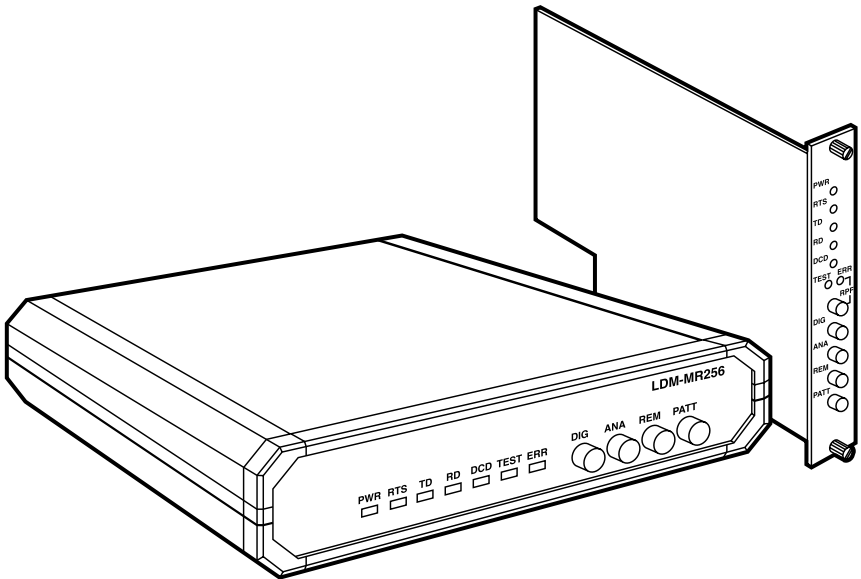




MARCH 2004
ME444A-R3
ME444AE-R3
ME444A-530-R3
ME444AE-530-R3
ME445C-35
ME445C-530
ME445C-X.21

256-kbps Line Driver

(V.35, RS-530, or X.21)



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**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.

Safety Warnings

Always observe standard safety precautions during installation, operation, and maintenance of this product. Only qualified and authorized service personnel should adjust, maintain, or repair this instrument. Do not attempt to adjust, maintain, or repair the equipment.

Telecommunication Safety

The safety status of each of the ports on the line driver appears below:

| <u>Ports</u> | <u>Safety Status</u> |
|---------------------------------------|--|
| V.24, V.35, V.36, X.21, RS-530 LAN | SELV Circuit operating with Safety Extra-Low Voltage |
| G.703, Line | TNV-1 Circuit whose normal operating voltage is within the limits of SELV, on which overvoltages from telecommunications networks are possible. |

FCC Part 15 User Information

This equipment has been tested and found to comply with the limits of a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instruction manual, may cause harmful interference to the radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Warning per EN 55022

This is a Class A product. In a domestic environment, this product may cause interference, in which case the user may be required to take adequate measures.

Declaration of Conformity

The line driver conforms to the following standard(s) or other normative document(s);

| | | |
|---------|-------------------|---|
| 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 (1992/3) | Safety of information technology equipment, including electrical business equipment. |

Supplementary Information

This product 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 by the manufacturer.

**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 conectado 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 física 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 líneas de energía.
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 objetos líquidos 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: Objetos 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

Compliance: FCC Class A, IC Class/classe A

Protocol: Synchronous or asynchronous

Clock Source: Internal, external (from attached device), or receive clock derived from the receive signal

Flow Control: None

Operation: 4-wire, full- or half-duplex, point-to-point or multipoint

Data Rate: Sync: 19.2, 32, 48, 56, 64, 72, 96, 112, 128, 144, 192, or 256 kbps (user-selectable); Async: 19.2, 28.8, 38.4, 57.6, or 115.2 kbps (user-selectable)

Maximum Distance: See the tables in the **Appendix**

User Controls: (4) Front-mounted buttons: (1) DIG, (1) ANA, (1) REM, (1) PATT; (1) Internal data-rate screwdial; (14) Internal jumpers and (1) internal 3-position DIP switch for timing, testing, signal levels/impedances, and other features

Diagnostics: V.54-compliant loopback tests; V.52-compliant BERT

Standards: Loopback tests: ITU-TSS V.54; BERT: ITU-TSS V.52

Leads/Signals Supported: See Tables 4-2 through 4-5

MTBF: 75,500 hours

Interfaces: Line side: Proprietary; Device side: ITU-TSS V.35

Connectors: ME444A-R3, ME444AE-R3: (1) 34-pin M-block female, (1) 5-position terminal block;

ME444A-530-R3, ME444AE-530-R3, ME445C-530, ME445C-35, ME445C-X21: (1) DB25 female, (1) 5-position terminal block

Indicators: (7) Front-mounted LEDs: PWR (power), RTS, TD, RD, DCD, TEST, ERR (error)

Temperature Tolerance: 32 to 122°F (0 to 50°C)

Humidity Tolerance: Up to 90% noncondensing

Maximum Altitude: 8000 ft. (2438.4 m)

Enclosure: High-impact plastic

Power: ME444A-R3: Directly from outlet through detachable 5-ft. (1.5-m) power cord (included); Optimal input: 115 VAC, 60 Hz; Input ranges: 103.5 to 126.5 VAC, 47 to 63 Hz; Consumption: 5 watts;

ME444AE-R3: Directly from outlet through detachable 5-ft. (1.5-m) power cord; Optimal input: 230 VAC, 60 Hz; Input ranges: 207 to 253 VAC, 47 to 63 Hz; Consumption: 5 watts;

ME445C: From the RackNest 2/14; Consumption: 5 watts

Size: ME444A/E-R3: 1.8"H x 7.6"W x 9.6"D (4.6 x 19.3 x 24.4 cm), but the buttons protrude up to 0.3" (0.8 cm) from the front panel and the connectors protrude up to 0.8" (2 cm) from the rear panel;

ME445C: 6.2"H x 0.9"W x 9"D (15.7 x 2.3 x 22.9 cm)

Weight: ME444A/E-R3: 3.1 lb. (1.4 kg); ME445C: 0.8 lb. (0.4 kg)

2. Introduction

The 256-kbps Line Driver is a short-range modem for synchronous or asynchronous transmission—full- or half-duplex—over unconditioned lines. With a range of up to 11.8 miles (19 km), the line driver operates at user-selectable synchronous data rates from 19.2 to 256 kbps or asynchronous data rates from 19.2 to 115.2 kbps. The line driver is available in standalone V.35 or RS-530 (ME444A/E-R3) or rackmount card V.35, RS-530, or X.21 (ME445C) versions.

The line driver uses conditional differential diphase modulation (EUROCOM Std. D1) to provide immunity from background noise, eliminate normal line distortion, and enable efficient transmission and reception of serial data over twisted-pair cable. The modem is coupled to the line through isolation transformers which, in conjunction with protective circuitry, safeguard against AC or DC overvoltages. With this protective circuitry, the line driver can operate even when DC is connected to the line.

Transmit timing is provided internally, derived externally from the PC or terminal, or regenerated from the receive signal. Receive timing is always regenerated from the receive signal.

The line driver features V.54 diagnostic capabilities for local analog loopback and local and remote digital loopback testing. In the digital loopback mode, the operator at either end of the line may test both modems and the line. The loopback is controlled either by pressing front-panel buttons or by manipulating signals on the V.35, RS-530, or X.21 (DTE) interface.

The line driver incorporates a built-in Bit Error Rate Tester (BERT). The internal BERT enables complete testing of both modems and the line without external test equipment. Pressing the line driver's front-panel PATT button causes the unit to generate a pseudo-random test pattern (511-bit, according to ITU-TSS V.52) for testing end-to-end connectivity. The ERR LED flashes when a bit error occurs.

2.1 Physical Description

The line driver stands alone as a desktop unit, or can be mounted in a 19-inch rack with optional brackets (see **Section 4.1**). Also available is a rackmount card version that installs in the RackNest 2/14 (see **Section 4.2**). For descriptions of the line driver's controls and indicators, see **Section 5.1**.

2.2 Functional Description

This section describes the operation of the line driver's circuit blocks, primarily the circuits required for correctly configuring the modem (see Figure 2-1 below).

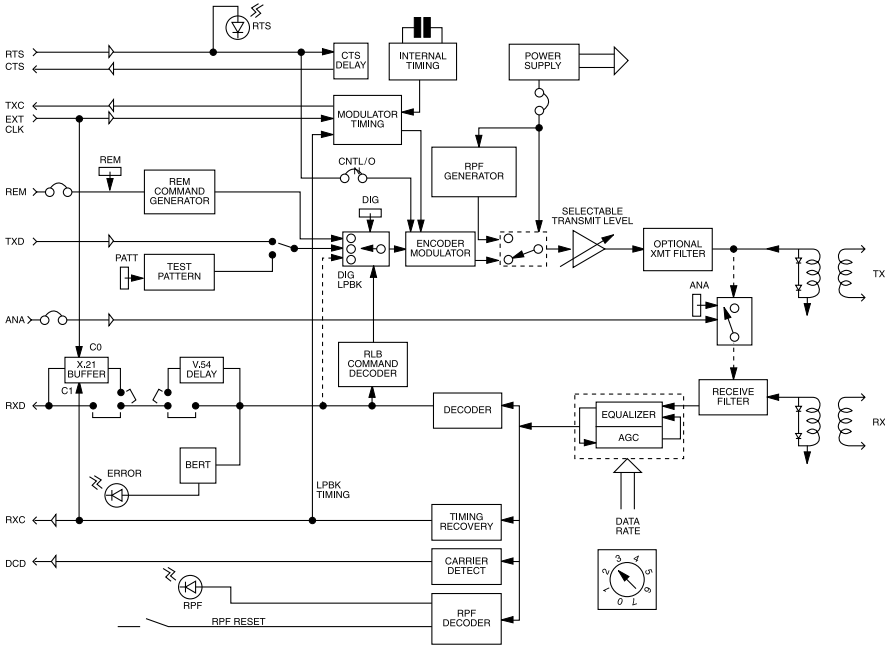


Figure 2-1. Line driver block diagram.

2.2.1 ENCODER MODULATOR

The encoder modulator receives data from the DTE, then modulates the data using the “conditional diphas modulation” technique. You can configure the encoder to operate in one of three modes:

- 4-wire full-duplex (point-to-point)
- 4-wire half-duplex (point-to-point)
- 4-wire multipoint

The appropriate mode is determined by the setting of two jumpers: CARRIER (J2) and RTS-CTS DLY (J4). For multipoint applications, two additional jumpers must be set: XMT IMP (J13) and RCV IMP (J10). See Section 3.3 for a more detailed explanation of the correct jumper settings.

NOTE

In multipoint applications, do not use the 0-msec option for the RTS-CTS delay.

2.2.2 MODULATION TIMING

This circuit supplies the transmit clock to the encoder. Three clock sources are available on the XMT CLK jumper (J3):

- INT—Internal clock. From the modem's internal crystal oscillator.
- EXT—External clock. From DTE.
- RCV—Receive clock. Recovered from the receive signal.

There is also an ASY (asynchronous) setting, but this has no function and should not be selected.

2.2.3 SIGNAL LEVELS

Two options are available for the transmit and receive signal levels: 0 and -6 dBm. You can control the transmit level with the XMT LVL jumper. You can control the receive level with the RCV LVL jumper.

2.2.4 RECEIVER

The receiver comprises several circuits, as shown in the block diagram (see Figure 2-1):

- The RECEIVE FILTER, which removes all the out-band frequencies.
- The EQUALIZER, which comprises several equalizers activated according to data rate.
- The digital Automatic Gain Control (AGC), which automatically compensates for the attenuation of the line.

2.2.5 V.54 DIAGNOSTICS

V.54 loops are activated manually with the front-panel buttons, or through the DTE interface. The buttons and the DTE interface can be enabled or disabled separately by jumpers J7 and J8 (shown in Figure 3-1 and described in Table 3-1).

When you use the line driver as a tail-end to a digital network, the V.54 DLY jumper in the modems located close to the network should be set to ON to prevent multiple loopbacks. The delay switch is used to prevent the last modem from receiving the complete V.54 data sequence and, in turn, being induced into a loop.

2.2.6 TEST-PATTERN GENERATOR AND RECEIVER

This feature allows for easy and quick testing of the local modem as well as the communication link. When the PATT button on the front panel is pressed, the circuit sends and checks a standard 511-bit pseudo-random pattern. If the modem encounters errors, the ERR LED remains ON or blinks.

The test can be carried out in local analog loopback, in remote digital loopback, or in normal point-to-point operation opposite a remote line driver modem. Press the PATT pushbutton on the remote unit or connect a Bit Error Rate Tester that uses the standard 511-bit pattern.

2.3 Applications

The diagrams on this page and the following pages illustrate the line driver operating in various applications.

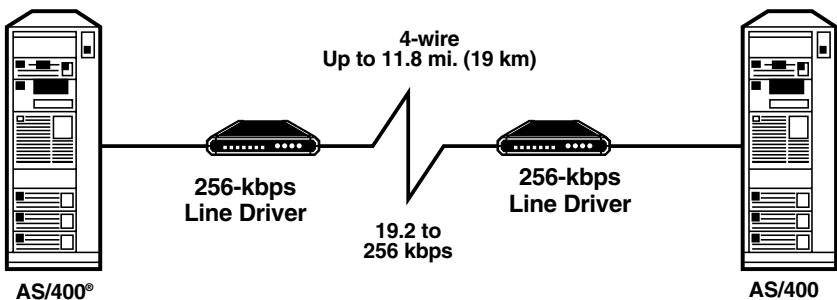


Figure 2-2. Point-to-point application.

256-KBPS LINE DRIVER (V.35, RS-530, OR X.21)

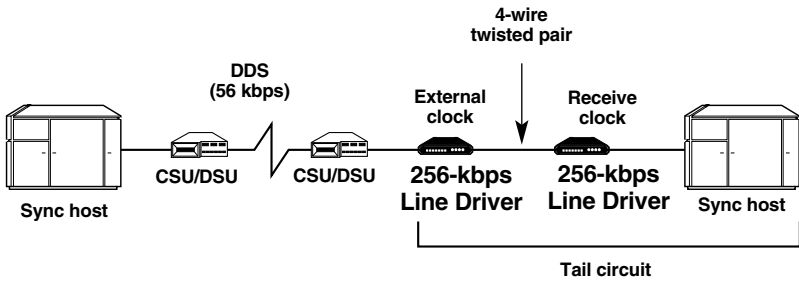


Figure 2-3. Tail-circuit application.

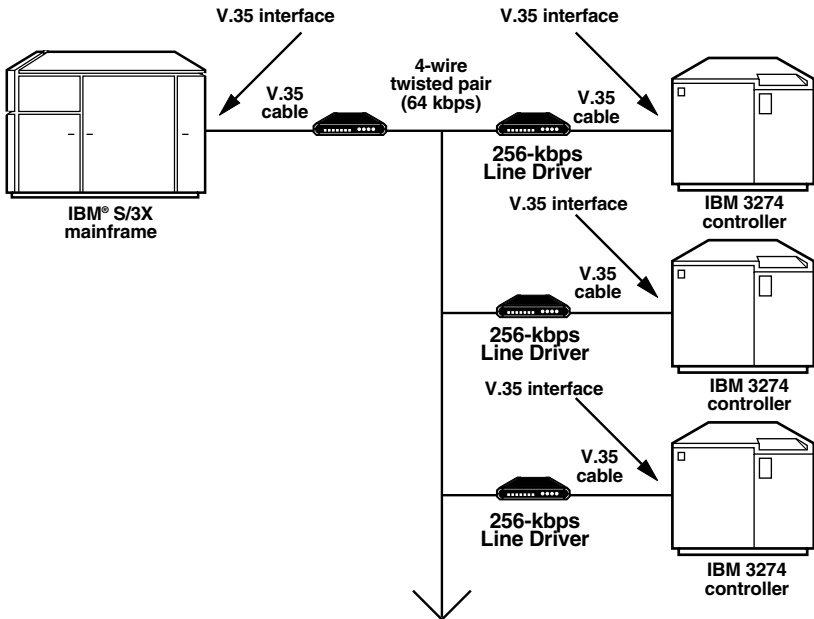


Figure 2-4. Multipoint application.

3. Configuration

This chapter explains how to configure your standalone or rackmount card line driver. After you configure it, see **Chapter 4** for how to install it, **Chapter 5** for how to operate it, and **Chapter 6** for how to test the system.

3.1 Placement of the Standalone Version

Place the 256-kbps Line Driver standalone model within 5 ft. (1.5 m) of a grounded, easily accessible AC outlet. The outlet should be capable of providing either 115 VAC (for the ME444A-R3 model) or 230 VAC (for the ME444AE-R3 model).

The line driver is designed to be placed on a tabletop or bench, and is shipped completely assembled. Allow at least 36" (91.4 cm) of frontal clearance for operation and access for maintenance. You also need at least 4" (10.2 cm) of clearance at the rear of the unit for signal lines and interface cables.

3.2 Installing the Card Version in the RackNest 2/14

The RackNest 2/14 is a special 19" rack component designed to host a number of our short-haul modems and line drivers. It consists of a rack chassis (with one or two power supplies) into which you can plug as many as 14 modem or driver cards.

The nest's rear panel consists of fourteen five-screw terminal blocks ("TB1") and fourteen connectors ("J1"). Each terminal block ("TB1") provides four screws for connecting nest-to-nest G.703 transmit and receive lines—the transmit pair can be connected to the terminals marked XMT, and the receive pair can be connected to the terminals marked RCV—plus a fifth screw for ground connection.

Each interface connector ("J1") is a DB25 female. The pinning of this connector depends on the type of card installed in the corresponding slot, because the cards will present and expect different signals on different pins. For the V.35 model of the line driver card (ME445C-35), the pinning is a special V.35-on-DB25 variant; for the RS-530 and X.21 models, the pinning is RS-530. Refer to Tables 4-2 through 4-5 (**Chapter 4**) for the pinouts of this connector, and for the pinning of the adapters or adapter cables that will be necessary to attach a V.35 or X.21 DTE to this connector.

256-KBPS LINE DRIVER (V.35, RS-530, OR X.21)

DESCRIPTION OF THE RACKNEST 2/14'S POWER SUPPLY

The 115-VAC RackNest 2/14 (our product code RM110A) uses the PS1000A power supply, which accepts 115-VAC input power. The 230-VAC RackNest 2/14 uses power supply PS1000AE, which accepts 230-VAC input power. Each of these power supplies consists of a power-line transformer and a fuse. The 115-VAC nest can also be ordered with dual power supplies (our product code RM110A-2PS); either of these power supplies can be hot-swapped if it fails.

All power-regulating circuitry for the RackNest 2/14 is located on the card modems themselves. Each card has two fuses which protect the entire system against power failure due to a short circuit in one card. Primary power needed is 115 or 230 VAC $\pm 10\%$, 47 to 63 Hz, at 24 VA maximum.

AC power should be supplied to the RackNest 2/14 through a standard power cable run between the AC mains socket on the rear of the nest's power-supply module—an IEC 320 male power inlet which contains an integral fuse—and a standard, grounded, easily accessible AC outlet. (If your nest is an RM110A, you can use the power cord supplied with it; if your nest is an RM110AE, use a power cord appropriate for your site's mains outlets.)

The nest begins operating and supplying power to the installed cards as soon as it is plugged into a mains outlet, and will continue operating until it is unplugged.

WARNING!

This unit should always be grounded through the protective earth lead of the power cable. Before AC power is connected to this unit, the mains plug should only be inserted into a socket outlet provided with protective earth contact. The protective action must not be negated by use of an extension cord without a grounding conductor.

Whenever it is likely that the unit's fuse (located in a bayonet-type fuse holder on the unit's rear panel) has been blown or damaged, make the unit inoperative and secure it against unintended operation until the fuse can be replaced. Make sure that only fuses of the required rating, as marked on the rear panel, are used for replacement. Do not use repaired fuses or short-circuit the fuse holder. Always disconnect the mains cable before removing or replacing the fuse.

Interrupting the grounding conductor, inside or outside the unit, or disconnecting the protective earth contact, can make this unit dangerous!

3.3 Configuring the Standalone or Card Version

Before attaching anything to the 256-kbps Line Driver standalone or rackmount card version, determine which data rate you’re going to use, what the system’s clock source should be, and how you want to set all of the other user-configurable options on the line driver. (Refer to Table 3-1 on the next two pages for a list of all of these options; the SW_n and J_n numbers in the table’s “Element” column correspond to the locations with the same numbers in Figure 3-1.)

Table 3-1. User-configurable options.

| Element | Function | Possible Settings | Standard Factory Setting |
|--------------------------------------|--|---|--------------------------|
| SW3 BAUD RATE dial | Select the data rate in kilobits per second. | Opt. 1 0-256 1-192 2-144 3-128 4-115.2* 5-112 6-96 7-72 8-64 9-57.6* A-56 B-48 C-38.4* D-32 E-28.8 F-19.2* *Async/ sync baud rate | 64 kbps |
| J1 V54 DIS jumper | Enable or disable requests for V.54 digital loopback tests from the remote line driver. | DIS EN | EN (enabled) |
| J2 CARRIER jumper | Select the transmit-carrier mode. When you set this jumper to “ON,” transmit carrier is constantly ON. When you set this jumper to jumper to “CNTRL,” transmit carrier is ON only when RTS is high. Use the CNTRL setting for multipoint applications. | CNTRL ON | ON |
| J3 XMT CLK jumper | Select the source of the transmit timing signal: internal clock, external clock (from DTE), or receive clock (from remote unit). Do not select the ASY (asynchronous, no clock) setting. | INT EXT RCV ASY | INT (Internal) |
| SW2 Data-format DIP switch | (This switch only comes into play when ASY [asynchronous] is selected on jumper J3. ASY should never be selected on this unit, so the settings of this switch are irrelevant.) | | |

Table 3-1 (continued). User-configurable options.

| Element | Function | Possible Settings | Standard Factory Setting |
|------------------------------------|---|--------------------------|--------------------------|
| J4 RTS-CTS DLY jumper | Select the delay in milliseconds that occurs during RTS-to-CTS transitions. Do not select 0 for multipoint applications. | 0 9 70 | 9 ms |
| J5 V54 DLY jumper | Turn V.54 delay ON or OFF. When you turn it ON, V.54 delay prevents multiple loopback of tail-end circuits. | ON OFF | OFF |
| J6 SW. EN. jumper | Enable or disable the DIG, ANA, and REM loopback-control buttons on the unit's front panel. | ON OFF | ON (enabled) |
| J7 RLB DTE** jumper | Enable or disable electronic control of remote digital loopback testing through the DTE interface. | EN DIS | EN (enabled) |
| J8 ALB DTE** jumper | Enable or disable electronic control of local analog loopback testing through the DTE interface. | EN DIS | EN (enabled) |
| J9 RCV LVL jumper | Select the level (in dBm) of receive input from the line. | -6 0 | 0 dBm |
| J10 RCV IMP jumper | Select the receive-line impedance. In multipoint applications, it is advisable to set the master modem and the last modem in the line to 150 Ω , and all others to HIGH. | 150 [Ω] HIGH | 150 ohms |
| J11 RPF. jumper | Enable or disable the remote power failure feature. | ON OFF | ON |
| J12 XMT LVL jumper | Select the level (in dBm) of transmit output to the line. | -6 0 | 0 dBm |
| J13 XMT IMP jumper | Select the transmit-line impedance in ohms. In multipoint applications, it is a good idea to set the master modem to "LOW." | 150 [Ω] LOW | 150 ohms |
| J14 CHASS jumper | Set to CON to connect signal ground to chassis ground. Set to DIS to keep the two grounds isolated from each other. | DIS CON | CON (connected) |
| **NOTES: | If the DTE does not provide the test pins for analog and remote loopback, the ALB DTE and RLB DTE jumpers must be always set to DIS. | | |

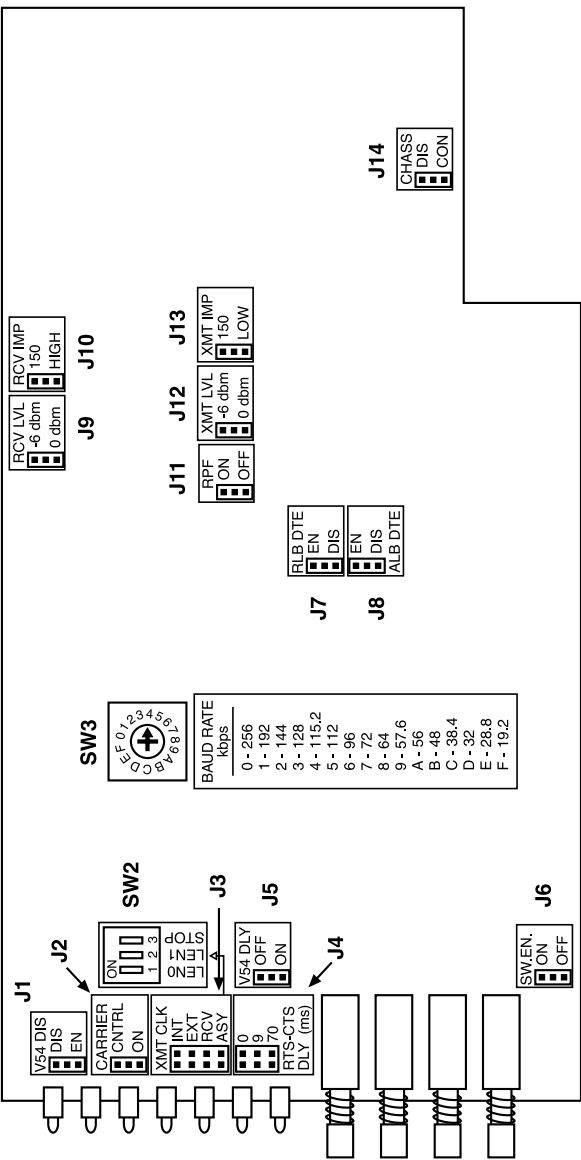


Figure 3-1. Layout of the 256-kbps Line Driver circuit board.

When you have everything at least tentatively decided, take these steps to set the unit's internal controls.

CAUTION!

Disconnect the standalone line driver from the power line before removing it from its housing.

WARNING: HIGH VOLTAGE!

Any adjustment, maintenance, and repair of the open 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 the power source.

1. Disconnect the AC power cord from the AC mains outlet.
2. Unscrew the two rear-panel screws until the rear panel becomes loose. This releases the unit's "drawer" mechanism; now you can pull the screws as if they were the knobs on a drawer and expose or remove the unit's circuit board.
3. Identify the control(s) (refer to Figure 3-1).
4. Move the control(s) to your desired position(s).
5. Replace the circuit board and screw the rear-panel screws back in.

4. Installation

4.1 Installing the Standalone Version in 19-Inch Racks

4.1.1 OVERVIEW

The 256-kbps Line Driver standalone version can be installed in 19-inch racks. It is 1U (1.75", 4.4 cm) high and is slightly less than half as wide as the available mounting area.

Two rack-adapter kits are available as special quotes: One kit provides the hardware necessary to install a single unit, and the other provides the hardware necessary to install two units side by side. **Sections 4.1.2 and 4.1.3** provide step-by-step instructions for installation of single or dual units.

CAUTION!

Disconnect the units from AC power while performing the following procedures.

4.1.2 INSTALLING A SINGLE UNIT IN A 19-INCH RACK

The rack-adapter kit for single-unit installation includes one short bracket and one long bracket. The brackets are fastened with screws to the two side walls of the case, as shown in Figure 4-1.

To prepare the standalone line driver for rack installation, attach the two brackets to the sides of the unit. Do this by inserting screws and flat washers into the two holes at the front of each side of the line driver (nuts are already in place inside the unit).

After attaching the brackets, install the unit in your 19-inch rack by fastening the brackets to the rack's side rails with four screws (not included in the kit), two on each side.

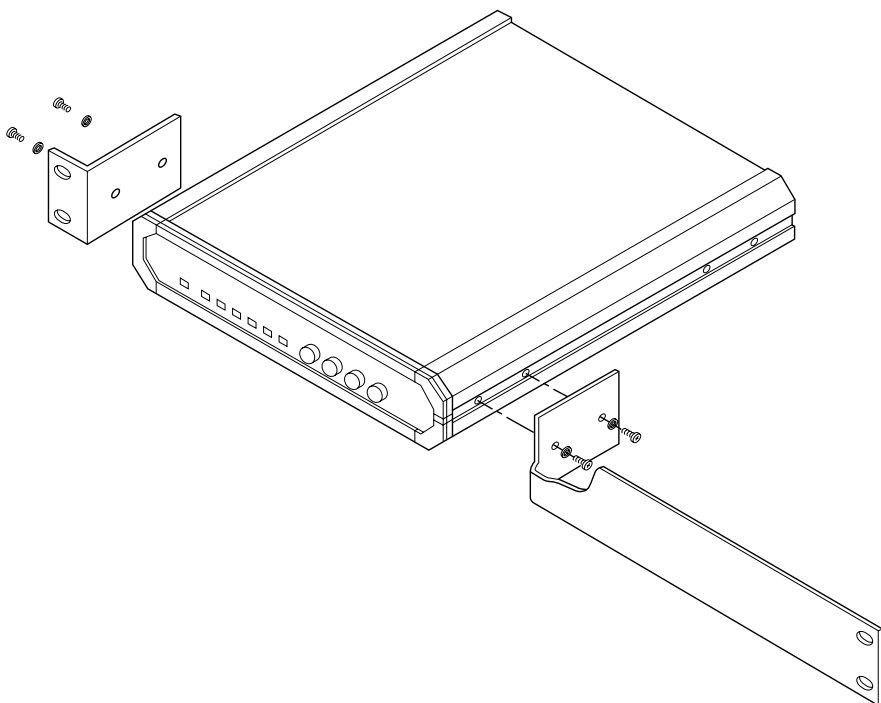


Figure 4-1. Installing a single unit in a 19-inch rack.

4.1.3 INSTALLING TWO STANDALONE UNITS IN A 19-INCH RACK

The adapter kit includes two long side rails (one for each unit), which slide into each other to fasten the units together, and two short side brackets, which hold the two line drivers side by side in a 19-inch rack. Refer to Figure 4-2 when you perform the following procedure:

1. Fasten one long side rail to each standalone line driver—one rail on the right side of one unit, the other rail on the left side of the other unit—using the four included screws and flat washers. The rails must be attached so that they “oppose” each other: The narrow flange of the first rail must face the wide flange of the second rail.
2. Using four included screws and flat washers for each bracket, attach the two short brackets to the vacant sides of the standalone line drivers.
3. Slide the two line drivers’ side rails into each other, fastening the two units together.

4. Secure the included plastic caps to the ends of the rails, to protect the rail ends and prevent the units from moving.
5. You can now use four screws (not supplied with the kit), two on each side, to fasten the assembled units to the side rails of the 19-inch rack.

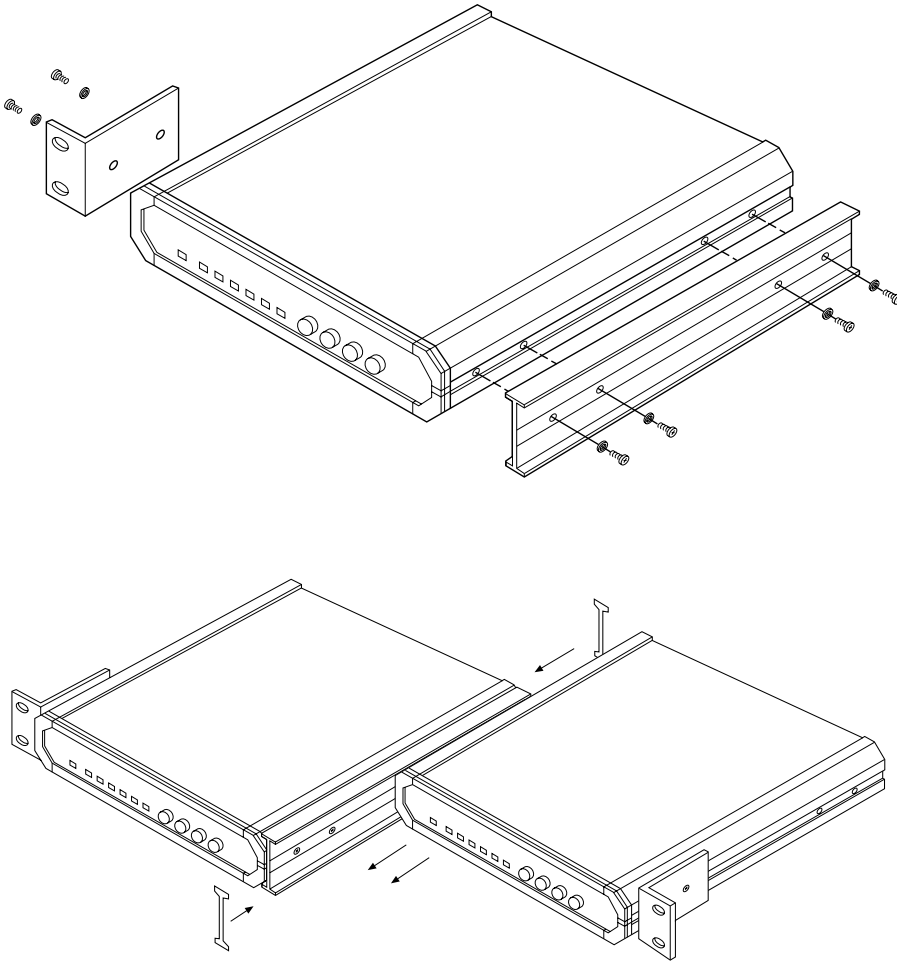


Figure 4-2. Installing two units in a 19-inch rack.

4.2 Installing the 256-kbps Line Driver Rackmount Card Version

THE RACKNEST 2/14 ILLUSTRATED

You will be installing the line driver card in the RackNest 2/14 as shown in Figure 4-3. The front and rear panels of the RackNest are shown in Figure 4-4; the numbered connectors, controls, and indicators are described in Table 4-1.

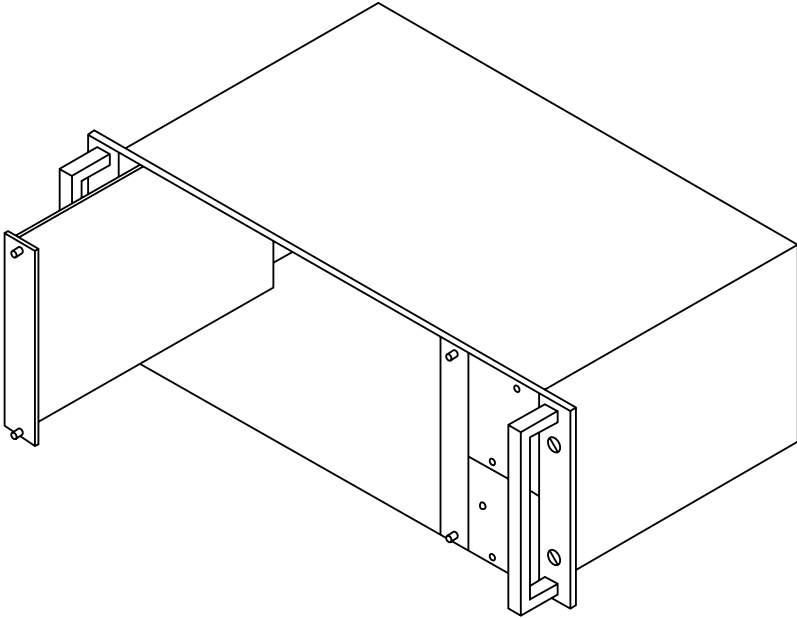


Figure 4-3. Installing a card in the RackNest 2/14.

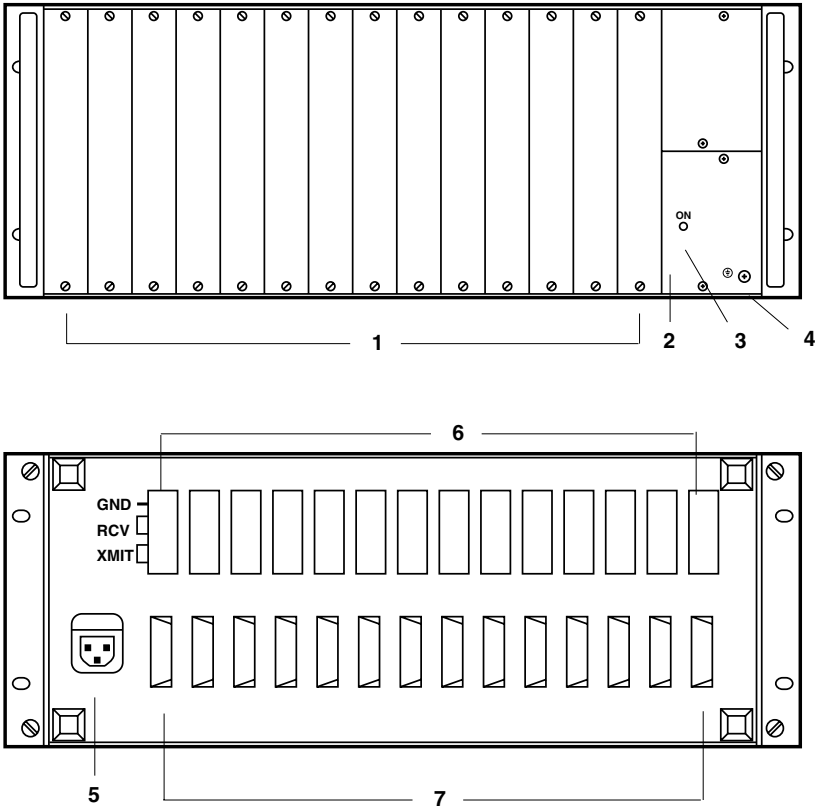


Figure 4.4. The RackNest 2/14 illustrated.

Table 4-1. Descriptions of RackNest 2/14 components.

| Item | Control, Indicator, or Connector | Function |
|-------------|---|---|
| 1 | Card Slots | Slots for installation of compatible cards (slot no. 1 located at the left-hand side). Unused slots are closed with blank panels. |
| 2 | Power-Supply Module | Provides power to modules installed in the enclosure. |
| 3 | ON Indicator | Lights when power supply is operating. |
| 4 | Chassis-Ground Terminal | Connector for attaching other grounds, devices, etc., to the RackNest's chassis ground (optional). |
| 5 | Power Connector | Power connector with integral fuse. |
| 6 | Main Channel Connectors (J1) | DB25 connectors for the module DTE connection. |
| 7 | 4-Wire Terminal Blocks (TB1) | For connection of 4-wire lines. Each modem card has a separate terminal-block connector. |

After you install the RackNest 2/14 in your 19" rack (refer to the RackNest's manual), take these steps to install a line driver card in the RackNest:

1. Insert the card into an empty slot on the RackNest (see Figure 4-3). Do not use excessive force. If the card does not go in easily, remove the card, realign it with the RackNest's enclosure guides, and push it into place.

NOTE

When the RackNest 2/14 is ON, personnel are not exposed to any voltage over 30V on any card or accessible area of the nest. Still, take all reasonable precautions to avoid electric shock.

2. Tighten the nut on the top of the card.
3. Push the bottom of the card as far into the RackNest as it will comfortably go, to ensure that its card-edge connector makes full contact with the RackNest's.
4. Run an appropriate cable from your DTE to the corresponding DB25 connector ("J1") on the back of the RackNest:
 - *ME445C-530 (RS-530) units:* You can use standard RS-530 (DB25 male-to-male) cable. Refer to Table 4-2 for more information.
 - *ME445C-35 (V.35) units:* Either this cable needs to be specially pinned (see Table 4-3) and have a DB25 male connector at the RackNest end and an M/34 male connector at the DTE end, or you need to use a correctly pinned, short DB25-male-to-M/34-female cable or similar adapter to patch between the V.35 (M/34 male-to-male) cable and the RackNest's DB25 connector. Call Black Box for a quote on this type of cable.
 - *ME445C-X21 (X.21) units:* Either this cable needs to be pinned for RS-530 to X.21 (see Table 4-5) and have a DB25 male connector at the RackNest end and a DA15 ("DB15") male connector at the DTE end, or you need to use a correctly pinned, short DB25-male-to-DA15-female cable or similar adapter to patch between the X.21 (DA15 male-to-male) cable and the RackNest's DB25 connector. Call Black Box for a quote on this type of cable.
5. If you haven't already done so, install the remote RackNest 2/14. Repeat steps 1 through 4 at the remote site.

6. Run twisted-pair cable between the local and remote cards. Attach one pair of wires to the corresponding XMT terminals (“TB1”) on the back of the local RackNest and the corresponding RCV terminals on the remote RackNest; attach the other pair of wires to the RCV terminals on the local RackNest and the XMT terminals on the remote RackNest. (It doesn’t matter which wire in each pair goes to which terminal in each pair; the cards autosense parity.) If you’re using a ground wire, attach it to the GND terminal on one RackNest (*not* both of them!)

Table 4-2. Pinout of the RackNest 2/14's DB25 connector when ME445C-530 is installed or RS-530 standalone's DB25 connector.

| SIGNAL NAME (ABBREV.) | ITU-TSS CIRCUIT | LEAD TYPE | DB25 PIN |
|---|-----------------|-----------|----------|
| Shield (SHD) | 101 | | 1 |
| Signal Ground (SGND) | 102 | | 7 |
| Transmitted Data (TD) | 103 | A B | 2 14 |
| Received Data (RD) | 104 | A B | 3 16 |
| Request to Send (RTS) | 105 | A B | 4 19 |
| Clear to Send (CTS) | 106 | A B | 5 13 |
| DCE Ready (DCR) a.k.a. Data Set Ready (DSR) | 107 | A B | 6 22 |
| Data Terminal Ready (DTR) | 108 | A B | 20 23 |
| Received Line Signal Detector (RLSD), a.k.a. Carrier Detect (CD) | 109 | A B | 8 10 |
| Transmitter Sig. Elem. Timing (DTE Source) (TSETT), a.k.a. External Clock (EXTC) | 113 | A B | 24 11 |
| Transmitter Sig. Elem. Timing (DCE Source) (TSETC), a.k.a. Transmit Clock (TC) | 114 | A B | 15 12 |
| Receiver Sig. Elem. Timing (DCE Source) (RSETC), a.k.a. Receive Clock (RC) | 115 | A B | 23 22 |
| Remote Loopback (RL) | 140 | | 21 |
| Local Loopback (LL) | 141 | | 18 |
| Test Mode (TM) | 142 | | 25 |

Table 4-3. Pinout of the RackNest 2/14's DB25 connector when ME445C-35 is installed.

| SIGNAL NAME (ABBREV.) | ITU-TSS CIRCUIT | LEAD TYPE | DB25 (RACK-NEST) PIN | M/34 (NORM. V.35) PIN |
|--|-----------------|-----------|----------------------|-----------------------|
| Frame (Protective) Ground (FGND) | 101 | | 1 | A |
| Signal Ground (SGND) | 102 | | 7 | B |
| Send Data (SD) | 103 | A B | 9 11 | P S |
| Receive Data (RD) | 104 | A B | 12 13 | R T |
| Request to Send (RTS) | 105 | | 4 | C |
| Clear to Send (CTS) | 106 | | 5 | D |
| Data Set Ready (DSR) | 107 | | 6 | E |
| Data Terminal Ready (DTR) | 108 | | 20 | H |
| Received Line Signal Detector (RLSD), a.k.a. Carrier Detect (CD) | 109 | | 8 | F |
| Serial Clock Transmit External (SCTE), a.k.a. External Clock (EXTC) | 113 | A B | 19 16 | U W |
| Serial Clock Transmit (SCT), a.k.a. Transmit Clock (TC) | 114 | A B | 14 10 | Y AA, a |
| Serial Clock Receive (SCR), a.k.a. Receive Clock (RC) | 115 | A B | 23 22 | V X |
| Remote Digital Loopback (RL) | 140 | | 21 | HH, h* |
| Local Analog Loopback (LL) | 141 | | 18 | JJ, j* |
| Test Mode (TM) | 142 | | 25 | KK, k* |

*Black Box often assigns these signals to these M/34 pins, but your DTE might use different pins (if it supports these signals at all). Consult your DTE's manual.

Table 4-4. Pinout of the V.35 standalone's M/34 connector.

| SIGNAL NAME (ABBREV.) | ITU-TSS CIRCUIT | LEAD TYPE | V.35 PIN |
|--|-----------------|-----------|----------|
| Frame (Protective) Ground (FGND) | 101 | | A |
| Signal Ground (SGND) | 102 | | B |
| Send Data (SD) | 103 | A B | P S |
| Receive Data (RD) | 104 | A B | R T |
| Request to Send (RTS) | 105 | | C |
| Clear to Send (CTS) | 106 | | D |
| Data Set Ready (DSR) | 107 | | E |
| Data Terminal Ready (DTR) | 108 | | H |
| Received Line Signal Detector (RLSD), a.k.a. Carrier Detect (CD) | 109 | | F |
| Serial Clock Transmit External (SCTE), a.k.a. External Clock (EXTC) | 113 | A B | U W |
| Serial Clock Transmit (SCT), a.k.a. Transmit Clock (TC) | 114 | A B | Y AA |
| Serial Clock Receive (SCR), a.k.a. Receive Clock (RC) | 115 | A B | V X |
| Remote Digital Loopback (RL) | 140 | | HH |
| Local Analog Loopback (LL) | 141 | | JJ |
| Test Mode (TM) | 142 | | KK |

Table 4-5. Pinout of the RackNest 2/14's DB25 connector when ME445C-X21 is installed.

| SIGNAL NAME (ABBREV.) | ITU-TSS CIRCUIT | LEAD TYPE | DB25 (RACK-NEST) PIN* | DA15 (NORM. X.21) PIN |
|---|-----------------|-----------|-----------------------|-----------------------|
| Shield (n/a) | 101 | | 1 | 1 |
| Ground (G) a.k.a. Signal Ground (SGND) | 102 | | 7 | 8 |
| Transmit (T) | 103 | A B | 2 14 | 2 9 |
| Receive (R) | 104 | A B | 3 16 | 4 11 |
| Control (C) a.k.a. Request to Send (RTS) | 105 | A B | 4 19 | 3 10 |
| Indication (I) a.k.a. Carrier Detect (CD) | 109 | A | 8 10 | 5 12 |
| RS-530: Transmitter Signal Element Timing (DTE Source) (TSETT)† | 113 | A B | 24 11 | 7† 14† |
| Signal Timing (S) | 114 | A B | 15 12 | 6 13 |

*This pinout follows the TIA RS-530 standard.

†Standard X.21 does not support an external clock, and specifies that DA15 Pins 7 and 14 should be used for the Byte Timing (B) A and B signals. Because Byte Timing is hardly ever used, but an external clock is often necessary for today's data communication, many Black Box devices are designed to this modified specification in which the RS-530 external-clock signal replaces Byte Timing.

4.3 Connecting Data Cables

After you set the standalone line driver's internal controls, it's ready to be cabled for operation.

Its electrical connectors are located on its rear panel. These consist of a female V.35 interface connector labeled "DTE," a 5-screw terminal block, and an IEC 320 AC inlet that contains an integral fuse compartment.

The V.35 interface connector, a 34-pin M-block female, carries input/output data, clock signals, and control signals between the line driver and the DTE or DCE (refer to Table 4-4).

The terminal block has five screws for connecting transmit and receive lines—the transmit pair where XMT is indicated (for data output from the unit), the receive pair where RCV is indicated (for data input to the unit), and a drain wire from the cable shield, if you are using shielded cable, where GND is indicated. The XMT and RCV pairs are not sensitive to polarity.

Connect power and data cables to the line driver as described in the following subsections.

4.3.1 POWER CONNECTION

The power connection provides AC voltage to the line driver.

To make this connection on the 115-VAC (ME444A-R3) models, first attach the IEC 320 female outlet of the included power cord to the IEC 320 male inlet on the standalone line driver's rear panel.

To make this connection on the 230-VAC (ME444AE-R3) models, first attach the IEC 320 female outlet of an appropriate power cord to the IEC 320 male inlet on the standalone line driver's rear panel. (This power cord must have a plug on the other end that will fit the site's mains outlets.)

WARNING!

BEFORE PLUGGING THIS UNIT INTO AN OUTLET OR OTHER LIVE POWER SOURCE, make sure its protective earth contact is connected to the protective conductor of the (mains) power cord. The mains plug must be inserted only in a socket outlet provided with a protective earth contact. The protective action must not be negated by use of an extension cord (power cable) without a protective (grounding) conductor.

If the line driver's fuse blows (opens), make sure that you replace it only with a

fuse rated for the required amount of current. You must avoid using repaired fuses or short-circuiting the fuse holders. The fuse, and one replacement fuse, are located in the top part of the mains connector on the line driver's rear panel. The nominal current value of the fuse is 0.125 A for 230-VAC operation or 0.25 A for 115-VAC operation.

Whenever it is likely that the protection offered by the fuse has been impaired, the unit must be made inoperative and secured against any unintended operation.

After you have attached the power cord and have made sure that the cord is properly grounded, you can plug the power cord into a working mains outlet.

CAUTION!

The unit has no power switch. It starts operating as soon as power of the proper type is applied to its POWER connector.

4.3.2 LINE CONNECTION

The LINE connection provides an interface for the TX and RX signals between pairs of line drivers. To make this connection, attach the line wires to the terminal block on the line driver this way:

- XMT + (remote line driver) to RCV + (local unit);
- XMT – (remote unit) to RCV – (local unit);
- RCV + (remote unit) to XMT + (local unit);
- RCV – (remote unit) to XMT – (local unit);
- Optional: Shield or drain wire (line cable) to ground (local line driver—the rightmost terminal).

All connections are made on the back of the line driver.

4.3.3 DTE CONNECTION

The interface (DTE) connector provides an interface for input/output data, as well as clock and control signals, between the line driver and a V.35 DTE or DCE. This connector is a standard 34-pin M-block ("M/34") female. The pinout of this connector is shown in Table 4-4.

To connect the line driver to a V.35 DTE or DCE, use an appropriate cable that is pinned correctly (straight-through for DTE, properly crossed for DCE). Run this cable from the other device to the line driver and attach it to the line driver's interface connector.

Your line driver should now be ready for continuous operation.

5. Operation

This chapter contains a list of the controls and indicators and their functions, as well as a brief description of how to operate the unit. Installation procedures must be completed and checked before you attempt to operate the line driver.

5.1 Controls and Indicators

The front panel of the standalone line driver is shown in Figure 5-1 below. The front panel of the rackmount card line driver is shown in Figure 5-2. It contains all of the unit's external controls and indicators. The functions of the controls are described in Table 5-1, and the meanings of the indicators are described in Table 5-2. In each of these tables, the letters and numbers under the heading "Item" correspond to the letters and numbers in Figure 5-1 or 5-2.

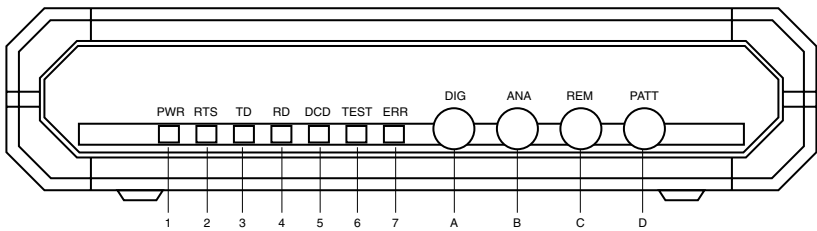


Figure 5-1. The front panel of the standalone line driver.

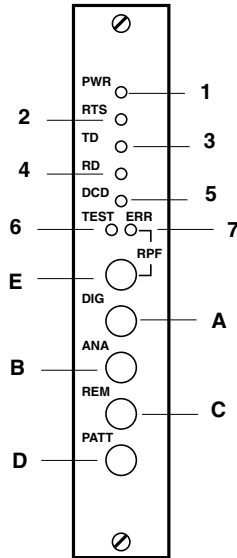


Figure 5-2. The front panel of the rackmount card line driver.

Table 5-1. The controls.

The Item labels in this table correspond to those in Figures 5-1 and 5-2.

| ITEM | CONTROL | FUNCTION |
|------|---------|--|
| A | DIG | Pressing the local digital loopback button causes the local LDM-MR256 to loop received data and clock to its transmitter. Data Set Ready goes low. |
| B | ANA | Pressing the local analog loopback (V.54 Loop 3) button causes the local LDM-MR256 to loop its transmitter output back to its receiver. This loopback may also be activated from the DTE when the "ALB DTE" jumper is set to EN. |
| C | REM | Pressing the remote digital loopback (V.54 Loop 2) switch causes the remote LDM-MR256 to loop received data and clock to its transmitter. Data Set Ready goes low. This loopback may be also activated from the DTE when the "RLB DTE" strap is set to EN. |
| D | PATT | Pressing the PATT button causes the LDM-MR256 to send and receive a 511 test pattern. If errors are encountered, the ERR LED becomes steadily lit or blinks. Receive Data and Clear to Send go low. Note: The unit's "CARRIER" jumper should be set to ON; if it is set to CNTRL, the RTS signal must be high. |
| E | RPF | Remote Power Failure resets the ERR/RPF LED. |

Table 5-2. The indicators.

The item numbers in this table correspond to Figures 5-1 and 5-2.

| ITEM | INDICATOR | FUNCTION |
|------|-----------|---|
| 1 | PWR | Green LED is on when power is on. |
| 2 | RTS | Yellow LED is on when terminal activates Request to Send. |
| 3 | TD | Yellow LED is on when steady SPACE is being transmitted. It flickers when data is transmitted. |
| 4 | RD | Yellow LED is on when steady SPACE is being received. It flickers when data is received. |
| 5 | DCD | Yellow LED is on when a valid receive signal is present. |
| 6 | TEST | Red LED is on when the LMD-MR256 is in any of the loopback modes. |
| 7 | ERR | LED goes ON when PATT switch is activated and then dims. If there are errors in the test pattern, the LED blinks or remains ON. |

5.2 Operating Procedure

The line driver operates entirely unattended, although we recommend that you monitor its LEDs occasionally. To turn the unit off, you must unplug its power cord from the outlet—it has no power switch.

If you want to reconfigure the line driver for a different type of operation, make very sure to unplug the unit first. After the unit is powered down, change the settings of its internal controls as necessary, following the instructions in **Section 3.3**.

6. Troubleshooting

This chapter explains system-test and fault-isolation procedures.

The line driver provides local loopback and remote digital loopback in compliance with the V.54 standard. Unless you disable them, the unit's loopback tests can be activated manually from the unit's front panel, and the local analog and remote digital loopbacks can be activated electronically through the DTE connection.

6.1 Loop Tests

The loop-test buttons (DIG, ANA, and REM) and LEDs built into the line driver allow you to rapidly check the unit, the attached cables, and the attached DTEs. Use the test procedures described in this chapter to verify normal system operation and to isolate faulty equipment if a failure occurs. (Before testing the operation of the system equipment and line circuits, make sure that all devices are turned on and are properly configured.)

6.2 The Bit-Error-Rate Tester (BERT)

You can activate the line driver's internal Bit Error Rate Tester in any diagnostics test in which the transmitted test pattern is looped back to the BERT for comparison. An example is shown in Figure 6-1 on the next page.

The line driver is also capable of operating opposite any 511 BERT tester. When you use one line driver opposite another, either with one or both PATT buttons pressed (see Figure 6-2) or with an external BERT transmitting the same V.52 (511-bit) pattern, you can test the complete link. To activate the BERT, press the PATT button. The ERR LED will light momentarily, just to confirm that the LED is working, and then the test will proceed. If errors are detected, the ERR LED will be continuously lit (if the errors are continuous) or will blink (for intermittent errors).

NOTE

For the line driver's BERT to operate correctly, the CARRIER jumper must be set to ON or the RTS signal must be high.

While PATT is pressed, the V.35 interface is functionally disconnected.

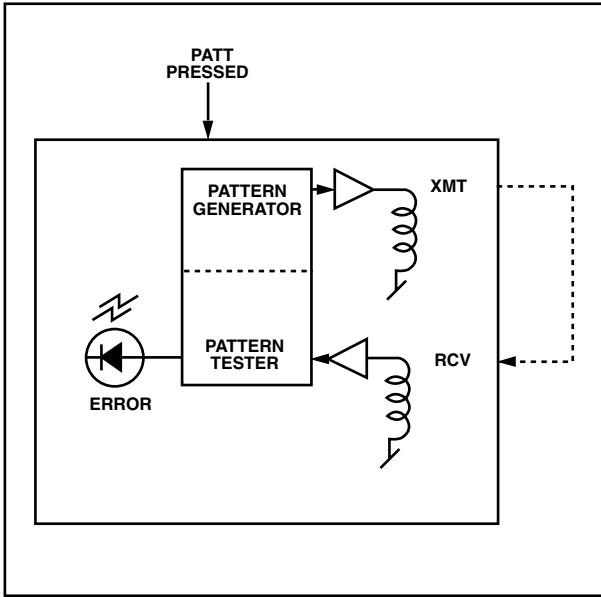


Figure 6-1. BERT using loops.

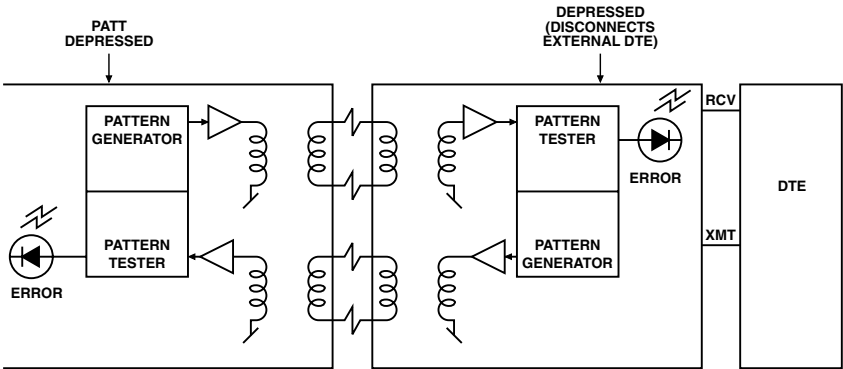


Figure 6-2. Two line drivers doing end-to-end BERT.

6.3 The Modem Self-Test

To verify that the line driver itself is operating correctly, initiate the modem self-test by pressing the PATT and ANA buttons (refer to Figure 6-3 below):

1. Press ANA to start local analog loopback. Both the TEST and DCD LEDs should light. If the DCD LED doesn't light, make sure that the RTS signal is not OFF (low) while the CARRIER jumper is OFF.
2. Press PATT to begin test-pattern transmission. Verify that the TEST and DCD LEDs are still lit and that the ERR LED lights briefly.
3. If the ERR stays lit or continues to flicker after the initial flash, the line driver is faulty; call Black Box to arrange for repair or replacement. Otherwise, the unit passes the test; restore all of the buttons to their normal positions.

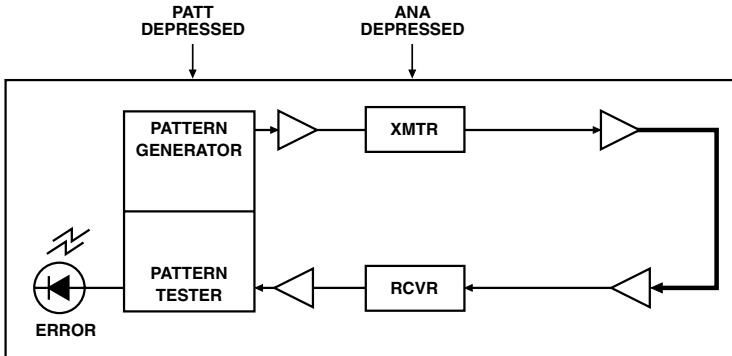


Figure 6-3. Modem self-test.

6.4 Local Analog Loopback

Activate the local analog loopback test by pressing the ANA button or by raising the level of the Local Loopback signal received by the line driver's V.35 connector (Pin J). This test checks the performance of the local line driver, the local DTE, and the connections between them. Perform this test separately at the local and remote sites (refer to Figure 6-4 on the next page):

1. Press ANA or raise Local Loopback to start local analog loopback. The TEST LED should light. The line driver's G.703 transmit output should be connected to its own receiver.

2. Verify that the DTE is operating properly and can be used for a test.
3. Perform the test using one of these methods:
 - Send data from the DTE and check the echoed data stream.
 - Hook up an external Bit Error Rate Test (BERT) unit in place of the DTE.
 - Use the line driver's internal BERT. Press the PATT button. The ERR LED should light briefly just to confirm that the LED is working, and then the test will proceed. If errors are detected, the ERR LED will be continuously lit (if the errors are continuous) or will blink (for intermittent errors).
4. Repeat Steps 1 through 3 at the remote site.
5. If the BERT tests show no errors, but the data echoed back to either DTE is bad, check the DTE and the cable connecting it to the line driver—one of them is faulty.
6. After the test is complete or the fault has been corrected, restore the ANA button to its normal position. Proceed with the digital loopback tests.

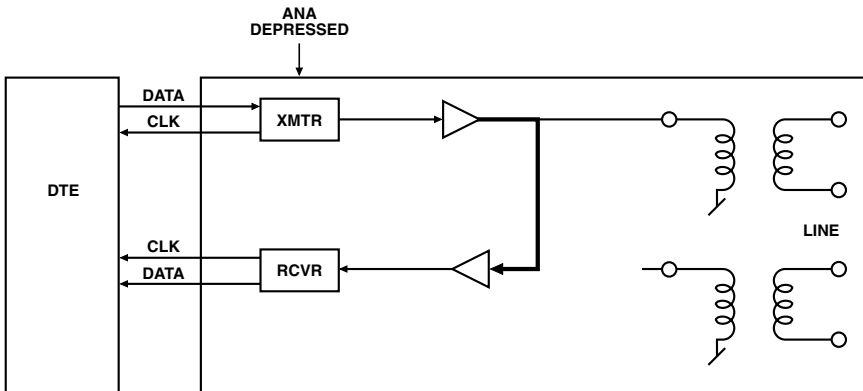


Figure 6-4. Local analog loopback.

6.5 Remote Digital Loopback

Activate the remote digital loopback test by pressing the REM button or by raising the level of the remote loopback signal received by the line driver's V.35 connector (Pin HH). This test involves creating an outbound loopback at the remote line driver (see Figure 6-5 on the next page). The test checks the performance of the local and remote units and the line between them:

1. Press REM or raise remote loopback; the local line driver will signal the remote unit to start remote digital loopback. The TEST LED should light on both units. The remote line driver's receive input should be connected to its own transmitter.
2. Perform a Bit Error Rate Test (BERT). Either:
 - Hook up an external Bit Error Rate Test (BERT) unit in place of the local DTE; or
 - Use the local line driver's internal BERT. Press the PATT button. The ERR LED should light briefly just to confirm that the LED is working, and then the test will proceed. If errors are detected, the ERR LED will be continuously lit (if the errors are continuous) or will blink (for intermittent errors).
3. If the BERT test indicates a fault, but both line drivers pass their modem self-tests, there is a problem somewhere in the communication line between the units.
4. After the test is complete or the fault has been corrected, restore the REM button to its normal position. Proceed with local digital loopback.

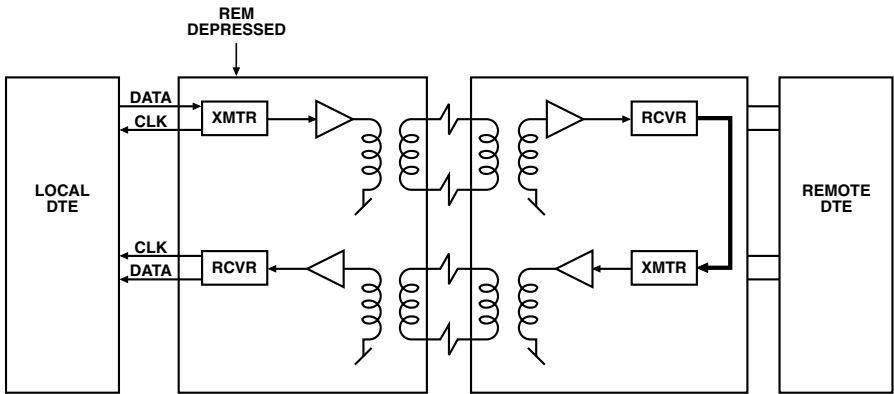


Figure 6-5. Remote digital loopback.

6.6 Local Digital Loopback

Activate the local digital loopback test by pressing the DIG button on the line driver's front panel. This test involves creating an outbound loopback at the local line driver (see Figure 6-6 on the next page). It works the same way as if the remote operator had initiated a remote digital loopback at the remote site. With this test, the remote operator can check the performance of the remote and local line drivers and the line between them:

1. Press DIG; the local line driver will signal the remote unit and will start local digital loopback. The TEST LED should light on both units. The local line driver's receive input should be connected to its own transmitter.
2. Perform a Bit Error Rate Test (BERT). Either:
 - Hook up an external BERT unit in place of the remote DTE; or
 - Use the remote line driver's internal BERT. Press the PATT button. The ERR LED should light briefly just to confirm that the LED is working, and then the test will proceed. If errors are detected, the ERR LED will be continuously lit (if the errors are continuous) or will blink (for intermittent errors).
3. If the BERT test indicates a fault, but both line drivers pass their modem self-tests (see **Section 6.3**), there is a problem somewhere in the communication line between the units.

4. After the test is complete or the fault has been corrected, restore the DIG button to its normal position.

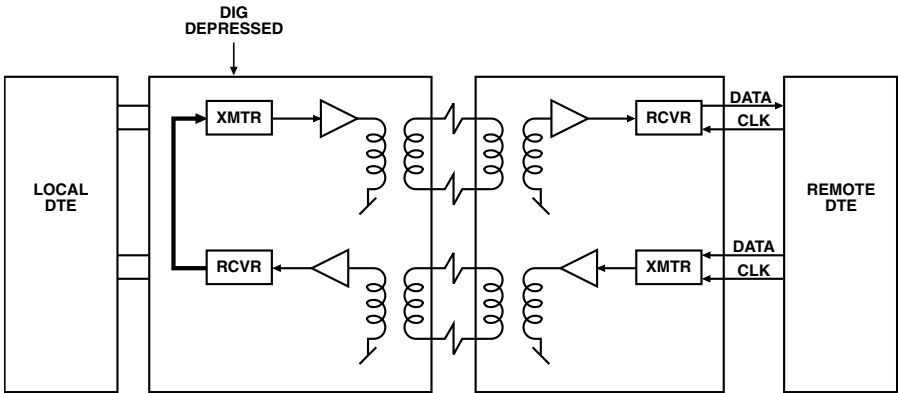


Figure 6-6. Local digital loopback.

6.7 Calling Black Box

If you determine that your line driver 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. The problem might be solvable over the phone.

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.

6.8 Shipping and Packaging

If you need to transport or ship your line driver:

- Package it carefully. We recommend that you use the original container.
- If you are shipping the line driver for repair, make sure you include its power cord. If you are returning the LDM-MR256, make sure you include its manual as well. Before you ship, contact Black Box to get a Return Authorization (RA) number.

Appendix: Maximum Distances

The maximum distance that a pair of line drivers can communicate across will vary depending on the data rate and the thickness (gauge) of the wires. In multipoint applications, it will also vary depending on the number of slaves on the line. Approximate maximum distances for different combinations of these factors are listed in the tables below. Please be aware that these numbers are only approximations; the distances shown might not be attainable for all applications. Also, maximum distances will always be less than those listed when line drivers are used in noisy environments.

Table A-1. Approximate range.

| Baud Rate (kbps) | 19-AWG (0.8 mm) | | 22-AWG (0.6 mm) | | 24-AWG (0.5 mm) | | 26-AWG (0.4 mm) | |
|---------------------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|
| | km | miles | km | miles | km | miles | km | miles |
| 256 | 3.7 | 2.3 | 2.85 | 1.8 | 2.25 | 1.4 | 1.9 | 1.2 |
| 192 | 6 | 3.7 | 4.5 | 2.8 | 3.5 | 2.2 | 2.7 | 1.7 |
| 144 | 10.6 | 6.6 | 6.75 | 4.2 | 4.5 | 2.8 | 3.4 | 2.1 |
| 128 | 12.4 | 7.7 | 7.3 | 4.5 | 5 | 3.1 | 3.6 | 2.2 |
| 115.2* | 12.8 | 8 | 7.65 | 4.8 | 5.25 | 3.3 | 3.8 | 2.4 |
| 112 | 12.8 | 8 | 8 | 5 | 5.5 | 3.4 | 4 | 2.5 |
| 96 | 13 | 8.1 | 8.3 | 5.2 | 6 | 3.7 | 4.15 | 2.6 |
| 72 | 15 | 9.3 | 9.4 | 5.8 | 6.25 | 3.9 | 4.3 | 2.7 |
| 64 | 17.6 | 10.9 | 11 | 6.8 | 7.5 | 4.7 | 5.3 | 3.3 |
| 57.6* | 18.8 | 11.7 | 11.75 | 7.3 | 8 | 5 | 5.6 | 3.5 |
| 56 | 18.8 | 11.7 | 11.75 | 7.3 | 8 | 5 | 5.6 | 3.5 |
| 48 | 19.4 | 12.1 | 12.2 | 7.6 | 8.25 | 5.1 | 5.8 | 3.6 |
| 38.4* | 20 | 12.4 | 12.5 | 7.8 | 8.5 | 5.3 | 6 | 3.7 |
| 32 | 20.5 | 12.7 | 12.85 | 8 | 8.75 | 5.4 | 6.2 | 3.9 |
| 28.8* | 20.5 | 12.7 | 12.85 | 8 | 8.75 | 5.4 | 6.2 | 3.9 |
| 19.2** | 23 | 14.3 | 14 | 8.7 | 9.75 | 6.1 | 7 | 4.3 |

*Async baud rate

**Sync/async baud rate



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