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NETWORK SERVICES

AUGUST 1998

MX270A MX270AE
MX271A MX271AE
MX272A MX272AE
MX273A MX273AE
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MX275A MX275AE
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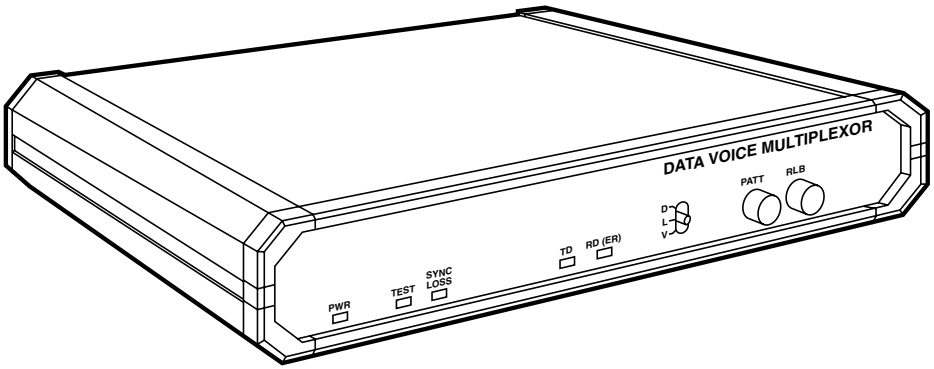
MX277A MX277AE

Data Voice Multiplexors



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RADIO FREQUENCY INTERFERENCE STATEMENTS

This equipment generates, uses, and can radiate radio-frequency energy, and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio communication. It has been tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart B of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when the equipment is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of Industry Canada.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe A prescrites dans le Règlement sur le brouillage radioélectrique publié par Industrie Canada.

NORMAS OFICIALES MEXICANAS (NOM)
ELECTRICAL SAFETY STATEMENT

INSTRUCCIONES DE SEGURIDAD

1. Todas las instrucciones de seguridad y operación deberán ser leídas antes de que el aparato eléctrico sea operado.
2. Las instrucciones de seguridad y operación deberán ser guardadas para referencia futura.
3. Todas las advertencias en el aparato eléctrico y en sus instrucciones de operación deben ser respetadas.
4. Todas las instrucciones de operación y uso deben ser seguidas.
5. El aparato eléctrico no deberá ser usado cerca del agua—por ejemplo, cerca de la tina de baño, lavabo, sótano mojado o cerca de una alberca, etc..
6. El aparato eléctrico debe ser usado únicamente con carritos o pedestales que sean recomendados por el fabricante.
7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recomendado por el fabricante.
8. Servicio—El usuario no debe intentar dar servicio al equipo eléctrico más allá a lo descrito en las instrucciones de operación. Todo otro servicio deberá ser referido a personal de servicio calificado.
9. El aparato eléctrico debe ser situado de tal manera que su posición no interfiera su uso. La colocación del aparato eléctrico sobre una cama, sofá, alfombra o superficie similar puede bloquea la ventilación, no se debe colocar en libreros o gabinetes que impidan el flujo de aire por los orificios de ventilación.
10. El equipo eléctrico deber ser situado fuera del alcance de fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.
11. El aparato eléctrico deberá ser connectado a una fuente de poder sólo del tipo descrito en el instructivo de operación, o como se indique en el aparato.

12. Precaución debe ser tomada de tal manera que la tierra fisica y la polarización del equipo no sea eliminada.

13. Los cables de la fuente de poder deben ser guiados de tal manera que no sean pisados ni pellizcados por objetos colocados sobre o contra ellos, poniendo particular atención a los contactos y receptáculos donde salen del aparato.

14. El equipo eléctrico debe ser limpiado únicamente de acuerdo a las recomendaciones del fabricante.

15. En caso de existir, una antena externa deberá ser localizada lejos de las lineas de energia.

16. El cable de corriente deberá ser desconectado del cuando el equipo no sea usado por un largo periodo de tiempo.

17. Cuidado debe ser tomado de tal manera que objectos liquidos no sean derramados sobre la cubierta u orificios de ventilación.

18. Servicio por personal calificado deberá ser provisto cuando:

    A: El cable de poder o el contacto ha sido dañado; u

    B: Objectos han caído o líquido ha sido derramado dentro del aparato; o

    C: El aparato ha sido expuesto a la lluvia; o

    D: El aparato parece no operar normalmente o muestra un cambio en su desempeño; o

    E: El aparato ha sido tirado o su cubierta ha sido dañada.

TELECOMMUNICATION SAFETY STATEMENTS

Always observe standard safety precautions during installation, operation, and maintenance of this product. Only qualified and authorized service personnel should carry out adjustment, maintenance, or repairs to this instrument. No adjustment, maintenance, or repairs should be performed by either the operator or the user.

The safety status of each of these ports on the Data Voice Multiplexor is declared according to EN 41003 and is detailed in the table below:

Safety Status	**Ports**
SELV	DATA (RS-232/V.24, V.35)
TNV	VOICE (FXO and FXS)

SELV = Safety Extra-Low Voltage

TNV = Telecommunications Network

In order to ensure the safety of the operator, the DV-MUX3 must be connected to a reliable protective earth and the signal ground must be connected to the chassis ground at all times.

Additional conditions concerning safety:

- The FXO interface is suitable for direct connection to the PSTN, and does not rely on the protective earth for safety.
- The FXS interface is intended for connection of a telephone set or similar equipment and is not intended for a direct connection to the PSTN.

DECLARATION OF CONFORMITY (CE)

The manufacturer declares that the 230-VAC versions of the Data Voice Multiplexor conform to the following standards:

EMC:	EN 55022 (1994)	Limits and methods of measurement of radio-disturbance characteristics of information-technology equipment.
	EN 50082-1 (1992)	Electromagnetic compatibility: Generic immunity standards for residential, commercial, and light industry.
Safety:	EN 60950 (1992/93)	Safety of information-technology equipment, including electrical business equipment.

The product herewith complies with the requirements of the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC. The product was tested in a typical configuration.

CE

TRADEMARKS USED IN THIS MANUAL

Any trademarks mentioned in this manual are acknowledged to be the property of the trademark owners.

Contents

Chapter **Page**

1. Specifications

1.1 General (High-Level)

Compliance — FCC Part 15 Subpart B Class A, DOC Class/MDC classe A; 230-VAC models only: CE

Multiplexor Type — 3-channel adaptive

Multiplexing Method — Bit-interleaved time-division multiplexing

Management and Supervision Overhead — 0.8 kbps for main-link data rates from 9.6 to 32 kbps;
1.6 kbps for rates from 48 to 128 kbps
3.2 kbps for rates higher than 128 kbps

1.2 Main Link

Data Rate — 9.6 to 256 kbps, autodetected

Protocol — Synchronous

Clock Source — External

Interface — MX270, MX272, MX274, and MX276 models:
EIA/TIA RS-232, ITU-T V.24 serial, DTE;
MX271, MX273, MX275, and MX277 models:
ITU-T V.35 serial, DTE

Connector — DB15 female, adapter cable included:
RS-232 models: DB15 male to DB25 female;
V.35 models: DB15 male to M/34 female

1.3 Data Channels

Data Rate — 0.8 to 252.8 kbps, depending on mode and main-link data rates:
- ADAPTIVE mode:
  - Main-link rate minus voice-channel rate minus overhead if at least one voice channel is active;
  - Main-link rate minus overhead if both channels are idle;
- NON-ADAPTIVE 1 mode:
  - Main-link rate minus assigned voice-channel rate minus overhead;
- NON-ADAPTIVE 2 mode:
  - Assigned rate (sum of this and assigned voice-channel rate and overhead must not equal more than 256 kbps)

Protocol — Synchronous

Clock Source — Receive and transmit clocks derived from main-link clock

Interface — MX270, MX272, MX274, and MX276 models:
EIA/TIA RS-232, ITU-T V.24 serial, DCE;
MX271, MX273, MX275, and MX277 models:
ITU-T V.35 serial, DCE

Connector — DB15 female, adapter cable included:
RS-232 models: DB15 male to DB25 female;
V.35 models: DB15 male to M/34 female

1.4 Voice Channels

1.4.1 General

Number of Voice Channels — MX270 through MX273 models: Two; MX274 through MX277 models: One

Digitizing Technique and Voice-Transmission Rates— ITU-T Rec. G.723 compliant MPMLQ low-bit-rate digitizing at 4.8, 6.4, 7.2, 9.6, or 12.8 kbps

Fax Support and Fax Rates— In-band, at 2.4, 4.8, 7.2, or 9.6 kbps

End-to-End Processing Delay — 120 ms

Acceptable Bit-Error Ratio for Channel — 1×10^{-13} or better

Interface — MX270, MX271, MX274, and MX275 models: EIA/TIA-464 loop-start 2-wire Foreign Exchange Office (FXO);
MX272, MX273, MX276, and MX277 models: EIA/TIA-464 loop-start 2-wire Foreign Exchange Station (FXS);
See **Sections 1.4.5** and **1.4.6** for more details

Connector — RJ-45 (8-pin) female for each channel

1.4.2 Analog Characteristics (at 9.6 kbps)

Nominal Transmit Level — +2 to –13 dBm, independently adjustable for each channel in steps of 1 ±0.15 dB

Nominal Receive Level — Independently adjustable for each channel in steps of 1 ±0.15 dB:
FXO models: +2 to –13 dBm;
FXS models: +1 to –13 dBm

Frequency Response — Referenced to 1020 Hz:
300 to 3000 Hz at ±0.5 dB;
250 to 3400 Hz at ±1.1 dB

Signal-to-Distortion Ratio — At 9.6 kbps, using ITU-T Rec. G.712, G.713, method 2:
From 0 to –30 dBm0: Better than 33 dB;
From +3 to –45 dBm0: Better than 22 dB

Idle Channel Noise — Better than –70 dBm0

1.4.3 Adaptive Echo Canceler

Integral Module Echo-Path Length — 8 ms

Echo Return-Loss Enhancement (ERLE) — Greater than 30 dB

Convergence Speed — Better than ITU-T Rec. G.165

Dial-Pulse Distortion — ±4 ms maximum

1.4.4 Fax Characteristics

Standards — Supports Group III fax machines complying with ITU-T Rec. T.4 and T.30

Fax Data Rates/ Channel Bandwidth — All with auto-fallback:
2.4 kbps/4.8 kbps;
4.8 kbps/6.4 or 7.2 kbps;
7.2 kbps/9.6 kbps;
9.6 kbps/12.8 kbps

1.4.5 FXO Interface

DC Impedance — Off hook: 150 Ω at 150-mA feed, 330 Ω at 25-mA feed;
On hook: More than 1 MΩ

AC Input Impedance — Off hook: 600 Ω;
On hook: 20 kΩ at 20 Hz, 70 Vrms

Off-Hook Return Loss — Off hook: Better than 22 dB

On-Hook Ring-Detect Range — Greater than 20 Vrms at 17 to 25 Hz

Transformer Isolation — 3000 Vrms

1.4.6 FXS Interface

Nominal Impedance — 600 Ω

Return Loss (at 300 to 3400 Hz)— Better than 20 dB

Feed Current — 25 mA at 300-Ω loop resistance

Ringer — 40.5 to 49.5 Vrms, overload protected, 19.8 to 24.2 Hz, 1 second ON, 3 seconds OFF

1.5 General (Low-Level)

Configuration Transfer — Downloading from "master" unit to "slave" unit across main link

User Controls — Front-mounted:
(2) Pushbuttons for diagnostic testing;
(1) 3-position slide switch for channel selection;
Internal:
(4) Jumper blocks for various configuration options

Diagnostics — Remote loopback, BERT on the data channel, and tone injection on the voice channels

Indicators — (5) Front-mounted LEDs: PWR, TEST, SYNC LOSS, TD, and RD (ER)

Power — From utility-power (mains) outlet, through detachable 6-ft. (1.8-m) power cord and rear-mounted IEC 320 male power inlet, to internal transformer:
Models with "-A"-suffix product codes:
103.5 to 126.5 VAC, 47 to 63 Hz;
Models with "-AE"-suffix product codes:
207 to 253 VAC, 47 to 63 Hz;
Consumption: 15 VA (21 watts maximum)

Temperature Tolerance — 32 to 104˚F (0 to 40˚C)

Humidity Tolerance — Up to 90% noncondensing

Size — 1.7"H x 7.6"W x 9.4"D (4.4 x 19.3 x 24 cm)

Weight — 6 lb. (2.7 kg)

2. Introduction

2.1 Overview

2.1.1 Purpose and Main Features

The Data Voice Multiplexor (DVM) is a versatile adaptive time-division multiplexor (TDM) for voice, fax, and data. The DVM allows the multiplexing of one or two low-bit-rate voice/fax channels with one synchronous data channel, for transmission through a dialup or leased-line modem link operating at rates in the range of 9.6 through 256 kbps. Asynchronous data can also be transmitted by using asynchronous-to-synchronous converters, or by oversampling (for oversampling, the asynchronous data rate must not exceed ¼ of the synchronous channel rate).

The DVM maintains bandwidth efficiency by keeping multiplexing and link-supervision overhead very low. In addition, the DVM offers three user-selectable multiplexing modes that allow maximization of the bandwidth efficiency while taking into account the characteristics of the user equipment:

- Maximum bandwidth efficiency is achieved in the proprietary adaptive mode. In this mode, the DVM dynamically reassigns the link bandwidth normally used by the voice channels to the data channel when both voice channels are idle. In this mode, the data channel can serve statistical multiplexors, remote bridges, and other equipment that tolerates changes in the link data rate.

- The other two multiplexing modes, intended for use with equipment that is not capable of handling the varying clock rate of the adaptive mode, are standard (non-adaptive) modes that support predetermined channel data rates (see **Section 2.2**). The non-adaptive modes differ only in the supported data rates:

  - One non-adaptive mode supports the standard data rates (based on the "n x 75 bps" scheme). In this mode, the data channel can serve all types of data-terminal equipment.

  - The other non-adaptive mode provides the user with access to all the link bandwidth that is not used by the voice channel. In this mode, the data channel can serve data-terminal equipment capable of operation in accordance with the rate of the clock signals provided by the DVM, including operation at data rates thatare not necessarily based on the "n x 75 bps" scheme.

Thus, the DVM allows using a single modem link for the transmission of two voice/fax channels, and in addition allows the transmission of a data channel.

The DVM, especially when operating in its unique adaptive multiplexing mode, offers very high bandwidth efficiency without introducing the long, variable link delay typical of statistical multiplexors.

2.1.2 Voice/Fax-Channel Features

The Data Voice Multiplexor can be ordered with one or two voice/fax channels. To reduce bandwidth requirements and still achieve high quality voice transmission, the voice channels process the audio signals using a standard digitizing algorithm (MPMLQ—Multipulse Maximum-Likelihood Quantization—as per ITU-T Rec. G.723) and adaptive echo cancellation.

The bandwidth assigned for the transmission of a voice channel is user-selectable: 4.8, 6.4, 7.2, 9.6, or 12.8 kbps. This bandwidth includes in-band signaling and synchronization overhead. When operating at a digitized voice-data rate of 6.4, 7.2, 9.6, or 12.8 kbps, the end-to-end voice performance is nearly toll quality. To improve the perceived link quality, the DVM voice channel includes an adaptive echo canceler (echo delay less than 8 milliseconds) that handles near-end reflections such as those caused by the hybrids used for 2W/4W conversion. The echo canceler's convergence time is better than ITU-T Rec. G.165 requirements.

To maintain voice quality on bad communication links, when operating at 7.2, 9.6, or 12.8 kbps the DVM voice channels include Hamming forward-error-correction (FEC) coding that protects the critical information bits in the digitized voice data stream. The FEC code can maintain voice quality for link error rates down to 1×10^{-3} (one in a thousand).

Each channel supports fax transmission for Group III fax machines in accordance with ITU-T Rec. T.4 and T.30 at rates of 2.4, 4.8, 7.2, or 9.6 kbps (depending on the voice-channel rate). Each channel automatically identifies the type of signal (voice or fax) and switches accordingly between the voice and fax modes. Therefore, the user can follow regular faxing procedures.

Each voice channel has its own level-adjustment switches, to provide optimal selection of receive and transmit levels.

The voice channels are available in two options:

- 2W FXO interface: Two-wire 600-ohm analog interface and FXO loop-start signaling for direct connection to PABX extension lines.
- 2W FXS interface: Two-wire 600-ohm analog interface and FXS loop-start signaling for direct connection of a subscriber telephone set. The FXS interface generates the required line-feed current and ringing voltage locally.

The FXO and FXS options are usually operated in a link, with the FXO interface at the PABX side, and the FXS interface on the subscriber's side. In addition, two FXS interfaces can also be operated in a link, to provide PLAR (Private Line with Auto-Ring) telephone service.

2.1.3 Data-Channel Features

The Data Voice Multiplexor's data channel is a synchronous channel. The electrical interface of the data channel is user-selectable (X.21, V.35, V.36/RS-449, RS-530, or RS-232). The data channel is terminated with a DB15 female connector, wired for ITU-T X.21. When a different interface is selected, an appropriate adapter cable (available on a special-quote basis) must be inserted between the DVM and the cable connecting to the user's equipment.

The data channel can operate at rates of 0.8 to 252.8 kbps, depending on the selected mode and the main link's data rate. Note that when the RS-232 interface is selected, the maximum data rate is limited by the electrical characteristics of this interface, which usually cannot work above 64 kbps.

The data-channel interface is configured as a DCE; that is, it provides timing signals to the user's equipment—the receive and transmit timing is derived from the main link clock.

The data channel is transparent to users' data. The control lines generated by the data-channel interface are Carrier Detect (CD) and Clear to Send (CTS). For the RS-232 interface, the DSR line is also provided. Those lines are asserted when the DVM is operating normally (that is, when the configuration is valid, the DVM is synchronized, and the channel is not being tested). For interfaces other then RS-232, the CD line can be externally connected to the DSR line to enable operation of terminal equipment that needs DSR to tell that the other device is active, such as IBM equipment.

The channel interface does not include control lines for hardware flow control; therefore, when users' applications require flow control, the users' equipment must use software flow control.

2.1.4 Main-Link Characteristics

The electrical interface of the main link is user-selectable (X.21, V.35, V.36/RS-449, RS-530, or RS-232). The main link is terminated with a DB15 female connector, wired for ITU-T X.21.

When a different interface is selected, an appropriate adapter cable (available on a special-quote basis) must be inserted between the Data Voice Multiplexor and the cable connecting to the data-communication equipment (modem, CSU/DSU, etc.) serving the main link. Note that the main-link interface can be selected independently of the data-channel interface, so the DVM can work as an interface converter on the data channel.

The DVM can operate at main link rates of 9.6 to 256 kbps (or up to about 64 kbps, when the selected interface is RS-232). The interface is configured as a DTE; that is, it requires clock signals for both the receive and transmit paths from the equipment to which it is connected.

The following control lines are used on the main link interface:

- The RTS line, which is asserted as long as the DVM is powered.
- The DTR and RI lines, used only in the dialup mode.

The dialup mode allows the DVM to operate over the public switched telephone network (PSTN), using dialup modems to transmit the main link data over standard PSTN lines.

2.1.5 Dialup Mode

The dialup mode is available only when the main link interface is V.35 or RS-232. In this mode, the Data Voice Multiplexor asserts the DTR line of its main link interface when payload traffic (from the voice or data channels) must be transmitted. This causes the modem to dial a number preprogrammed by the user, and thus to set up a connection to the remote DVM. When the remote DVM senses the assertion of the RI line in its main link interface (indication of incoming call provided by the dialup modem), it synchronizes to the other DVM and starts normal data transfer. When payload traffic stops, the DVM switches its DTR line off, causing the modem to disconnect the link.

2.1.6 Bandwidth Allocation

Bandwidth allocation is based on the automatic identification of the main link's clock rate. After successful identification of the main link rate, the Data Voice Multiplexor assigns the bandwidth required by the voice channels (as selected by the user), and uses the remaining main-link bandwidth, except for the link-management and link-supervision overhead, to transmit the data channel. The overhead is 0.8 kbps for main-link data rates of 9.6 to 32 kbps, 1.6 kbps for data rates of 48 to 128 kbps, and 3.2 kbps for data rates higher than 128 kbps.

To maximize the throughput of the data channel beyond what is available with standard multiplexors, the DVM has three user-selectable bandwidth-allocation modes:

- **Adaptive mode:** The DVM monitors the use of the voice channels and assigns the required bandwidth on demand. When both voice channels are idle, their bandwidth is temporarily reassigned to the data channel. These changes are smoothly made without disrupting in any way the flow of traffic.

  The state of the voice channels is determined by the channel-control signal transmitted end-to-end:

  - For a voice channel equipped with an FXO interface, the channel-control signal generated by the channel indicates the reception of ringing by that channel. The control signal received by that channel indicates the detection of a subscriber off-hook condition by the FXS interface of the voice channel located at the other end of the link (off-hook includes pulse dialing).

  - For a voice channel equipped with an FXS interface, the channel-control signal generated by that channel indicates the detection of an off-hook condition (including pulse dialing). The control signal received by that channel indicates either the reception of ringing by the FXO interface of the voice channel located at the other end of the link (when the other end is equipped with an FXO interface), or the detection of a subscriber off-hook condition (when the other end is also equipped with an FXS interface).

  When the channel-control signal at either end of the link is switched to the active state, the DVM immediately assigns the required bandwidth to the voice channels, and reduces the clock rate supplied to the data channel. Note that the DVM always assigns the full bandwidth needed by voice channels. Therefore, when both channels are enabled on DVM models equipped with two voice channels, the DVM assigns bandwidth for two channels even if only one channel is active.

- **Non-adaptive mode 1:** The bandwidth required for the voice channels (as selected by the user) is permanently assigned to these channels. The remaining bandwidth, minus the management and synchronization overhead, is available to the data channel. This mode is mainly intended to allow the connection of equipment that is capable of operating at non-standard data rates but cannot tolerate the clock-rate changes that occur routinely in the adaptive mode. Such equipment can then use the highest available data rate, and thus achieve the highest possible bandwidth efficiency.

- **Non-adaptive mode 2:** In this mode, the DVM operates as a standard TDM multiplexor, i.e., the bandwidth required for the voice channels is permanently assigned to these channels, and the data channel data rate is a standard data rate (see Table 1-2) that can be transmitted within the remaining main-link bandwidth. This mode reduces the bandwidth efficiency a bit, but allows you to connect data equipment designed for standard data rates to the DVM's data channel.

2.1.7 Other Features

All the Data Voice Multiplexor's operating parameters can be selected by the user, by means of internal jumpers and switches.

To minimize setup time and to prevent configuration errors, the DVM has a master-slave configuration downloading facility. When this facility is used, all the critical configuration parameters selected on the DVM defined as the master unit are downloaded through the main link to the slave DVM. Configuration downloading is automatically performed when a link is established between two DVM units. This arrangement ensures the two units will always use consistent configurations.

The DVM has comprehensive diagnostic capabilities, which include:

- Power-up self-test.
- Internal BERT (bit-error-rate testing) facility, which allows rapid evaluation of transmission quality without requiring external test equipment.
- Tone injection, which allows evaluation of voice-channel quality.
- Remote test loops activated by a front-panel switch.
- Front-panel indicators, which show main-link synchronization status, transmit and receive activity on any desired channel, and activation of a test loop. In addition, the front-panel indicators also indicate failures in the power-up self-test, configuration errors, and fault conditions related to the main-link clock signals.

The DVM can be ordered for either 115- or 230-VAC operation and has very low power consumption. It is built into a compact case that can be placed on desktops or shelves. An optional rackmount-adapter kit (our product code RM523) allows the installation of one or two units side by side in a 19" rack. Unit height is only lU (1.75 in., 4.4 cm).

2.2 A Typical Application

Figure 1-1 below shows a typical application for a DVM. This application shows how an organization can use the DVM to connect privileged telephone subscribers located in another city—at a main branch office, for example—to the PABX serving the head offices. This arrangement allows those remote subscribers to use all the features, speed, and convenience available to local subscribers of the main-office PABX without the expense of leasing a dedicated voice line or allocating a full data channel for this purpose.

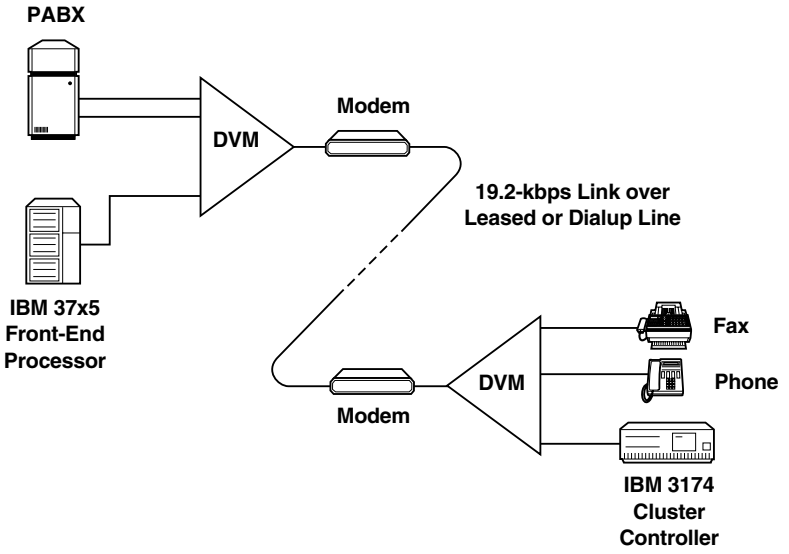

Figure 2-1. Typical DVM application in an SNA link.

In this example, the connection is made by sharing an already existing SNA link, based on 19.2-kbps modems operating over a telephone line. This link is being used to connect the IBM® 3174 Cluster Controller located at the branch office to an IBM 37x5 Front End Processor located at the main offices.

The DVMs are inserted between the IBM devices and the corresponding modems:

- The IBM 3174 and IBM 37x5 are connected to the data channels of the two DVM units.
- One local subscriber line of the PABX located at the main offices is connected to the first voice channel of the DVM. This voice channel uses an FXO interface.
- The second voice channel of the DVM is used for PLAR service, and is connected directly to the subscriber's telephone set. This voice channel uses an FXS interface.
- At the branch office, the two local subscriber sets are connected to the two voice channels of the DVM. These voice channels use the FXS interface.

The first voice channel (connected at the main office to a subscriber line of the PBX) is used for voice/fax transmission.

After the DVM equipment is added, the data rate available to the SNA link depends on the main link rate and the selected voice bandwidth. In this example, the main link rate is 19.2 kbps; assuming the voice channels operate at 6.4 kbps, the guaranteed bandwidth available to the SNA link decreases to 5.6 kbps (faster modems—for example, 28.8 kbps modems—would of course increase the guaranteed bandwidth).

However, the main advantage of using the DVM in this application is the availability of an adaptive mode: By using the DVM's adaptive mode, the decrease in the bandwidth would occur only when a voice channel is actually in use—in other words, when someone makes a call. When the voice lines are idle, the bandwidth available to the SNA link is 18.4 kbps.

NOTE

IBM communication equipment uses the DSR line as an indication of channel activity. For such applications, an appropriately wired cable must be used to connect the DSR line to the DCD line of the DVM's data-channel connector.

Note that the DSR line is supported only for the RS-232 interface.

The adaptive mode of the DVM also can be used when the available main-link bandwidth is shared with statistical multiplexors, or with any other type of equipment that can run at the rate of the clock signals supplied to it. This issue is further explained in **Section 2.5**.

2.3 Dialup-Mode Guidelines

The dialup mode allows the use of a switched PSTN line to connect between two Data Voice Multiplexor units, thereby reducing the operating cost as the line is used only on demand.

The dialup mode requires the use of the master-slave configuration. For proper operation, the DVM installed at the central location must be defined as the master, and the other DVM must be defined as the slave.

2.3.1 Conditions for Activation/Deactivation of a Voice Channel

The DVM interprets the following conditions as a request from a voice channel for the connection of the link to the remote DVM:

- **For a voice channel with FXS interface:** The detection of an off-hook condition at the voice-channel interface.
- **For a voice channel with FXO interface:** The detection of incoming ringing at the voice-channel interface.

The indication that a voice channel no longer needs the link to the remote DVM is derived in the following ways:

- **For a voice channel with FXS interface:** The detection of switching from the off-hook to the on-hook condition. This is the normal way the communication on the voice channel is ended.
- **For a voice channel with FXO interface:** The stopping of the incoming ringing, but only if the remote subscriber did not go off-hook in response to the ringing. Note that if the remote subscriber has been off-hook, the ending of communication is controlled only by the remote subscriber.

2.3.2 Conditions for Activation/Deactivation of a Data Channel

The indication that the user's terminal is active is derived from the state of the DTR line in the data-channel interface (the terminal is assumed to be active when its DTR line is ON).

2.3.3 Conditions for Activation of the Main Link

A DVM will activate the main link to the other DVM upon the detection of the first valid request for connection. The link will remain connected as long as at least one valid request is present.

- Valid connection requests originating from a voice channel can be made by either the master or the slave DVM, because the DVM's dialup mode is designed to operate symmetrically with respect to voice channels.
  This symmetry reflects the way voice channels are used (either side can initiate a call to the other side).

- Valid connection requests originating from the data channel can be made only by the slave DVM, because the DVM's dialup mode is designed to operate asymmetrically with respect to the data channel. This means that a request for connecting the link to the other DVM can be made only by the slave DVM.
  This asymmetry reflects the way data systems operate: the equipment at the master-DVM end (bridge, front-end processor, etc.) is assumed to operate continuously, so that it is always ready to accept the connection to the remote equipment (i.e., the equipment at the slave-DVM end), but there is no point to maintain the connection when the remote equipment has nothing to send. This approach is particularly well suited to applications like the one shown in Figure 2-1, which are clearly asymmetrical. In the application shown in Figure 2-1, the DVM connected to the IBM 37x5 must be configured as the master.

2.3.4 Conditions for Disconnection of the Main Link

The disconnection of the main link can be initiated only by the slave DVM. The disconnection is performed after both voice channels (on both DVM units) are inactive and the DTR line in the slave data channel interface is OFF continuously for a period of 25 seconds.

The disconnection may also be initiated if the synchronization is lost for two seconds. This operation can also be performed by the master DVM.

2.3.5 Dialup Modem Settings

Before starting the operation, the dialup modems serving the main link must be configured as follows:

- Synchronous operation.
- Modem clock source:
  - Modem connected to the master DVM: Internal clock.
  - Modem connected to the slave DVM: Loopback timing (that is, its transmit timing must be locked to the recovered receive clock).
- Error-correction and compression functions disabled.
- DTR dialing-mode operation (DTR option 108.1).
- Program the directory number to be dialed by each modem.
- Configure each modem for switching to the originate mode upon assertion of the DTR line, and for switching to the answer mode upon detection of active RI line (that is, a modem must dial the preprogrammed number when the DTR line is asserted; if the DTR line is not asserted, the modem must answer automatically when the RI line is asserted).
- The disconnection time following the deassertion of the DTR line must be set to 50 msec.

NOTE

Correct clock-source selection is essential for proper operation of the DVM. If the timing is not correctly selected, the DVM may periodically lose synchronization.

2.3.6 Control Over the Main-Link Modems

The control of the dialup modems serving the main link is made by means of the DTR line of the DVM's main link interface. Assuming that the modems were configured as explained in **Section 2.3.1.E**, the sequence for setting up and for disconnecting the link between two DVM units is as follows:

- The link is in the disconnected state when no user traffic is present. Both DVM units monitor the state of the RI line on their main link interface.
- When a voice channel at either the master or the slave DVM is activated (see previous section), or the DTR line on the data-channel interface of the slave DVM is asserted, the corresponding DVM asserts the DTR line on its main link interface. This causes the modem to dial the number preprogrammed by the user.
- When the remote DVM senses the assertion of the RI line in its main link interface (indication of incoming call provided by the dialup modem), it asserts the DTR and RTS lines in its main link interface, and tries to synchronize to the other DVM.
- In case the DVM does not synchronize within 40 seconds, it switches the DTR line OFF. If a request for connection is still present, the DVM returns the DTR line to ON after 100 ms. This interval is sufficient for the modem to disconnect, and then to start a new dialing attempt.
- When the two DVMs synchronize, they assert the CD and CTS lines on their data-channel interfaces.
- Normally, the disconnection of the link is initiated by the slave DVM, after 25 seconds during which both voice channels are inactive and the DTR line of the slave's data channel interface is OFF continuously. To disconnect, the slave DVM switches the DTR line on its main link interface OFF. This causes the slave modem to go on-hook.

  If the master DVM senses a loss-of-synchronization condition for two seconds, the master DVM switches the DTR line on its main link interface OFF. This causes the master-end modem to go on-hook.

2.4 System-Bandwidth Utilization

Tables 1-1 and 1-2 below and on the next page list the bandwidth available to the DVM data channel as a function of the number and digitizing rate of the voice channels:

- Table 1-1 provides the data-channel bandwidths for the adaptive and non-adaptive 1 modes. Under Idle Voice Channels, you will find the bandwidth available, in the adaptive mode, for the data channel when both voice channels are idle.
- Table 1-2 provides the bandwidths for the non-adaptive 2 mode (this mode is intended for equipment limited to operation at standard data rates).

Table 2-1. Data-Channel Bandwidth in Kilobits per Second as a Function of Voice-Channel and Main-Link Rates for Adaptive Mode and Non-Adaptive Mode 1

Main-Link Data Rate	Data-Channel Bandwidth (kbps) vs. Voice-Channel Digitizing Rate (kbps)										Idle Voice Channels (Adaptive Mode Only)
	One Voice Channel					Two Voice Channels					
	4.8	6.4	7.2	9.6	12.8	4.8	6.4	7.2	9.6	12.8	
9.6	4	2.4	1.6	—	—	—	—	—	—	—	8.8
12	6.4*	4.8	4	1.6	—	1.6	—	—	—	—	11.2
14.4	8.8	7.2*	6.4	4	0.8	4	0.8	—	—	—	13.6
16.8	11.2	9.6*	8.8	6.4	3.2	6.4	3.2	1.6	—	—	16
19.2	13.6	12	11.2	8.8	5.6	8.8	5.6	4	—	—	18.4
21.6	16	14.4*	13.6	11.2	8	11.2	8	6.4	1.6	—	20.8
24	18.4	16.8	16	13.6	10.4	13.6	10.4	8.8	4	—	23.2
26.4	20.8	19.2*	18.4	16*	12.8	16*	12.8	11.2	6.4	—	25.6*
28.8	23.2	21.6	20.8	18.4	15.2	18.4	15.2	13.6	8.8	2.4	28
32	26.4	24.8	24	21.6	18.4	21.6	18.4	16.8	12	5.6	31.2
38.4	32.8	31.2	30.4	28	24.8	28	24.8	23.2	18.4	12	37.6
48	41.6	40	39.2	36.8	33.6	36.8	33.6	32	27.2	20.8	46.4
56	49.6	48*	47.2	44.8	41.6	44.8	41.6	40	35.2	28.8	54.4
64	57.6	56*	55.2	52.8	49.6	52.8	49.6	48*	43.2	36.8	62.4
112	105.6	104	103.2	100.8	97.6	100.8	97.6	96*	91.2	84.8	110.4
128	121.6	120	119.2	116.8	113.6	116.8	113.6	112*	107.2	100.8	126.4
192	184	182.4	—	179.2	176	179.2	176	174.4	169.6	163.2	188.8
256	248	246.4	—	243.2	240	243.2	240	238.4	233.6	227.2	252.8

* In the non-adaptive 1 mode, these configurations yield standard data rates on the data channel, that can be used in addition to the data rates available in the non-adaptive 2 mode.

Table 2-2. Data-Channel Bandwidth in Kilobits per Second as a Function of Voice-Channel and Main-Link Rates for Non-Adaptive Mode 2

Main-Link	Data-Channel Bandwidth (kbps) vs. Voice-Channel Digitizing Rate (kbps)									
Data Rate	One Voice Channel					Two Voice Channels				
	4.8	6.4	7.2	9.6	12.8	4.8	6.4	7.2	9.6	12.8
9.6	3.6	2.4	1.2	—	—	—	—	—	—	—
12	2.4	4.8	3.6	1.2	—	1.2	—	—	—	—
14.4	7.2	3.6	1.2	2.4	—	2.4	—	—	—	—
16.8	9.6	3.6	2.4	4.8	2.4	4.8	2.4	1.2	—	—
19.2	9.6	4.8	2.4	7.2	4.8	7.2	4.8	3.6	—	—
21.6	14.4	4.8	2.4	9.6	7.2	9.6	7.2	3.6	1.2	—
24	14.4	7.2	4.8	9.6	9.6	9.6	9.6	1.2	2.4	—
26.4	19.2	9.6	7.2	14.4	9.6	14.4	9.6	4.8	4.8	—
28.8	19.2	9.6	7.2	14.4	14.4	14.4	14.4	4.8	7.2	2.4
32	19.2	7.2	9.6	19.2	7.2	19.2	7.2	4.8	9.6	4.8
38.4	19.2	7.2	9.6	19.2	7.2	19.2	7.2	4.8	9.6	4.8
48	38.4	14.4	28.8	19.2	28.8	19.2	28.8	9.6	19.2	19.2
56	38.4	28.8	19.2	38.4	28.8	38.4	28.8	14.4	19.2	19.2
64	38.4	28.8	38.4	19.2	28.8	19.2	28.8	38.4	19.2	19.2
112	96	38.4	72	56	38.4	56	38.4	72	56	56
128	112	38.4	112	56	38.4	56	38.4	72	56	56
192	128	64	—	128	64	128	64	56	112	112
256	192	64	—	128	64	128	64	112	128	128

2.5 System-Timing Considerations

This section explains the timing modes and clock rates available for the main link of the DVM, and for its data and voice channels.

2.5.1 Main-Link Timing

The main link transmit and receive paths of the DVM require external receive and transmit clock signals derived from the network clock. The transmit and receive clock must be derived from the same source. The DVM will however tolerate phase difference and jitter between the two clocks. Therefore, when the two DVM units are connected through a modem link, one of the modems must be configured for operation with its internal clock, and the other must use loopback timing (operation on the recovered receive clock).

The main link clock signals always determine the DVM receive and transmit timing. Thus, the DVM always distributes downward the system timing.

The main link rate (any standard rate in the range of 9.6 to 256 kbps) is automatically identified by actually measuring the clock frequency. The DVM will provide an alarm indication if the measured frequency is not close enough to one of the supported main-link rates.

2.5.2 Data-Channel Timing

The data channel supplies receive and transmit clock signals derived from the link clock to the attached equipment, and expects the user equipment to accept and generate data in accordance with these signals.

NOTE

When using the DVM in adaptive mode, it is strongly recommended to operate the equipment connected to the data channel with independent transmit and receive clock signals. This prevents the possibility of short error bursts occurring when dynamic bandwidth reallocation is performed.

When it is not possible to use independent transmit and receive clock signals, and the occurrence of error bursts is undesirable, it is recommended to use the non-adaptive mode.

2.5.3 Voice-Channel Timing

The voice channel digitizing rate (4.8, 6.4, 7.2, 9.6, or 12.8 kbps) is always locked to the main link receive clock.

3. Installation

The Data Voice Multiplexor is delivered completely assembled. It is designed for installation as a standalone desktop unit or for mounting in a 19" rack. (Rackmounting the DVM requires special-order rackmount kits; see **Appendix B**.)

This chapter contains general configuration and installation procedures.

After installing the unit, refer to **Chapter 4** for operating instructions.

If you have any problems, refer to **Chapter 5** for test and diagnostics instructions.

WARNING!

No repairs should be performed by either the operator or the user; such activities should be performed only by a skilled technician who is aware of the hazards involved. Always observe standard safety precautions during installation, operation, and maintenance of this product.

3.1 Unpacking the DVM

Carefully take the Data Voice Multiplexor and all its accessories out of the box and place them securely on a clean surface. Inspect everything: You should have received the DVM itself, a power cord, two interface-adapter cords, and this manual. If anything's missing or damaged, call Black Box right away.

3.2 Site Requirements

3.2.1 Power*power;requirements

Data Voice Multiplexor units should be installed within 1.5 m (5 feet) of an easily accessible grounded AC mains outlet capable of furnishing the nominal supply voltage of the DVM (either 115 or 230 VAC). The supply voltage is marked on a label located on the rear panel, near the power connector.

The DVM does not include a power switch, and will start operating as soon as its power cable is connected to power. Therefore, a circuit breaker located at a convenient location, that will also serve as an on/off switch, must be included in the circuit used to provide power to the DVM.

3.2.2 Cable Connections

The DVM has two DB15 female connectors (one connector for the data channel, and the other connector for the main link) and two RJ-45 connectors for the two voice channels. Adapter cables are included for RS-232 or V.35 interface conversion. **Appendix A** provides connector pinouts and wiring data for these adapter cables.

3.2.3 Front- and Rear-Panel Clearance

When the Data Voice Multiplexor is installed in a 19" rack, allow at least 90 cm (36 inches) of frontal clearance for operator access. Always allow at least 10 cm (4 inches) clearance at the rear of the unit for interface-cable connections.

3.2.4 Ambient Requirements

The ambient operating temperature of the Data Voice Multiplexor should be 0 to 45˚C (32 to 104˚F), at a relative humidity of up to 90% noncondensing.

Do not stack DVM units, because this will obstruct the free flow of cooling air around the units.

3.3 Configuration

The Data Voice Multiplexor contains several printed circuit boards, identified in Figure 3-1:

- **Main board.** This board contains most of the DVM circuits.
- **Voice-channels module.** In accordance with your order, this module can include one or two voice channels.
- **Voice channel interface modules.** Two types of voice channel interface boards are available:
  - DVM-FXO for FXO interface.
  - DVM-FXS for FXS interface.

  Figure 2-1 shows two interface modules installed on the voice channels module. One interface module is required for each voice channel. The appropriate module is factory-installed in accordance with your order.

Prior to DVM installation, the internal jumpers and switches located on these boards must be set in accordance with your requirements, as explained below. This section provides information on the functions of the internal jumpers and switches located on each board, and provides step-by-step instructions for making the internal settings.

WARNING! ELECTRICAL SHOCK HAZARD!

We strongly recommend that only qualified and authorized service personnel be permitted to access the inside of the DVM.

Disconnect the unit from all the cables and from the power line before removing the power cord.

Line voltage is present inside the DVM when it is connected to power. Moreover, external fault conditions may cause dangerous high voltages to appear on the voice-channel cables connected to the DVM. Observe all the applicable safety precautions, and in particular always disconnect all the cables connected to the DVM, and then disconnect the input power from the DVM, before disconnecting the DVM power cord from the enclosure.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved. Capacitors inside the instrument may still be charged even after the instrument has been disconnected from its source of supply.

CAUTION!

The DVM contains components sensitive to electrostatic discharge (ESD). To prevent ESD damage, avoid touching the internal components, and before moving jumpers, touch the DVM frame.

3.3.1 Opening the DVM's Case

The Data Voice Multiplexor's jumpers are located on its boards, which are attached to the rear panel. To reach the internal jumpers:

1. Disconnect all the cables connected to the DVM.
2. Unscrew the two large captive screws located on the rear panel.
3. Carefully pull the rear panel out. The internal boards will slide out together with the panel. The DVM has several tall components which barely clear the top cover; make sure you do not damage these components.

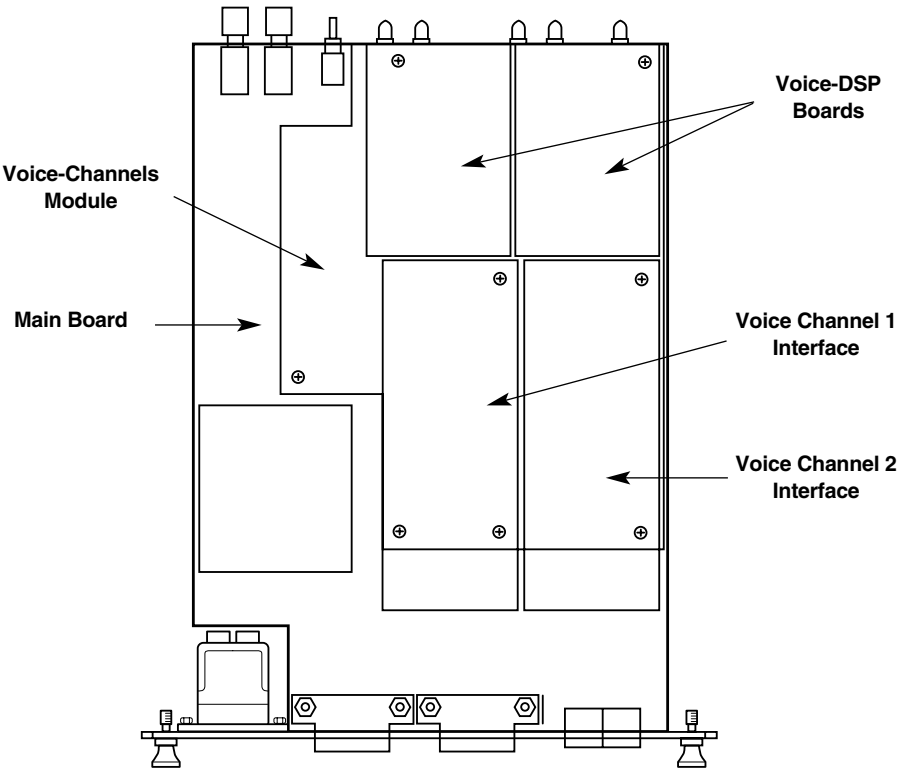

Figure 3-1. Identification of the DVM's internal modules.

3.3.2 The Main-Board Jumpers

The user-selectable jumpers located on the main board of the Data Voice Multiplexor are identified in Figure 3-2.

In addition to the jumpers identified in Figure 3-2, there are other factory-set jumpers on the main board which must not be moved.

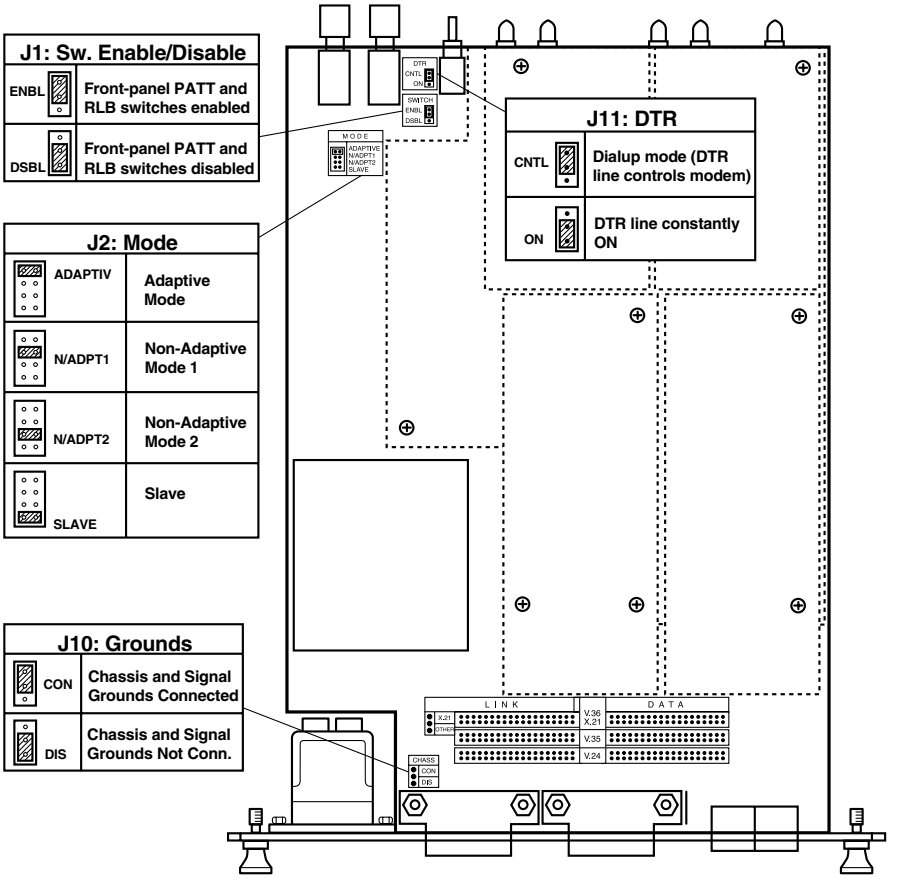

Figure 3-2. Identification of the DVM's main-board jumpers.

3.3.2.A Switch-Control Jumper J1

This jumper allows you to disable the front-panel PATT and RLB pushbuttons, to prevent the activation of tests and loops by unauthorized persons. It has two positions:

ENBL (default setting): The front-panel pushbuttons can control the activation of tests and loops.

DSBL: The front-panel pushbuttons are disabled and do not have any effect.

3.3.2.B Mode-Selection Jumper J2

This jumper selects the Data Voice Multiplexor's bandwidth-allocation mode and its configuration mode. The jumper has four positions:

ADAPTIV (default setting): The DVM operates as a master, and uses the adaptive bandwidth-allocation mode. In this mode, the DVM detects the main-link data rate, allocates the bandwidth configured for voice channels, and assigns the remaining bandwidth (minus the link-management overhead) to the data channel. In addition, when the voice channel is idle, the DVM automatically reallocates its bandwidth to the data channel. The ADAPTIV mode ensures that the main link bandwidth is always fully utilized; however, not all types of user equipment can support the dynamic changes in clock rate that occur in this mode. See Table 1-1 for the available data rates.

N/ADPT1: The DVM operates as a master, and uses the non-adaptive 1 allocation mode. In this mode, the DVM determines the data rate of the data channel as in the adaptive mode, except that the bandwidth required by the voice channel is permanently allocated. This mode achieves the best utilization of the main link bandwidth when the data channel's data rate cannot be dynamically changed. See Table 1-1 on for the available data rates.

N/ADPT2: The DVM operates as a master, and uses the non-adaptive 2 allocation mode. In this mode, the DVM allocates the data channel the highest standard data rate that fits within the bandwidth left after allowing for the voice channel and link-management and supervision overhead. See Table 1-2 on for the available data rates.

SLAVE: The DVM operates as a slave unit. That is, its configuration is determined by the information downloaded through the main link by the remote unit.

The use of a master-slave configuration expedites link setup and reduces the chance of configuration errors; therefore, whenever feasible, set the MODE jumper of one of the DVM units operating in a link to the SLAVE position.

NOTE

In a master-slave configuration, the allocation mode set on the DVM unit selected as master is downloaded to the slave unit, and overrides the local slave setting. The master-slave configuration is mandatory for the dial-up mode.

CAUTION!

Do not set both DVMs in a link to the SLAVE setting; they will not work. If you accidentally do so, a configuration-error indication (TEST indicator flashing, SYNC LOSS indicator off) will be displayed after the DVM units synchronize.

3.3.2.C Grounding-Selection Jumper J10

This jumper controls the connection between the signal-ground lines and the chassis-ground line. The appropriate position must be determined by the installation manager. The jumper has two positions:

CON (default setting): Signal ground is connected to chassis ground.

DIS: Signal ground is disconnected from chassis ground.

3.3.2.D DTR Jumper J11

This jumper is used to enable the dialup mode. The dialup mode can be enabled only when the DVM main link interface uses the RS-232 interface. For other interfaces, the dialup mode is not available, irrespective of the setting of this jumper. The jumper has two positions:

CNTL: When the RS-232 interface is selected, the dialup mode is enabled. In this case, the DVM controls the state of the DTR line in the main link interface as explained in **Section 2.2**.

ON (default setting): The dialup mode is disabled, and the DTR line in the main link interface is ON as long as the DVM is powered.

3.3.3 The Controls on the Voice-Channels Module

The user controls located on the Data Voice Multiplexor's voice-channels module are identified in Figure 3-3.

NOTE

In a master-slave configuration, the digitizing rate and the number of voice channels selected on the voice-channels module of the DVM unit selected as master are downloaded to the slave unit.

3.3.3.A Digitizing-Rate Switch SW6

This DIP switch selects the voice channels' digitizing rate. The switch has three active positions, designated S1, S2, and S3. Table 3-1 lists the digitizing-rate selection (0 = OFF, 1 = ON).

Table 3-1. Digitizing-Rate Selection

SW6 Position			Digitizing Rate
SW1	SW2	SW3	
0	0	0	4.8 kbps
1	0	0	6.4 kbps (default setting)
0	1	0	7.2 kbps
0	0	1	9.6 kbps
0	1	1	12.8 kbps

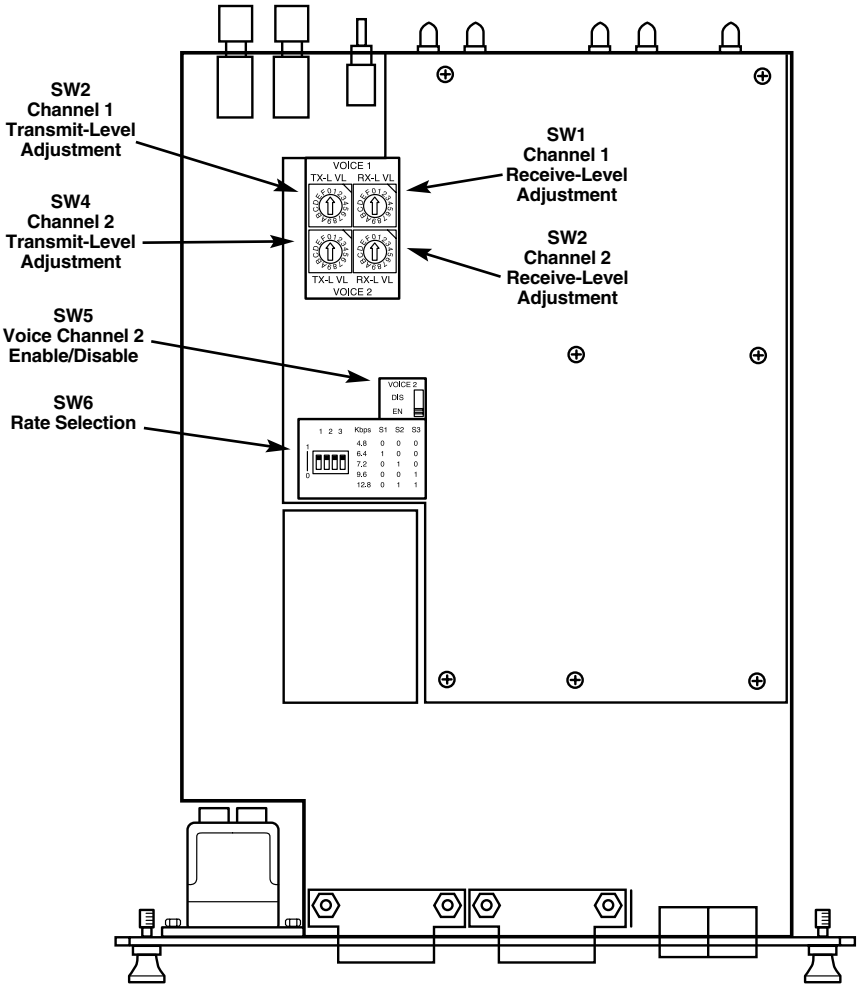

Figure 3-3. Controls on the Voice-Channels Module

3.3.3.B VOICE2-Enable/Disable Switch SW5

On Data Voice Multiplexor units equipped with two voice channels, this switch allows the user to disable voice channel 2. By disabling voice channel 2, the bandwidth available to the data channel is increased. The switch has two positions:

DIS: Voice channel 2 is disabled.

EN (the default setting): Voice channel 2 is enabled.

3.3.3.C Level-Adjustment Dials SW1 through SW4

These dials are used to select the nominal input and output levels of the Data Voice Multiplexor's voice channels:

SW1 selects the nominal output level of voice channel 1's receive path.

SW2 selects the nominal input level of voice channel 1's transmit path.

SW3 selects the nominal output level of voice channel 2's receive path.

SW4 selects the nominal input level of voice channel 2's transmit path.

NOTE

The application of an input signal atthe nominal transmit level results in a 0 dBm0 digital level, that yields a far-end output signal level equal to the far-end nominal receive level. Figure 3-4 explains how to determine the required levels.

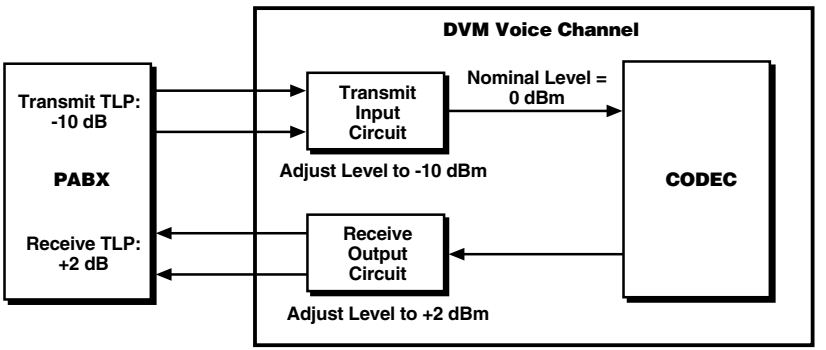

Figure 3-4. Selection of transmit and receive levels.

The input and output levels can be set in 1-dB steps in the range of +2 dBm to –13 dBm, as shown in Table 3-2. In addition, a reference table is attached to the top of the DVM's power transformer.

Table 3-2. Voice-Channel Level Adjustment

Level (dBm)	Switch Position
+2	E
+1	F
0	0
–1	1
–2	2
–3	3
–4	4
–5	5
–6	6
–7	7
–8	8
–9	9
–10	A
–11	B
–12	C
–13	D

For both the FXO and FXS interfaces, 0 dBm is the default setting.

NOTE

For the FXO interface, the maximum level is +1 dBm, so position E should not be selected in an FXO-model unit.

3.3.4 When You're Finished

After completing the internal settings, reinstall the Data Voice Multiplexor as follows:

1. Insert the front side of the DVM board into both card guides (grooves) on the internal side of the case walls, and then carefully slide the board in. Be careful to prevent damage to the tall components. If resistance is felt before the rear panel touches the case, pull the board out and then repeat the procedure.

2. Fasten the rear panel by fully screwing in the two large rear-panel screws.

3.4 Making Cable Connections

Figure 2-7 below shows the Data Voice Multiplexor's rear panel. The DVM has two DB15 female connectors located on the rear panel, one for connection to the main link, and the other for the data channel. In addition, the DVM's rear panel includes two RJ-45 connectors for the two voice channels.

Appendix A lists the pinouts for these connectors, and provides information on the adapter cables available for each connector.

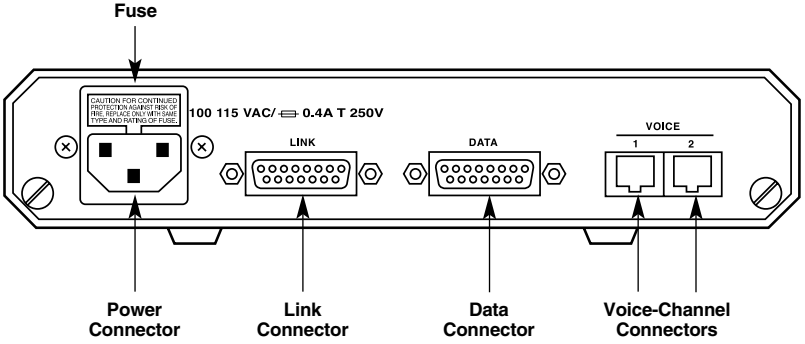

Figure 3-7. The rear panel of the Data Voice Multiplexor.

3.4.1 Grounding

For your protection, the DVM must always be grounded. Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal can make this instrument dangerous. Intentional interruption is prohibited.

3.4.2 Power Connections

The Data Voice Multiplexor does not have an on/off switch, so it will start operating as soon as power is connected.

WARNING!

BEFORE POWERING UP this instrument and before connecting any other cable, the protective earth terminals of this instrument must be connected to the protective conductor of the power cord. The power plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective acfion must not be negated by use of an extension cord (power cable) without a protective conductor (grounding).

Make sure that only fuses with the required rated current are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

Whenever it is likely that the protection offered by fuses has been impaired, the instrument must be made inoperative and be secured against any unintended operahon.

CAUTION!

The DVM is available in models that differ in the rated supply voltage (115 VAC or 230 VAC). Before first-time installation, check that the DVM's nominal supply voltage, marked on a label on its rear panel, matches the nominal voltage available at your mains outlet.

AC power should be supplied to the DVM through the standard power cable for your region, terminated by a standard 3-prong plug. Run the cable from the AC-power connector on the DVM's rear panel to a standard grounded AC outlet that provides a nominal voltage equal to the DVM's nominal supply voltage.

3.4.3 The Main Link Connection

The Data Voice Multiplexor's main link interface is configured as a DTE interface, intended for connection to a synchronous modem that is capable of providing the clock signals that determine DVM main link data rate.

The main link connector is a DB15 female connector, wired as ITU-T X.2 1. When a different interface is selected by means of the internal jumpers, an interface conversion adapter cable must be inserted between the DVM main link connector and the cable connecting to the main link modem. The following adapter cables are included with your DVM:

V.35	Use V.35 adapter cable, terrninated in a 34-pin female connector.
V.24/RS-232	Use V.24 adapter cable, terrninated in a DB25 female connector.

3.4.4 Data Channel Connections

The Data Voice Multiplexor's data-channel interface is configured as a data-communication equipment (DCE) interface, thereby allowing direct connection to data-terminal equipment (DTE).

The data-channel connector is a DB15 female connector, wired as ITU-T X.21.

When a different interface is selected by means of the internal jumper, an interface conversion adapter cable must be inserted between the DVM and the cable connecting the user's equipment. The required adapter cables are the same cables listed in **Section 3.4.3** for the main link connector.

3.4.5 Voice-Channel Connections

Each voice-channel connector is terminated in an 8-pin RJ-45 connector.

4. Operation

4.1 The Front-Panel Indicators and Controls

Figure 3-1 shows the front panel of the Data Voice Multiplexor. The numbered components are identified in Table 3-1.

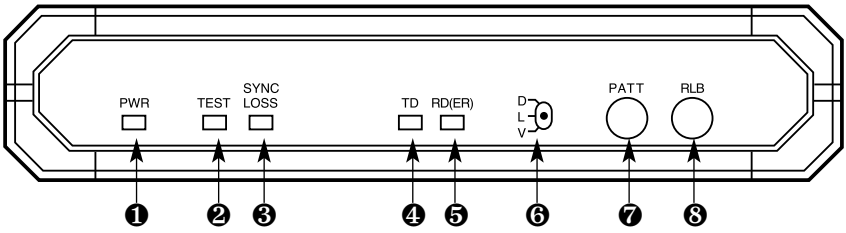

Figure 3-1. The DVM's front panel.

Table 3-1. The DVM's Controls and Indicators

Item	Control or Indicator	Function
1	PWR LED	Lights when the DVM is powered ON.
2	TEST LED	Lights steadily when a BERT test, tone injection, or a remote loop is active on the DVM. Flashes (0.5 second on/0.5 second off) when a configuration error occurs.
3	SYNC LOSS LED	Lights when the DVM is not frame-synchronized.
4	TD LED	Lights to indicate the presence of data on the transmit pair of the channel selected by means of the SELECT switch (item 6).
5	RD/ER LED	During normal operation, lights steadily to indicate the presence of data on the receive pair of the channel selected by means of the SELECT switch (item 6). During BERT testing, lights when errors are detected.
6	SELECT switch	Selects a channel for testing (by means of the PATT and RLB pushbuttons, items 7 and 8) and for monitoring (by the TD and RD indicators, items 4 and 5): **D** = Data channel **L** = Main link **V** = Voice channel
7	PATT pushbutton	Activates the transmission of a 511-bit pseudo-random test sequence on the data channel, and the detection of errors in the received sequence (BERT testing), or the tone injection (1000 Hz, 0 dBm0) on the voice channel(s). This function can be disabled by the internal J1 jumper.
8	RLB pushbutton	Controls the activation of a remote loop on the channel selected by the SELECT switch (item 6). This function can be disabled by the internal J1 jumper.

4.1.1 Special Diagnostic Indications

In addition to the basic indications listed in Table 3-1, additional fault conditions can be indicated. The indications used for these conditions are combinations of display states based on simultaneous lighting of SYNC LOSS and the flashing of the TEST indicator, and a specific state of the TD and RD/ERR indicators. The available indications are as follows (remember, **SYNC LOSS is lit** and **TEST is flashing**):

TD and RD/ER both ON
Failure in power-up self-test (EPROM checksum or the internal hardware test failed), or the Data Voice Multiplexor's voice channels module is not installed. The DVM should be repaired; call for technical support.

TD and RD/ER both OFF
The DVM main link interface does not receive clock signals, or the main link's clock rate (as measured by the DVM) does not fit any of the supported rates, or the rate is outside the allowable accuracy limits.

4.1.2 Configuration-Error Indication

The flashing of the TEST indicator while the SYNC LOSS indicator is off indicates a configuration error. The configuration-error indication is displayed under the following circumstances:

- Bandwidth "overflow": The total bandwidth assigned to the data and voice channels, including the link-synchronization and -supervision overhead, exceeds the main link data rate determined by measuring the link's clock-signal frequency.
- Both Data Voice Multiplexor units connected in a link are configured as "slaves."
- Both DVM units connected in a link are configured as "masters," but their configurations are different.
- A master DVM unit with two active voice channels attempts to download configuration information to a slave unit having only one voice channel.
- The local DVM operator has pressed the RLB button to activate a remote loopback on a channel on which a loopback has already been activated by the other side.

4.2 Operating Procedure

After being prepared for operation using the instructions in **Chapter 3**, the Data Voice Multiplexor normally operates unattended. Operator intervention is only required when the DVM is set up for the first time, or must be adapted to new operational requirements that require the changing of the internal settings.

4.2.1 Turning the DVM ON

First make sure neither of the DVM's front-panel pushbuttons are pressed.

The DVM does not have a power switch, so it immediately starts operating when power is applied. To apply power, connect the DVM power cable to its rear POWER connector, then plug the other end into a grounded mains outlet.

When power is connected, the DVM performs self-test. During self-test, all the indicators light for approximately half a second, then change to their normal states.

The PWR indicator remains lit as long as power is available.

4.2.2 Normal Operation

During normal operation, all of the front-panel indicators except PWR and occasionally TD and RD/ER (see following section) are off.

NOTE

At power-up, the SYNC LOSS alarm LED might light up, indicating that the other communication equipment serving the DVM link is not yet operating. The indicator must turn off as soon as all the link equipment is operated.

In case the SYNC LOSS indicator lights and/or the TEST indicator flashes, refer to **Chapter 5** for troubleshooting instructions.

The TEST indicator will light steadily when a test is activated.

4.2.3 Monitoring Channel Activity

To monitor traffic activity on a desired channel or on the main link, set the SELECT switch to the corresponding position.

The TD and RD/ERR indicators show the traffic activity on selected channel (their brightness is proportional to the traffic load). If the TD and RD/ERR indicators are off while the selected channel transmits or receives data, refer to **Chapter 5** for troubleshooting instructions.

NOTE

The PATT and RLB pushbuttons can be disabled by the internal J1 jumper. When disabled, the TEST indicator remains off when a pushbutton is pressed.

4.2.4 Loop Activation

When it is necessary to activate a test loop, set the SELECT switch to the position corresponding to the desired channel, and then press the RLB button. The TEST indicator turns on, and the TD and RD indicators show data activity on the transmit and receive pairs of the selected channel.

The loop remains activated as long as the RLB button remains pressed. Note that the activation of a main link loop interrupts the service to all the users served by the DVM link, whereas a channel loop interrupts only the user traffic on the selected channel.

When the loop is no longer required, release the pressed button by pressing it again. The TEST indicator turns off.

Refer to **Chapter 5** for a description of the test loops.

4.2.5 BERT Activation

To activate the BERT (bit-error-rate test), set the SELECT switch to the DATA position, and then press the PATT button. The TEST indicator turns on, the TD indicator must light, and the RD/ERR indicator lights if errors are detected (ideally, the RD/ERR indicator should remain off during the test).

NOTES

1. The BERT test can be activated only on the data channel. Pressing the PATT button when the SELECT switch is set to LINK has no effect.

2. In order to obtain meaningful results from the BERT test, the local DVM must receive, on the tested channel, a test pattern similar to the transmitted pattern. This can be achieved either by connecting a remote loop on the same channel, or by simultaneously activating the BERT test at the remote DVM (provided the link is operating properly). Otherwise, the DVM will not receive the test sequence and will indicate errors.

The BERT continues as long as the PATT button remains depressed. Note that the activation of the BERT interrupts the service to the users of the selected channel.

When the test can be stopped, release the pressed button by pressing it again. The TEST indicator turns off.

Refer to **Chapter 5** for a more detailed description of the BERT.

4.2.6 TONE INJECTION

To activate tone injection, set the SELECT switch to the VOICE position, and then press the PATT button. The TEST indicator turns on.

The remote side should hear a 1000-Hz tone at the nominal channel level (0 dBm). The RD/ERR and TD indicators continue operating as usual.

NOTES

The echo canceler used on the voice channels cannot perform its function when the same tone is simultaneously transmitted and received. Therefore, do not try to activate tone injection together with a remote loopback, nor activate simultaneously tone injection at both the local and the remote DVM.

Tone injection is simultaneously activated on both voice channels, therefore it interrupts the service to the users of the two channels.

Tone injection continues as long as the PATT button remains pressed. Note that tone injection interrupts the service to the users of the voice channels.

When tone injection can be stopped, release the pressed button by pressing it again. The TEST indicator turns off.

Refer to **Chapter 5** for a more detailed description of tone injection.

4.2.7 TURNING THE DVM OFF

Disconnect the power cable from the mains outlet, and then from the DVM's rear-panel power inlet.

5. Troubleshooting

5.1 The Diagnostic Functions

Three types of diagnostic functions are available on the Data Voice Multiplexor:

- Remote loopback.
- Bit-error-rate testing (BERT, available only on the data channel).
- Tone injection (available only on the voice channels).

The BERT, tone injection, and remote loop are initiated from the front-panel PATT and RLB pushbuttons, respectively, on the channel currently selected with the SELECT switch. The operating procedures are explained in **Section 4.3**. For a functional description of the test functions available on each channel, refer to the various subsections of this section.

The activation of the tests can be disabled by the internal jumper J1, located on the DVM's main board (see Figure 5-2). If troubleshooting is required and the DVM does not respond to the PATT and RLB pushbuttons, first check the position of this jumper.

When performing tests, be aware of the following guidelines and restrictions:

- Activation of a channel test or loop interrupts the service to the users served by the DVM channel under test.
- Activation of the main-link loop interrupts the service to all the users served by the DVM link.
- On any channel, only one DVM can activate a remote loopback. If the remote loopback has already been activated by the other DVM, the TEST indicator starts flashing (which indicates a configuration error).

5.1.1 Activating a Diagnostic

A test or loop is activated on the channel selected by the SELECT switch by pressing the corresponding button on the front panel. As long as any test or loop is activated, the TEST indicator lights.

To deactivate the test or loop, press the same pushbutton again. If this was the only active test or loop, the TEST indicator will turn off.

The commands for the activation/deactivation of remote loops are transmitted end-toend through the main link. Therefore, when a remote loop is activated, the DVM TEST indicators light at both ends of the link.

5.1.2 BERT

The bit-error-rate test (BERT) is available only on the data channel. This test is used to obtain a rapid qualitative evaluation of data transmission without using external test equipment.

When the test is activated, a test signal is applied to the selected channel of the DVM. The test signal, an internally-generated 2^9 - 1 (511) bit pseudo-random sequence, is internally connected to the input of the tested channel's transmit path. The transmitted data can either be returned to the receive path of the channel by means of a loop somewhere along the data path (for example, by connecting the remote channel loop, or by a physical loopback connection), or a similar sequence can be transmitted from the other end of the data channel (either by simultaneously activating the BERT test at the remote DVM or by connecting a test-pattern generator).

The received signal is routed to an internal test sequence evaluator. The evaluator compares the received data, bit by bit, to the original data and detects any difference (bit error). Each detected error is indicated by flashing the RD/ERR indicator.

While the BERT test is activated, the CD and CTS lines in the local data channel connector are set low (inactive).

5.1.3 Tone Injection

The test tone (1000 Hz, 0 dBm) is a digital sequence, repeating at a rate of 1000 Hz, generated by the digital voice processor and sent to the remote side. The sequence is identical to the data stream that would have been generated if a 1000-Hz signal at a nominal level of 0 dBm were applied to the input of the voice channel being tested. Therefore, the remote user can hear the tone in the telephone earpiece, and can also make measurements using test equipment.

When the DVM is equipped with a voice module with two channels, the tone is simultaneously sent on both channels.

Since the tone is sent in only one direction (toward the remote DVM), the other direction operates as usual.

The tone canceler suppresses the tone on the receive side of the local voice channel, so any attempt to activate tone injection at both ends of the link, or to use a remote loopback while the tone is sent, will not allow you to hear the tone.

5.1.4 Remote Data-Channel Loopback

During a remote data-channel loop, the local channel's transmit-data signal is multiplexed by the local DVM and sent to the remote DVM.

At the remote DVM, the data channel is demultiplexed, the receive-data signal is looped back to the transmit path of the remote data channel, and then returned through the link to the local data channel as received data.

While the loop is activated, the CD and CTS lines in the remote data channel interfaces are set low (inactive).

Figure 5-1 on the next page shows the loop connections. As long as the loop is activated and the link connecting the two DVM units operates properly (both the local and remote SYNC LOSS indicators will remain off), the data equipment connected to the local DVM must receive its own signals without errors, and the local RD indicator must light when the local TD indicator lights.

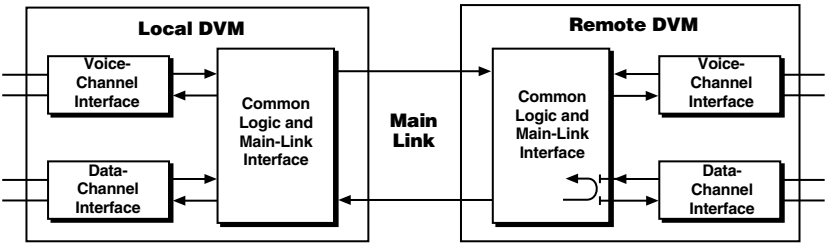

Figure 5-1. Remote loopback of the data channel.

5.1.5 Remote Voice-Channel Loopback

The voice channel's remote loopback is similar to the data channel's loopback. While the loopback is connected, you must receive your own voice clearly and loudly from a phone connected to the local DVM.

During the remote voice-channel loopback, the voice channel will be disconnected on the remote side.

5.1.6 Remote Main-Link Loopback

During the remote main-link loopback, both the voice and data transmit data are looped back by the remote DVM to the receive side of the local DVM, demultiplexed and applied to the two channels as received data. Figure 4-2 shows the loop connections.

The indications and the response of the data-channel user' s data equipment are the same as for the data-channel loopback, and those of the voice channel are the same as for the voice channel's remote loopback.

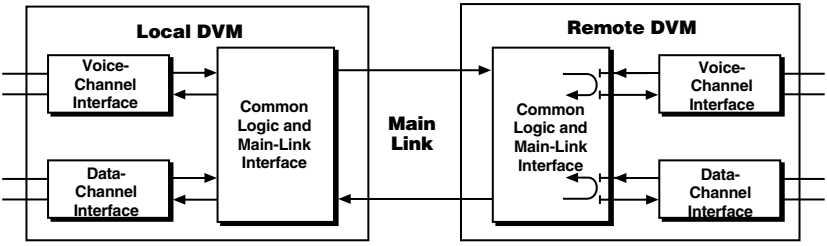

Figure 5-2. Remote loopback of the main link.

5.2 Problems That Might Be Indicated

If a problem occurs, check the Data Voice Multiplexor's front-panel LEDs. Then refer to the following lists of LED patterns and trouble symptoms to find what might be wrong.

Whenever a problem appears the first time you operate a new link, or just after the configuration of an existing link has been changed, before starting the troubleshooting, check again all the internal settings of the local and remote DVM units against the prescribed parameters.

PWR off

1. No AC power. Check that both ends of the AC-power cable are properly connected, and that power is available at the mains outlet to which the DVM is connected. Try a different outlet.
2. Blown fuse. Replace with a fuse of the proper rating.
3. Defective DVM. Call Black Box for technical support.

TEST flashes
SYNC LOSS lights
TD and RD/ERR light

Local DVM failed self-test. Make sure the voice-channels module is installed. If it is, call Black Box for technical support.

TEST flashes
SYNC LOSS lights
TD and RD/ERR off

Local DVM does not receive valid clock signals from the data-communication equipment connected to its main-link connector. Check that the connection cable between the local DVM and the data-communication equipment connected to its main-link connector is in order. Check that the data-communication equipment is configured to operate as a DCE and that it supplies transmit- and receive-clock signals at the correct rate to the DVM.

TEST off
SYNC LOSS lights

1. Problem in the data transmission facility. Troubleshoot the data-transmission facility that connects the two DVMs.
2. Problem at local DVM. Activate the local loopback on the DCE equipment connected to the main link. If the SYNC LOSS indicator continues to light, call Black Box for technical support.
3. Problem at the remote DVM. Repeat the procedure given for probable causes above on the remote DVM.

TEST flashes
SYNC LOSS off

Configuration error. Check for these errors, and correct them if necessary:

- Both the local and remote DVM are configured as slave units.
- Both are configured as master units, but the parameters are different.
- Both are configured as master units, but their J2 (mode) jumpers are set differently.
- Both are in remote loopback in the same channel.

SYNC LOSS lights intermittently

Receive clock and transmit clock are not from the same source. If the modem on one side is set to transmit timing, the modem on the other side must be set to loopback timing.

TEST off
SYNC LOSS off
Local voice-channel user cannot hear or set up calls.
Local data channel operates normally.

1. Incorrect selection of voice-channel interface, or problem in the channel-connection cables. Check that the proper interface is used: An FXO interface must be connected to a PABX, and an FXS interface must be connected to a telephone set. Check the connection cables.
2. Problem at local DVM. Activate tone injection at the remote DVM and check that the test tone is heard. Deactivate tone injection, activate the voice-channel loop, and check that a strong sidetone is heard in the telephone set earpiece. If not, call Black Box for technical support (there may be a fault on main board or on the interface board).
3. Problem at remote DVM. Use the same procedure as for the local DVM, but at the remote unit.

TEST off
SYNC LOSS off
Local data-channel user cannot receive data.
Local voice channel operates normally.

1. Problem on the cables, or on the line between the DTE and DVM. Activate the data-channel loopback and BERT. If the RD/ERR indicator of the local DVM does not light (no errors), check the cables and the line between the DVM and the DTE.
2. Problem at local DVM. If the RD/ERR indicator of the local DVM lights during the above test, call Black Box for technical support.
3. Problem at remote DVM. Use the same procedure as for the local DVM, but at the remote unit.

5.3 Calling Black Box

If you determine that your Data Voice Multiplexor is malfunctioning, *do not attempt to alter or repair the unit.* It contains no user-serviceable parts. Contact Black Box Technical Support at 724-746-5500.

Before you do, make a record of the history of the problem. We will be able to provide more efficient and accurate assistance if you have a complete description, including:

- the nature and duration of the problem.
- when the problem occurs.
- the components involved in the problem.
- any particular application that, when used, appears to create the problem or make it worse.
- the results of any testing you've already done.

5.4 Shipping and Packaging

If you need to transport or ship your Data Voice Multiplexor:

- Package it carefully. We recommend that you use the original container.
- Before you ship the unit back to Black Box for repair or return, contact us to get a Return Authorization (RA) number.

Appendix A: Interface Pinouts

This appendix provides information on the types and pinouts of the various interface connectors of the Data Voice Multiplexor and its adapter cables. (Note that the adapter cables for the link and data channels are identical, despite some slight differences in the pin functions.)

In the "Direction" field of the pinout tables, the following conventions are used:

IN = Input to DVM

OUT = Output from DVM

N. C. = No connection (not used)

A.1 Main Link and Data-Channel Interfaces

The main link and data-channel interface connectors are DB15 female connectors pinned out for the ITU-T X.21 interface. The V.35 models of the Data Voice Multiplexor come with adapter cables that patch these to M/34 connectors pinned out for ITU-T V.35, as shown in Table A- 1.

Table A-l. Main Link and Data-Channel Interface Connectors and V.35 Adapter-Cable Connectors

DB15 Interface Connector Pin (X.21)	M/34 Adapter-Cable Connector Pin (V.35)	V.35 Circuit Ref.	Direction		Function
			LINK	DATA	
1	A	101	—	—	FGND
2	P	103	OUT	IN	TXD A
3	C	105	OUT	N. C.	RTS
4	R	104	IN	OUT	RXD A
5	F	109	N. C.	OUT	DCD
6	Y	114	IN	OUT	TXC A
7	V	115	IN	OUT	RXC A
8	B	102	—	—	SGND
9	S	103	OUT	IN	TXD B
10	H	108.1	OUT	IN	DTR
11	T	104	IN	OUT	RXD B
12	J	125	IN	N. C.	RI
13	AA	114	IN	OUT	TXC B
14	X	115	IN	OUT	RXC B
15	D	106	N. C.	OUT	CTS

The RS-232/V.24 models of the Data Voice Multiplexor come with adapter cables that patch the main-link and data-channel connectors to DB25 connectors pinned out for EIA/TIA RS-232 (ITU-T V.24), as shown in Table A- 2.

Table A-l. Main Link and Data-Channel Interface Connectors and RS-232/V.24 Adapter-Cable Connectors

DB15 Interface Connector Pin (X.21)	DB25 Adapter-Cable Connector Pin (V.24)	V.24 Circuit Ref.	Direction		Function
			LINK	DATA	
1	1	101	—	—	FGND
2	2	103	OUT	IN	TXD
3	4	105	OUT	IN	RTS
4	3	104	IN	OUT	RXD
5	8	109	N. C.	OUT	DCD
6	15	114	IN	OUT	TXC
7	17	115	IN	OUT	RXC
8	7	102	—	—	SGND
9	6	107	IN	OUT	DSR
10	20	108.1	OUT	IN	DTR
11, 13, 14	—	—	N. C.	N. C.	Not used
12	22	125	IN	N. C.	RI
15	5	106	N. C.	OUT	CTS

A.2 Voice-Channel Interfaces

The voice-channel interface has 8-pin RJ-45 connectors, but only the two center pins (Pins 4 and 5) are used: In both the FXO and FXS interfaces, Pins 4 and 5 carry 2-wire voice input/output.

Appendix B: Rackmounting

The Data Voice Multiplexor can be installed in 19" racks. Unit height corresponds to 1U (1.75"), and the width is slightly less than half of the available mounting width. You can install either a single unit or two units side by side in your rack; our optional adapter kit (RM523) has all the parts you need for either installation.

This Appendix provides step-by-step installation instructions for each option.

WARNING!

Disconnect all the cables from the units, and then disconnect the units from power, while performing the following procedures. Always observe standard safety precautions during installation, operation, and maintenance of this product. No internal settings, adjustment, maintenance, or repairs should be performed by either the operator or the user; such activities should be performed only by a skilled technician who is aware of the hazards involved.

B.1 Rackmounting a Single DVM

The single-unit rack-adapter kit includes one short bracket and one long bracket. The brackets are fastened by means of screws to the two side walls of the case, as shown in Figure B-1.

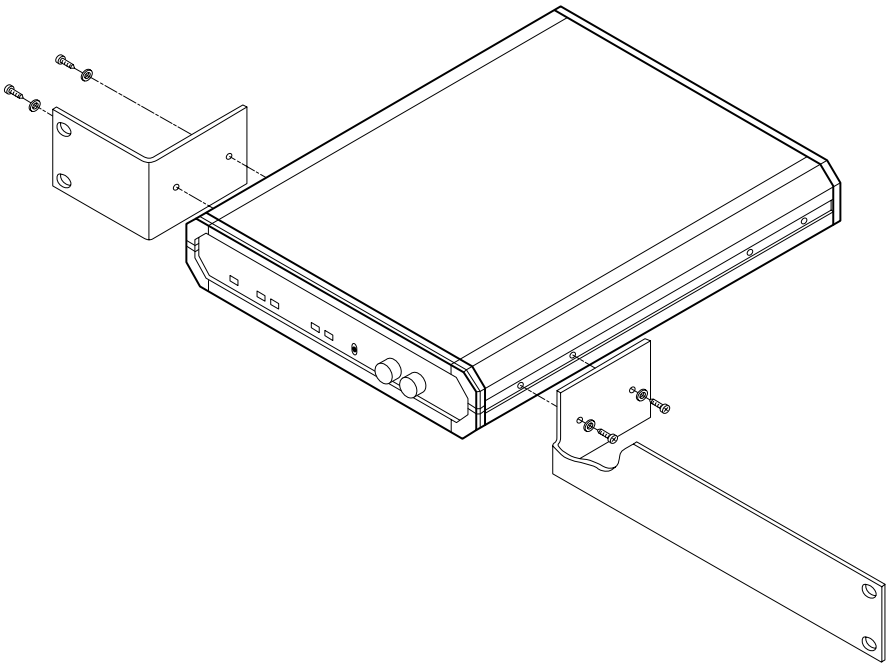

Figure B-1. Installing a single DVM in a 19" rack.

To prepare the unit for rack installation:

1. Attach the two brackets to the side walls of the unit. Each bracket is fastened by means of two screws (with flat washers), which are inserted into the two front holes on the side wall (nuts are already in place, on the inner side of the wall).

2. After attaching the brackets, the unit is ready for installation in the 19" rack. To install in the rack, fasten the brackets to the side rails of the 19" rack by means of four screws (not included in the kit), two each side.

B.2 Rackmounting Two DVMs Side By Side

The dual-unit rack adapter kit includes two rails for attaching the two units side by side, two short adapter brackets, and various hardware. Refer to Figure B-2 and prepare the two DVM units for attachment as directed on the next page.

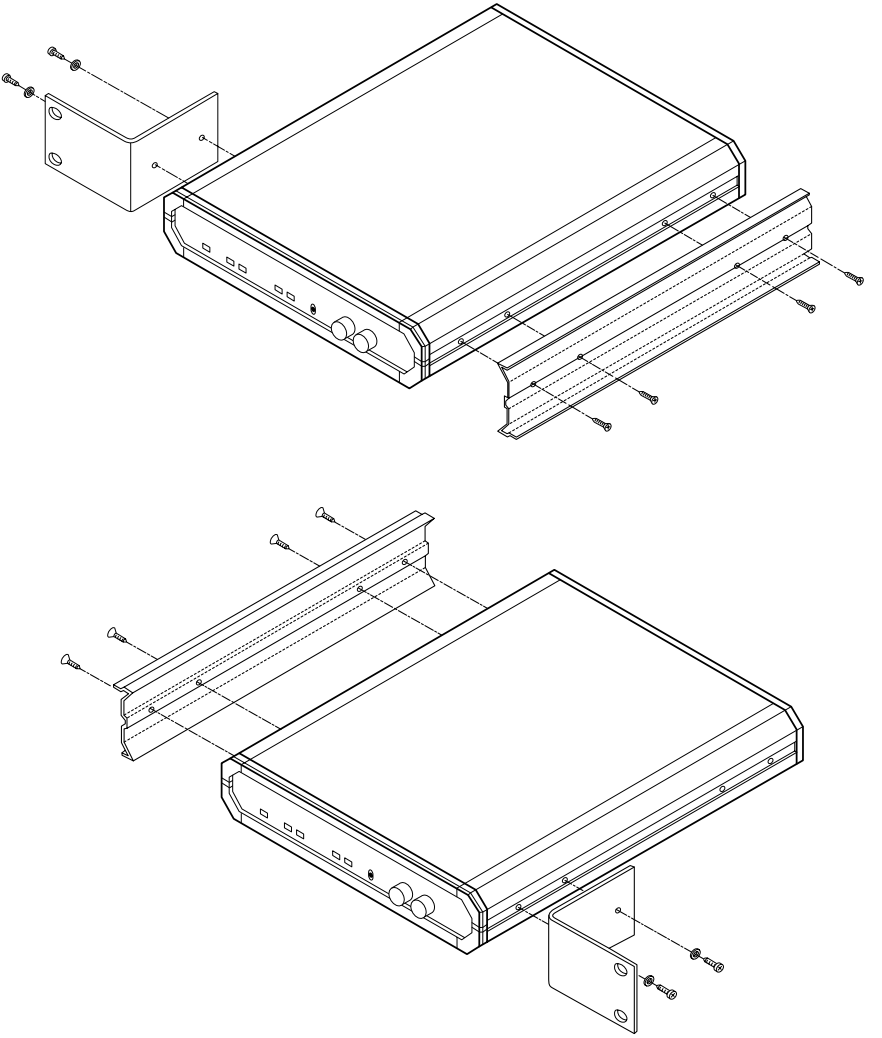

Figure B-2. Preparing two DVMs for dual rackmounting.

1. Fasten one short adapter bracket to the left-hand side wall of the unit intended to be on the left. Use two of the four longer screws supplied in the kit, and insert flat washers.

2. Use the same procedure to fasten the second short adapter to the right-hand wall of the unit intended to be on the right.

3. Position one of the two rails supplied in the kit on the right-hand wall of the unit intended to be on the left, and align its holes with the holes on the wall.

4. Insert four short Philips screws and screw them through the rail into the holes on the unit wall.

5. Use the same procedure to attach the second rail to the left-hand wall of the unit intended to on the right. Make sure the wider rim of this rail is opposite the short rim of the other rail, as shown inFigure C-2.

Now refer to Figure B-3 and attach the two units as follows:

6. Position the ends of the rails attached to the two units so that the rails can slide one into the other, and then slide the units to bring the panels in line.

7. Now insert plastic I-shaped caps between the two units, to cover the empty spaces left at the ends of the two rails.

The assembled units can now be fastened to the side rails of the 19" rack by means of four screws (not included in the kit), two on each side.

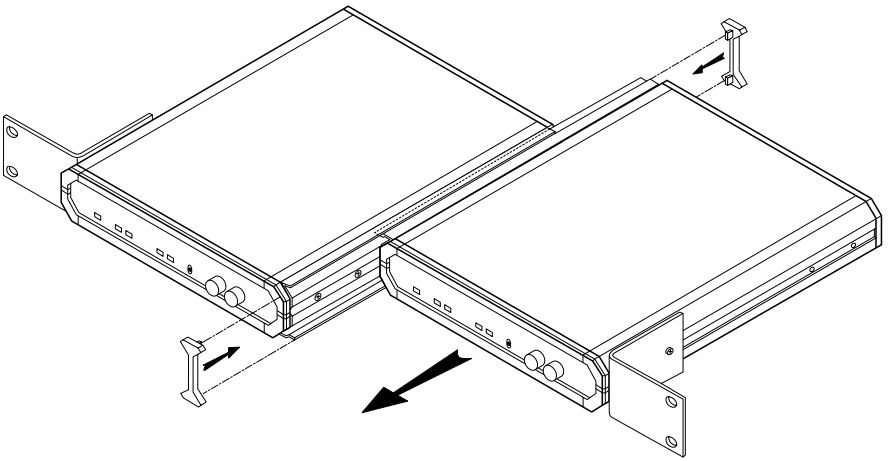

Figure B-2. Fastening two DVMs together for rackmounting.

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