PUB 42604

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Connecting Arrangement

C25

Interface Specification

July 1971

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS

326-662

NOTICE

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TECHNICAL REFERENCE

CONNECTING ARRANGEMENT C25

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PRELIMINARY

CONNECTING ARRANGEMENT C25

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 transmitting and receiving terminal equipment and communications systems to the Bell System telecommunications network. The tariffs also provide for the indirect (acoustic or inductive) connection of such equipment or systems. Both methods require compliance with network protection criteria given in the tariffs.

Direct electrical connection is made through a connecting arrangement and associated network control signaling unit (if required) furnished, installed, and maintained by the Telephone Company.

1.2 Application

Connecting Arrangement C25 provides a means for automatically connecting a customer-provided communications system of a centrex type to a voice grade private line for access to Bell System Central Office automatic message accounting equipment (Fig. 1). The arrangement accepts from customer-provided automatic number identification (ANI) equipment, the trunk and station numbers associated with direct outward dialed (DOD) calls which have been placed over a group of Central Office trunk lines (e.g., dial "9") terminated on a particular Central Office and equipped with Voice Connecting Arrangement CD7, CD8, or CDH.

1.3 Ordering and Identification

The connection service described in this Technical Reference is identified by the Bell System as Connecting Arrangement C25 and is available only in connection with certain Telephone Company Central Offices. One Connecting Arrangement C25 and its associated voice grade private line has a capacity to handle the identification for up to 250 outgoing trunks depending upon the call attempts and traffic load on the Central Office. An overloaded connecting arrangement will result in calls being billed to the listed PBX number. If two or more groups of trunks are terminated on different serving Central Offices a separate Connecting Arrangement C25 must be ordered for each trunk group. In this case, it is the responsibility of the customer-provided equipment to select the proper connecting arrangement associated with a trunk group for transmission of the number identification information. 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 connecting arrangement are:

(a) To protect Telephone Company personnel and equipment from potentially hazardous voltages which may be applied at the interface.

(b) To provide access to a Telephone Company Central Office associated with automatic message accounting equipment for automatic calling station identification.

(c) To receive an indication from the customer-provided automatic number identification equipment that a trunk number and a station number have been identified and stored.

(d) To signal the Central Office that a trunk number and station number have been identified at the PBX.

(e) To recognize a transmit information command signal from the Central Office and signal the customer-provided automatic number identification equipment that the Central Office is conditioned to accept information.

(f) To provide terminators as specified in Electronic Industries Association (EIA) Standard RS-232C for customer-provided clock and information leads.

(g) To convert EIA serial binary signals from the customer-provided equipment to frequency-shift-keying signals of the proper level for transmission over the control channel to the Central Office.

(h) To provide indication of the disconnect of customer-provided equipment to the serving Central Office.

(i) To provide indication of a Central Office disconnect to the customer-provided equipment.

2.2 Physical

Connecting Arrangement C25 consists of a panel assembly equipped with a plug-in interconnecting unit. The unit is assembled on an 8-inch

printed wiring board which plugs into a connector on the panel. The panel measures 4-1/2-by 8-by 11-1/2-inches and is arranged for mounting in a standard 23-inch relay rack. The relay rack will be mounted by the Telephone Company in an appropriate location so that the front and back of this arrangement are accessible for testing and maintenance. The unit requires 24 volts dc and 48 volts dc which is normally provided in connection with the other voice connecting arrangements furnishing service to the customer-provided communications system. Connecting Arrangement C25 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 per circuit are provided from Connecting Arrangement C25 for the customer's use. Technical information pertaining to these leads is discussed in Section 4. The leads and their functions are as follows:

Lead Designation	Function
CS	seizure/disconnect
CBS1 CBS2	transmit command indication
CDT	information transmission
CCK	clock pulses
CG	signal reference ground for CS, CDT, CCK leads

Leads from this arrangement will be terminated on a Telephone Company-provided interface connecting block conveniently located to permit

testing, maintenance, trouble isolation, and ease of connection to the customer-provided equipment. The customer must provide and install the conductors and make the necessary connections of his equipment to the voice connecting arrangement at this block. The CDT and CCK leads must be separate, individually shielded wire. The shields shall be grounded to the CG lead at the customer-provided equipment only; the shields must not be grounded at the interface connecting 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 solid, unstripped, polyethelene or polyvinyl cloride insulated (.008 inches maximum thickness) conductors of 20 through 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-provided equipment should be located within 50 feet of the interface connecting block to minimize signal degradation on the information and clock leads.

3. OPERATION

3.1 Idle Condition

When Connecting Arrangement C25 is in the idle condition, the customer-provided automatic number identification equipment shall provide a positive (ON) EIA voltage signal (see Paragraph 4.2) to the arrangement over lead CDT; it shall provide standard clock pulses over the CCK lead; and an open between the CS and CG leads (see Fig. 3 and Paragraph 4.21). The CBS1 and CBS2 leads are open when the connecting arrangement is in the idle condition. The CG lead is the signal reference ground for the EIA voltage on leads CDT and CCK.

3.2 Seizure

When the customer-provided equipment is conditioned to transmit trunk and station number information associated with an outgoing call, a closure shall be provided to the connecting arrangement between the CS and CG leads. This closure operates a relay in the connecting arrangement which prepares a closure path on the CBS1 and CBS2 leads and subsequently signals the Central Office. When the Central Office is prepared to receive the identified trunk and station number, the Central Office signaling circuits operate a relay in the connecting arrangement which completes the closure on the CBS1 and CBS2 leads toward the customer-provided equipment as a transmit command signal. A delay in the command signal of longer than 3 seconds should be considered as a major failure of the service. It is recommended that the stored identification information for that particular call be dumped to avoid loss of sequence identification because of a backup of stored information. However, the condition may be temporary and additional attempts for identification of subsequent calls should be made.

3.3 Information Transmission

Within a timed interval (greater than 10 milliseconds but less than 20 milliseconds) after the customer-provided equipment receives the contact closure between the CBS1 and CBS2 leads, it shall transmit the trunk and station number to Connecting Arrangement C25 over the CDT lead. Each complete message from the customer-provided equipment to the connecting arrangement consists of 41 binary bits; one premessage bit followed by a 40-bit word (8 digits, 5 bits per digit). Four digits (20 bits) identify the trunk; the other four (20 bits) identify the station.

Each five-bit digit consists of two "1" bits (negative EIA voltage) and three "0" bits (positive EIA voltage) using the two-out-of-five code of Table A. The premessage bit level is always a "1" bit. The repetition rate of the pulses must be synchronized with the customer-provided clock pulses on the CCK lead (See Fig. 4 and Paragraph 4.21).

Note: As a trouble-locating aid, the customer-provided equipment should transmit all "1" bits (beginning with the first detected error digit and lasting for the remainder of the message) when it has detected an error or failed to identify the station making the call (see Paragraph 3.5).

3.4 Disconnection

The customer-provided automatic number identification equipment must maintain an uninterrupted contact closure between the CS and CG leads from the time of seizure of the connecting arrangement until completion of transmission of trunk and station number information. If the cus-

tomer-provided equipment disconnects first after the transmission of identification information the customer-provided equipment shall remove the contact closure between the CS and CG leads. The connecting arrangement recognizes this open as a disconnect signal, opens the closure between the CBS1 and CBS2 leads, and signals the Central Office. Upon receiving a disconnect signal from the Central Office, the connecting arrangement returns to the normal idle state (see Section 4 for specific timing information). If the Central Office disconnects first, the connecting arrangement provides a disconnect signal to the customer-provided equipment by removing the contact closure between the CBS1 and CBS2. After the customer-provided equipment removes the contact closure between the CS and CG leads, the connecting arrangement will return to the normal idle state.

3.5 Call Billing

The Central Office receives the identification information and stores the station number in a memory slot associated with the trunk number for all outgoing calls using the trunk lines whether or not the information is required for call billing. When the automatic message accounting equipment requires the station number for call billing, the number is read out of storage. If the equipment determines that the number is invalid either because of digits in error or an incomplete number, the call is billed to the listed PBX number.

4. SPECIFIC DESIGN CONSIDERATIONS

4.1 Supervisory Paths

4.11 Seizure Path

The CS and CG leads provide the means for the customer-provided automatic number identification equipment to seize Connecting Arrangement C25 for subsequent connection to the Central Office. The customer's equipment must provide a contact closure between the CS and CG leads at the initial seizure of the connecting arrangement. The closure must be released less than 10 milliseconds after the completion of the transmission of trunk and station number information to the Central Office (under normal conditions, total time is approximately 300 milliseconds). The CS lead has a maximum potential of 60 volts dc through 2250 ohms. The CG lead is grounded at the connecting arrangement and shall be used by the customer-provided equipment as a signal reference ground for the information and clock lead circuits.

The customer's leads must be capable of carrying .025 ampere, through an inductive load. Contact protection is provided by the connecting arrangement. The minimum open circuit insulation resistance of the customer-provided equipment between the CS and CG lead, and from either lead to ground, should be 30,000 ohms. The maximum external loop resistance, including contact resistance, measured across these leads at the interface connecting block toward the customer-provided equipment shall not exceed 500 ohms when indicating a closure.

4.12 Transmit Command Path

The CBS1 and CBS2 leads provide a contact closure toward the customer-provided equipment when Connecting Arrangement C25 receives a transmit

command signal from the Central Office. The customer-provided equipment must recognize this closure as a transmit command signal from the connecting arrangement. Removal of this closure, when it occurs prior to the customer-provided equipment opening the CS and CG leads, must be recognized by the customer-provided equipment as an indication that the Central Office has disconnected.

The nominal resistance measured across leads CBS1 and CSB2 at the interface connecting block toward Connecting Arrangement C25 is less than 10 ohms when indicating a closure. The maximum peak voltage from either of these leads to ground from the customer-provided equipment should not exceed 135 volts. The customer-provided equipment load across the CBS1 and CBS2 leads shall not exceed .5 ampere peak. The customer-provided equipment shall provide appropriate contact protection.

4.2 Clock and Information Paths

The customer-provided clock and information signals on the CCK and CDT leads must conform to the electrical characteristics as specified in Section 2 of Electronic Industries Association Standard RS-232-C, entitled "Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange," dated August 1969. Connecting Arrangement C25 provides terminators for leads CCK and CDT as specified in EIA RS-232-C. Connecting Arrangement C25 subsequently converts the dc pulses from the customer-provided equipment to a signal suitable for transmission to the Central Office over the voice grade private line. The open voltage on the CCK and CDT leads from the connecting arrangment ter-

minator toward the customer-rprovided automatic number identification equipment driver is essentially zero volts. The CG lead is used on the signal reference ground for the CCK and CDT leads.

4.21 Clock Lead

The pulses on the CCK lead shall be provided by the customer-provided equipment. These pulses must be an accurate transistion between positive and negative EIA voltages with a repetition rate of 735.3 pps ± 0.1 percent, a rise time of 2 microseconds, and a duration of 30 microseconds. A tuning fork oscillator may be used to provide the required repetition rate. Clock pulses should be provided continually, even when the customer-provided equipment is in the idle condition. If the clock pulses are stopped for any reason, they must be resumed before a bit signal is initiated by the customer-provided equipment; at least three clock pulses must be transmitted to the connecting arrangement following the end of the information message.

4.22 Information Lead

The pulses on the CDT lead provided by the customer-provided equipment shall be synchronized with the repetition rate of the clock pulses. The rise time and duration of the information pulse is not critical provided it has reached its peak amplitude at the start of the leading edge of the clock pulse. The information pulse must not change until after the clock pulse is no longer present. Consequently, the leading edge of the information pulse must precede the clock pulse by at least 3 microseconds and the trailing edge must lag the clock pulse by at least 3 microseconds.

4.3 Grounding

Connecting Arrangement C25 is provided with a common signal ground (a metallic cold water pipe or other approved ground) which is always bonded to the electric power ground and telephone protector ground, where present. The CG lead is grounded at the unit and provides signal reference ground for the interface leads. It is expected that the customer-provided equipment will be grounded in compliance with applicable electrical codes such as the National Electrical Code (NEC).

4.4 Functional Sequence of Operation

The customer-provided automatic number identification equipment initiates a bit for access to the Central Office with a contact closure between the CS and CG leads.

Following a minimum interval of 45 milliseconds, Connecting Arrangement C25 provides a closure between the CBS1 and CBS2 leads as a transmit command signal to the customer-provided equipment. (A delay of 3 seconds or greater between the CS and CG closure and the CBS1 and CBS2 closure indicates either a major failure of the service or a temporary traffic overload in Central Office equipment.) Following the CBS1 and CBS2 closure the customer-provided equipment shall begin number identification transmission; the interval between the CBS1 and CBS2 closure and the start of information transmission must be greater than 10 milliseconds but less than 20 milliseconds. Transmission time for number information, is equal to 55.76 milliseconds. The accurate reception of number information at the Central Office can not be assured if the 20 millisecond time is ex-

ceeded before the start of transmission. Following the last bit of transmitted number information, the customer-provided equipment shall remove the closure between the CS and CG leads to release connection to the Central Office. The interval between the last bit of number information and removal of the CS and CG closure must be less than or equal to 10 milliseconds. Following the release of Central Office connection by the customer-provided equipment (open on the CS and CG leads) there must be a minimum interval of 45 milliseconds before the customer-provided equipment initiates another bit for access (closure between the CS and CG leads). (See Fig. 5 for sequence diagram.)

5. SERVICE AND MAINTENANCE CONSIDERATIONS

5.1 Responsibility of the Customer

The tariffs permitting connection of customer-provided terminal equipment or communications systems state that where telecommunications service is available under these tariffs for use in connection with terminal equipment or communications systems, provided by a customer, 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 does not endanger the safety of Telephone Company employees or the public; damage, require change in or alteration of, the equipment or systems or other facilities of the Telephone Company, interfere with the proper functioning of such equipment or systems of facilities, impair the operation of the telecommunications

system of 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 system provided by a customer is causing or is likely to cause such hazard or interference, the customer shall take such steps or make such change as shall be necessary to remove or prevent such hazard or interference.

5.2 Responsibility of the Telephone Company

The tariffs permitting connection of customer-provided terminal equipment and communications systems state that the Telephone Company shall not be responsible for the installation, operation or maintenance of said terminal equipment or communications systems. Telecommunications service is not represented as adapted to the use of customer-provided equipment or systems and where such equipment or systems are connected to Telephone Company facilities, the responsibility of the Telephone Company shall be limited to the furnishing of facilities, including the protective connecting arrangements and network control signaling units, suitable for telecommunications service and to the maintenance and operation of such facilities in a manner proper for such services. Subject to this responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by the customer-provided equipment or systems or for the quality of, or defects in, such transmission, (ii) the reception of signals by customer-provided equipment or systems, or (iii) address signaling where such signaling is performed by customer-provided tone-type signaling equipment. The

Telephone Company shall not be responsible to the customer if changes in minimum network protection criteria contained in the tariffs (and in this Technical Reference) or in any of the facilities, operations or procedures of the Telephone Company render any customer-provided facilities obsolete or require modification or alteration of such equipment or systems or otherwise affect its use of performance.

5.3 Trouble Reporting Procedure

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

(a) Customer's name

(b) Customer's address

(c) Listed telephone number

(d) Description of the trouble

(e) Customer's contact for additional information

If a Telephone Company service call results in the location of the trouble in the customer-provided equipment, the customer is liable to be charged for the service call.

PRELIMINARY

APPENDIX A

GLOSSARY

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

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

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

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

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

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

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

PRELIMINARY

APPENDIX B

REFERENCES

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

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

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

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

(e) EIA Standard RS-232-C, "Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange," order from Electronic Industries Association, 2001 Eye Street, N. W., Washington, D. C. 20006

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

(g) Breen, C., and Dahlbom, C.A., "Signaling Systems for the Control of Telephone Switching," Bell System Technical Journal, Vol. 39, No.6 (November 1960), P. 1381.

* Available through Western Electric Company, Inc.
Commerical 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)

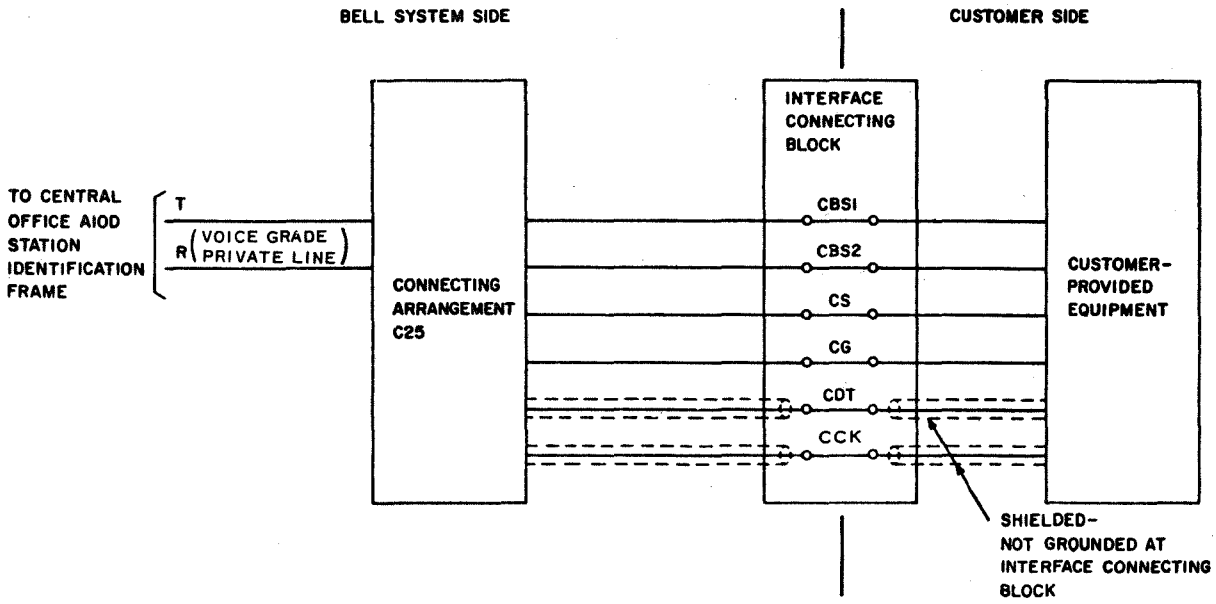
These journals may be purchased by writing to:

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

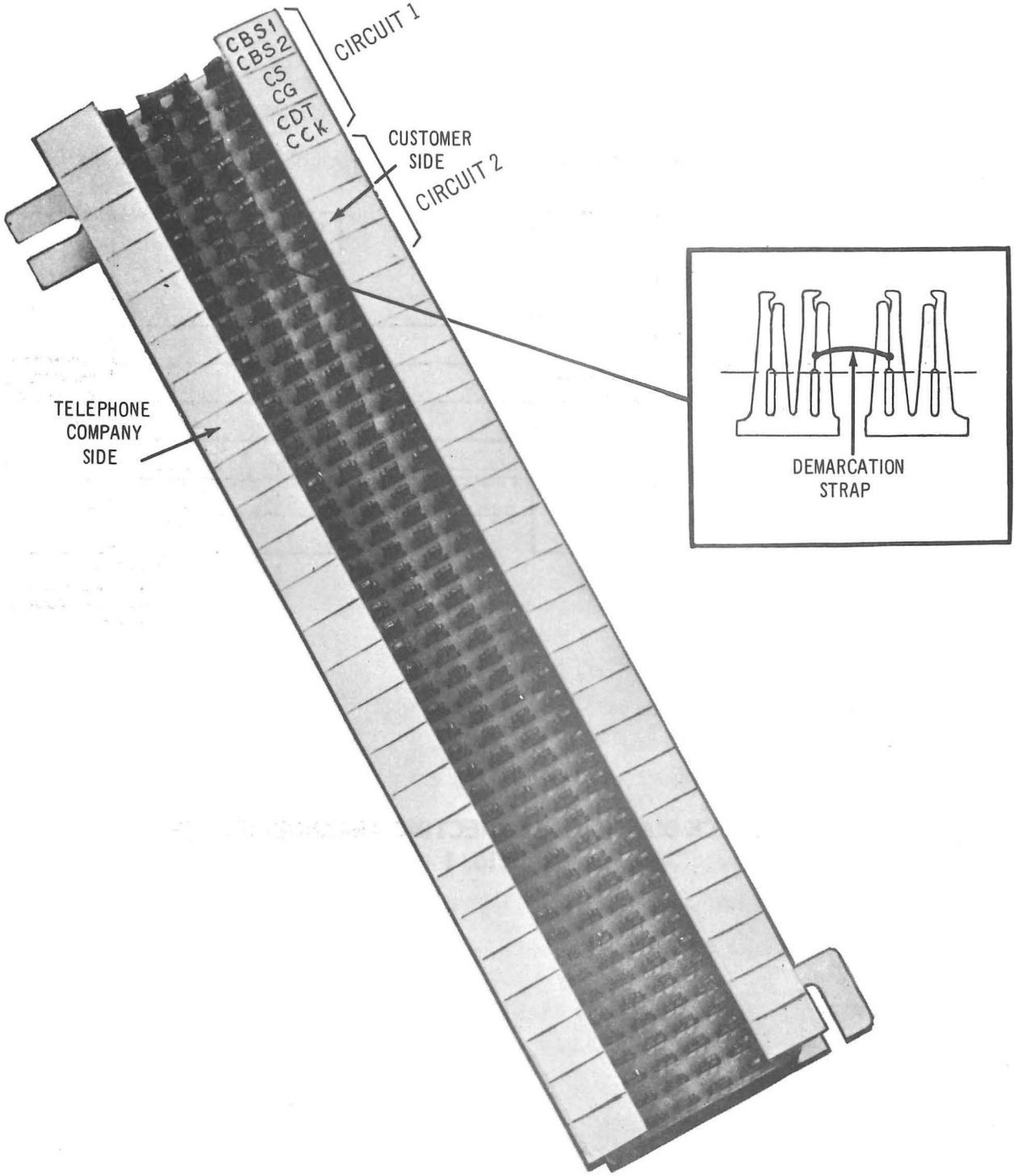
TABLE A

2/5 DIGIT CODE

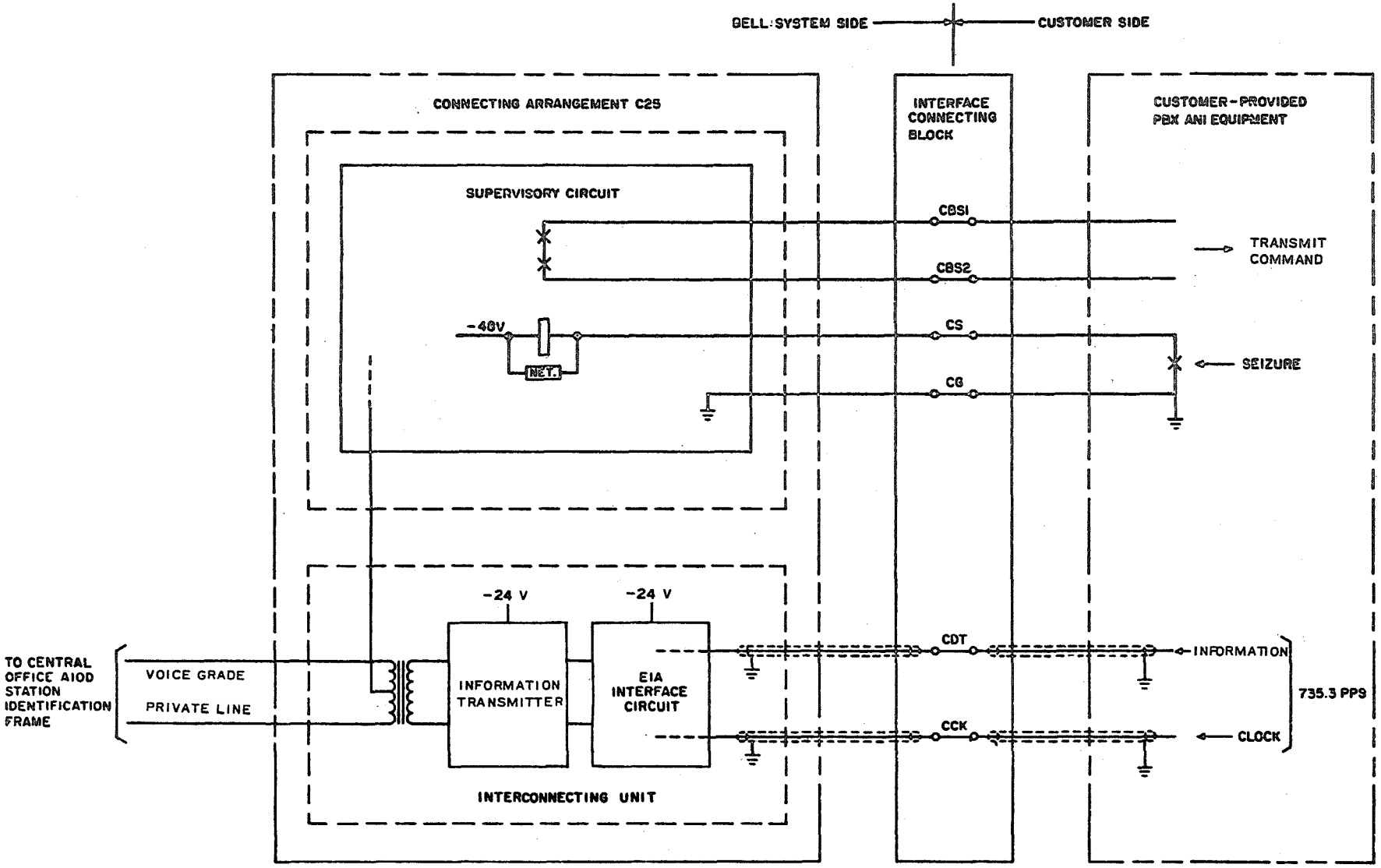
DIGIT NUMBER	ORDER OF TRANSMITTED BITS				
	1	2	3	4	5
0	0	0	0	1	1
1	1	1	0	0	0
2	1	0	1	0	0
3	0	1	1	0	0
4	1	0	0	1	0
5	0	1	0	1	0
6	0	0	1	1	0
7	1	0	0	0	1
8	0	1	0	0	1
9	0	0	1	0	1



BLOCK DIAGRAM – CONNECTING ARRANGEMENT C25
FIG. 1

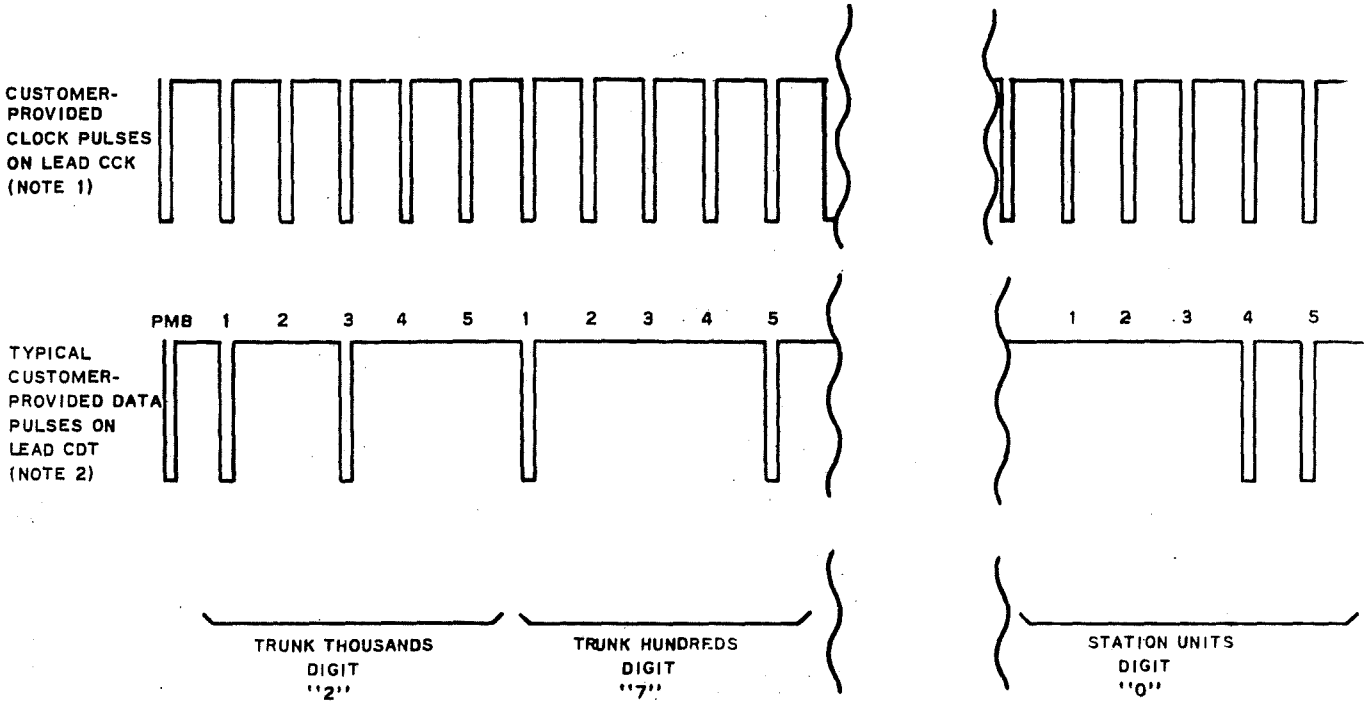


TYPICAL INTERFACE CONNECTING BLOCK
FIG. 2



SIMPLIFIED SCHEMATIC – CONNECTING ARRANGEMENT C25
FIG. 3

PRELIMINARY

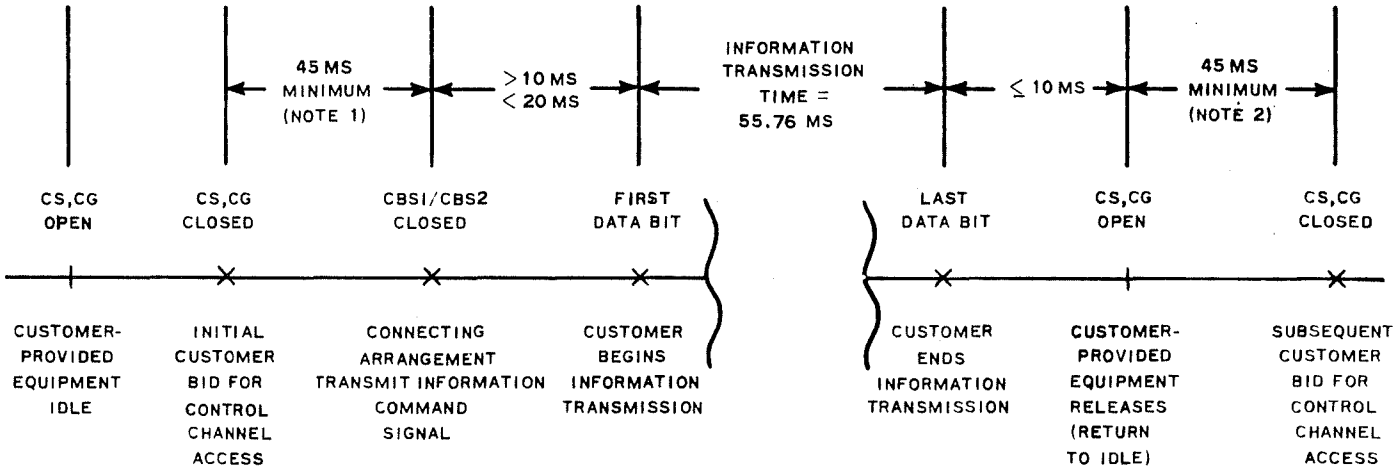


NOTES:

1. CUSTOMER-PROVIDED CLOCK PULSES MUST HAVE A REPETITION RATE OF 735.3 PPS ± 0.1 PERCENT, RISE TIME 2 MICROSECONDS, DURATION 30 MICROSECONDS.
2. CUSTOMER-PROVIDED DATA PULSES MUST BE SYNCHRONIZED WITH REP RATE OF CLOCK PULSES; INFORMATION PULSE MUST LEAD CLOCK PULSE BY A MINIMUM OF 3 MICROSECONDS AND LAG CLOCK PULSES BY A MINIMUM OF 3 MICROSECONDS.

TYPICAL CUSTOMER CLOCK AND INFORMATION PULSES ON LEADS CCK AND CDT
FIG. 4

PRELIMINARY



NOTES:

1. A DELAY OF 3 SECONDS BETWEEN CUSTOMER BID AND RETURN OF TRANSMIT INFORMATION COMMAND SIGNAL USUALLY INDICATES TROUBLE ON THE CONTROL LINE OR TEMPORARY TRAFFIC OVERLOAD IN CENTRAL OFFICE DATA PROCESSING EQUIPMENT.
2. THERE MUST BE A MINIMUM INTERVAL OF 45 MILLISECONDS BETWEEN CUSTOMER RELEASE OF CONNECTING ARRANGEMENT (RETURN TO IDLE CONDITION) AND SUBSEQUENT CUSTOMER BID FOR CONTROL CHANNEL ACCESS.

FUNCTIONAL SEQUENCE DIAGRAM

FIG. 5