PUB 42108

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Voice Connecting Arrangement

FTP

Interface Specification

April 1974

ENGINEERING DIRECTOR – CUSTOMER EQUIPMENT SYSTEMS

PRELIMINARY

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TECHNICAL REFERENCE

VOICE CONNECTING ARRANGEMENT FTP

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VOICE CONNECTING ARRANGEMENT FTP

1. GENERAL

1.1 Introduction

F.C.C. tariffs and corresponding intrastate tariffs filed by the Bell System provide for the electrical connection of customer-provided voice transmitting and receiving terminal equipment and communications systems to the Bell System telecommunications network by means of a connecting arrangement. The connecting arrangement includes circuit elements to provide network control signaling unit functions as well as certain other network protection functions and is furnished, installed, and maintained by the Telephone Company. In addition, the tariffs require compliance by the customer-provided equipment with network protection criteria specified therein.

1.2 Application

Voice Connecting Arrangement FTP provides a means of connecting a customer-provided source of music or recorded information to the Music-On-Hold and/or Background-Music-Over-Paging features of the Telephone Company-provided Com Key® 718 and Com Key® 1434 Communications Systems.

In the Com Key 718 and 1434 Communications Systems equipped with the Music-On-Hold feature, the music or recorded announcement will be transmitted to the distant party automatically when the line is placed on hold. For systems equipped with the paging features, background music or announcements can be applied when the system is not in use for paging. The customer-provided source of music or announcement must be in continuous operation as the connecting arrangement does not provide a start signal when a line is placed on hold.

1.3 Ordering and Identification

The protective connection service described in this Technical Reference is identified by the Bell System as Voice Connecting Arrangement FTP. One connecting arrangement should be ordered for each Com Key 718 or 1434 Communications System. In addition, an order should be placed for the Music-On-Hold and/or Paging features of the Telephone Company-provided Com Key 718 or 1434 Communications System. The local Telephone Company business office or Marketing representative will provide information regarding availability and rates for this service.

2. DESCRIPTION

2.1 Functions

The major functions of this protective voice connecting arrangement are:

(a) To protect Telephone Company personnel and equipment from hazardous voltages which may be applied by the customer-provided equipment.

(b) To provide access to the telecommunications network and/or loudspeaker paging for customer-provided music or information source.

(c) To limit abnormally high signal voltages from the customer-provided equipment.

(d) To provide sufficient coupling loss between lines connected to a common music source to insure privacy while on hold.

2.2 Physical

The voice connecting arrangement consists essentially of a voice coupler (see Figure 1) and does not require local power. The wall mounted coupler is approximately 4 inches wide, 2-3/4 inches high, 1-5/8

inches deep, and weighs approximately 1/2 pound. It will operate over a temperature range from 0° to 55° C and a humidity range from 5 to 95 percent.

2.3 Interface Leads

Two interface leads, CT and CR, are terminated externally on screw terminals (see Fig. 1). The customer must connect the output of his music or announcement source to these terminals. Loop resistance of the CT and CR leads between the connecting arrangement and the customer-provided equipment shall not exceed 50 ohms.

3. OPERATION

3.1 Music-On-Hold

An incoming or outgoing call is handled in the normal manner for a Bell System key telephone set. When the "Hold" button is depressed, the customer-provided source of music or announcement is automatically connected to the line which has been placed on hold. Since the protective connecting arrangement does not provide a start signal to the customer-provided equipment, the customer-provided equipment must be in a continuously operating mode.

When the hold bridge is removed by depressing the associated pick-up key with the handset off-hook, the customer-provided source of music or announcement is disconnected from the line.

3.2 Background Music-Over-Paging

Background music or announcements can be applied from the continuously operating customer-provided music or announcement source. Requirements for switching from music to announcement or vice-versa shall be incorporated in the design of the customer-provided equipment.

The paging feature of the Com Key 718 or 1434 Communications System, when in use, takes precedence over the customer-provided source and temporarily cuts it off. It is reconnected automatically when paging is completed.

4. SPECIFIC DESIGN CONSIDERATIONS

4.1 Transmission Path (leads CT and CR)

4.11 Impedance

The impedance of Voice Connecting Arrangement FTP is a function of the connection between the arrangement, the input circuits of Com Key 718 or 1434, and the central office line. For design purposes, the inband impedance of this voice connecting arrangement shall be considered to be 8 ohms. DC resistance is approximately 1 ohm.

4.12 DC Signals and Power

The customer's equipment should not present dc current greater than .6 ma on the CT and CR leads into the protective voice connecting arrangement. The voice coupler in the arrangement is a transformer-input device, and dc current above this level may cause distortion of the voice signal. The customer-provided source should provide an ac input to the connecting arrangement.

4.13 Bandwidth

The nominal voice-frequency bandwidth of the telecommunications network extends from about 300 to 3000 Hz. In general, an end-to-end connection may be expected to have a loss characteristic which increases on either side of this band.

4.14 Signal Power Levels

The tariffs state that the average power (in any 3-second interval) delivered at the central office should not exceed -12 dBm in order to prevent excessive noise and crosstalk from interfering with other services. Because of the additional loss required to provide privacy, in this case an exception is made to the limit given in the tariffs; the maximum permissible voice signal power at the Interface Terminals for Voice Connecting Arrangement FTP is 1 dB below one watt (+29 dBm) when averaged over any 3-second interval. To meet this specification the maximum available power from a customer-provided 8 ohm source when averaged over any 3-second interval (measured at the CT and CR leads with a 8 ohm load substituted for the connecting arrangement) should not exceed 1 dB below 1 watt (+29 dBm). This limit has been set so that when the average loss of loops in the Bell System are considered (including the insertion loss of the voice connecting arrangement), the limit of -12 dBm at the local central office will be met.

Voice Connecting Arrangement FTP, acting in concert with the input arrangement of Com Key 718 or 1434, has sufficient attenuation to insure privacy between any two calling parties that are connected to a common music or recorded information source. The isolation between customers can be expressed in terms of the loss from the calling party terminals of one voice connecting arrangement to the calling party terminals of any other voice connecting arrangement. This loss when measured across 900 ohms at 1000 Hz is approximately 80 dB.

4.15 Measuring Maximum Available Inband Power

The measuring methods described below are satisfactory for estimating the maximum power averaged over a 3-second interval to determine that the inband signal power criteria specified in paragraph 4.14 is being met.

Method A

Operate the customer-provided equipment into an 8 ohm load in parallel with a series combination of 2000 ohms and 900 ohms, as shown in Figure 3 (this assumes that the customer-provided equipment has an 8 ohm source impedance). The 900 ohm resistor should be 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 ensure a proper measurement technique, the control settings on these meters should be as shown below.

Western Electric 3-Type Noise Measuring Set		Hewlett-Packard Transmission and Noise Measuring Set Model 3555B	
Control	Setting	Control	Setting
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)	3k Hz FLAT
		NORM/DAMP (Switch)	DAMP

In almost all cases, the speech or music power averaged over any 3-second interval will not exceed 1 dB below one watt (+29 dBm) if the maximum meter swing does not exceed 93 dBrn.

*These meters do not have a 3-second averaging time, but when used to measure speech they give a reliable estimate of a 3-second average. The use of meters with shorter time constants, such as VU meters or voltmeters, is not recommended.

Method B

The accuracy of Method A can be somewhat improved by increasing the size of the damping capacitance in the Western Electric 3-Type Noise Meter 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 nearly approximate a 3-second averaging meter. (NOTE: This modification does not necessarily hold for the Model 3555B or noise meters other than the Western Electric 3-Type.) With the additional damping, the power averaged over any 3-second interval will not exceed 1 dB below one watt (+29 dBm) if the maximum meter swing does not exceed 91 dBrn.

4.16 Signal Power Distribution

The telecommunications network incorporates tone signaling devices that are used for interoffice network control functions. These devices, which are connected at all times to the telephone circuit, are designed to detect a single frequency tone at 2600 Hz. They are, however, relatively insensitive to energy at this frequency if sufficient energy is present at the same time in 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 signal applied by the customer-provided equipment to the voice connecting arrangement 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.

If music is applied by the customer-provided equipment, it could at times have energy solely in this band of frequencies. To prevent interference to network control signaling functions, the customer-provided equipment, when applying music, should preferably include a 2600 Hz band elimination filter with the following minimum attenuation characteristics relative to 1000 Hz:

(a) 25 dB loss at 2600 Hz

(b) 15 dB loss at any other frequency in the band from 2500 to 2700 Hz.

A possible alternative to the use of a filter to limit power in the 2450 to 2750 Hz band is to set the music power at the Interface Connecting Block so that it does not exceed 18 dB below the maximum permissible voiceband power (i.e., it does not exceed +11 dBm), when averaged over any 3-second interval. This alternative does not insure compliance with the protection criteria, and does not remove the customer's responsibility to meet the protection criteria prescribed in the tariffs and as outlined in Paragraph 4.14 of this Technical Reference. It does provide a simplified method which may provide satisfactory performance on many types of music. If used, its effectiveness should be checked by using the actual signals supplied.

The above requirement applies to Music-On-Hold only.

4.17 Out-of-Band Signal Power Limits

To protect other services, it is necessary that the signal, which is 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 not exceed 18 dB below the specified maximum inband signal power.

(b) The power in the band from 4005 Hz to 10,000 Hz shall not exceed +26 dBm.

(c) The power in the band from 10,000 Hz to 25,000 Hz shall not exceed +18 dBm.

(d) The power in the band from 25,000 Hz to 40,000 Hz shall not exceed +6 dBm.

(e) The power in the band above 40,000 Hz shall not exceed -8 dBm.

The limits exceed the out-of-band limits normally specified because of the insertion loss of the equipment between the input to Voice Connecting Arrangement FTP and the input to the line to the central office, which will be at least 42 dB.

4.18 Signal Limiting

A voice signal limiter is incorporated in the transmission path of the connecting arrangement to protect the telecommunications network from applications of abnormally high signal levels. This has no effect on normal voice or normal tone address signal levels. This limiter does not abrogate the customer's responsibility to meet the network protection criteria, as prescribed in the tariffs and as outlined in Paragraph 4.14.

4.2 Grounding

Voice Connecting Arrangement FTP is normally floating (ungrounded). In the event that a fuse in the customer's input side of the protective connecting arrangement operates, due to a fault or overload, a signal ground is provided to operate the fuse in the other side of the line (Fig. 2).

Both leads toward the connecting arrangement will be grounded and the connecting arrangement will present an open circuit to the customer-provided equipment. The general grounding requirements for the customer-provided equipment are covered in Paragraph 5.2.

5. GENERAL DESIGN CONSIDERATIONS

5.1 Foreign and Surge Voltage Protection

Where telephone lines are exposed to power line contact, lightning induction, or a rise in ground potential exceeding 300 volts, protective devices are installed at the central office and on the customer's premises. Typically, these devices will provide a path to ground for foreign voltages that exceed about 600 volts peak. Since the customer's equipment is connected to the telephone line through the voice connecting arrangement, the customer's equipment is protected from any resulting longitudinal surges. Residual metallic surges on the transmission leads due to foreign potentials will be limited by the protective connecting arrangement to no greater than 30 volts.

The customer is responsible for providing protection, internal to his equipment and facilities, against foreign and hazardous voltages from his equipment and facilities being applied to the voice connecting arrangement.

5.2 Grounding

It is expected that the customer's equipment, if powered from commercial power, will be grounded in accordance with applicable electrical codes, e.g., National Electrical Code (NEC), and should be bonded to the ground electrode to which the telephone protector is grounded but not using the telephone ground clamp. Self-powered or passive customer's equipment need not be grounded. Provisions should be made

within the customer's equipment for connecting together all internal signal grounds. 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 signal ground may be obtained with a proper connection to a metallic cold water pipe, using a single No. 14 AWG, or larger copper conductor. The other end should be connected to the ground return terminal of the customer's equipment. The run should be short, straight, and a continuous piece of wire. Proper attention should be given to providing the lowest possible resistance connection at each end of the circuit. It is imperative that this ground be connected at the same location to the water piping system or ground electrode as the telephone protector or signal ground lead but not using the Telephone Company ground clamp. This lead shall not be fused.

5.3 Telecommunications Network Characteristics

5.31 End-to-End Electrical Loss

The end-to-end electrical loss of a connection is a function of the impedances of both end terminations and the losses of the interoffice trunks, the serving central offices, and the facilities to the serving offices. The information found in the REFERENCES in Appendix B may be used to determine statistical loss distributions for different types of calling patterns on the telephone network.

5.32 Nonlinearities

Nonlinearities such as compression, clipping, phase shift, and harmonic distortion can exist on the telecommunications network. Normally, these are insignificant for speech transmission. It is expected that harmonic distortions will result in single tones which are no greater than about 5% of the fundamental.

6. SERVICE AND MAINTENANCE CONSIDERATIONS

6.1 Responsibility of the Customer

The tariffs regulating the connection to the telecommunications network by means of connecting arrangements of customer-provided terminal equipment or communications systems state that where long distance message telecommunications service is available under these tariffs for use in connection with customer-provided terminal equipment or communications systems, the operating characteristics of such equipment or systems 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 equipment or systems provided by a customer do not endanger the safety of Telephone Company employees or the public; damage, require change in or alteration of, the equipment or systems or other facilities of the Telephone Company; interfere with the proper functioning of such equipment or systems or facilities; impair the operation of the telecommunications network, or otherwise injure the public in its use of the Telephone Company's services. Upon notice from the Telephone Company that the equipment or system provided by a customer is causing or is likely to cause such hazard or interference, the customer shall take such steps or make such change as shall be necessary to remove or prevent such hazard or interference.

6.2 Responsibility of the Telephone Company

The tariffs regulating the connection to the telecommunications network by means of connecting arrangements of customer-provided terminal equipment and communications systems state that the Telephone Company shall not be responsible for the installation, operation or maintenance of said terminal equipment or communications systems. Long distance message telecommunications service is not represented as adapted to the use of customer-provided equipment or systems and where such equipment or systems are connected to Telephone Company facilities, the responsibility of the Telephone Company shall be limited to the furnishing of facilities, including the protective connecting arrangements and network control signaling units, suitable for long distance message telecommunications service and to the maintenance and operation of such facilities in a manner proper for such services. 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 systems or for the quality of, or defects in, such transmission, (ii) the reception of signals by customer-provided equipment or systems, or (iii) address signaling where such signaling is performed by customer-provided tone-type signaling equipment. The Telephone Company shall not be responsible to the customer 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 facilities obsolete or require modification or alteration of such equipment or systems or otherwise affect its use or performance.

6.3 Trouble Reporting Procedure

When trouble is experienced with this service, the customer should perform the necessary testing at the interface to sectionalize the difficulty, i.e., determine whether the service impairment is located 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. The Telephone Company's repair attendant should be given:

(a) Customer's name

(b) Customer's address

(c) Listed telephone number

(d) Description of the trouble

(e) Uniform Service Order Code (USOC) FTP

(f) Customer's contact for additional information

If a Telephone Company service call to the customer's premises results in the location of the trouble in the customer-provided equipment, the customer will be charged for the service call.

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APPENDIX A

GLOSSARY

ADDRESS SIGNALS - denotes dc dial pulses or appropriate pairs of tone signals transmitted to a central office that represent the telephone number of the distant party.

COMMUNICATIONS SYSTEM - 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 - protective equipment provided by the Telephone Company to accomplish the electrical connection of customer-provided equipment with the telecommunications network.

CUSTOMER - the term "Customer" denotes the person, firm or corporation which orders service and is responsible for the payment of charges and compliance with Telephone Company regulations.

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.

DIAL PULSE RATE - repetition of pulses for switching purposes, usually expressed in pulses-per-second.

INTERDIGITAL TIMING - the minimum time required between digits for the switching equipment to respond to the last digit received and ready itself for receiving the next digit.

INTERFACE TERMINALS - the Telephone Company-provided connecting point to which the customer brings and connects the wire or cable from his equipment to the protective voice connecting arrangement.

NETWORK CONTROL SIGNALING - denotes 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 reorder 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 - denotes the terminal equipment furnished, installed, and maintained by the Telephone Company for the performance of network control signaling. (See Note below.)

OFF-HOOK SUPERVISION - the conditioning of the CT and CR leads by the customer-provided equipment which indicates a customer's telephone is answering or originating a call.

ON-HOOK SUPERVISION - the conditioning of the CT and CR leads by the customer-provided equipment which indicates that the customer's telephone has disconnected or that the equipment is idle.

PERCENT BREAK - the period of time of an open interval in a dial pulse sequence compared to the total time of an open and closed interval, expressed as a percentage.

NOTE: Under the tariff regulations, the terms "connecting arrangement" and "network control signaling unit" are separate and distinct from each other; however, the term "connecting arrangement" is generally used to include the functions of network control signaling.

SUPERVISORY SIGNALS - signals used to initiate a request for service by the calling party (off-hook); to notify the called party that he is being called (ringing); to indicate an answered call (off-hook); to indicate a disconnect (on-hook); and to recall an operator or distant party to a connection (switchhook flash).

TALKING BATTERY - direct current supply typically used to energize carbon transmitters in telephone sets.

TELECOMMUNICATIONS NETWORK - the central office switching equipment, associated interoffice and intraoffice facilities, and terminal equipment which provide Long Distance Message Telecommunications Service or private line service.

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

TONE ADDRESS SIGNALS - signals generated by customer-provided equipment for dialing into Bell System TOUCH-TONE equipped switching equipment.

VOICE CONNECTING ARRANGEMENT - a protective connecting arrangement designed to transmit speech signals as contrasted to one designed to transmit data signals.

PRELIMINARY

APPENDIX B

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) Gresh, P. A., "Physical and Transmission Characteristics of Customer Loop Plant," BSTJ, Vol. 48, No. 10 (December 1969), p. 3337.

*(c) Breen, C., and Dahlbom, C. A., "Signaling Systems for the Control of Telephone Switching," BSTJ, Vol. 39, No. 6 (November 1960), p. 1381.

*(d) Bodle, D. W., and Gresh, P. A., "Lightning Surges in Paired Telephone Cable Facilities," BSTJ, Vol. 40, No. 2 (March 1961), p. 547.

**(e) Bell System Data Communications Technical Reference - PUB 41007 - 1969-1970 Switched Telecommunications Network Connection Survey (Reprints of Bell System Technical Journal Articles) - April 1971.

***(f) "Principles of Electricity Applied to Telephone and Telegraph Work," by American Telephone and Telegraph Company, New York, New York.

***(g) "Switching Systems," by American Telephone and Telegraph Company, New York, New York.

(h) "Notes on Transmission Engineering," by United States Independent Telephone Association, Washington, D. C.

***(i) "Transmission Systems for Communications," by Bell Telephone Laboratories, Inc.

***(j) "Notes on Distance Dialing - 1968," by American Telephone and Telegraph Company, New York, New York.

*These journals may be purchased by writing to:

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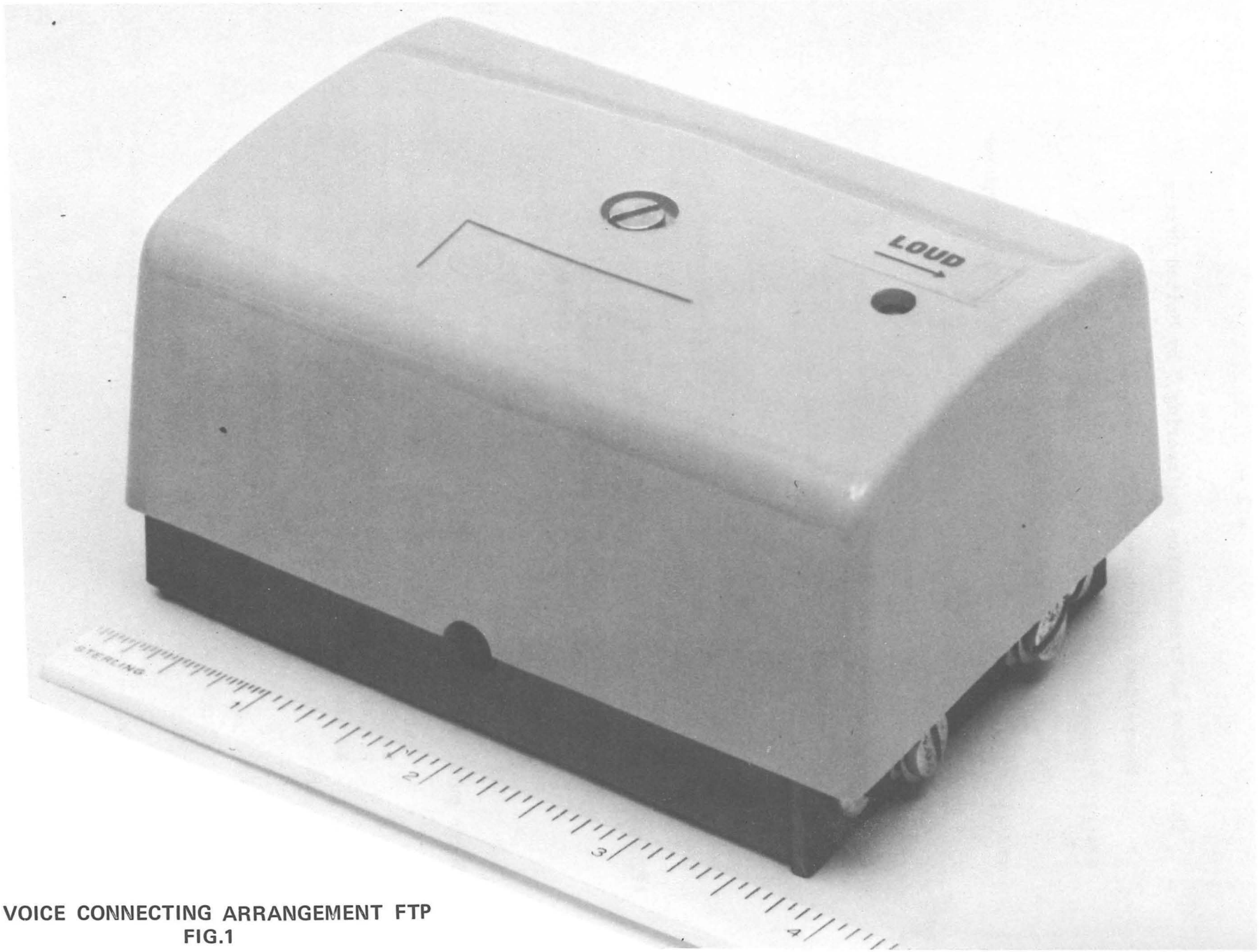
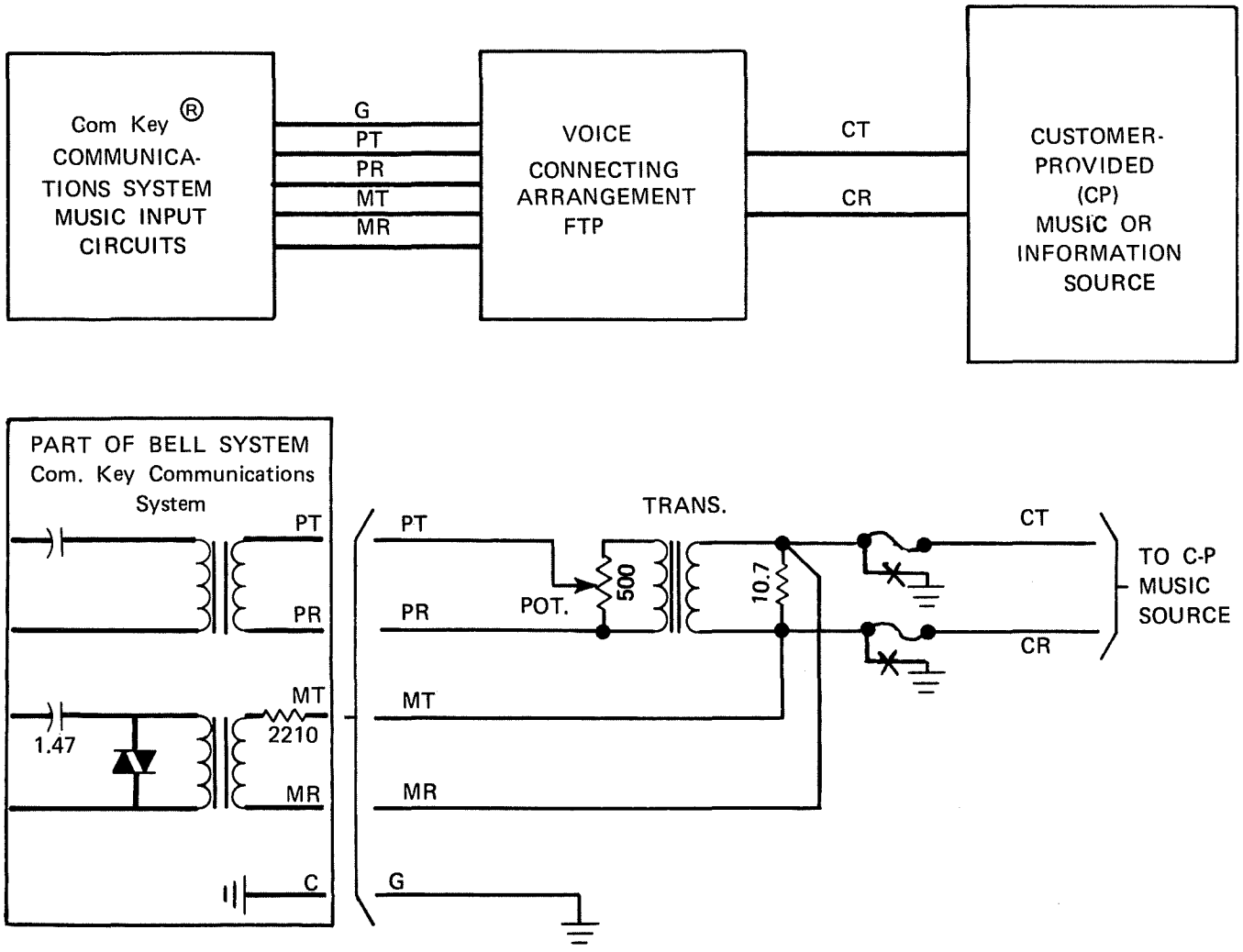
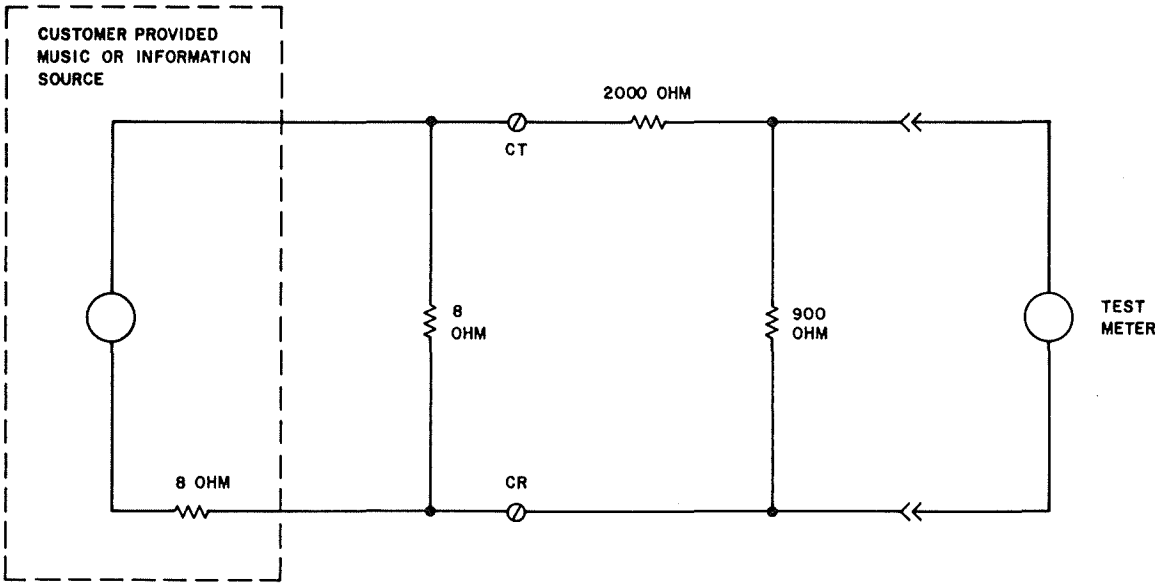


VOICE CONNECTING ARRANGEMENT FTP
FIG.1

PRELIMINARY



BLOCK DIAGRAM AND SIMPLIFIED SCHEMATIC
VOICE CONNECTING ARRANGEMENT FTP
FIG. 2



SCHEMATIC FOR POWER MEASUREMENT
FIG. 3