

PRELIMINARY

**Bell System Voice Communications
TECHNICAL REFERENCE**

**Voice
Connecting
Arrangements**

CDQ2W

CDQ2X

**Interface
Specification**

June 1971

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS



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NOTICE

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TECHNICAL REFERENCE

VOICE CONNECTING ARRANGEMENTS CDQ2W AND CDQ2X

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1. GENERAL

1.1 Introduction

F.C.C. tariffs and corresponding intrastate tariffs filed by the Bell System provide for the direct electrical connection of customer-provided voice transmitting and receiving terminal equipment and communications systems to Bell System private line facilities. The tariffs also provide for the indirect (acoustic or inductive) connection of such equipment or systems. Both methods require compliance with network protection criteria given in the tariffs.

Direct electrical connection is made through a voice connecting arrangement and associated signaling unit furnished, installed, and maintained by the Telephone Company.

1.2 Application

Voice Connecting Arrangements CDQ2W and CDQ2X are two of a series of voice connecting arrangements which provide for the direct electrical connection of customer-provided equipment, or systems, to Telephone Company private line facilities. These arrangements provide a 2-wire voice transmission interface with the Telephone Company providing the channel signaling. Typically, they will be used for two-way dial repeating tie lines to a customer-provided PBX (See Fig. 4 and 7). These arrangements provide a Type I interface as defined in the Transmission Engineering Technical Reference "Private Line Interconnection - Voice Applications" dated June 1970 (See Appendix C). This Technical Reference should be consulted for general information on private line services.

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Voice Connecting Arrangement CDQ2W provides a contact type signaling interface for two-way dialing and answer/disconnect supervision over two pair of leads. Voice Connecting Arrangement CDQ2X provides an E and M lead (one pair of signaling leads plus signal ground) type of interface for these functions.

Voice Connecting Arrangements C2Q2W and CDQ2X and the associated private line channel provide a means of transmitting voice, dialing, and answer/disconnect signals from one PBX to another. The facility signaling system associated with the private line connected to these connecting arrangements will permit simultaneous two-way signaling.

In designing a tie line network, the requirements of the terminal signaling equipment must be considered to insure system compatibility. The requirements for terminal supervision signals, i.e., timing and other parameters, are a function of the type trunk circuit and the requirements of the switching system with which it is associated.

When the distant end of the private line is terminated in a Telephone Company-provided PBX, close coordination between the customer and the Telephone Company will be required to insure end-to-end compatibility of the terminal signaling and supervision circuits. The requirements for dial pulse signals to Bell System switching equipment are discussed in Paragraph 4.3. These arrangements are not offered for use in transmitting data signals.

1.3 Ordering and Identification

The connection services described in this Technical Reference are identified by the Bell System as Voice Connecting Arrangements CDQ2W and CDQ2X. One voice connecting arrangement should be ordered for each tie trunk which is to be connected to the customer-provided equipment. The local Telephone Company business office or Marketing representative will provide information regarding availability and rates for these services.

2. DESCRIPTION

2.1 Functions

The major functions of these voice connecting arrangements are:

- (a) To protect Telephone Company personnel and facilities from potentially hazardous voltages which may be applied to the voice connecting arrangement.
- (b) To provide longitudinal isolation.
- (c) To provide voice transmission to and from Telephone Company private line facilities.
- (d) To limit abnormally high voice signal levels to the private line network.
- (e) To receive and transmit supervisory signals between the customer-provided equipment and the facility signaling unit.
- (f) To receive dial pulse signaling from the customer-provided equipment and transmit to the distant end equipment.
- (g) To deliver dial pulse signaling from the distant end equipment to the customer-provided equipment.

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2.2 Physical

Voice Connecting Arrangements CDQ2W and CDQ2X are arranged to be assembled on a standard 23-inch relay rack mounting (Fig. 1). The relay rack will be provided and mounted by the Telephone Company in an appropriate location so that the front and back of this arrangement are accessible for testing and maintenance. Voice Connecting Arrangements CDQ2W and CDQ2X consist of a voice coupler circuit which provides 2-wire voice transmission; a facility signaling circuit to receive and transmit signals over the loop; and a dc signal isolation circuit to provide the signaling interface for seizure, dc dialing, and answer and disconnect supervision. The customer must provide a separately fused 60 ± 0.1 Hz, 117 ± 12 volt ac, fused at 15 amperes grounded outlet for each Bell System -48 volt power supply. The grounded U-blade outlet should not be under control of a switch and must be within reach of the power cord. One power supply will supply up to 12 connecting arrangements.

This arrangement will function satisfactorily within a temperature range of 0° to 55°C and a humidity range from 5 to 95 percent.

2.3 Interface Leads

2.3.1 Voice Connecting Arrangement CDQ2W

Six interface leads (3 pairs) per tie trunk are provided from the Voice Connecting Arrangement CDQ2W to an interface connecting block (see Fig. 2) for the customer's use. Technical information pertaining to these leads is discussed in Section 3 and Paragraph 4.2.

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The leads and their functions are as follows:

<u>Lead Designation</u>	<u>Function</u>
CT CR	Two way voice transmission
CS CG	Outgoing signals (to the connecting arrangement) - seizure, dc dial pulses, answer and disconnect supervision
CBS1 CBS2	Incoming signals (from the connecting arrangement) - seizure, dial pulses, and answer and disconnect supervision from distant end

2.32 Voice Connecting Arrangement CDQ2X

Four interface leads per tie trunk are provided from the Voice Connecting Arrangement CDQ2X to an interface connecting block (see Fig. 5). In addition, one signal ground lead for each group of four connecting arrangements is brought to the interface.

Technical information pertaining to these leads is discussed in Section 3 and Paragraph 4.2.

The leads and their function are as follows:

<u>Lead Designation</u>	<u>Function</u>
CT CR	Two way voice transmission
CTM	Outgoing signals (to the connecting arrangement) - seizure, dial pulses, and answer and disconnect supervision

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CTE

Incoming signals (from the connecting arrangement) - seizure, dial pulses, and answer and disconnect supervision from distant end

CG

Signal ground - one lead per four connecting arrangements installed

2.33 Method of Connection

Leads from Voice Connecting Arrangements CDQ2W and CDQ2X will be terminated on a Telephone Company-provided interface connecting block conveniently located to permit testing, maintenance, trouble isolation, and ease of connection to the customer-provided equipment. The customer must provide and install the conductors and make the necessary connections of his equipment to the voice connecting arrangement at this block.

Typical interface connecting blocks are shown in Fig. 2 and 5. This "quick connect" connecting block utilizes tin plated spring clip terminal strips which accommodate unstripped, polyethelene or polyvinyl chloride (8 mils maximum thickness) insulated conductors of No. 20 to 24 AWG. A Reliable Electric R714B Tool or equivalent is used to press the insulated wire down into the slot. The spring pressure of the clip cuts away the insulation and makes the electrical connection. The Telephone Company will provide strapping clips between the second and third terminals of the block to interconnect the leads. The clips should be removed by the customer's representative when it is necessary to test toward the customer-provided equipment and then replaced to restore the circuit to service.

3. OPERATION

3.1 General

The operational details for Voice Connecting Arrangements CDQ2W and CDQ2X depend on the requirements of the switching system to which they are connected. As described in Paragraph 1.2, these arrangements, along with the associated private line, provide a means of transmitting voice, dialing, and answer/disconnect signals from one PBX to another. The operation described in this Section is typical of many Bell System tie lines. However, exact details of signaling sequence (i.e., timing, start dial signals, etc.) are a function of the terminal signaling equipment. This information must be obtained from the supplier of the terminal signaling equipment.

3.2 Voice Connecting Arrangement CDQ2W

Voice Connecting Arrangement CDQ2W provides a contact type of signaling interface. The operation of the signaling system is "duplex"; that is, signals can be sent simultaneously in both directions without interference.

3.21 Incoming Call from the Distant PBX

When the distant PBX seizes the line connected to Voice Connecting Arrangement CDQ2W, the facility signaling unit detects that seizure and causes the (P) relay in the signal isolation circuit to operate (see Fig. 3). This relay closes a contact (over CBS1 and CBS2 leads) to which the customer-provided communications system must respond by:

- Connecting dial pulse receiving equipment to CBS1 and CBS2
- Return dial tone (if provided) over CT and CR to the distant PBX

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When dialing is completed and the station has answered, the customer-provided equipment must respond by providing a contact closure over the CS and CG leads to operate the (A) relay in the signal isolation unit. This relay, in operating, transmits answer supervision to the distant PBX.

The voice coupler unit provides a 2-wire voice frequency transmission path to the customer-provided equipment over the CT and CR leads. This path is cut through at all times for passing call progress tones (audible ringing, busy, etc.) to the distant end.

3.22 Outgoing Call to the Distant PBX

The customer-provided PBX causes the voice connecting arrangement to seize the tie trunk by providing a contact closure over the CS and CG leads. This contact closure operates the (A) relay in the signal isolation circuit. The facility signaling unit signals the distant PBX resulting in dial tone being returned (when provided) over the CT and CR leads. When dial pulse addressing is used the contact closure on the CS and CG leads should be opened and closed with the dial pulses. This will operate and release the (A) relay in the signal isolation unit and repeat the dial pulses to the distant PBX. When answer supervision is returned from the distant end, it is detected by the facility signaling unit of this arrangement and the (P) relay in the signaling applique unit operates. This relay closes a contact over the CBS1 and CBS2 leads to repeat answer supervision to the customer-provided equipment.

3.23 Disconnection

If the distant end disconnects first, the (P) relay in the signal isolation unit releases, opening the contact closure over the CBS1 and CBS2 leads to the customer-provided equipment which must recognize this as a disconnect signal and open the contact closure over leads CS and CG.

If the customer-provided equipment connected to this arrangement disconnects first, the customer-provided contact closure, over the CS and CG leads, opens and the (A) relay in the signal isolation circuit releases, signaling the distant end. The distant end will then return a disconnect signal which is transmitted to the customer-provided equipment as an open between leads CBS1 and CBS2.

3.3 Voice Connecting Arrangement CDQ2X

Voice Connecting Arrangement CDQ2X provides an E and M lead type of signaling interface. The lead designated CTE corresponds to the E lead while the CTM lead corresponds to the M lead. The E and M signaling system derives its name from certain historical designations of the signaling leads on the circuit drawings for these systems. All signaling between the trunk equipment in the customer-provided PBX and the connecting arrangement is accomplished over these two leads (plus a common signal ground). The CTM lead transmits battery and ground signals from the customer-provided equipment toward the connecting arrangement while the CTE transmits open and ground signals from the connecting arrangement to the customer-provided equipment. The near-end condition is reflected by

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the CTM lead and the far-end condition by the CTE lead. The operation of the signaling system is "duplex"; that is, signals can be sent simultaneously in both directions without interference.

The input and output signals for a circuit between point A and point B terminated in Voice Connecting Arrangement CDQ2X at each end are shown in the following table.

<u>Signal A to B</u>	<u>Signal B to A</u>	<u>Condition at A</u>		<u>Condition at B</u>	
		<u>CTM Lead</u>	<u>CTE Lead</u>	<u>CTM Lead</u>	<u>CTE Lead</u>
on-hook	on-hook	GRD	Open	GRD	Open
off-hook	on-hook	BAT	Open	GRD	GRD
on-hook	off-hook	GRD	GRD	BAT	Open
off-hook	off-hook	BAT	GRD	BAT	GRD

3.31 Incoming Call from the Distant PBX

When the distant PBX seizes the line connected to Voice Connecting Arrangement CDQ2X, the facility signaling unit detects that seizure and causes the (K1) relay in the signal isolation unit to operate (see Fig. 6). This relay closes a grounded contact (over the CTE lead) to which the customer-provided communications system must respond by:

- Connecting dial pulse receiving equipment to CTE
- Returning dial tone (if required) over CT and CR to the distant PBX

When dialing is completed and the customer-provided station has answered, the customer-provided equipment must respond by providing battery over the CTM lead (see Paragraph 4.3) to operate the (K2) relay in the signal isolation unit. This relay, in operating, transmits answer supervision to the distant PBX.

The voice coupler unit provides a 2-wire voice frequency transmission path to the customer-provided equipment over the CT and CR leads. This path is cut through at all times for passing call progress tones (audible ringing, busy, etc.) to the distant end.

3.32 Outgoing Call to the Distant PBX

The customer-provided dial communications system causes the voice connecting arrangement to seize the tie trunk by providing battery over the CTM lead to operate the (K2) relay in the signal isolation unit. This causes the facility signaling unit to signal the distant PBX resulting in dial tone being returned (when provided) over the CT and CR leads. For dc dial pulsing, the customer-provided signal on the CTM lead alternates between battery and ground following the dial pulses from the customer's equipment. This causes the (K2) relay in the signal isolation unit to operate and release, thereby repeating dial pulses to the distant PBX. When answer supervision is returned from the distant end, it is detected by the facility signaling unit which causes the (K1) relay in the signal isolation unit to operate. This relay closes a contact to ground over the CTE lead to repeat answer supervision to the customer-provided equipment.

3.33 Disconnection

If the distant end disconnects first, the (K1) relay in the signal isolation unit releases, opening the CTE lead to the customer-provided equipment. The customer-provided equipment must recognize this as a disconnect signal and place ground on the CTM lead.

If the customer-provided equipment connected to this arrangement disconnects first, the customer-provided signal on this CTM lead is changed from battery to ground and the (K2) relay in the signal isolation unit releases. This in turn signals the distant end. The distant end will then return a disconnect signal which is then transmitted to the customer-provided equipment as an open circuit on the CTE lead.

4. SPECIFIC DESIGN CONSIDERATIONS

4.1 Transmission Path

A detail discussion of private line design will be found in the Transmission Engineering Technical Reference "Private Line Interconnection - Voice Applications," dated June 1970, PUB 43201 (see Appendix C). This Reference should be consulted for information on the transmission design principles that should be followed in engineering private line systems. Private line facilities provided by the Telephone Company will conform to the requirements outlined in this Technical Reference.

4.11 Insertion Loss

Voice Connecting Arrangements CDQ2W and CDQ2X do not provide for voice signal amplification except to meet Telephone Company transmission level requirements on the facilities. Where no amplifiers are employed, the insertion loss of the connecting arrangement is approximately 1.0 dB.

4.12 Impedance

For design purposes the input impedance of these connecting arrangements should be considered to be 600 ohms and, therefore, the impedance of the customer-provided equipment should be 600 ohms for optimum signal power transfer across the interface.

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. The voice connecting arrangement does not limit this bandwidth.

4.14 Voice Signal Power Level

In order to prevent interference to other Telephone Company services, customer-generated voice signal levels must comply with certain minimum protection criteria. F.C.C. tariffs and corresponding intrastate tariffs which provide for the electrical connection of customer-provided communications systems with facilities furnished for private line service by the Telephone Company states that:

"Since private line channels utilize Telephone Company facilities in common with other services, it is necessary in order to prevent excessive noise and crosstalk that the power of the signal applied to the Telephone Company lines be limited. Because each private line service is individually engineered, a single valued limit for all applications cannot be specified. Therefore, the power of the signal which may be applied by the customer-provided equipment to the Telephone Company interface located on the customer's premise will be specified by the Telephone Company for each application to be consistent with the signal power allowed on the telecommunications network."

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For Voice Connecting Arrangements CDQ2W and CDQ2X the maximum acceptable voice signal power at the interface connecting block is -13 dBm on transmission leads CT and CR when averaged over any 3-second interval.

Using measuring Method A (see Paragraph 4.15), in almost all cases, the speech power, averaged over any 3-second interval, will not exceed -13 dBm in the maximum meter swing does not exceed 80 dBrn. With the additional damping of measuring Method B, the power averaged over any 3-second interval will not exceed -13 dBm if the maximum meter swing does not exceed 78 dBrn.

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 criteria is being met.

Method A

Operate the customer-provided equipment into a 600 ohm load, (this assumes that the customer-provided equipment has a 600 ohms source impedance), bridged by a Hewlett-Packard Transmission and Noise Measuring Set - Model 3555B, or a Western Electric 3-type Noise Measuring Set, or the equivalent.*

* 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. The use of meters with shorter time constants, such as VU meters or standard voltmeters, is not recommended.

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To insure a proper measurement technique, the control settings on these meters should be as shown below.

<u>Western Electric 3-Type Noise Measuring Set</u>		<u>Hewlett-Packard Transmission 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-600 BAL
WTG (Plug-in Network)	3Kc FLAT	NOISE WTG (Switch)	3 kHz FLAT
		NORM/DAMP (Switch)	DAMP

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 noise meters other than the Western Electric 3-Type).

4.16 Signal Power Distribution

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

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 be at least 31 dB below one milliwatt (18 dB below the signal level specified in Section 4.14).
- (b) The power in the band from 4000 Hz and 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.

4.18 Voice Signal Limiter

A voice signal limiter is incorporated in the transmission path (leads CT and CR) to protect the Bell System private line network from applications of abnormally high signal levels. This has no effect on normal voice signal levels.

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This limiter does not abrogate the customer's responsibility to meet the network protection criteria as prescribed in the Tariffs and as outlined in Section 4 of this Technical Reference.

4.2 Supervisory and DC Signaling Paths

4.21 Outgoing Signals for Voice Connecting Arrangement CDQ2W
(Leads CS and CG)

This pair of leads provides the means of answering an incoming call and initiating an outgoing call from the customer's communications system. In the idle state (on-hook), leads CS and CG should be open. The off-hook condition is indicated by closing CS to CG through contacts in the customer-provided equipment. When dc dial pulses are to be transmitted, the contact between CS and CG should be opened and closed in unison with the dial pulses.

The CS lead has a maximum of -52 volts dc through 4000 ohms. The CG lead is grounded at the voice connecting arrangement. (See 4.4, Grounding). Leads CS and CG will load the customer's contact with 0.013 ampere, maximum, inductive load. Due to the inductive nature of the load, a contact protection network is provided across leads CS and CG in the voice connecting arrangement (see Fig. 3).

The maximum external loop resistance including contact resistance across the CS and CG leads measured at the interface connecting block toward the customer-provided equipment shall not exceed 100 ohms (equivalent to 1800 ft. of 24 gauge cable) when indicating a closure. The minimum open circuit insulation resistance across the CS and CG leads and from either lead to ground should be 100,000 ohms.

4.22 Incoming Signals for Voice Connecting Arrangement CDQ2W
(Leads CBS1 and CBS2)

This pair of leads provides the distant PBX with a means for seizing and impulsing to the customer-provided equipment on incoming calls. These leads also provide the customer's equipment with answer supervision from the distant PBX on outgoing calls. Leads CBS1 and CBS2 indicate the condition that exists at the distant PBX. The idle state (on-hook) is indicated by an open between these two leads. The off-hook state is indicated by a closure between the leads. DC dial pulse signals generated by the distant PBX will cause the contact in the signal isolation unit to open and close.

The current from the customer's equipment on these leads shall not exceed 0.35 ampere. The maximum open circuit voltage between leads CBS1 and CBS2 shall not exceed 130 volts.

4.23 Outgoing Signals for Voice Connecting Arrangement CDQ2X
(Lead CTM)

This lead provides the means of answering an incoming call and initiating an outgoing call from the customer's communications system. In the idle state (on-hook), lead CTM should be closed to ground (lead CG). The off-hook condition is indicated by removing the ground and placing battery on lead CTM. A typical circuit for providing the proper signals on lead CTM is shown in Fig. 6.

When dc dial pulses are to be transmitted, the CTM lead should be changed from battery to ground in unison with the dial pulses.

The customer's battery signal applied to lead CTM shall be a nominal -48 volts dc (range -45 to -52 volts). A typical circuit for applying this signal is shown in Fig. 6. The battery signal should be passed through a resistance lamp or other current limiting device that will limit the maximum current in case of a fault condition to 0.35 amperes.

Relay K2 will present a load of 2490 ohms resistive in series with a 120 ohm relay coil.

The maximum external loop resistance including contact resistance across the CTM and CG lead measured at the interface connecting block toward the customer-provided equipment shall not exceed 100 ohms (equivalent to 1800 feet of 24 gauge cable) when indicating a closure.

4.24 Incoming Signals for Voice Connecting Arrangement CDQ2X (Lead CTE)

This lead provides the distant PBX with a means for seizing and impulsing to the customer-provided equipment on incoming calls. This lead also provides the customer's equipment with answer supervision from the distant PBX on outgoing calls. Lead CTE indicates the condition that exists at the distant PBX. The idle state (on-hook) is indicated by an open circuit on lead CTE. The off-hook condition is indicated by a ground on lead CTE. DC dial pulse signals, generated by the distant PBX, will cause a contact in the signal isolation unit to open and close alternating the CTE lead between ground and open in unison with the dial pulse.

The current from the customer's equipment on lead CTE shall not exceed 0.35 amperes. A protection network is provided to prevent contact damage resulting from inductive load switching. The maximum open circuit voltage between leads CTE and CG shall not exceed 130 volts.

4.25 Common Signal Ground for Voice Connecting Arrangement CDQ2X (Lead CG)

This lead provides signal ground from the customer's equipment to the signal isolation unit (see Fig. 6) for E and M type signaling; it is isolated from Bell System frame ground within the signal isolation unit. There is one CG lead for each group of four signal isolation units. Lead CG should be connected to signal ground in the customer-provided equipment.

4.3 Dial Pulses

When the distant end terminal signaling equipment is provided by the Telephone Company, dial pulses generated by the customer-provided equipment over the interface leads CS and CG to Voice Connecting Arrangement CDQ2W and lead CTM to Voice Connecting Arrangement CDQ2X, must be at a rate between 8 and 11 pulses-per-second with a percent break of between 58 and 64 percent. A minimum of 600 milliseconds must be provided between digits. The customer-provided equipment must also be able to receive dial pulses at any rate between 8 and 11 pulses-per-second with a percent break of between 25 and 90 percent, generated by the voice connecting arrangement over the interface lead CTE or CBS1 and CBS2. A minimum of 600 milliseconds will be provided between digits. It is expected, when dial signaling is used, that each receiving end tie trunk circuit in the communication system will be equipped with pulse correction.

4.4 Grounding

Voice Connecting Arrangements CDQ2W and CDQ2X are provided with a common ground (a metallic cold water pipe or other approved ground) which is always bonded to the electric power ground and the telephone protector ground where present.

The CG lead of Voice Connecting Arrangement CDQ2W is grounded at the unit to provide a common signal ground. The customer is not permitted to derive the main ground for his equipment through this lead. The CG lead of Voice Connecting Arrangement CDQ2X is isolated from ground in the signal isolation unit. The general grounding requirements for customer-provided equipment are covered in Paragraph 5.3.

5. GENERAL DESIGN CONSIDERATIONS

5.1 Foreign and Surge Voltage Protection

Where telephone lines are exposed to foreign voltages by direct contact or induction (e.g., power line crosses or lightning), protective devices are installed at the Central Office and on the customer's premises which provide a path to ground for foreign voltages exceeding about 600 volts peak. Since the customer's equipment is connected to the telephone line through the voice connecting arrangement, it is protected from longitudinal surges by transformer and relay isolation. Additional circuitry within the voice connecting arrangement limits the maximum metallic (i.e., transverse) surge between transmission leads due to foreign potential to less than 30 volts.

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The customer is responsible for providing protection against foreign and hazardous voltages from his equipment and facilities being applied to the voice connecting arrangement. The surge potential on transmission leads at the interface shall be limited to 30 volts metallic. The surge potential on the other leads shall be limited to 600 volts peak between leads or from one lead to ground.

5.2 Voltage Limitations

When it is necessary for the customer to apply an operational voltage to the transmission or control leads of a voice connecting arrangement, certain limitations shall be observed. These limitations are for the purpose of providing adequate protection to personnel and plant facilities, and unless otherwise specified in Section 4 of this Technical Reference, any steady-state voltage applied by the customer-provided equipment to conductors connected to a voice connecting arrangement 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*)

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

The power supplies and wiring methods used in the customer-provided equipment should meet the provisions of the applicable electrical code such as the National Electrical Code (NEC), Article 725, for Class 2 remote control and signal circuits.

5.3 Grounding

It is expected that the customer's equipment, if powered from commercial power, will be grounded in accordance with applicable electrical codes such as NEC. 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 as the telephone protector or signal ground but not using the Telephone Company ground clamp. This lead shall not be fused.

6. SERVICE AND MAINTENANCE CONSIDERATIONS

6.1 Responsibility of the Customer

The tariffs permitting direct electrical connection of customer-provided communications systems state that:

Where private line service is available under this tariff for use in connection with terminal equipment or communications systems, provided by a customer,

authorized user or joint user, 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, authorized user or joint user does not endanger the safety of Telephone Company employees or the public, damage, require change in or alteration 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 Telephone Company's facilities 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, authorized user or joint user 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.

6.2 Responsibility of the Telephone Company

The tariffs permitting direct electrical connection of customer-provided communications systems state that:

The Telephone Company shall not be responsible for installation, operation or maintenance of any terminal equipment or communications systems provided by a customer, authorized user, or joint user. Private line service is

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not represented as adapted to the use of such equipment or systems and where such equipment or system is connected to Telephone Company facilities the responsibility of the Telephone Company shall be limited to the furnishing of facilities suitable for private line service and to the maintenance and operation of such facilities in a manner proper for such private line service. Subject to this responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by such equipment or system, or for the quality of or defects in, such transmission, or (ii) the reception of signals by such 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 or authorized user or joint user if changes in protection criteria contained in the tariffs and Section 3 of this Technical Reference, or in any of the facilities, operations, or procedures of the Telephone Company render any facilities provided by a customer, authorized user or joint user obsolete or require modification or alteration of such equipment or system 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 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 into the listed "Repair Service" number which 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) Private line identification number
- (e) Description of the trouble
- (f) Customer's contact for additional information

The customer will be responsible for payment of a service charge for visits by the Telephone Company to the premises of the customer when the service difficulty or trouble report results from the use of equipment or facilities provided by the customer.

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APPENDIX A

GLOSSARY

CHANNEL - a path (or paths) for electrical communication, between two or more stations or Telephone Company offices. A channel may be furnished in such manner as the Telephone Company may elect. A channel may be derived from cable, radio or a combination thereof, and may consist of one or more physical facilities or routes.

COMMUNICATIONS SYSTEM - channels and other facilities which are capable, when not connected to private line service, of communications between customer-provided terminal equipment or Telephone Company stations.

CUSTOMER - 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 - devices or apparatus and their associated wiring, provided by a customer, authorized user or joint user which do not constitute a communications system and which, when connected to the communications path of the telecommunications system, 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 CONNECTING BLOCK - the Telephone Company-provided connecting point to which the customer brings and connects the leads of his equipment and to which the Telephone Company brings and connects leads from the voice connecting arrangement.

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NETWORK CONTROL SIGNALING - the transmission of signals used in the telecommunications system to perform functions such as supervision (control, status, and charging signals), address signaling (e.g., 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 system.

PRIVATE LINE - the term "Private Line" denotes the channels, channel terminals, service terminals, channel arrangements and equipment furnished to a customer as a unit, that is, without intermediate interexchange channel switching arrangements.

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).

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

VOICE COUPLER - the part of Voice Connecting Arrangement which connects the transmission path from the customer-provided equipment to the private line network.

VOICE CONNECTING ARRANGEMENT - equipment provided by the Telephone Company to accomplish the direct electrical connection of customer-provided facilities with the facilities of the Telephone Company, or the direct electrical connection of Telephone Company facilities.

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VOICE CONNECTING UNIT - the portion of the voice connecting arrangement including the voice coupler which provides the interconnection function between the customer-provided equipment and the Telephone Company facilities.

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.

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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) "Principles of Electricity Applied to Telephone and Telegraph Work" by American Telephone and Telegraph Company, New York, New York.
- *(f) "Switching Systems," by American Telephone and Telegraph Company, New York, New York.
- *(g) "Notes on Transmission Engineering," by United States Independent Telephone Association, Washington, D.C.
- *(h) "Transmission Systems for Communications," by Bell Telephone Laboratories, Inc.

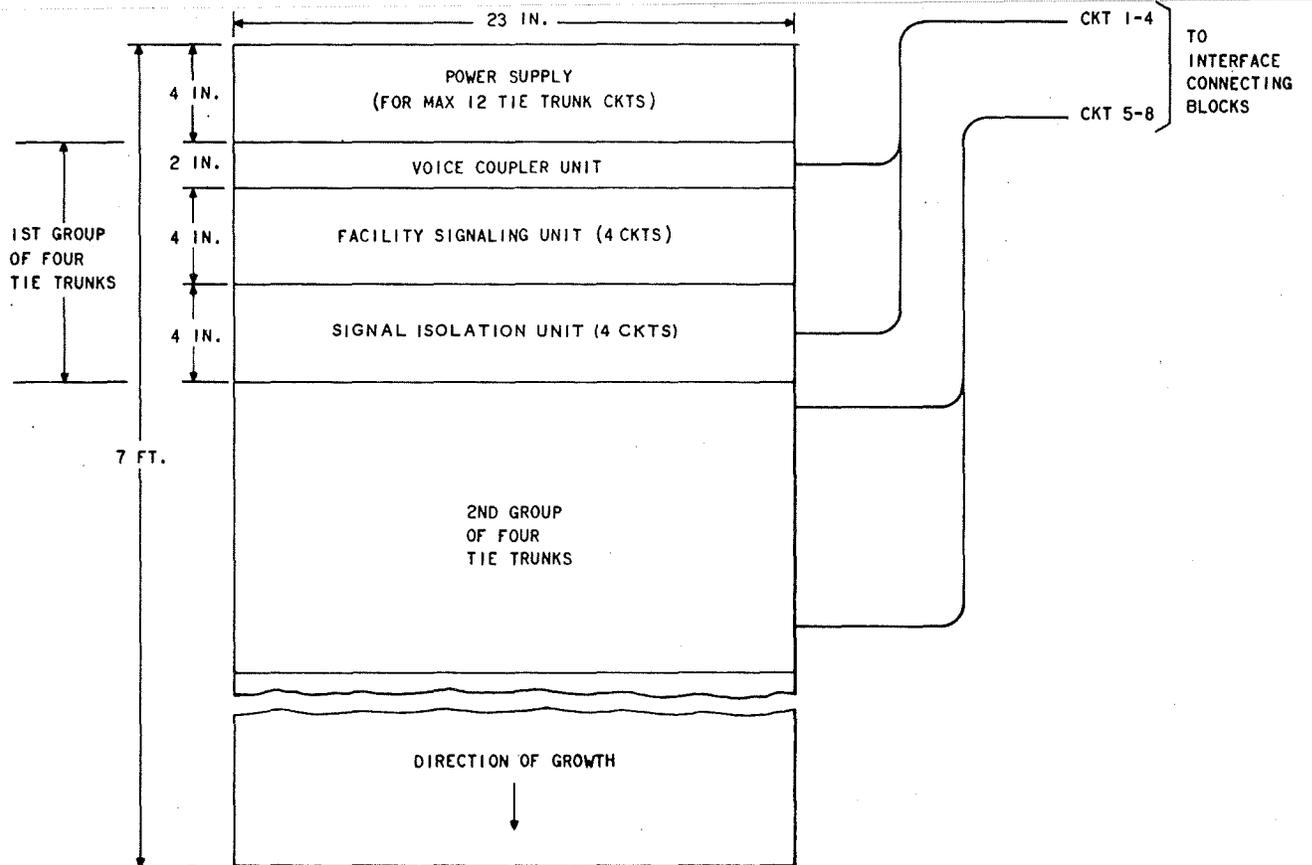
PRELIMINARY

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- *(i) Bell System Transmission Engineering Technical Reference,
"Private Line Interconnection - Voice Applications," dated
June 1970, PUB 43201.

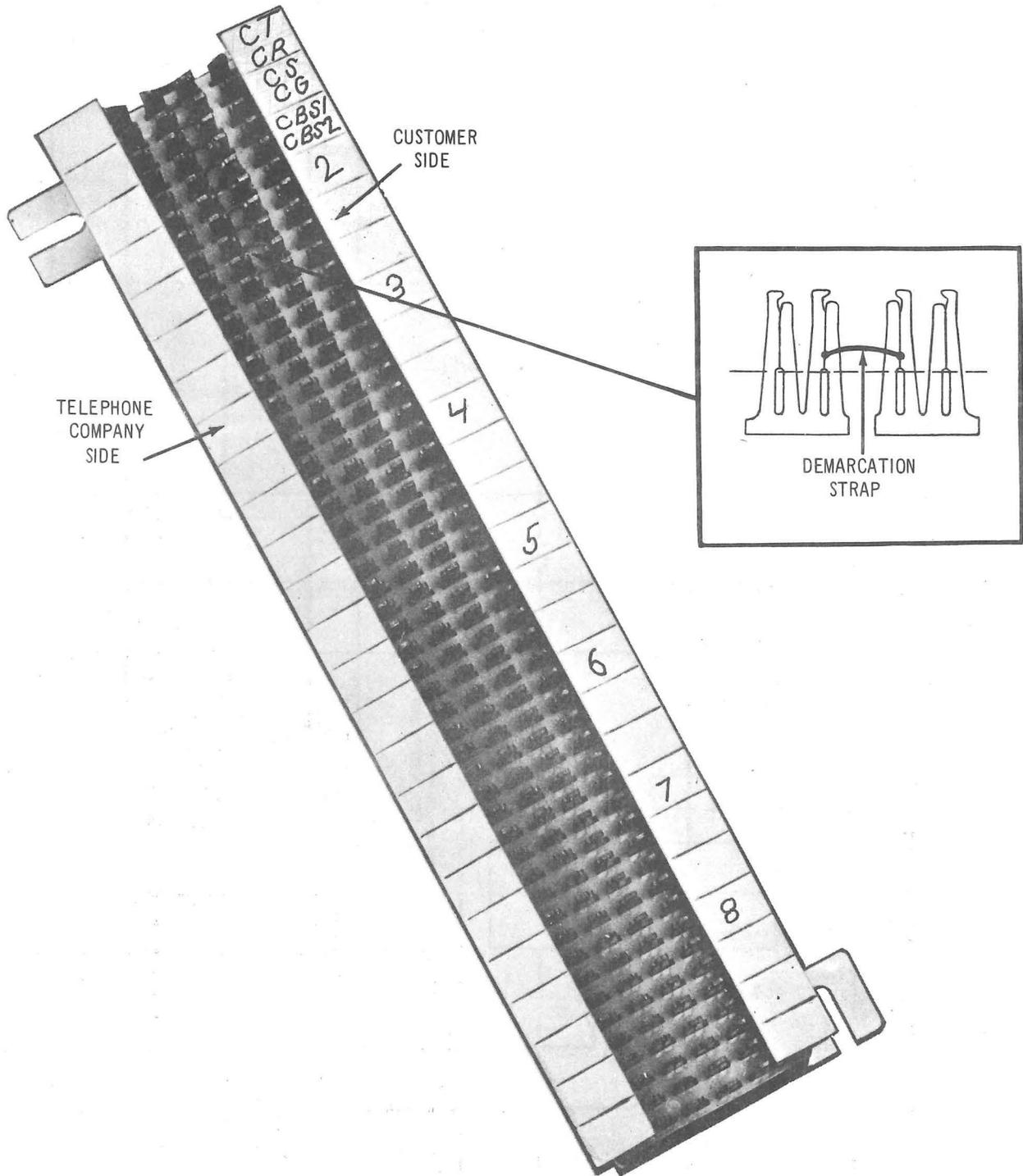
*Available through Western Electric Company, Incorporated
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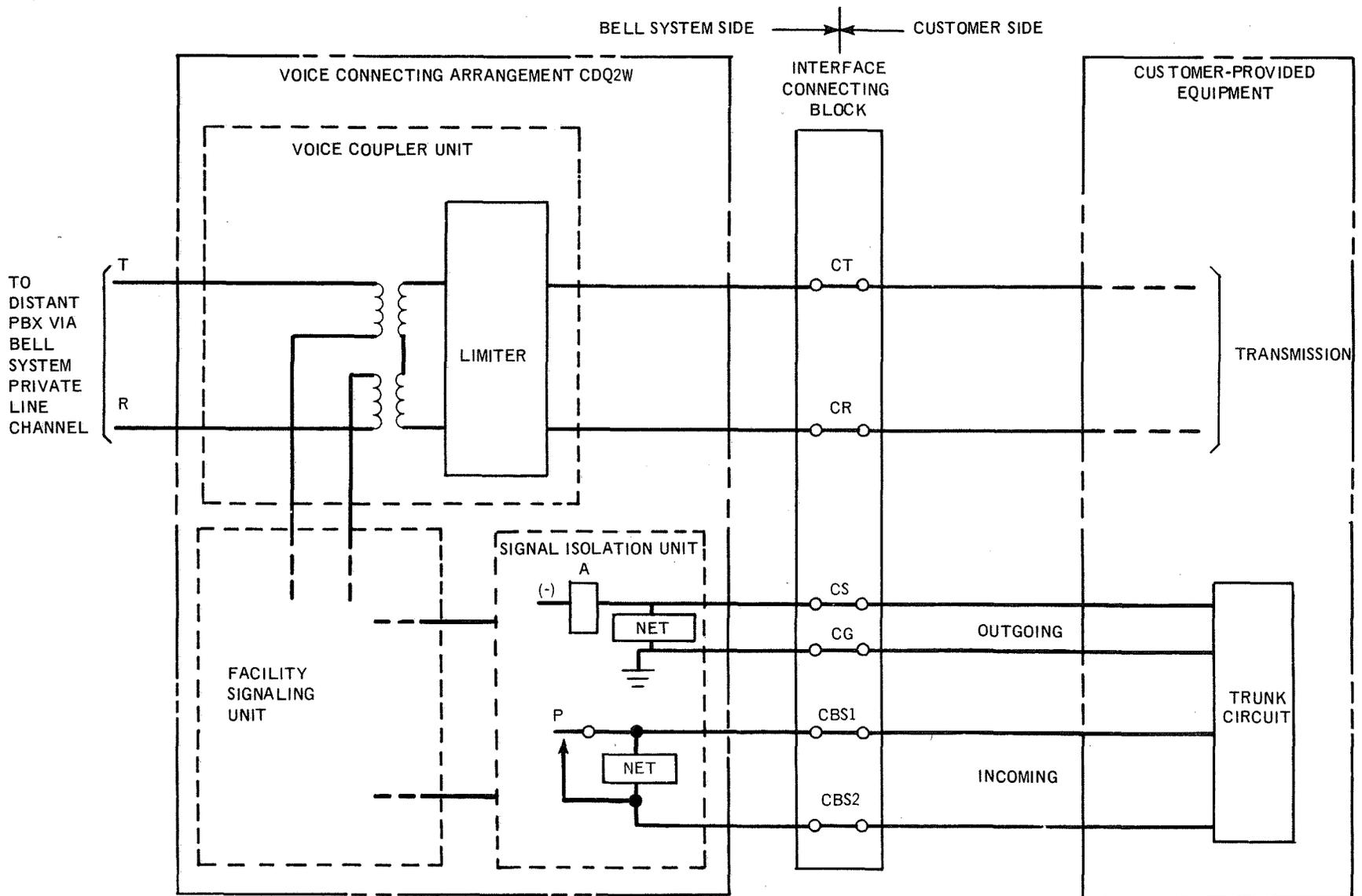


VOICE CONNECTING ARRANGEMENTS CDQ2W AND CDQ2X
TYPICAL RELAY RACK MOUNTING
FRONT VIEW
FIG. 1

PRELIMINARY



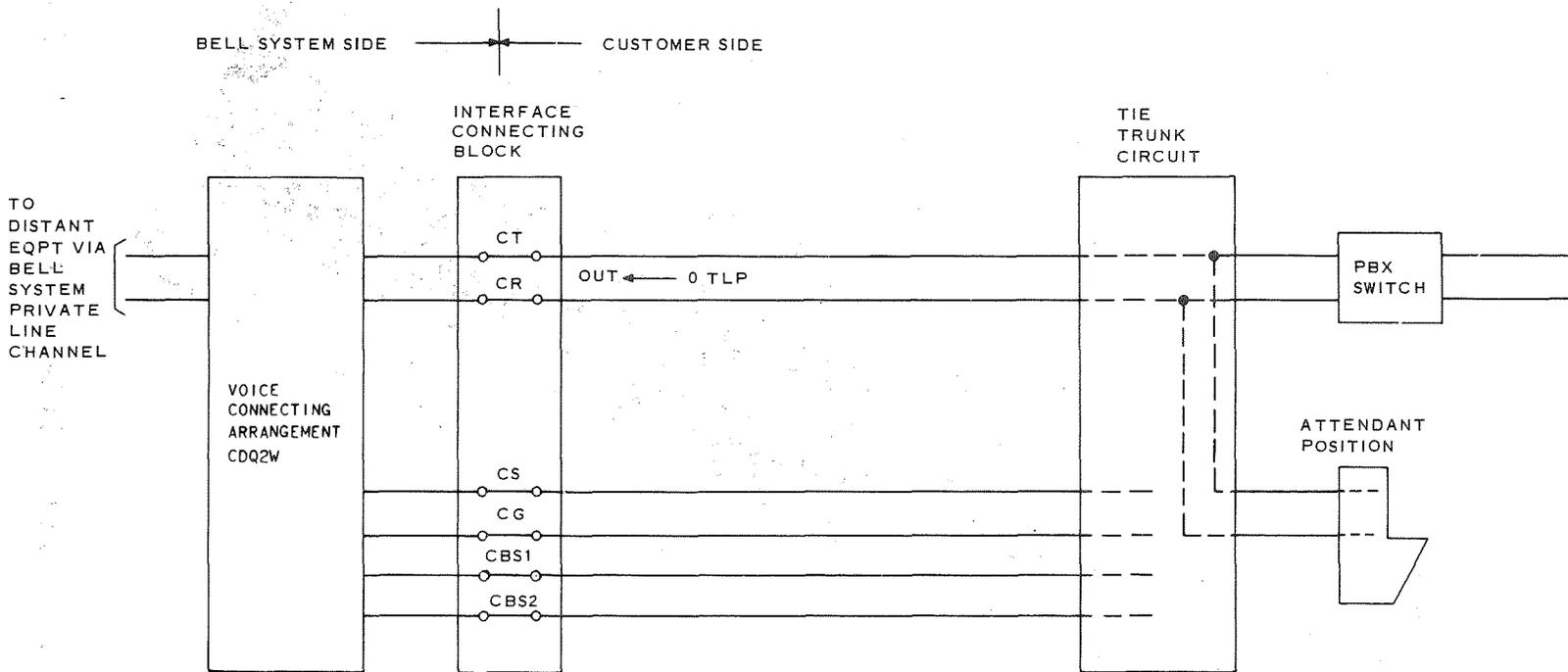
TYPICAL INTERFACE CONNECTING BLOCK FOR CDQ2W
FIG. 2



SIMPLIFIED SCHEMATIC - VOICE CONNECTING ARRANGEMENT CDQ2W

FIG. 3

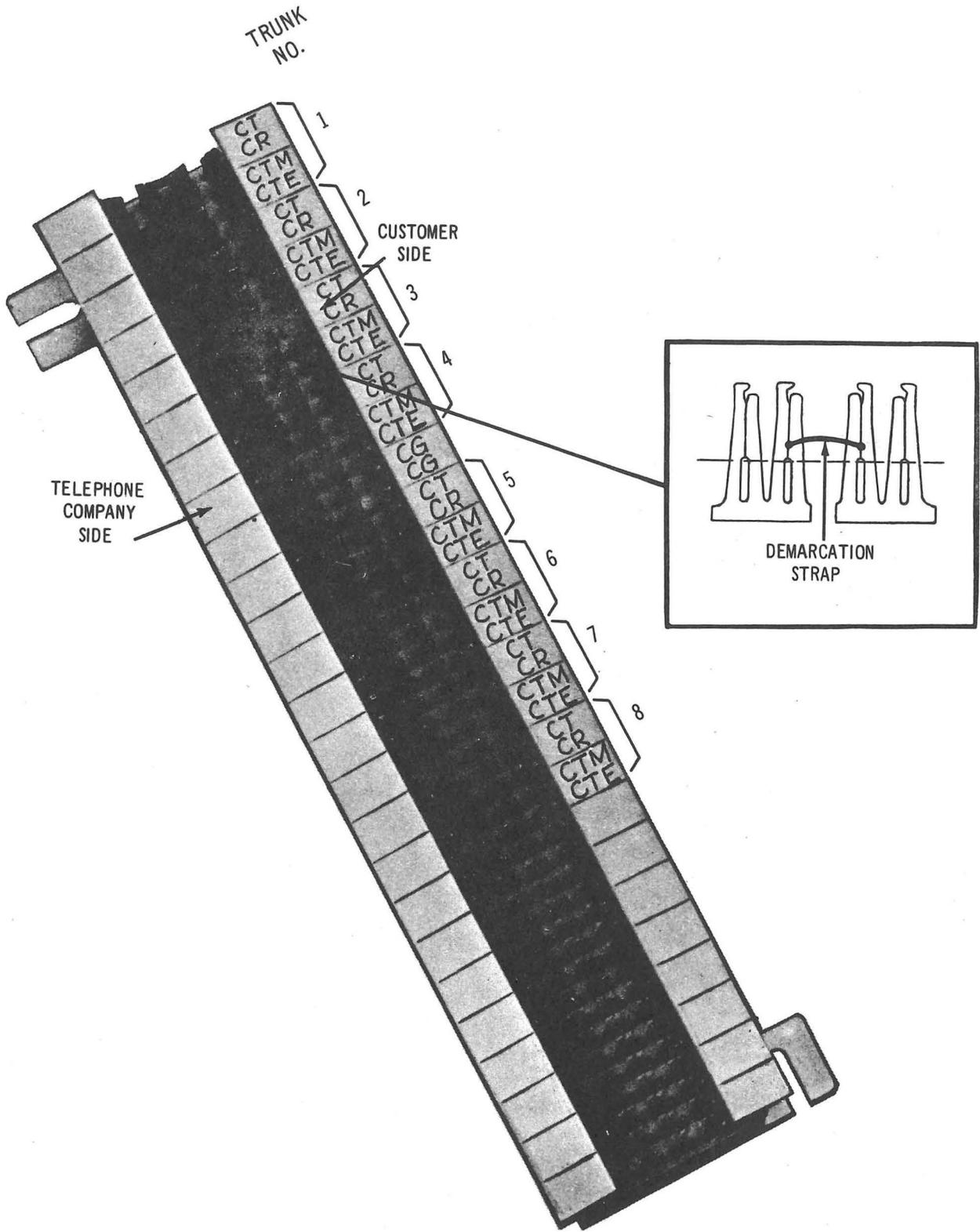
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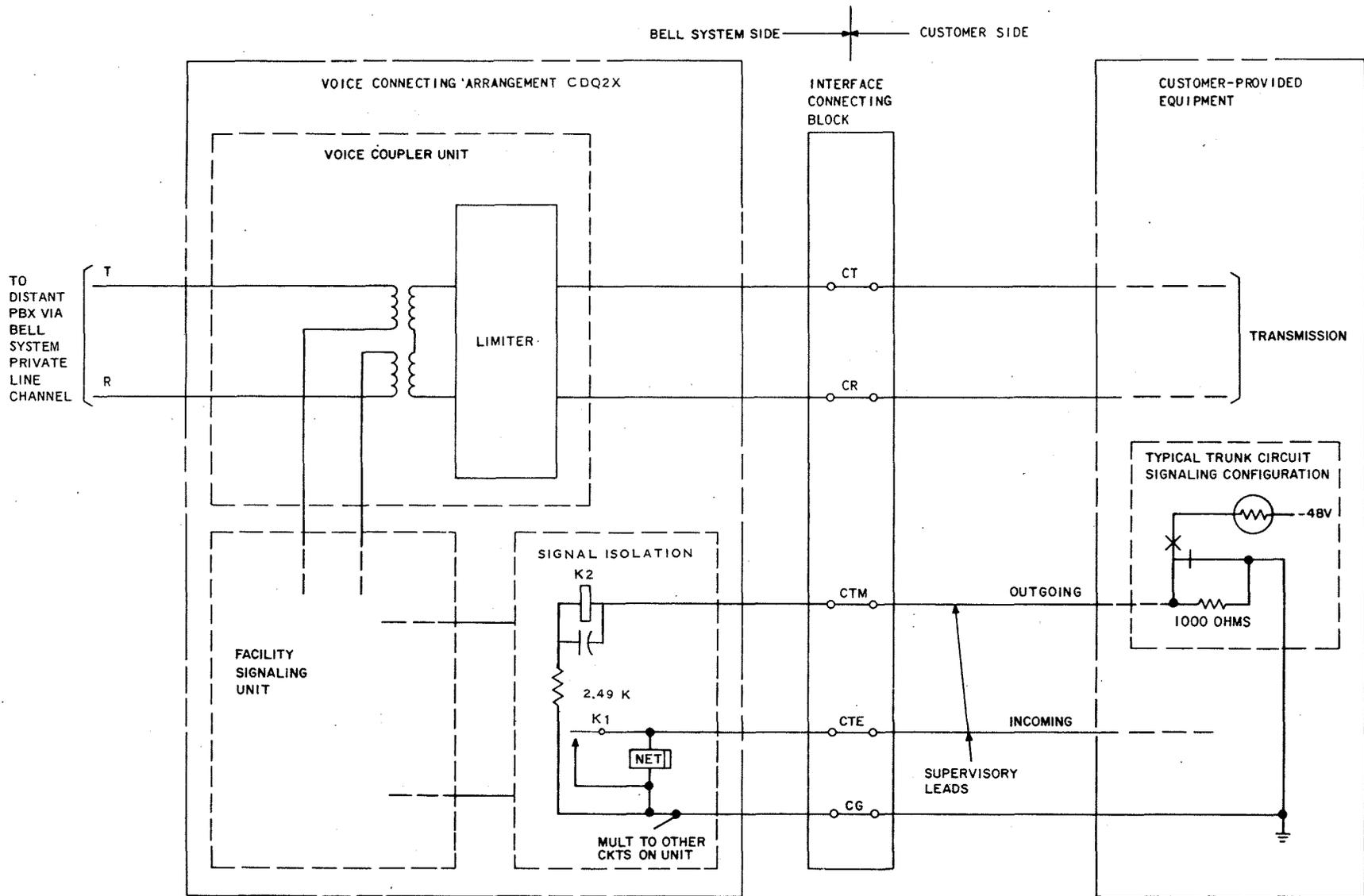
BLOCK DIAGRAM - VOICE CONNECTING ARRANGEMENT CDQ2W
FIG. 4

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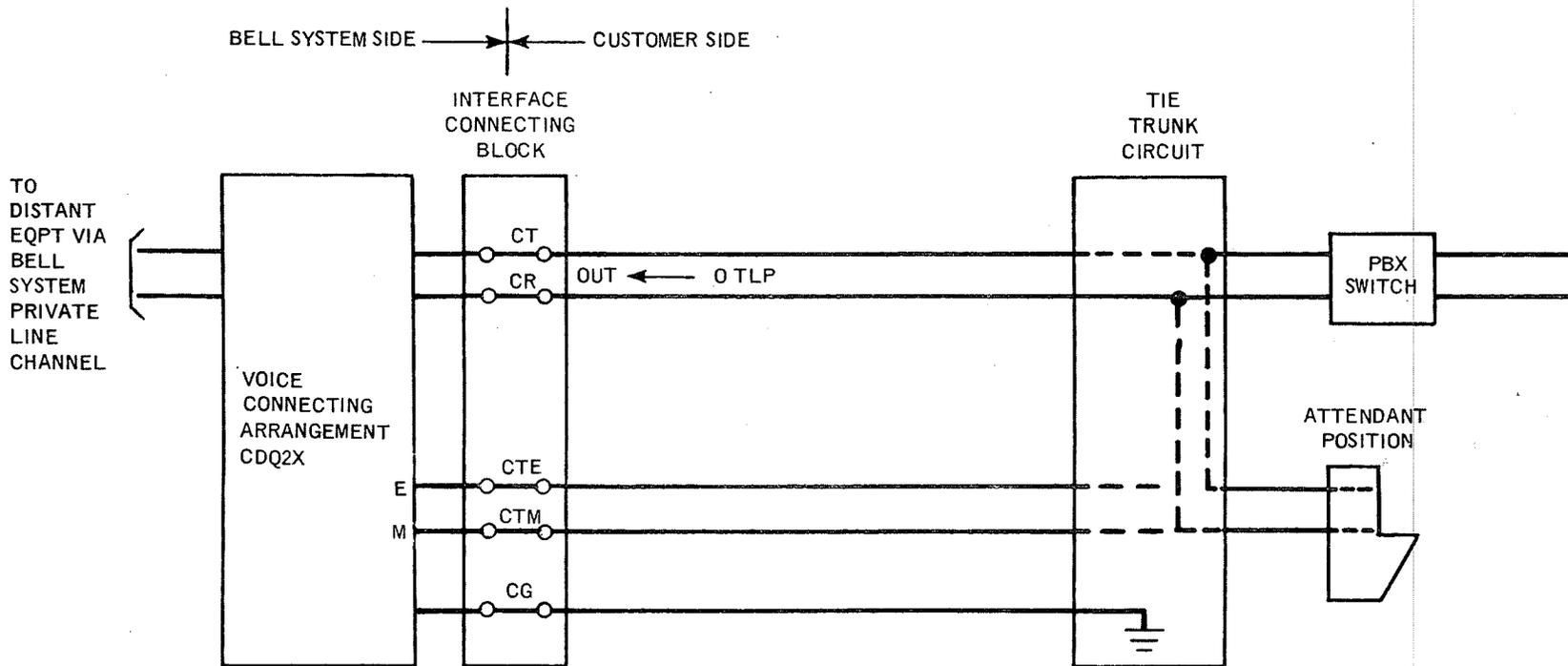


TYPICAL INTERFACE CONNECTING BLOCK FOR CDQ2X
FIG. 5



SIMPLIFIED SCHEMATIC - VOICE CONNECTING ARRANGEMENT CDQ2X
FIG. 6

PRELIMINARY



BLOCK DIAGRAM - VOICE CONNECTING ARRANGEMENT CDQ2X
FIG. 7