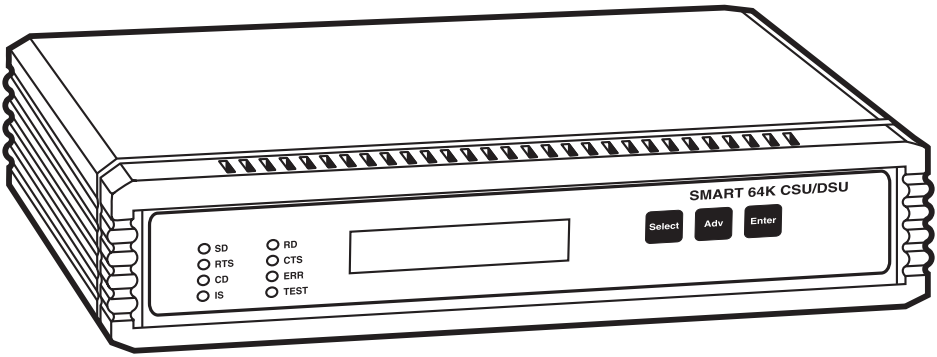
FEBRUARY 2003
MT190A
MT190A-D48
MT190A-D130

Smart 64K CSU/DSU
120-VAC
24–48-VDC
130-HVDC



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Order **toll-free** in the U.S.: Call **877-877-BBOX** (outside U.S. call **724-746-5500**)
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Mailing address: **Black Box Corporation**, 1000 Park Drive, Lawrence, PA 15055-1018
Web site: **www.blackbox.com** • E-mail: **info@blackbox.com**

FEDERAL COMMUNICATIONS COMMISSION
AND
INDUSTRY CANADA
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.

UL

This product is UL® listed.

FCC Requirements for Telephone-Line Equipment

1. The Federal Communications Commission (FCC) has established rules which permit this device to be directly connected to the telephone network with standardized jacks. This equipment should not be used on party lines or coin lines.

2. If this device is malfunctioning, it may also be causing harm to the telephone network; this device should be disconnected until the source of the problem can be determined and until the repair has been made. If this is not done, the telephone company may temporarily disconnect service.

3. If you have problems with your telephone equipment after installing this device, disconnect this device from the line to see if it is causing the problem. If it is, contact your supplier or an authorized agent.

4. The telephone company may make changes in its technical operations and procedures. If any such changes affect the compatibility or use of this device, the telephone company is required to give adequate notice of the changes.

5. If the telephone company requests information on what equipment is connected to their lines, inform them of:

   a. The telephone number that this unit is connected to.

   b. The ringer equivalence number.

   c. The USOC jack required: RJ-11C.

   d. The FCC registration number.

   Items (b) and (d) can be found on the unit's FCC label. The ringer equivalence number (REN) is used to determine how many devices can be connected to your telephone line. In most areas, the sum of the RENs of all devices on any one line should not exceed five (5.0). If too many devices are attached, they may not ring properly.

6. In the event of an equipment malfunction, all repairs should be performed by your supplier or an authorized agent. It is the responsibility of users requiring service to report the need for service to the supplier or to an authorized agent.

Certification Notice for Equipment Used in Canada

The Industry Canada label identifies certified equipment. This certification means that the equipment meets certain telecommunications-network protective, operation, and safety requirements. Industry Canada does not guarantee the equipment will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company's inside wiring associated with a single-line individual service may be extended by means of a certified connector assembly (extension cord). The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized maintenance facility—in this case, Black Box. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines, and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

CAUTION

Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

The LOAD NUMBER (LN) assigned to each terminal device denotes the percentage of the total load to be connected to a telephone loop which is used by the device, to prevent overloading. The termination on a loop may consist of any combination of devices, subject only to the requirement that the total of the load numbers of all the devices does not exceed 100.

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.

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1. Specifications

DDS Data Rate: 2400, 4800, and 9600 bps; 19.2, 56, and 64 kbps

Diagnostics: Operational line testing: In spec/out of spec;
Parametric testing (± -0.5 dBm): Line attenuation, background noise, impulse noise

DTE Data Rates: Async: 1200, 2400, 4800, and 9600 bps; 19.2, 38.4, 56, and 64 kbps; Sync: 300, 600, 1200, 2400, and 4800 bps; 14.4, 19.2, 28.8, 38.4, 56, and 64 kbps

Line Type: DDS

Loopback: Digital loop, local loop, remote loop, CSU, DSU

Protocol: Sync or async

Indicators: (6) simulated LED indicators on the front-panel LCD display: In Svc, Car Det, Req Send, Clr Send, Send Data, and Recv Data (two vertical columns of LEDs provide the same operational information whether or not the LCD display is currently displaying such information)

Connectors: Line: (1) 4-wire RJ-48S; Data ports: (1) DB25 female (DCE), (1) M/34 female (DCE) (Pinouts for these connectors appear in **Appendix A**)

Approvals: FCC Class A, UL®, CSA, FCC Part 68 (1U5USA-74399-DE-N)

Receiver Sensitivity: 0 to -60 dB for 56,000-bps and 64,000-bps operation

Temperature Tolerance: Operating: 32 to 104°F (0 to 40°C); Storage: 32 to 158°F (0 to 70°C)

Operating Humidity: Up to 95%, non-condensing

Altitude Tolerance: 10,000 ft. (3048 m) maximum

Power: MT190A: 120-VAC, 60-Hz, 30-W external transformer;
MT190A-D48: 24–48-VDC external transformer, 2 amps;
MT190A-D130: 130-VDC external transformer, 2 amps

Size: 1.8"H x 8.6"W x 8.4"D (4.6 x 21.8 x 21.3 cm)

Weight: 2.6 lb. (1.2 kg)

2. Introduction

2.1 Overview

The Smart 64K CSU/DSU is an advanced Channel Service Unit/Data Service Unit that uses Digital Signal Processor technology. It's a standalone unit that connects two remote locations together to form a wide-area network (WAN), and it operates in a point-to-point or multipoint environment on Dataphone Digital Service (DDS) provided by the common carriers.

This multi-rate-line digital termination unit operates at all common speeds between 2400 bps and 64,000 bps. The line speed and the DTE speed may be the same or different. The CSU/DSU supports both asynchronous and synchronous operation.

The rear panel has one DB25 DTE connector for RS-232 devices (labeled Port 1), one M/34 DTE connector for V.35 devices (labeled V.35 Port 1), a power connection receptacle, and an RJ-48S female network connector. Limited Distance Modem operation is also available; one unit is configured with a master clock setting. At 56,000 bps, depending upon wire gauge, the CSU/DSU can operate error-free up to 10 miles (16.1 km) away.

The CSU/DSU has three front-panel touchpad buttons (Select, Advance, and Enter) to help you easily manipulate the CSU/DSU through port and line settings, diagnostic testing, and selecting an operational display. An LCD display next to the buttons provides a visual interface into the CSU/DSU's menu system as well as its operation. The LCD display is a single-line, 16-character position display.

All defined *line* speeds that have DTE *port* speeds less than or equal to the *line* speed will match each other. One exception exists for 57,000 bps asynchronous operation, which is supported on a 56,000-bps DDS facility. In addition, synchronous as well as asynchronous character formats and timings are supported in both point-to-point and multipoint applications.

Electrical requirements are supplied by an external power transformer. For the MT190A, the power transformer accepts 120 VAC. For the MT190A-D48, the power-supply cable accepts 24 to 48 VDC. For the MT190A-D130, the power-supply cable accepts 130 VDC.

The electrical connection is free from any dangerous voltages on the PC board itself. UL and CSA approvals exist for the power transformer only.

The unit is a DCE device and only requires straight-through cables for all DTE equipment. Cable requirements are shown in **Appendix A**.

2.2 What the Package Includes

Your package should include the following items:

- (1) Smart 64K CSU/DSU
- (1) Straight-through RJ-48S male-male network interface connection cable
- (1) Power supply (120-VAC, 24–48-VDC, or high-power 130-VDC)
- This users' manual

If anything is missing or damaged, please contact Black Box at 724-746-5500.

3. Installation

3.1 Positioning the CSU/DSU

We recommend that you use a grounded 120-VAC, 47–63-Hz power receptacle for the MT190A. The power transformer has a six-foot, two-conductor cable with the appropriate power connector for the CSU/DSU. Make sure that the DTE cable is long enough to reach the back of the CSU/DSU. Position the CSU/DSU between the DTE equipment and communications network interface. You can attach the interface cables before or after you configure the CSU/DSU.

NOTE

For information about the CSU/DSU's DC versions (MT190A-D48 and MT190A-D130), see Section 3.5.

3.2 Primary Channel Connection

One DB25 RS-232 female connector and one M/34 V.35 female connector are on the CSU/DSU's rear panel. *Only one of these may be used at a time!* These are for a DTE user connection to the CSU/DSU. Each connector is configured as a DCE. Any DTE device connecting to a CSU/DSU port should use a straight-through cable. Use cable less than six feet (1.8 m) long for RS-232 connections and less than 50 feet (15.2 m) long for V.35 connections. You should only use shielded cables. Pinouts for the various cables are shown in **Appendix A**.

3.3 RJ-48S Network Connection

The communications network connection is a four-wire connection using an eight-wire connector: the RJ-48S. This connector is designated by Bell Core as the proper termination for a DDS circuit. Typically, a common carrier will terminate the DDS circuit in a connector containing a female RJ-48S receiver. Use a straight-through six-foot or shorter RJ48S cable with male connectors at each end. The network interface connection is made directly between the RJ-48S female receiver on the rear of the CSU/DSU and the female connector provided by the service provider.

The female RJ-48S connector, as viewed by looking directly at the rear of the CSU/DSU, contains the pin designation number, 1 through 8, beginning with pin 1 at the left and ending with pin 8 at the right.

With respect to the CSU/DSU with I.Q., Pins 1 and 2 are the transmit pair. Pins 7 and 8 are the receive pair. Pins 3–6 are not used.

Pin	Signal
1	TX (Tip)
2	TX (Ring)
3	Not used
4	Not used
5	Not used
6	Not used
7	RX (Tip)
8	RX (Ring)

Dataphone Digital Service (DDS) is tariffed in various geographical areas throughout the United States with slight variations. All geographical areas include speeds ranging from 2400 bps to 64,000 bps. The Smart 64K CSU/DSU supports all available speeds as tariffed by the various service providers. DDS is by definition a synchronous service; however, the CSU/DSU provides both asynchronous and synchronous operation. Asynchronous DTE connections are converted to synchronous connections by the CSU/DSU, transmitted as synchronous data over the DDS link, and reconverted to asynchronous at the remote CSU/DSU location.

Local loop lengths will vary depending upon proximity of the end user's location to the local service provider. The CSU/DSU uses an automatic gain control system to compensate for various local loop lengths. The receiver range is 0 to -60 dB at 56,000 bps, which permits operation over long local loops (21,000 feet using 26-gauge wire). Central office OCUs (Office Channel Units) used by the service provider must also be capable of operation with this same receiver range in order for the CSU/DSU to operate at this extended local loop distance.

3.4 Menu Interface

You can access the menu system through the LCD display using three pressure-sensitive buttons: Select, Advance, and Enter.

3.4.1 SELECT

This places the CSU/DSU in non-operational mode at the Configuration option.

3.4.2 Advance

This displays the next option in a series of options. For example, when in configuration mode, the Advance button displays the next line speed, port speed, async or sync, etc. When in operational mode, the next real-time operational mode (LED simulations, Line utilization statistics, or Port utilization statistics) is displayed.

3.4.3 Enter

This button accepts the option currently displayed in the LCD window and displays the next option in a series of options. It's similar to the Advance button in that it displays an option, but it differs in that the option is actually selected and used or executed (for example, Enter immediately begins the execution of a Digital Loop after being displayed by Advance).

3.5 DC Power Connection Procedure

MT190A-D48 and MT190A-D130 include the power-supply cable shown in Figure 3-1. One end has a standard barrel connector for insertion into the CSU/DSU. The other end is an unterminated wire to connect to a fused DC bus connection. The fuse requirements for this connection are:

Table 3-1. DC power connectors

Part Number	Voltage	Amps
MT190A-D48	DC (24–48 VDC)	2 amps
MT190A-D130	HVDC (130 VDC ±10 VDC nominal)	2 amps

Figure 3-1 illustrates the DC power cable.

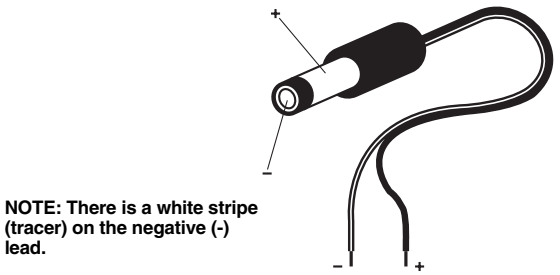


Figure 3-1. DC power cable.

INSTALLATION PROCEDURE

1. Inspect the unit and verify the model number.
2. Identify the DC power source.
3. Check for DC power voltage and polarity with a voltmeter.
4. Remove the fuse or open the circuit breaker.
5. Connect the all-black wire to the positive (+) terminal.
6. Connect the black wire with white tracer to the negative (-) terminal.
7. Safely isolate the barrel connector from conductive materials.
8. Insert the fuse or close the circuit breaker.
9. Check the voltage and polarity on the barrel connector.
10. Remove the fuse or open the circuit breaker.
11. Insert the barrel connector into the unit.
12. Insert the fuse or close the circuit breaker.
13. The unit should power up normally, and Telco circuit installation can begin.

4. Operation

The CSU/DSU will be in normal operational mode once you configure it through its front-panel LCD display, supply power by the external transformer, make the network connection with the RJ-48S cable, and attach the DTE device via the M/34/V.35 port or the DB25/RS-232 port. The CSU/DSU is operating normally when the front-panel LCD display shows a simulated LED pattern with a solid **In Svc ***. This appears at the left-most character position of the LCD display below the label **In Svc**.

4.1 LCD Front-Panel Operation

The CSU/DSU has a sixteen-character LCD display and three pushbuttons on its front panel. Six simulated LEDs indicate the operating status of the CSU/DSU using a real-time update of an asterisk (*) character, which appears next to the IS, CD, RTS, CTS, SD, and RD indicators. The LED functions are described in the table below:

LED Indicator	Function
IS	When on steadily, this LED indicates that a correct (In Service) pattern from the Telco is being received.
CD	When on, this LED indicates that valid data is present on the DDS receive line pair. When off, it is either not in service, the idle signal is being received, or no signal is present.
RTS	When on, this LED indicates that RTS is present from the DTE or is being provided by the unit itself (RTS constant).
CTS	When on, this LED indicates that the unit is in service and has a valid RTS signal from the remote DTE terminal.
SD	This LED flashes when DTE transmit data is present (a Space condition turns on the LED).
RD	This LED flashes when DTE receive data is present (a Space condition turns on the LED).

4.2 Run-Time Operational Displays

The CSU/DSU has three operational displays that you may select during normal operation. When the CSU/DSU first becomes operational, a lead status simulation is shown on the LCD display. The center of the display reads **Comm** to indicate that the composite leads are being displayed. Press Advance once to switch the display to a Line utilization statistics display. This display shows the word **Line** in the center. It provides a real-time updated display of the transmit and receive utilization from the Telco as a percentage of total capacity. Press **Advance** again to show a Port utilization display. This is identical to the Line presentation in format, but reports DTE activity. Press **Advance** a third time to return the CSU/DSU to the original **Comm** display.

4.3 LEDs

In addition to the LCD display, eight LEDs are on the left side of the front panel. The LEDs include Send Data, Receive Data, Request to Send, Clear to Send, Carrier Detect, Error, In Service, and Test. All of these LEDs (except Error and Test) function the same as the LCD display, except that they are always visible.

During normal operation, the Err LED is off. If errors are detected on the network interface, the Err LED lights, indicating the line condition. Any time during normal operation that the Err LED lights, serious line errors are taking place. The telephone company must correct this problem.

The Test LED indicates that the CSU/DSU is not in a normal operational condition. The Test LED lights any time the CSU/DSU is in a test mode, whether initiated by you or initiated by the telephone company (CSU or DSU loop tests).

4.4 Self-Test

Enter self-test by pressing **Select** once, **Advance** twice, then **Enter** twice.

Self-Test causes the CSU/DSU to internally connect its transmitter to its receiver. An internal pattern generator then begins outputting a known pattern of data, which the CSU/DSU checks for accuracy as it receives it back internally. During this process, the LCD displays **Self Test Pend**. Once the pattern has been received correctly for five to fifteen seconds (this varies with the speed selected for the CSU/DSU), the LCD displays the message **Self Test Pass**. The message condition continues for as long as the CSU/DSU correctly receives the test pattern. Press **Select** to end the self-test and place the CSU/DSU at the Configuration menu level. You can initiate a self-test even when the CSU/DSU is not connected to a network. Run the self-test first to validate the CSU/DSU's operation.

4.5 Digital Loop

To enter Digital Loop, press **Select** once, **Advance** twice, **Enter** once, **Advance** once, then **Enter** once.

Digital Loop performs a bi-directional loopback at the CSU/DSU's main processor. All data arriving from the network is reflected back to the network; all data received from the port is reflected back to the port. Both reflections are simultaneous and independent. These reflections will time out after 5 minutes. Pressing **Select** once ends the Digital Loop and returns the unit to the Configuration menu level.

4.6 Local Loop

To enter Local Loop, press **Select** once, Advance twice, **Enter** once, **Advance** twice, then **Enter** once.

Local Loop performs a bi-directional loopback at the CSU/DSU's network interface connection. All data arriving from the network is reflected back to the network; all data received from the port is reflected back to the port. Both reflections are simultaneous and independent. These reflections will time out after 5 minutes. Pressing **Select** once ends the Local Loop and returns the unit to the Configuration menu level.

4.7 2047 Pattern Generator/Receiver

To enter 2047 Pattern Generator/Receiver mode, press **Select** once, **Advance** twice, **Enter** once, **Advance** four times, then **Enter** once.

In this mode, the CSU/DSU generates a standard 2047 pattern and sends it to the network interface. This enables you to test a network that is experiencing errors. Any standard test set or BERT may be used at the other end of the circuit to receive the 2047 pattern and check for errors. In addition, the CSU/DSU will look for a 2047 pattern on the receive side of the network interface. If present, **RX** will appear at the extreme right side of the LCD display. The display also shows an error counter that counts errors up to a total of 99. To clear the error counter to zero, press **Enter**. To insert errors in the transmit pattern, press **Advance**. Pressing and releasing **Advance** once generates one error.

To select the 2047 Pattern Generator/Receiver mode, configure the CSU/DSU for synchronous operation and line speed equal to port speed. If you don't do this, the 2047 Pattern Generator/Receiver mode displays an **Option Error 2** message.

To terminate the 2047 Pattern Generator/Receiver mode, press **Select** once. This returns the CSU/DSU to the Configuration menu level. There is no automatic timeout for 2047 mode.

4.8 Remote Loop

To enter Remote Loop, press **Select** once, **Advance** twice, **Enter** once, **Advance** three times, then **Enter** once.

This test is extremely useful in initial installations on new DDS circuits that are not frame relay. If the pair of CSU/DSUs do not pass the Rmt/Loop test, they will not pass data correctly from the DTE sources. Verify with an end user that the CSU/DSUs do or do not pass the Remote Loop test before proceeding to other correctional activities. Often, a Remote Loop test initiated from one end will operate in one direction, but not the other. Under these circumstances, it is easy to identify which pair of DDS wires (Transmit or Receive) is functional and which is not.

This test can be performed only between two Smart 64K CSU/DSUs. The initiating CSU/DSU outputs a data pattern on its transmit pair to a remote CSU/DSU. The remote CSU/DSU observes the test pattern for five to fifteen seconds to determine whether or not the pattern is accurate and valid. If so, the remote CSU/DSU displays the LCD message **Remote Loop Pend** and begins transmitting the same test pattern back to the originating CSU/DSU. The originating CSU/DSU checks the incoming data for the presence of a special test pattern of data. Once received for five to fifteen seconds, the originating CSU/DSU changes its initial LCD message, **Remote Loop Pend**, to **Remote Loop Pass**.

Once this test is in operation, any bit errors detected by the originating CSU/DSU or the remote CSU/DSU will cause the LCD message to revert back to a **Remote Loop Pend** condition. This will continue as long as bit errors are detected. When the pattern is again received accurately, the **Remote Loop Pass** message is again displayed. This display will timeout after 5 minutes.

To terminate the Remote Loop test, press **Select** once. This returns the CSU/DSU to the Configuration menu level.

4.9 Line Analysis—The I.Q. System

To enter the Line Analysis or I.Q. system mode, press **Select** once, **Advance** twice, **Enter** once, **Advance** five times, then **Enter** once.

The CSU/DSU contains a unique system of testing called **Line Analysis**. This mode provides Intelligent Quantitative Parametric Testing of the network interface, which gives you information about the receive line signal. The line characteristics examined include attenuation, background noise, and impulse noise. See **Chapter 5** for complete details.

To terminate the Line Analysis mode, press **Select** once. This returns the CSU/DSU to the Configuration level.

4.10 Locking the Front Panel

To ensure that an operational condition is not accidentally interrupted, the CSU/DSU can lock and unlock its front-panel buttons. To lock the buttons, press **Advance** and **Enter** while in operational mode and hold them down for five seconds. The LCD display will show a **….Locked….** message. To unlock, again press **Advance** and **Enter** for five seconds.

4.11 Factory Configuration

The default factory configuration is 56,000 bps line, 56,000 bps port, synchronous, slave clock, and RTS constant. To select this configuration at any time, press all three buttons while applying power to the CSU/DSU.

4.12 Telco Central Office Loopbacks

The CSU/DSU performs the mandatory telephone-company-initiated loopbacks, CSU Loop and DSU Loop.

4.13 Telco CSU Loopback

To initiate the Telco CSU Loopback, the telephone company performs a sealing current reversal on the DDS circuit. The CSU/DSU senses this condition and initiates a uni-directional loopback at the network interface. While in this mode, any data sent by the telephone company will be reflected back at the network interface. The CSU/DSU displays the message **Telco CSU Loop** on the LCD.

4.14 Telco DSU Loopback

To initiate the Telco DSU Loopback, the telephone company performs a specific bi-polar code violation on the DDS circuit. The CSU/DSU senses this condition and initiates a uni-directional loopback at the processor interface. While in this mode, any data sent by the telephone company will be reflected back. The CSU/DSU displays the message **Telco DSU Loop** on the LCD.

4.15 Five-Minute Timer

The CSU/DSU employs an internal five-minute timer that monitors any user-initiated test condition. After five minutes of being in a non-operational state other than the Telco CSU and DSU Loopbacks, 2047 Pattern Generator/Receiver, and Line Analysis, the CSU/DSU automatically returns to a normal operating condition. This prevents the CSU/DSU from accidentally being left in a test condition.

4.16 Flow Control

The CSU/DSU supports several methods of flow control through the DDS network. Since the CSU/DSU provides clear channel operation with absolute character transparency on all channels, all of the software flow controls defined for asynchronous operation are supported. The software flow control systems include (but are not limited to) XON/XOFF, ENQ/ACK, ENQ/Anything, plus others.

The CSU/DSU also supports hardware flow control via two common leads appearing on most synchronous and asynchronous systems—Request To Send (RTS) and Data Carrier Detect (DCD). When the CSU/DSU receives an external RTS lead signal that is high, the remote CSU/DSU raises its DCD lead. This also is true in reverse. For DTE systems requiring flow control, this is sufficient for normal operation.

4.17 Multipoint Operation and Anti-Streaming

In multipoint environments, RTS raises the remote CSU/DSU's DCD lead and vice versa.

The CSU/DSU will operate in all defined multipoint environments including port speed equals line speed, rate adaptive, asynchronous, and synchronous data formats.

NOTE

64k Clear Channel operation is not a multipoint environment.

The CSU/DSU also supports an anti-streaming feature. Streaming means that the DTE device raises its RTS lead and fails to lower it in a short amount of time.

Such conditions result in a streaming condition in which the entire multipoint circuit ceases to operate. You can configure the CSU/DSU to set a timer whenever RTS is raised by the DTE. If the timer expires before the DTE lowers its RTS lead, the CSU/DSU automatically shuts down the DTE and resumes IDLE on the

network, allowing other DTE units in the multipoint to continue operation. In addition, for malfunctioning DTEs that persist in streaming, you may also select an anti-streaming counter. If the count of streaming conditions equals or is greater than the selected count that you establish, the CSU/DSU will take the failing DTE off-line. You must intervene manually after the DTE is repaired to continue operation of the failing DTE location. To do this, re-initialize or power-cycle the CSU/DSU.

Parameters for the anti-streaming timer include Off, 0.5, 1.0, and 6.5 seconds. Parameters for the anti-streaming occurrence counter include Off, 1, 10, and 50. Anti-streaming only appears on the menu system if **RTS External** is selected; otherwise, it is in an Off condition.

4.18 Limited Distance Modem Operation

The CSU/DSUs operate extremely well as Limited Distance Modems (LDMs). The connecting copper wire can be private end-user cabling or unloaded cabling from the local telephone company.

The distance that the CSU/DSU may traverse depends on the wire gauge used, along with the number of splice points that the wire may have, as well as the speed at which the CSU/DSUs must operate. Refer to the table below to determine whether the CSU/DSU will function properly in a given LDM environment.

Network Interface Speed	Max. Distance with No Noise	Max. Distance with Noise
72,000 bps	28,000 ft. (-61 dB)	20,000 ft. (-43 dB)
56,000 bps	30,000 ft. (-62 dB)	22,000 ft. (-45 dB)
25,600 bps	32,000 ft. (-55 dB)	24,000 ft. (-41 dB)
19,200 bps	35,000 ft. (-55 dB)	26,000 ft. (-41 dB)
12,800 bps	36,000 ft. (-49 dB)	29,000 ft. (-40 dB)
9600 bps	36,000 ft. (-44 dB)	31,000 ft. (-38 dB)
6400 bps	38,000 ft. (-40 dB)	35,000 ft. (-36 dB)
4800 bps	46,000 ft. (-42 dB)	42,000 ft. (-38 dB)
3200 bps	60,000 ft. (-46 dB)	45,000 ft. (-34 dB)
2400 bps	78,000 ft. (-52 dB)	52,000 ft. (-34 dB)

All measurements are for 24-gauge wire. With 19-gauge wire, the above distances are approximately two times longer. With 26-gauge wire, the above distances are approximately 70% of the stated length. A network interface speed of 72,000 bps corresponds to a Clear Channel 64,000-bps circuit or a 56,000-bps DDS II circuit. Non-standard network interface speeds shown above correspond to DDS II speeds. The **Max. Distance with No Noise** column indicates the maximum distance achieved by a Smart 64K CSU/DSU when no noise is present with its corresponding dB attenuation loss. The **Max. Distance with Noise** column indicates the maximum distance the CSU/DSU can reach with the maximum allowable background and impulse noise present with its corresponding dB attenuation loss.

Clock settings for LDM operation are unique. For normal DDS operation, the CSU/DSUs are set to **Slave Clock**. Timing is thus derived from the DDS network. For LDM operation, clock timing must be available from the CSU/DSUs. To do this, set one of the two CSU/DSUs to **Master Clock** and the other CSU/DSU to **Slave Clock**.

4.19 Error Messages

An error screen appears a) when you request an option that is not available under the current configuration, or b) if you need to take some action before the selected option will become available.

The screen appears as follows:

Option error #

The pound sign (#) is replaced with a number (1, 2, or 3) indicating the reason this screen was displayed. 1, 2, and 3 are described as follows:

1. An attempt was made to run the 2047 Pattern Generator/Receiver while in async or rate adaptive mode.

2. You have executed a sequence of events making it necessary to recalculate the gain setting before the requested option can be used. The gain is calculated each time the CSU/DSU powers up or you press **Enter** from the Normal Mode menu screen.

3. The CSU/DSU tried to establish a link with the port speed set to a value greater than the link speed.

4.20 Normal Mode Initialization Display

Upon power-on or when the Normal Mode menu screen option is selected, the CSU/DSU begins testing the network interface signal to determine how much front-end gain is necessary. While this is being calculated, the LCD screen displays **Initializing…**.

Com * appears on the LCD screen, and the CSU/DSU begins operating. After a few more seconds, internal digital signal processing calculations are complete. If you press **Select**, the message **Please wait** will be displayed. The entire time for all of this to occur is approximately 5–8 seconds.

4.21 Version Number Display

At the top level of the menu, **Configuration** is displayed. On the same level are various options including **Normal Mode**, **Diagnostics**, **Master/Slave Clock**, and **Version Number**. The Version Number is the current software revision level of code operating within the CSU/DSU. Black Box Technical Support may request the version number while diagnosing a problem with the CSU/DSU.

5. Line Analysis

The Smart 64K CSU/DSU is equipped with a diagnostic subsystem that's capable of doing a complete line analysis of the network interface. This function is termed I.Q., or Intelligent Quantitative Parametric Testing. I.Q. uses the Digital Signal Processing (DSP) power of the on-board DSP processor to measure line attenuation, noise, bi-polar violations, and actually compares the signal quality to the AT&T® and RBOC line specifications. It determines whether a line is "in specification" or "out of specification." If a DDS line is out of specification due to attenuation, background noise, or impulse noise, a simple LCD display message indicates the problem.

Analyzing a line involves seven steps after setup and initiation. These steps are described in **Sections 5.3** through **5.9**.

5.1 Setup

In order for the Line Analysis subsystem to perform properly, a signal must be present on the DDS circuit. Line Analysis was calibrated using a standard 2047 pattern and is required for I.Q. testing. The source for a 2047 pattern at the other end of a circuit may be the telephone company central office test board or another CSU/DSU located at the other end of the circuit. If two CSU/DSUs are placed at opposite ends of the same circuit, one can be put in 2047 pattern generation mode to perform the testing. The telephone company central office can also generate the required 2047 pattern. You may also use an external BERT at the other end of the DDS circuit you're testing.

5.2 Initiation

To initiate Line Analysis testing, the CSU/DSU should be brought to a normal operating condition on the DDS circuit first. To do this, plug the line into the RJ-48S female connector on the rear of the CSU/DSU. Press **Select**, **Advance**, then **Enter**. Depending upon whether the DDS circuit is properly provisioned, the circuit may appear to operate correctly at this time. CSU and DSU central office loopbacks may be initiated as required for testing.

To place the CSU/DSU into Line Analysis mode, press **Select**, **Advance** twice, **Enter**, **Advance** five times, then **Enter**.

5.3 Step 1: Network Interface Rate Calculation

The following message is displayed on the front panel of the CSU/DSU: **NI Rate Calc: XX**. Determining the rate or frequency of the network interface takes anywhere from a few seconds to one minute. There are ten possible DDS frequencies for both DDS I and DDS II speeds. (DDS I and DDS II refer to Type 1 and Type 2 digital data service available from your service provider.) The **XX** in **NI Rate Calc: XX** is a seconds counter. When complete, Line Analysis will present one of the following messages:

NI: DDS II 72.0K—(see the first Note, below)

NI: DDS I 56.0K

NI: DDS II 25.6K

NI: DDS I 19.2K

NI: DDS II 12.8K

NI: DDS I 9.6K

NI: DDS II 6.4K

NI: DDS I 4.8K

NI: DDS II 3.2K

NI: DDS I 2.4K

NOTE

Line Analysis cannot detect whether 64.0K Clear Channel DDS II is in use versus 56.0K DDS II. Both have the same network interface rate of 72.0K.

NOTE

Customer Service personnel have often spent days trying to determine why a specific DDS circuit does not work properly. Occasionally, the telephone company providing the service places an Office Channel Unit in service at the wrong speed or with/without a secondary channel (DDS I vs DDS II). This can now be detected and corrected.

5.4 Step 2: Attenuation Calculation

To view the attenuation calculation for the network interface, press **Advance**. The CSU/DSU Line Analysis subsystem now calculates the attenuation of the network interface signal in dB units. This calculation is accurate to within 0.5 dB and is expressed as a negative value.

The CSU/DSU displays the following signal attenuation message:

Sig: -XX.XXdB

Where **XX.XX** is a numeric value of the signal attenuation.

NOTE

Bellcore Specification TR 62310 indicates that the maximum attenuation for any DDS circuit should not be greater than –38.00 dB (72K through 9.6K) or –34.00 dB (6.4K through 2.4K) depending upon NI frequency. In practice, most Regional Bell Operating Companies (RBOCs) have selected a more stringent standard of –34.00 dB for all network interface frequencies. Line Analysis will provide attenuation readings in the range of 0.00 dB to approximately –60.00 dB.

5.5 Step 3: Line Status Display

Press **Advance** to view the Line Status Display. The next step of Line Analysis is to declare a DDS circuit "in" or "out" of specification. This is shown in the following display:

Line: OK

Line: Bad Err:ABI

where

A = Attenuation out of specification

B = Background noise out of specification

I = Impulse noise out of specification

If a line is in specification, the **OK** message is given. If out of specification, one or more of the letters **A**, **B**, or **I** will be present. The letter(s) present indicate the condition(s) causing the DDS line to be declared out of specification. Again, **Enter** will reset the conditions, causing a new calculation to be performed and displayed. The Step 3 display works in conjunction with Steps 4, 5, and 6.

5.6 Step 4: Background Noise Display

To view the background noise display for the network interface, press **Advance**. Press **Enter** to clear the CSU/DSU of previous background noise calculations. Line Analysis provides a continuous calculation of noise that's present (both background and impulse). The maximum noise value is retained unless you clear it by pressing **Enter**. One of the following displays will appear:

Bkg: S/N Small

Bkg: S/N Large

Bkg: >>XX.XXdBm

Bkg: <<-XX.XXdBm

Background noise is any combination of white noise, near-end cross talk, and power noise. A comparison of maximum background noise specifications given by Bellcore TR 62310 is presented as the XX.XX value. The XX.XX value varies depending upon the network interface frequency. The dynamic noise measurement taken from the line signal is either greater than or less than the specification value from 62310. If greater than the specification value, the line will be shown as out of specification in Step 3. Allow several minutes of calculation to allow the CSU/DSU's Line Analysis subsystem to detect the maximum background noise that's present on the network interface.

For very small attenuation circuits (0 to –10 dB), the signal to noise ratio is so strong in favor of the signal that even if a large amount of background noise were present, it would not affect operation on the DDS circuit. For such conditions, the "S/N Large" message is displayed. In addition, for large attenuation circuits (>39.00 dB), the DDS circuit is already out of specification and the measurement of background noise that's present may be of interest but of no value. When the noise measurement of highly attenuated circuits becomes too large, **S/N Small** is displayed.

NOTE

When a circuit is out of specification, the CSU/DSU might still operate error-free. This is both a plus and a minus. The plus is that a circuit that's out of specification often operates without errors on some manufacturers' CSU/DSU. The minus is that telephone companies often declare a circuit in specification by merely operating a commercial CSU/DSU on the line before it is turned over to the user. This is *not* a valid test of a circuit being in specification.

NOTE

Bellcore Specification TR 62310 indicates that the maximum background noise allowable (that may be presented) varies by frequency of the network interface. An independent specification also exists for impulse noise. If both are present at the same time, background noise may encompass the impulse noise that may be present or may be additive. With the additive condition, both background and impulse noise may be in specification, but the combination of the two may show that one or both of the background/impulse noise limits are exceeded. Under such circumstances, the DDS line will be declared out of specification in Step 3. A limitation of Bellcore TR 62310 is that it assumes that only one type of noise may be present on any given DDS circuit.

5.7 Step 5: Impulse Noise Display

Press **Advance** to view the impulse noise display. Press **Enter** to discard previous noise calculations and take new readings. Line analysis provides a constant calculation of noise that's present—both background and impulse. The maximum noise value is retained unless cleared by pressing **Enter**. One of the following displays will be shown:

Imp: S/N Small

Imp: S/N Large

Imp: >>-XX.XXdBm

Imp: <<-XX.XXdBm

Impulse noise is any noise event that occurs, disappears, and then reappears. For the purposes of Line Analysis, calibration was done with a pseudo random impulse noise source which on the average appeared every 200 millisecs and had a duration of 80 microsecs. The Bellcore TR 62310 specification indicates that no noise event will re-occur after it is present for 200 millisecs.

However, event timing may be as much as several minutes apart. For this reason, impulse noise calculations will continue for a number of minutes to obtain a true reading of signal impulse noise. The CSU/DSU's I.Q. Line Analysis subsystem operates for minutes, hours, or days (if necessary). Results are not cleared until you press **Enter**. If a problem circuit needs to operate overnight to detect noise, the CSU/DSU's I.Q. accommodates this environment. A comparison of maximum impulse noise specifications given by Bellcore TR 62310 is the XX.XX value. The XX.XX value varies depending upon the network interface frequency. The dynamic noise measurement taken from the line signal is either greater than or less than the specification value. If greater than the specification value, the line will

be out of specification in Step 3. As stated before, you should allow several minutes of calculation to allow the CSU/DSU's I.Q. Line Analysis subsystem to detect the maximum impulse noise that's present on the network interface.

For very small attenuation circuits (0 to –10.0 dB), the signal to noise ratio is so strong in favor of the signal that even if a large amount of impulse noise were present, it would not affect operation on the DDS circuit. For such conditions, **S/N Large** is displayed. In addition, for large attenuation circuits (>-38.00 dB), the DDS circuit is already out of specification and the measurement of impulse noise that is present may be of interest but of no value. When the noise measurement of highly attenuated circuits becomes too large, **S/N Small** is displayed.

5.8 Step 6: Bi-Polar Violations Display

Press **Advance** to view the Bi-polar Violations display. Bi-polar violations that may be present are shown on the following display:

Vs: Z S D F C I E

where

Z = Zero Violation

S = Out of Service Violation

D = DSU Loop Violation

F = Out of Frame Violation

C = CSU Loop Violation

I = Idle Violation

E = Error Violation

Although this dynamic display is cryptic, it's extremely valuable in detecting errors that may be occurring on the received DDS signal. Depending upon the pattern of data used, there may be no violations present. If, however, the 2047 pseudo random pattern is present, a Zero violation is expected and should be present. Any of the violations may be present under normal circumstances except for the Error Violation. Violation sequences sent to the CSU/DSU's Line Analysis subsystem that are not valid are declared an Error Violation. If errors are occurring on the received line signal, this display becomes "alive" with any or all violations occurring at the same time. The display updates every ¼ seconds and reflects violations that have occurred in the past ¼ second.

5.9 Step 7: Loop Status Display

Press **Advance** to view the Loop Status Display. This final display in the Line Analysis series gives the status of central-office-initiated CSU and DSU loops that may be present. The display appears as follows:

Loop Status: —

Loop Status: CSU

Loop Status: DSU

If no loop is present, the **—** message is shown. If a current reversal is present, the **CSU** message is shown. If a DSU loop is present, the **DSU** message is shown.

NOTE

In new DDS circuit installations, you might want to detect loops that were left in an "ON" condition by the telco central office. In addition, for wiring in which transmit and receive are reversed, the "CSU" message will be displayed.

NOTE

The CSU/DSU's I.Q. Line Analysis subsystem is always in a state of line loopback. Anything received on the CSU/DSU's I.Q. receive pair will be reflected on the transmit pair. During Line Analysis, the port of the CSU/DSU's I.Q. is *not active*. No data is received or transmitted on the DTE connection.

6. Troubleshooting

6.1 Calling Black Box

If you determine that your Smart 64K CSU/DSU is malfunctioning, do not attempt to alter or repair the unit. It contains no user-serviceable parts. Contact Black Box 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.

6.2 Shipping and Packaging

If you need to transport or ship your Smart 64K CSU/DSU:

- Package it carefully. We recommend that you use the original container.
- If you are shipping the Smart 64K CSU/DSU for repair, make sure you include everything that came in the original package. Before you ship, contact Black Box to get a Return Authorization (RA) number.

Appendix A. Required Cable

You can configure the DTE interface cable for V.35 or RS-232 signaling. In either case, special cables are required to make the connection between the primary channel of the CSU/DSU and the data terminal equipment. These cables are wired as indicated in the two tables that follow.

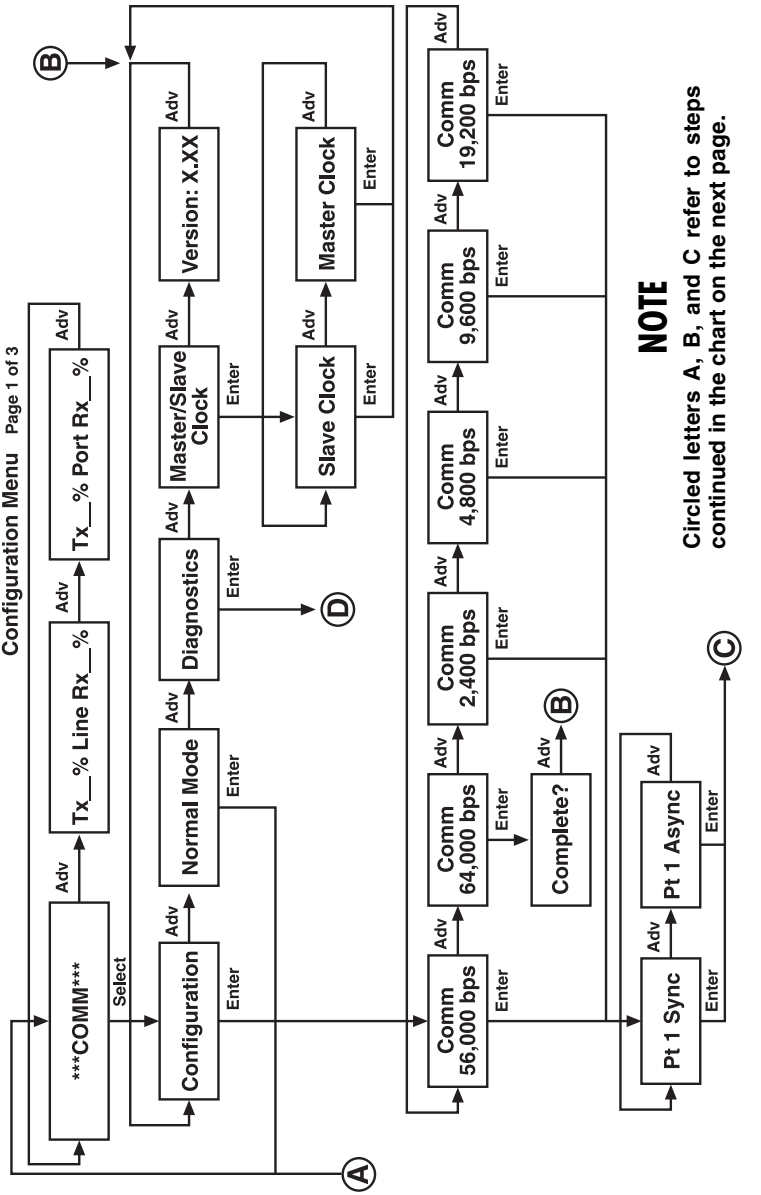
NOTE

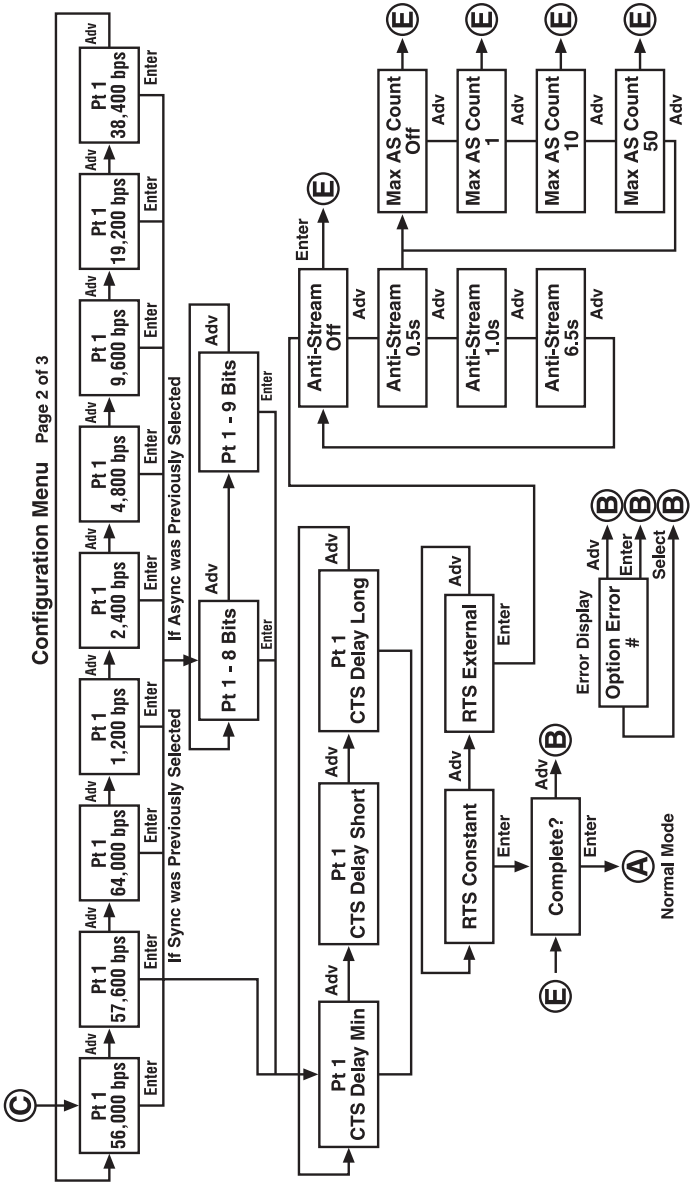
See Section 3.2 for cable-length requirements.

Pin Definitions V.35	Designation	Source
B	Signal Ground	Both
A	Chassis Ground	Not connected
C	Request to Send (RTS)	DTE
E	Data Set Ready (DSR)	CSU/DSU
H	Data Terminal Ready (DTR)	Not connected
D	Clear to Send (CTS)	CSU/DSU
F	Data Carrier Detect (DCD)	CSU/DSU
P	Transmit Data (A)	DTE
S	Transmit Data (B)	DTE
R	Receive Data (A)	CSU/DSU
T	Receive Data (B)	CSU/DSU
Y	Transmit Timing (A)	CSU/DSU
AA	Transmit Timing (B)	CSU/DSU
V	Receive Timing (A)	DTE
X	Receive Timing (B)	DTE

Pin Definitions RS-232	Designation	Source
2	Transmit Data	DTE
3	Receive Data	CSU/DSU
4	Request to Send (RTS)	DTE
5	Clear to Send (CTS)	CSU/DSU
6	Data Set Ready (DSR)	CSU/DSU
7	Signal Ground	Both
8	Data Carrier Detect (DCD)	CSU/DSU
15	Transmit Clock (Sync Only)	CSU/DSU
17	Receive Clock (Sync Only)	CSU/DSU
20	Data Terminal Ready (DTR)	DTE

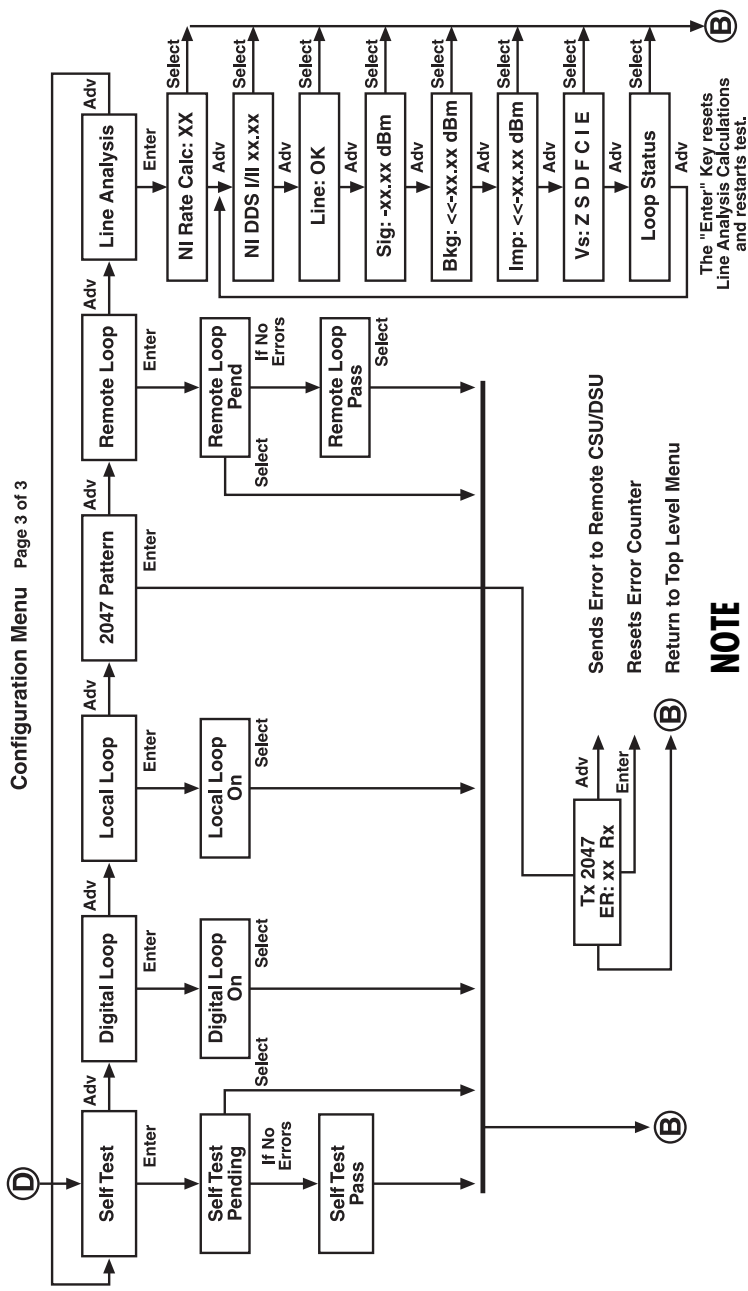
Appendix B. Menu System Flow Chart





NOTE

Circled letters A, B, and C refer to steps continued from the chart on the previous page. Circled letter E refers to steps continued on the next page.


Configuration Menu Page 3 of 3
Self Test
Digital Loop
Local Loop
2047 Pattern
Remote Loop
Line Analysis
Adv
Enter
Select
Self Test Pending
If No Errors
Self Test Pass
Digital Loop On
Local Loop On
Remote Loop Pend
Remote Loop Pass
NI Rate Calc: XX
NI DDS I/II xx.xx
Line: OK
Sig: -xx.xx dBm
Bkg: <<-xx.xx dBm
Imp: <<-xx.xx dBm
Vs: Z S D F C I E
Loop Status
The "Enter" Key resets Line Analysis Calculations and restarts test.
Tx 2047 ER: xx Rx
Sends Error to Remote CSU/DSU
Resets Error Counter
Return to Top Level Menu
NOTE
Circled letters refer to steps continued from the the previous two pages.

Glossary

CSU (Channel Service Unit): A device that functions as a digital modem. It transmits and receives digital signals, performing functions such as filtering and signal shaping.

DCE (Data Communications Equipment): A device that establishes, maintains, and terminates a data communications session and provides encoding or conversion if necessary.

DDS (Dataphone Digital Service): DDS is a private line digital service, offered by AT&T and the Bell operating companies. It commonly runs at data rates of 2400, 4800, 9600, and 56,000 bps.

DSU (Data Service Unit): A device used in conjunction with a CSU to ensure proper signal shaping and encoding.

DTE (Data Terminal Equipment): A device that is an information source.

DTU (Digital Termination Unit): The DTU combines a Channel Service Unit (CSU) and a Data Service Unit (DSU) in a single package.

I.Q.: A shorthand designation for Intelligent Quantitative Parametric Testing. I.Q. is also commonly used to connote a level of intelligence, implying that the Smart 64K CSU/DSU is an intelligent CSU/DSU.

Mark: A condition in which the Telco line is transmitting or receiving an all-ones signal.

Space: A condition in which the Telco line is transmitting or receiving an all-zeroes signal.

Telco (TELephone COmpany): A general reference to any of the common carriers.

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