

PRELIMINARY

**Bell System Voice Communications
TECHNICAL REFERENCE**

**Voice
Connecting
Arrangement**

CDQ4X

**Interface
Specification**

October 1971

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS



PRELIMINARY

NOTICE

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

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TECHNICAL REFERENCE

VOICE CONNECTING ARRANGEMENT CDQ4X

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

1.2 Application

Voice Connecting Arrangement CDQ⁴X is one 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. The transmission interface is 4-wire and the signaling interface provides for E and M type signaling (one pair of signaling leads plus signal ground).

The interface provided by Voice Connecting Arrangement CDQ⁴X is a Type III interface as described in the Transmission Technical Reference "Private Line Interconnection - Voice Application." This Technical Reference should be consulted for general information on private line services (see Appendix C for ordering information). Voice Connecting

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Arrangement CDQ4X and the associated private line channel provides 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 this connecting arrangement 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 given in Paragraph 4.4.

1.3 Ordering and Identification

The connection service described in this Technical Reference is identified by the Bell System as Voice Connecting Arrangement CDQ4X. One Voice Connecting Arrangement CDQ4X 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 this service.

2. DESCRIPTION

2.1 Functions

The major functions of this voice connecting arrangement 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 isolation to minimize the introduction of longitudinal noise.
- (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.

2.2 Physical

Voice Connecting Arrangement CDQ4X is 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 Arrangement CDQ4X consists of a voice repeater circuit which provides 4-wire voice transmission; a facility

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signaling unit to receive and transmit signals over the loop; and a dc signal isolation unit 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, 15 ampere grounded U-blade outlet for each Bell System -48 volt power supply. The 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

Six interface leads per tie trunk are provided from Voice Connecting Arrangement CDQ4X to an interface connecting block (see Figure 3). 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	One way voice transmission toward the transmission facility (transmit)
CT1 CR1	One way voice transmission from the transmission facility (receive)
CTM	Outgoing signals (to the connecting arrangement) - seizure, dial pulses, and answer and disconnect supervision

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<u>Lead Designation</u>	<u>Function</u>
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

Leads from Voice Connecting Arrangement CDQ4X will be terminated on a Telephone Company-provided interface connecting block conveniently located (within 25 feet of the connect arrangement equipment) 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.

A typical interface connecting block is shown in Figure 2. This "quick connect" type connecting block utilizes tin-plated spring clip terminal strips which accommodate unstripped, polyethylene 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.

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The customer-provided equipment must be located so that the maximum external loop resistance, including contact resistance, between leads CTM and CG does not exceed 100 ohms. However, this distance should be held to a minimum to prevent crosstalk and noise interference.

3. OPERATION

3.1 General

Voice Connecting Arrangement CDQ4X 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 two leads (plus a common signal ground). The customer-provided equipment transmits battery and ground signals toward the connecting arrangement over the CTM lead while open and ground signals are received in the customer-provided equipment over the CTE lead. The near-end condition is reflected by 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 mutual interference.

The input and output signals for a circuit between point A and point B terminated in Voice Connecting Arrangement CDQ4X at each end are shown in the following table.

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<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

The operational details for Voice Connecting Arrangement CDQ4X depend on the requirements of the switching system to which it is 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 Incoming Call from the Distant PBX

When the distant PBX seizes the line connected to Voice Connecting Arrangement CDQ4X, the facility signaling unit detects that seizure and causes the (K1) relay in the signal isolation unit to operate (see Figure 4). 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 4.21) 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 4-wire voice frequency transmission path to the customer-provided equipment over the CT, CR and CT1, CR1 leads. This path is cut through at all times for passing call progress tones (audible ringing, busy etc.) to the distant end.

3.3 Outgoing Call to the Distant PBX

The customer-provided dial communications system causes the voice connecting arrangement to seize the tie trunk by changing from battery to ground on 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.

3.4 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 the 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

4.1.1 Transmission Design

A detail discussion of private line design will be found in the Transmission Technical Reference, "Private Line Interconnection - Voice Applications" (see Appendix C for ordering information). 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.

4.1.2 Insertion Loss and Impedance

Voice Connecting Arrangement CDQ4X contains voice frequency amplifiers (Fig. 4) in both the transmit and receive paths to compensate

for facility loss and to establish the specified Transmission Level Points (TLP) at the interface. (See Paragraph 4.14).

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 voice grade private line facilities extends from about 300 to about 3000 Hz. In general, an end-to-end connection may be expected to have a loss characteristic which increases with increasing frequencies in the upper half of the band and with decreasing frequencies in the lower half of the band. The voice connecting arrangement does not limit this bandwidth.

4.14 Transmission Level Points (TLP)

In order to specify the levels between which the tie trunk will operate, common reference levels between the Telephone Company and the customer-provided equipment are required. For a tie trunk, the PBX switch in the outgoing (transmit) direction, at each end, is normally designated the 0 Transmission Level Point (0 TLP) for that direction of transmission (see Fig. 3). All other level points on the tie trunk are referred to this point by the nominal loss (-) or gain (+) in dB between them at 1000 Hz. In designing their tie trunk facilities the Telephone Company will provide +7 (receive pair) and -16 (transmit pair) Transmission Level Points (TLP) at the interface connecting block as shown in Fig. 3. These values were chosen to provide standard interface levels

which are readily available in commercial channel, signaling, and terminal equipment. Another advantage is that the customer's terminal equipment is not required to have gain devices.

4.15 Voice Signal Power Levels

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 direct electrical connection of customer-provided communications systems with facilities furnished for private line service by the Telephone Company state 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."

For Voice Connecting Arrangement CDQ4X the maximum acceptable voice signal power at the interface connecting block is -29 dBm on leads CT and CR (transmit pair) when averaged over any 3-second interval.

The transmit pair is at a -16 TLP as described in Paragraph 4.14 and the value of -29 dBm corresponds to a -13 dBm referred to the 0 TLP (-13 dBm0).

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Voice Connecting Arrangement CDQ4X is suitable for passing customer generated data signals provided they meet the 3-second average power limits outlined above. Further information on the data transmission characteristics of voice grade private lines can be found in the Data Communications Technical Reference, "Transmission Specifications for Voice Grade Private Line Data Channels" dated March 1969. In addition, if the transmitted signal level exceeds -29 dBm by more than 6 dB for a period exceeding 20 milliseconds, distortion may occur due to the properties of the limiter circuit in the voice connecting arrangement.

Using measuring Method A (see Paragraph 4.16), in almost all cases, the speech power (averaged over any 3-second interval) will not exceed -29 dBm if the maximum meter swing does not exceed 64 dBrn. With the additional damping of measuring Method B, the speech power averaged over any 3-second interval will not exceed -29 dBm if the maximum meter swing does not exceed 62 dBrn.

The value -16 TLP at the interface connecting block requires the customer to provide a pad in the transmitting direction so that the loss from the PBX switch (0 TLP) to the interface connecting block (-16 TLP) is 16 dB (see Fig. 1).

The desired loss in the receive direction, i.e., between the +7 TLP and the PBX switch, is a function of several factors including the intended use of the trunk, its length, and the type of channel facilities provided by the Telephone Company. Suggested loss values and other transmission engineering information for tie trunks is covered in Transmission

Engineering Technical Reference "Private Line Interconnection - Voice Applications".

4.16 Measuring Maximum Available Inband Speech 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 discussed in Paragraph 4.15 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 ohm 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. 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 and Noise Measuring Set Model 3555B</u>	
<u>Control</u>	<u>Setting</u>	<u>Control</u>	<u>Setting</u>
FUNCTION (Switch)	BRDG	INPUT (Switch)	NOISE/BRDG
NORM/DAMP (Switch)	DAMP	FUNCTION (Pushbutton)	VF/Nm-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

* 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.

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.)

4.17 Signal Power Distribution

The telecommunications network incorporates tone signaling devices that are used for network control functions. These devices, which may be employed on private line circuits 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.

4.18 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 47 dB below one milliwatt (18 dB below the signal level specified in Paragraph 4.15).

- (b) The power in the band from 4000 Hz to 10,000 Hz shall not exceed 32 dB below one milliwatt.
- (c) The power in the band from 10,000 Hz to 25,000 Hz shall not exceed 40 dB below one milliwatt.
- (d) The power in the band from 25,000 Hz to 40,000 Hz shall not exceed 52 dB below one milliwatt.
- (e) The power in the band above 40,000 Hz shall not exceed 66 dB below one milliwatt.

4.19 Signal Limiting

A voice signal limiter is incorporated in the transmission path to protect the Bell System private line network from applications of abnormally high signal levels. This has no effect on normal voiceband 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 4.15.

4.2 Supervisory and DC Signaling Paths

4.21 Outgoing Signals

Lead CTM 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 Figure 4.

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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. 4. 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.

4.22 Incoming Signals

Lead CTE 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.

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 pulses.

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 lead CTE and CG shall not exceed 130 volts.

4.3 Common Signal Ground

Lead CG provides signal ground from the customer's equipment to the signal isolation unit (see Fig. 4) for E and M 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. Leads CG should be connected to signal ground in the customer-provided equipment.

4.4 Dial Pulses

When the distant end terminal signaling equipment is provided by the Telephone Company, dial pulses generated by the customer-provided equipment over interface lead CTM to Voice Connecting Arrangement CDQ4X, 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. 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.

4.5 Grounding

Voice Connecting Arrangement CDQ4X is provided with a common signal 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 is isolated from ground in the signal isolation unit. The general grounding requirements for 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 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 and metallic surges.

The customer is responsible for providing protection 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 such as NEC. Provisions should be made within the customer's equipment for connecting together all internal signal grounds. This

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 lead CTE and CG shall not exceed 130 volts.

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Lead CG provides signal ground from the customer's equipment to the signal isolation unit (see Fig. 4) for E and M 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. Leads CG should be connected to signal ground in the customer-provided equipment.

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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.

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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

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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 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 systems, 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 4 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

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- (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 of 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 lead 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 inter-exchange 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 (switch-hook 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 the 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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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.

PRELIMINARY

- 2 -

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

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

* Available through Western Electric Company, Inc.
Commercial Relations
P. O. Box 1579
Newark, New Jersey 07102

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APPENDIX C

WHERE TO OBTAIN REFERENCE MATERIAL

1. Bell System Technical References

These references may be purchased by writing to:

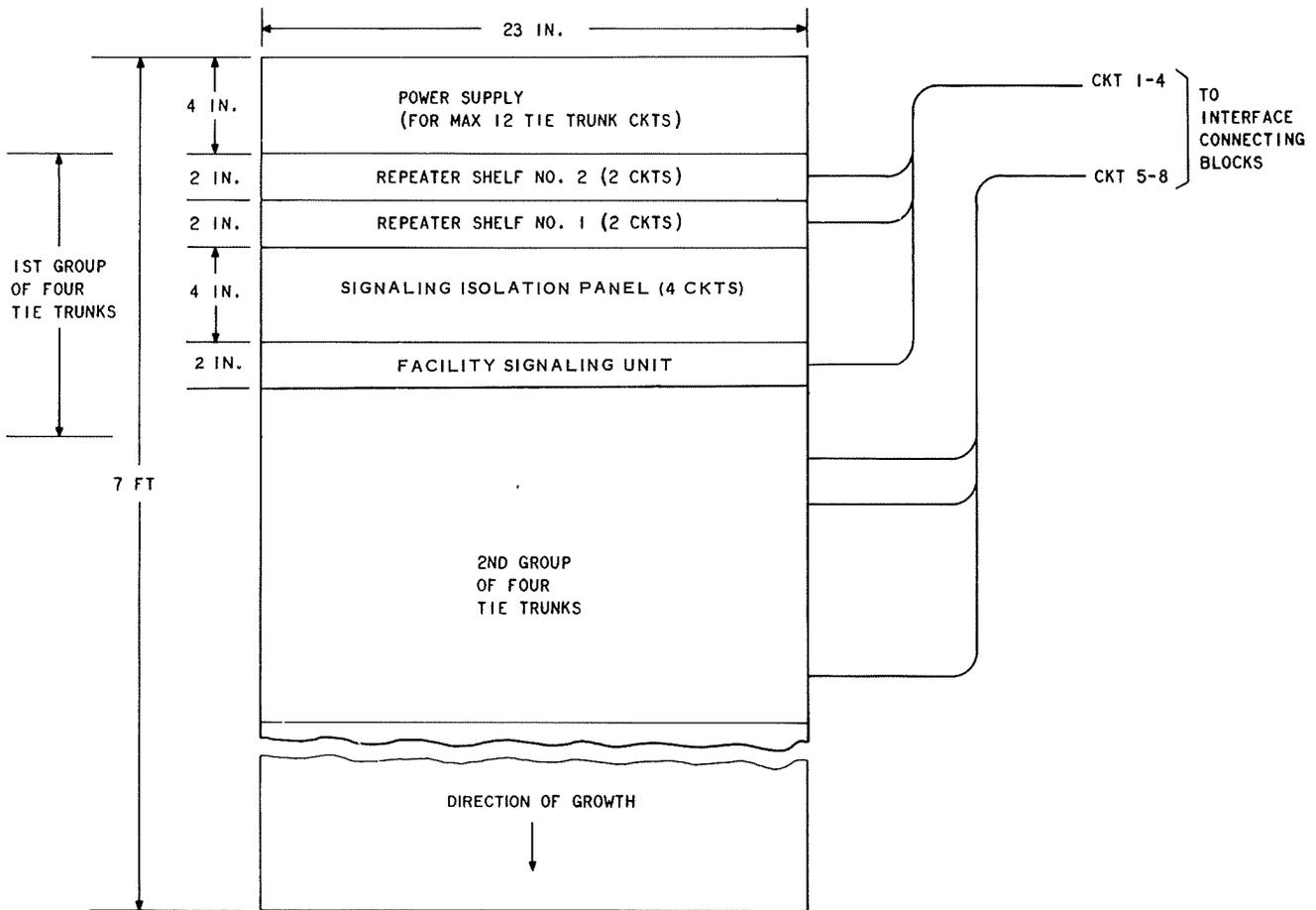
Western Electric Company, Inc.
Commercial Relations
P. O. Box 1579
Newark, New Jersey 07102

2. Bell System Technical Journals (BSTJ)

These journals may be purchased by writing to:

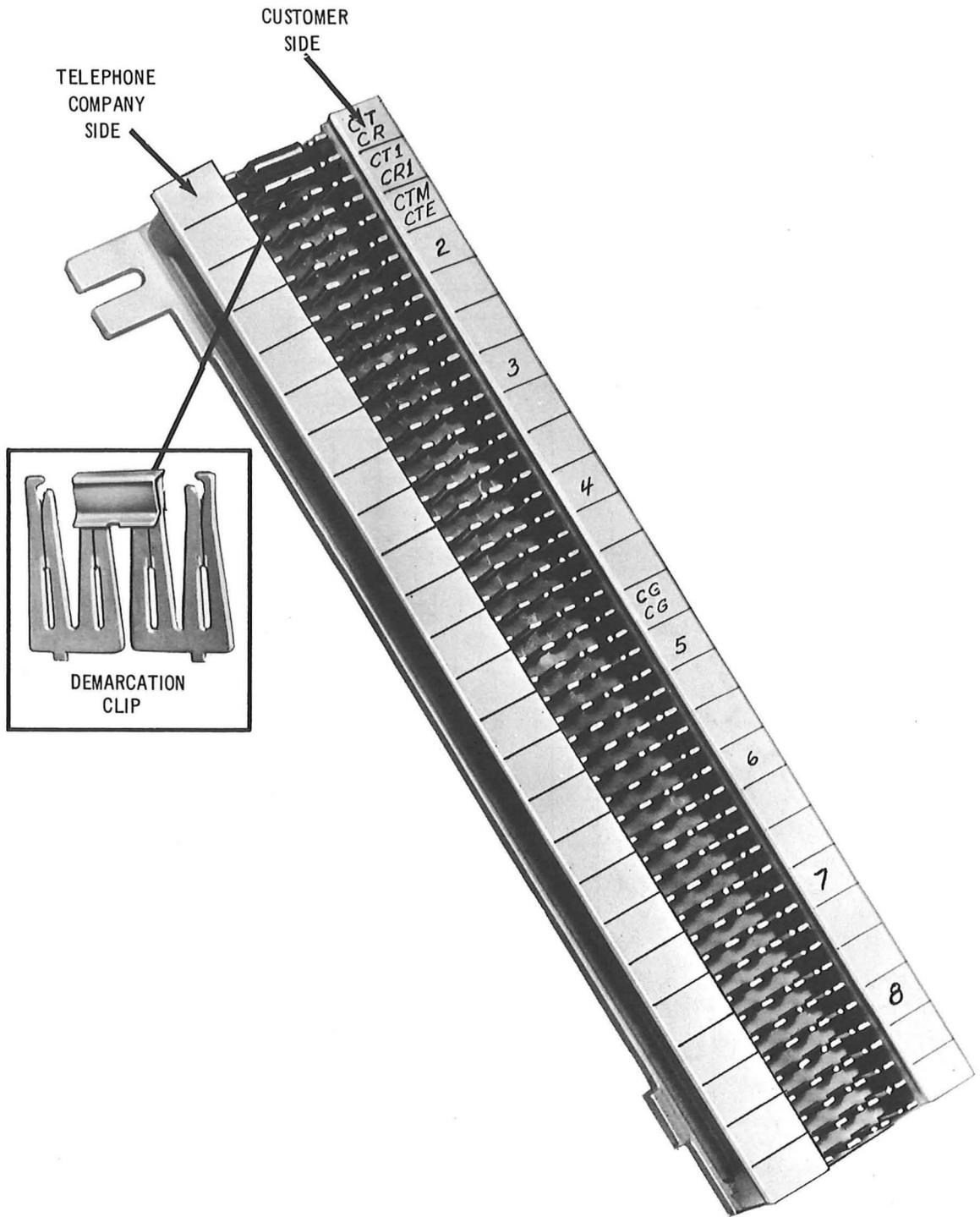
Mr. F. J. Schwetje
Bell Telephone Laboratories, Inc.
Mountain Avenue, Room 3C115
Murray Hill, New Jersey 07974

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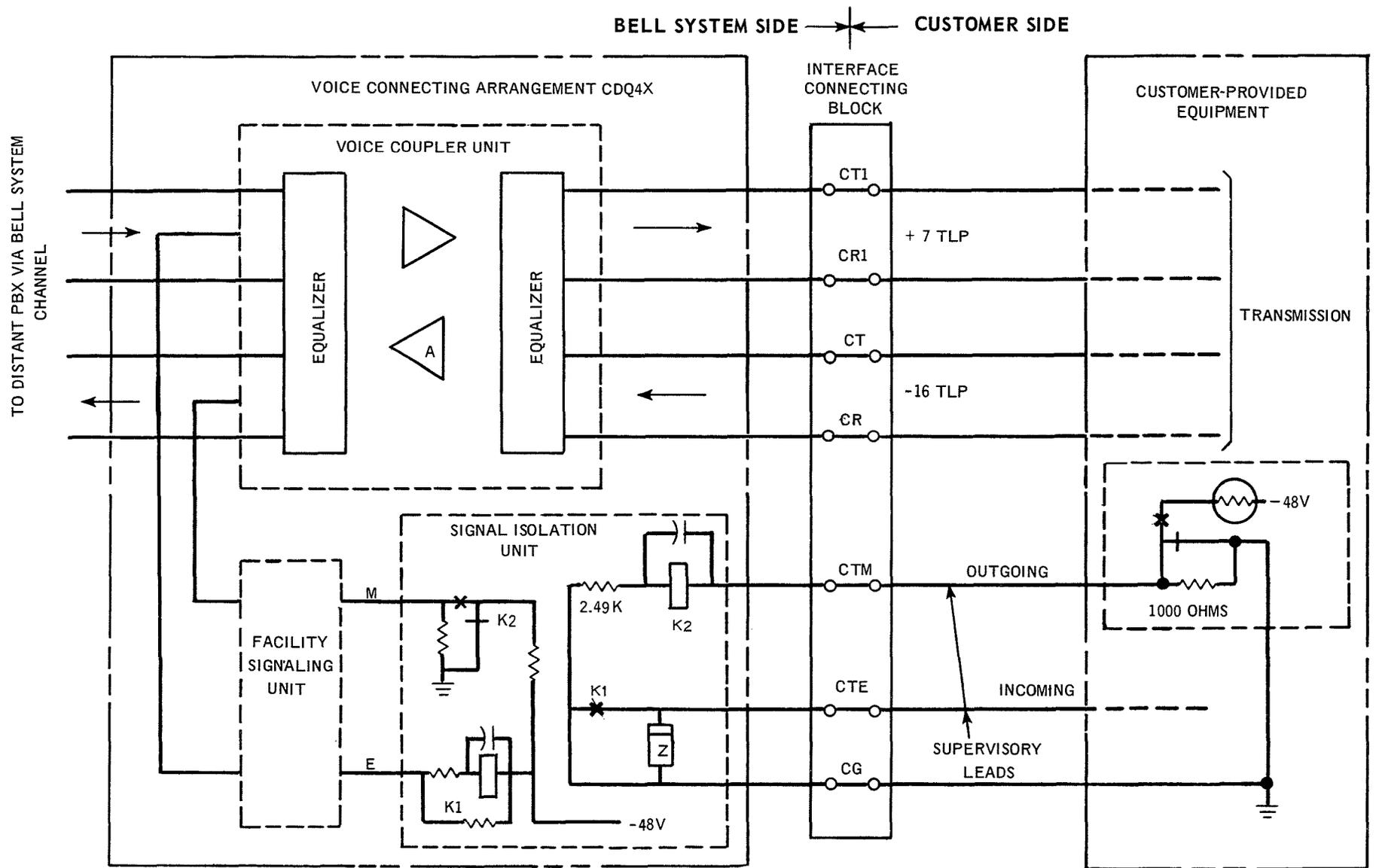
VOICE CONNECTING ARRANGEMENT CDQ4X
Typical Relay Rack Mounting, Front View
FIG. 1

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TYPICAL INTERFACE CONNECTING BLOCK

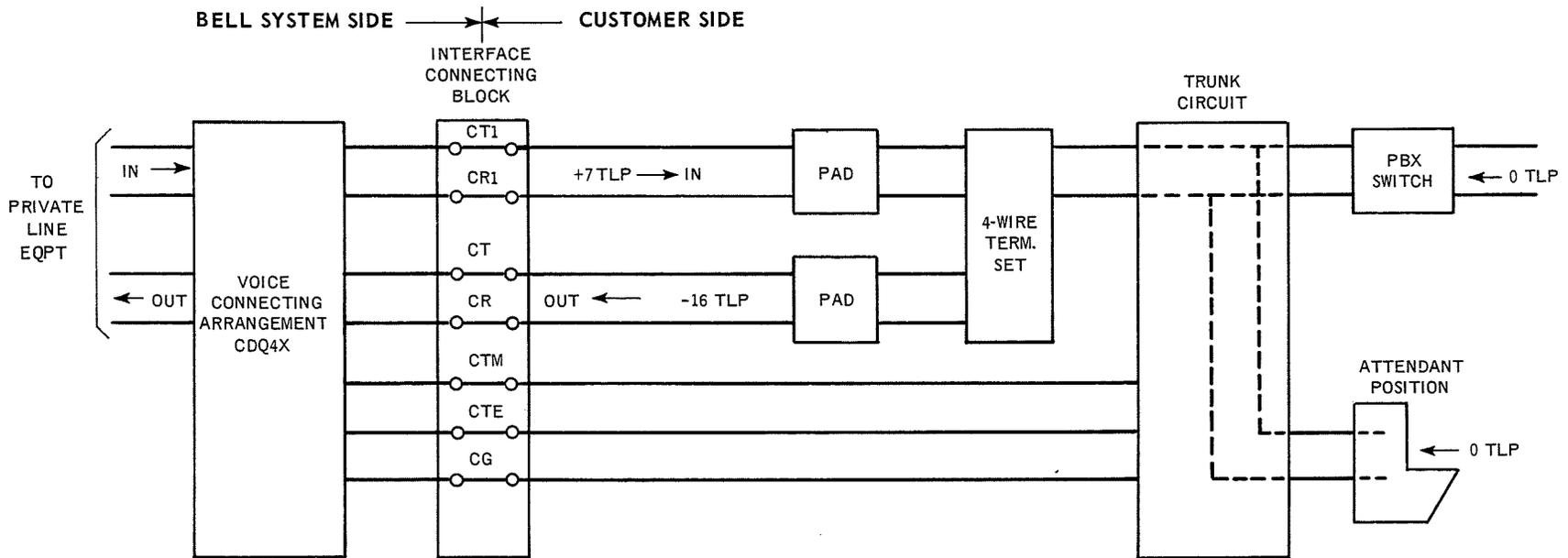
FIG. 2



- AGC AMP
- CONTACT PROTECTION NETWORK

SIMPLIFIED SCHEMATIC — VOICE CONNECTING ARRANGEMENT CDQ4X

FIG. 4



**BLOCK DIAGRAM - APPLICATION OF VOICE CONNECTING ARRANGEMENT CDQ4X
FIG. 3**

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