

PRELIMINARY

**Bell System Voice Communications
TECHNICAL REFERENCE**

**Voice
Connecting
Arrangement**

CDY

**Interface
Specification**

October 1969

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS



PRELIMINARY

NOTICE

This Technical Reference is specifically intended for the developers and designers of telephone voice communications systems and equipment which interface with the Bell System telecommunications network and for technical consultants to use in designing communications systems and arrangements requiring connections to the Bell System telecommunications network. The right to revise this Technical Reference for any reason, including conformity with USASI, EIA, CCITT or other standards, to utilize new advances in the state of the technical arts, or to reflect changes in the design of the equipment and/or service described herein is expressly reserved.

If further information is required, please contact:

Engineering Director - Customer Telephone Systems
American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

PRELIMINARY

PREFACE

The material in this Technical Reference is intended for use by designers and manufacturers of telephone equipment who expect to connect their communications equipment with the Bell System telecommunications network. This material covers guides which, if followed, should permit the transmission and reception of voice signals without interference to other Telephone Company services.

The responsibility of the Bell System with respect to the use of customer-provided equipment is set forth in the appropriate Tariff regulations.

In furnishing this material, the Bell System Telephone Companies make no claims or representations and assume no responsibility, beyond that set forth in the Tariff regulations, for the suitability of the transmission path or the performance of the telecommunications system. The Bell System is in no way responsible for the design, performance, installation, operation, or maintenance of the communications systems or equipment provided by others which are connected to the telecommunications network, and does not endorse or approve any such system or equipment. The material in this Technical Reference is furnished in the interest of preventing interference to other Telephone Company services and users, and is not furnished with the intent to provide complete design specifications or parameters, or to assure the quality or performance of customer-provided telephone systems and equipment.

PRELIMINARY

TABLE OF CONTENTS

	<u>PAGE</u>
1. GENERAL	1
2. SYSTEM DESIGN CONSIDERATIONS	1
2.1 Voice Connecting Arrangement CDY	1
2.2 Service and Maintenance Considerations	2
2.21 Responsibility of the Customer	2
2.22 Responsibility of the Telephone Company	3
2.23 Trouble Reporting Procedure	4
2.3 Foreign and Surge Voltage Protection	4
2.4 Hazardous Voltage Limitations	5
3. DESCRIPTION OF VOICE CONNECTING ARRANGEMENT CDY	5
3.1 Physical	5
3.2 Functions	6
3.3 Operations with a Line Circuit	6
3.4 Operations without a Line Circuit	6
3.5 Interface Leads	7
3.6 Method of Connection	7
4. ELECTRICAL CHARACTERISTICS	8
4.1 General	8
4.2 Transmission Parameters	8
4.3 Signaling Parameters	9
4.4 Grounding	10
5. POWER AND IMPEDANCE CONSIDERATIONS FOR CUSTOMER- PROVIDED EQUIPMENT	11
5.1 General	11
5.2 Average Power at the Central Office	11
5.3 Maximum Available Power	11
5.4 Signaling Considerations	12
5.5 Out-of-Band Limits	12
5.6 Internal Impedance	13
6. TESTING AND MEASURING METHODS	13
6.1 Measuring Maximum Available Power	13
7. TELECOMMUNICATIONS NETWORK CHARACTERISTICS	14
7.1 General	14
7.2 End-to-End Electrical Loss	14
7.3 Bandwidth and Frequency Response	14
7.4 Nonlinearities	15
8. REFERENCES	16
9. GLOSSARY	18

PRELIMINARY

LIST OF FIGURES

Fig. 1. Interface Connecting Block

Fig. 2. Block Diagram - Voice Connecting Arrangement CDY

1. GENERAL

F.C.C. Tariff No. 263 and corresponding intrastate Tariffs filed by the Bell System provide for the direct connection of customer-provided voice transmitting and receiving terminal equipment and communications systems to the Bell System telecommunications network. Direct electrical connection is made through a voice connecting arrangement furnished, installed, and maintained by the Telephone Company. The Tariffs also provide for the indirect (acoustic or inductive) connection of such equipment or systems.

In addition, the Bell System retains responsibility for network control signaling. This includes the switchhook, dialing and control functions, as well as the function of voice signal limiting and isolation of Central Office battery from the customer-provided equipment.

For new or additional service, contact your local Telephone Company business office or Marketing representative. For ready identification, the Telephone Company describes this service as Voice Connecting Arrangement CDY.

2. SYSTEM DESIGN CONSIDERATION

2.1 Voice Connecting Arrangement CDY

Voice Connecting Arrangement CDY is used to terminate - without connection to the telecommunications network - a line from a customer-provided system in a Telephone Company-provided Key Telephone Set. This arrangement is provided only in those instances where the key telephone service has been provided in conjunction with normal telephone exchange

service. This will enable the customer to have access to his own communications system as well as the telecommunications network through the use of one instrument. The transmission leads, a pair of conductors, provide the voice and signal coupling between the Key Telephone Set and the customer-provided equipment.

2.2 Service and Maintenance Considerations

2.2.1 Responsibility of the Customer

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

Where long distance message telecommunications service is available under this Tariff for use in connection with customer-provided communications systems, the operating characteristics of such 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 customer-provided systems do not endanger the safety of Telephone Company employees or the public; damage, require change in or alteration of, the equipment or other facilities of the Telephone Company; interfere with the proper functioning of such equipment or facilities; impair the operation of the telecommunications system or otherwise injure the public in its use of the Telephone Company's services. Upon notice from the Telephone Company that the customer-provided system is causing or is likely to cause such hazard or interference the customer shall make such change as shall be necessary to remove or prevent such hazard or interference.

2.22 Responsibility of the Telephone Company

The Tariffs permitting direct electrical connection of customer-provided communications system state that:

The Telephone Company shall not be responsible for the installation, operation or maintenance of any customer-provided communications systems. Long distance message telecommunications service is not represented as adapted to the use of customer-provided systems and where such systems are connected to Telephone Company facilities the responsibility of the Telephone Company shall be limited to the furnishing of facilities suitable for long distance message telecommunications service and to the maintenance and operation of such facilities in a manner proper for such telecommunications service; subject to this responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by the customer-provided systems or for the quality of, or defects in, such transmission, or (ii) the reception of signals by customer-provided systems.

The Telephone Company shall not be responsible to the customer or otherwise if changes in the criteria contained in the Tariffs and Paragraph 5 of 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 otherwise affect its use or performance.

2.23 Trouble Reporting Procedure

When trouble is experienced with this service the customer should perform the necessary testing to sectionalize the difficulty by opening the circuit at the Interface Connecting Block and testing only toward the customer-provided equipment. If the tests indicate the trouble is in the Telephone Company-provided equipment, it should be promptly reported to the Telephone Company. Trouble reports should be called to 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) Description of the trouble.
- (e) Customer's contact for additional information.

2.3 Foreign and Surge Voltage Protection

Where telephone lines are exposed to lightning, power circuit contact, or induction, 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 customer is responsible for providing protection, internal to his equipment and facilities, against foreign and surge voltages from his equipment and facilities being applied to the voice connecting arrangement. The surge potential on the transmission leads shall be limited to 600 volts.

2.4 Hazardous Voltage Limitations

When it is necessary for the customer to apply an operational voltage to facilities interconnected with telephone facilities, certain voltage limitations shall be observed. These limitations are for the purpose of providing adequate protection to personnel and plant facilities, and unless otherwise specified in Paragraph 4.2 and 4.3 of this Technical Reference, steady-state voltages applied by customer-provided equipment to conductors connected to Voice Connecting Arrangement CDY should be limited to the following:

	<u>dc</u>	<u>ac (RMS)</u>
Maximum voltage, any conductor to ground	135	50
Maximum voltage, conductor to conductor	(135 (270*	(50 (100*

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

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

3. DESCRIPTION OF VOICE CONNECTING ARRANGEMENT CDY

3.1 Physical

Voice Connecting Arrangement CDY consists of a telephone pickup key on a Telephone Company--provided Key Telephone Set and an optional standard Telephone Company--provided Key Telephone System line circuit. Leads associated with this arrangement will be terminated on a Telephone Company--provided Interface Connecting Block (Fig. 1) conveniently located within 25 feet of the arrangement to permit testing, maintenance, trouble isolation, and ease of connection to the customer-provided equipment. The

maximum external dc resistance across the transmission leads measured at the Interface Connecting Block shall not exceed 50 ohms. This arrangement will function satisfactorily within a temperature range of 0° to 50°C and a humidity range of 5 to 95 percent.

3.2 Functions

The major functions of this voice connecting arrangement are:

- (a) To provide voice-frequency access to and from the customer-provided equipment.
- (b) To provide for dialing into the customer-provided equipment.
- (c) To provide for accepting ringing signals from the customer-provided equipment.

3.3 Operations with a Line Circuit

The customer-provided equipment accesses the Telephone Company-provided Key Telephone Set by applying ringing voltage over the CT and CR leads which activates the Telephone Company line circuit (Fig. 2). An audible signal will be heard and a flashing lamp (when illumination is provided) will appear at the pickup button assigned to the customer-provided equipment. The call can be answered at any appearance of this line in the usual manner available with the Telephone Company-provided Key Telephone Service. The customer's equipment must furnish talking battery to the Telephone set for this line.

A call can be originated by a customer at any appearance of this line in the usual manner available with the Telephone Company-provided Key Telephone Service.

3.4 Operations without a Line Circuit

The customer must provide external signals for an incoming call

to the Telephone Company-provided Key Telephone Set. The call can be answered at any appearance of this line in the usual manner available with the Telephone Company-provided Key Telephone Service. The customer's equipment must furnish talking battery to the telephone set for this line.

A call can be originated by a customer at any appearance of this line in the usual manner available with the Telephone Company-provided Key Telephone Service.

3.5 Interface Leads

Two interface leads per circuit are provided from Voice Connecting Arrangement CDY to an Interface Connecting Block (see Fig. 1) for the customer's use. Technical information pertaining to the transmission leads is discussed in Paragraph 4. This pair of leads, designated CT and CR, provides the two-way voice transmission and signaling path to and from the voice connecting arrangement.

The customer must provide and install the conductors from the customer-provided equipment to the Interface Connecting Block. This block will accept leads up to 18 gauge or smaller.

3.6 Method of Connection

Leads from Voice Connecting Arrangement CDY will be terminated by the Telephone Company in a terminal box equipped with the Interface Connecting Block (Fig. 1). The customer or his representative will make the necessary connections to associate his equipment with the voice connecting arrangement at this terminal box. Leads from the voice connecting arrangement will be terminated by the Telephone Company on studs under

washers secured by nuts on an Interface Connecting Block mounted in the box. Separate nuts and washers on the same studs will be provided for the customer's connections. These will be designated as follows:

<u>DESIGNATION</u>	<u>FUNCTION</u>
CT	voice transmission
CR	pair
2	designates second circuit
3	designates third circuit

4. ELECTRICAL CHARACTERISTICS

4.1 General

The Telephone Company--provided Key Telephone Set can generate dial pulses over leads CT and CR towards the customer--provided equipment at the rate of 8 to 11 pulses per second with a percent break of 58 to 64 percent. There is no insertion loss with Voice Connecting Arrangement CDY. The voice--frequency range of the telephone set is about 300 to 3000 Hz. The customer's equipment must furnish talk and signal battery. No voice signal amplification is provided by this arrangement.

4.2 Transmission Parameters

For design purposes, the impedance of the customer--provided equipment connected to leads CT and CR should be 600 ohms. The voice signal levels must comply with the applicable Tariffs. The Tariffs permitting electrical connection of customer--provided communications systems state:

"To prevent excessive noise and crosstalk in the network, it is necessary that the power of the signal at the Central Office not

exceed 12 dB below one milliwatt when averaged over any three-second interval. To insure that this limit is not exceeded, the power of the signal which may be applied by the customer-provided equipment to the Telephone Company interface located on the customer's premises will be specified for each type of connecting arrangement, but in no case shall it exceed one milliwatt."

For Voice Connecting Arrangement CDY, the maximum permissible voice signal power at the Interface Connecting Block is -9 dBm when averaged over any 3-second interval.

4.3 Signaling Parameters

Talking and dialing battery must be furnished by the customer-provided equipment to the Telephone Company-provided Key Telephone Set over CT and CR leads when a call is initiated to or received by this station. The voltage supplied, when measured at the Interface Connecting Block, can range from a minimum of 5 volts dc to a maximum of 20 volts dc. The current can range from .02 to .08 ampere dc, and shall be limited to a maximum of .1 ampere dc. Ringing voltage from the customer-provided equipment, over leads CT and CR, shall be from 16 to 36 Hz at a minimum of 55 volts RMS and a maximum of 130 volts RMS (ringing voltage superimposed upon talk or trip battery) measured at the Interface Connecting Block.

The ringing generator current must flow into the loop CT-CR, when applied, so that the ringing can be tripped on a loop basis in this arrangement. The customer's tripping circuit shall be capable of limiting the peak current through the voice connecting arrangement to .035 ampere maximum. The ringing voltage supply shall be grounded.

4.4 Grounding

In general, it is desirable that circuits in the customer's equipment which connect to the voice connecting arrangement have some path to ground. A direct or resistive ground on one side of the power supply would be an example of such a path. This practice avoids the possibility of the entire circuit involved being at an indeterminate potential with respect to ground. Such a potential, perhaps as a result of electrostatic induction, could result in an insulation breakdown in the arrangement. It is expected that the customer's equipment, if powered from commercial power, will be grounded in accordance with applicable electrical codes (NEC) and should be bonded to the telephone protection ground electrode when available. Self-powered or passive customer's equipment need not be grounded. One side of the customer's ringing generator supply, when provided, must be grounded.

Voice Connecting Arrangement CDY is provided with a common signal ground which is always bonded to a metallic cold water pipe or other ground approved by the NEC serving as the electric power ground and telephone protector ground (where present).

As an example, a good ground may be obtained with a proper connection to a metallic cold water pipe, using a single No. 6 AWG 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, if possible, a continuous piece of wire. 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 as the telephone protector or signal ground. This lead shall not be fused.

5. POWER AND IMPEDANCE CONSIDERATIONS FOR CUSTOMER-PROVIDED EQUIPMENT

5.1 General

The following Paragraphs are provided to acquaint the customer with the transmission criteria specified in the Tariff which protect the telecommunications network and its customers if and when connections are made between the network and customer-provided equipment by means of a voice connecting arrangement.

5.2 Average Power at the Central Office

The average power (in any 3-second interval) delivered to a 900 ohm resistive load at the Central Office should not exceed -12 dBm. The limitations described in 5.2 on power at the customer's location have been set to meet an average of -12 dBm when all loops in the Bell System are considered.

5.3 Maximum Available Power

The Central Office power criterion, in 5.2 above, can be satisfied by limiting the maximum available power* from a customer-provided 600 ohm source to -9 dBm when averaged over any 3-second interval. The customer-provided equipment should be so designed that the average power over any 3-second interval applied to the Interface Connecting Block associated with Voice Connecting Arrangement CDY does not exceed -9 dBm.

*The available power of a source is the maximum power that the source can deliver to a load. Maximum power transfer occurs when the load and source impedances are matched.

This level is compatible with the requirements of those voice connecting arrangements which provide actual connection to the telecommunications network. Thus, no further adjustment is required if a connection to the network through an appropriate voice connecting arrangement (such as Voice Connecting Arrangement 3A or CD5) is desired at a later date. The recommended procedure for estimating the maximum available power is given in Paragraph 6.

5.4 Signaling Considerations

The telecommunications network incorporates tone signaling devices that are used for network control functions. These devices, connected at all times to the telephone circuit, are designed to be sensitive to single frequency tones at 2600 Hz. They are, however, relatively insensitive to energy at this frequency if sufficient energy is present at the same time as other frequencies in the voiceband.

In order to prevent the interruption or disconnection of a call, or interference with network control signaling, it is necessary that the signal applied by the customer-provided equipment to the voice connecting arrangement at no time have energy solely in the 2450 to 2750 Hz band. If signal power is in the 2450 to 2750 Hz band, it must not exceed the power present at the same time as in the 800 to 2450 Hz band.

5.5 Out-of-Band 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 not exceed 27 dB below one milliwatt.

- (b) The power in the band from 4000 Hz to 10,000 Hz shall not exceed 16 dB below one milliwatt.
- (c) The power in the band from 10,000 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.

5.6 Internal Impedance

The internal impedance of the customer's equipment should be approximately 600 ohms balanced to ground.

6. TESTING AND MEASURING METHODS

6.1 Measuring Maximum Available Power

The following measuring method is satisfactory for estimating the maximum power averaged over a 3-second interval to determine that the inband criterion is being met:

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 Telephone Test Meter 3555B, a Western Electric 3C (3A) Noise Measuring Set, or the equivalent.* The meter FUNCTION switch should be in the BRIDGE position, the slide switch marked DAMP/NORM in the DAMP position, and 3 kHz flat weighting should be used. In almost all cases the speech power averaged over any 3-second interval will not exceed -9 dBm if the maximum meter swing does not exceed 84 dBrn.

*These meters do not have a 3-second averaging time, but when used on speech they give a reliable estimate of a 3-second average.

The accuracy of this method can be somewhat improved by increasing the size of the damping capacitance in the Western Electric 3C (3A) Noise Meter by 150 microfarads. To do this connect the negative lead of a 150 microfarad capacitor to either terminal of the NORM/DAMP switch and connect the positive lead to ground. This allows the meter to more nearly approximate a 3-second averaging meter. (NOTE: This modification does not necessarily hold for noise meters other than the Western Electric 3C [3A].) With the additional damping the power averaged over any 3-second interval will not exceed -9 dBm if the maximum meter swing does not exceed 82 dBm. The use of meters with shorter time constants, such as a VU meter or a standard voltmeter, is not recommended.

7. TELECOMMUNICATIONS NETWORK CHARACTERISTICS

7.1 General

Information describing the component parts and operating characteristics of the Bell System telecommunications network has been published. Various articles are listed in Paragraph 8.

7.2 End-to-End Electrical Loss

The end-to-end electrical loss of a connection is a function of the impedance of both end terminations; the losses of the loops at both ends, and the end-office loss. The information given in the REFERENCES may be used to determine statistical loss distributions for different types of calling patterns on the telecommunications network.

7.3 Bandwidth and Frequency Response

The nominal voice-frequency bandwidth of the telecommunications network extends from about 300 to 3000 Hz. In general, an end-to-end

connection may be expected to have a loss characteristic which increases with increasing frequency. This voice connecting arrangement does not limit this bandwidth.

7.4 Nonlinearities

Nonlinearities such as compression, clipping, and harmonic distortions can exist on the telecommunications network. Normally, these are low enough to be ignored. It is expected that total harmonic distortions no greater than about 5 percent of the fundamental will normally be encountered.

8. 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), 42, No. 5 (September 1963), p. 1999.
- (b) Nasell, I., "The 1962 Survey of Noise and Loss on Toll Connections," BSTJ, 43, No. 2 (March 1964), p. 697.
- (c) Nasell, I., "Some Transmission Characteristics of Bell System Toll Connections," BSTJ, 47 No. 6 (July-August), p. 1001.
- (d) Nasell, I.; Ellison, C.R.; and Homstrom, R.; "The Transmission Performance of Bell System Intertoll Trunks," BSTJ, 47, No. 8 (October 1968), p. 1561.
- (e) Hinderliter, R.G., "Transmission Characteristics of Bell System Subscriber Loop Plant," IEEE Transactions, Communications and Electronics, September 1963, p. 464.
- (f) Alexander, A.A.; Gryb, R.M.; and Nast, D.N.; "Capabilities of the Telephone Network for Data Transmission," BSTJ, 39, No. 3 (May 1960), p. 431.
- (g) Breen, C., and Dahlbon, C.A., "Signaling Systems for the Control of Telephone Switching," BSTJ, 39, No. 6 (November 1960), p. 1381.
- (h) Bodle, D.W., and Gresh, P.A., "Lightning Surges in Paired Telephone Cable Facilities," BSTJ, 40, No. 2 (March 1961). p. 547.

PRELIMINARY

- 17 -

- * (i) "Principles of Electricity Applied to Telephone and Telegraph Work," by American Telephone and Telegraph Company, New York, New York.
- * (j) "Switching Systems," by American Telephone and Telegraph Company, New York, New York.
- (k) "Notes on Transmission Engineering," by United States Independent Telephone Association, Washington, D.C.
- * (l) "Notes on Distance Dialing - 1968," by American Telephone and Telegraph Company, New York, New York.
- * (m) "Transmission Systems for Communications," by Bell Telephone Laboratories.

*Available through Graybar Electric Company.

9. GLOSSARY*

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

CUSTOMER-PROVIDED EQUIPMENT - denotes systems, devices, apparatus, and their associated wiring, provided by a customer.

END-OFFICE - the last serving Central Office in the switching hierarchy of the telecommunications network.

INTERFACE CONNECTING BLOCK - the Telephone Company furnished connecting point to which the customer brings and connects the leads of his equipment and to which the Telephone Company brings and connects leads from the voice connecting arrangement.

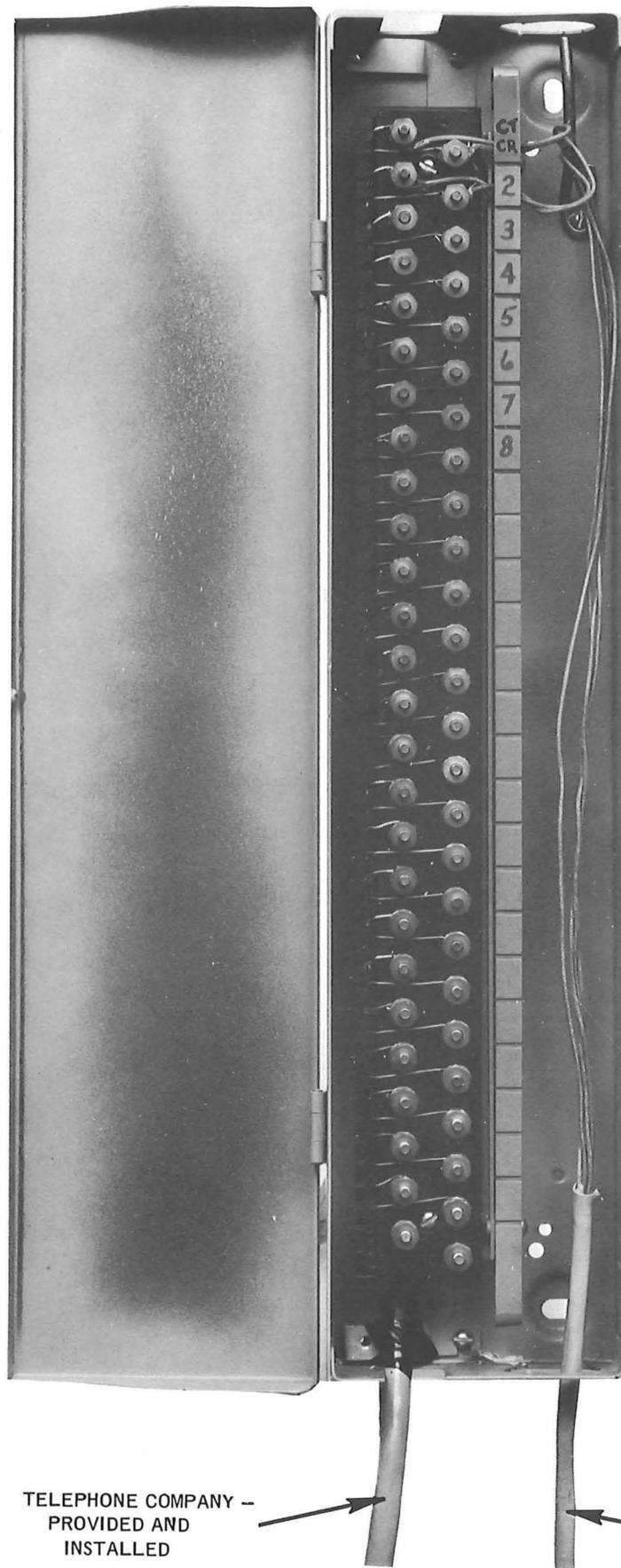
LINE CIRCUIT - that part of Voice Connecting Arrangement CDY which detects supervisory signals from customer-provided equipment for audible and visual indications.

TELECOMMUNICATIONS NETWORK - the Bell System voice switching equipment, associated interconnecting facilities and station equipment which connects its customers together.

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

*May differ in letter from exact wording as used in the Tariffs

VOICE CONNECTING ARRANGEMENT - Voice Connecting Arrangement CDY provided by the Telephone Company to accomplish the direct electrical connection of customer-provided facilities with the facilities of the Telephone Company and to connect the transmission path from the customer-provided equipment to the Telephone Company-provided Key Telephone Set.

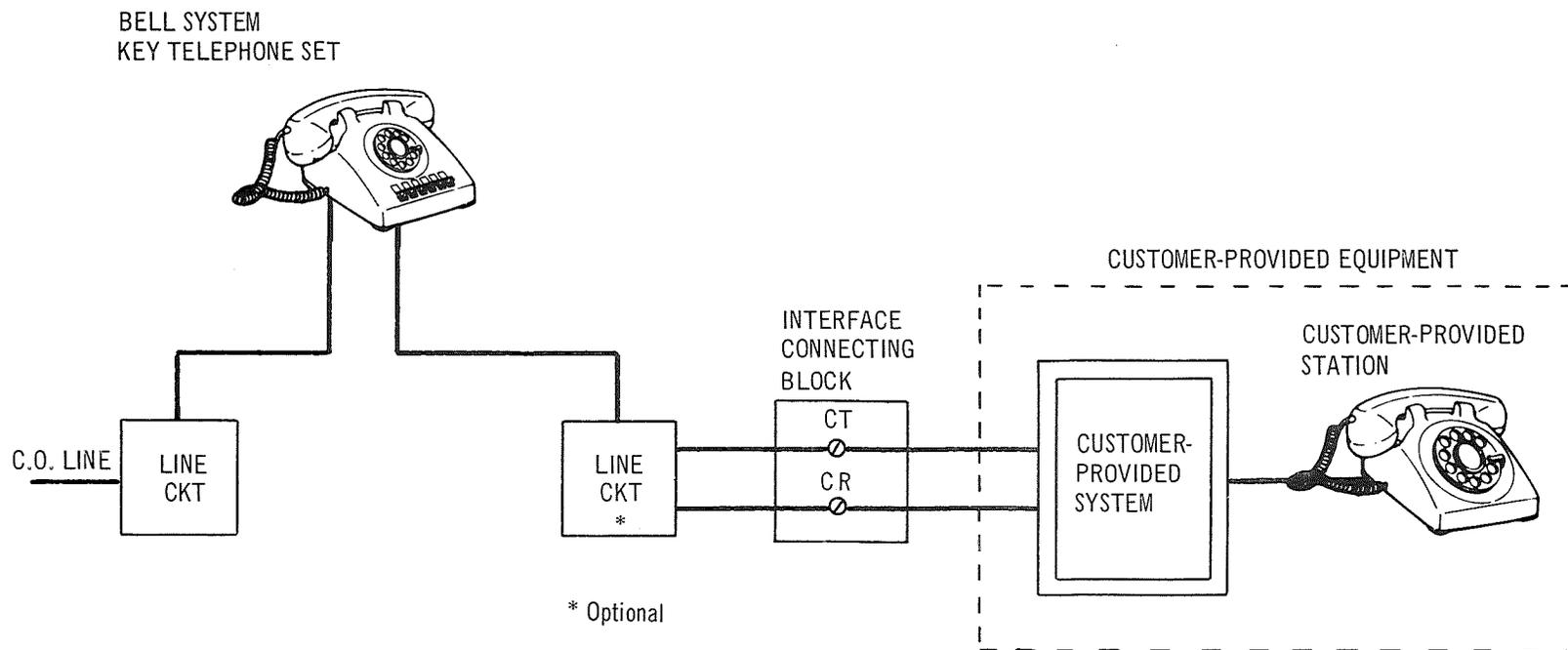


TELEPHONE COMPANY --
PROVIDED AND
INSTALLED

CUSTOMER -- PROVIDED
AND
INSTALLED

INTERFACE CONNECTING BLOCK

Figure 1



BLOCK DIAGRAM – VOICE CONNECTING ARRANGEMENT CDY

FIG. 2