PUB 42504

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Voice Connecting Arrangement

C232W

Interface Specification

September 1971

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS

NOTICE

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

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PRELIMINARY

TECHNICAL REFERENCE

VOICE CONNECTING ARRANGEMENT C232W

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1. GENERAL

1.1 Introduction

F.C.C. tariffs and corresponding intrastate tariffs filed by the Bell System provide for the direct electrical connection of customer-provided voice transmitting and receiving terminal equipment and communications systems to Bell System private line facilities. The tariffs also provide for the indirect (acoustic or inductive) connection of such equipment or systems. Both methods require compliance with network protection criteria stated in the tariffs.

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

1.2 Application

Voice Connecting Arrangement C232W provides a 2-wire voice connection between a customer-provided communications system or terminal and a Telephone Company-provided private line facility (Fig. 1). One pair of transmission leads provides the voice transmission path between this arrangement and the customer-provided equipment. No signaling or supervisory functions are provided by this arrangement. The customer-provided terminal equipment may contain an inband signaling system (see Paragraph 3.2). This connecting arrangement provides transformer isolation between the private line facility and the interface. Sub-voice (dc or 20 Hz) signaling can not be used with this connecting arrangement.

Private line facilities associated with this connecting arrangement may be used for non-switched point-to-point service or PBX tie trunks. These

facilities may be connected at the distant end either to Telephone Company or customer-provided terminal equipment or systems. The use of standard Bell System single frequency (SF) inband channel signaling (2600 Hz) is not possible with this interface. For this reason, Voice Connecting Arrangement C232W can not be used on PBX dial tie trunks between a Telephone Company PBX and customer-provided PBX.

This connecting arrangement is not offered for use in transmitting data signals.

The interface provided by Voice Connecting Arrangement C232W is a Type II interface as described in the Transmission Engineering Technical Reference "Private Line Interconnection - Voice Applications," dated June 1970, PUB 43201 (See Appendix C) This Technical Reference should be consulted for general information on private line services.

1.3 Ordering and Identification

The connection service described in this Technical Reference is identified by the Bell System as Voice Connecting Arrangement C232W. One Voice Connecting Arrangement C232W should be ordered for each private line which is to be connected to the customer-provided equipment. The local Telephone Company business office or Marketing representative will provide information regarding availability and rates for this service.

2. DESCRIPTION

2.1 Functions

The major functions of this voice connecting arrangement are:

(a) To protect Telephone Company personnel and facilities from

potentially hazardous voltages which may be applied to the voice connecting arrangement.

(b) To provide voiceband and inband signaling transmission to and from a Telephone Company-provided private line facility (channel)

(c) To limit abnormally high voice signal levels to the private line facility (channel).

(d) To provide longitudinal isolation.

2.2 Physical

Voice Connecting Arrangement C232W consists of a 2-wire voice coupler circuit mounted in an appropriate housing. Several different physical equipment arrangements may be used to implement this connection service. In small installations, where only a few circuits are to be terminated and signal amplification is not required, the voice coupler is mounted on a 4-inch by 2-1/2-inch metal base equipped with a plastic cover. This unit is shown in Fig. 2. For larger installations requiring a large number of voice connecting arrangements to terminate a number of private line channels, a 23-inch relay rack mounting may be used. The Telephone Company will provide and mount the voice coupler in an appropriate location so that the equipment is accessible for testing and maintenance. The Telephone Company should be consulted concerning equipment space requirements if a number of private lines are to be terminated at one location.

The voice coupler used for most installations will not require a source of power. However, if amplification is required to meet Telephone Company transmission requirements, the Telephone Company will provide a

power supply. The customer must provide a separately fused 60±0.1 Hz, 117±12 volt ac, fused at 15 amperes grounded outlet for each -48 volt supply. The grounded U-blade outlet should not be under control of a switch and must be within reach of the power cord. As many as 50 connecting arrangements may be operated from a single power supply.

This arrangement will function satisfactorily within a temperature range of 0° to 55° C and a humidity range from 5 to 95 percent.

2.3 Interface Leads

Two interface leads, designated CT and CR, provide the transmission path between Voice Connecting Arrangement C232W and the customer-provided equipment (see Fig. 1). When the mounting arrangement shown in Fig. 2 is used, these leads are brought out to two screw terminals, designated 3 and 4, located on the bottom of the voice coupler.

In larger installations the leads from a group of voice couplers may be terminated on a separate Telephone Company-provided connecting block conveniently located within 25 feet of the connecting arrangement to permit testing, maintenance, trouble isolation, and ease of connection to the customer-provided equipment. A typical interface connecting block used in such installations is shown in Fig. 3. This "quick connect" type connecting block utilizes tin plated spring clip terminal strips which accommodate unstripped, polyethylene and polyvinyl chloride (max. 8 mils thickness) insulated conductors of No. 20 to 24 AWG. A Reliable Electric R714B Tool or equivalent is used to press the insulated wire down into the slot. The spring pressure of the clip cuts away the insulation and

makes the electrical connection. The Telephone Company will provide strapping clips between the second and third terminals of the block to interconnect the leads. The clips should be removed by the customer's representative when it is necessary to test toward the customer-provided equipment and then replaced to restore the circuit to service.

The customer must provide and install the wiring between his equipment and the connecting arrangement and make the necessary connections of his equipment to the terminals provided with the voice connecting arrangement.

3. SPECIFIC DESIGN CONSIDERATIONS

3.1 Transmission Path

A detail discussion of private line design will be found in the Transmission Technical Reference, "Private Line Interconnection - Voice Applications" (see Appendix C). This Reference should be consulted for information on the transmission design principles that should be used in engineering private line systems. Private line facilities provided by the Telephone Company will conform to the requirements outlined in this Technical Reference.

3.11 Insertion Loss

Voice Connecting Arrangement C232W does not provide for voice signal amplification except to meet transmission level requirements on Telephone Company-provided facilities. Where no amplifiers are employed the insertion loss of the connecting arrangement is approximately 1 db.

3.12 Impedance

The impedance of Voice Connecting Arrangement C232W is a nominal 600 ohms. The exact value is a function of the equipment used for the

voice coupler and the type of cable used for the local loop to the Central Office. The customer's equipment should be 600 ohms for optimum voice signal power transfer across the interface.

3.13 Bandwidth

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

3.14 Voice Signal Power Levels

In order to prevent interference to other Telephone Company services, customer-generated voice signal levels must comply with certain minimum protection criteria. Tariff F.C.C. No. 260 and corresponding intrastate tariffs which provide for the direct electrical connection of customer-provided communications systems with facilities furnished for private line service by the Telephone Company state that:

> "Since private line channels utilize Telephone Company facilities in common with other services, it is necessary in order to prevent excessive noise and crosstalk that the power of the signal applied to the Telephone Company lines be limited. Because each private line service is individually engineered a single valued limit for all applications cannot be specified. Therefore, the power of the signal which may be applied by the customer-provided equipment to

the Telephone Company interface located on the customer's premise will be specified by the Telephone Company for each application to be consistent with the signal power allowed on the telecommunications network."

For Voice Connecting Arrangement C232W the maximum acceptable voice signal power at the interface connecting block is -13 dBm on leads CT and CR when averaged over any 3-second interval.

Using measuring Method A (see Paragraph 3.16), in almost all cases, the speech power (averaged over any 3-second interval) will not exceed -13 dBm if the maximum meter swing does not exceed 80 dBrn. With the additional damping of measuring Method B, the power averaged over any 3-second interval will not exceed -13 dBm if the maximum meter swing does not exceed 78 dBrn.

3.15 Measuring Maximum Available Inband Speech Power

The measuring methods described below are satisfactory for estimating the maximum power averaged over a 3-second interval to determine that the inband criteria discussed in Paragraph 3.14 is being met.

Method A

Operate the customer-provided equipment into a 600 ohm load, (this assumes that the customer-provided equipment has a 600 ohm source impedance), bridged by a Hewlett-Packard Transmission and Noise Measuring Set - Model 3555B, or a Western Electric 3-Type Noise Measuring Set, or the

equivalent.* To insure a proper measurement technique, the control settings on these meters should be as shown below:

Western Electric 3-Type Noise Measuring Set		Hewlett-Packard Transmission and Noise Measuring Set Model 3555B	
Control	Setting	Control	Setting
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.)

3.16 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 31 dB below one milliwatt (18 dBm below the signal level specified in Paragraph 3.14).

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

(b) The power in the band from 4000 Hz and 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.

3.17 Signal Limiting

A voice signal power limiter is incorporated in the transmission path to protect the Bell System private line network from applications of abnormally high signal levels. This has no effect on normal voice signal or inband 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 3.14.

3.2 Signaling Methods

Voice Connecting Arrangement C232W does not provide any signaling functions. It is anticipated that the customer-provided terminal equipment would contain some type of inband signaling system.

In situations where the customer-provided switching system can connect the private line channel to the telecommunications network, any single tone 2600 Hz energy on the private line channel must be blocked by the customer's trunk equipment. Signal power distribution criteria

for connecting arrangements used on Central Office trunks require that at no time shall energy solely in the 2450 to 2750 Hz band be applied to the connecting arrangement. 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. The customer-provided channel signaling equipment must be designed to insure that these requirements are met when the private line facility using C232W is connected to the telecommunications network through the customer-provided switching equipment.

3.3 Grounding

Voice Connecting Arrangement C232W is not provided with a common signal ground. The general grounding requirements for the customer-provided equipment are discussed in Paragraph 4.3.

4. GENERAL DESIGN CONSIDERATIONS

4.1 Foreign and Surge Voltage Protection

Where telephone lines are exposed to foreign voltages by direct contact or induction (e.g., power line crosses or lightning), protective devices are installed at the Central Office and on the customer's premises which provide a path to ground for foreign voltages exceeding about 600 volts peak. Since the customer's equipment is connected to the telephone line through the voice connecting arrangement, it is protected from metallic and longitudinal surges.

The customer is responsible for providing protection against foreign and hazardous voltages from his equipment and facilities being applied to the voice connecting arrangement.

4.2 Voltage Limitations

The customer-provided equipment must not supply any dc voltages on leads CT and CR toward the voice connecting arrangement. All ac voltages must comply with the provisions of Paragraphs 3.14 and 3.16. The power supplies and wiring methods used in the customer-provided equipment should meet the provisions of applicable electrical codes such as the National Electrical Code (NEC), Article 725, for Class 2 remote control and signal circuits.

4.3 Grounding

Voice Connecting Arrangement C232W is normally isolated from ground and therefore customer-provided signaling and power supply connections must be isolated from ground. It is expected that the customer's equipment should comply with applicable electrical codes such as the National Electrical Code (NEC).

5. SERVICE AND MAINTENANCE CONSIDERATIONS

5.1 Responsibility of the Customer

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

> Where private line service is available under this tariff for use in connection with terminal equipment or communications systems, provided by a customer, authorized user or joint user, the operating characteristics of such equipment or systems shall be such as not to interfere with any of the services offered by the Telephone

Company. Such use is subject to the further provisions that the equipment or systems provided by a customer, authorized user or joint user does not endanger the safety of Telephone Company employees or the public, damage, require change in or alteration of, the equipment or other facilities of the Telephone Company; interfere with the proper functioning of such equipment or facilities; impair the operation of the Telephone Company's facilities or otherwise injure the public in its use of the Telephone Company's services. Upon notice from the Telephone Company that the equipment or systems provided by a customer, authorized user or joint user is causing or is likely to cause such hazard or interference the customer shall take such steps as shall be necessary to remove or prevent such hazard or interference.

5.2 Responsibility of the Telephone Company

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

The Telephone Company shall not be responsible for installation, operation or maintenance of any terminal equipment or communications systems provided by a customer, authorized user, or joint user. Private line service is not represented as adapted to the use of such equipment or systems and where such equipment or system is connected to Telephone Company facilities the responsibility of the Telephone Company shall be limited to the furnishing of facilities suitable for private line service and to the maintenance and operation

of such facilities in a manner proper for such private line service. Subject to this responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by such equipment or system, or for the quality of or defects in, such transmission, or (ii) the reception of signals by such equipment or systems or (iii) address signaling where such signaling is performed by customer-provided tone-type signaling equipment. The Telephone Company shall not be responsible to the customer or authorized user or joint user if changes in the criteria contained in the tariffs (and Section 3 of this Technical Reference) or in any of the facilities, operations, or procedures of the Telephone Company render any facilities provided by a customer, authorized user or joint user obsolete or require modification or alteration of such equipment or system or otherwise affect its use or performance.

5.3 Trouble Reporting Procedure

When trouble is experienced with this service, the customer should perform the necessary testing at the interface to determine whether the service impairment is located in the customer-provided equipment or in the equipment provided by the Telephone Company. If the tests indicate that the trouble is in the Telephone Company-provided equipment, it should be promptly reported to the Telephone Company. Trouble reports should be called into the listed "Repair Service" number which can be found in the front of the telephone directory. The repair attendant should be given:

(a) Customer's name

(b) Customer's address

(c) Customer's telephone number

(d) Private line identification number

(e) Description of the trouble

(f) Customer's contact for additional information

The customer will be responsible for payment of a service charge for visits by the Telephone Company to the premises of the customer when the service difficulty or trouble results from the use of equipment or facilities provided by the customer.

PRELIMINARY

APPENDIX A

GLOSSARY

CHANNEL - a path (or paths) for electrical communication, between two or more stations or Telephone Company offices. A channel may be furnished in such a manner as the Telephone Company may elect. A channel may be derived from cable, radio or a combination thereof, and may consist of one or more physical facilities or routes.

COMMUNICATIONS SYSTEM - channels and other facilities which are capable, when not connected to private line service, of communications between customer-provided terminal equipment or Telephone Company stations.

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

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

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 voice connecting arrangement.

PRIVATE LINE - the term "Private Line" denotes the channels, channel terminals, service terminals, channel arrangements and equipment furnished to a customer as a unit, that is, without intermediate interexchange channel switching arrangements.

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

VOICE COUPLER - the part of the voice connecting arrangement which connects the transmission path from the customer-provided equipment to the private line network.

VOICE CONNECTING ARRANGEMENT - equipment provided by the Telephone Company to accomplish the direct electrical connection of customer-provided facilities with the facilities of the Telephone Company, or the direct electrical connection of Telephone Company facilities.

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.

*(e) "Principles of Electricity Applied to Telephone and Telegraph Work," by American Telephone and Telegraph Company, New York, New York.

*(f) "Switching Systems," by American Telephone and Telegraph Company, New York, New York.

(g) "Notes on Transmission Engineering," by United States Independent Telephone Association, Washington, D. C.

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

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

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

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

PRELIMINARY

APPENDIX C

WHERE TO OBTAIN REFERENCE MATERIAL

1. Bell System Technical References

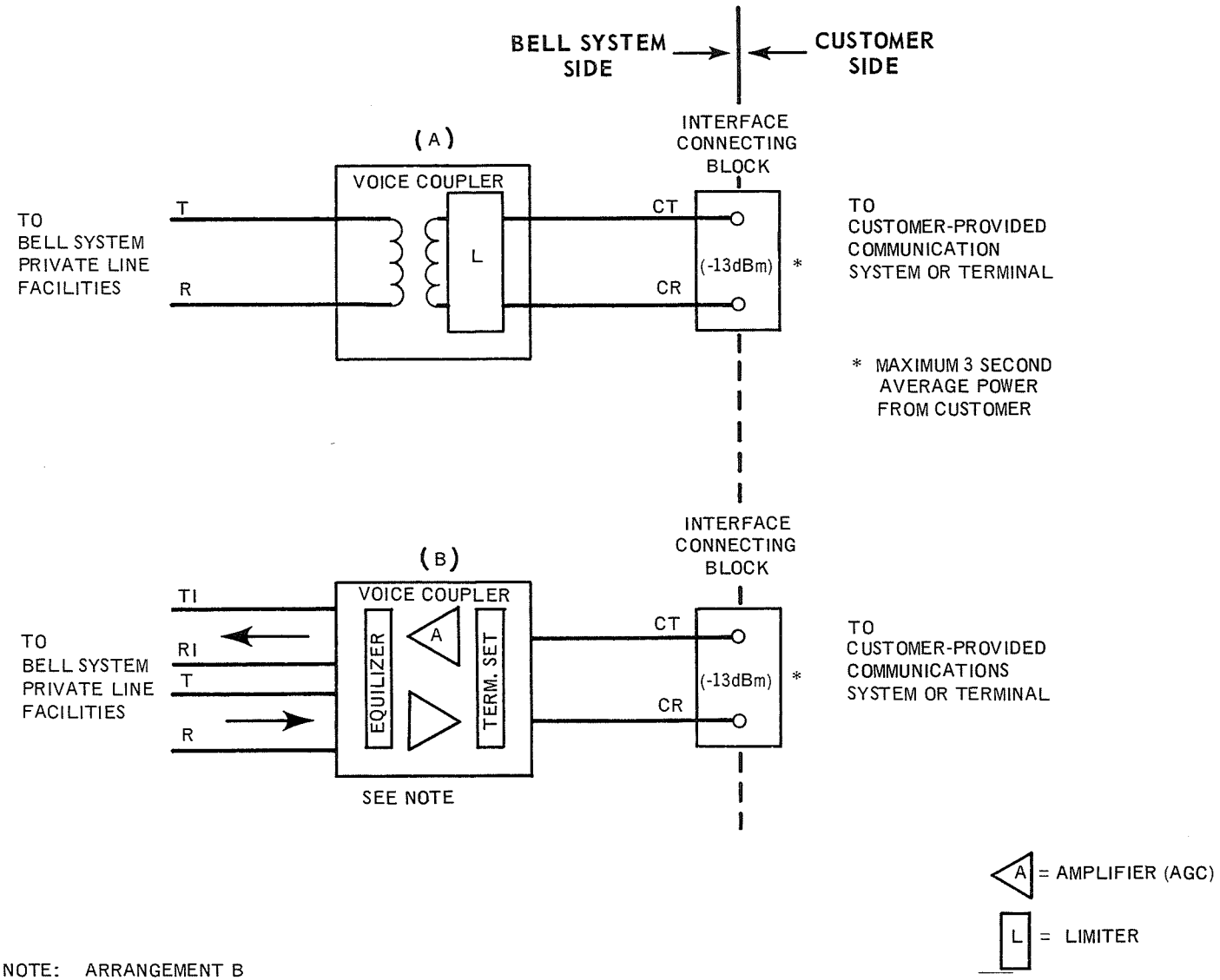
These references may be purchased by writing to:

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

2. Bell System Technical Journals (BSTJ)

These journals may be purchased by writing to:

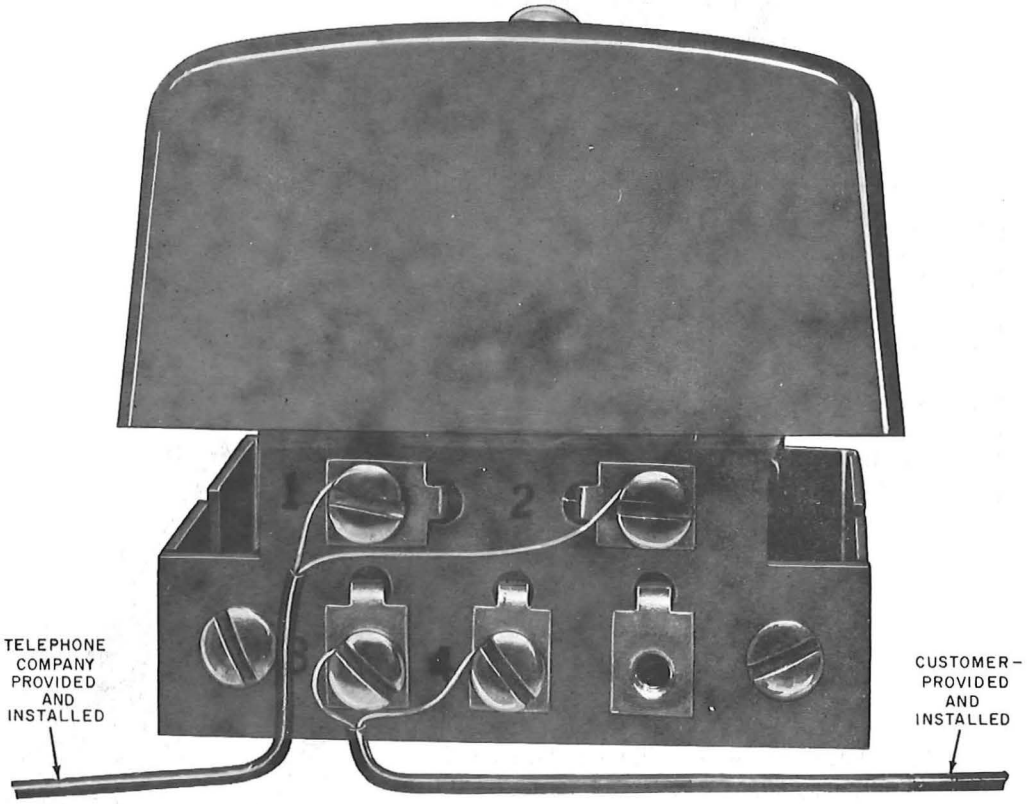
Mr. F. J. Schwetje
Bell Telephone Laboratories, Inc.
Mountain Avenue, Room 3C115
Murray Hill, New Jersey 07974



NOTE: ARRANGEMENT B
PROVIDED ONLY WHERE REQUIRED
TO MEET TRANSMISSION OBJECTIVES

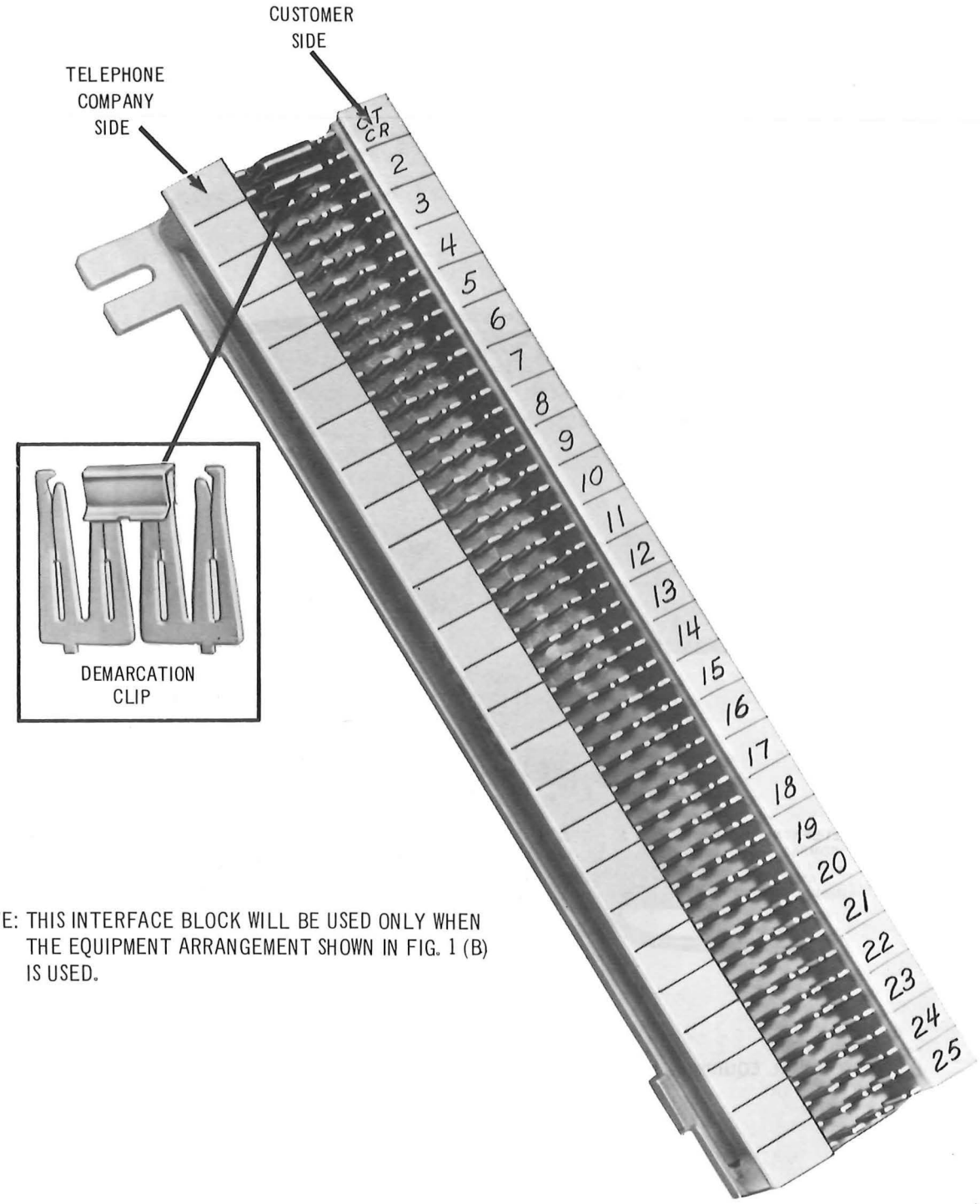
SIMPLIFIED SCHEMATIC – VOICE CONNECTING ARRANGEMENT C232W
FIG. 1

PRELIMINARY



NOTE
TYPICAL EQUIPMENT FOR
FIG. 1 (A)

VOICE CONNECTING ARRANGEMENT C232W
FIG. 2



NOTE: THIS INTERFACE BLOCK WILL BE USED ONLY WHEN THE EQUIPMENT ARRANGEMENT SHOWN IN FIG. 1 (B) IS USED.

TYPICAL INTERFACE CONNECTING BLOCK
FIG. 3