PUB 42609

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Protective Connecting Arrangement CTH

Interface Specification

December 1973

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS

PRELIMINARY

NOTICE

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If further information is required, please contact:

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American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

TECHNICAL REFERENCE

CONNECTING ARRANGEMENT CTH

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PRELIMINARY

CONNECTING ARRANGEMENT CTH

1. GENERAL

1.1 Introduction

F.C.C. tariffs and corresponding intrastate tariffs filed by the Bell System 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 a protective connecting arrangement. The connecting arrangement includes network control signaling unit functions and is furnished, installed, and maintained by the Telephone Company. In addition, the tariffs require compliance with network protection criteria given in the tariffs.

1.2 Application

Protective Connecting Arrangement CTH provides a means for connecting customer-provided call restricting equipment to a central office trunk (e.g., local, foreign exchange or WATS line) terminated only on a Telephone Company-provided PBX or Centrex-CU system* (Fig. 1), i.e., systems in which the switching equipment is located on the premises of the customer. The arrangement provides an indication to customer-provided equipment of the supervisory condition and address information (dial pulse and TOUCH-TONE® signaling) present on the PBX-CO trunk while the trunk is in use, and a means by which the customer-provided equipment may initiate a request to deny completion of an outgoing call from the PBX. It also permits the customer to provide a distinctive call restricting tone towards the calling station. The PBX does not have to be of the type which can be arranged to selectively divert outgoing calls.

The supervisory and dialing information is provided to the customer-provided equipment through a high resistance connection to the PBX-CO trunk.

*CTH cannot be used with 101 ESS.

If a dry-contact type interface, instead, is desired by the customer for detecting this information, the customer requires Connecting Arrangement RCX in addition to Connecting Arrangement CTH. Connecting Arrangement RCX cannot be used with TOUCH-TONE telephone stations since no ac dialing (TOUCH-TONE) information is available to the customer-provided equipment with that arrangement.

1.3 Ordering and Identification

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

One Connecting Arrangement CTH should be ordered for each outgoing or two-way trunk for which call restricting capability is required. If Connecting Arrangement RCX is also required, one RCX arrangement should also be ordered for each Connecting Arrangement CTH ordered. Contact your local Telephone Company business office or Marketing representative for information regarding rates for, and the availability of, these connecting arrangements.

2. DESCRIPTION

2.1 Functions

The major functions of Connecting Arrangement CTH are:

(a) To protect Telephone Company personnel and facilities from potentially hazardous voltages which may be applied by the customer-provided equipment.

(b) To provide isolation from longitudinal imbalance.

(c) To indicate to customer-provided equipment, trunk status information, including supervisory and address (dial pulse or TOUCH-TONE signaling) information, through a high resistance connection to the PBX-CO trunk.

(d) To provide for accepting a request signal from customer-provided equipment to restrict completion of an outgoing call from the Telephone Company PBX.

(e) Provides for application of a customer-provided distinctive call restricting tone toward the calling station.

2.2 Physical

The basic unit consists of equipment for two connecting arrangements CTH mounted on one 2-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 non-switched customer-furnished nominal 117 ±12 volt, 60 ±1 Hz source, fused at 15 amperes. The connecting arrangement will function satisfactorily within a temperature range of 0 to 55°C and a humidity range of 5 to 95 percent.

2.3 Interface Leads

Four, six or eight interface leads per circuit are provided from Connecting Arrangement CTH 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:

Lead Designation	Function
CDPT, CDPR	Trunk status indicator to customer-provided equipment and customer-provided tone signal
CG, CS	Call denial request from customer-provided equipment

CTS) CTG	Customer-provided tone signal (optional)
CBAT	Customer-provided -48 volt battery (optional)
CGND	Customer-provided ground (optional)

Leads from this arrangement will be terminated on a Telephone Company-provided Interface Connecting Block conveniently located (nominally within twenty-five feet of the connecting 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 connection of 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, polyethelene 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 strapping wires or bridging clips between the second and third terminals of the block to interconnect the leads. The straps or bridging clips should be removed by the customer's representative when it is necessary to test toward the customer-provided equipment and then be 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 call restricting request leads measured at the Interface Connecting Block shall not exceed 50 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 terminating impedance on the CDPT and CDPR leads is high.

3. OPERATION

3.1 Outgoing Call

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 by dialing an access code (e.g., dial "9"). The resulting trunk seizure consists of a loop closure through the PBX to the off-hook station, causing line current to flow. At the same time supervisory relays in the connecting arrangement (Fig. 3) operate. These relays in operating bridge the high resistance (100kOhm) trunk status indicator leads CDPT and CDPR to the tip and ring of the trunk. 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 supervisory and dialing information is provided to the customer-provided equipment by means of the trunk status indicator leads (CDPT and CDPR).

If on the basis of the digits dialed, the customer-provided equipment determines that the completion of the call associated with this connecting arrangement is to be restricted, the customer-provided equipment provides a contact closure across the call denial request leads CS and CG. In response to this closure the transfer relay is operated in the connecting arrangement. Operation of the transfer relay provides the following functions:

(a) Releases the loop to the central office, indicating a disconnect and causing the central office to return the trunk to the idle condition.

(b) Provides a transmission path from the CDPT and CDPR or the CTS and CTG leads, depending on the option selected by the customer, to the calling station. This permits the customer-provided equipment to send a distinctive call restricting tone to the station as a notification that he has dialed a restricted call and should disconnect.

(c) Energizes the timing circuit which starts a long time out cycle (approximately 15 seconds).

(d) Bridges a ringing detector to the central office side of the connecting arrangement to detect an incoming call.

If upon hearing the call restrict tone, the calling station disconnects, the PBX trunk is released. The long timing cycle is cancelled and a disconnect timing cycle is initiated to allow the PBX trunk to fully disconnect before it can be reseized for another call. If the calling station does not disconnect in approximately 15 seconds, a forced disconnect will be initiated and after the disconnect timing cycle mentioned above, will restore the trunk to the idle condition.

3.2 Incoming Call

If the central office attempts to complete an incoming call while the connecting arrangement is in the restrict mode (transfer relay operated), the ringing detector will operate, which in turn initiates a forced disconnect. Upon completion of the disconnect timing sequence, the PBX trunk and the connecting arrangement will restore to the idle condition. The incoming call will then complete in the normal manner.

4. SPECIFIC DESIGN CONSIDERATIONS

4.1 Trunk Status Indicator Path

The trunk status indicator leads (CDPT and CDPR) provide a high resistance connection to both the ring and tip conductors of the associated PBX-CO trunk. This resistance consists of 100,000 ohms ±3% in each interface lead of the trunk status indicator path and will, therefore, 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.

The trunk status indicator path provides 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 (dc dial pulse and TOUCH-TONE signaling) at all times 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 4.32. 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 connecting arrangement to the serving central office, to the Telephone Company PBX, and 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.

These leads are to be used by the customer-provided equipment to receive information on the status of the PBX trunk, and, at the customer's option, may be used to apply a distinctive call restricting tone toward the calling station when the connecting arrangement is in the restrict mode. Signal voltages applied to these leads shall not exceed +1 dBm. If the signal on leads CDPT and CDPR or leads CTS and CTG (optional) during the restrict mode exceed +1 dBm a non-linear limiting device is shunted across these leads resulting in distortion of the signal.

4.11 Tone Applique Path

Leads CTS and CTG are available, at the customer's option, to permit the customer-provided equipment to apply a distinctive call restricting tone toward the calling station when the connecting arrangement is in the restrict mode (transfer relay operated). These leads will be used when the design of the customer-provided equipment requires separation of the Trunk Status Indicator Path from the Tone Applique Path. (Signal power levels outlined in paragraph 4.1 apply.)

4.12 Call Denial Request Path

The call denial request leads (CS and CG) provide a means of initiating a request from the customer-provided equipment to deny completion of an outgoing call from the Telephone Company-provided PBX.

The CS lead has a maximum potential of -48 volts dc through a 2450 ohm relay winding. Lead CG is grounded at the connecting arrangement. This lead shall not be used by the customer to ground his equipment.

The call denial request pair will offer the customer-provided equipment a maximum non-inductive load of 24 milliamperes.

The minimum open circuit insulation resistance of the customer-provided equipment between the CS and CG leads, and from either lead to ground, should be 100,000 ohms. The maximum external loop resistance including contact resistance across the CS and CG leads measured at the interface block toward the customer-provided equipment shall not exceed 50 ohms when indicating a closure.

The closure on these leads, when given, shall be provided only during the interval following the receipt of the first through the sixth digits of the number dialed to insure that the call is not completed (answered) and, therefore, billed.

A momentary closure of not less than 50 milliseconds is required as an indication to the connecting arrangement that the call is to be restricted. Only one call denial request is possible with each contact closure on the CS and CG leads; 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. If provided at other times, in some instances it can result in the abandonment of a call in progress.

4.13 Battery and Ground Leads

Leads CBAT and CGND can be provided optionally, at the customer's request, to permit the customer to apply -48 volts dc and ground to the CDPT and CDPR leads, or an open, in the idle condition. Unless otherwise specified, the Telephone Company will apply -48 volts dc and ground to these leads in the idle condition.

4.2 Trunks

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 Connecting Arrangement CTH. In all cases, the conditions described are those existing on the central office trunk side of the connecting arrangement. The degree to which the values given would be altered by the high resistance of the trunk status indicator path is a function of the input impedance of the customer-provided equipment.

4.21 Loop Start PBX Trunks

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

Figure 4 shows a simplified schematic of a typical loop start trunk. The connecting arrangement would generally be bridged onto the trunk close to the PBX.

A variety of dc potentials are present depending on the type of central office switching system. Some older offices (panel) use a battery supply that is nominally -24 volts. The majority of the central

offices have a -48 volt supply. On some loops, range extension equipment may be employed that utilizes -48, -72, or -96 volt supply.

In the off-hook condition, the dc voltages applied to the trunk status indicator 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 resistances of up to 2500 ohms may be encountered in some cases.

The on-hook exchange loop polarity (not seen by the customer-provided equipment) is negative on the ring side and positive on the tip side. The PBX trunk may be exposed to polarity reversals during the progress of a call. If such polarity reversals occur, they will be reflected on the CDPT and CDPR leads.

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" is the general term used to describe the condition when no current flows through the loop.

The length of 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. Consecutive switching system initiated opens longer than 100 ms, however, are not expected to occur with less than 100 ms separation.

4.22 Ground Start PBX Trunks

This type of facility is generally used for two-way combination (direct dialed outward - attendant completing inward) trunks. 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 signaling mode when the central office tip ground is received. The battery supply connection is then similar to that shown for loop start trunks in Figure 4. When it is ready to receive dial pulses, or TOUCH-TONE signals, the central office will return dial tone.

When the PBX station or the attendant goes on-hook (disconnects) 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.

4.3 Address Signaling

4.31 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 (see Fig. 5).

4.32 TOUCH-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 voice-band 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
Nominal	697	1	2	3	Spare
Low Group	770	4	5	6	Spare
Frequencies	852	7	8	9	Spare
(Hz)	941	*	0	#	Spare

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

A. Frequency Deviation

Tone frequencies are within ±1.5 percent of their nominal values.

B. Voice Energy Suppression

Voice energy from the telephone transmitter or other source is suppressed at least 45 dB below the signal power measured at the telephone set during tone signal transmission. In the case of automatic dialing, the suppression is maintained continuously until pulsing is completed.

C. Rise Time

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

D. Pulsing Rate

Minimum duration of two-frequency tone signal:	50 ms
Minimum interdigital time:	45 ms
Minimum cycle time (period):	100 ms

4.4 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 6,000 ohms.

4.5 Grounding

Connecting Arrangement CTH requires 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 call denial request pair is grounded at the unit, it is not permitted to derive the main ground for the customer's equipment through this lead from the connecting arrangement. 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 foreign voltages by direct contact or induction (e.g., power line crosses or lightning), protective devices are installed at the central office and at the PBX. Typically, these devices will provide a path to ground for foreign voltages that exceed about 600 volts peak. Since the customer's equipment is connected to the telephone line through the connecting arrangement, while the trunk is in use, the customer's equipment is isolated from longitudinal and metallic surges by the high resistance, consisting of 100,000 ohms connected separately to the tip and ring conductors.

The customer is responsible for providing protection, internal to his equipment and facilities, against foreign and hazardous voltages from his equipment and facilities being applied to the 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., the 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. Self-powered or passive customer's equipment need not be grounded. Provisions should be made within the customer's equipment for connecting together all internal

signal grounds. This connection shall be isolated from both the grounding (green) conductor run with the power supply primary conductors and the chassis or frame of the customer-provided equipment.

The customer's signal ground may be obtained with a proper connection to a metallic cold water pipe, using a single No. 14 AWG, or larger copper conductor. The other end should be connected to the ground return terminal of the customer's equipment. The run should be short, straight, and a continuous piece of wire. Proper attention should be given to providing the lowest possible resistance connection at each end of the circuit. It is imperative that this ground be connected at the same location to the water piping system 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 AND MAINTENANCE CONSIDERATIONS

6.1 Responsibility of the Customer

The tariffs regulating the connection to the telecommunications network by means of connecting arrangements of customer-provided terminal equipment or communications systems state that where long distance message telecommunications service is available under these tariffs for use in connection with customer-provided terminal equipment or communications systems, 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 or make such change as shall be necessary to remove or prevent such hazard or interference.

6.2 Responsibility of the Telephone Company

The tariffs regulating the connection to the telecommunications network by means of connecting arrangements of customer-provided terminal equipment and communications systems state that the Telephone Company shall not be responsible for the installation, operation, or maintenance of said terminal equipment or communications systems. Long distance message telecommunications service is not represented as adapted to the use of customer-provided equipment or systems and where such equipment or systems are connected to Telephone Company facilities, the responsibility of the Telephone Company shall be limited to the furnishing of facilities, including the protective connecting arrangements and network control signaling units, suitable for long distance message telecommunications service and to the maintenance and operation of such facilities in a manner proper for such 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 systems or for the quality of, or defects in, such transmission, (ii) the

reception of signals by customer-provided 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 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 facilities obsolete or require modification or alteration of such equipment or systems 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 sectionalize the difficulty, i.e., determine whether the service impairment is located in the customer-provided equipment or in the equipment provided by the Telephone Company. If the tests indicate that the trouble is in the Telephone Company-provided equipment, it should be promptly reported to the Telephone Company. Trouble reports should be called into the listed "Repair Service" number which can be found in the front of the telephone directory. The repair attendant should be given:

(a) Customer's name

(b) Customer's address

(c) Listed telephone number

(d) Universal Service Order Code (USOC) CTH

(e) Description of the trouble

(f) Customer's contact for additional information

If a Telephone Company service call results in the location of the trouble in the customer-provided equipment, the customer will be charged for the service call. The Telephone Company does not maintain or repair the customer-provided equipment.

PRELIMINARY

APPENDIX A

GLOSSARY

ADDRESS SIGNALS - denotes dc dial pulses or appropriate pairs of TOUCH-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.

CONNECTING ARRANGEMENT - protective equipment provided by the Telephone Company to accomplish the electrical connection of customer-provided equipment with the telecommunications network.

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 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, both rotary and tone signaling), 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)

OFF-HOOK SUPERVISION - indicates that the telephone is answering or originating a call.

ON-HOOK SUPERVISION - indicates that the telephone has disconnected or that the equipment 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.

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, Wide Area 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.

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.

PRELIMINARY

APPENDIX B

REFERENCES

Some references describing various transmission characteristics of the telecommunications network are listed below:

+(a) McAdoo, K. L., "Speech Volumes on Bell System Message Circuits - 1960 Survey," Bell System Technical Journal (BSTJ), Vol. 42, No. 5 (September 1963), p. 1999.

+(b) Gresh, P. A., "Physical and Transmission Characteristics of Customer Loop Plant," BSTJ, Vol. 48, No. 10 (December 1969), p. 3337.

+(c) Breen, C., and Dahlbom, C. A., "Signaling Systems for the Control of Telephone Switching," BSTJ, Vol. 39, No. 6 (November 1960), p. 1381.

+(d) Bodle, D. W., and Gresh, P.A., "Lightning Surges in Paired Telephone Cable Facilities," BSTJ, Vol. 40, No. 2 (March 1961), p. 547.

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

**(j) "Notes on Distance Dialing-1968," by American Telephone and Telegraph Company, New York, New York.

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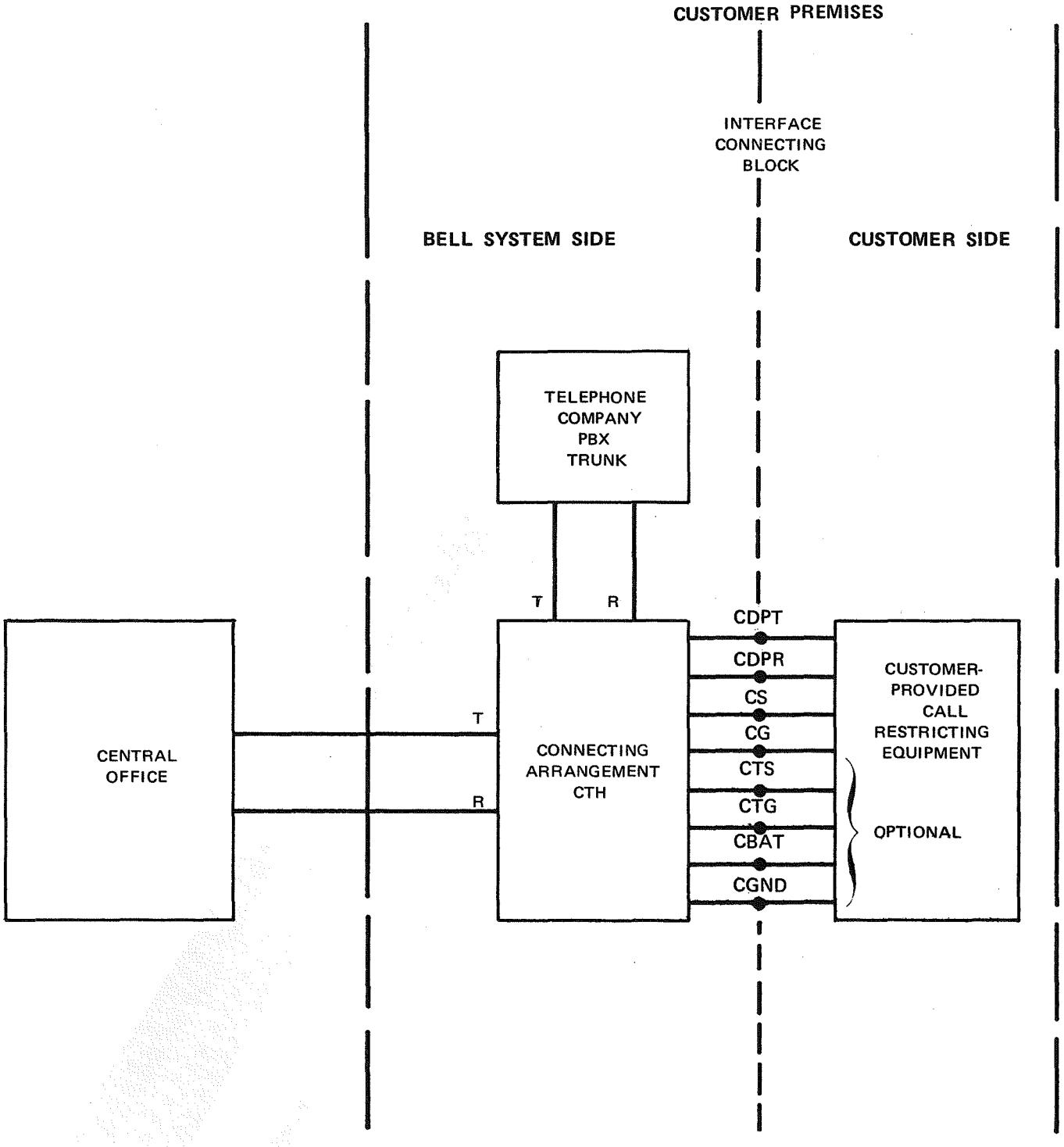
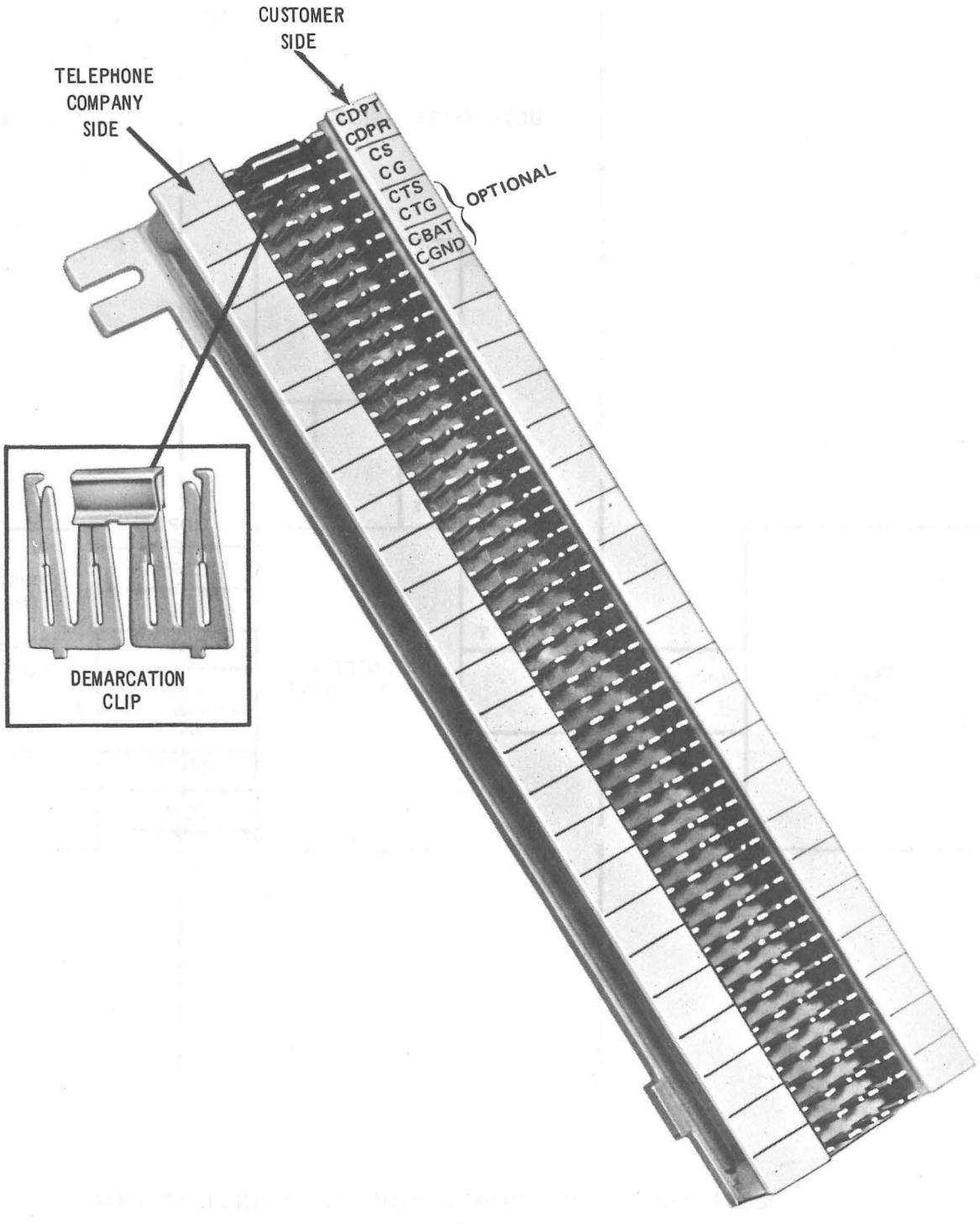
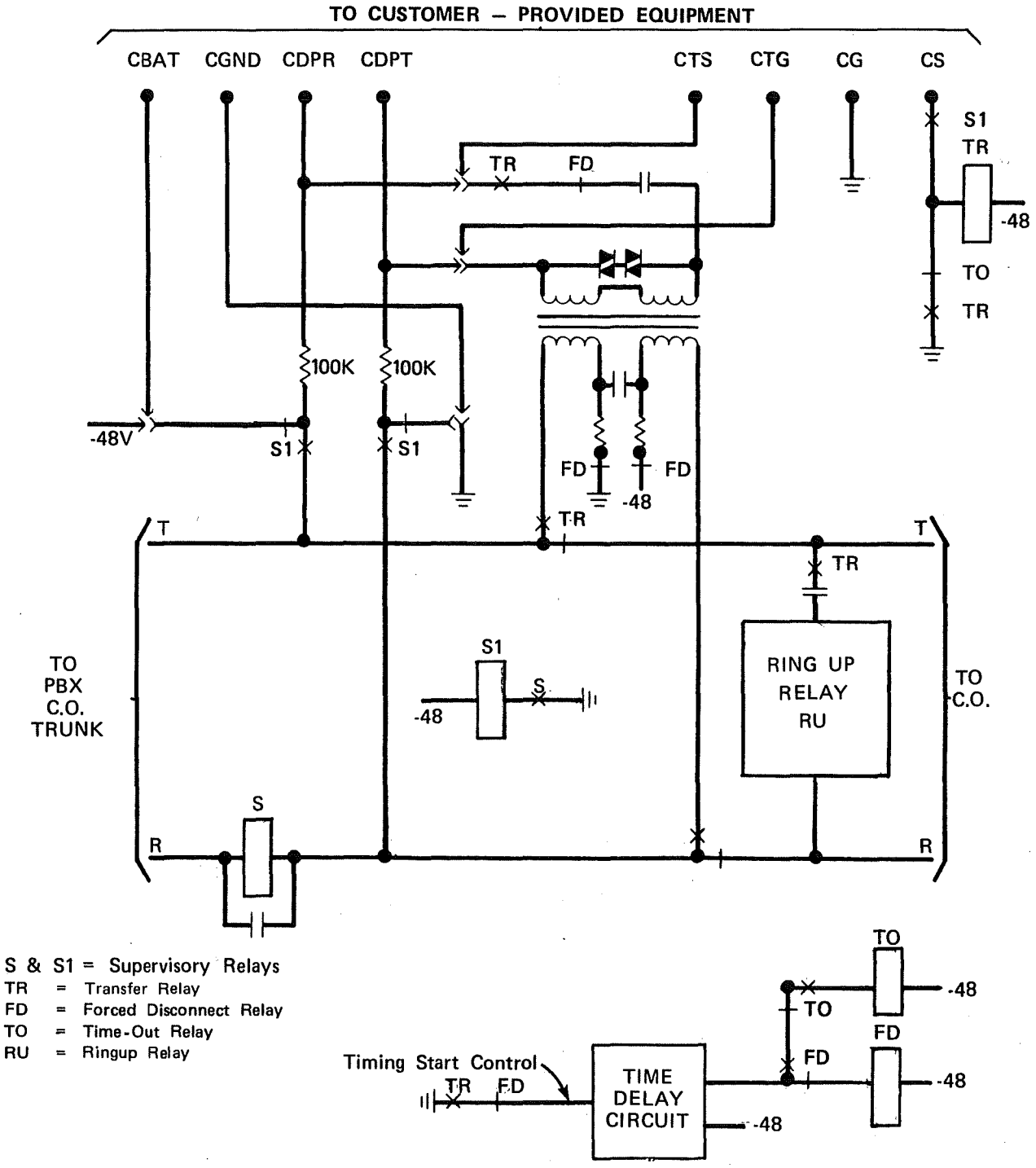


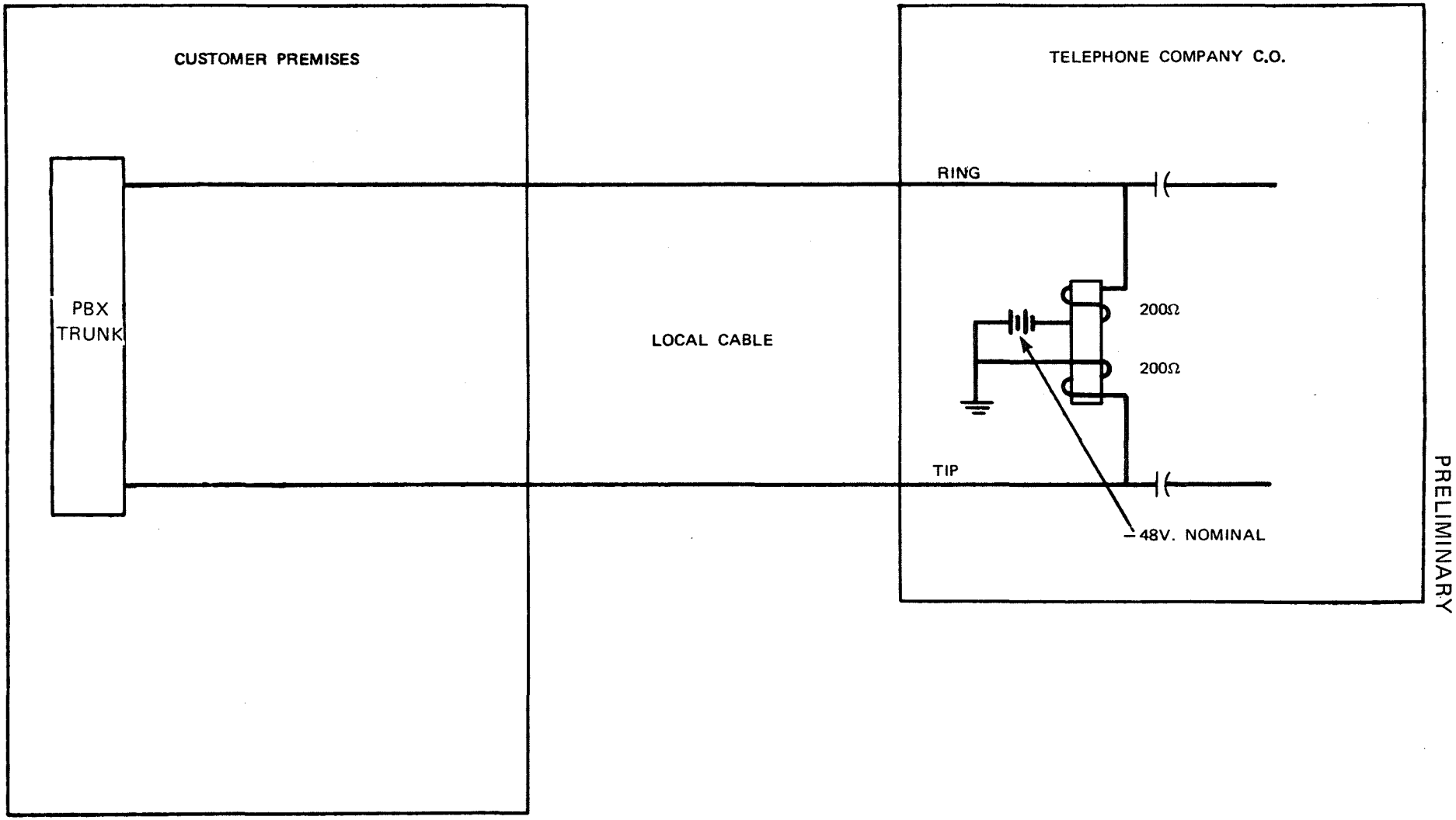
BLOCK DIAGRAM – CONNECTING ARRANGEMENT CTH
FIG. 1



TYPICAL INTERFACE CONNECTING BLOCK
FIG. 2



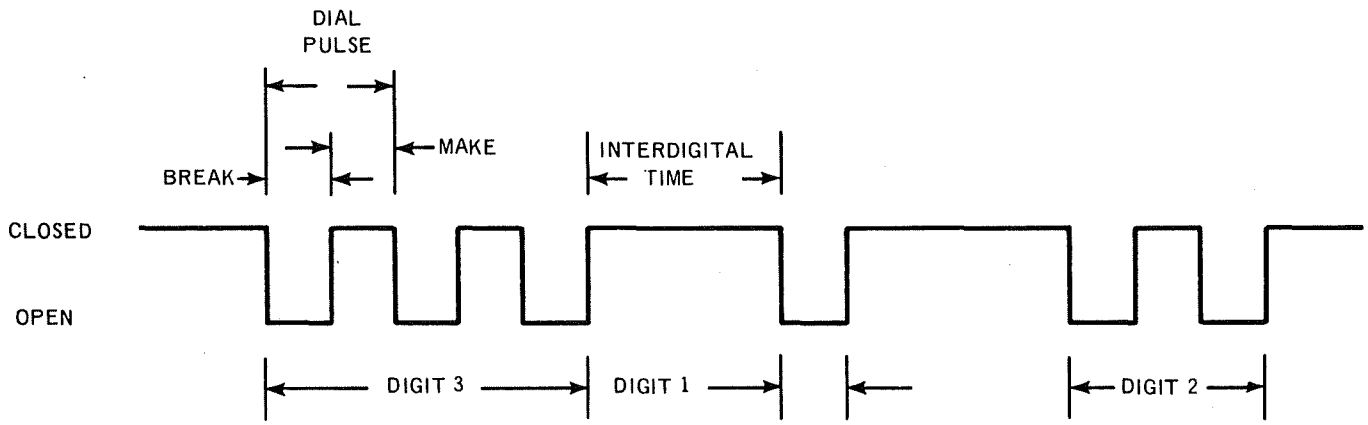
SIMPLIFIED SCHEMATIC
CONNECTING ARRANGEMENT CTH
FIG. 3



SIMPLIFIED SCHEMATIC
TYPICAL LOOP START TRUNK

FIG. 4

TYPICAL PATTERN OF DIAL PULSES EXPECTED OVER LEADS CDPT AND CDPR (WHEN DIALING NUMBER 312)



DIAL PULSE RATE: 8 – 11 PULSE-PER-SECOND (nominally 10 pps)
PERCENT BREAK: 58 - 64 PERCENT OF TOTAL MAKE-PLUS-BREAK nominally 61%
INTERVAL INTERDIGITAL TIME: 600 MILLISECONDS MINIMUM

CONNECTING ARRANGEMENT CTH
DIAL PULSE CHARACTERISTICS
FIG. 5