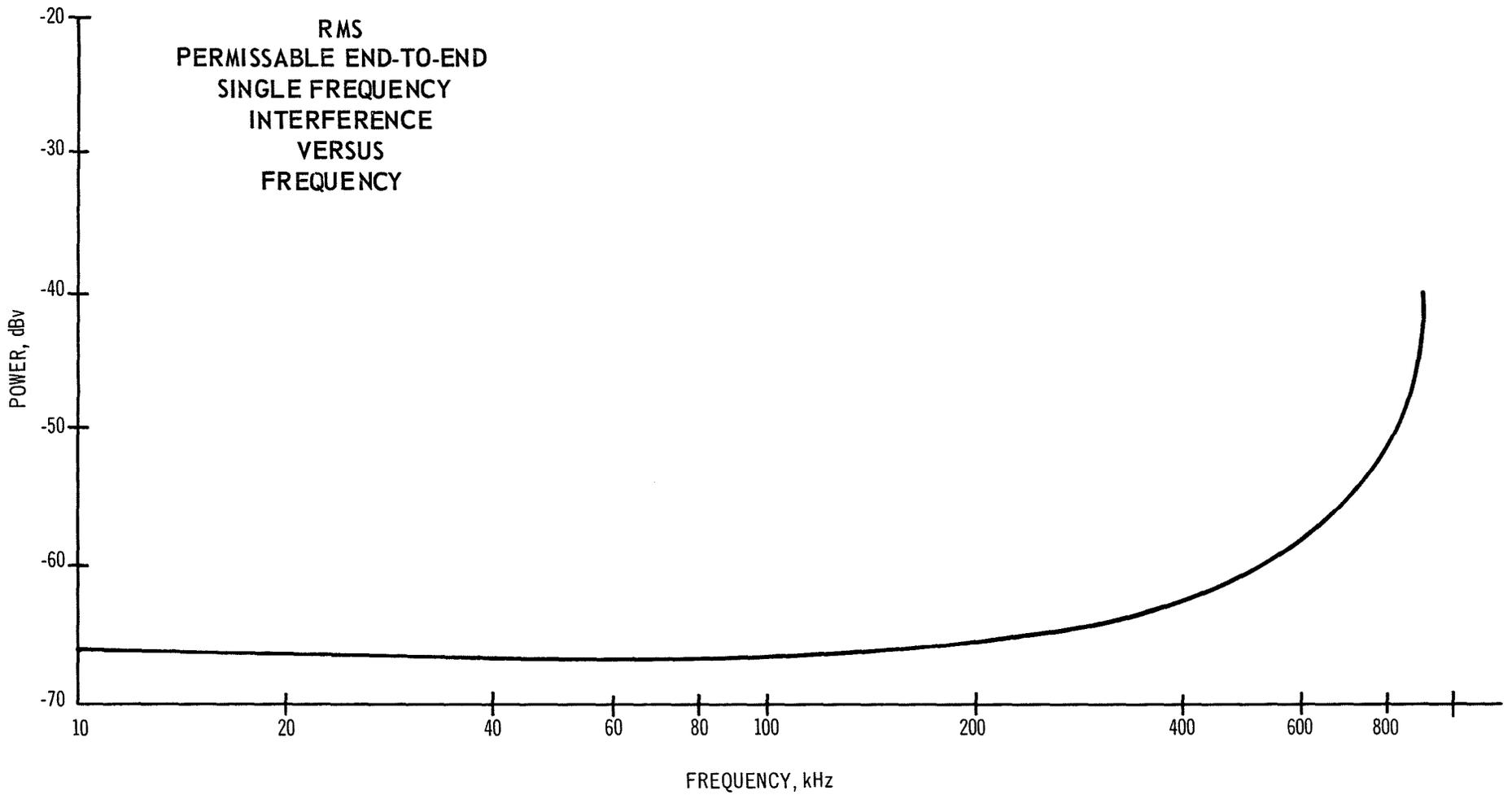


GAIN VARIATION  
FIG. 17



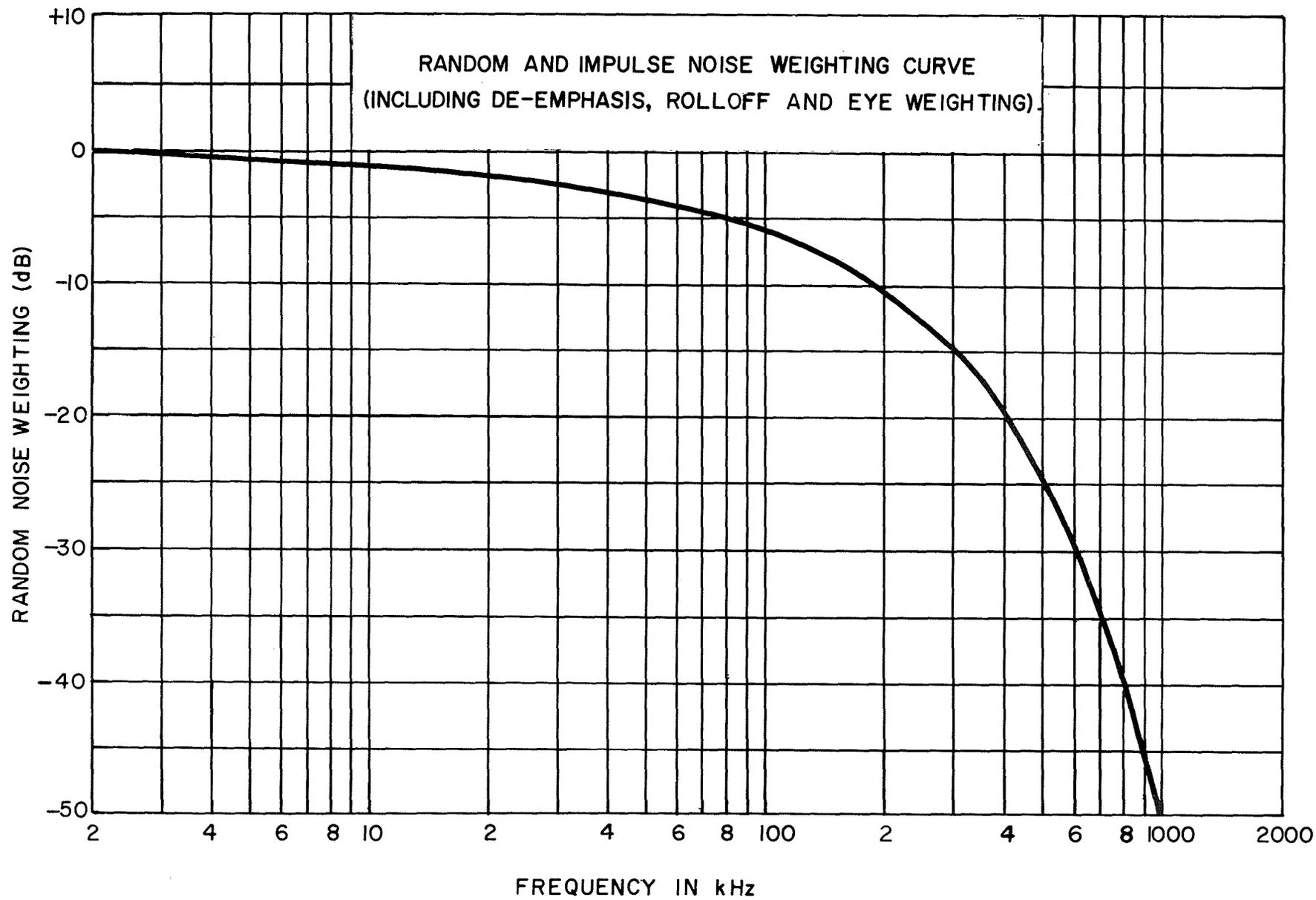
PRELIMINARY

FIG. 18



PRELIMINARY

**FIG. 19**



PRELIMINARY

FIG. 20