

Bell System

# TECHNICAL REFERENCE

PROTECTIVE CONNECTING  
ARRANGEMENT CTD

INTERFACE SPECIFICATION  
REVISED JUNE 1975



**Bell System Voice Communications**  
**TECHNICAL REFERENCE**

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**Protective  
Connecting  
Arrangement**

**CTD**

**Interface  
Specification**

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**Revised**

**June 1975**

**ENGINEERING DIRECTOR – CUSTOMER EQUIPMENT SYSTEMS**



## NOTICE

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

This Technical Reference supersedes and replaces Bell System Voice Communications Technical Reference for Connecting Arrangement CTD dated October 1973.

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**TECHNICAL REFERENCE**  
**PROTECTIVE CONNECTING ARRANGEMENT CTD**  
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## 1. GENERAL

### 1.1 Introduction

FCC 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 CTD provides a means for connecting customer-provided call restricting equipment to a central office trunk (eg, local, foreign exchange or WATS line) terminated only on a Telephone Company-provided PBX or Centrex-CU system (Fig. 1), ie, systems in which the switching equipment is located on the premises of the customer.\* This protective connecting arrangement provides an indication to customer-provided equipment of the supervisory condition and address information (dial pulse and TOUCH-TONE<sup>®</sup> signaling) present on the PBX trunk, and a means by which the customer-provided equipment may initiate a request to deny completion of an outgoing call from the PBX. The PBX must be of the type which can be arranged to selectively divert outgoing calls.

The supervisory and dialing (TOUCH-TONE or dial pulse) information is provided to the customer-provided equipment through a high resistance connection to the PBX-CO trunk. If a

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\* For the purpose of this Technical Reference, the 101 ESS is considered to be a central office vehicle.

<sup>®</sup> Registered Service Mark of AT&T Co.

dry-contact type interface is desired by the customer for detecting dial pulses, the customer can order Protective Connecting Arrangement RCX in addition to Protective Connecting Arrangement CTD.

### 1.3 Ordering and Identification

The protective connection service described in this Technical Reference is identified by the Bell System as USOC (Uniform Service Order Code) CTD. One Protective Connecting Arrangement CTD should be ordered for each outgoing or two-way trunk for which call denial capability is required. If Protective Connecting Arrangement RCX is also required, one RCX arrangement should also be ordered for each Protective Connecting Arrangement CTD. 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 this protective connecting arrangement are:

- (a) To protect Telephone Company personnel and facilities from hazardous voltages which may be applied by the customer-provided equipment.
- (b) To provide isolation against longitudinal imbalance.
- (c) To indicate to customer-provided equipment, trunk status information, including supervisory and address (dial pulse and TOUCH-TONE signaling) information, through a high-impedance connection to the PBX-CO trunk.
- (d) To accept a request signal from customer-provided equipment to deny completion of an outgoing call from the Telephone Company PBX.

## 2.2 Physical

Protective Connecting Arrangement CTD consists of equipment for up to four connecting arrangements mounted on one 2 x 23 inch mounting plate. This mounting plate may be relay rack mounted in or near the PBX switching equipment or housed in an apparatus mounting box near the customer-provided equipment. An associated -48 volt rectifier power supply is provided when the connecting arrangement is located remote from the PBX. The power supply requires a grounded outlet connection to a nonswitched customer-furnished nominal 117  $\pm$ 12 volt, 60  $\pm$ 1 Hz source, fused at 15 amperes.

## 2.3 Interface Leads

Four interface leads per circuit are provided from Protective Connecting Arrangement CTD to the Interface Connecting Block for the customer's use (Fig. 1). Technical information pertaining to these leads is discussed in Section 4.

The leads and their functions are as follows:

<u>Lead Designation</u>	<u>Functions</u>
CDPT ) CDPR )	Trunk status indicator to customer-provided equipment
CB ) CS )	Call denial request from customer-provided equipment

Leads from this protective connecting arrangement 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 from his equipment to the connecting arrangement at this block.

A typical Interface Connecting Block is shown in Fig. 2. This "quick connect" type "66" connecting block utilizes tinplated spring clip terminal strips which accommodate unstripped, polyethylene or polyvinyl chloride (8 mils max. thickness) insulated conductors of 20 to 26 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 bridging 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. A test for continuity should be made after replacing the bridging clips.

The customer-provided equipment must be located so that the maximum external loop resistance, including contact resistance, across the CB and CS leads measured at the protective connecting arrangement shall not exceed 180 ohms when indicating a closure. However, the distance between the connecting arrangement and the customer-provided equipment should be as short as possible to avoid interference between circuits since the source impedance of the CDPT and CDPR leads is high.

## 3. OPERATION

A station user behind the Telephone Company-provided PBX desiring to make an outgoing call is connected to an outgoing or two-way trunk from the PBX to the central office (Fig. 3 and Fig. 4) by dialing an access code (eg, dial "9"). The resulting trunk seizure consists of a loop closure through the PBX to the off-hook station, causing line current to flow. When the central office is ready to receive dial pulse or TOUCH-TONE address signals, dial tone is returned to the off-hook station behind the PBX. The station user then dials the number associated with the desired called party. The line condition, supervisory, and dialing information on the trunk is provided to the customer-provided equipment by means of the CDPT and CDPR leads.

On the basis of the digits dialed, if the customer-provided equipment determines that the completion of the call associated with this connecting arrangement is to be denied, the customer-provided equipment then provides a momentary contact closure across the CB and CS leads. In response to this closure, Protective Connecting Arrangement CTD provides a standard polarity reversal signal of controlled duration to the PBX. If the calling line has a "toll restricted" class of service, the call will be transferred to a call denial tone circuit or to the

switchboard attendant (depending on the type of PBX) to prevent call completion. At the same time, the loop to the central office is released by the PBX thereby removing line current and causing the central office to return the trunk to the idle condition and to abandon the outgoing call. If the calling party does not disconnect, an incoming call will be completed to the attendant in the normal manner.

If the calling party has a "toll allowed" class of service, the polarity reversal will not cause the call to be transferred.

## **4. SPECIFIC DESIGN CONSIDERATIONS**

### **4.1 Trunk Status Indicator Path**

Leads CDPT and CDPR provide a high impedance ( $100,000 \pm 3\%$  ohms in each lead) connection to both the tip and ring conductors of the associated PBX-central office trunk only when the trunk is seized. The connection will present a loss to voiceband and dc signals of up to 46 dB or more, depending on the impedance characteristics of the customer-provided equipment. When the trunk is idle (no loop current), the connection to the tip and ring is removed. In the idle condition, the resistors may be connected to -48 volt battery and ground or left open at the user's option (see Fig. 3 and Fig. 4).

Leads CDPT and CDPR provide a means for the customer-provided equipment to detect, through the resistors in each interface lead, the dc and ac status of the trunk, including supervisory and address information while the trunk is in use. The supervisory signals (which consist of "on-hook," indicating an idle or disconnect condition; "off-hook," indicating a request for service by a calling party or an answered call by a called party; and "switchhook flash," indicating operator recall to a connection) and dc dial pulse address information can be detected as dc voltage level differences across the CDPT and CDPR leads. TOUCH-TONE address information consists of two voiceband frequencies for each digit, as discussed in Section 4.14. The supervisory and address signal levels become a function not only of the customer-provided equipment termination but also a function of the length of the loop from the protective connecting

arrangement to the serving central office, the loop to the Telephone Company PBX, and the loop to the station behind the PBX originating the outgoing call. For this reason, details cannot be given on the exact voltage levels that will be encountered in any particular installation.

The CDPT and CDPR leads are to be used by the customer-provided equipment to receive information on the status of the PBX trunk. The following paragraphs describe in general terms the conditions that occur on the various types of PBX-central office trunks. This information is not intended to be all inclusive but is intended as a guide to assist designers of equipment that will be used with Protective Connecting Arrangement CTD. In all cases, the conditions described are those existing on the trunk side of the connecting arrangement. The degree to which the values given would be altered by the high resistance of the CDPT and CDPR leads is a function of the input impedance of the customer-provided equipment.

### **4.11 Loop Start PBX Trunks**

This type of facility is used for some PBX-central office trunks (usually one-way trunks or two-way attendant-only completion).

Figure 5 shows a simplified schematic of a typical loop start trunk. The protective connecting arrangement would generally be bridged onto the trunk close to the PBX. The PBX trunk will not be exposed to polarity reversals during the progress of a call.

In the off-hook conditions, the dc voltages applied to the CDPT and CDPR leads will be reduced by the battery feed resistance and the resistance of the loop. The loop resistance of most PBX trunks is 1300 ohms or less. However, loop resistance of up to 2500 ohms may be encountered in some cases.

In the process of establishing a talking path, the central office circuit, through which dc current is supplied, is changed and various trunk tests are made which can interrupt trunk current (open the loop). "Open" is the general term used to describe the condition when no current flows through the loop.

The length of the open intervals that a PBX trunk can expect to encounter depends on the type of office, class of service, and the progress of the call. Most offices will not generate opens

longer than 300 ms. In some offices, however, the length of the open is traffic-dependent and unbounded. With old or new systems, consecutive switching system initiated opens longer than 100 ms are not expected to occur with less than 100 ms separation.

#### 4.12 Ground Start PBX Trunks

This type of facility can be used for PBX-CO trunks of the following types:

- (a) One-way outgoing (dial "9" or attendant completed)
- (b) Two-way (dial "9" or attendant completed)

In some situations, loop start may be used on one-way service, but in recent years the trend has been to make all PBX trunks ground start. To seize the line for an outgoing call, the PBX places a ground on the ring conductor and the central office responds with a ground on the tip. The PBX switches from the ground start to the loop mode when the central office tip ground is received. When it is ready to receive dial pulses, the central office will return dial tone.

When the PBX station or the attendant goes on-hook at the end of a call originated by the PBX, the loop path is opened by the PBX trunk circuit. The central office will then revert to the idle state (open tip).

Disconnect from the distant end will be indicated by an open on the tip conductor.

#### 4.13 DC Dial Pulse Signaling

In general, dc dial pulses are generated at the telephone set at a nominal rate of 10-pulses per second, with a minimum of 8- and a maximum of 11-pulses per second. The percent break is a minimum of 58 percent and a maximum of 64 percent. The minimum interdigital time is 600 milliseconds.

#### 4.14 Tone Address Signaling

The signaling code for the Bell System TOUCH-TONE calling system provides for 16 distinct signals. Each signal is composed of two voiceband frequencies, one from each of two mutually exclusive frequency groups of four frequencies each. The signal frequencies are spaced and selected on the basis that the two frequencies of any valid signal combination are

not harmonically related. The frequency pairs assigned for the signaling are as follows:

Nominal High Group Frequencies (Hz)					
		1209	1336	1477	1633
<u>Nominal</u>	<u>697</u>	1	2	3	Spare
<u>Low Group</u>	<u>770</u>	4	5	6	Spare
<u>Frequencies</u>	<u>852</u>	7	8	9	Spare
<u>(Hz)</u>	<u>941</u>	*	0	#	Spare

These address signals can be expected to have the following characteristics at the originating station:

##### 1. Frequency Deviation

Tone frequencies are within  $\pm 1.5$  percent of their nominal values.

##### 2. Voice Energy Suppression

Voice energy from the telephone transmitter or other source should be suppressed (eg, the transmitter should be muted) at least 45 dB during tone signal transmission. In the case of automatic dialing, the suppression should be maintained continuously until pulsing is completed.

##### 3. Rise Time

Each of the two frequencies of the signal should attain at least 90 percent of full amplitude within 5 ms; and preferably within 3 ms for automatic dialers, from the time that the first frequency begins.

##### 4. Pulsing Rate

Minimum duration of two-frequency tone signal: 50 ms

Minimum interdigital time: 45 ms

Minimum cycle time (period): 100 ms

#### 4.15 Longitudinal Balance

It is expected that the customer-provided detection device will present a balanced circuit to the CDPT and CDPR connecting arrangement interface leads to minimize the possibility of introducing longitudinal noise to the PBX trunk facility. That is, each conductor should have equal impedance to ground.

Balanced operation will also insure that the customer-provided equipment is not subject to longitudinal noise that may be present on the telephone facility.

The customer-provided device should maintain balance within 20,000 ohms.

#### **4.2 Call Denial Request Path (Leads CB and CS)**

There are two types of equipment used to provide Protective Connecting Arrangement CTD. The only significant difference is in the circuit connected to the CS terminal. Since there is no way to insure the use of one or the other for a given installation, connecting equipment should be compatible with both types of equipment used by the Telephone Company to provide Protective Connecting Arrangement CTD. Figures 3 and 4 show the two types of equipment used to implement Protective Connecting Arrangement CTD.

To divert a call, the customer's equipment connects CB to CS. CB is connected to Telephone Company-supplied "battery" in both arrangements. This "battery" is a nominal -48 volts dc. CB must not be used to power the customer's equipment.

Figure 3 shows the equipment which uses a 640 ohm relay and a 22 volt zener diode connected from terminal CS to ground. The relay is bridged with a diode to make it appear as a noninductive load to the customer's equipment. With the circuit shown in Figure 3, the maximum resistance in the path from CB to CS must be less than 180 ohms to insure operation of the relay.

Figure 4 shows the equipment which uses a 2450 ohm relay connected from CS to ground. This relay is also bridged with a diode to make it appear as a noninductive load to the customer's equipment. With the circuit shown in Figure 4, the maximum resistance in the path from CB to CS must be less than 1000 ohms to insure operation of the relay.

The closure on these leads, when given, shall be provided only during the interval starting at the receipt of the first digit of the number dialed and ending two seconds after the receipt of the last digit to insure that the call is not completed (answered) and, therefore, billed.

Since the closure on leads CB and CS causes the protective connecting arrangement to reverse the polarity to the trunk, the station placing the call, will in some cases, also receive this reversal. Bell System TOUCH-TONE® telephones will, in general, not operate under reverse polarity conditions. It is, therefore, preferable to cause the reversal within two seconds after the last digit to prevent lost digits caused by momentary reversals sent to authorized stations while dialing is still in progress.

The closure shall be at least one second in duration, and the minimum open interval between successive closures shall be at least 50 milliseconds. Only one call denial request is possible with each contact closure on the CB and CS leads and, therefore, the contact closure must be opened and reclosed for each call denial request. Once the contact closure is removed for any interval of time, it shall not be reclosed except during the acceptable time interval discussed above and only on calls required to be denied completion. If provided at other times, it can result in the disconnect of a call in progress.

#### **4.3 Grounding**

Protective Connecting Arrangement CTD is provided with a common signal ground (a metallic cold water pipe or other appropriate ground) which is always bonded to the electric power ground and telephone protector ground, where present. Although the CS lead of the call denial request path is grounded at the protective connecting arrangement through the relay winding (2450 ohms nominal, circuit of Figure 4), it is not permitted to use this lead to derive the main ground for the customer's equipment. The general grounding requirements for the customer-provided equipment are covered in Section 5.2.

### **5. GENERAL DESIGN CONSIDERATIONS**

#### **5.1 Foreign and Surge Voltage Protection**

Where telephone lines are exposed to power line contacts, 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 this 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, eg, 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.

## 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 CTD from the Telephone Company.

- (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 equipment and ordering the protective connecting arrangement by code CTD.
- (b) Connecting the equipment to the interface connecting block.
- (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 equipment 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 equipment or 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 (1) the through transmission of signals generated by the customer-provided equipment or for the quality of, or defects in, such transmission, (2) the reception of signals by customer-provided equipment, or (3) 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 the technical specifications 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. Location and telephone number of the location if different
- E. Uniform Service Order Code (USOC) CTD
- F. Nature of trouble
- G. 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.

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

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

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

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

**INTERFACE 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 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 denomination, 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 is answering or originating a call.

**ON-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 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).

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

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

## 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.
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- \*\*\* (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.

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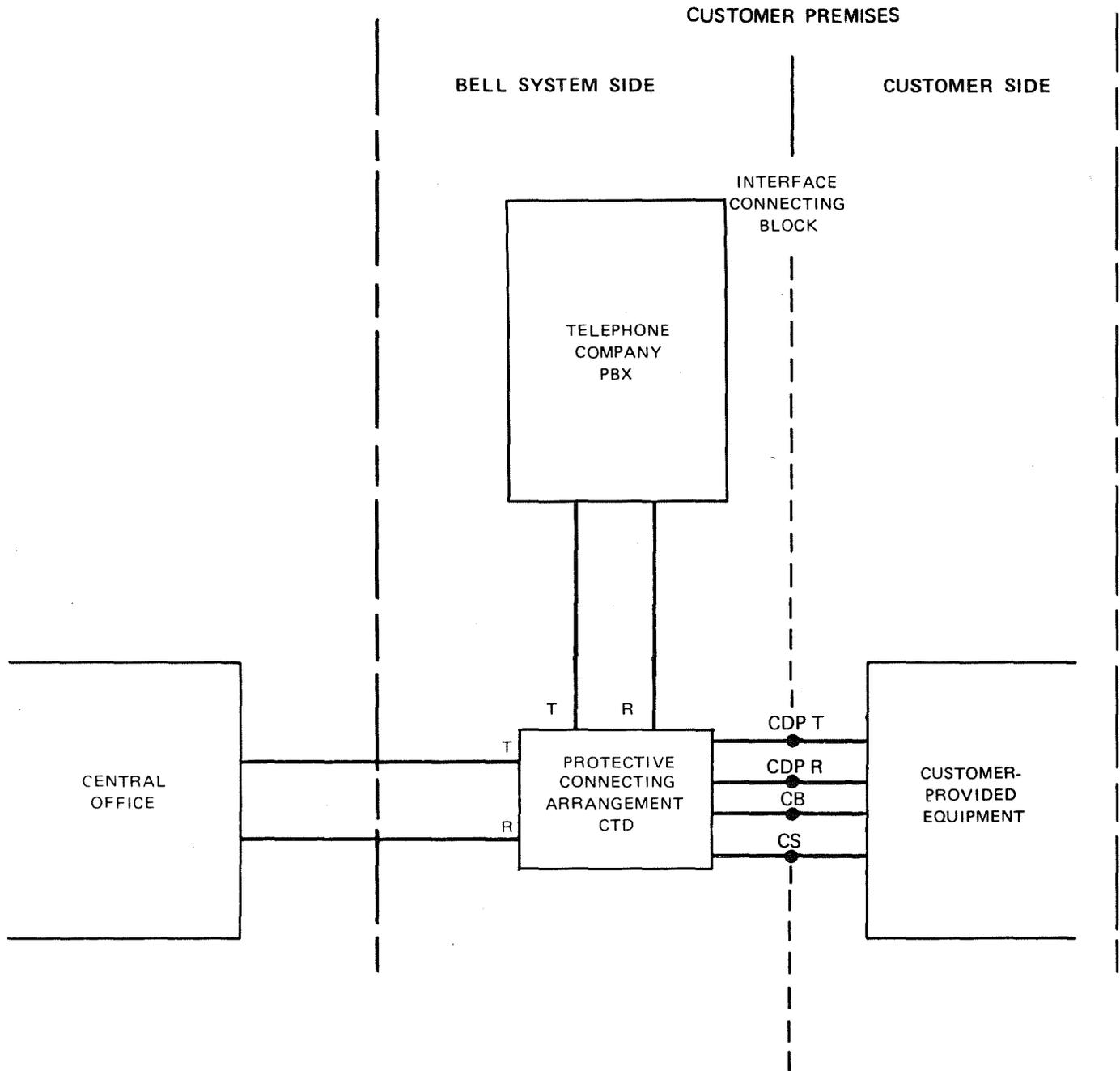
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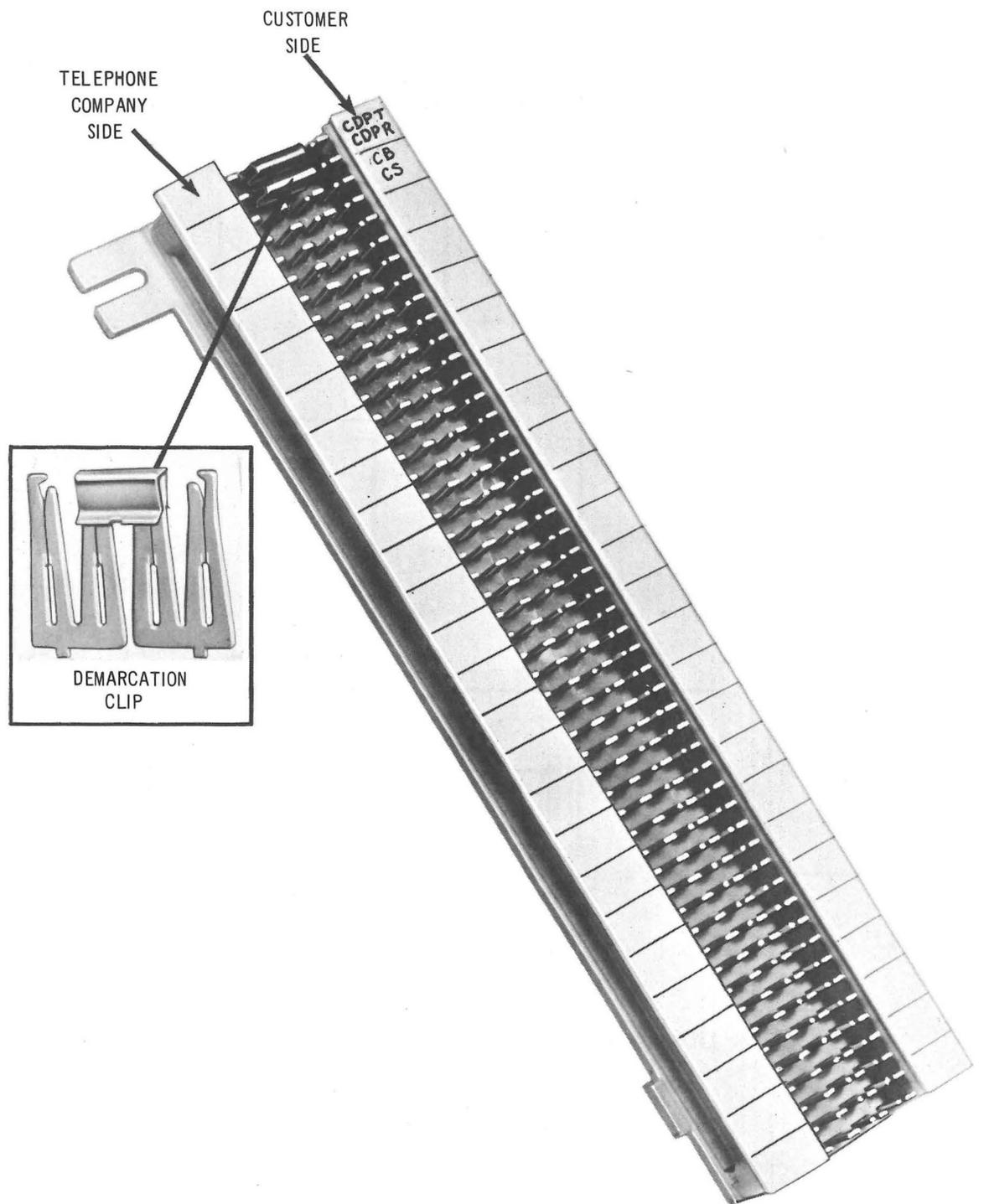
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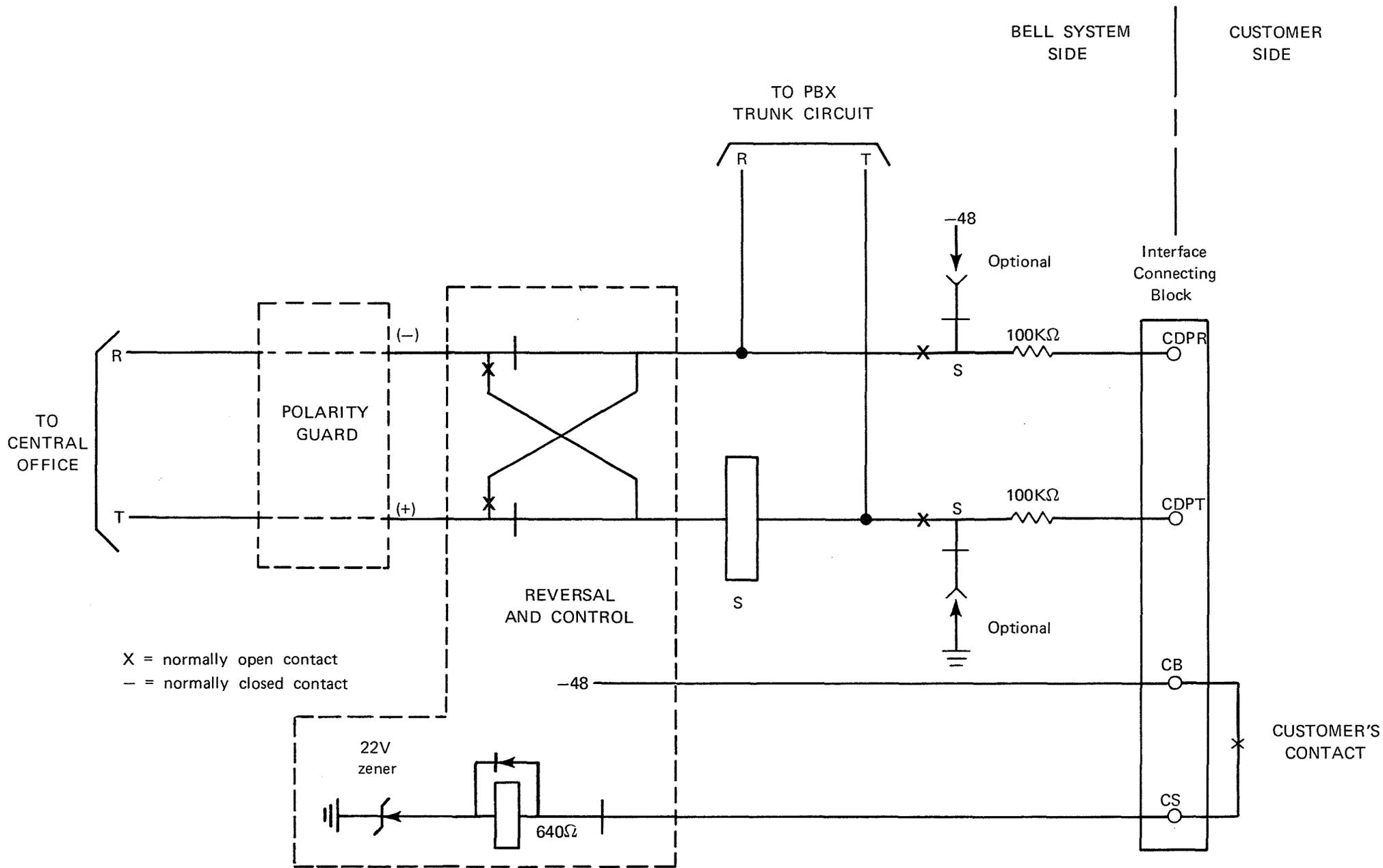
BLOCK DIAGRAM - PROTECTIVE CONNECTING ARRANGEMENT CTD

FIG. 1



TYPICAL INTERFACE CONNECTING BLOCK

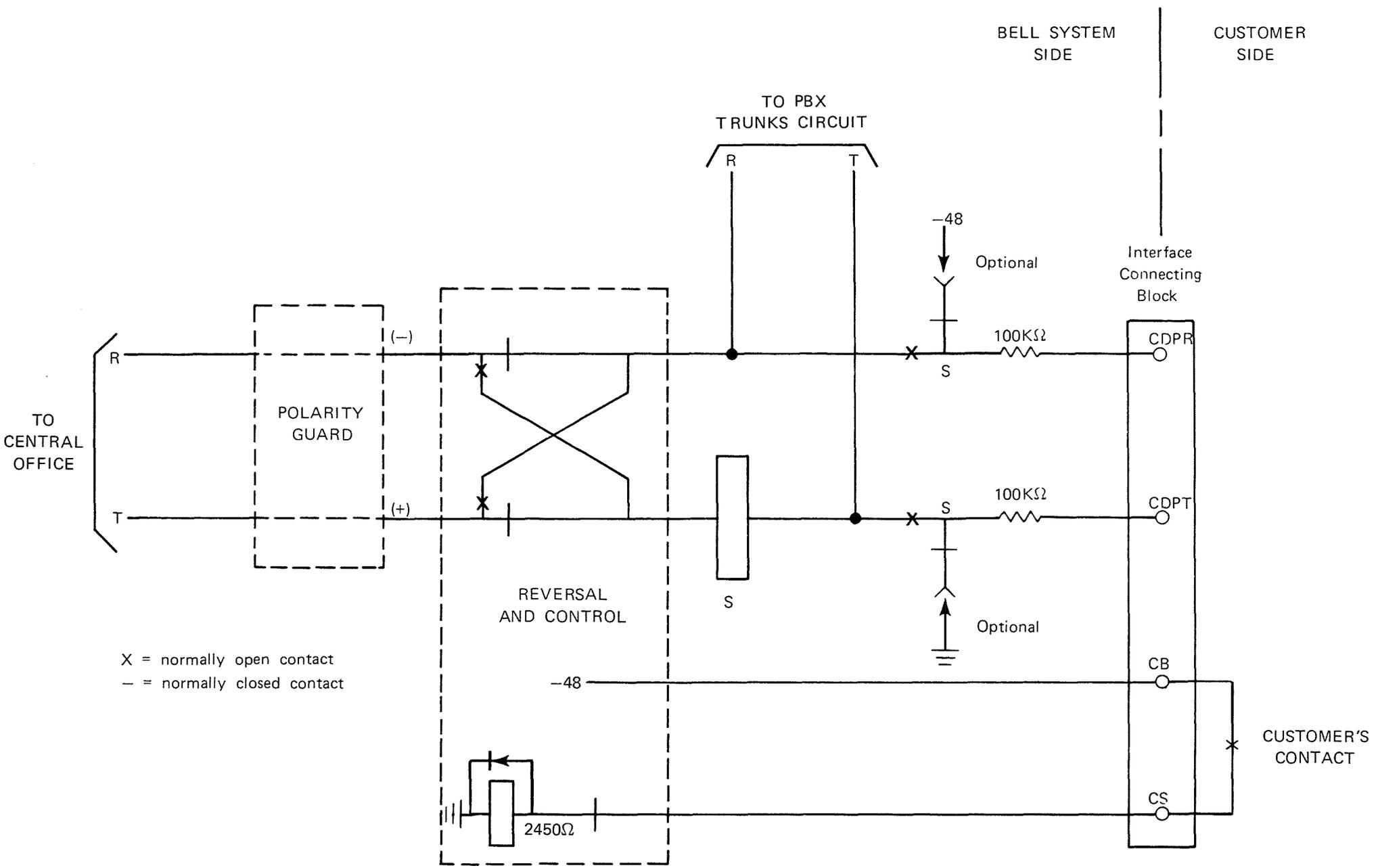
FIG. 2



SIMPLIFIED SCHEMATIC – PROTECTIVE CONNECTING ARRANGEMENT CTD \*

Fig. 3

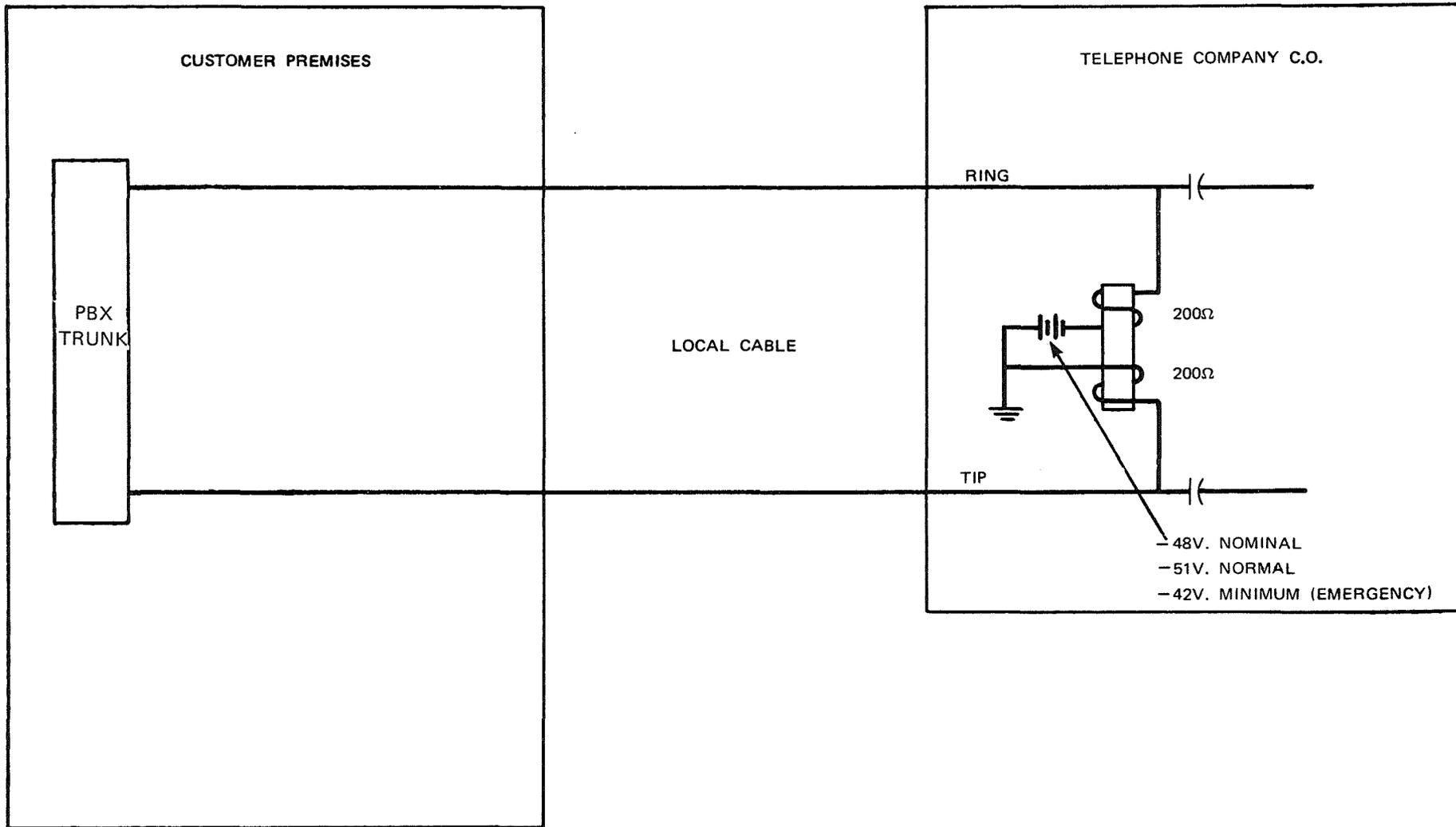
\*SEE FIGURE 4 FOR VARIATION



SIMPLIFIED SCHEMATIC – PROTECTIVE CONNECTING ARRANGEMENT CTD\*

Fig. 4

\*SEE FIGURE 3 FOR VARIATION



TYPICAL CENTRAL OFFICE  
BATTERY FEED CIRCUIT

FIG. 5