PUB 42407

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Voice Connecting Arrangements

C24
C2H

Interface Specification

October 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 Telephone 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.

If further information is required, please contact:

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PRELIMINARY

TECHNICAL REFERENCE

VOICE CONNECTING ARRANGEMENT C24 and C2H

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VOICE CONNECTING ARRANGEMENTS C24 and C2H

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1. GENERAL

1.1 Introduction

The tariffs filed by the Bell System provide for the direct electrical connection of customer-provided voice transmitting and receiving equipment and communications systems to Telephone Company terminal equipment. 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 C24 provides a 4-wire voiceband connection between a Telephone Company PBX service tie trunk terminal and a customer-provided communications facility. Voice Connecting Arrangement C2H provides the same connection between a Telephone Company Centrex service tie trunk terminal and a customer provided facility. Voice Connecting Arrangements C24 and C2H are applicable only for voice circuits where the terminating equipment of the customer-provided communications facility is located on the same customer premises as the Telephone Company equipment. In the case of Centrex-CO service this would be the same location as the attendant console. The services described here are not intended for providing entrance facilities for

customer-provided microwave channels. Transmission Technical Reference "Voice Grade Entrance Facilities for Extending Customer Provided Communications Channels" dated May 1969 describes the provision of entrance facilities (See Appendix "C" for Technical Reference ordering information).

1.3 Ordering and Identification

The connection service described in this Technical Reference is identified by the Bell System as Voice Connecting Arrangement C24 or C2H. One Voice Connecting Arrangement C24 or C2H and one tie trunk terminal should be ordered for each circuit to be connected to the customer-provided equipment. The customer should order Voice Connecting Arrangement C24 where he subscribes to normal PBX service and C2H where he subscribes to centrex service.

If the tie trunk terminal is to be connected to other than stations of the associated switching equipment details should be given to the Telephone Company. Such connections may include local central office trunks or other tie trunks. If pad control is desired as a part of the tie trunk terminal, the requirements should be stipulated. Transmission Technical Reference "Private Line Interconnection - Voice Applications" dated June 1970 provides information concerning design considerations and parameters for channel facilities. Tandem network considerations are also discussed in this Technical Reference.

The local Telephone Company business office or Marketing representative will provide information regarding availability and rates for, these services.

2. DESCRIPTION

2.1 Functions

The major functions of these voice connecting arrangements are:

(a) To protect Telephone Company personnel and facilities from hazardous voltages which may be applied to the voice connecting arrangement by the customer's equipment.

(b) To provide line supervisory and dial pulse signals to and from customer provided facilities.

(c) To provide voice transmission to and from customer provided facilities.

(d) To limit abnormally high voice signal levels to the Telephone Company equipment.

(e) To provide longitudinal isolation.

2.2 Physical

Voice Connecting Arrangements C24 and C2H are designed to be assembled on a standard 23-inch relay rack or apparatus mounting. The mounting and equipment will be provided and installed by the Telephone Company in an appropriate location so that the front and back of all equipment is accessible for testing and maintenance.

Essentially, Voice Connecting Arrangements C24 and C2H consist of a two-way voice repeater providing 4-wire voice transmission toward

the customer-provided equipment and a signaling unit which provides dc isolation for two-way seizure, dialing, answer and disconnect supervision signals (on an E & M basis). This equipment 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

Six interface leads (3 pair) per circuit are provided from the Voice Connecting Arrangement C24 or C2H to an interface connecting block (see Fig. 2). In addition one ground and one battery lead is brought to the interface for each group of four connecting arrangements.

Technical information pertaining to these leads is discussed in Sections 3 and 4.

The leads and their function are as follows:

Lead Designation	Function
CT, CR	One way (incoming) voice transmission path to the Telephone Company equipment.
CT1, CR1	One way (outgoing) voice transmission path from the Telephone Company equipment.
CFE	Incoming Signals - Seizure, dial pulses, answer and disconnect supervision to the Telephone Company equipment.
CFM	Outgoing Signals - Seizure, dial pulses, answer and disconnect supervision from the Telephone Company equipment.

Lead Designation	Function
CG	Customer-provided signal ground - one lead per four connecting arrangements.
CB	Customer-provided signal battery - one lead per four connecting arrangements.

2.4 Method of Connection

Leads from this arrangement will be terminated on a Telephone Company-provided interface connecting block conveniently located within 25 feet of the Telephone Company equipment to permit testing, maintenance, trouble islation, 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 voice connecting arrangement at this block.

A typical interface connecting block is shown in Fig. 2. This "quick connect" type connecting block utilizes tin-plated spring clip terminal strips which accommodate unstripped polyethylene or polyvinyl chloride insulated (8 mils maximum thickness) 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.

3. OPERATION

3.1 Signal Lead Condition

Voice Connecting Arrangements C24 and C2H provide an E and M lead type of signaling interface. The lead designated CFE corresponds to the E lead while the CFM lead corresponds to the M lead. The E and M signaling system derives its name from certain historical designations of the signaling leads on the circuit drawings for these systems. Two-way seizure, dial pulsing and answer supervision between the customer provided equipment and the connecting arrangement are indicated over the two leads in conjunction with customer provided signal battery and ground leads.

The operation of the signaling system is "duplex"; that is, signals can be sent simultaneously in both directions without interference. The CFM lead transmits ground and battery signals toward the customers facility while the CFE lead receives open and ground signals from that facility. Thus the near end (telephone company equipment) is reflected by the CFM lead and the far end by the CFE lead as shown in the following table:

Lead	Condition	Indication
CFE	open	on hook from CP equip.
CFE	ground	off hook from CP equip.
CFM	ground	on hook from Telco equip.
CFM	battery	off hook from Telco equip.

3.2 Incoming Call to the Telephone Company Equipment

When the customer-provided equipment places a ground on the CFE lead, the K1 relay of the signaling unit, will operate from battery on the CB lead. The K1 closed contact provides a seizure to the Telephone Company tie trunk and switching equipment. If dial tone is required to indicate readiness to receive dial pulses, it will be provided over leads CT1 and CR1. If a delay dial signal is required (from common control equipment), battery will be returned on the CFM lead until the terminating equipment is ready to receive dial pulses. The CFM lead will then revert to a ground condition to indicate "start dial".

The K1 relay will follow dial pulses received on the CFE lead and will pass them to the switching equipment. When dialing is completed properly, audible ring will be returned on the CT1 and CR1 leads. When the called station answers, supervision to the customer-provided equipment will be indicated by battery on the CFM lead as a result of the K2 relay operating.

3.3 Outgoing Call from the Telephone Company Equipment

Seizure of the Telephone Company tie trunk terminal causes the K2 relay of the signaling unit to operate providing a contact closure between the CB and CFM leads. The resulting battery on the CFM lead indicates seizure to the customer-provided equipment. At this time dial tone (if required) should be returned from the distant end on the CT and CR leads. Also a delay dial signal (if required by common control equipment) should be returned by a ground on the CFE lead from the

customer-provided equipment until the distant end is ready to receive dial pulses.

Outgoing dial pulses to the customer-provided equipment will be repeated by the K2 relay alternately changing the condition of the CFM lead from battery to ground.

When the called party answers, ground should be returned on the CFE lead by the customer-provided equipment.

3.4 Disconnect

If the Telephone Company equipment disconnects first, the K2 relay releases changing the CFM lead condition from battery to ground. The customer-provided equipment must recognize this indication and remove ground from the CFE lead in order to restore the K1 relay and associated terminal equipment to normal.

If the distant end disconnects first, the customer-provided equipment should remove the ground from the CFE lead. Release of the K1 relay will be recognized as a disconnect by the Telephone Company equipment. When the associated terminal equipment restores to normal, the K2 relay will release changing the CFM lead condition from battery to the normal ground.

4. SPECIFIC DESIGN CONSIDERATIONS

4.1 Transmission Path

4.11 Insertion Loss

Voice Connecting Arrangements C24 and C2H contain an automatic level control amplifier (Fig. 3) in the incoming voice path and a

variable loss pad in the outgoing voice path to establish the specified Transmission Level Points (TLP) at the interface (See Paragraph 4.14).

4.12 Impedance

The impedance of Voice Connecting Arrangements C24 and C2H is 600 ohms for both the incoming and outgoing voice paths. Therefore, the customer-provided equipment should be 600 ohms for optimum voice signal power transfer across the interface.

4.13 Bandwidth

The nominal voice-frequency bandwith of the telecommunications network extends from about 300 to about 3000 Hz. The voice connecting arrangement does not limit this bandwith.

4.14 Voice Signal Power Levels

In order to prevent interference to other services, customer generated voice signal levels must comply with certain minimum protection criteria.

For Voice Connecting Arrangements C24 and C2H the maximum acceptable voice signal power at the interface connecting block is -6 dBm on leads CT and CR (incoming voice path) when averaged over any 3 second interval.

Using measuring Method A (see Paragraph 4.15), in almost all cases, the speech power (averaged over any 3-second interval) will not exceed -6 dBm if the maximum meter swing does not exceed 87 dBrn. With the additional damping of measuring Method B, the power averaged over any 3-second interval will not exceed -6 dBm if the maximum meter swing does not exceed 85 dBrn.

In order to specify the levels at which the tie trunks will operate, common reference levels between the Telephone Company and the customer-provided equipment are required. For a tie trunk, the PBX switch in the outgoing (transmit) direction, at each end, is normally designated the 0 Transmission Level Point (0 TLP) for that direction of transmission. All other level points on the tie trunk are referred to this point by the nominal loss (-) or gain (+) in dB between them at 1000 Hz. In designing their tie trunk facilities the customer should establish a +7 (toward the connecting arrangement on CT and CR leads) and -16 (from the connecting arrangement on CT1 and CR1 leads) Transmission Level Points (TLP) at the interface connecting block as shown in Fig. 1. These values were chosen to provide standard interface levels which are readily available in commercial channel, signaling, and terminal equipment.

In designing their tie trunk termination, the Telephone Company will establish a 0 TLP at the PBX switch in the transmitting direction (toward the connecting arrangement). Pads and amplifiers will be adjusted to give the +7 and -16 TLP at the interface described above.

The overall design loss of a tie trunk is a function of several factors including the intended use of the trunk, its length, and the type of channel facilities. Loss values and other transmission engineering information for tie trunks is covered in Transmission Engineering Technical Reference entitled "Private Line Interconnection - Voice Applications" dated June 1970 (See Appendix C for ordering information).

4.15 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 4.14 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

* 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.

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 be sensitive to 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 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 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 24 dB below one milliwatt (18 dB below the signal level specified in Paragraph 4.14).

(b) The power in the band from 4000 Hz to 10,000 Hz shall not exceed 9 dB below one milliwatt.

(c) The power in the band from 10,000 Hz to 25,000 Hz shall not exceed 17 dB below one milliwatt.

(d) The power in the band from 25,000 Hz to 40,000 Hz shall not exceed 29 dB below one milliwatt.

(e) The power in the band above 40,000 Hz shall not exceed 43 dB below one milliwatt.

4.18 Signal Limiting

A voice signal limiter is incorporated in the incoming transmission path (leads CT and CR) to protect the Bell System telecommunications network from applications of abnormally high signal levels. This has no effect on normal voice 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 Supervisory and DC Signaling Leads

4.21 Incoming Signals - Lead CFE

This lead indicates seizure of the Telephone Company equipment by the customer-provided equipment on incoming calls. It also provides the Telephone Company equipment with answer supervision from the customer's equipment on outgoing calls. The customer-provided equipment shall hold this lead in a normally open condition and provide a ground on it to initiate an incoming call. This ground shall be held

for the duration of the call except during dialing when it reverts to the open condition corresponding to the break interval of dc dial pulses generated from the distant end.

On an outgoing call the customer-provided equipment shall indicate distant end answer supervision by grounding the CFE lead.

At the completion of any call the customer's equipment shall remove the ground and return this lead to the normal open condition indicating disconnect and restoral of the distant end equipment.

The customer-provided equipment shall provide the ground on the CFE lead through a make contact capable of carrying 0.025 amp. dc.

The maximum external loop resistance including contact resistance across the CFE and CG lead measured at the interface connecting block toward the customer-provided equipment shall not exceed 100 ohms (equivalent to 1800 feet of 24 gauge cable) when indicating a closure.

4.22 Outgoing Signals - Lead CFM

This lead indicates seizure of the customer-provided equipment by the Telephone Company equipment on outgoing calls. It also provides the customer's equipment with answer supervision (except for calls into the telecommunications network) on incoming calls. The customer-provided equipment shall recognize ground on this lead as the normal condition and a change to battery as a seizure indication. Except during dialing when it reverts to ground corresponding to the break interval of dc dial pulses generated by the Telephone Company equipment, the battery condition is maintained for the duration of the call.

On an incoming call to the Telephone Company equipment, the CFM lead will usually provide a change from ground to battery condition to indicate called party answer. On calls switched to the message network, answer supervision is not normally provided, therefore this feature cannot be guaranteed when connection is made from private line services.

At the completion of a call the return of this lead to ground condition will indicate to the customer's equipment that the Telephone Company equipment has restored to normal.

The normal ground on the CFM lead is thru a contact capable of carrying 0.5 ampere.

The applied battery when relay K2 is operated is supplied thru a resistance lamp (see Fig. 3) to limit the current in case of a fault condition to 0.35 ampere. The characteristics of the resistance lamp are shown in Fig. 4.

4.23 Common Signal Ground - Lead CG

This lead provides signal ground from the customer's equipment to the signaling unit (see Fig. 3). It is isolated from Telephone Company frame ground within the unit. There is one CG lead for each group of four connecting arrangements. Lead CG shall not be fused.

The customer's ground connection shall be in accordance with applicable electrical codes such as the National Electrical Code (NEC).

4.24 Common Signal Battery - Lead CB

This lead provides signal battery from the customer's equipment to the signaling unit (see Fig. 3). It is isolated from the Telephone Company battery supply. There is one CB lead for each group of four connecting arrangements.

This lead shall supply -48 volts dc referenced to lead CG (range -44 to -52 volts) with less than 1 percent ripple.

The maximum dc drain from this supply is 1.44 ampere per CB lead.

4.3 Dial Pulses

Dial pulses passed by the customer-provided equipment over interface lead CFE to Voice Connecting Arrangement C24 or C2H shall be at a rate between 8 and 11 pulses-per-second with a percent break of between 25 and 90 (nominal 61) percent. A minimum of 600 milliseconds shall be provided between digits.

The customer-provided equipment shall also be able to receive dial pulses over interface lead CFM from Voice Connecting Arrangement C24 or C2H at a rate between 8 and 11 pulses-per-second. These pulses will be presented with a percent break of between 58 and 64 (nominal 61) percent and 600 millisecond minimum interdigital timing.

4.4 Grounding

Voice Connecting Arrangements C24 and C2H are 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 the telephone protector ground where present). This ground is isolated from the interface leads. The general grounding requirements for customer-provided equipment are covered in Paragraph 5.3.

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 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 through the voice connecting arrangement, there is protection from longitudinal and metallic 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.

5.2 Voltage Limitations

The customer-provided equipment must not supply any dc voltages on leads CT, CR, CT1 or CR1 toward the voice connecting arrangement.

When it is necessary for the customer to apply an operational voltage to the control leads of a voice connecting arrangement, certain limitations shall be observed. These limitations are for the purpose of providing adequate protection to personnel and plant facilities, and unless otherwise specified in the Technical Reference, any steady-state voltage applied by the customer-provided equipment to conductors connected to a voice connecting arrangement should not exceed the following:

	dc	ac (RMS)
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 applicable codes such as the National Electrical Code (NEC), Article 725, for Class 2 remote control and signal circuits.

5.3 Grounding

It is expected that the customer's equipment, if powered from commercial power, will be grounded in accordance with applicable electrical codes such as the National Electrical Code. 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 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 as the telephone protector or signal ground 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 permitting direct electrical connection of customer-provided communications systems indicate that:

> Where long distance message telecommunication or private line service is available under these tariffs for use in connection with customer provided communications systems, the operating characteristics of these systems shall be such as not to interfere with any of the services offered by the Telephone Company. This use is subject to the further provision that the systems provided by a customer do not: (i) endanger the safety of Telephone Company employees or the public (ii) damage, require change in or alteration of, the equipment, systems or other facilities of the Telephone Company, (iii) interfere with the proper functioning of such equipment, systems or facilities, (iv) impair the operation of the telecommunications network or (v) 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 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 permitting connection of customer-provided communications systems indicate 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. Where these systems are connected to Telephone Company equipment or facilities, the responsibility of the Telephone Company shall be limited to the furnishing of equipment or facilities including the protective connecting arrangements and network control signaling units, and to the maintenance and operation of such equipment or facilities in a manner proper for the telecommunications service. Beyond this liability, the Telephone Company shall not be responsible for (i) the quality, in through transmission, of signals generated by the customer-provided systems or (ii) the reception of signals by customer provided systems, or (iii) address signaling where such signaling is performed by customer-provided tone type signaling equipment.

The Telephone Company shall not be responsible if changes in minimum network protection criteria contained in the tariffs, this Technical Reference, any of the equipment, facilities, operations or procedures of the Telephone Company render any customer-provided systems obsolete or otherwise affect the use or performance of the customer-provided systems.

6.3 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) Listed telephone number

(d) Description of the trouble

(e) 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 report results from the use of equipment or facilities provided by the customer.

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APPENDIX A

GLOSSARY

CENTREX Service - an automatic switching system service providing PBX service and in addition Direct Inward Dialing and Identified Outward Dialing.

CENTREX - CO (Company) - the provision of Centrex service by switching equipment located on telephone company owned or leased premises; the station equipment and attendant facilities are located on the premises of the customer.

CENTREX - CU (Customer) - the provision of centrex service by switching, station equipment, and attendant facilities located on the premises of the customer.

CHANNEL - a path (or paths) for electrical communication, between two or more locations. 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 - equipment which is capable of connecting or switching one terminal (line or station) to one or more other terminals.

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 EQUIPMENT - devices or apparatus and their associated wiring, provided by a customer, authorized user or joint user which when connected to Telephone Company equipment are so connected either electrically, acoustically, or inductively.

DELAY DIAL SIGNAL - consists of an "off hook" on seizure, followed by an "on hook", indicating readiness to receive pulses. This signal is required to prevent a sender from outpulsing before the receiving equipment is ready to receive the pulses.

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 voice connecting arrangement.

NETWORK CONTROL SIGNALING - the transmission of signals used in the telecommunications system to perform functions such as supervision (control, status, and charging signals), address signaling (e.g., 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 system.

NETWORK CONTROL SIGNALING UNIT - the terminal equipment furnished, installed, and maintained by the Telephone Company for the performance of network control signaling.

PERCENT BREAK - the period of time of the open interval compared to the total time of the open and closed intervals in a dial pulse sequence expressed as a percentage.

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 inter-exchange channel switching arrangements.

SUPERVISORY SIGNALS - signals used to initiate a request for service by the calling party (off-hook); 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).

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

TRANSMISSION LEVEL POINT (TLP) - a point in a transmission system at which the transmission level (expressed in dB) is defined as the nominal or design gain (or loss) at 1000 Hz referenced to an arbitrary point in the system called the 0 Transmission Level Point (0 TLP). The 0 TLP (not to be confused with 0 dBm) is a point chosen for engineering convenience and is not an indication of signal power level.

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.

VOICE CONNECTING UNIT - that portion of the voice connecting arrangement including the voice coupler which provides the interconnection function between the customer-provided equipment and the Telephone Company facilities.

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) Nasell, I., "The 1962 Survey of Noise and Loss on Toll Connections," BSTJ, Vol. 43, No. 2 (March 1964), p. 697.

(c) Nasell, I., "Some Transmission Characteristics of Bell System Toll Connections," BSTJ, Vol. 47, No. 6 (July-August) 1968), p. 1001.

(d) Nasell, I., Ellison, C. R., and Homstrom, R., "The Transmission Performance of Bell System Intertoll Trunks," BSTJ, Vol. 47, No. 8 (October 1968), P. 1561.

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

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

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

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

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

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APPENDIX C

WHERE TO OBTAIN REFERENCE MATERIAL

1. Bell System Technical References

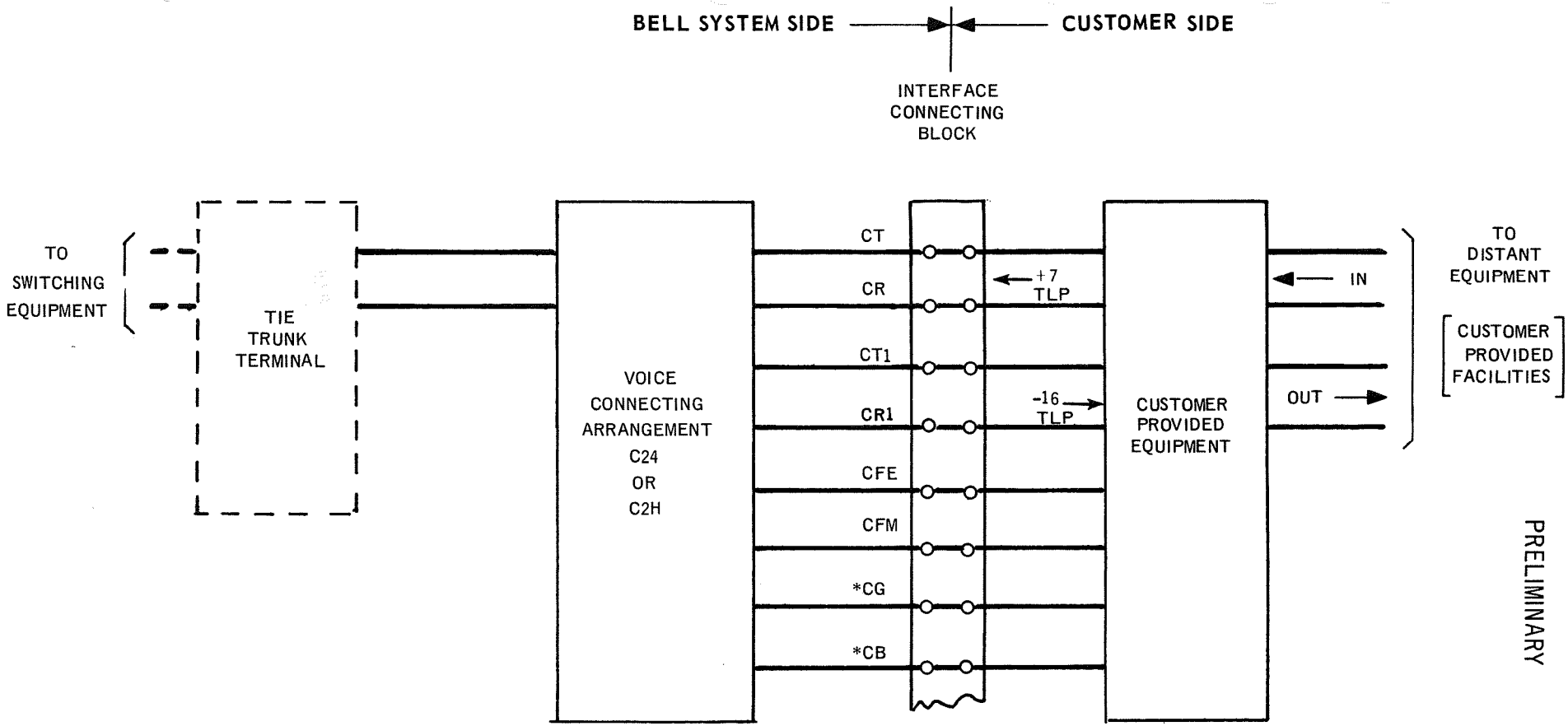
These references may be purchased by writing to:

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:

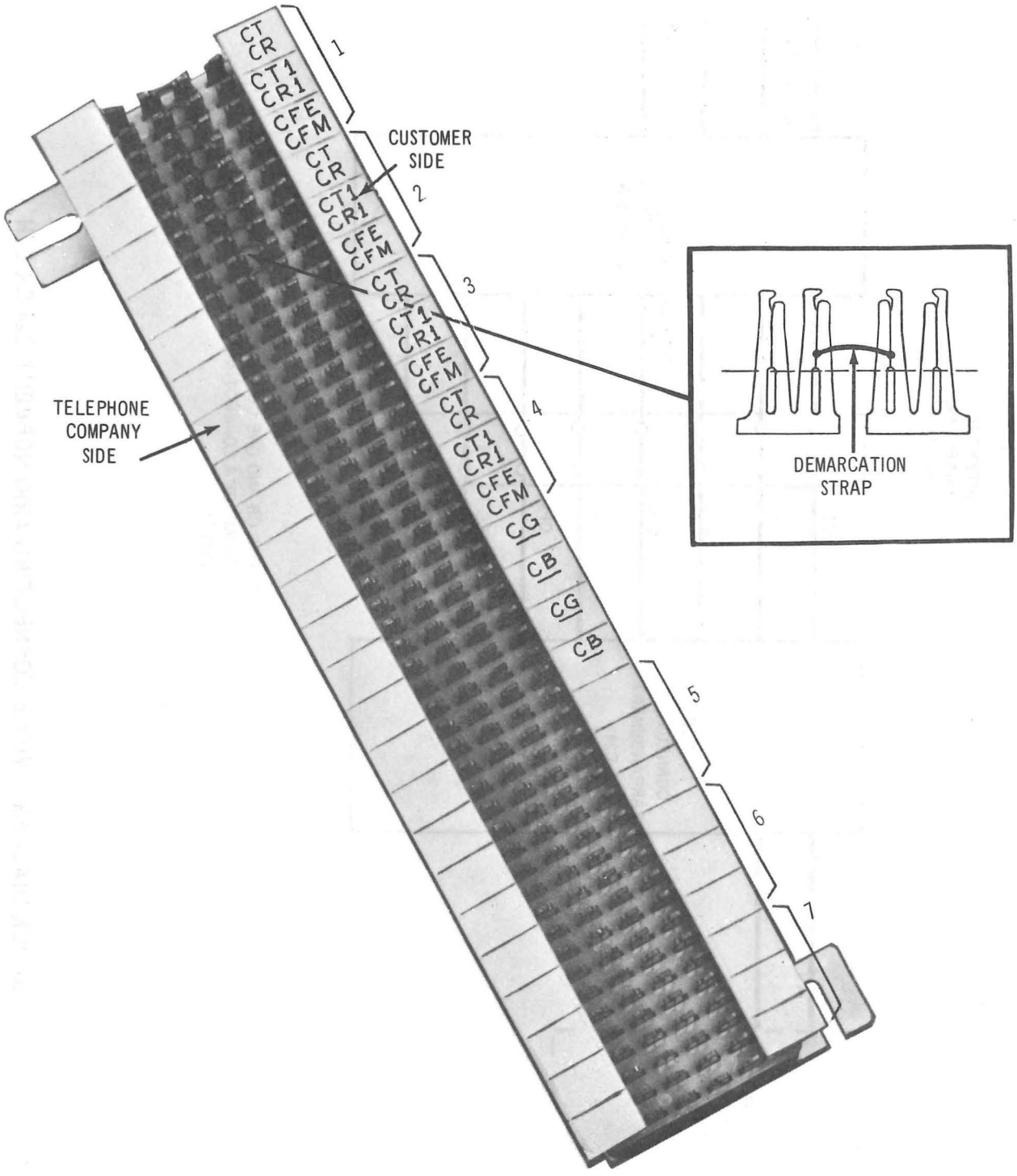
Mr. F. J. Schwetje
Bell Telephone Laboratories, Inc.
Mountain Avenue, Room 3C115
Murray Hill, New Jersey 07974



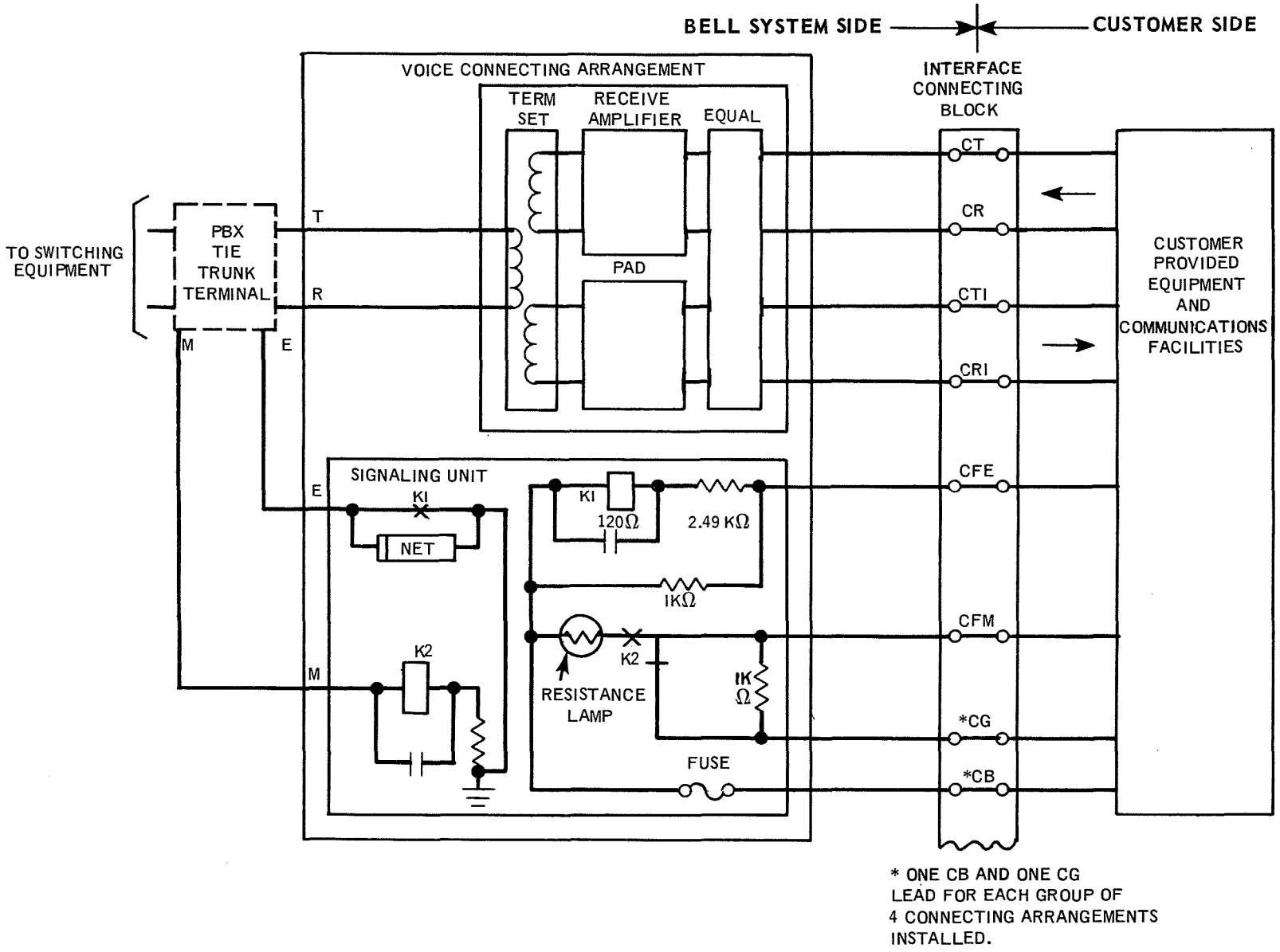
* ONE CB AND ONE CG LEAD FOR EACH GROUP OF 4 CONNECTING ARRANGEMENTS INSTALLED.

BLOCK DIAGRAM – VOICE CONNECTING ARRANGEMENT C24 OR C2H

FIG. 1



TYPICAL INTERFACE CONNECTING BLOCK
FIG. 2



SIMPLIFIED SCHEMATIC (TYPICAL) – VOICE CONNECTING ARRANGEMENT C24 OR C2H
FIG. 3

PRELIMINARY

RESISTANCE LAMP
TYPICAL CURVE RESISTANCE VS. CURRENT

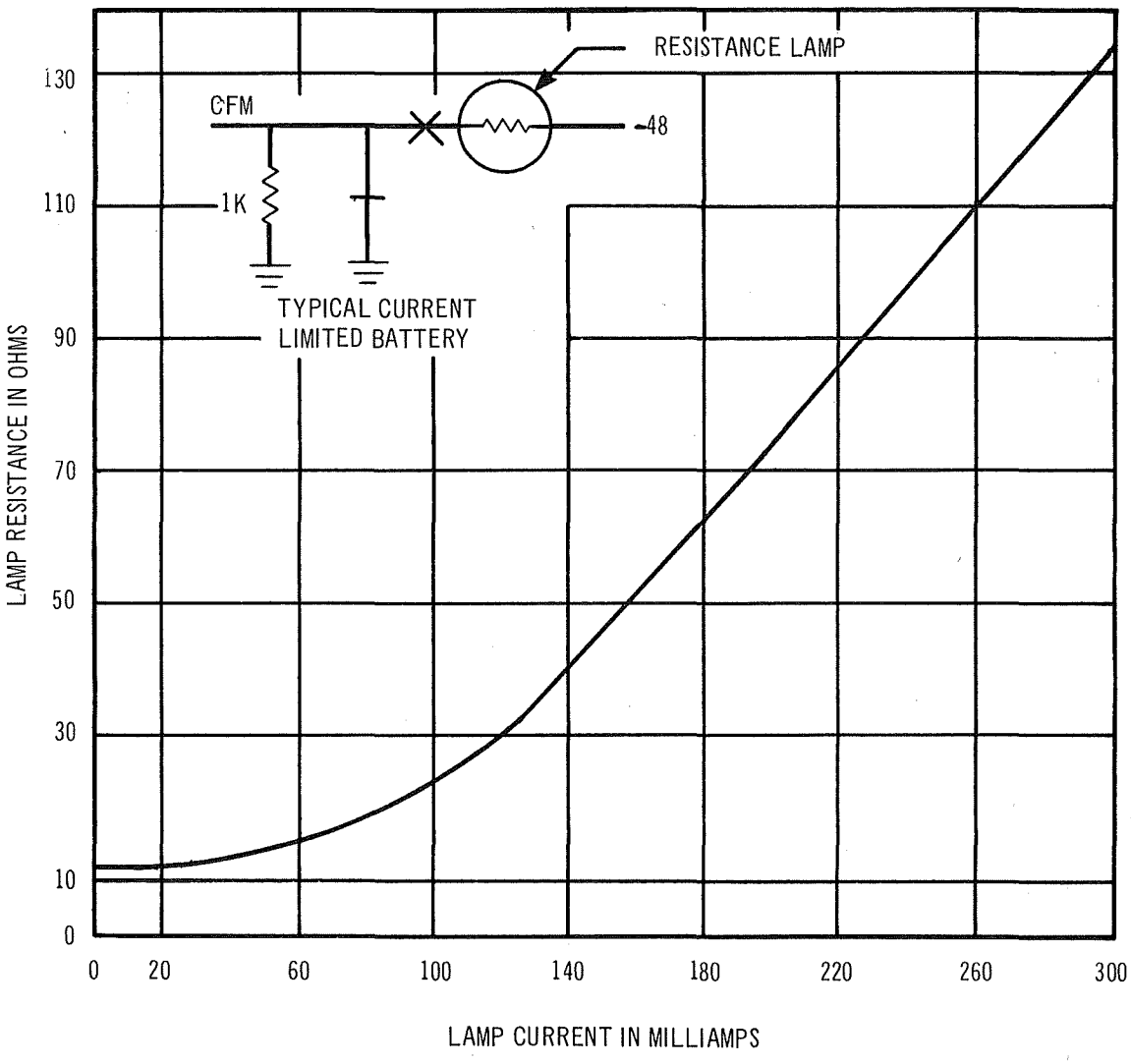


FIG. 4