

DV-1D Data/Voice DSU

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Rev. Date: December 3, 1997

8500048

1. DESCRIPTION

1.1 GENERAL

The DCB DV-1D is a Data and Voice DSU designed to operate over dedicated (leased) 56 or 64Kbps digital telephone lines. The DV-1D provides two user interfaces (one voice, one data) which can be used simultaneously and continually over a single digital leased line. These two inputs are derived from a multiplexed signal transmitted and received over a standard 56 or 64Kbps digital data telephone line. Such lines are standard types throughout North America, and are provided by local telephone companies or long distance carriers, under services known as Dataphone Digital Service (DDS).

The DV-1D Data/Voice DSU can be used with telco provided lines, or in private networks for high speed, point-to-point applications requiring both voice and data connectivity.

The DV-1D's advanced design, compact size, and reliability make it an ideal product for most applications requiring the transmission of simultaneous voice and data over a single dedicated digital facility.

1.2 FEATURES AND BENEFITS

1.2.1 SIMULTANEOUS VOICE AND DATA OPERATION

The unit operates continually over a single standard digital telephone line on the network side, and provides one synchronous or asynchronous data connection and one voice telephone type connection on the customer (user) side. The two user interfaces (one voice, one data) are independent of each other, and may be operated simultaneously over the single digital telephone line. No blocking or slowdown of data or throughput will occur.

1.2.2 AUTOMATIC BANDWIDTH OPTIMUMIZATION FOR DATA

The DV-1D can be user configured for "**MAX**imum bandwidth utilization" so as to utilize as much of the digital line bandwidth as possible for data, when the voice channel is not in use. This user selection option provides nearly the entire digital bandwidth for the data whenever the voice channel is in the idle, or "on hook", condition.

1.2.3 STANDARD INTERFACE CONNECTORS

The unit contains an RJ-48S type modular telco connector for the line interface, and a standard DB-25 connector for the data interfaces on the customer side. The voice interfaces are of two types, two-wire loop signaling, or two-wire/four-wire E&M. The two-wire loop signaling user port is terminated through a standard RJ-11C type modular jack, while the two-wire/four-wire E&M voice channel is terminated through an eight wire RJ-45X type modular jack. Only one of the two voice channel connections is active at any one time. All the customer connections to the DV-1D are made through easily accessible connectors on the rear panel of the unit.

1.2.4 FLEXIBLE RANGE OF VOICE INTERFACES

The DV-1D provides several varieties of interfaces for its single voice circuit. The unit may be provisioned to provide a standard telephone interface for dial-up access (Foreign Exchange - Subscriber, FXS mode), direct connection to a PBX line port or outside telco provided line (Foreign Exchange - Office, FXO mode), automatic ringdown from telephone to telephone (Private Line Automatic Ringdown, PLAR mode), or the unit may be configured to provide an analog voice tie trunk between two Private Branch Automatic Exchanges (PABX, 2W/4W E&M interface). Each mode is selected by a single switch setting located conveniently on the rear panel of the unit. The DV-1D is compatible with virtually all telephone sets, private automatic branch exchanges (PBX), and telco provided standard telephone lines.

1.2.5 FLEXIBLE CHOICE OF DATA INTERFACES

The DV-1D offers a wide range of choices for the data interface on the customer side. The data channel may operate at speeds of 9.6, 14.4, 19.2, 28.8, or 38.4 Kbps either synchronously or asynchronously. Additionally, lower asynchronous speeds are supported by digital oversampling, and higher synchronous rates can be supported to maximize throughput for LAN-to-LAN traffic. The physical interface is through a DB-25 type connector, which can be user configured to provide either an RS-232, RS-530/RS-422, or V.35 type of interface electrically. Additionally, the data channel may be optioned for either sync or async operation, and the user may select either DTE or DCE transmit clock when in synchronous mode. When in synchronous mode, the DV-1D is independent of both data protocol and format. In all cases, the data circuit is independent of traffic type and protocol.

1.2.6 AUTOMATIC ADAPTIVE EQUALIZATION FOR TELCO SIDE

The adaptive equalization circuitry automatically compensates for distance and line quality of the digital line, which allows the unit to work error-free in normal environments without adjustments. Generally, the unit need only be plugged into the telco provided modular service jack (demarc) to begin to transmit and receive information properly.

1.2.7 INTEGRAL CLOCK GENERATOR

The DV-1D Data/Voice DSU offers two timing modes for synchronization; DDS (Looped) timing from the network, derived from the received signal on the 4-wire loop, or Internal (Int) timing via an internal crystal oscillator. This offers flexibility by allowing the unit to work in public network applications, as well as for use in point-to-point private applications.

1.2.8 EXTENSIVE DIAGNOSTIC CAPABILITIES

The DV-1D offers several test modes for diagnostic purposes. It can perform several types of loopbacks, designed to isolate and identify faults within the entire network. The unit can be placed in a Local Loopback mode, which removes it from the external telephone network, and causes the data and voice channels to be looped back upon themselves. This provides a simple means for testing the DV-1D for proper operation. The Remote Loopback mode sends a unique signal to the far end DV-1D, causing it to present a loopback towards the network and back to the near end. This enables the user to test the telephone circuit all the way to the far end multiplexer. Simple status lamps on the front of the unit indicate proper operation. Also, the DV-1D responds to all standard network generated loopback patterns and signals, so that the telephone company can initiate diagnostic tests and assist in the resolution of problems with the circuits when necessary. All tests are simple to operate and easy to interpret.

1.2.9 USE OF VLSI TECHNOLOGY

The DV-1D utilizes Very Large Scale Integration (VLSI) technology in the form of state of the art microprocessors and Field Programmable Logic Arrays (FPLAs) to insure high reliability, maximum performance, low power consumption, and compact size. This maximizes reliability and minimizes the need for spares.

1.2.10 FRONT PANEL LED'S/CONTROL

The front panel holds 10 LED'S and a LOOPBACK switch for quick identification of all status conditions, and convenient selection of test modes.

1.2.11 COMPACT SIZE

The unit is physically compact, light, and is contained in a housing made of durable plastic, designed to sit on a desktop or in an equipment room. The DV-1D will operate in a broad range of environmental conditions, and requires minimal space and no special power or cooling. Power for the DV-1D is derived from a standard AC wall outlet.

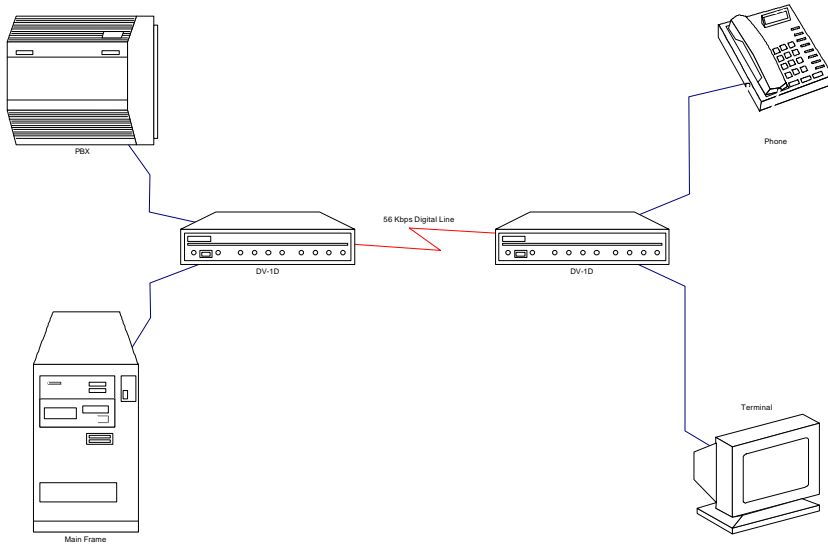
1.2.12 EASY INSTALLATION

The DV-1D is designed for easy installation and operation. No trained personnel are needed to install or activate the unit. All connections are made on the rear of the unit. The unit is optioned via two "DIP" switches located on the rear panel. No alignments or adjustments are required.

1.2.13 LOW POWER CONSUMPTION

The unit has a low power consumption and uses an external power supply (supplied with unit) which plugs into a standard 120 V, 60 Hz grounded outlet.

1.3 APPLICATIONS



The DV-1D Data/Voice DSU provides end-to-end connectivity for one voice circuit and one data circuit over a standard digital telephone line, such as provided by local telephone companies and long distance carriers. **In these applications, the DV-1D operates in “loop” timing mode, deriving its timing from the telephone network for purposes of synchronization.** Connection to the network is via a standard RJ-48S type modular jack.

The DV-1D connects to DTE (Data Terminal Equipment) via the DB-25 interface connector mounted on the rear panel of the unit. The DTE can be one of many devices, such as computer mainframes, mini-computers, workstations, CAD/CAM equipment, multiplexers, LAN bridges, video display terminals, video conferencing equipment, high speed printers, etc. Typical applications include connection of terminals at a remote location to a mainframe at a central location, or connections of a remote PC to a LAN. The DV-1D is a time division unit, whose operation is independent of traffic density or data usage. The DV-1D provides a data connectivity “pipeline” for the data channel, extended over the 56 or 64Kbps facility.

The DV-1D connects to voice telephone equipment through either an RJ-11C type (six pin) modular jack, or an RJ-45X type (eight pin) modular jack, located on the rear of the unit. The single voice circuit of the DV-1D can provide end-to-end connectivity for a single standard telephone circuit with loop signaling (ringing and dialing) control, or a PBX-to-PBX tie trunk with E&M signaling control. Typical applications are for remote connection of a telephone to a PBX station circuit (off-premise station), or remote connection to an outside telephone line (off-premise extension). The DV-1D can also be used to support FAX or analog data transmission between two facilities, or can support a point-to-point voice ringdown circuit ("hot line"). When used to connect a phone at a remote location to the PBX at the central location, the DV-1D provides a means for the remote user to have an extension of the PBX, equivalent to those on-site. The use of Adaptive Differential Pulse Code Modulation (ADPCM) in the DV-1D, allows the DV-1D to provide the unique feature of user selectable voice quality, based upon the user's needs for both voice quality and for data speed and throughput. The voice circuit can be provisioned to use 16 Kbps (good), 24 Kbps (better), or 32 Kbps (best) voice coding. The more bandwidth selected for the voice coding, the better the voice quality for the voice channel, but less bandwidth remains to be used by the data channel. The user has the option of deciding which combination of voice coding and data speeds best fits his application needs. The use of ADPCM voice coding provides for a high quality voice connection with minimum transmission delay. The DV-1D contains all the equipment necessary for all voice and signaling applications, including the generators of the ringing and talk battery signals.

The DV-1D can also be used in private, point-to-point network applications, providing access over any four-wire (two twisted pairs) facility. When used in a private, point-to-point application, the unit provides its own clock synchronization via the internal clock generator (Internal timing mode).

2. SPECIFICATIONS

2.1 GENERAL

Number of Voice Channels (Ports): 1

Voice Type: 16, 24, or 32 Kbps ADPCM (user selectable), derived from mu-law companded 8-bit PCM, 8000 Hz sample rate.

Number of Data Channels (Ports): 1

Data Type: Synchronous or Asynchronous, RS-232C, RS-530, or RS-422 compatible.

Aggregate: 56 or 64Kbps (clear channel), four-wire bipolar, DDS compatible.

Transmit Timing Source: Looped from network (Slave), or internal (Master).

Diagnostics: Local Loopback, Remote Loopback, and Network Loopback (responds to telco generated DSU and CSU loopback commands).

2.2 DATA INTERFACE

User Interface: RS-232C, RS-530, or RS-422, supported through a DB-25 female connector

Data Speeds: 9.6, 14.4, 19.2, or 38.4 Kbps, for synchronous or asynchronous data, user selectable. Asynchronous speeds below 9.6 Kbps can be accommodated by operating in maximum synchronous mode. Additionally, synchronous data can be supported in the "**MAX**imum Bandwidth Control" mode, allowing for nearly all of the 56 or 64Kbps output for data when the voice channel is not in use.

Supported Leads: Transmit Data, Receive Data, Transmit Clock (sync), External Transmit Clock (sync), Receive Clock (sync), RTS, CTS, DTR, DSR, and DCD.

Approximate RTS to CTS Delays:

500 microseconds at 38,400 bps.

700 microseconds at 28,800 bps.

1 millisecond at 19,200 bps.

1.4 milliseconds at 14,400 bps.

2 milliseconds at 9,600 bps.

Input Elastic Buffer: 32 bits

Transmit Data Timing (synchronous operation): Provided by DCE (TC), or DTE (ETC), user selectable.

Synchronous Data Format: Any

Asynchronous Data Format: 8 Bit, no parity, or 7 Bit with parity (odd or even) for speeds of 9.6 Kbps or greater. Speeds below 9.6 Kbps may be accommodated in any format by operating the channel in maximum synchronous mode.

2.3 VOICE INTERFACE

User Interfaces: Two-wire (single pair, Tip and Ring), supported through RJ-11C (six-wire) type modular jack. Or two-wire/four-wire E&M, supported through eight wire RJ-45X type modular jack.

Signaling Types: Loop start FXS (interface to telephone set), loop start FXO (interface to station line or telephone line originating from central office switch or PBX), or PLAR (hot line between two phones), or E&M signaling, Types I or II.

Ring Signal: 86 Vrms, 20 Hz, two standard phones per channel maximum.

Longitudinal Balance: Greater than 45 dB, 200 - 4000 Hz.

Input (Transmit) Level: 0 dBm (600 ohms) at 1000 Hz produces a 0 dBm0 digital reference signal.

Output (Receive) Level: A 0 dBm0 received digital reference signal (1000 Hz) produces a -6 dBm \pm 1 dB output (600 ohms) at Tip and Ring.

Signal to Noise Ratio: Greater than 20 dB at 0 dBm0.

Idle Noise: Less than 20 dBm0.

Frequency Response: Relative to 1000 Hz level, \pm 2 dB, 300 - 3000 Hz

Dialing: Supports tone (DTMF) and pulse dialing.

Overvoltage Protection: Per FCC Part 68 requirements.

2.4 TELCO INTERFACE

Line Interface: 4-Wire, non-loaded cable.

Line Speed: 56 or 64Kbps.

Connector: RJ-48S.

Equalization: Automatic Adaptive (no alignments or adjustments).

Modulation: Bipolar, Return to Zero.

Transmit (Output) Impedance: 135 ohm \pm 10%.

Receive (Input) Impedance: 135 ohm \pm 10%.

Transmit (Output) Level: 1.4 V peak.

Receive (Input) Sensitivity: -46 dBmO.

Range: 3.0 to 9.5 miles depending on wire gauge.

Compatibility: Meets requirements of AT&T PUB 62310 for standard DDS service compatibility.

2.5 ENVIRONMENTAL

Operation: 0 to 50° C, 10 to 95% relative humidity.

Storage: -40 to 85° C, 10 to 85% relative humidity.

2.3 PHYSICAL / ELECTRICAL

10¼" W x 9¾" D x 2½" H.

120 VAC external power supply.

Less than 10 watts.

2.8 pounds.

3. INSTALLATION

3.1 INSPECTION AND INITIAL SELF TEST

Upon receipt of the equipment, visually inspect it for signs of damage. Immediately report any damage to the transportation company and to the supplier. Then perform the following quick and simple self tests.

1. Before connecting any of the telco or voice or data cables, plug the male connector at the small end of the cord of the external power supply (supplied with the unit) into the female receptacle marked POWER on the rear of the DV-1D. Then plug the power supply line cord into any standard grounded 120 VAC outlet.
2. Observe the front panel indicators. The POWER indicator should be illuminated. All other indicators should be off.
3. Next place the front panel switch marked LOOPBACK in the position marked LOC (left). The indicator next to the switch, and the indicators marked DCD and SYNC should illuminate. This basically indicates normal operation of the unit. Place the LOOPBACK switch back to its normal (center) position.
4. Next connect the unit to the telephone line using the modular cord supplied with the unit. The unit should be functional when plugged directly into the modular jack (demarc) supplied by the telephone company. If a valid signal is received by the DV-1D from the digital telephone line, the DCD indicator will light. Having done this, the DV-1D is ready for connection to the customer side equipment.

3.2 INSTALLATION

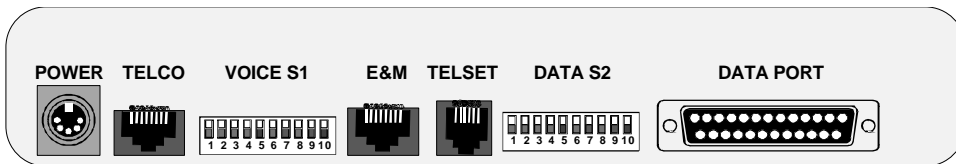


FIGURE 1

Installation of the DV-1D requires no special tools, adjustments, or measurements. Installation consists of properly setting the two ten position DIP switches (S1 and S2) located at the rear of the unit, and connecting the voice and data equipment to the appropriate connectors on the rear panel. Connection to the telephone network is accomplished by connecting the unit to the modular jack (demarc) supplied by the telephone company, using the modular cord supplied with the unit.

The Adaptive Distance Equalization circuitry of the DV-1D compensates for distance and line quality automatically, eliminating the need for adjustments.

Installation of the voice and data equipment is accomplished by first setting the two DIP switches to their appropriate settings per paragraph 3.3 below, and then connecting the data equipment to the DV-1D by connecting an appropriate data type cable, with a DB-25 connector, to the DB-25 type connector, marked DATA, located on the rear of the unit. The voice equipment is connected by using a standard six or eight wire modular cord to connect from the jacks marked TELSET or E&M on the rear of the unit to the appropriate jacks of the telephone set, PBX , or outside line to which the DV-1D is to be connected. The wiring plan of the modular jacks and of the DB-25 connectors follows the standard conventions. The telephone line jack is of the RJ-48S type.

The DB-25 connector for the data connections follows the convention for DCE equipment, and can be configured by the user to provide the electrical characteristics of an RS-232, RS-530, or V.35 interface. When configured as an RS-232 or an RS-530 interface, only a standard "straight through" cable is required to connect the DV-1D data channel to DTE equipment. When the data channel interface is configured for V.35, or if the user wishes to connect the DV-1D to an RS-422 DTE interface, an adapter cable is required, which can be purchased separately from DCB.

The six-wire modular jack for the loop voice telephone connections are of the RJ-11C type.

The eight-wire modular jack for the E&M voice telephone connection is an eight-wire RJ-45X type.

See Section 6 for pinouts of these interfaces.

After you make the telco, voice, and data connections, the installation needs only the correct setting of the DIP switches as described in the next section. The POWER LED should be on steady, and the DCD LED should be lit, indicating a successful telephone line connection, and presence of the digital signal from the network. If a DV-1D is already connected to the telephone line at the far end, and is configured properly, the SYNC LED should be lit, indicating the reception of a valid signal from the companion DV-1D at the far end of the telephone digital line circuit.

3.3 DIP SWITCH SETTINGS

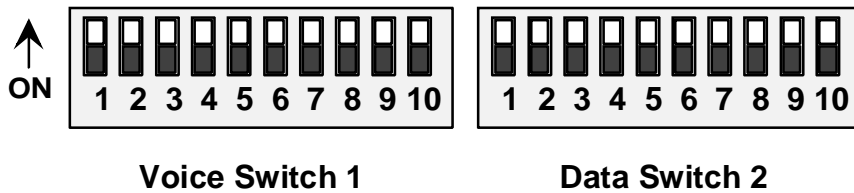


Figure 2

The two DIP switches, S1 and S2, need to be properly set for each particular user's application. In general, the first DIP switch, S1, controls the operation of the voice channel and the telephone line connection, and the second DIP switch, S2, controls the operation of the data channel. Both DIP switches need to be set properly for the unit to function correctly.

The two DIP switches, S1 and S2, are located on the rear of the DV-1D. In general, the first DIP switch, S1, controls the voice channel operation and levels, and the four-wire telco interface. Switch S1 is to be set as follows:

S1-1 & S1-2 These two switches control the operating mode of the voice channel of the DV-1D. They are coded in such a way as to configure the DV-1D for FXO, FXS, PLAR, or E&M operation as follows:

| S1-1 | S1-2 | Voice Channel Mode |
|------|------|--------------------|
| OFF | OFF | FXS |
| OFF | ON | FXO |
| ON | OFF | PLAR |
| ON | ON | E&M |

S1-3 When ON, S1-3 puts the voice channel in the 16 Kbps coding mode. This is the mode which uses the least amount of bandwidth for the voice channel and allows for maximum speed of the data channel. This voice coding selection will provide GOOD voice quality.

When OFF, 16 Kbps voice coding is NOT selected.

S1-4 When ON, the voice channel is configured to operate in the 24 Kbps coding mode. This choice of voice operation provides BETTER voice quality, while leaving less bandwidth available for data. Choose this setting if you require improved voice quality, but still wish to maintain a high data rate.

When OFF, the 24 Kbps voice coding mode is NOT selected.

S1-5 When ON, the voice channel is configured to operate in the 32 Kbps coding mode. This choice provides the BEST voice quality for the voice channel. This setting will provide "toll quality" voice, and will allow for high speed analog data and fax traffic over the voice channel. However, this setting provides the least amount of bandwidth to the data channel, and limits the speed of the data circuit accordingly.

When OFF, the 32 Kbps voice coding mode is NOT selected.

S1-6 & S1-7 These two switches configure the receive voice level of the voice channel when the voice channel is operating in any two-wire mode. This includes FXO, FXS, PLAR, and 2W E&M operation. When the DV-1D is configured for 4W E&M operation, these two switches are inactive. The two switches are coded to provide output receive levels of 0 dBm, -3 dBm, -6 dBm, or -9 dBm, as follows:

| S1-6 | S1-7 | Receive Output Level (2W) |
|------|------|---------------------------|
| OFF | OFF | 0 dBm |
| OFF | ON | -3 dBm |
| ON | OFF | -6 dBm |
| ON | ON | -9 dBm |

S1-8 When ON, this switch selects 4W E&M operation of the voice channel.

When OFF, this switch selects 2W E&M operation of the voice channel. Switch S1-8 is only active if E&M operation is chosen on S1-1 and S1-2.

S1-9 When ON, this switch selects 4W voice levels of -16 dBm transmit, and +7 dBm receive.

When OFF, this switch selects 4W voice levels of 0 dBm transmit, and -3 dBm receive. This switch is only active when the voice channel of the DV-1D has been configured for 4W E&M operation.

S1-10 When ON, this switch selects Type II E&M signaling.

When OFF, this switch selects Type I E&M signaling. This switch is only active when the DV-1D voice circuit has been configured for either 2W E&M or 4W E&M operation.

Another DIP switch(S4), located inside the unit, controls the voice line impedance as follows:

| | | |
|------|----------|-------------------|
| S4-1 | ON | 600 ohms (normal) |
| S4-2 | ON | 900 ohms |
| S4-3 | ON | 100 ohms |
| S4-4 | not used | |

Select only one of these settings.

The second DIP switch, S2, controls the operation of the data channel and the digital line interface.

S2-1 & S2-2 These two switches control the data interface, and determine what electrical interface is selected for the data channel. The two switches determine whether the data channel interface is electrically RS-232, RS-530/RS-422, or V.35 as follows:

| S2-1 | S2-2 | Data Channel Interface |
|------|------|------------------------|
| OFF | OFF | RS-232 |
| OFF | ON | RS-530/RS-422 |
| ON | OFF | V.35 |

S2-3, S2-4, & S2-5 These three switches determine the selected data speed, and whether or not the “**MAX**imum bandwidth allocation” feature is enabled. The correct setting of these switches selects the data channel operating speed to be 9.6, 14.4, 19.2, 28.8, or 38.4 Kbps, and whether or not the data speed is optimized when the voice channel is not used. The switch operation is as follows:

| S2-3 | S2-4 | S2-5 | Data Speed |
|------|------|------|----------------------------|
| OFF | OFF | OFF | 9.6 Kbps |
| OFF | OFF | ON | 14.4 Kbps |
| OFF | ON | OFF | 19.2 Kbps |
| OFF | ON | ON | 28.8 Kbps |
| ON | OFF | OFF | 38.4 Kbps |
| ON | OFF | ON | 19.2, with MBA (sync only) |
| ON | ON | OFF | 28.8, with MBA (sync only) |
| ON | ON | ON | 38.4, with MBA (sync only) |

S2-6 When ON, selects External Transmit Clock to load the input buffer of the data circuit if in synchronous data mode.

When OFF, selects the internal data clock (Transmit Clock) to load the input data buffer of the data circuit when in synchronous data mode.

S2-7 When ON, selects ASYNCHRONOUS data operation for the Data Channel.

When OFF, selects SYNCHRONOUS data operation for the Data Channel.

- S2-8 When ON, selects end-to-end (RTS to DCD) flow control operation for the Data Channel.
When OFF, no end-to-end flow control is provided for the Data Channel.
- S2-9 When ON, selects 56 Kbps line operation.
When OFF, selects 64 Kbps Clear Channel (72 Kbps line rate) line operation.
- S2-10 When ON, Internal Line (Master) Timing is selected.
When OFF, Loop Line (Slave) Timing is selected.

The following are allowable voice and data speed combinations:

| | Valid Data Speeds | |
|---------|----------------------------------|----------------------------------|
| Voice | 56Kbps Line | 64Kbps Line |
| 16 Kbps | 9.6, 14.4, 19.2, 28.8, 38.4 Kbps | 9.6, 14.4, 19.2, 28.8, 38.4 Kbps |
| 24 Kbps | 9.6, 14.4, 19.2, 28.8 Kbps | 9.6, 14.4, 19.2, 28.8, 38.4 Kbps |
| 32 Kbps | 9.6, 14.4, 19.2 Kbps | 9.6, 14.4, 19.2, 28.8 Kbps |

NOTE

If an invalid combination of DIP switch settings is chosen, the LOOPBACK, SYNC, LOC OH, and REM OH front panel indicators will flash continuously.

4. OPERATION

4.1 VOICE OPERATION

The DV-1D provides one voice channel derived from the multiplexed 56 or 64Kbps aggregate line signal. The voice channel utilizes Adaptive Differential Pulse Code Modulation (ADPCM), a method of voice compression approved by the major telephone companies as an acceptable means of reducing voice bandwidth. The user has the option of configuring the voice circuit to operate at 16 Kbps, 24 Kbps, or 32 Kbps. When choosing 16 Kbps operation, the voice quality derived from the voice circuit is good, and fax or analog data transmission may be slow or marginal. However, in this mode, maximum data speed is obtainable. When the DV-1D is configured for 16 Kbps voice on a 56 Kbps telephone line circuit, the user may have up to 38.4 Kbps of data throughput. Similarly, when the DV-1D is configured for 24 Kbps voice, the voice quality is noticeably better, but less data speed is available. Lastly, when the DV-1D is configured for 32 Kbps voice coding (best), the voice quality is full "toll quality", and fax and analog data are regularly supported through the voice circuit. In this mode, data speed is limited to 19.2 Kbps (sync) maximum on a 56 Kbps digital line or 28.8 Kbps (sync) maximum on a 64 Kbps line.

On the transmit (input) side of the voice circuit, the voice signals are received through a balanced line interface circuit which takes the two-wire bi-directional signal present on the telephone pair, and converts the signal into separate transmit and receive audio signals, when in two-wire operation. In four-wire E&M operation, the transmit and receive voice signals are already separated on two separate voice pairs to and from the PBX. The transmit voice signal is then amplified to produce the correct level, and then passed through a bandpass filter. The bandpass filter eliminates any high frequency components of the signal which cause interference with the analog-to-digital conversion process. The resulting voice signal is then sampled at 8000 samples per second, and converted to an eight bit digital representation of the samples. This method of voice digitization, called Pulse Code Modulation, conforms with Bell System standards for the transmission of voice information throughout the network. The digitized voice signal, now represented in 64 Kbps digital form, is then presented to the ADPCM digital signal processor for compression of the signal. The resulting output is a 16, 24, or 32 Kbps compressed voice digital signal which is then sent to the multiplexing circuit of the DV-1D for transmission over the aggregate to the companion DV-1D at the far end of the telephone line.

The receive portion of the DV-1D voice circuit provides the inverse functions. The 16, 24, or 32 Kbps compressed digital voice signal is presented to the ADPCM processor by the output of the multiplexer circuit. The ADPCM processor then expands (de-compresses) the signal back to a full 64 Kbps voice signal to be acted upon by the digital-to-analog converter. The D-to-A converter then converts the digital signal back to analog, it is passed through a low pass filter to eliminate the effects of the sampling frequency, level adjusted, and then passed through the line interface circuit to be presented to the two-wire telephone pair. This completes the end-to-end process of two-wire to four-wire conversion, digitization, compression, multiplexing and transmission at one end, then reception, demultiplexing, expansion, conversion back to analog, and application to the two-wire telephone interface at the other end.

Signaling (on-hook/off-hook, dialing, ringing) is handled separately from the voice signals in the DV-1D. Signaling information is transmitted from one DV-1D to its companion unit at the far end by means of a derived signaling channel which shares bandwidth with the framing (synchronizing) signal of the DV-1D, and contained within the multiplexed aggregate signal. The signaling information transmitted varies, depending on the operating mode selected for the voice channel. The four operating modes are described below.

FXS - In this mode, the DV-1D provides DC voltage and current (talk battery) for a local telephone instrument. By monitoring the presence or absence of current to the telephone instrument, the DV-1D detects whether the phone, or telephone equivalent, is idle (on hook) or busy (off hook). This information is then transmitted to the far end DV-1D, which must be placed in FXO mode. The on-hook or off-hook information is then relayed to the telephone switching equipment by the far end FXO unit.

Pulse dialing information is handled in the same way as on-hook/off-hook, since pulse dialing consists of rapid changes in on-hook/off-hook states. Tone dialing consists of audio frequency tones, and is therefore transmitted in digitized form through the voice paths (see discussion above), rather than through the signaling circuits. When a busy condition is received by a DV-1D in FXS mode from the far end, this represents an incoming call condition. This causes the DV-1D FXS circuit to provide a ringing signal (86 Vrms, 20 Hz) to the telephone set, or PBX or KTS trunk circuit. This ringing signal will continue in accordance to the information received from the far end unit, until the called party answers or the call is abandoned by the calling party. The DV-1D can safely ring up to two standard phones simultaneously.

CAUTION

Excessive ringing loads on the voice circuits can cause damage to the units! Each voice channel should be connected to the equivalent of two standard ringers or less.

FXO - The FXO mode is the inverse of the FXS mode. Indeed, to operate properly a DV-1D optioned for FXS mode must have a DV-1D optioned for FXO mode at the other end. When in FXO mode, the DV-1D's signaling circuits are conditioned to detect an incoming ring signal, representing an incoming call, and to provide a DC path (loop closure) to the PBX or central office switch to indicate on-hook/off-hook status. When ringing is detected, the FXO end will send a busy indication to the FXS unit at the far end, thus instructing it to ring its phone. When the far end FXS unit detects an off-hook condition, it sends a busy to the near end FXO which then provides an off-hook (loop closure) state to the telephone switching system. In this manner, the FXS/FXO pair together make the two DV-1D units at the two ends of the line appear "transparent" to the operation of a normal telephone line. Thus the user may establish the same type of telephone services over the circuit derived through the use of the DV-1D multiplexers that he or she could by direct connection over a normal telephone pair. In other words, the DV-1D multiplexer will not interfere, and will pass essentially unchanged, the signaling normally present in a standard telephone line connection.

PLAR - In this mode, the DV-1D and its far end companion provide a point-to-point "hot line" connection. Both units, near and far, must be optioned as PLAR circuits. A telephone instrument is connected at each end (Figure 4). When either phone is placed in the off-hook condition, a busy condition is transmitted to the far end DV-1D. This will cause the far end phone to ring. The ringing will continue, at a rate of 2 seconds of ringing, 4 seconds of silence, until the far end party answers, or the near end (calling) party abandons the call attempt. A special feature of the DV-1D prevents an inadvertent continuous ringing condition, by allowing the far end telephone to ring only twenty times. After twenty ringing cycles the DV-1D will cease to ring the phone until the near end hangs up, then reinitiates the call. The DV-1D should be connected to no more than two phones per voice channel (see FXS section).

E&M - In this mode, the DV-1D interfaces to the tie trunk port of a PBX, and provides either a Type I or a Type II E&M signaling interface. This is a logic level type interface, where typically the PBX places battery voltage on the M-lead to indicate an off-hook condition to the DV-1D, and the DV-1D in return, places a ground on the E-lead to indicate a busy condition to the PBX. The E&M interface of the DV-1D is available on the eight wire modular jack marked "E&M", and provides for either two-wire or four-wire voice operation, user selectable.

4.2 DATA OPERATION

The DV-1D is designed to provide one data channel in addition to the voice port. The port may be used to provide end-to-end connectivity for synchronous or asynchronous data. The DV-1D data channel may be user configured for speeds of 9.6, 14.4, 19.2, 28.8, or 38.4 Kbps, in synchronous or asynchronous mode. In addition, lower speeds can be accommodated for asynchronous data by utilizing the digital oversampling mode of operation, and additional speeds can be configured for synchronous operation to maximize the data throughput once a particular voice coding scheme has been chosen.

SYNC DATA - When configured for sync data, the DV-1D data port acts as an end-to-end "pipeline" for the data, independent of format or protocol. In synchronous data mode, data is exchanged with the DTE in accordance with clocks, normally provided by the DV-1D, and derived synchronously from the 56 or 64Kbps aggregate line output.

Specifically, RS-232C or RS-530/RS-422 data is received by the DV-1D on the appropriate transmit data pin of the DB-25 connector, and is sent to an elastic storage buffer, of 32 bits size. This data is loaded into the elastic store buffer either in accordance with the Transmit Clock (TC) provided from the DV-1D to the DTE, or in accordance with External Transmit Clock (ETC) provided by the DTE to the DV-1D. This selection is made with a DIP switch option, as discussed previously. When ETC is chosen for the transmit data, it should be noted that the DTE clock must be synchronous with the clock provided by the DV-1D as Receive Clock (RC), to avoid clock slips. No clock slips can occur when TC is used as the transmit data timing source.

After the elastic store buffer, data is presented to the multiplexer circuit of the DV-1D for transmission over the aggregate line output. The bandwidth of the aggregate dedicated for the data channel is determined by the line speed and by the user's choice of voice coding (voice quality). A table of the allowable synchronous data speeds for each combination is on page 17. For this reason, selection of 38,400 bits per second data speed is available only with 16 Kbps voice coding on a 56 Kbps line, or with 16 or 24 Kbps voice coding on a 64 Kbps line.

The data received from the aggregate at the far end is fed from the multiplexer circuit to a "First In, First Out" (FIFO) buffer of 16 bits in the data channel receive circuit. The output of the FIFO is then sent to the DTE in accordance with the Receive Clock (RC) through the data interface on the appropriate pin of the DB-25 connector.

MAXIMUM BANDWIDTH CONTROL - A unique feature of the DV-1D Data/Voice DSU/DSU is the use of "**MAX**imum Bandwidth Control" to provide the fastest possible data throughput when the voice channel is not in use. Typically used in applications for LAN-to-LAN connectivity between the two end sites, MBC provides essentially all of the 56 or 64Kbps bandwidth for the data circuit when the voice channel is in an idle (on-hook) state. When this feature is enabled by the appropriate setting of DIP switches S2-3 through S2-5, the DV-1D will provide the chosen combination of voice coding and data speed when the voice channel is in use, then automatically switch to a "data only" mode allowing maximum data speed when the voice channel is idle. When a user originates a call once again on the voice channel, the units at each end will automatically switch back into voice plus data mode. The "data only" mode of the DV-1D provides a "gapped clock" at a 56 or 72 Kbps clocking rate to the DTE, and is useable only for SYNCHRONOUS data.

ASync DATA - Async data is handled in either of two ways by the DV-1D. At speeds of 9.6, 14.4, 19.2, 28.8, or 38.4 Kbps, the user must select the correct speed setting as in the sync data mode, and must select ASYNC operation (S2-7 ON) . When operating at 9.6, 14.4, 19.2, or 38.4 Kbps, async data is processed through the microprocessor of the DV-1D. In this mode, the data undergoes an asynchronous-to-synchronous conversion by the use of a UART device on the DV-1D, which conforms to the specifications of CCITT recommendation V.14 for async to sync conversion.

The data is then reformatted in a synchronous form for transmission to the far end, within the bandwidth assigned to the data by the multiplexing circuitry of the DV-1D. The microprocessor receives and sends the data to and from the UART which provides the timing conversions necessary for the handling of asynchronous data, again in accordance with V.14 CCITT standard.

To operate properly in this mode, the data must be formatted as either EIGHT BIT, NO PARITY or SEVEN BIT WITH PARITY. The sense of the parity does not matter, since the DV-1D will treat the parity bit as a data bit. There is no restriction on the number of stop bits. When operating in this mode, the transmit and receive clocks at the data interface are not used.

Asynchronous data speeds below 9600 bits per second can be handled in any format and any speed by placing the DV-1D data channel in the maximum synchronous mode. The data will be transmitted and received through the sync data circuits, and will provide acceptable performance for any standard low speed asynchronous terminal or other device.

CONTROL LEADS - The DV-1D supports several control leads for its data interface, in both sync and async mode. The DV-1D will accept as inputs, in addition to data and clock, Data Terminal Ready (DTR), and Request to Send (RTS). The DV-1D will provide, as outputs in addition to data and clocks, Data Set Ready (DSR), Clear to Send (CTS), and Data Carrier Detect (DCD). The DV-1D responds to Request to Send with the assertion (positive voltage) of Clear to Send after a timed delay, of 20 clock cycles. The RTS-CTS delays are as follows:

| Data Speed | RTS-CTS Delay |
|------------|------------------|
| 9.6 Kbps | 2 milliseconds |
| 14.4 Kbps | 1.4 milliseconds |
| 19.2 Kbps | 1 milliseconds |
| 28.8 Kbps | 700 microseconds |
| 38.4 Kbps | 500 microseconds |

DTR received from the DTE has no effect on the DV-1D, other than the transmit data LED on the unit's front panel will illuminate only when DTR is asserted. DSR asserted by the DV-1D indicates that a valid signal is being received at the 56 or 64Kbps input port, and that the unit is not in a local loopback condition. The Data Carrier Detect (DCD) signal asserted by the DV-1D means a valid signal is received by the DV-1D at its aggregate line receive port, and the unit may possibly be in loopback mode. The receive data LED on the front panel will light only when DCD is asserted. Each of the control leads to and from the DTE is a standard unbalanced RS-232C compatible signal.

5. FRONT PANEL CONTROLS AND INDICATORS

5.1 Controls

The front panel LOOPBACK switch is a rocker type with three positions. The center position is the NORMAL position. When in this position, the DV-1D operates normally, and will transmit and receive voice and data information to and from the far end companion unit. When LOOPBACK is placed in the left position (LOC), the DV-1D is put into its local loopback condition. In this mode, the DV-1Ds transmit information is looped back to its receiver, and an all-ones condition is transmitted to the far end unit. This mode is used for troubleshooting and diagnostics.

When LOOPBACK is placed in the right (REM) position, the DV-1D will send a unique loopback signal to the companion DV-1D at the far end, causing it to perform a network loopback back towards the local DV-1D (see Section 7).

Note that when the LOOPBACK switch is in either the left (LOC) or right (REM) positions, the accompanying LED is lit, indicating a loopback test condition. After 2 minutes, if the switch is left in these positions, the test is terminated and the LED will go off, indicating the test has timed out.

5.2 Indicators

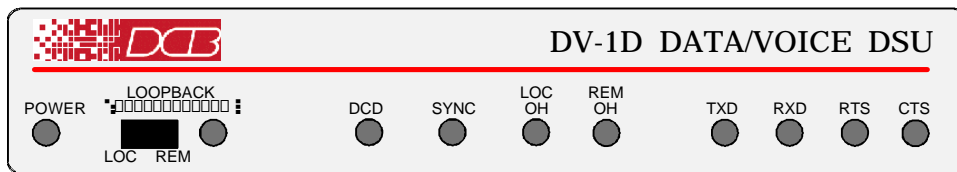


Figure 3

The following describes the ten green LED indicators located on the front of the DV-1D.

POWER When lit, this LED indicates that power is applied to the DV-1D unit.

LOOPBACK Located next to the LOOPBACK switch, this LED indicates that the DV-1D is in loopback mode.

- DCD** When lit, indicates a valid signal is being received by the DV-1D at its receive pair of the RJ-48S telephone line connection.
- SYNC** When lit, indicates the DV-1D receiver framing circuitry is receiving a valid synchronizing signal from its companion DV-1D unit at the far end, and is properly aligned to the incoming multiplexed signal.
- LOC OH** When lit, this LED indicates that an off-hook (busy) condition is being detected at the local telephone voice interface. When this occurs, the DV-1D sends an off-hook indication to the far end unit, so that the proper signaling state can then be provided to the voice equipment at that end of the circuit.
- REM OH** When lit, this LED indicates that the DV-1D is receiving an off-hook (busy) condition for the voice circuit from the DV-1D unit at the far end of the circuit. The DV-1D then translates this indication of off-hook status into the proper condition of the signaling circuits to the local telephone voice equipment.
- TXD** When lit, this LED indicates that the DV-1D is receiving a SPACE on its transmit data input (pin 2) from the DTE for its Data Channel, **AND** the Data Terminal Ready lead (DTR, pin 20) is asserted.
- When not lit, this LED indicates that the DV-1D is receiving a MARK from the DTE on its transmit data pin, **OR** the DTR lead from the DTE is not asserted.
- RXD** When lit, this LED indicates the DV-1D is sending a SPACE on its receive data output (pin 3) to the DTE, **AND** Data Carrier Detect (DCD, pin 8) is asserted by the DV-1D to the DTE.
- When not lit, this LED indicates that the DV-1D is sending a MARK to the DTE on the receive data lead, **OR** Data Carrier Detect is low (not asserted), indicating a loss of valid signal at the receiver of the DV-1D.
- RTS** When lit, this LED indicates that the Request-to-Send (RTS) lead of the data interface is asserted by the data terminal equipment.
- CTS** When lit, this LED indicates that the Clear-to-Send (CTS) lead of the data interface is being asserted towards the data terminal equipment by the DV-1D.

6. INTERFACE SIGNALS

6.1 DATA PORT INTERFACE (DB-25S)

| <u>SIGNAL</u> | <u>RS-232</u> | <u>RS-530</u> | <u>V.35*</u> |
|-----------------------------|---------------|---------------|--------------|
| Transmit Data (TxD) | Pin 2 | Pins 2 & 14 | Pins P & S |
| Transmit Clock (TC) | Pin 15 | Pins 15 & 12 | Pins Y & AA |
| External Transmit Clk (ETC) | Pin 24 | Pins 24 & 11 | Pins U & W |
| Data Terminal Ready (DTR) | Pin 20 | Pin 20 | Pin H |
| Request to Send (RTS) | Pin 4 | Pin 4 & 19 | Pin C |
| Receive Data (RxD) | Pin 3 | Pins 3 & 16 | Pins R & T |
| Receive Clock (RC) | Pin 17 | Pins 17 & 9 | Pins V & X |
| Clear to Send (CTS) | Pin 5 | Pin 5 & 13 | Pin D |
| Data Set Ready (DSR) | Pin 6 | Pin 6 | Pin E |
| Data Carrier Detect (DCD) | Pin 8 | Pin 8 & 10 | Pin F |
| Signal Ground (SG) | Pin 7 | Pin 7 & 23 | Pin B |
| Protective Ground (PG) | Pin 1 | Pin 1 | Pin A |
| Ring Indicator (RI) | Pin 22 | Pin 22 | Pin J |

* Using adapter cable.

6.2 TELCO INTERFACE (RJ-48S)

Transmit pair Pins 1 & 2
Receive pair Pins 7 & 8

6.3 2-WIRE VOICE INTERFACE (RJ-11C)

Two-wire Pair (Tip & Ring) Pins 3 & 4

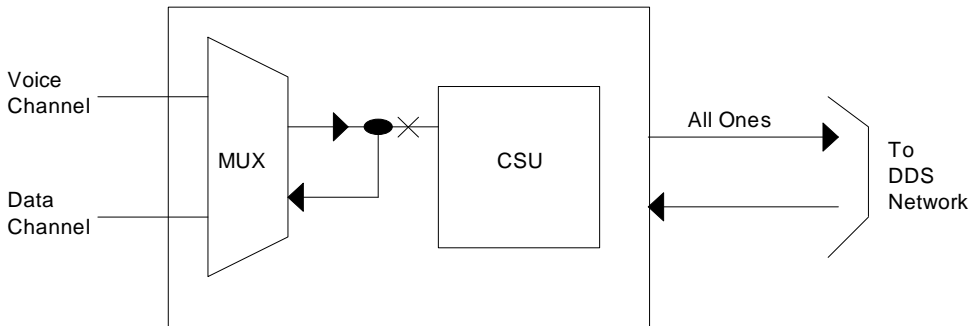
6.4 4-WIRE E&M INTERFACE (RJ-45)

Two-wire Pair (2W) or Transmit Pair (4W) Pins 4 & 5
Receive Pair (4W only) Pins 3 & 6
E-Lead Pin 2
M-Lead Pin 8
SG-Lead Pin 7
MB-Lead Pin 1

7. TROUBLESHOOTING

The DV-1D Data/Voice DSU provides a wide range of diagnostic capabilities for easy testing, troubleshooting and maintenance. Testing and diagnostic troubleshooting for the DV-1D consists of operation of the various loopback capabilities of the unit, and observance of the LED indicators on the front of the unit to verify correct operation. Additional, more comprehensive testing can be performed with the use of transmission test sets for the voice channels, and/or BERT type data test sets for the data channels. For most situations, however, the simple diagnostics resident within the DV-1D should be adequate.

Testing of the DV-1D is accomplished through the use of the three types of loopbacks available in the unit. The three types of loopbacks used in the DV-1D are LOCAL, REMOTE, and NETWORK. By utilizing these various loopbacks, a user at one end of a telephone line connection can successfully test both the near end DV-1D unit, the far end unit, and the telephone circuit in between.



DV-1D

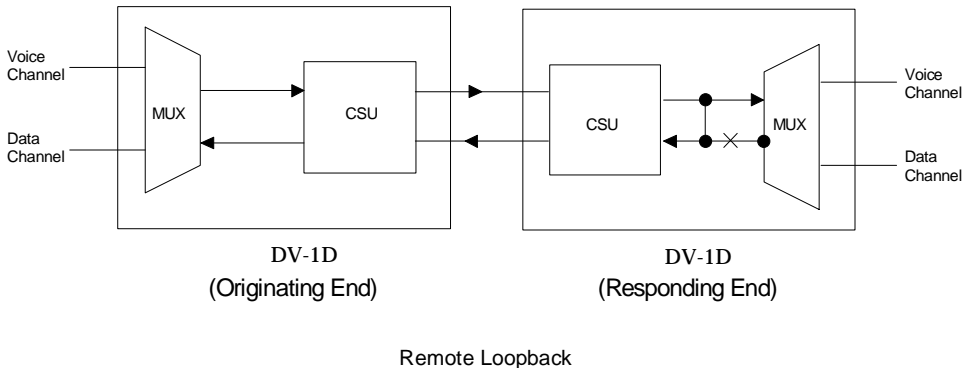
Local Loopback

The first diagnostic of use in the DV-1D is the LOCAL LOOPBACK. The LOCAL LOOPBACK is used to test the unit at the location where the test is being performed (near end). To perform the LOCAL LOOPBACK test, place the LOOPBACK switch on the front of the unit in the LOC position. The LED next to the switch should illuminate. This indicates that the 56 or 64Kbps output of the DV-1D is looped back to its receiver input. During this test condition, an all ones pattern is transmitted to the network. When in LOCAL LOOPBACK, observe the states of the DCD and SYNC LEDs. If these LEDs are both lit, proper operation of the local DV-1D is indicated.

While in local loopback mode, the data channel can be tested with a BERT test set if desired. The data transmitted on the data port will be received back on the same port.

Testing of the voice channels in LOCAL LOOPBACK is not possible, since the channels are looped back upon themselves. After completion of the LOCAL LOOPBACK test, place the LOOPBACK switch back its normal (center) position. The LED next to the switch should turn off.

Should the LOOPBACK switch remain in the LOC position, the LOCAL LOOPBACK condition will be automatically terminated after two minutes, and the LED will turn off, indicating the test has ended. To reestablish the loopback, put the switch in the normal position, then back to LOC.



To test the DV-1D at the far end, place the LOOPBACK switch in the REM position. Again, the LED next to the switch should light. In this mode, the near end DV-1D will transmit a special loopback code through its aggregate signal to the far end unit. Upon receipt of the special loopback by the far end unit, the far end unit will provide a loopback towards the network, and hence towards the testing end. This loopback signal from the far end includes a special pattern used to assist in determining proper transmission through the system. When both units and the transmission line are operating properly, the near end unit will have its SYNC and DCD lights on. This condition, during the REMOTE LOOPBACK test, indicates correct operation of both DV-1D units, and of the digital telephone connection between them.

Verification tests can be run by sending BERT tests through the data channels. Again, this test will terminate automatically after two minutes, if the LOOPBACK switch is left in the REM position.

If the REMOTE LOOPBACK test described above is not successful, the problem is either in the remote DV-1D unit, or in the telephone line. The LOCAL LOOPBACK test can be performed on the far end unit to determine if that unit is functioning properly. If the far end unit passes the LOCAL LOOPBACK test, the problem is likely to be in the digital telephone line.

If the problem is reported to the telephone company, diagnostic tests can be run on the dedicated facility between the two locations. The DV-1D will respond to both the standard CSU and DSU loopback signals which are sent by the telephone company's testing equipment. These two loopback signals from the telephone network will cause the DV-1D to provide a NETWORK LOOPBACK towards the telephone equipment.

When operating on a 56 Kbps digital line, the DV-1D supports the CSU Loopback, DSU Latching Loopback, and DSU Non-Latching Loopback. When operating on a 64 Kbps line, the DV-1D supports the CSU Loopback, and the Latching DSU Loopback only.

Using these loopbacks, the telephone company can check the local wiring and transmission from the telephone company central office out to the location of the DV-1D equipment. This capability aids in the rapid determination of the cause and location of a network transmission problem.

By utilizing these three types of loopbacks, the cause of a problem should be easily identified. Should it be determined that a fault exists in one of the DV-1D units, it should be replaced. The units are not field repairable, and should be returned to DCB for repair, if necessary. If technical assistance is required, contact the DCB Customer Support Department by calling (217) 352-3207 or by Email at support@dcbnet.com.

8. WARRANTY

All DCB products are warranted to be free of defects in materials and workmanship for one year. Data Comm for Business, Inc. will repair or replace any equipment proven to be defective within the warranty period. All warranty work is F.O.B. Champaign, IL. This warranty is exclusive of abuse, misuse, accidental damage, acts of God or consequential damages, etc. DCB liability shall not exceed the original purchase price.

All equipment returned for warranty repair must be accompanied by a Returned Material Authorization (RMA) number. To receive an RMA number, call (217) 352-3207 between 8 AM and 5 PM central time. Equipment must be shipped prepaid to DCB and will be returned at DCB's expense.

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