

PRELIMINARY

Bell System Voice Communications TECHNICAL REFERENCE

Protective Connecting Arrangement

C22

Interface Specification

**Revised
July 1976**

ENGINEERING DIRECTOR – CUSTOMER EQUIPMENT SYSTEMS



PRELIMINARY

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 other standards; 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 equipment and systems are set forth in the appropriate tariff regulations.

This Technical Reference supersedes and replaces preliminary Bell System Voice Communications Technical Reference for Voice Connecting Arrangement C22 dated March 1971.

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TECHNICAL REFERENCE

PROTECTIVE CONNECTING ARRANGEMENT C22

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PROTECTIVE CONNECTING ARRANGEMENT C22

1. GENERAL

1.1 Introduction

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

1.2 Application

Protective Connecting Arrangement C22 provides a means of connecting a customer-provided communications system (typically a PBX) to the telecommunications network via an inward trunk line from the serving central office (Fig. 1). The arrangement is used where the Bell System central office provides direct inward dialing (DID) service to the customer-provided equipment. This arrangement is provided for voice signal transmission only and cannot be used for transmission of data signals.

1.3 Power Outage Provisions

Protective Connecting Arrangement C22 is normally powered by a Telephone Company-provided power supply which operates from commercial power. Connecting arrangement power outage protection can be provided by a Telephone

Company battery backup system or a customer-provided power supply and battery backup system using two Voice Connecting Arrangement VCP's. These options are described in detail in Technical Reference Notice PUB 42607.

1.4 Ordering and Identification

The protective connection service described in this Technical Reference is identified by the Bell System as Uniform Service Order Code (USOC) C22. When ordering this service, the customer should specify this code. One protective connecting arrangement should be ordered for each inward trunk line that is to be connected. The availability of this service is dependent upon the capabilities and equipment availability of the serving central office.

Since calls will be dialed directly to PBX stations, arrangements must also be made for the assignment of DDD numbers as required. The availability of these numbers is dependent upon the number assignments made and planned for the serving central office. Arrangements for numbers should therefore be made before the C22 Protective Connecting Arrangements are ordered.

The local Telephone Company business office or marketing representative will provide information regarding availability and rates for both the C22 Protective Connecting Arrangements and the number assignments. When ordering service, the customer should also specify whether provision is to be made for any of the power outage protection methods described in Paragraph 1.3.

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 provide voice-only transmission to and from the telecommunications network.
- (d) To limit abnormally high voice and call progress signal levels from the customer-provided equipment.
- (e) To provide for accepting call supervisory signals from customer-provided equipment.
- (f) To provide line supervisory and incoming dial pulse signals to customer-provided equipment.
- (g) To limit transmission to one direction (toward calling party) until answer supervision is provided by customer-provided equipment.

2.2 Physical

Protective Connecting Arrangement C22 consists of an 8-inch printed wiring board mounted in a panel that will accommodate up to 14 of these units (Fig. 2). When power is supplied by the Telephone Company, each of the associated 24-volt and 48-volt rectifier power supply requires a grounded outlet connection to a non-switched, customer-furnished, nominal 117 ± 12 volt, 60 ± 1 Hz source, fused at 15 amperes.

2.3 Interface Leads

Six interface leads per circuit are provided from Protective Connecting Arrangement C22 to the Interface Connecting Block for the customer's use (Fig. 3). Technical information pertaining to these leads is discussed in Sections 3 and 4.

The leads and their functions are as follows:

<u>Lead Designation</u>	<u>Function</u>
CT) CR)	call progress tones and voice transmission (one way only before answer)
CS) CG)	start signal, answer, and disconnect
CDP1) CDP2)	incoming seizure, dial pulse repeating, and C.O. release

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 of his equipment to the protective connecting arrangement at this block. The block will normally be located within 25 feet of the connecting arrangement itself.

A typical Interface Connecting Block is shown in Fig. 3. This "quick connect" "66" type connecting block utilizes tin plated spring clip terminal strips which accommodate unstripped, insulated conductors of 20 to 26 gauge. 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.

The customer-provided equipment must be located so that the maximum external loop resistance, including contact resistance, across the CS and CG leads measured at the block shall not exceed 100 ohms when indicating a closure.

3. OPERATION

3.1 Connection of a Call

When the central office seizes the line associated with Protective Connecting Arrangement C22 for an incoming call (see Fig. 4), the connecting arrangement detects the seizure and provides a dry contact closure on the CDP1 and CDP2 leads to the customer-provided equipment. The closure will remain for the duration of the call except during in-dialing when pulsing appears on this contact. In addition, momentary opens may occasionally occur from transient pulses or other causes.

After seizure, dialing from the central office to the customer-provided system will be on either an immediate start or wink start basis depending primarily on the central office serving the customer-provided system. The local Telephone Company representative should be consulted to determine which mode of operation will apply for a given installation.

When the serving central office is of the step-by-step type, the 2 or 3 in-dialed digits will be sent to the customer's premises in the same format used to control the final stages of switching in the central office. Consequently, the customer-provided equipment must be prepared to receive dial pulses immediately after seizure.

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Under wink start operation, the customer-provided equipment shall provide a 200 millisecond nominal (140 to 400 millisecond) closure on the CS and CG leads when the equipment is ready to receive dial pulses.

After sending a wink start signal, the connecting arrangement may see a reflection of the off-hook to on-hook transition as a momentary open on CDP1 and CDP2. Since this will look like a digit 1, the customer-provided equipment should ignore any pulses on the CDP1 and CDP2 leads which occur within 70 milliseconds after the transmission of a wink start signal. Central offices will not begin to pulse until after this time. Under no circumstances should the customer-provided equipment return an answer signal during pulsing.

After dial pulses have been received, call progress tones (e.g., audible ringing, busy or reorder) may be applied by the customer-provided equipment to the CT and CR leads for transmission to the calling station. When the in dialed number is unassigned, a recorded announcement should be returned indicating that the call has been completed to a nonworking number. This same announcement should give the listed number for attendant assistance at the PBX. Announcements should also be provided when the PBX is out of service. A one-way unigain amplifier blocks incoming transmission from the central office during this interval and prior to an answer by the called station. Note that as shown in Figure 4, CT is at a-c ground and signals must be applied between CR and ground (CT) prior to answer.

When the called station answers, the customer-provided equipment shall provide a continuous contact closure on the CS and CG leads which causes an answer signal to be sent to the central office and the one-way amplifier to be removed from the CT and CR leads enabling two-way transmission. At this time, CT and CR provide for balanced transmission.

3.2 Disconnect

The customer-provided equipment should guard against momentary opens on the CDP1 and CDP2 leads which may result from transient pulses or other causes. An open on the CDP1 and CDP2 leads for longer than 140 milliseconds may be regarded as a central office disconnect signal. If the central office disconnects first, the customer-provided equipment shall open the contact closure between the CS and CG leads within 400 milliseconds after the CDP1 and CDP2 leads open. In those cases where the central office has disconnected first, there will be a momentary (up to 15 milliseconds) closure on CDP1 and CDP2 when CS and CG are opened. The customer-provided equipment should ignore this closure. The protective connecting arrangement will release the line to the central office when CS and CG are opened. If the customer-provided equipment disconnects first by removing the contact closure on the CS and CG leads, the central office will then disconnect as indicated by an open on the CDP1 and CDP2 leads. Depending on the type of equipment and services involved in the call, it can take up to 32 seconds to open CDP1 and CDP2. The customer-provided equipment must be able to process a new incoming call whenever CDP1 and CDP2 are open.

3.3 Testing

The bridging clips provided on the leads at the Interface Connecting Block should be removed by the customer's representative when it is necessary to test toward the customer-provided equipment. Arrangements can be made through the Telephone Company to temporarily busy out a line in order to test the customer-provided equipment. After testing, the straps or clips should be replaced and the Telephone Company should be instructed to restore the circuit to service.

4. SPECIFIC DESIGN CONSIDERATIONS

4.1 Transmission Path (Leads CT and CR)

4.11 Insertion Loss

The insertion loss of Protective Connecting Arrangement C22 after the call has been answered (CS connected to CG) is a nominal 1 dB over the voice-frequency range of 300 Hz to 3000 Hz.

4.12 Impedance

The impedance of Protective Connecting Arrangement C22 is a function of the impedance of the line to the central office. For design purposes, the input impedance of this arrangement should be considered to be 600 ohms. Therefore, the impedance of the customer-provided equipment should be 600 ohms for optimum voice signal power transfer across the interface.

Prior to return of answer supervision, the connecting arrangement presents an unbalanced transmission path to the customer-provided equipment (tip ground).

4.13 Bandwidth

The nominal voice-frequency bandwidth of the telecommunications network 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 on either side of this band. This protective connecting arrangement does not limit the bandwidth.

4.14 Signal Power Level

The tariffs state that the average power (in any 3-second interval) delivered at the central office should not exceed -12 dBm in order to prevent excessive noise and crosstalk from interfering with other services. To meet this specification, the maximum available power from a customer-provided

source when averaged over any 3-second interval (measured at the CT and CR leads with a 600 ohm load substituted for the connecting arrangement) should not exceed -9 dBm. This limit has been set so that when the average loss of PBX trunks in the Bell System are considered (including the insertion loss of the protective connecting arrangement), the limit of -12 dBm at the central office will be met.

Using measuring Method A (see Paragraph 4.15), the power averaged over any 3-second interval will, in almost all cases, not exceed -9 dBm if the maximum meter swing does not exceed 84 dBrn. With the additional damping of measuring Method B, the power averaged over any 3-second interval will not exceed -9 dBm if the maximum meter swing does not exceed 82 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 signal power criteria specified in Paragraph 4.14 are 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.

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

Western Electric 3-Type
Noise Measuring Set

Hewlett-Packard Transmission
and Noise Measuring Set
Model 3555B

<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 the Model 3555B or 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, which are connected at all times to the telephone circuit, are designed to detect a single-frequency tone at 2600 Hz. They are, however, relatively insensitive to energy at this frequency if sufficient energy is present at the same time 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 protective 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 27 dB below one milliwatt.
- (b) The power in the band from 4005 Hz to 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 Signal Limiting

A voice signal limiter is incorporated in the transmission path of the protective connecting arrangement to protect the Bell System telecommunications network from applications of abnormally high signal levels. This has no effect on normal voice or normal tone address signal levels.

This limiter does not abrogate the customer's responsibility to meet the network protection criteria as prescribed in the tariffs and as outlined in Paragraph 4.14.

4.2 DC Signaling Paths

4.21 Answer Supervisory Path

The CS and CG leads provide a means of answering and disconnecting on an incoming call. When required, they are also used to provide a wink start signal via the protective connecting arrangement to the dial pulse sender in

the serving central office. The CS lead has a maximum potential of -26 volts dc through 590 ohms. The CG lead is grounded at the connecting arrangement but cannot be used by the customer as the primary ground for his equipment.

The CS and CG pair will offer the customer-provided equipment a maximum inductive load of .05 ampere. Contact protection is provided by the connecting arrangement. The minimum open circuit insulation resistance of the customer-provided equipment between the CS and CG lead should be 100,000 ohms. When indicating a closure, 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 should not exceed 100 ohms.

4.22 Seizure Supervisory Path

The CDP1 and CDP2 leads provide a contact closure to the customer-provided equipment when the protective connecting arrangement is seized on an incoming call and remain closed for the duration of the call except during dialing. The open circuit resistance is greater than 15,000 ohms and the closed circuit resistance is less than 5 ohms. In addition, momentary opens and/or closures may result from transient pulses or other causes. The customer's equipment load on these leads should not exceed .50 ampere peak. The customer's equipment shall provide appropriate contact protection.

Protective Connecting Arrangement C22 provides dial pulses sent by the central office over the CDP1 and CDP2 leads to the customer-provided equipment. The dial pulses will be generated at a nominal rate of 10 pulses-per-second, with a minimum of 8 pulses-per-second and a maximum of 11 pulses-per-second. The percent break will be between a minimum of 25 percent and

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a maximum of 90 percent. The minimum interdigital time after the first digit will be approximately 600 milliseconds.

4.3 Grounding

Protective Connecting Arrangement C22 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 telephone protector ground, where present. Although the CG lead of the outgoing supervisory pair is grounded at the protective connecting arrangement, it is not permitted to derive the main ground for the customer's equipment through this lead. The general grounding requirements for the customer-provided equipment are covered in Paragraph 5.2.

5. GENERAL DESIGN CONSIDERATIONS

5.1 Foreign and Surge Voltage Protection

Where telephone lines are exposed to power line contact, lightning exposure, power line induction, or a rise in ground potential exceeding 300 volts RMS, protective devices are installed at the central office and on the customer's premises. These devices 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 so that foreign and hazardous voltages from his equipment and facilities are not applied to the protective connecting arrangement.

5.2 Grounding

It is expected that the customer's equipment, if powered from commercial power, will be grounded in accordance with applicable electrical codes, e.g., National Electrical Code (NEC), and should be bonded to the ground electrode to which the telephone protector is grounded but not using the telephone ground clamp. Provisions should be made within the customer's equipment for connecting together all internal signal grounds. This connection shall be isolated from both the grounding (green) conductor run with the power supply primary conductors and the chassis or frame of the customer-provided equipment.

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

5.3 Telecommunications Network Characteristics

5.3.1 End-to-End Electrical Loss

The end-to-end electrical loss of a connection is a function of the impedance of both end terminations and the losses of the interoffice trunks, the serving central offices, and the facilities to the serving offices. The

information found in the REFERENCES in Appendix B may be used to determine statistical loss distributions for different types of calling patterns on the telephone network.

5.32 Nonlinearities

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

6. SERVICE RESPONSIBILITIES

6.1 Responsibility of the Manufacturer

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

- a) Informing the purchaser as to which protective connecting arrangement his equipment has been designed to work with.
- b) Advising the purchaser to order this protective connecting arrangement by code (C22) 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 a device and ordering the protective connecting arrangement by code (C22).
- 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 device from use if the customer detects that it is defective or if the Telephone Company notifies the customer that the equipment is causing a hazard or interference as specified above.

6.3 Responsibility of the Telephone Company

The Telephone Company shall not be responsible for the installation, operation or maintenance of any customer-provided terminal equipment. Long distance message telecommunications service is not represented as adapted to the use of customer-provided equipment and where such equipment is connected to Telephone Company facilities, the responsibility of the Telephone Company shall be limited to the furnishing of facilities suitable for telecommunications service and to the maintenance and operation of such facilities in a manner proper for such telecommunications services. Subject to this responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by the customer-provided equipment or for the quality of, or defects in, such transmission, (ii) the reception of signals by customer-provided equipment, or (iii) address signaling where such signaling is performed by customer-provided tone-type signaling equipment.

The Telephone Company shall not be responsible to the customer or otherwise if changes in minimum network protection criteria contained in the tariffs and in this Technical Reference or in any of the facilities, operations

or procedures of the Telephone Company render any customer-provided equipment obsolete or require modification or alteration of such equipment or otherwise affect its use or performance.

7. MAINTENANCE OF SERVICE

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

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

- (a) Customer's name
- (b) Customer's address
- (c) Listed telephone number
- (d) Description of the trouble
- (e) Uniform Service Order Code (USOC) C22
- (f) Customer's contact for additional information

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

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GLOSSARY

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

COMMUNICATIONS SYSTEM - denotes channels and other facilities which are capable, when not connected to the Long Distance Message Telecommunications Service, of communications between customer-provided terminal equipment or Telephone Company stations.

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

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

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

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

INTERFACE 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.

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NETWORK CONTROL SIGNALING - denotes the transmission of signals used in the telecommunications network which perform functions such as supervision (control, status, and charging signals), address signaling (dialing), calling and called number identification, audible tone signals (call progress signals indicating reorder or busy conditions, alerting, coin denominations, coin collect and coin return tones) to control the operation of switching machines in the telecommunications network.

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

OFF-HOOK SUPERVISION - the conditioning of the interface leads by the customer-provided equipment which indicates that it 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.

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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 - 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.

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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) Bell System Data Communications Technical Reference - PUB 41007 - 1969-1970 Switched Telecommunications Network Connection Survey (Reprints of Bell System Technical Journal articles) - April 1971.
- *** (f) "Principles of Electricity Applied to Telephone and Telegraph Work," by American Telephone and Telegraph Company, New York, New York.
- *** (g) "Switching Systems," by American Telephone and Telegraph Company, New York, New York.

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- (h) "Notes on Transmission Engineering," by United States
Independent Telephone Association, Washington, D. C.
- *** (i) "Transmission Systems for Communications," by Bell
Telephone Laboratories, Inc.
- *** (j) "Notes on Distance Dialing - 1975," by American Telephone
and Telegraph Company, New York, New York.

*These journals may be purchased by writing to:

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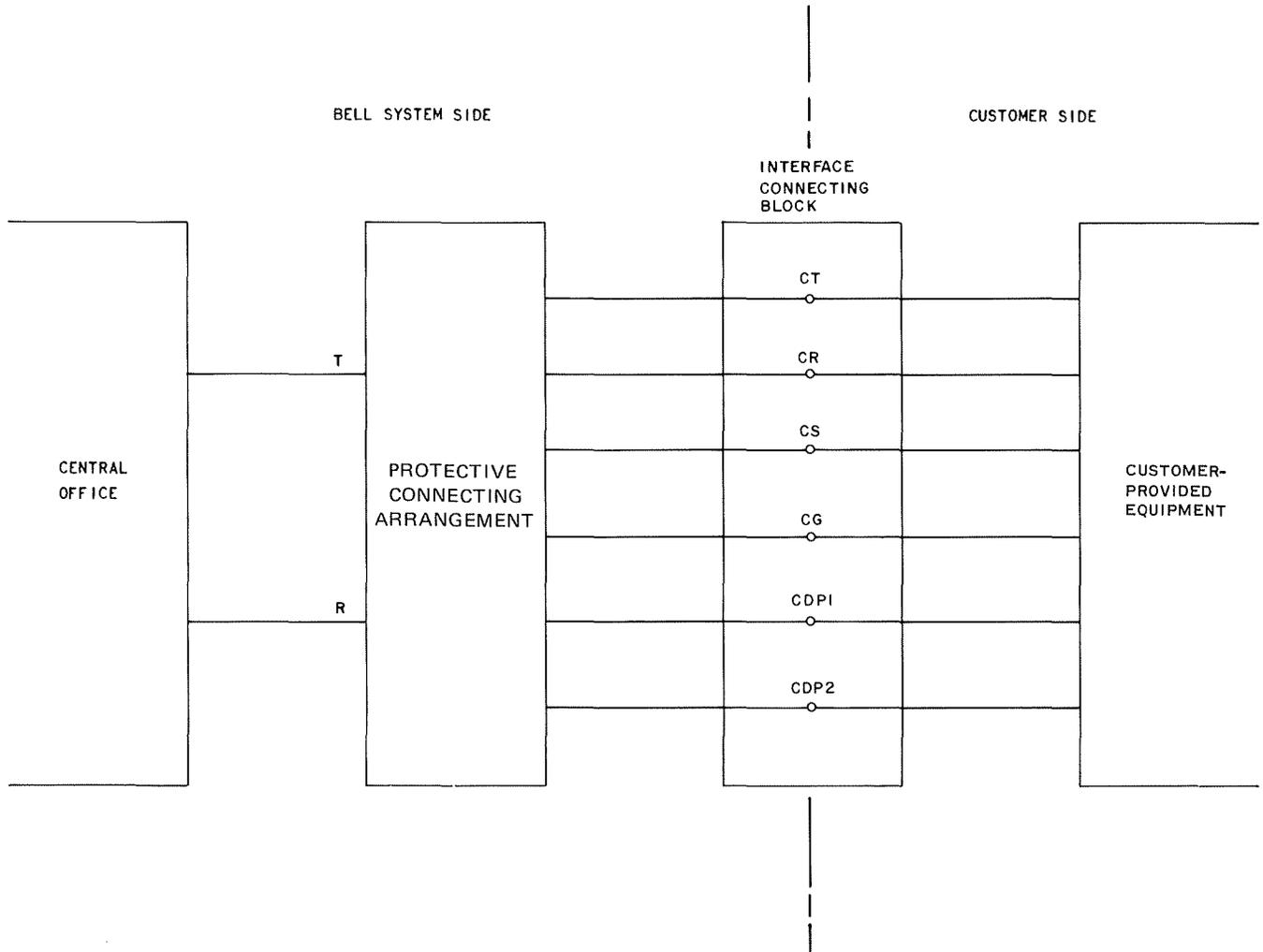
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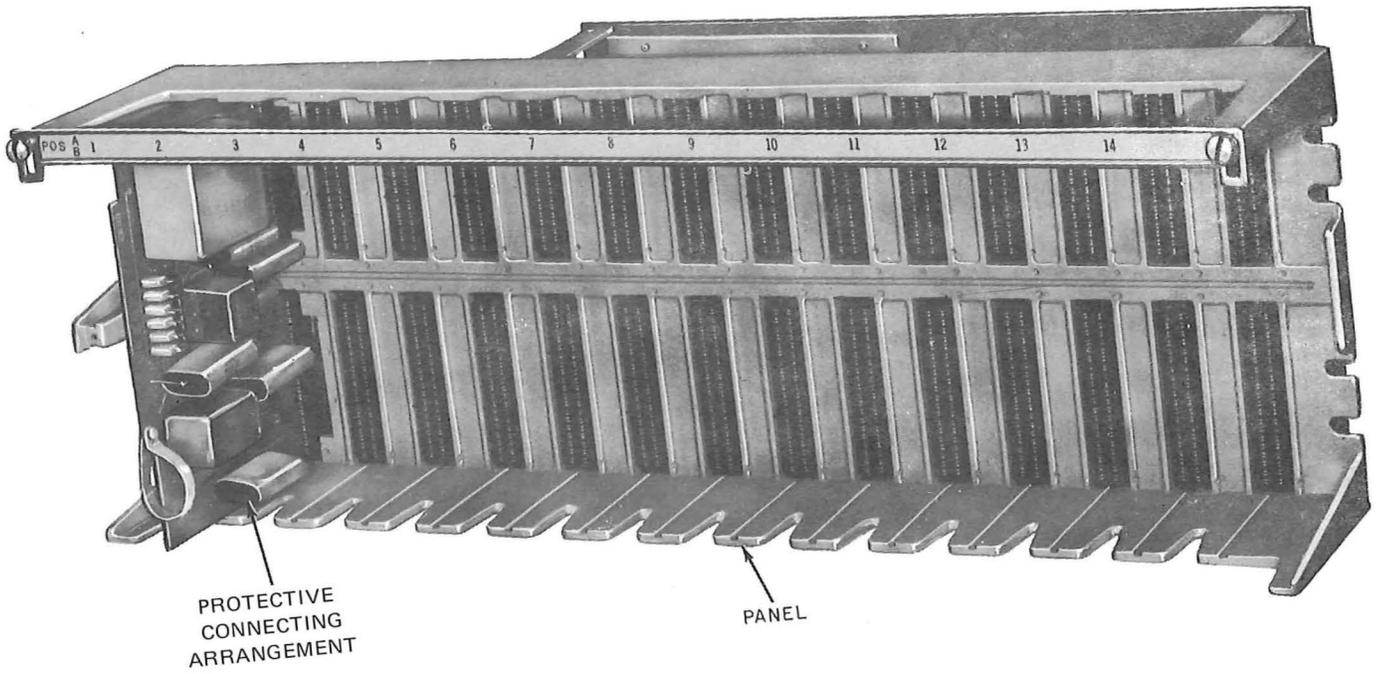
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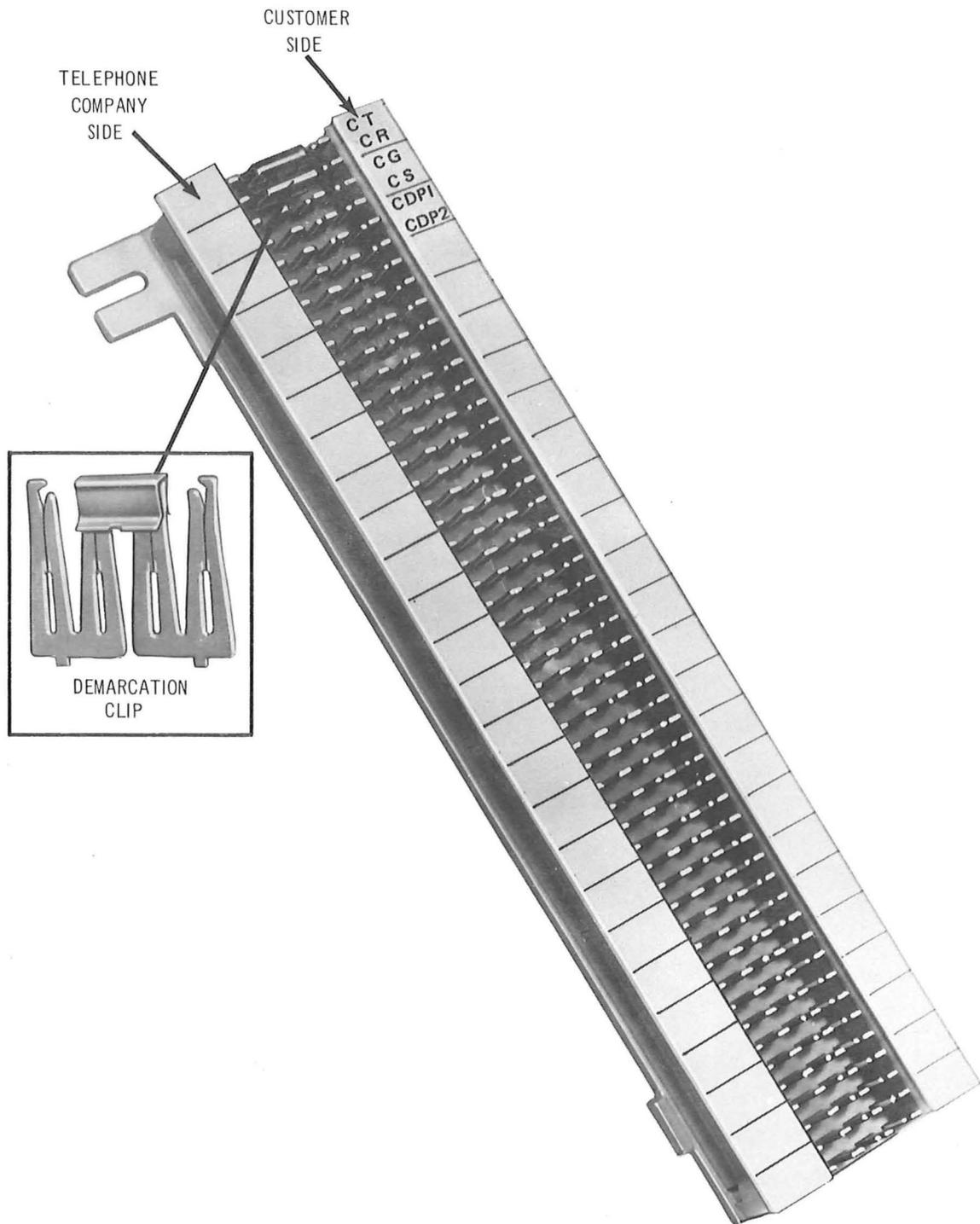
BLOCK DIAGRAM — PROTECTIVE CONNECTING ARRANGEMENT C22
FIGURE 1

PRELIMINARY



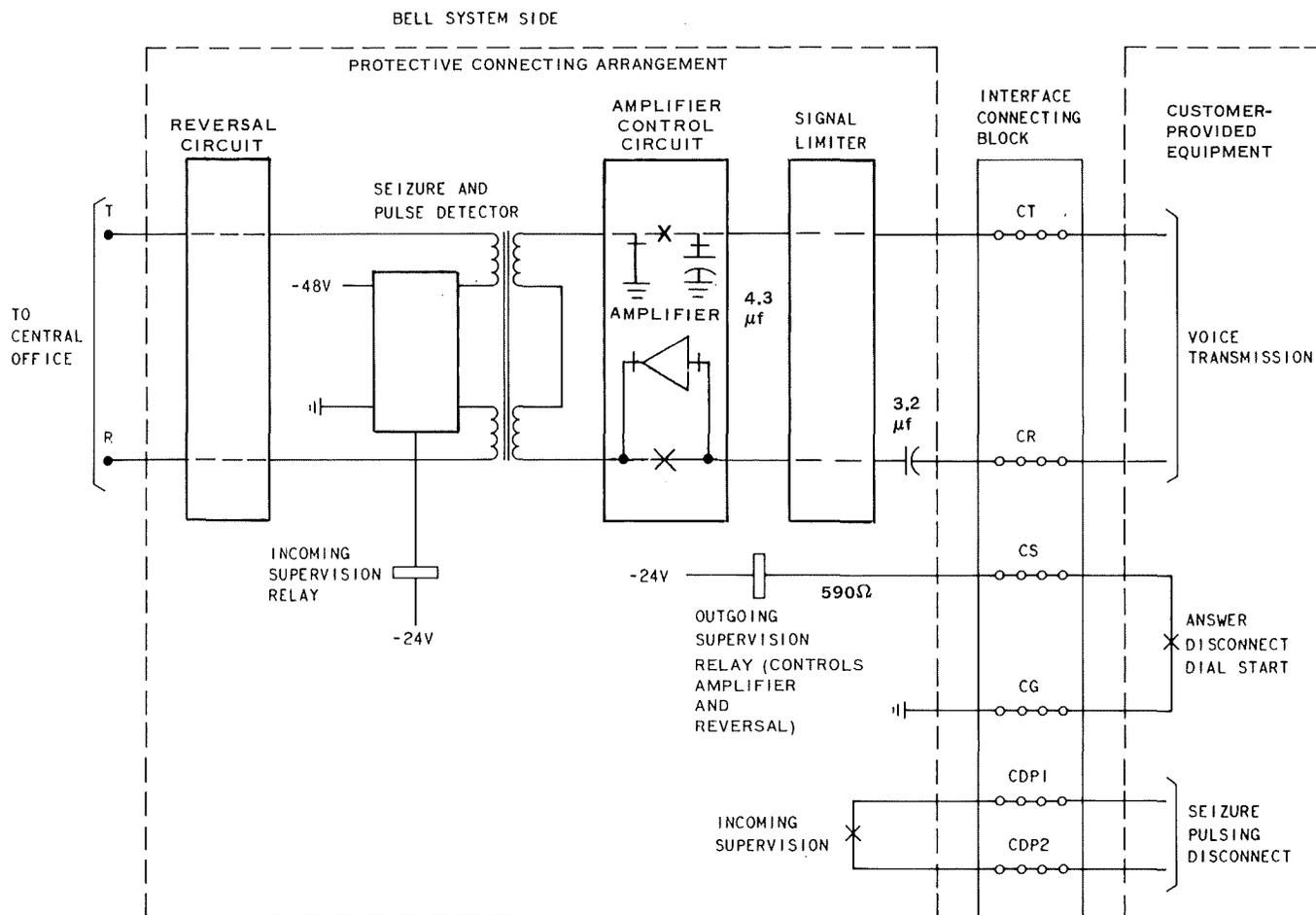
MOUNTING ARRANGEMENT FOR PROTECTIVE CONNECTING ARRANGEMENT C22
FIGURE 2

PRELIMINARY



TYPICAL INTERFACE CONNECTING BLOCK
FIGURE 3

PRELIMINARY



SIMPLIFIED SCHEMATIC - PROTECTIVE CONNECTING ARRANGEMENT C22

FIGURE 4