PUB 42109

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Protective Connecting Arrangement

FTM

Interface Specification

November 1975

ENGINEERING DIRECTOR – CUSTOMER EQUIPMENT SYSTEMS

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PRELIMINARY

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TECHNICAL REFERENCE

PROTECTIVE CONNECTING ARRANGEMENT FTM

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PRELIMINARY

PROTECTIVE CONNECTING ARRANGEMENT FTM

1. GENERAL

1.1 Introduction

F.C.C. tariffs and corresponding intrastate tariffs filed by the Bell System Companies 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 protective 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

Protective Connecting Arrangement FTM provides a means by which a customer-provided source of music or recorded information may be connected to the Music-On-Hold feature of a Telephone Company-provided key telephone system.

The music or recorded announcement will be transmitted to the distant party automatically when the line is placed on hold. 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.

When a start signal is required, Protective Connecting Arrangement LVH may be specified. This arrangement is described in Technical Reference - Voice Connecting Arrangement LVH - PUB 42105.

When a customer-provided source of music or recorded information is to be connected to both the Music-On-Hold and Background-Music-Over-Paging features or to only the Background-Music-Over-Paging feature of the Telephone Company-provided Com Key® 718 and Com Key® 1434 Communications Systems, Protective Connecting Arrangement FTP may be specified. This arrangement is described in Technical Reference - Voice Connecting Arrangement FTP - PUB 42108.

1.3 Ordering and Identification

The protective connection service described in this Technical Reference is identified by the Bell System as Uniform Service Order Code (USOC) FTM. One connecting arrangement should be ordered for each customer-provided source of music or recorded information to be connected to the key telephone system. In addition, an order must be placed for the Music-On-Hold feature of the Telephone Company-provided key telephone system. The local Telephone Company business office or marketing representative will provide information regarding availability and rates for these services.

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2. DESCRIPTION

2.1 Functions

The major functions of this protective connecting arrangement and the circuitry used to provide the Music-On-Hold feature in a key telephone system are:

(a) To prevent the introduction to the telecommunications network of hazardous voltages which could cause harm to Telephone Company personnel and/or facilities.

(b) To provide isolation against longitudinal imbalance.

(c) To provide access to the telecommunications network for a customer-provided music or information source.

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

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

(f) To prevent interference by the customer-provided equipment with the network control signaling functions of the key telephone system.

2.2 Physical

The protective connecting arrangement consists essentially of fuse protection and impedance matching which does not require local power. The wall mounted coupler (see Figure 1) is approximately 4 inches wide, 2-1/2 inches high, 2 inches deep, and weighs approximately 1/2 pound.

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.

3. OPERATION

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.

4. SPECIFIC DESIGN CONSIDERATIONS

4.1 Transmission Path (Leads CT and CR)

4.11 Impedance

The impedance of Protective Connecting Arrangement FTM is a function of the input circuits to the key telephone system and the central office lines. For design purposes, the inband impedance of this connecting arrangement should be considered to be 8 ohms. DC resistance is also approximately 8 ohms.

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 connecting arrangement. The input circuits of the key telephone system are transformer-input devices, 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 the Music-On-Hold circuitry, the maximum permissible voice signal power at the Interface Terminals for Protective Connecting Arrangement FTM 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 an 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 is considered (including the insertion loss of the protective connecting

arrangement and Music-On-Hold circuitry), the limit of -12 dBm at the local central office will be met.

Protective Connecting Arrangement FTM, acting in concert with the input arrangement of the key telephone system, 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 input arrangement to the calling party terminals of any other input 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 are 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.

*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 standard voltmeters, is not recommended.

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.

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 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 the 2450 to 2750 Hz 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 connecting arrangement 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.

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.

These limits specified at the Telephone Company-customer-provided equipment interface are consistent with the out-of-band limits specified in the tariffs because the insertion loss of the equipment between the input to Protective Connecting Arrangement FTM and the input to the line to the central office will be at least 42 dB.

4.18 Signal Limiting

A voice signal limiter is incorporated in the transmission path of the Music-On-Hold circuitry to protect the telecommunications network from applications of an abnormally high signal level. 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

Protective Connecting Arrangement FTM is normally balanced to ground as shown in Figure 2. In the event that a fuse in the customer's input side of the protective connecting arrangment operates, due to a fault or overload, a signal ground is introduced on that path to the Bell System key telephone equipment. The connecting arrangement also provides protection via the fuses if both the CT and CR leads are floating at a hazardous potential. This is accomplished by providing the 8.04 ohm load impedance for the music source with its center point connected to signal ground. 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 exposure, power line induction, or a rise in ground potential exceeding 300 volts RMS, protective devices are installed at the central office and on the customer's premises that will provide a path to ground for foreign voltages that exceed about 600 volts peak.

The manufacturer is responsible for designing his equipment and facilities in such a way that foreign and hazardous voltages from his equipment and facilities are not applied to the protective 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. 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. 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 RESPONSIBILITIES

6.1 Responsibility of the Manufacturer

The manufacturer of the terminal equipment is responsible for the following:

(a) Informing the purchaser as to which protective connecting arrangement his equipment has been designed to work with.

(b) Advising the purchaser to order this protective connecting arrangement by code FTM from the Telephone Company and order the Music-On-Hold feature for the Telephone Company-provided key telephone system.

(c) Providing information to the purchaser that specifies installation, operational, routine maintenance, and repair procedures which, if properly employed by the purchaser, will assure compliance with this Technical Reference.

(d) All patent or other liability arising out of the use, offering or distribution of such equipment by or to them.

6.2 Responsibility of the Customer

The tariffs regulating the connection of customer-provided terminal equipment or communications systems through connecting arrangements to the telecommunications network state that 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 as shall be necessary to remove or prevent such hazard or interference.

The customer desiring to use customer-provided equipment is responsible for the following:

(a) Informing the Telephone Company of his intention to use such a device and ordering the protective connecting arrangement by code FTM and order the Music-On-Hold feature for the Telephone Company-provided key telephone system.

(b) Connecting the equipment to the interface terminals.

(c) Assuring that the equipment in use continues to comply with all the requirements of the applicable tariffs and this Technical Reference.

(d) Following the installation, operational, routine maintenance, and repair procedures specified by the manufacturer.

(e) Removing the device from use if the customer detects that it is defective or if the Telephone Company notifies the customer that the equipment is causing a hazard or interference as specified above.

6.3 Responsibility of the Telephone Company

The Telephone Company shall not be responsible for the installation, operation or maintenance of any customer-provided terminal equipment. Long distance message telecommunications 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 telecommunications service and to the maintenance and operation of such facilities in a manner proper for such telecommunications 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 for the quality of, or defects in, such transmission, (ii) the reception of signals by customer-provided equipment, 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 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.

7. MAINTENANCE OF SERVICE

Maintenance of equipment supplied by the Telephone Company shall be done only by the Telephone Company.

When trouble is experienced with this service, the customer should disconnect the terminal equipment to determine whether the service impairment is located in the customer-provided equipment or in the equipment provided by the Telephone Company. If the terminal equipment is determined to be defective, the customer shall immediately discontinue its use until such time as the customer has it repaired. If the tests indicate that the trouble is in the Telephone Company-provided equipment, a trouble report should be promptly referred to the Telephone Company's "Repair Service" whose number can be found in the front of the telephone directory. The 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) FTM

(f) Customer's contact for additional information

The customer shall be responsible for the payment of a service charge for visits by the Telephone Company to the customer's premises where the service difficulty or trouble report results from the use of customer-provided equipment.

PRELIMINARY

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.

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 of his equipment to the protective 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 interface leads by the customer-provided equipment which indicates that it has disconnected and 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.

PROTECTIVE CONNECTING ARRANGEMENT - protective equipment provided by the Telephone Company to accomplish the electrical connection of customer-provided equipment with the telecommunications network. It is designed to transmit speech signals as contrasted to one designed to transmit data signals.

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 initate 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).

TELECOMMUNICATIONS NETWORK - 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.

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 - 1975," by American Telephone and Telegraph Company, New York, New York.

*These journals may be purchased by writing to:

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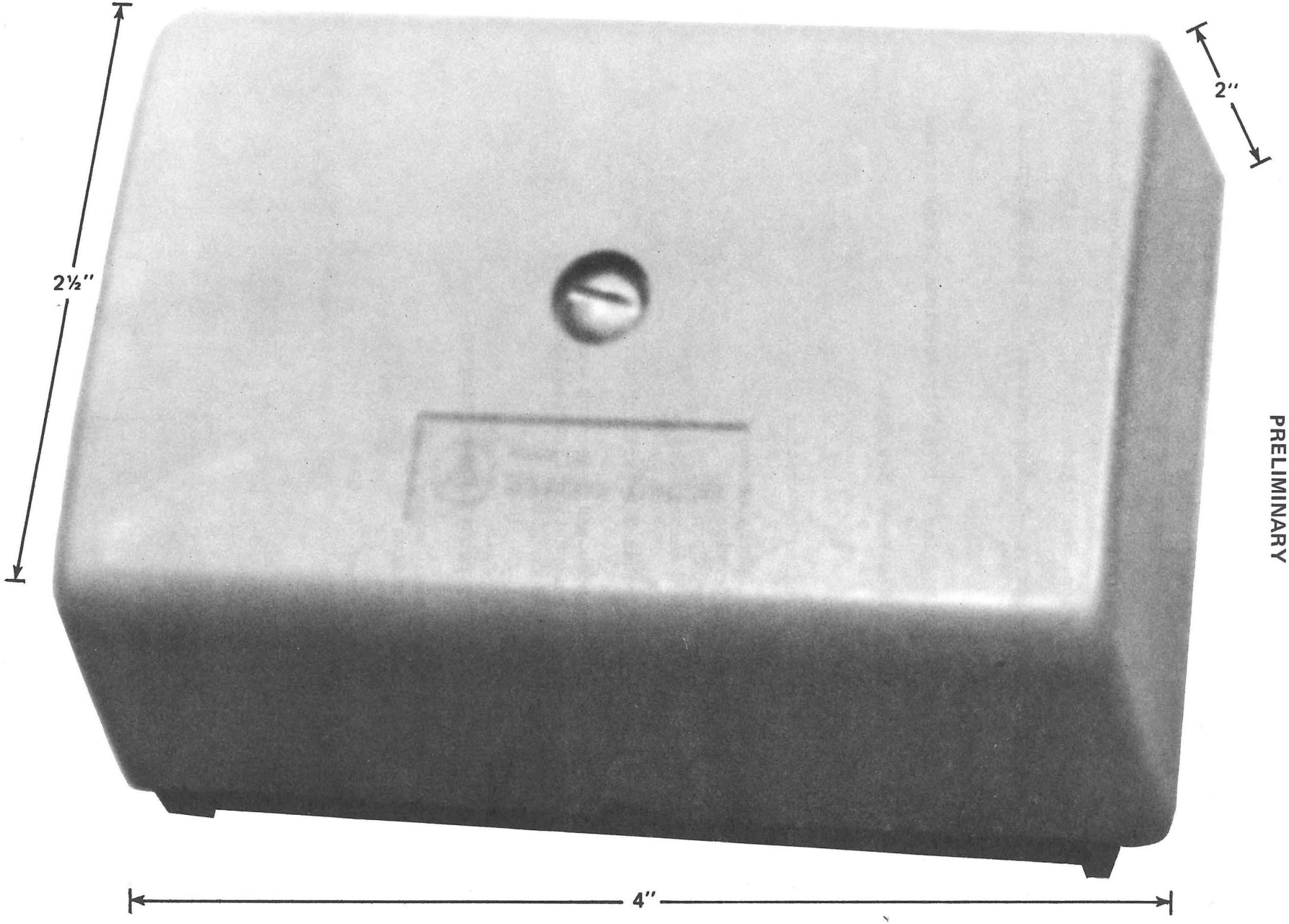
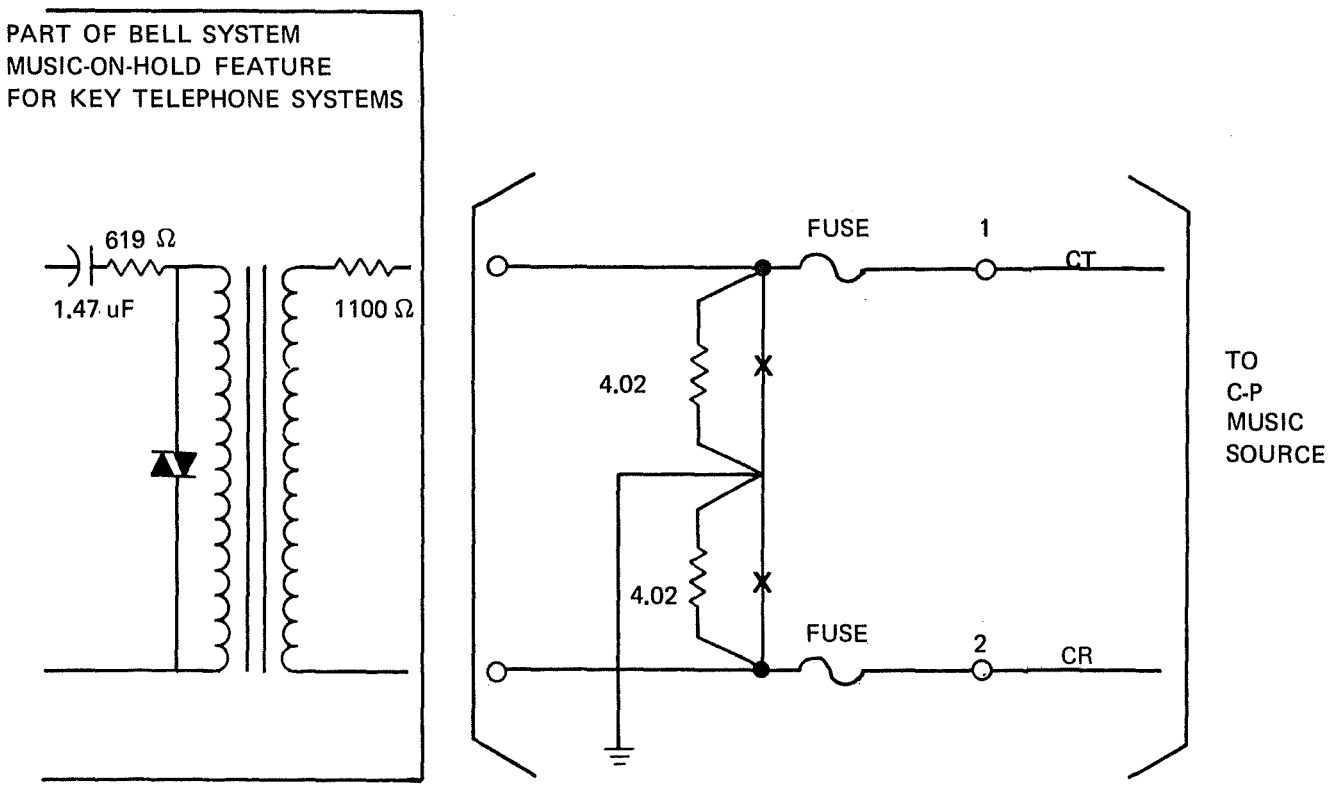


PRELIMINARY

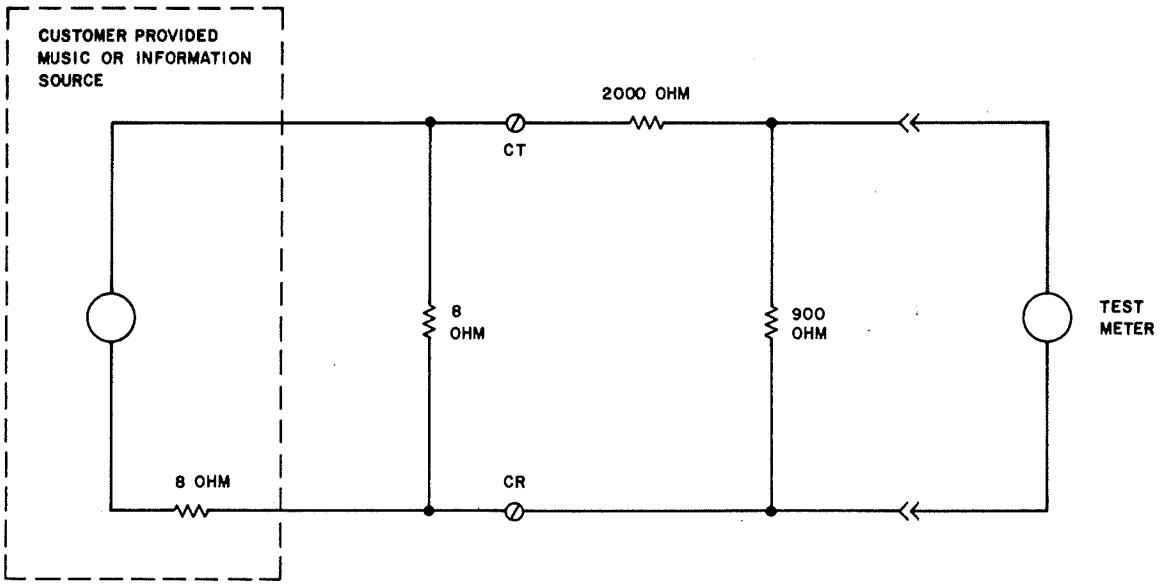
PROTECTIVE CONNECTING ARRANGEMENT FTM
FIG. 1



X INDICATES NORMALLY OPEN CONTACT

SIMPLIFIED SCHEMATIC
PROTECTIVE CONNECTING ARRANGEMENT FTM

FIG. 2



SCHEMATIC FOR POWER MEASUREMENT
FIG. 3