VOICE BANDWIDTH PRIVATE LINE DATA CIRCUITS

DESCRIPTION

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1. GENERAL

1.01 This section describes the voice bandwidth (300-3200 Hz) channels used for private line (PL) data services. Voice bandwidth data is defined as data signals occupying a single voice-frequency channel (approximately 300 to 3200 Hz or less with some types of facilities). These services include telemetry and alternate voice/data service; for example, 2001 and 3002 channels covered by FCC Tariff No. 260. These channels may be used to provide 2-point, multipoint, and certain switching arrangements. The information in this section includes the description of various types of conditioning that can be obtained on these different channels.

1.02 This section is reissued to update information on the Application of Protective Arrangements in Part 3, add information on DAS 829-Type in Part 4, add information on Signaling Arrangements in Part 5, and include information on D-Type Conditioning in Part 6. Additional minor changes are also made throughout the section. Since numerous changes are made, arrows normally used to denote changes have been omitted.

1.03 Engineering information is contained in Section 880-420-100 and its associated sections. The references to various related voiceband data maintenance sections are given in Fig. 1. Voice-only operation is not covered in this section but may be found in the Division 310 and 311 series of practices.

1.04 There is no difference technically in the transmission requirements of the 2000 series channels when ordered for data operation and those of a 3002 channel, except in some cases (such as PBX tie trunks) for standard 1000-Hz loss. The difference arises from applications that are described in FCC Tariff No. 260 and the local administration of these channels. The 2000 series of channels may be connected to exchange and toll services, but the 3002 channel must not. When customer-provided modems (CPM) or multiplexers terminate the channel, protective arrangements may be required as covered in Part 3 of this section.

1.05 Although operation of these services is basically 2-point, certain multipoint and switched arrangements are also used. One-way, half-duplex, and full-duplex data modes may be used. Both 2-wire and 4-wire facilities and terminals are employed. Where 4-wire facilities are used, an equal-level loop-back arrangement is specified in all cases.

2. ABBREVIATIONS AND COMMON TERMS

2.01 This part provides abbreviations used in voice bandwidth data service and circuit terminology that are generally encountered. In addition, definitions of unique terms are given.

A. Abbreviations

2.02 A listing of common abbreviations that may be encountered are as follows:

- BIT—Binary Digit
- CCO—Circuit Control Office
- CCSA—Common Control Switching Arrangement
- CDT—Communications Display Terminal

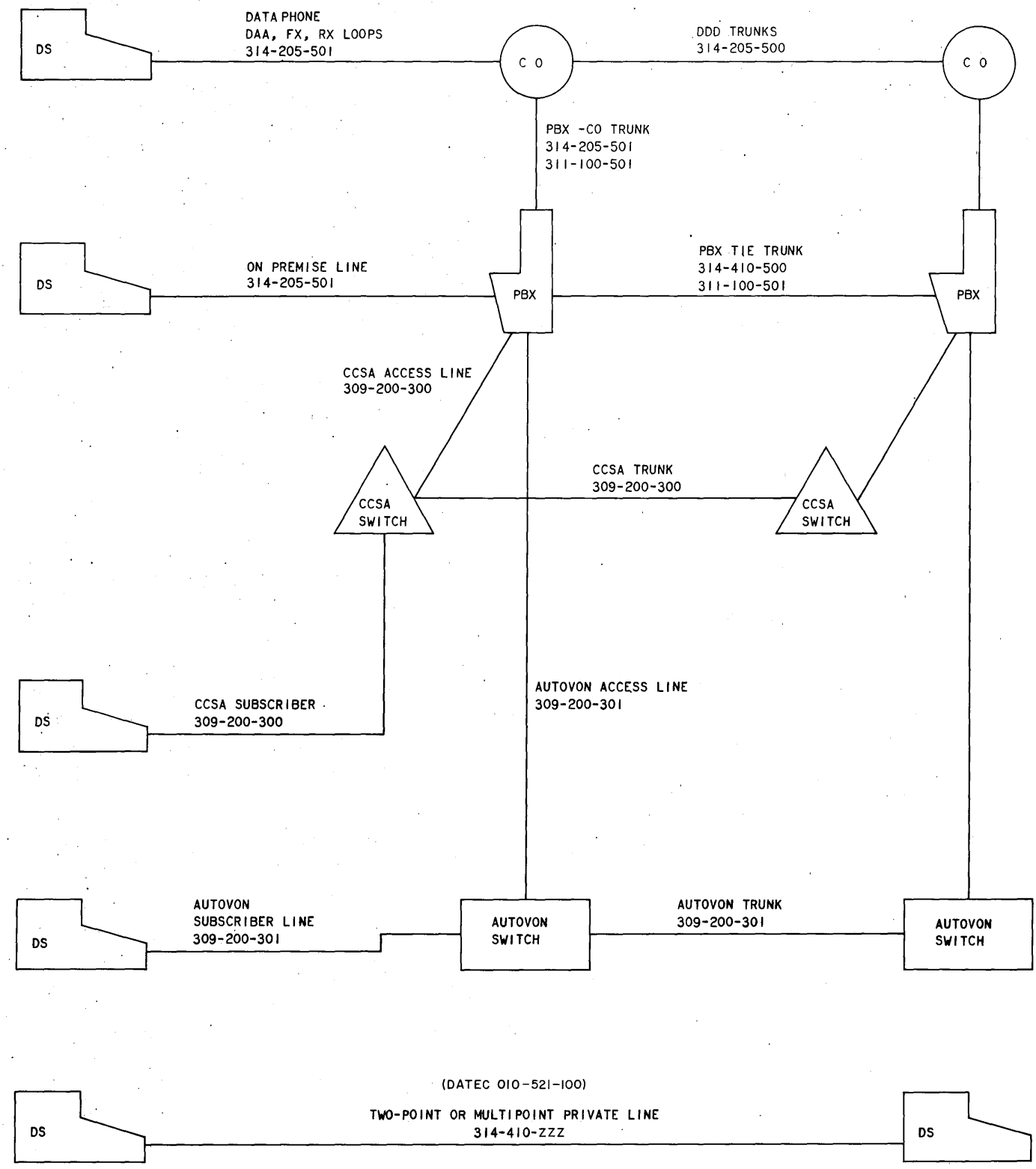


Fig. 1—Reference for Voiceband Data Transmission

- CLRC—Circuit Layout Record Card
- CO—Central Office
- COAM—Customer Owned and Maintained (this term is now outdated)
- CRT—Cathode-Ray Tube
- CSTC—Central Serving Test Center
- DAS—Data Auxiliary Set
- DATEC—Data Technical Support
- DDD—Direct Distance Dialing
- DS—Data Set
- DTS—Data Test Set
- HPDC—High Performance Data Conditioning
- IXC—Interexchange Channel
- LC—Local Channel
- MODEM—Modulator-Demodulator (Data Set)
- PBX—Private Branch Exchange (Switchboard—Manual or Automatic)
- SCAN—Switched Circuit Automatic Networks
- SSN—Switched Service Network
- TELCO—Telephone Company
- TCN—Telecommunications Network
- TMS—Transmission Measuring Set
- TTY—Teletypewriter.

B. Common Terms

2.03 Definitions of common terms are as follows:

(a) ***Baud***—A unit of signaling speed derived from the duration of the shortest signaling element. The speed in bauds is equal to the number of signaling elements per second.

(b) ***Bell System Technical References***—A reference source providing interface information to designers and manufacturers of business machines, communications systems, and terminal equipment. The subjects covered include data set interface specifications, data systems and terminals, data connecting arrangements, and various transmission channels and services.

Note: Bell System organizations may order Technical References by using Form SD-1.80.80 and addressing it to the following locations:

Western Electric Co., Inc.
Indiana Publication Center
P.O. Box 26205
Indianapolis, Indiana 46226

The DATEC support team maintains a file of Technical References and can be used as a source for this type of information.

(c) ***Benchmark Measurements***—These are measurements made on a looped-back or one-way basis when the PL data circuit is known to meet all requirements. They are performed immediately following the completion of installation and circuit order tests and the results recorded for later reference purposes.

(d) ***Bridge***—A device used to interconnect more than two middle and/or end links on multipoint circuits.

(e) ***Customer-Provided Equipment (CPE)***—Any equipment provided by the customer and connecting to the telephone company (telco) line. Both CPM and customer-provided terminal (CPT) are considered CPE and may be designated as CPE.

(f) ***Customer-Provided Modem (CPM)***—Customer-provided data set.

(g) ***Customer-Provided Terminal (CPT)***—Customer-provided terminal equipment at the

data station. Generally, this is equipment located on the customer side of the telephone company modem interface and wholly provided by the data customer. Examples of CPT are digital computers, communication controllers, card and paper tape readers and punches, and magnetic tape readers and recorders.

(h) ***Data Access Arrangement (DAA)***—An arrangement by which data service is provided by connecting station equipment to the access line through a protective coupling device. The term implies the use of CPM and no data performance is specified.

(i) ***Data Test Center (DTC)***—An office responsible for remote testing of data sets. Access to this office may be gained through a dedicated line or DDD facilities.

(j) ***End Link***—The facility between a central office relay switching location [not switched services network (SSN)] or a bridging location and the transmission interface at the customer premises. This definition holds regardless of whether the end link consists of only a local channel or of intercity facilities and a local channel (see Fig. 2).

(k) ***Equal-Level Loop-Back***—A circuit arrangement interconnecting the receive and transmit paths and correcting for any differences in transmission level point (TLP) at the point of connection. The simplest way to accomplish this is to interconnect two identical TLPs, for example, at −3 and −3. To interconnect a −3 TLP receive point with a +13 TLP transmit point, an amplifier with 16 dB of gain would be required in the loop-back path. This ensures that signals on the line are maintained at standard data level during loop-back tests when a test signal at data level is applied toward the customer station.

(l) ***Full-Duplex Operation***—The transmission of signals in both directions simultaneously.

(m) ***Half-Duplex Operation***—The transmission of signals alternately in either direction, or for communication in one direction only, including bidirectional simultaneous transmission of tones required solely for control purposes or quick turnaround or synchronization.

(n) ***Local Channel***—The transmission facility between the customer premises and the serving test center (STC). Refer to the definition of STC.

(o) ***Middle Link***—The facility between central office switching and/or bridging locations. The connection between two bridges in the same central office is not considered to be a middle link. (Refer to Fig. 2.)

End link and middle link definitions apply only to multipoint and central office relay switched circuits.

(p) ***Network Control Office (NCO)***—A designated office responsible for the coordination of all maintenance activities involving two or more circuits or links in a network.

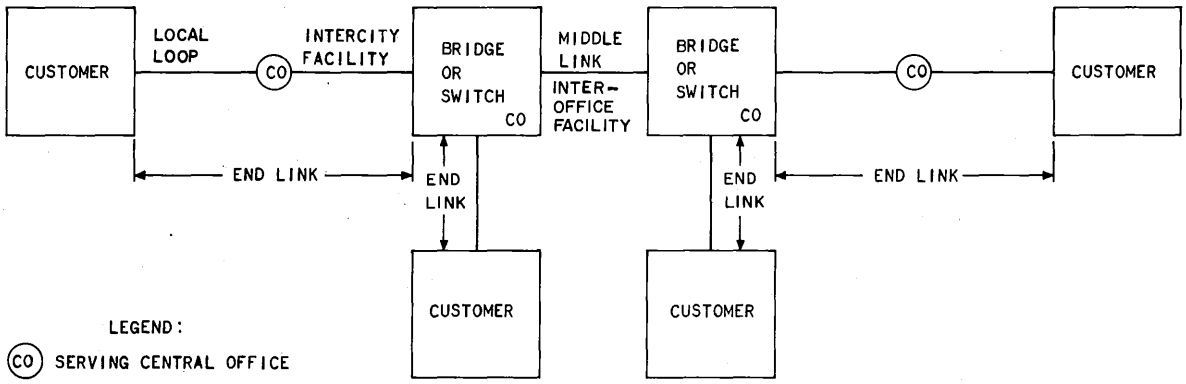


Fig. 2—End Link and Middle Link Definitions

(q) ***Plant Control Office (PCO)***—The designated office responsible for all maintenance activities on a circuit or circuit link. The PCO maintains records for each circuit or circuit link and should be informed of all trouble reports.

(r) ***Plant Service Center (PSC)***—The designated location to receive data service reports, whether local repair service, special service reports, data test center, etc. The PSC is responsible for handling, controlling, and clearing all trouble reports on special services, but often finds it necessary and advantageous to request the assistance of more specialized groups.

(s) ***Protective Arrangement***—An equipment arrangement provided by the telephone company through which a customer may connect his communications equipment (such as a modem) to a PL channel which will not access the switched message network.

(t) ***Serving Test Center (STC)***—A designated office responsible for testing transmission facilities, station equipment, and apparatus, in response to a customer report either taken directly or received from another office. It is also responsible for maintaining circuit records on those circuits for which it is designated an STC. If a PCO has not been designated, the STC is also responsible for coordinating maintenance activities, maintaining circuit layout record cards, and circuit history records.

(u) ***Transmission Level Point (TLP)***—A reference level point on a circuit numerically equal to the algebraic sum of 1000-Hz gains (+) and losses (−) from an arbitrarily defined reference point (0 TLP) to the point of measurement.

TLP—General Definition and Use for PL Data Channel Design

2.04 The following is intended to clarify the term transmission level point (TLP). An understanding of TLP is necessary before making measurements on PL data circuits.

(a) In discussing a channel, it is necessary to describe the power (of the signal, noise, or test tones) present at a particular point in the channel and compare this power to the power present at other points in the channel. Figure 3 illustrates the relationship between TLPs and test tone power in dBm for a simple 2-point circuit. The power present at a particular point in a channel is dependent upon the power at the source, where the source is applied, and the loss or gain in the channel between the points in question. Since this information is not always available, it is convenient to describe the power present in a channel by comparing it to some standard reference point in the channel.

(b) Describing this power is similar to the problem of trying to describe the height of a mountain. In order to measure the height of a mountain, it is necessary to pick a reference height from which to measure. If the reference height is standardized, then comparison of two mountains can be made even though they are thousands of miles apart. The widely accepted standard reference height for measuring mountains is sea level.

(c) The standard reference point for measuring power in Bell System channels is called the zero transmission level point, or 0 TLP. This reference point makes it possible to compare the signal power at two points in the channel even though the points are many miles apart.

(d) With the establishment of the 0 TLP concept, the power present in a channel is described by stating what this power would be if it were accurately measured at the 0 TLP. The standard notation used to describe the power in this case is dBm0. For example, the term −13 dBm0 means that the power at the 0 TLP is −13 dBm; if a −13 dBm0 signal were measured at the 0 TLP, the meter would indicate −13 dBm. An example of a −13 dBm0 signal is shown in Fig. 3 for test signals on a typical 2-point PL data channel.

(e) After the power at the 0 TLP is described, the power (from the same source) at any other point in the channel can be determined. For example, if the signal is −13 dBm when measured at the 0 TLP, it will be 13 dB below the numeric value of any TLP on the channel when measured at that TLP. If the signal is −13 dBm at the 0 TLP, then the power at the +5 TLP would be +5 −13 = −8 dBm. If this −13 dBm0 signal were measured with a transmission measuring set (TMS) at the +5 TLP, the meter would indicate −8 dBm. Similarly, if a −13 dBm0

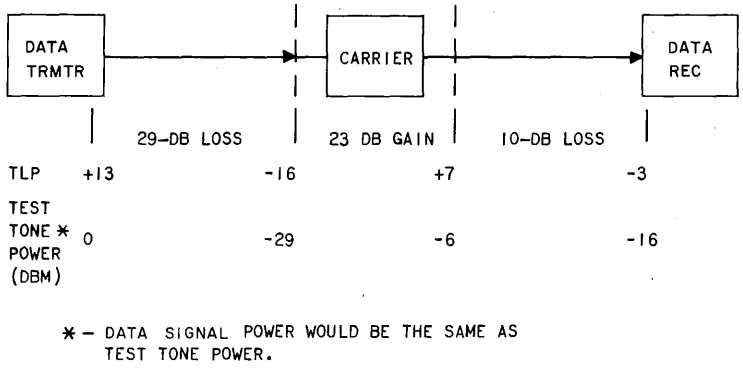


Fig. 3—Relationship Between TLP and Test Tone Power

signal were measured at the −3 TLP, the meter would indicate −16 dBm [(−13) + (−3) = (−16)].

Note: The numeric value of the TLP does not describe the power present at that point any more than the elevation of a mountaintop above sea level describes how high the mountain rises above the plains which surround it. In order to know how high the mountain rises above the plains, it is necessary to know the elevation of the plains above sea level as well as the elevation of the mountain itself. In order to know the power present at a given TLP, it is necessary to know the power present at some other TLP in the channel. As mentioned previously, the standard way to describe the signal is in terms of its power at the 0 TLP (with the notation dBm0). The signal can be described in dBm0 if the power is known at any TLP. For example, if a −29 dBm signal is applied to the channel at the −16 TLP, the signal at the 0 TLP is −29 + 16 = −13 or a −13 dBm0 signal. The power at the −16 TLP is 16 dB lower than the power at the 0 TLP. Therefore, to find the power at the 0 TLP, 16 dB must be added to the power at the −16 TLP.

(f) Use of the 0 TLP reference also permits transmission objectives and measured results to be stated independently of any specific TLP. For example, the end-to-end impulse noise threshold objective is 71 dBrnc0. Knowing this, the appropriate value at any other TLP can be determined. For measurements at the −3 TLP receive terminal, 3 dB should be subtracted from the objective to determine the absolute threshold, which is 68 dBrnc. For measurements at the +7 TLP DEMOD OUT jack, 7 dB should be added to the objective to determine the absolute threshold which is 78 dBrnc. Similarly, if a channel was designed for 0 dB net loss and 0 dBm transmit power and −13 dBm0 design, the receiver is a +13 TLP, and 13 dB should be added to the relative objective to obtain the absolute setting, which is 84 dBrnc.

3. APPLICATION OF PROTECTIVE ARRANGEMENTS

3.01 Protective arrangements may be required for voiceband PL channels where the channels connect to CPE and do not access the switched message network. The regulations regarding the application of protective arrangements are as follows:

(a) Protection against potentially hazardous voltages and longitudinal imbalance will be provided by the telephone company (telco) on the customer premises on interstate services installed on or after February 15, 1973.

(b) Existing stations on interstate services installed prior to February 15, 1973 will not be retrofitted with protective arrangements.

(c) Protection against excessive signal power level on interstate services and some intrastate services will be accomplished by the telco at the central office (CO) by surveillance, rather than by equipment on the customer premises. Where excessive signal power is detected, the telco may provide signal power limiting devices on the customer premises or at the CO.

(d) Interstate voicegrade channels connected to CPE that applies ringing below 300 Hz are exempt from protection at this time, although protective criteria for signal power level (other than ringing) will apply in this instance.

3.02 Where the customer transmits signals in the band from 300 to 3000 Hz, protection against potentially hazardous voltages and longitudinal imbalance can be provided by one of the following:

- 31B voice coupler
- Protected repeat coil
- J53050D-1, L1 interconnecting unit
- Data auxiliary set 828A
- Data auxiliary set 829-type
- V4 repeater.

Where PL voice circuits also provide signaling leads to the customer, the signaling leads should also be protected by the following means:

(a) The J53050C-1, L3 interconnecting unit (for contact closure signaling)

(b) The J53050C-1, L2 interconnecting unit (for E and M lead signaling).

Where the customer has equipment that transmits signals in the band from 300 to 3000 Hz, and in addition, makes use of dc continuity where it is available, this protection can be achieved by means of the 119A interconnecting unit.

3.03 Signal power limiting can be achieved by use of the F-58122 automatic gain control (AGC) amplifier or a 1000A or 1000B data coupler. The 1000A or B data coupler can be installed on the customer premises, while the F-58122 AGC amplifier can be installed either at the customer premises or the CO.

3.04 General information on the above protective arrangement equipment may be found in Part 4 of this section.

4. STATION ARRANGEMENTS

A. General

4.01 Data auxiliary set (DAS) 828A or the new codes of DAS 829-type provide standard, prewired, tested station arrangements for terminating 4-wire PL voiceband data channels. Other types of station equipment may be specified and are generally similar in function. Hazardous voltage protection and preservation of longitudinal balance are required in most new station installations involving CPE. The provision of in-band signal power limiting within the station arrangement is not generally required under interstate tariffs but may be required under some intrastate tariffs. When in-band signal power limiting is not provided, surveillance techniques will be employed to assure signal power level compliance to the minimum protective criteria. The circuit layout record card (CLRC) should indicate the type of station equipment to be used to provide protection against potentially hazardous voltages and longitudinal imbalance, and if also required, in-band signal power limiting.

B. Customer Station Interface Levels

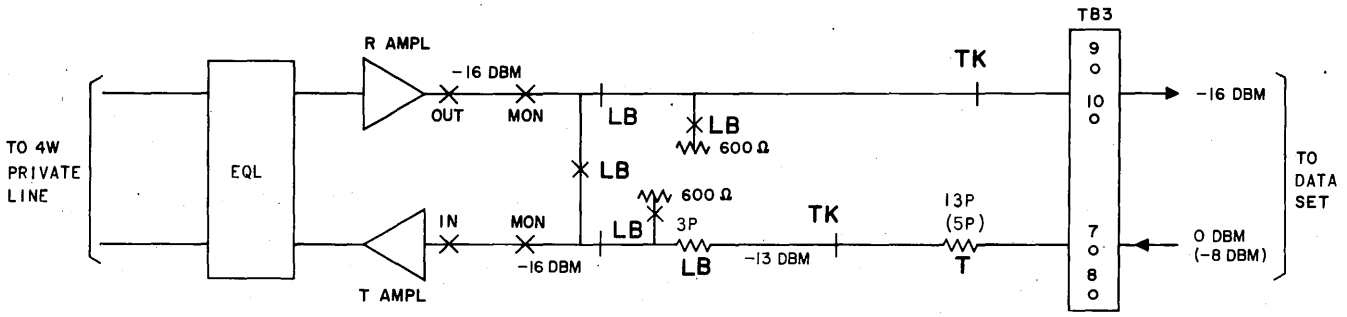
4.02 The current standard transmit power at the data set interface is 0 dBm (+13 TLP). This design is used for those data sets which can transmit at 0 dBm. Older CPMs which cannot transmit at 0 dBm may interface at a +5 TLP and transmit at −8 dBm. The standard receiver power at the data set interface is −16 dBm (−3 TLP) in all cases. Nonstandard interface levels may be negotiated by the customer and are to be indicated on the CLRC. In all cases the channel is designed on a −13 dBm0 basis (the data power is 13 dB below the TLP). Typical arrangements showing the DAS 828A using these designs are shown in Fig. 4, 5, 6, and 7.

4.03 The basic ground rules for determining circuit design when using DAS 829-type are as follows:

(a) −13 dBm 0 design.

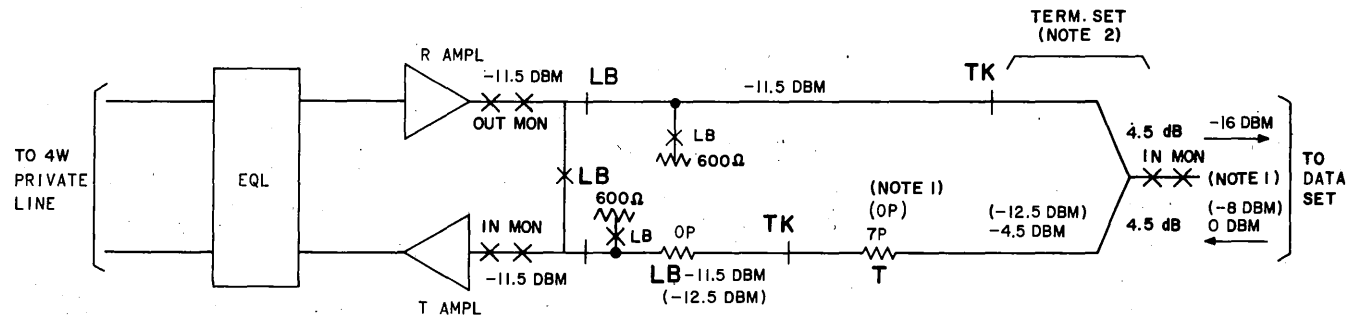
(b) The modem interface will be +13 TLP (0 dBm) transmit and −3 TLP (−16 dBm) receive.

(c) Equal-level loop-back is always provided.



NOTE:
FOR +5 TLP TRANSMIT, CORRESPONDING TO -8 DBM, THE T PAD VALUE WOULD BE 5DB, AS SHOWN IN PARENTHESES.

Fig. 4—Circuit Design for Data Only, 4-Wire Data Set



NOTES:
1. VALUES FOR +5 TLP TRANSMIT ARE IN PARENTHESES.
2. S1 SCREW AND COMP NET SCREW MUST BE DOWN IN ALL CASES.

Fig. 5—Circuit Design for Data Only, 2-Wire Data Set

An arrangement showing the DAS 829-type using the above rules is shown in Fig. 8. Additional transmission circuit design guidelines for use with DAS 829-type are provided in Section 598-082-100.

4.04 Field experience shows that a polling operation in combination with a high noise environment causes problems in certain older Bell System data sets due to AGC operation. Since these sets have a large dynamic range, a −16 dBm received level is not required. If the received signal power and noise power are reduced with a pad, the AGC range may be properly centered and the modem performance improved. The basic channel design should not be changed from a 16-dB net loss. Instead, a pad may be added at the data set receive input and considered part of the data set. For polling applications where split or 2-wire bridges are used and the master station uses the continuous carrier option, the referenced pads are needed only at the master station receiver and are not required at the outlying stations. Data set 201B requires a 12-dB pad while data sets 202D and 202R generally require a 16-dB pad as shown in Fig. 9. The new family of data sets (201C, 202T, 208A, and 209A) are designed to operate at a data power of −16

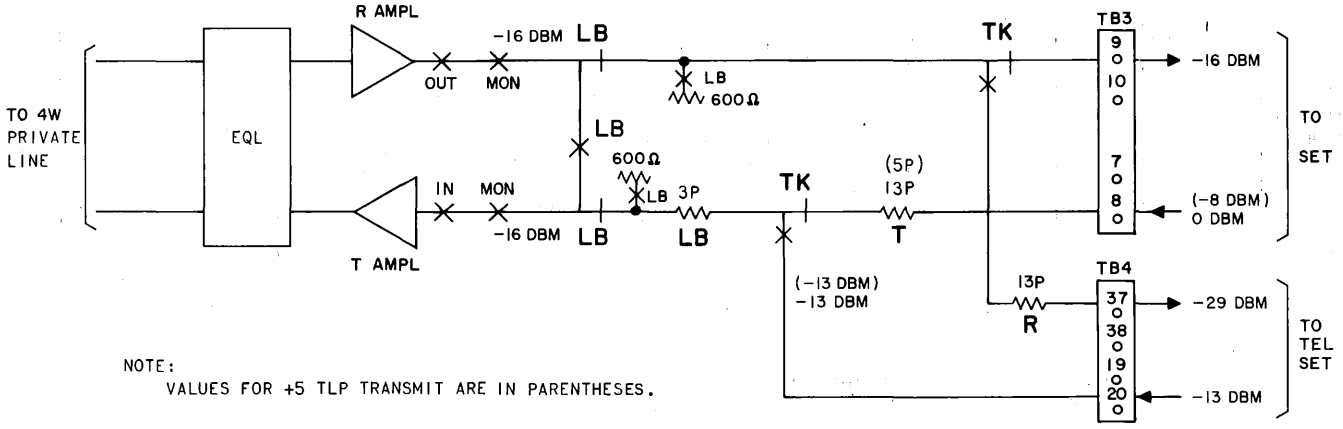


Fig. 6—Circuit Design for Data/Voice, 4-Wire Data Set

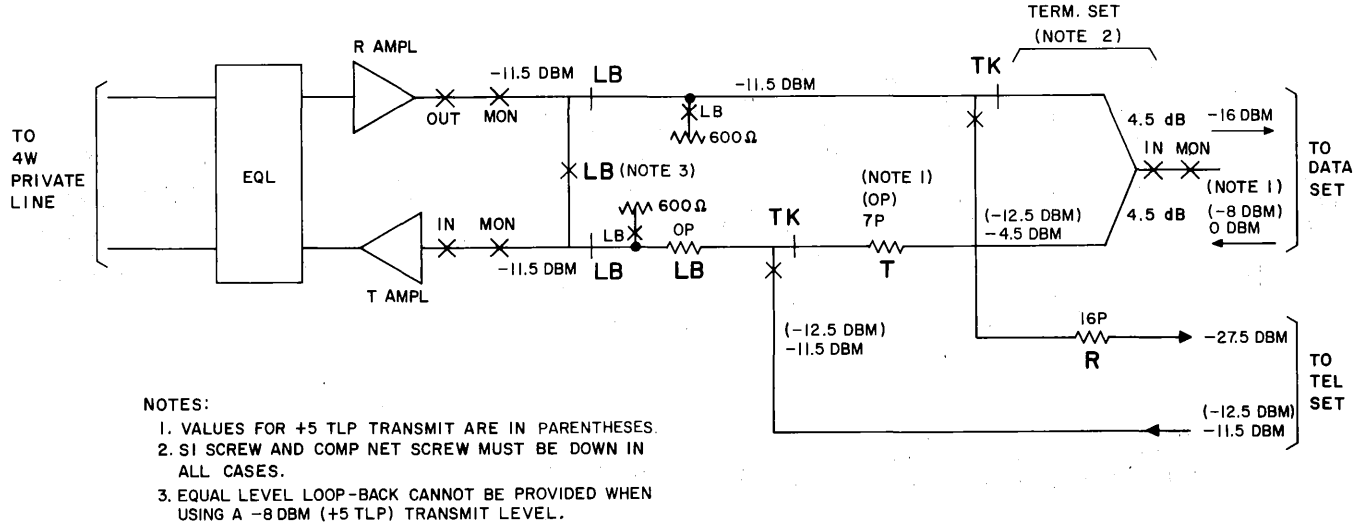


Fig. 7—Circuit Design for Data/Voice, 2-Wire Data Set

dBm. Thus, no pad is to be used. If these sets replace an older set requiring a pad, the pad must be removed.

C. Data Auxiliary Set 828A

4.05 Descriptive information on this apparatus is given in Section 598-080-100. The DAS provides amplification or attenuation in transmit and receive pairs, equalization (in receive line), and line facility loop-back of a 4-wire PL data channel. The DAS 828A can provide equal-level loop-back for testing.

4.06 DAS 828A or the standard V4 repeater mountings equipped with 227-type amplifiers provide adequate protection against hazardous voltage and longitudinal imbalance. Isolation of dc and of longitudinal surges is also provided.

4.07 If 849-type networks are used in lieu of 227-type amplifiers, adequate protection may not be assured. The DAS 828A, designated by

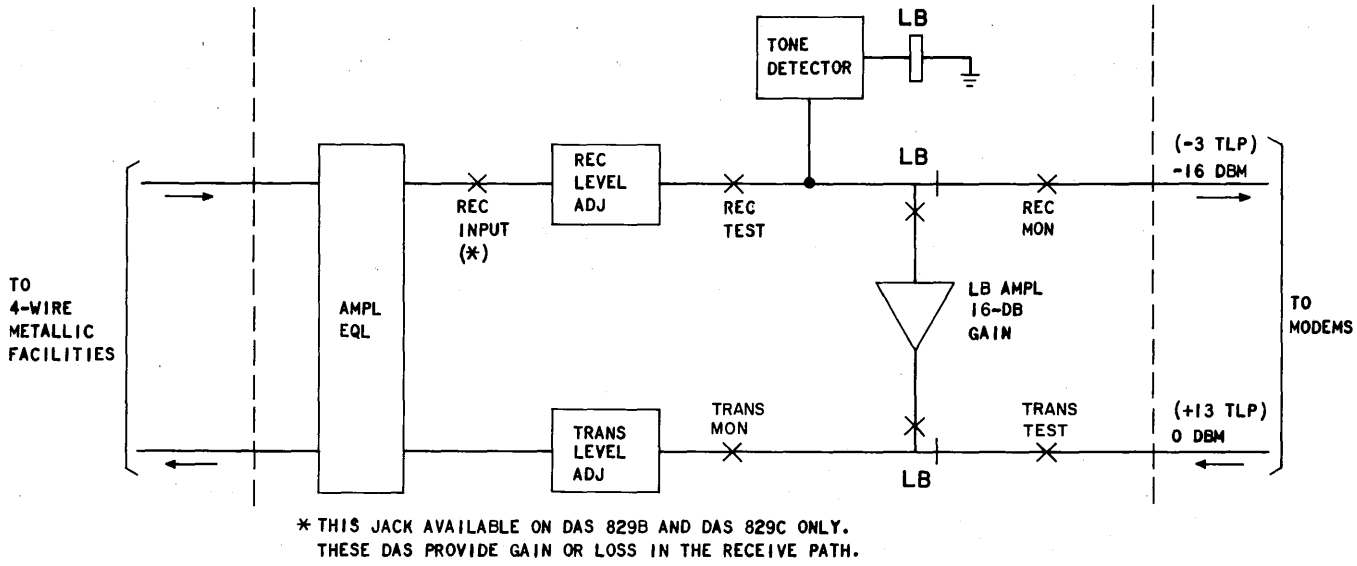


Fig. 8—Circuit Design for Data Only Using DAS 829-Type

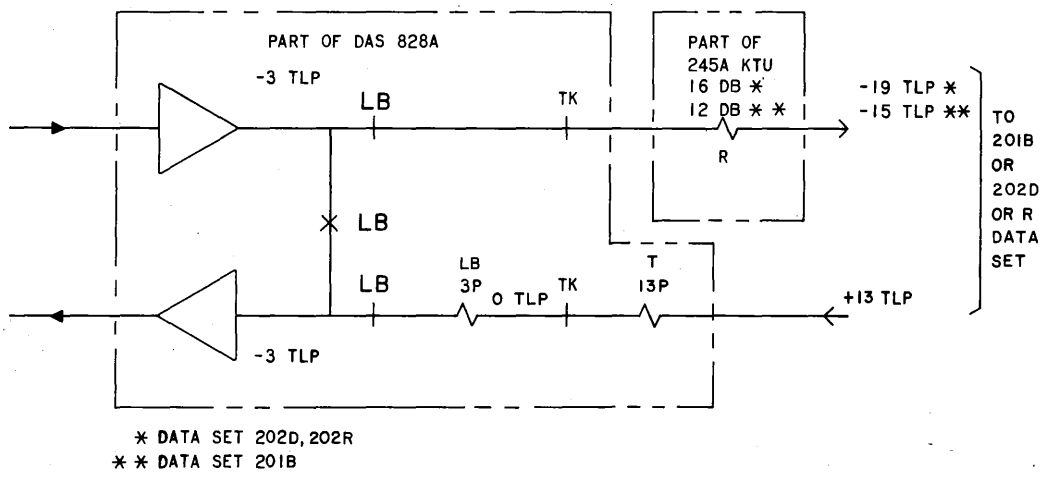


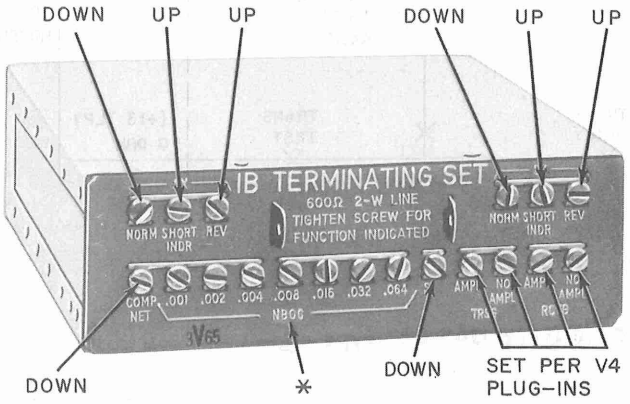
Fig. 9—Station Arrangement Suggested at Master Station for Polling Applications Using Data Sets 201B, 202D, and 202R

series 4 or higher, includes hazardous voltage protection and the restriction that 227-type amplifiers be used is no longer required. The use of 227-type amplifiers is the preferred arrangement when signal power limiting is not required. The F-58122 AGC amplifier may be used in place of the 227-type amplifier when signal power limiting is required in addition to hazardous voltage and longitudinal imbalance protection.

4.08 Loop-back capability in the DAS can be actuated on a local or remote basis. The loop-back circuit is operated by direct current sent over the simplex leads from a remote point, except where the simplex leads are used for 20-Hz signaling, or by applying direct current from a locally operated key and power supply. For 4-wire interface applications, the 44A1 data unit can be plugged into the empty term set socket in order to provide a tone-operated loop-back capability.

4.09 A 1B terminating set is usually provided when a 2-wire data set is used. In cases where a 900-ohm data set is used, the 1A terminating

set would be provided. The typical screw settings for the 1B terminating set when it is used as part of the DAS 828A are shown in Fig. 10. In this case, the 44A1 data unit must be mounted external to the DAS 828A if tone-operated loop-back is required.



* THESE SCREWS ARE NORMALLY UP BUT MAY BE PLACED DOWN IF RETURN LOSS TESTS OF STATION INDICATE AN IMPROVEMENT IS REQUIRED.

Fig. 10—1B Terminating Set—Screw Settings

D. Data Auxiliary Set 828C

4.10 This DAS provides transmission capability over the DDD network for one 4-wire voiceband data circuit using two DDD connections. The primary function of this apparatus is to furnish a backup facility for a 4-wire PL data channel.

4.11 DAS 828C is designed specifically to work along with DAS 828A, but may be used with other PL termination arrangements. It is for use only with Bell System data sets. More descriptive information on DAS 828C is given in Section 598-080-101.

E. Data Auxiliary Set 829-Type

4.12 Descriptive information on this apparatus is given in Section 598-082-100. DAS 829-type is designed for the same application as the DAS 828A for the standard 4-wire PL having a −16 dB loss, 0 dBm transmit level, and interfacing with a 4-wire modem. The DAS 829-type functions, and is referred to, as a channel interface unit (CIU). The CIU is installed between the 4-wire metallic facilities from the CO and terminal equipment at a station.

4.13 The CIUs are available in three basic station codes as follows:

DAS 829A-L1

DAS 829B-L1

DAS 829C-L1

Any one particular PL channel termination requires the use of only one code of CIU. The CIU code that is used depends on the facilities involved.

4.14 Each of the three DAS 829-types is described as follows:

DAS 829A-L1—is used for nonloaded or short loaded loops when no gain is required in transmit or receive paths. Slope equalization is accomplished with 600- or 1200-ohm line terminations. Attenuation is accomplished in the transmit or receive paths.

DAS 829B-L1—is used for nonloaded or short loaded loops. It is required for long nonloaded loops and provides 150-, 600-, or 1200-ohm line termination for slope equalization. Gain or attenuation can be provided in the receive path. Attenuation is provided in the transmit path.

DAS 829C-L1—is used for short nonloaded or for loaded loops and provides extensive equalization capability. This unit provides the same equalization capabilities as the 359A or the 359K equalizer. Gain or attenuation can be provided in the receive path. Attenuation is provided in the transmit path.

4.15 A standard, self contained, tone activated loop-back capability is present in each DAS 829-type. Loop-back is equal level and provides controlled impedances.

4.16 Two data mountings, the 44A1 and 46A1, are designed for use with the DAS 829-type. The 44A1 provides a single card housing for one DAS 829-type. The 46A1 provides a housing for

a maximum of eight DAS 829-type, and can be any combination of the three codes of DAS 829. The single card mounting is the same size as the new data set 202 S/T, and the multiple housing is the same size as the data set 202 S/T multiple housing. These arrangements are considerably smaller than the equivalent DAS 828-type described in Section 598-080-100.

4.17 Supplementary functions of alternate voice and dial backup are provided by data units, which are plug-in circuit packs of the same size as the DAS 829-type. These are the 48A1 and the 48B1 data units, respectively. Various single and multiple channel termination arrangements are available and are described in Sections 598-082-100 and 598-082-101.

F. F-58122 Amplifier

4.18 The F-58122 AGC amplifier can be used to replace the 227-type amplifier in DAS 828A or the V4 repeater where in-band signal power limiting is required. Additional descriptive informaton is given in Section 332-104-103. Adjustment procedures for the amplifier are given in Section 332-104-503 (V4 repeater) or 598-080-500 (DAS 828A).

G. 1000A and 1000B Data Couplers

4.19 Both the 1000A and 1000B couplers provide protection from hazardous voltage, longitudinal imbalance and excessive inband signal power. The basis for selection between the two is whether dc power is available from the line.

4.20 The 1000A data coupler is a line-powered protection unit that restricts the customer signals automatically to a prescribed maximum average signal power ranging from 0 dBm to −10 dBm in 1-dB steps. This unit has a 1.8-dB insertion loss at 1000 Hz that must be included in the end-to-end channel loss. This loss must be considered when making circuit tests.

4.21 The 1000B data coupler performs the same function as the 1000A in restricting the output signal. However, the signal level can only be set for either 0 dBm or −8 dBm. In addition, the 1000B data coupler has an internal dc power supply power unit that requires 117-volt 60-Hz power from a local source. The insertion loss is 1.6 dB at 1000 Hz, which must be included in the end-to-end channel loss.

4.22 Both types of data coupler contain a 2800-Hz test oscillator that is actuated by a slide switch on the coupler by the user or telco employee. The oscillator tone level is high enough to activate the level control circuit which in turn reduces the test tone to the proper output level and verifies the limiting action of the coupler. The test tone also provides a preliminary transmission test of the facility by comparing the received level at the test center with previous measurements. More descriptive information on the data couplers is given in Sections 590-103-103 and 590-103-108.

H. 31B Voice Coupler

4.23 The 31B voice coupler is suitable for use as a protection device on the following types of PL circuits:

- Voice PLs without telco-provided channel signaling
- Data PLs that do not require signal power limiting on the customer premises.

The 31B voice coupler provides a compact, inexpensive means of obtaining protection against hazardous voltages which might originate in customer equipment, and of ensuring longitudinal balance regardless of the degree of imbalance (to ground) of the customer equipment. It also provides isolation between the customer equipment and the line with an adequate insulation breakdown rating to protect the customer terminals from longitudinal surges. The insertion loss of the 31B voice coupler is 0.7 dB. More descriptive information on this coupler is given in Sections 463-331-103 and 463-331-104.

I. Protected Repeat Coil

4.24 The protected repeat coil provides the same functions as the 31B voice coupler, with the added function of providing access to the simplex path of the transmission facilities when required for telco use. Typically, 120-U or -W type coils are used; however, if the channel requirements specify low values of delay distortion, the 177G-type repeat coil is used. Insertion losses for the repeat coil in combination with the protective resistor are about 0.7 dB for the 120-type and 0.9 dB for the 177-type.

4.25 The J53050D, L1 interconnecting unit contains four sets of protected repeat coils on a 23-inch panel for protecting four 4-wire transmission circuits. It is covered by CD- and SD-1E-207-01 and is described in Section 463-360-101.

J. Loop-Back Arrangements

4.26 A remotely controlled equal-level loop-back arrangement is required at the customer location on those circuits which may be accessed by an STC (or similar organization equipped with a voice-frequency transmission testing capability).

4.27 A dc activated loop-back arrangement is satisfactory in those cases where the dc simplex path from the STC (or equivalent) is available to the customer location. The simplex path should have a resistance of less than 800 ohms and should not be required for signaling or other purposes.

4.28 A tone-operated loop-back arrangement should be provided when dc loop-back operation is not possible from the STC serving that customer. It can be used where the simplicity of tone-operated loop-back is preferred over dc activated loop-back.

Remote Loop-Back Arrangements

4.29 A dc operated arrangement allows the PL circuit to be looped back remotely from a dc access point, such as a CO or testing center. The loop-back (LB) relay, located at the customer station, is operated by applying 48-volt dc CO battery and ground over the simplex path of the 4-wire metallic circuit. For DAS 828A-L1, a minimum of 30 mA is required to operate the LB relay. Under this condition, a maximum of 800 ohms simplex resistance is specified. This corresponds to two 1600-ohm 2-wire local loops. When using the DAS 828A-L1/2, the 4-wire simplex path is used for signaling and is not available for remote dc loop-back activation.

4.30 The tone-operated arrangement utilizes the 44A1 data unit to operate the LB relay. This data unit is a 2713-Hz tone detector and can be plugged into the term set socket of the DAS 828A. More descriptive information is given in Section 590-100-131.

4.31 To activate the loop-back at locations equipped with the 44A1 data unit, a 2713 $\pm$2 Hz tone is applied toward the station at data level for not less than 5 seconds. Upon removal of the tone, the loop-back path will be established. To deactivate the loop-back, the 2713-Hz tone is again applied for a minimum of 5 seconds. The 406A tone generator is available for use at the testboard to supply the 2713-Hz signal for activation and release of the tone activated loop-back. More descriptive information on the 406A tone generator is given in Section 314-821-100.

4.32 The DAS 829-type has tone loop-back circuitry which operates like a DAS 828A equipped with a 44A1 data unit. The tone activated loop-back circuit is an integral part of all codes of the DAS 829-type.

5. SIGNALING ARRANGEMENTS

5.01 When alternate voice capability is required, 20-Hz manual ringdown signaling has been customarily used on PL data circuits. The DAS 828A provides this capability at the customer station.

5.02 A D1B ringdown converter (SD-56163-01) may be used at the serving central office to convert the 20-Hz signaling into E and M signaling. The converter may be connected directly to carrier channels such as N1, ON, or T carrier using D1, D2, or D3 channel banks, which provide an out-of-band E and M signaling capability. The D1B converter is connected to a single frequency (SF) unit with E and M signaling capability for use over channels which do not have a self-contained signaling capability.

5.03 A typical 20-Hz station arrangement using DAS 828A is shown in Fig. 11. A simplified schematic diagram of the D1B converter is shown in Fig. 12.

> ***Note:*** The D1B ringdown converter will only operate from 20-Hz ringing current. The station power supply must therefore provide 20-Hz ringing current to the DAS 828A-L1/2. This requirement prevents the use of 20-type power supplies since these supply 30-Hz ringing current.

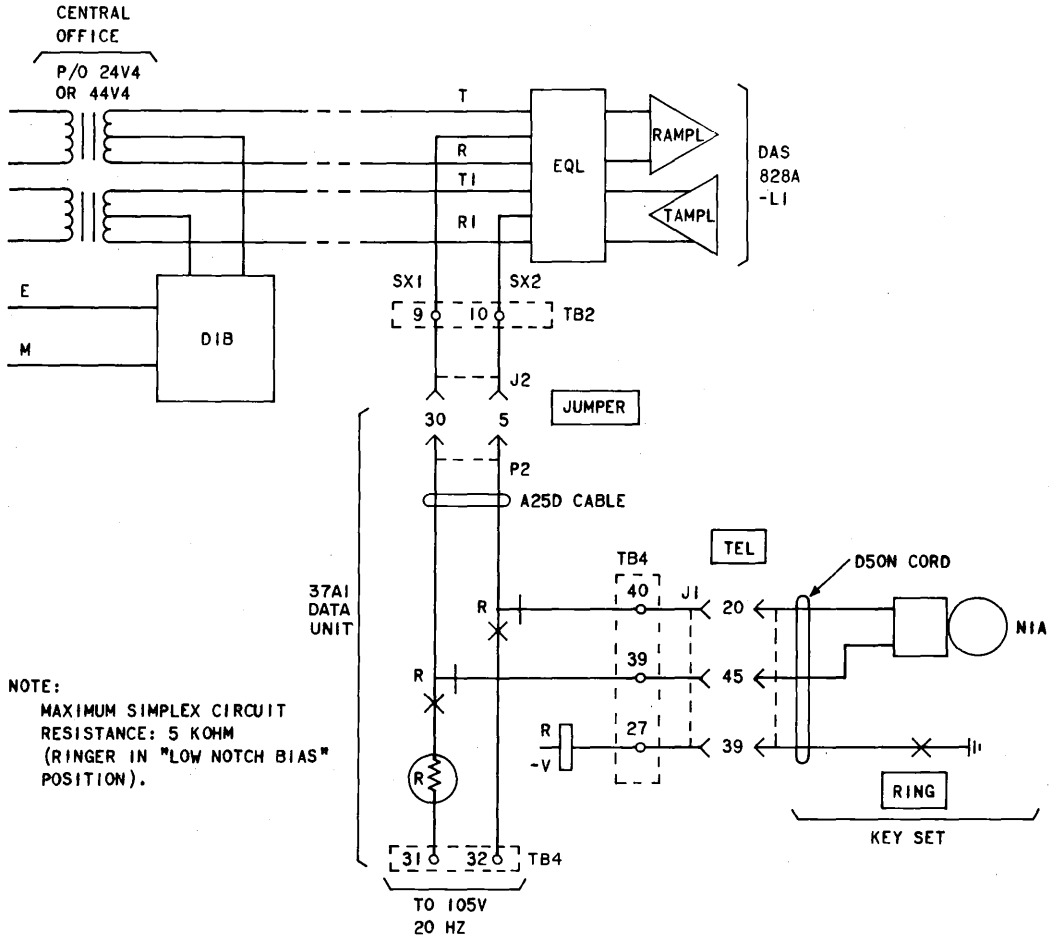


Fig. 11—Typical 20-Hz Ringdown Circuit for Private Line Data Station

5.04 Operation of the ringdown signaling is as follows:

(1) The customer places the DAS 828A in the talk mode and pushes the RING key on the associated key set. A 20-Hz signal is transmitted over the 4-wire simplex path while the key is depressed.

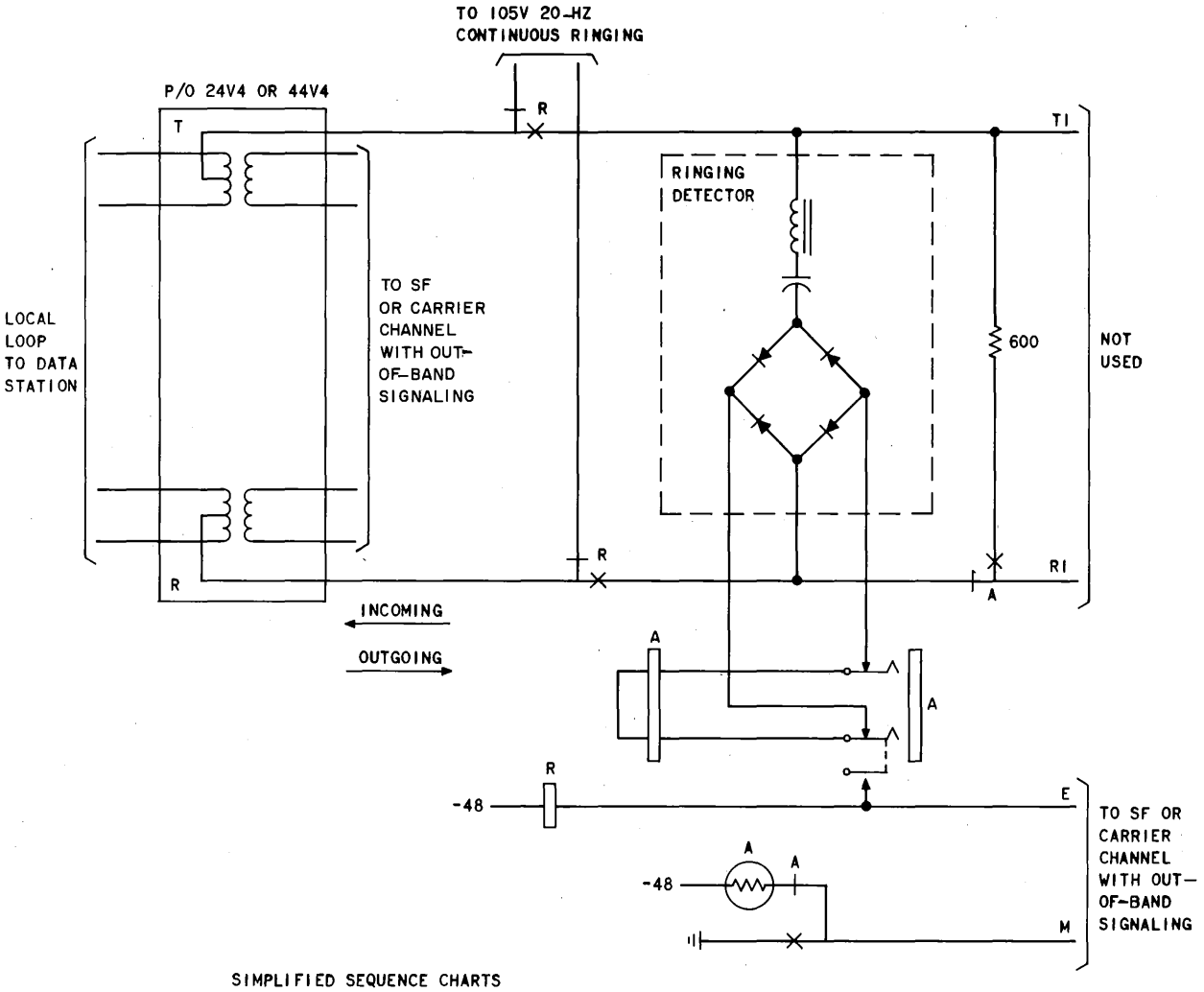
(2) The D1B detects the 20-Hz signal on the 4-wire simplex path and operates the A relay (Fig. 11) causing −48 volt battery to be removed from and ground to be placed on the M lead (on-hook condition).

(3) If the D1B is connected to an SF unit, the ground on the M lead causes the SF unit to transmit a 2600-Hz tone on the channel. The tone is applied momentarily at a −8 dBm0 level, followed by a steady −20 dBm0 level (−36 dBm at a −16 TLP) for as long as the 20-Hz signal is detected by the D1B.

(4) The SF unit at the distant end, upon detection of a 2600-Hz tone (with no significant energy outside the 2450-2750 Hz band), removes ground from and places an open on the E lead (on-hook condition).

(5) The open on the E lead causes the R relay in the associated D1B to release, causing 20 Hz to be placed on the 4-wire simplex path toward the station as long as the open remains on the E lead.

(6) The ringer at the station is activated by the 20-Hz signal. The DAS 828A may be in the data, talk, or loop-back mode and receive



SIMPLIFIED SEQUENCE CHARTS

IDLE CIRCUIT: NO 20 HZ FROM TIE TRUNK CIRCUIT, A RELAY RELEASES BAT ON M LEAD; GRD ON E LEAD, R RELAY OPERATED, NO 20 HZ TOWARD TIE TRUNK CIRCUIT.

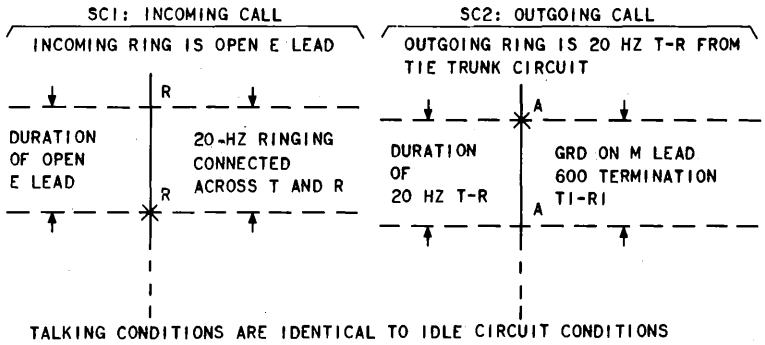


Fig. 12—Simplified Schematic of D1B Ringdown Converter

the ringing signal. The ringing signal stops when the calling customer releases the RING key; going off-hook at the called station does not halt the ringing signal.

5.05 The resistance of the simplex path between the DAS 828A and the D1B should not exceed 5000 ohms. If a metallic circuit is available between two data stations and the simplex resistance between data stations does not exceed 5000 ohms, the stations can ring each other directly without the need for auxiliary signaling equipment. The station ringers should be set in the low notch position for long loops.

5.06 The ringing voltage transmitted by either the DAS 828A or the D1B should be 105 volts at a frequency of 20 Hz. The D1B can detect a ringing voltage as low as 15 volts. The station ringer should operate on ringing signals of 50 volts or more, as measured across the ringer.

5.07 The sensitivity of an SF unit to the received 2600-Hz signal varies with the type of SF unit being used. In general, received SF tone levels lower than −19 dBm at a +7 TLP may prevent the SF unit from recognizing an on-hook (ringing) signal. Very high level noise or crosstalk may also cause the SF unit to fail to recognize an on-hook signal because of the guard action in the unit.

5.08 If the transmitted data signal has energy in the 2450- to 2750-Hz band which is greater than the energy in an 800- to 2450-Hz band, the SF unit may falsely recognize this as an on-hook signal and transmit a 20-Hz ringing tone to the customer station. In this case, it may be necessary for the customer to make a choice as to whether the CPM can be modified or substituted to remove this energy, or whether the telco signaling arrangements should be removed. This matter should be treated as a trouble condition and referred to DATEC via lines of supervision.

> ***Note:*** Bell System data sets do not create this trouble condition and are compatible with SF signaling.

5.09 A trouble condition which may be very irritating to the customer is a steady ring. There is no way for the customer to stop the ring other than to hold his RING key depressed. In such a case, open both pairs towards the station receiving the ring to temporarily halt transmission of the 20-Hz signal to the customer. This condition is commonly caused when the E lead between the SF unit and the D1B is opened, usually at the frame.

Signaling Arrangement for DAS 829-Type

5.10 When DAS 829-type is used at the station, inband, end-to-end locked-in signaling with 30-second time-out can be provided by the addition of the 48A1 data unit. This data unit provides for alternate voice use of the PL and uses an inband signal of 2600-Hz for ringdown signaling. An interrupted tone signal is returned to the calling station to indicate that the called station is receiving the 2600-Hz signaling tone. A 2-wire telephone set is used. Additional information on this type of signaling is given in Section 598-082-101.

> ***Note:*** The alternate voice arrangement provided by the 48A1 data unit is not interchangeable with alternate voice arrangements of either the DAS 828-type or locally engineered systems requiring 20-Hz ringdown signaling unless signal conversion equipment is provided.

6. CIRCUIT CONDITIONING

6.01 FCC Tariff No. 260 provides for a basic voicegrade channel (2001, 3002) and five types of C conditioning. These are designated as follows:

- 2001, 3002—Basic channel
- C1
- C2
- C3—Used only for switched services networks such as CCSA or SCAN
- C4
- C5—Used only for 2-point circuits.

6.02 These grades of C-type conditioning are used to indicate the tightness of limits applied to circuit parameters of attenuation distortion and delay distortion. These are classified as bandwidth parameters and are covered more fully in Part 8 of this section.

6.03 The differences between the C1, C2, C4, and C5 grades of conditioning are the attenuation distortion and envelope delay distortion limits which must be met in order to meet the requirements of FCC Tariff No. 260. The interface parameters and facility parameters (given in Part 8) are not affected by the grade of C-type conditioning selected.

6.04 C3 conditioning is restricted to switched services network only. Information on this type of conditioning is given in Section 309-200-301.

6.05 The requirements for attenuation distortion and envelope delay distortion for the various grades of C conditioning are given in Section 314-410-500.

High Performance Data Conditioning (HPDC)

6.06 A new offering called HPDC or type D1 conditioning is available on interstate voicegrade analog data channels in 2-point arrangements. This conditioning provides more stringent control over nonlinear distortion and signal-to-noise ratio than that on previously offered data channels. These parameters are the ones most likely to affect high-speed voiceband modems operating on analog channels. Since HPDC is dependent upon facility selection, as described in Section 314-410-105, this offering may not be available in some locations.

7. CIRCUIT CONFIGURATIONS

7.01 The basic circuit configurations for PL data service are as follows:

(a) 2-Point

(b) Multipoint

(c) Central Office Relay Switched

(d) Customer Premises Switched

(e) Overseas.

Combinations of these configurations may appear in a single PL circuit. When certain combinations are used, the error performance rate may be met using various forms or grades of C conditioning.

7.02 The "point" in 2-point and multipoint is defined to be one or more stations terminating a serving link (local channel). This is typically a single station on a long haul circuit, but may consist of more than one data station, providing the local distributing arrangement introduces negligible distortion to data and none of the stations requires more than 1500 feet of cable from the distributing arrangement. Refer to Fig. 13. This distributing arrangement may consist of a bridging and/or a switching arrangement. To meet the requirement of negligible distortion, a bridge in such an application needs to be of the 2-wire resistive type that presents 600 ohms to all legs. In the case of 4-wire, a separate 2-wire bridge is installed for each direction of transmission on the 4-wire circuit.

> ***Note:*** The facilities on the two sides of a local distributing arrangement are considered to be a part of the same end link and are not considered as constituting separate links. If more than 1500 feet of cable is required to interconnect a station with the local distributing arrangement, that station should be served by a separate end link from a CO bridge as shown in the lower portion of Fig. 13.

Intraexchange circuits may be subject to fewer restrictions, depending on local practice.

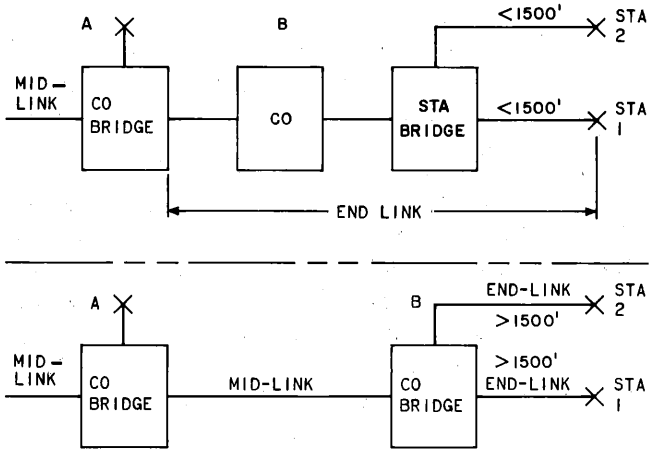


Fig. 13—Circuit Conversion of End Link to Midlink

A. 2-Point Circuits

7.03 Two-point circuits provide data communication between two locations. These circuits may

be basic, or have C1, C2, C4, or C5 conditioning. C3 conditioning is restricted to switched services network only. Information on this type of conditioning is given in Section 309-200-301. C5 conditioning can be ordered only on 2-point circuits. Some C5 circuits have more than one station per exchange, but only one can be connected at a time. A given station may communicate only with a particular designated station in the distant exchange. No trouble report will be accepted or testing done for combinations of stations other than those specified by the service order.

B. Multipoint Circuits

7.04 These circuits may be basic, or have C1, C2, or C4 conditioning. If any part of a multipoint circuit is conditioned, all parts must be conditioned to the same degree. C4 conditioning on multipoint circuits is restricted to 3- or 4-point operation. An example of 4-point operation is given in Fig. 14 where only one station is shown for each exchange. Station A is the master station and B, C, and D are remote stations. The grade of C4 conditioning can be specified between A and B, A and C, and A and D. No conditioning is specified between remote stations. Three-point operation is similar, with Station D omitted.

7.05 Figure 15 shows the maximum of four midlinks permitted with the basic or the C1 or C2 conditioned channel.

Note: The links between bridges in the same building are not considered middle links. These bridges should be electrically as close together as feasible and in no case farther than 1500 feet of 22-gauge wire apart.

C. Central Office Relay Switched Circuits

7.06 Figure 16 shows a configuration utilizing a maximum of three CO switches that are allowed under the interstate tariff. The circuit may be unconditioned or have C1 or C2 conditioning between all pairs of stations.

D. Customer Premises Switched Circuits

7.07 Figure 17 shows a customer premises switched connection. This arrangement is permissible; however, no overall conditioning can be guaranteed.

7.08 The overall connection may be arranged to approximate the response of a basic channel or a C2 conditioned channel by conditioning each individual channel as specified in Section 314-410-300. Only the individual channel should be measured; never the overall connection.

7.09 It will not necessarily be possible to meet the end-to-end facility parameter requirements on the overall connection, since it may include more local and short haul facilities in tandem than normal.

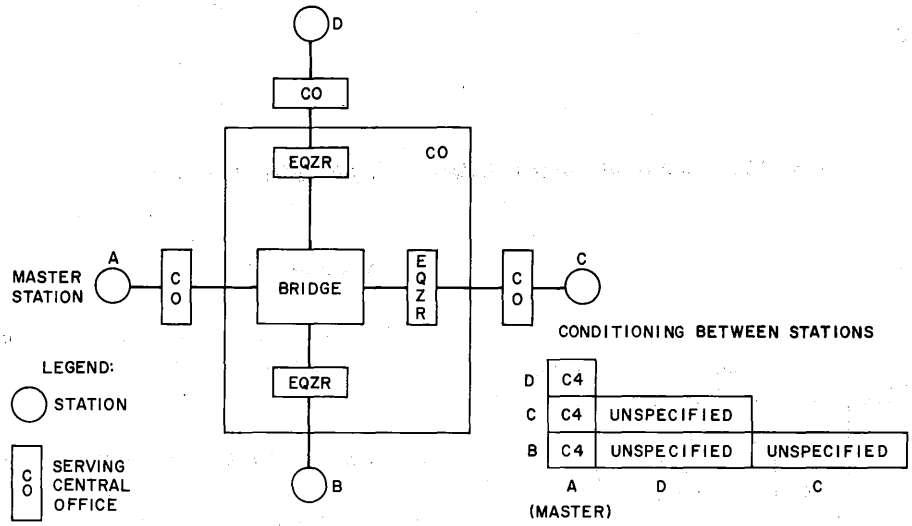


Fig. 14—4-Point Arrangement

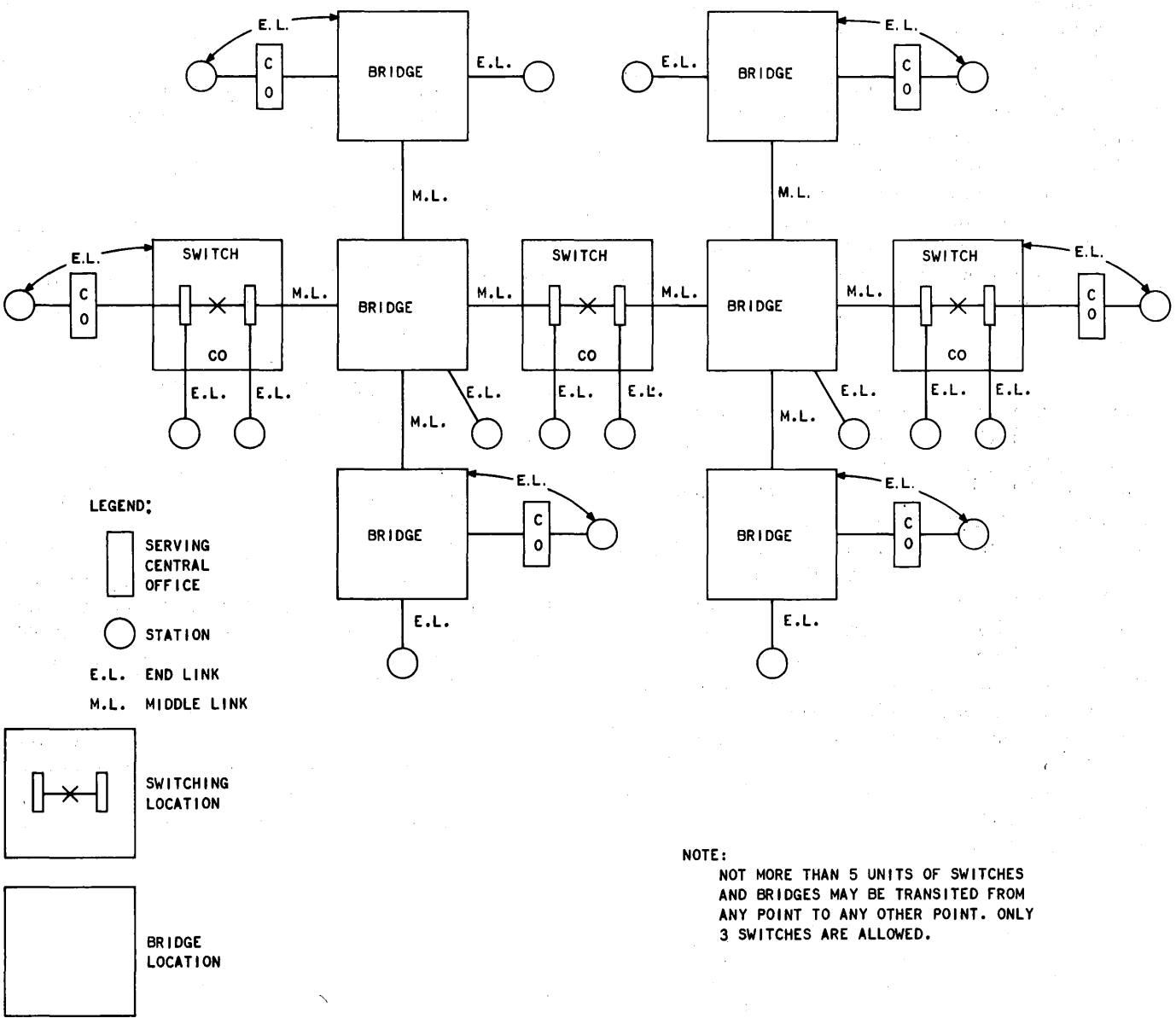


Fig. 15—Combined Central Office Switched Multipoint Circuit

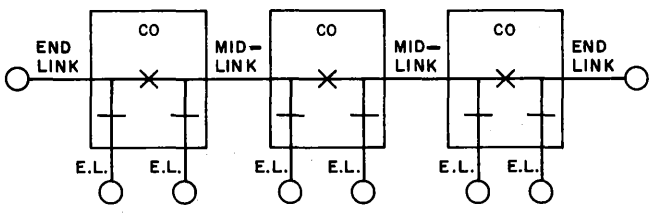


Fig. 16—Interstate Central Office Relay Switched Configuration

E. Overseas Circuits

7.10 Information on overseas circuits is given in Section 314-410-103.

8. CATEGORIES OF TRANSMISSION PARAMETERS

8.01 The circuit transmission requirements are divided into the following categories:

- Interface parameters

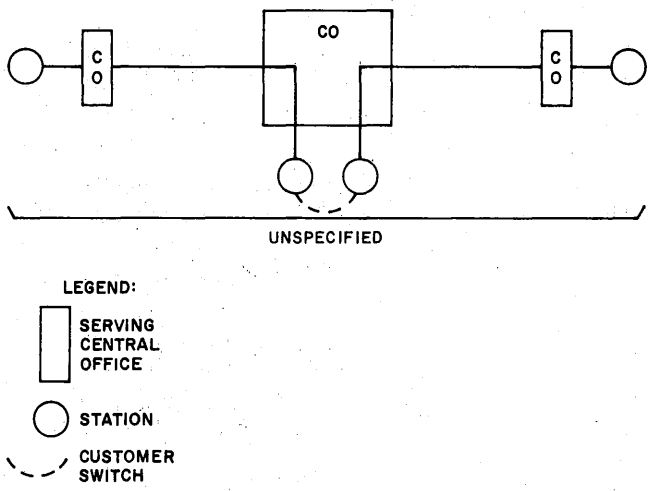


Fig. 17—Customer Switching Arrangement

- Bandwidth parameters
- Facility parameters.

Table A shows the various parameters that apply to these categories.

8.02 The interface parameter specifications are influenced by two considerations: electrical protection of the telephone network and its operating personnel, and standardization of PL network design arrangements. The interface parameter specifications may be changed in unusual situations to accommodate unique customer requirements. These changes will be specified either by special tariff or "special assembly" provisions.

8.03 The bandwidth parameters are an indication of the usable bandwidth of a channel. Some of these parameters are specified by tariff. They are normally controlled by means of facility selection and equalizer selection and adjustment.

8.04 The facility parameters listed in Table A represent potential impairments to a data signal that can be caused by typical telephone transmission equipment. The facility parameter limits specified in Section 314-410-500 are common to all voiceband data circuits, regardless of the type of C conditioning used. Tighter limits for C-notched noise and nonlinear distortion, as specified in Section 314-410-105, may be obtained by means of facility selection when the circuit is ordered with type D1 conditioning [high performance data conditioning (HPDC)].

9. SYSTEMS AND ASSEMBLIES

9.01 This part defines and discusses the terms "Systems" and "Assemblies". These are defined as follows:

(a) ***Data Transmission Systems***—A service where Bell System data sets are used with the recommended channel conditioning (C-type and D-type, as appropriate) as specified in Section 314-410-101. In such systems the operating speed of the data set, conditioning on the channel, and the configuration of the circuit are compatible and provide a satisfactory level of performance as defined in Bell System Practices and Technical References.

(b) ***Data Transmission Assemblies***—Services that do not meet the requirements as defined for data systems are called data transmission assemblies. These assemblies are tariffed arrangements of facilities, equipment, and allowable interconnections that a customer may lease. No level of data performance (error rate) is specified for the overall data assembly.

9.02 Included in the category of data transmission systems are those cases where Bell System data sets are used with the recommended conditioning in the following network configurations:

- 2-point channels
- Multipoint channels meeting certain design criteria as specified in 7.04
- Up to four 2-point channels in tandem when arranged for CO switching (see 7.06)
- CCSA networks
- Foreign exchange (FX) channels used to dial a switched telecommunications network connection to a point within 200 airline miles of the FX central office.
- Tandem tie trunk connections between on-premises PBX stations. For Bell System 201-type and 202-type modems, up to two tie trunks can be in the connection, provided the length of the overall connection does

TABLE A

CATEGORIES OF TRANSMISSION PARAMETERS

INTERFACE PARAMETERS	BANDWIDTH PARAMETERS	FACILITY PARAMETERS
Terminal Impedance	Frequency Response (Attenuation Distortion)	1000-Hz Loss Variation
Transmitted Data Signal Power	Envelope Delay Distortion	Message Circuit Noise (C-Message Noise)
Transmitted Test Signal Power		C-Notched Noise
Received 1000-Hz Test Tone Power		Impulse Noise
In-Band Signal Power		Single Frequency Interference
Out-of-Band Signal Power		Frequency Shift
Longitudinal Balance		Peak-to-Average Ratio (P/AR)
		Phase Intercept Distortion
		Phase Jitter
		Nonlinear Distortion
		Echo*
		Phase Hits
		Gain Hits (Dropouts)
		Return Loss*

*Echo and Return Loss may also be considered as interface parameters in some circumstances.

not exceed 4000 miles, and the tie trunks are appropriately C-conditioned. For Bell System 203-type and 208-type modems, performance will be supported over a single tie trunk. No data performance will be supported from modems attached to off-premises stations or between modems connected together by an off-network call.

- For the Bell System 209A-L1 modem, performance will be supported when a basic 3002-type channel equipped with type D1 high performance data conditioning (HPDC) is used.

9.03 Some examples of data transmission assemblies are as follows:

- Private lines or tie lines using Bell System data sets but with less than recommended grades of conditioning
- Direct distance dialing (DDD) from tie lines or tandem tie lines and off-network common

control switching arrangement (CCSA) operation

- Access to CCSA from satellite or tributary PBXs or from off-premises PBX extensions to DDD or CCSA.

9.04 Any Bell System services which are interconnected with customer-provided devices such as multiplexers and data processing devices are treated overall as a data transmission assembly although each individual Bell System service may be treated as a data transmission system.

10. REFERENCES

10.01 The following documents provide additional descriptive information on facilities and equipment associated with PL voiceband data service.

NUMBER	TITLE
AT&T PUB 41004	Data Communications Using Voiceband Private Line Channels—October 1973
AT&T PUB 41008	Analog Parameters Affecting Voiceband Data Transmission—Description of Parameters—October 1971
AT&T PUB 41009	Transmission Parameters Affecting Voiceband Data Transmission — Measuring Techniques—January 1972

SECTION	TITLE
010-521-100	Data Technical (DATEC) Support
309-200-301	Switched Services Networks Using Central Office Switching Machines—AUTOVON—Service Maintenance
Division 310	Non-Switched Special Services System
Division 311	Switched Special Services System
314-016-125	TWX Service—Attenuation Equalization Arrangements and Adjustments—Using 44V4 Repeaters
314-410-101	Voice Bandwidth Private Line Data Circuits—Transmission Requirements of Bell System Data Sets
314-410-103	Voice Bandwidth Private Line Data Circuits—Overseas Circuits
314-410-104	Voice Bandwidth Private Line Data Circuits—Circuit Conditioning Requirements Using the Collins CLA-101A System
314-410-105	Voice Bandwidth Private Line Data Circuits—High Performance Data Conditioning (HPDC)—Description and Test Requirements
314-410-300	Voice Bandwidth Private Line Data Circuits—Maintenance
314-410-500	Voice Bandwidth Private Line Data Circuits—Tests and Requirements
314-820-100	Data Systems—Common Circuits, Equipment and Procedures—Envelope Delay Characteristics of 200-Type Delay Equalizers
314-820-104	Envelope Delay Characteristics of 384- and 385-Type Equalizers
314-821-100	Data Systems—Central Office—406A Tone Generator—Description
332-104-103	V4 Telephone Repeater—F58122 AGC Amplifier
332-104-503	V4 Telephone Repeater—F58122 AGC Amplifier—Tests and Adjustments
463-331-103	Voice Connecting Arrangement CD4—31B Voice Coupler
463-331-104	Voice Connecting Arrangement CDX—Using 31B Voice Couplers

SECTION	TITLE
463-360-101	Voice Connecting Arrangements CDQ2W and CDQ2X
590-103-103	1000A Data Coupler—Description, Installation, Maintenance, and Tests
590-103-108	1000B Data Coupler—Description, Installation, Maintenance, and Tests
598-080-100	Data Auxiliary Set 828A—Description and Operation
598-080-101	Data Auxiliary Set 828C—Description and Operation
598-082-100	Data Auxiliary Set 829-Type—Channel Interface Units—Voiceband Private Line Channels— Description
598-082-101	Data Auxiliary Set 829-Type—Supplementary Functions for Voiceband Private Line Channels (Alternate Voice and Dial Backup)—Description
660-200-301	Special Services—Protection and Safeguarding
880-420-100	Private Line Data Circuits—Voice Bandwidth—General Design Information
880-440-101	Dataphone Service—Analysis of Transmission Factors