Pub 41801

Data Access Agrmt
CDT

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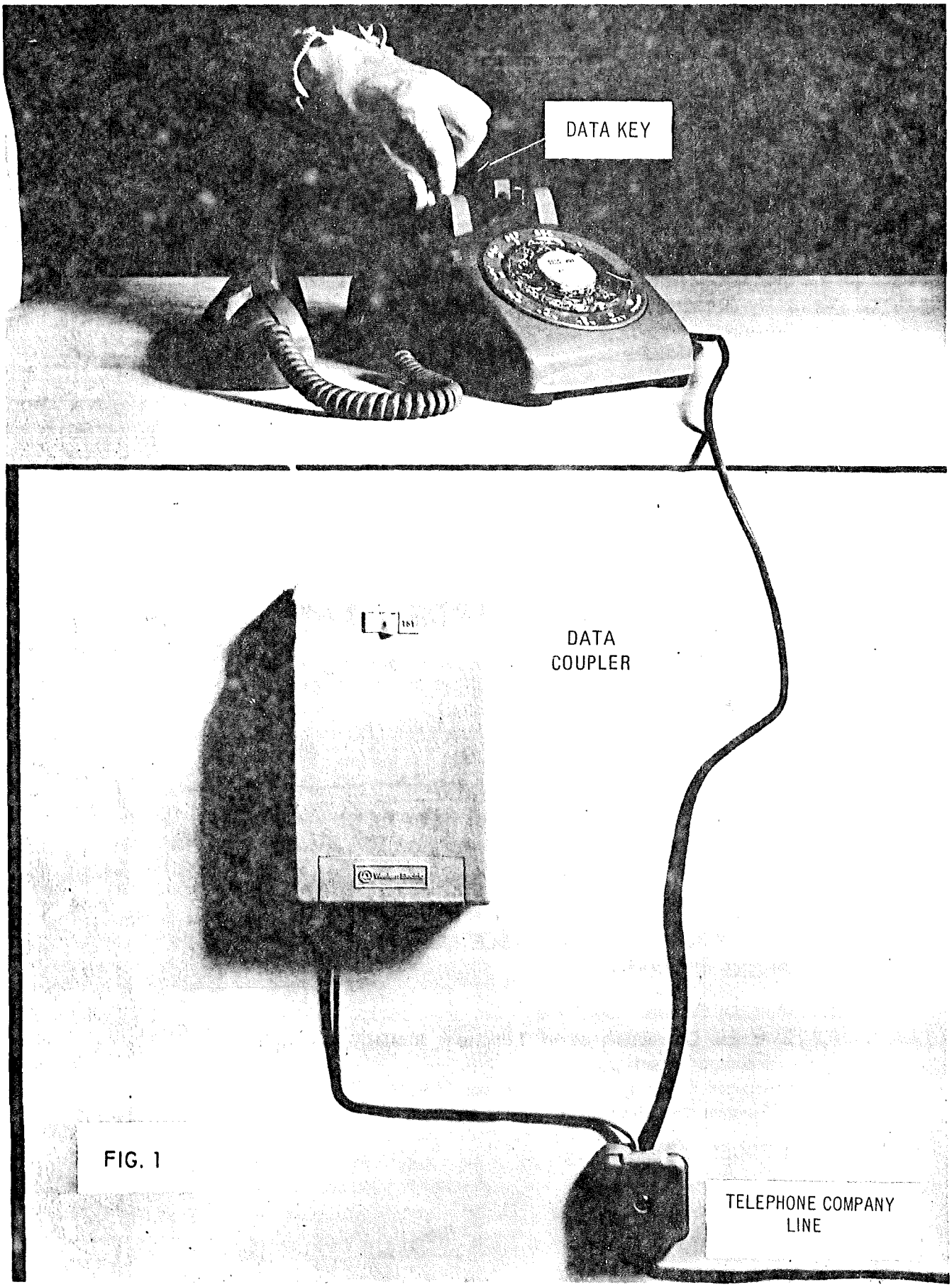

FIG. 1

1. GENERAL

FCC Tariff No. 263 and corresponding intrastate tariffs filed by the Bell System provide for the direct electrical connection of customer-provided data transmitting and receiving equipment to the telecommunications network through a Data Access Arrangement. All modulating and demodulating functions are to be performed by the customer's equipment, but the Bell System retains responsibility for providing network control signaling (this includes furnishing switchhook, dialing, accounting and control functions). The data signal format (such as serial or parallel; binary or multilevel; FM, AM or PM; digital or analog) will be the modem manufacturer's option. In addition to data signals, customer-provided equipment may input machine-generated voice signals or live speech.

The standard Data Access Arrangement CDT described in this Technical Reference consists of a manual coupling unit associated with a standard telephone set as shown in Figure 1. This arrangement permits manual call origination and answering in addition to the capability of manually transferring between the talk and data modes. In those locations where TOUCH-TONE® calling service is available and is subscribed to for the lines which serve his data station, the customer may optionally generate network addressing tone signals for transmission through Data Access Arrangement CDT provided that these tones conform to the characteristics specified in Section 4. The code, CDT, is the Telephone Companies' uniform service ordering code (USOC) for this Data Access Arrangement and must be specified by the customer when ordering this arrangement.

Other Data Access Arrangements with different capabilities are available. These units have features which allow both automatic network addressing by dial pulse or tone signaling and automatic call answering and have either contact or EIA RS-232-B voltage interface circuitry.

2. DESCRIPTION OF THE DATA ACCESS ARRANGEMENT

2.1 Physical

The Data Coupler used with Data Access Arrangement CDT is shown in Figure 2. It is 5 inches in width, 7 inches in height, 1-3/4 inches in depth, weighs approximately 1-1/2 lbs. and is arranged to be mounted on a vertical surface, however, the coupler is not position sensitive. The physical dimensions of the coupler are shown in Figure 3. It is designed to operate over a temperature range from 20° to 120°F with a relative humidity of up to 95 percent. Two No. 4 screw terminals marked DT and DR are provided under a protective cover on the bottom of the coupling unit to permit electrical

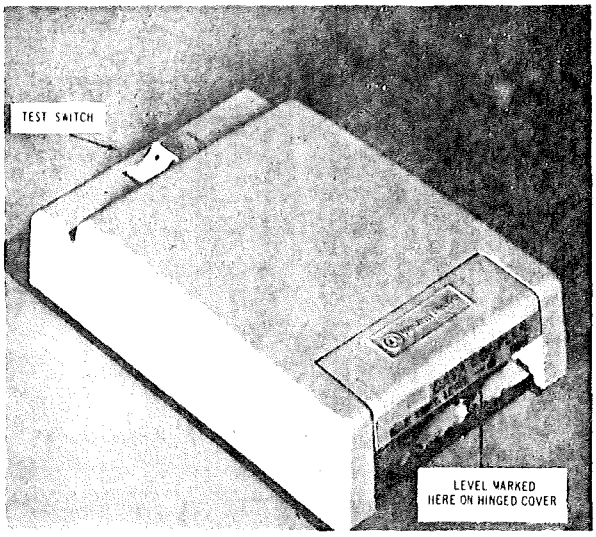

Fig. 2 –Data Coupler

connection to a customer-provided modem. The function of the TEST switch located on top of the coupling unit cover is described in Section 2.4. The coupler is powered over the Telephone Company lines and requires no external customer supplied power source. In addition to installation with a standard telephone set, this Data Access Arrangement may also be used on a line which is associated with key telephone equipment. This type of operation requires that one of the key telephone

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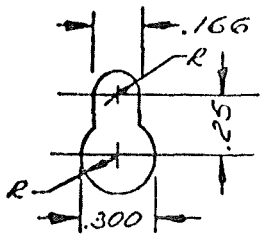
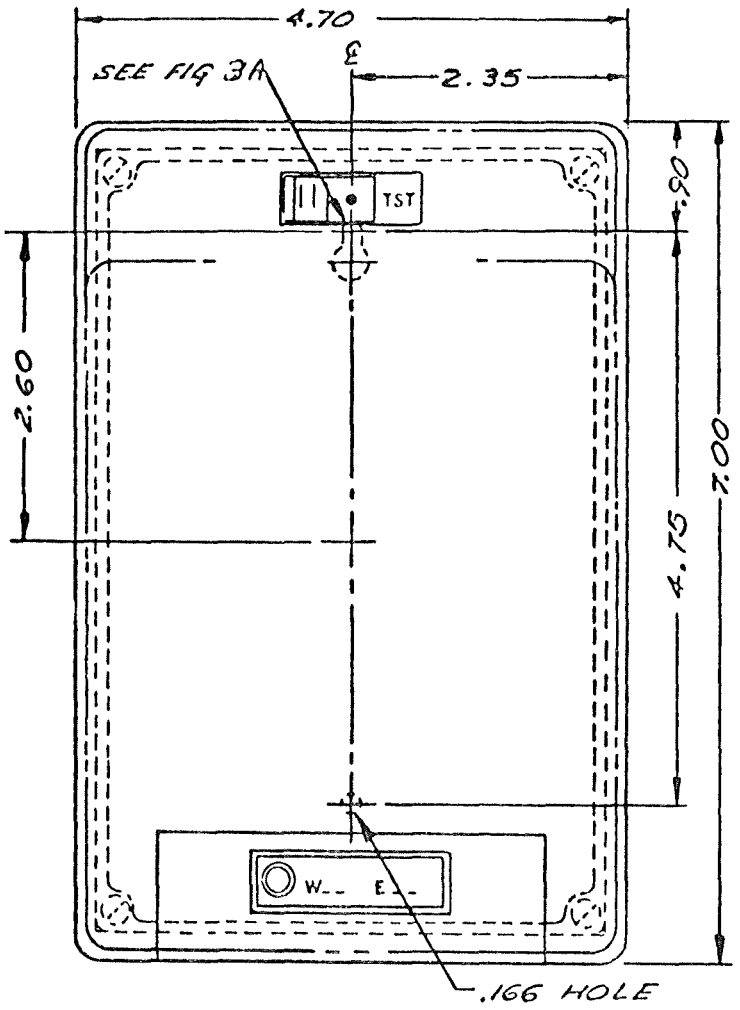


FIG. 3A



OVERALL DIMENSIONS AND MOUNTING
LAYOUT FOR CDT DATA COUPLER

FIGURE 3

set keys must be dedicated to the voice-data transfer function for the coupler. This is in addition to the normal line pickup key associated with the telephone line on which the data coupler is installed. Note that in these key system applications the data coupler is associated with a particular line on the key system and cannot be switched to the other lines appearing on the key system by operating their line pickup keys.

2.2 Functions

The Data Access Arrangement CDT is diagrammed in Figure 4. The major functions of these circuits are:

a. To protect telephone personnel and equipment from any accidentally applied hazardous voltages from customer-provided data modems.

b. To provide longitudinal isolation of the telephone plant from customer-provided data modems to help control noise levels.

c. To automatically limit the data modem's total signal power to a specified value (if the customer's signal power is too high) to prevent interference with other telephone services.

d. To provide a transmission path connecting customer-provided data modems to the telecommunications network.

e. To provide necessary features for network control signaling through the use of a regular telephone set.

f. To allow attendants to manually transfer control of the telephone line between the telephone set and the customer-provided data modem.

g. To provide for remote testing of the unit at a Telephone Company test center.

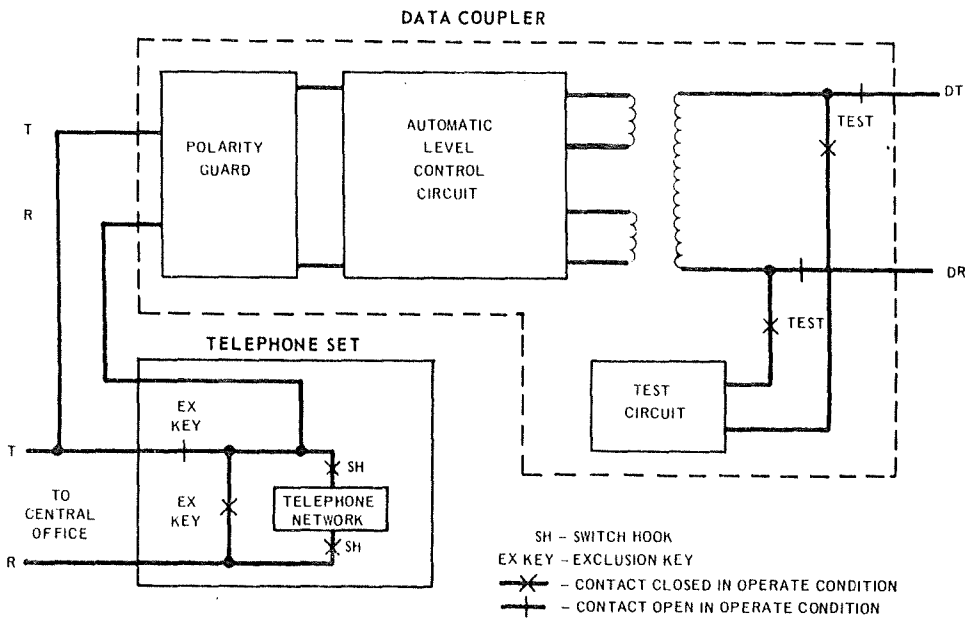


FIG. 4 - DATA ACCESS ARRANGEMENT CDT

2.3 Operation

A data call using the Data Access Arrangement CDT is placed in a manner similar to a regular telephone call. To initiate a call, the attendant lifts the handset of the associated telephone set, waits for and receives dial tone, and dials the telephone number of the desired station.

At the answering (called) station, the call is handled in the normal manner. With manual answering, both stations are in the talk mode. The attendants then verify that their equipments are ready to transmit and/or receive data. When both stations are ready, the attendants lift the data keys on their telephone sets and the modems may transmit and receive data. If the call is to an automatic answering data set, upon recognition of the answer tone signal from the modem, the attendant at the calling station lifts the data key and the modems may transmit and receive data. To terminate a call at a manual station at the completion of the data transmission, the attendant must return the data key to its initial position and hang up the handset.

2.3.1 Operation with Customer-Provided Tone Address Signaling

On installations where the customer has ordered TOUCH-TONE calling service, in order to address the network with customer-generated tone address signals through the coupler, the attendant must first lift the telephone handset to go off-hook. Then the data key on the telephone must be lifted to transfer the loop from the telephone to the coupler and the customer's terminal. When dial tone is present, the network may be addressed through the coupler subject to the tone signal requirements of Section 4.4. Monitoring for call progress signals, if required, is the customer's responsibility. These signals include dial tone, busy tone, reorder tone, audible ring, and call intercept. Each of these signals is described briefly in the next paragraph. To terminate a call, the attendant must return the data key on the telephone to its initial position and hang up the telephone handset.

Busy and reorder tones are call progress tones which indicate either station busy or trunk equipment busy. Reorder tone is a fast (120 interruptions per minute) on-off tone signal while busy tone is a slower (60 interruptions per minute) on-off signal. An audible ringing tone is a call progress tone which is sent back to the calling party to indicate both completion to the called station line and that the called station is being rung. Audible ringing signals are typically a two-second on, four-second off signal. Call intercept involves the intervention of either a Telephone Company operator's recorded voice or an actual operator to provide information to the caller about reasons why a call is not completed. This may, for example, involve a change in the number of the called party.

2.4 Telephone Company Test Call for Maintenance on the Data Access Arrangement

After a trouble report is received by the Telephone Company, to expedite clearing of the trouble, the Telephone Company test center will normally call the customer's data station to request assistance in testing the Data Access Arrangement and the loop facility. When the customer assistance is requested, the following is a typical test sequence. When the customer receives a call at his data station from the test desk personnel, his telephone handset will be off-hook and in the talk mode. The customer will be instructed to stay off-hook and to enter the data mode via the data key (exclusion key) on the telephone set and at a prescribed time thereafter, to depress the TEST switch. Instructions will also be given prior to entering the data mode to return to the talk mode and release the TEST switch after a certain period of time. This will complete the test, and the results can be discussed with the test center and any subsequent action, if necessary, can be determined.

As shown in Figure 4 in the TEST mode, the TEST switch on the coupling unit opens the DT and DR leads to the customer's equipment and replaces it with a test oscillator. Therefore, in the TEST mode, no signals can pass in either direction through the interface, and the customer-provided modem will not be operable over the telephone line. The test oscillator produces a 2800 Hz test tone at a level high enough to invoke the automatic level control circuit described in Section 4.3. In this way, a

measurement of the test tone at the Telephone Company test center tests both the loss through the coupling unit and the loop facilities plus it checks the automatic level control circuit for proper operation.

The 2800 Hz oscillator test tone was chosen to test the Data Access Arrangement and loop and is not intended for end-to-end measurements on an established connection. When a call is switched over the telecommunications network, the type of transmission facilities which make up the connection will vary from call to call. Therefore, the information gained from a single end-to-end measurement has little significance. This effect is explained in more detail in Reference a.

2.5 Echo Suppressor Considerations

Many customer-provided data modems may have the capability to transmit and receive data simultaneously. This feature is commonly known as "duplex" operation, as opposed to "half-duplex" operation where a modem is either transmitting or receiving at any given time.

Within the message telecommunications network there may be separate paths for the two directions of transmission. In voice communications at least one of the paths is usually idle at any given time. In order to protect the person who is talking from hearing a disturbing "echo" of his voice on long distance calls, the idle receive path is attenuated by a device called an "echo suppressor." As a result, voice or data signals may only be transmitted in one direction at a time under normal conditions. If duplex operation is desired, the echo suppressor must be disabled by the customer-provided modem.

The echo suppressor may be disabled by applying a single frequency tone, the level of which is in the range of 0 to 5 dB below the maximum specified data signal level within the band 2010-2240 Hz for at least 400 milliseconds. No other signal or tone should be applied elsewhere during this disabling period. The echo suppressor will remain disabled if the data signal (or other energy of similar magnitude) is applied immediately (within 100 milliseconds) after the disabling tone is removed from the line. Any interruptions in the subsequent signal over 100 milliseconds in duration will permit the echo suppressor to again become enabled.

The "turnaround" time of echo suppressors when not disabled as described above is a characteristic which concerns the half-duplex operation of data modems. A modem which is receiving half-duplex signals from a distant modem should not begin transmitting at the instant the distant modem ends transmission. This restriction is caused by the delay in the removal of the high attenuation placed in the receive path by the echo suppressor. This delay, called "turnaround" time, is usually about 100 milliseconds. Additional information concerning echo suppressors and disabling may be found in Reference a.

3. ELECTRICAL CHARACTERISTICS OF THE DATA ACCESS ARRANGEMENT

3.1 Input Impedance

The input impedance between terminals DT and DR on Figure 4 when the Data Access Arrangement is in the talk mode is at least 100 ohms. In the data mode, the magnitude of the input impedance between terminals DT and DR will be *nominally* 600 ohms. This input impedance is essentially a 1-1/2 to 1 transformer reduction of the impedance of the telephone line. In actual installations this impedance will vary both from line to line and as a function of frequency. Due to these variations, it is suggested that a customer-provided modem be capable of driving impedances with magnitudes ranging from *200* to *1200* ohms and phase angles from about -50^{o} to $+30^{o}$. Impedances outside this range may occasionally be encountered.

Since the coupler uses transformer coupling to the telephone line, it provides an isolated termination to the customer-provided modem on leads DT and DR. The customer may ground one side of his signal output, if required, by his design.

3.2 Input-Output Characteristics

The input-output characteristics of the Data Access Arrangement CDT on an average Bell

System telephone loop (provided the signal power conforms to Section 4.2 below) are as follows:

Insertion loss: 2 dB at 1000 Hz

Insertion loss deviation relative to 1000 Hz:

300 Hz to 500 Hz less than *0.5* dB

500 Hz to 3000 Hz less than *0.25* dB

Envelope delay distortion:

1000 Hz to 2400 Hz less than *15* μsec

500 Hz to 3000 Hz less than *40* μsec

Nonlinear distortion:

The harmonic energy in the band from 300 Hz to 3000 Hz is at least 50 dB below the fundamental

Any distortion of the data signal by the Data Access Arrangement will be negligible compared to the distortions encountered on a typical data call using the telecommunications network.

3.3 Signal Level Control Circuit

While Section 4.2 prescribes limits on the maximum allowable signal power which may be applied by the customer, in order to prevent interference to other customers if this prescribed maximum is inadvertently exceeded, the data coupler is equipped with an automatic level control (limiter) circuit.

The limiter consists of a variolosser, the loss of which is controlled by a circuit that detects the average 3-second total signal power applied by the customer. If the average power exceeds the prescribed limit in any 3-second interval, the variolosser limiting device attenuates the customer's signals in both the transmitting and receiving directions to the prescribed limit. The limiter operation is such that it will be invoked in a time less than 3 seconds in inverse proportion to the excess power. A set of power transfer characteristics is presented in Figure 5 for different values of maximum allowable customer signal power. The power output values in the figure are reduced by the 2 dB loss through the coupling unit.

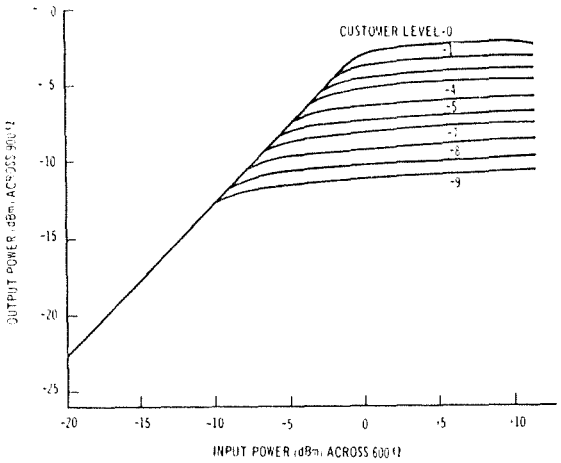


Fig. 5 – Limiting Characteristics of the 1000A Data Coupler

The variolosser causes negligble distortion of data signals in the vicinity of the prescribed limit. However, tariff regulations prescribe that customers should not intentionally invoke the variolosser action. Should the limiter action be inadvertently invoked, it will also reduce the level of any signal in the receiving direction, and it may *seriously* degrade the return loss of the station termination. On calls through the telecommunications network, this degraded return loss may result in echoes and instability on the connection which may cause errors in the data transmission.

If the specified power input to the coupler is grossly exceeded, the linear attenuation of signals cannot be guaranteed and permanent damage to the coupler and interruption of service may result.

4. MODEM DESIGN RESTRICTIONS

4.1 Impedance of the Modem

The impedance of the modem, whether transmitting or receiving, should be a nominal 600 ohms over the frequency spectrum used by the modem. The modem's impedance over the frequency band from 250 to 3200 Hz should result in a return loss of at least 14 dB when measured against a nonreactive resistor of 600

ohms. Conformance to this requirement will standardize the impedances used in power measurements and tend to mitigate the noise and echoes encountered in the transmission path.

4.2 Signal Power

To provide satisfactory transmission performance and to prevent interference with other telephone services, certain requirements must be placed on the electrical characteristics of the signals from a customer's modem.

The average power of the signal transmitted by a modem over any 3-second interval should not exceed the level prescribed by the Telephone Company at the time of installation. This level will range between 0 dBm and -10 dBm into 600 ohms depending on the loss of the loop between the data coupler and the central office and will be specified in steps of 1 dB. The objective is to obtain a signal level of no more than -12 dBm (averaged over 3 seconds) at the local central office. For example, with a loop loss of 3 dB and a coupling unit loss of 2 dB, the value specified would be (-12 dBm +5 dB) or -7 dBm at the interface. This maximum input signal power will be marked on the coupling unit protective cover as shown in Figure 2.

According to FCC Tariff No. 263, the power in the band from 3,995 Hertz to 4,005 Hertz should be at least 18 dB below the power of the signal as specified in the paragraph above. The power in the band from 4,000 to 10,000 Hz should not exceed 16 dB below one milliwatt. The power in the band from 10,000 Hz to 25,000 Hz should not exceed 24 dB below one milliwatt. The power in the band from 25,000 to 40,000 Hz should not exceed 36 dB below one milliwatt. The power in the band above 40,000 Hz should not exceed 50 dB below one milliwatt.

The out-of-band power limitations given above apply for signal power levels measured at the coupler interface.

4.3 Signal Power Distribution

The telecommunications network incorporates tone signaling devices that are used for network control functions. These devices, connected at all times to the telephone circuit, are designed to be sensitive to single frequency tones at 2600 Hz. They are relatively insensitive to energy at these frequencies 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 interface 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.

4.4 Requirements on Tone Address Signals

This section applies only to installations of the Data Access Arrangement CDT which are used to connect manual customer-provided data equipment to a central office line or to a Bell System PBX equipped for TOUCH-TONE Service.

4.4.1 Frequency Allocation Code

The signaling code for the Bell System TOUCH-TONE calling system provides for 16 distinct signals. Each signal is composed of exactly two voiceband frequencies, one from each of two mutually exclusive frequency groups of four frequencies each. The signal frequencies are spaced and selected on the basis that the two frequencies of any valid signal combination are not harmonically related. The frequency pairs assigned for signaling are as follows:

		Nominal High Group Frequencies, Hz			
		1209	1336	1477	1633
Nominal	697	1	2	3	Spare
Low Group	770	4	5	6	Spare
Frequencies	852	7	8	9	Spare
Hz	941	*	0	#	Spare

4.4.2 Tone Address Signal Characteristics

In order for the central office receiver to properly register the digits, tone address signals

must meet the following requirements (measured by the customer into a 600-ohm resistive termination on the transmission leads where the normal connection to the data coupler is made):

1. Frequency Deviation

   Tone frequencies shall be within ±1.5 percent of their nominal assigned frequencies.

2. Extraneous Frequency Components

   The total power of all extraneous signal components shall be 20 dB or more below the combined tone address signal power in the voiceband above 500 Hz as defined in Section 2.3.

3. Voice Suppression

   If a customer-provided telephone is used on the customer side of the data coupler interface as a part of the data station, voice signals shall be suppressed at least 45 dB during tone address signal transmission (the telephone transmitter shall be muted). In the case of automatic dialing, it is essential that the suppression be maintained until dialing is completed.

4. Rise Time

   Each of the two tones shall attain at least 90 percent of full amplitude within 5 milliseconds, and preferably within 3 or less milliseconds for automatic dialers, from the time the signal begins. This is most important for central office detection since automatic dialing may use near the minimum duration of signal.

5. Signaling Rate

Minimum duration of two frequency signal:	50 milliseconds
Minimum inter-digital time:	45 milliseconds
Minimum cycle time (tone-on plus tone-off) per digit:	100 milliseconds

6. Tone Leak

   The tone leak or nonsignal level shall be less than -55 dBm.

7. Transient Voltages

   Peak transient voltages accompanying the tone address signal (e.g., at the wave front when the tone generator is turned on) shall be no greater than 12 dB above the zero-to-peak voltage of the composite two-frequency signal.

4.4.3 Power Requirements for End-to-End and Tone Address Signaling

When a customer intends to use tone signals both for end-to-end data transmission and for central office addressing, data signal power must not exceed -12 dBm averaged over 3 seconds at the local central office, as described in Section 4.2 of the Technical Reference. This requires the signal level and duty cycle of the tone generator be adjusted so that at the coupler interface the 3-second average power does not exceed the value specified on the coupling unit protective cover. For example, if each tone is applied at the specified maximum level, then the combined power of the two tones will meet the objective when using a 50 percent duty cycle based on 3 seconds. However, to ensure detection by the central office receiver, it is necessary that the minimum level of each tone should not be lower than 5 dB below the value specified on the coupling unit protective cover. It is further required to ensure detection that not more than 4 dB difference exists between the levels of the high and low frequencies. Any difference in signal power level between the two tones within this 4 dB range is permitted. The maximum level, minimum level, and difference in level between frequencies restrictions given above include manufacturing tolerances and allowable variations over service life of the equipment.

The specification will ensure proper central office detection of the addressing tones and will allow the customer to use the maximum prescribed power level for data signals on the telecommunications network.

4.4.4 Tone Signal Power Requirements for Addressing Only

In some applications where the customer-provided modem does not use tone signaling for data transmission, he may wish to provide a separate tone generator for network addressing. In order to eliminate the need for individually adjusting the tone power levels from this generator at each location, this section recommends an optional fixed tone power level at the coupler interface. For adjustment during manufacturing, the recommended nominal tone signal powers measured into a 600-ohm resistive termination in place of the data coupler is -4 to -6 dBm per frequency. The allowable variations over the generator life are:

Minimum power of low group frequency: −10 dBm
Minimum power of high group frequency: − 8 dBm
Maximum power per frequency pair: + 2 dBm
Maximum difference in level between frequencies: 4 dB

These signal levels are consistent on the average, with the maximum signal level specifications in the tariffs of -12 dBm at the central office where loop loss, insertion loss of the data access arrangement, and dialing duty cycle are considered.

− 2 dBm – nominal level for two-frequency pair
6 dB – correction factor for 25% dialing duty cycle based on 3 seconds
− 8 dBm – nominal 3-second average power at input to coupler
2 dB – insertion loss of coupler
−10 dBm – nominal 3-second average power applied to the loop
3 dB – average loop loss
−13 dBm – 3-second average power at central office

4.5 Foreign and Surge Voltage Protection

Where telephone lines are exposed to lightning, power circuit contact, or induction, protective devices are installed at the central office and on the customer's premises that will provide a path to ground for foreign voltages that exceed about 600 volts peak. Since the customer's modem is connected to the telephone line through the 1000A Data Coupler, the modem is protected from longitudinal surges by transformer isolation. The maximum metallic (i.e., transverse) surge between conductors DT and DR (see Figure 3) due to foreign potential that the customer's equipment should encounter is 50 volts.

The customer is responsible for providing protection, internal to his modem, against surge and hazardous voltages being applied to the coupler. The maximum metallic surge potential applied to the conductors DT and DR from the customer's modem shall be limited to 50 volts. The customer's equipment should not apply steady – state longitudinal voltages in excess of 50 volts to leads DT and DR. Furthermore, the customer's modem should not present direct current in excess of 1 milliampere into the DT and DR leads since a transformer is used as the input device and direct currents may cause distortion of the data signals.

4.6 Installation Wiring Standards

The power supplies and wiring methods used in the customer-provided modem should meet the provisions of the National Electrical Code (NEC), Article 725, for Class 2 remote control and signal circuits. Adherence to the methods described in that standard regarding electrical installation is intended to maintain the integrity of the protective isolation provided by the Data Access Arrangement to the telephone plant.

5. SERVICE AND MAINTENANCE CONSIDERATIONS

5.1 Responsibility of the Customer

The tariffs permitting direct electrical connection of customer-provided data transmitting and receiving equipment state that:

Where long distance message telecommunications service is available under this tariff for use in connection with customer-provided communications systems, the operating characteristics of such systems shall be such as not to interfere with any of the services offered by the Telephone Company. Such use is

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

5.2 Responsibility of the Telephone Company

The tariffs permitting direct electrical connection of customer-provided data transmitting and receiving equipment state that:

The Telephone Company shall not be responsible for the installation, operation or maintenance of any customer-provided communications systems. Long distance message telecommunications service is not represented as adapted to the use of customer-provided systems, and where such systems are connected to Telephone Company facilities, the responsibility of the Telephone Company shall be limited to the furnishing of facilities suitable for long distance message telecommunications service and to the maintenance and operation of such facilities in a manner proper for such telecommunications service; subject to this responsibility, the Telephone Company shall not be responsible for (i) the through transmission of signals generated by the customer-provided systems or for the quality of, or defect in, such transmission, or (ii) the reception of signals by customer-provided systems. The Telephone Company shall not be responsible to the customer, or otherwise, if changes in minimum network protection criteria contained in the tariffs and Section 5 of this Technical Reference, or in any of the facilities, operations or procedures of the Telephone Company render any customer-provided facilities obsolete or require modification or alteration of such equipment or otherwise affect its use or performance.

5.3 Trouble Reporting Procedure

When trouble is experienced with this service, the customer should perform the necessary testing to sectionalize the difficulty by opening the circuit at the interface terminals, DT and DR, and testing toward the customer-provided equipment. If the tests indicate the trouble is in the Telephone Company-provided equipment, it should be promptly reported to the Telephone Company. Unless advised otherwise, the trouble reports should be called to the listed "Repair Service" number which can be found in 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.

6. OPTIONAL EQUIPMENT AVAILABLE FROM THE TELEPHONE COMPANY

6.1 Multiple Feature Telephone

In addition to the standard telephone available with Data Access Arrangements the customer may, at his option, select the Multiple Feature Telephone in lieu of the standard telephone set. The Multiple Feature Telephone furnishes 1) a capability for aural monitoring of line signals during the data exchange, and 2) a Telephone Set Mode Indication feature.

The aural monitor arrangement permits the telephone receiver to be bridged across the line whenever the line is connected to the coupler. This is accomplished through the normal operation of lifting the data key on the multiple feature telephone.

In the normal usage of the telephone for voice exchange the receiver and the transmitter are connected to the line through a network. In this arrangement, a listener experiences acoustic pressures near his ear which are the result of the receiver's conversion of the electrical signals to acoustic pressure. In the monitor arrangement,

the receiver alone is bridged across the line and again it converts the electrical signals to acoustic pressures. In order to avoid loss of data signal power into the coupler, high impedance bridging is used. Consequently, there is a loss in signal energy and the acoustic pressure is smaller than normal. This acoustic pressure loss in the monitor arrangement is nominally 5 vu. In addition, it should be recognized that the monitor is a bidirectional transducer and, therefore, a path exists through it whereby noise can be coupled into data signals and cause some degradation. However, the coupling path has significant loss so that room noise should not be a problem except in very noisy environments.

The Telephone Mode Indicator is a contact closure between terminals MI and MI1 of a second connecting block. The contacts are open whenever the telephone central office line is connected to the coupler, i.e., when the telephone handset is lifted and the data key is pulled up. Thus, the Telephone Mode Indicator closed condition shows that the station is in the telephone mode.

The Multiple Feature Telephone when provided can be arranged to provide either the aural monitor or Telephone Mode Indicator or both. In the instance both features are specified operation of the data key, (1) transfers the transmission path to the Data Access Arrangement, (2) connects the aural monitor across the line, and (3) opens the Telephone Mode Indicator contact.

6.2 Electrical Characteristics of Telephone Mode Indicator Leads

The contacts in the Telephone Mode Indicator are designed to operate with either resistive loads or with inductive loads equipped with contact protection where the open circuit voltage is less than 50 volts dc. Customer equipment should limit current through the Data Mode Indicator contacts to less than 50 milliamperes dc. There may be momentary contact bounce associated with the Data Mode Indicator which should be ignored by the customer's data terminal. This contact bounce is most likely to occur in the first five milliseconds of operate or release time.

The contact closure is through a significant length of cable and several connecting points. It is recommended that circuits used to detect this contact closure be capable of operating with a potential difference between terminals MI and MI1 of up to 2 volts for any current up to 50 milliamperes. The resistance in the open contact condition is greater than 1 megohm and the impedance to ground from either terminal is greater than 500K ohms. When the contact is open, the cable is unterminated at the telephone and in the open condition there may be spurious voltages (from high impedance sources) at terminals MI and MI1.

6.3 Customer Ordering Information for Multiple Function Telephone

The Universal Service Ordering Code (USOC) for the Multiple Function Telephone is CBY. In addition to this code the customer should specify the telephone set features required, i.e., aural monitor or telephone mode indicator or both. The customer should contact his data transmitting equipment supplier to determine his need for a multiple function telephone and the features to be specified.

7. REFERENCES

Some references describing various transmission characteristics of the telecommunications network are listed below. These references should prove useful to the designers of data modems.

a. Technical Reference: "Data Communications Using the Switched Telecommunications Network." — PUB 41005

b. Technical Reference: "1969-70 Switched Telecommunications Network Connection Survey (Reprints of Bell System Technical Journal Articles) — April 1971" — PUB 41007

c. Technical Reference: "Analog Parameters Affecting Voiceband Data Transmission — Description of Parameters — October 1971" — PUB 41008

d. Technical Reference: "Transmission Parameters Affecting Data Transmission — Measuring Techniques — January 1972" — PUB 41009

e. Technical Reference: "Acoustic and Inductive Coupling for Data and Voice Transmission — October 1972" — PUB 41803

f. Technical Reference: "Data Auxiliary Set 801A (Automatic Calling Unit) Interface Specification — March 1964" — PUB 41601

g. Technical Reference: "Data Auxiliary Set 801C (Automatic Calling Unit) Interface Specification — September 1965" — PUB 41602