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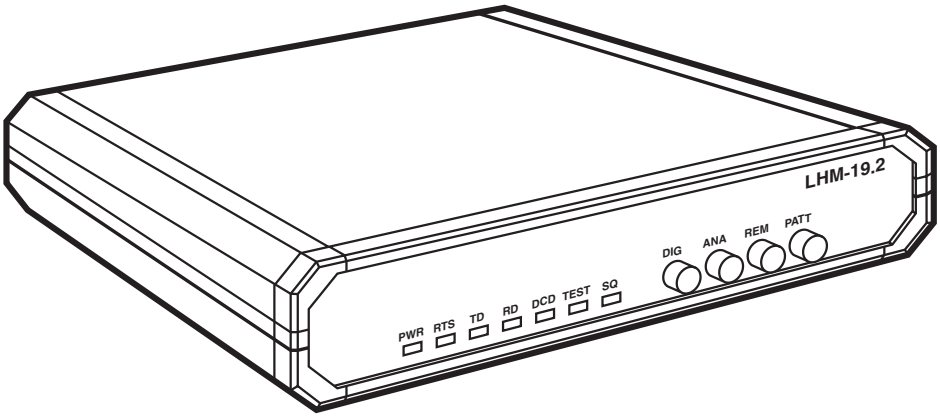
NETWORK SERVICES

MARCH 2001
ME380A

19.2-kbps RS-232 Long-Haul Modem (LHM-19.2)



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The manufacturer declares that the LHM-19.2 conforms to the following EMC and safety standards:

- EN55022 (1994): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment."
- EN50082-1 (1992): "Electromagnetic compatibility: Generic immunity standard for residential, commercial, and light industry."
- EN60950 (1992/3): "Safety of information technology equipment, including electrical business equipment."

The LHM-19.2 herewith complies with the requirements of the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC. The product was tested in a typical configuration.

Also, in accordance with EN41003, we declare the safety status of the ports on the LHM-19.2: The port labeled "DTE" has SELV (Safety Extra Low Voltage) status, and the ports (terminals) labeled "XMT" have TNV (Telecommunication Network Voltage) status within SELV limits.

CE

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

Compliance — EMI/RFI: CE (EN55022, EN50082-1), FCC Part 15 Subpart J Class A, IC Class/classe A;
Electrical safety: CE (EN60950, EN41003)

Cable Required — Between ME380A units: 4-wire twisted pair, 19 to 26 AWG;
Between ME380A and DTE: EIA/TIA RS-232 cable with DB25 male connector on ME380A end

Interface — To line: 4-wire telco style (do *not* connect to PSTN);
To device: Serial EIA/TIA RS-232/CCITT V.24, DCE

Protocol — To line: Synchronous;
To device: Synchronous or asynchronous (user-selectable); for line transmission, async data is converted to sync using ITU V.14 compliant methods

Clock Source — Either internal, external from local device, or recovered from remote LHM-19.2 (user-selectable)

Data Format — User-selectable for any word length from 8 to 11 bits, including 5, 6, 7, or 8 data bits; even, odd, or no parity; and 1, 1.5, or 2 stop bits; see Table 3-1 in **Chapter 3**

Data Rate — 1.2, 2.4, 4.8, 9.6, or 19.2 kbps (user-selectable)

Transmit Level — 0, –3, –6, –9, or –12 dBm (user-selectable)

Transmit Impedance — 600 ohms or "LOW" (user-selectable)

Receive Impedance — 600 ohms or "HIGH" (user-selectable)

Return Loss — Greater than 15 dB

Carrier — Controlled by RTS or constantly ON (user-selectable)

CTS Signal — ON only when modems are synchronized

Encoding — 16-state, 8-dimensional Trellis coding

Modulation — QAM with error correction

Equalization — Adaptive

Synchronization Delay — Startup: Up to 8 seconds;
Resync: Up to 5 seconds

Line Type — 4-wire, at least voice-grade

Maximum Transmission Distance — Unloaded lines: Up to 37.2 miles (60 km)—see Table 1-1;
Conditioned lines: Up to 62 miles (100 km), depending on line quality

Table 1-1. Maximum transmission distance.

Wire Gauge	Up to 9600 bps	At 19.2 kbps
19 AWG	37.2 mi. (60 km)	28 mi. (45 km)
22 AWG	21.1 mi. (34 km)	16.1 mi. (26 km)
24 AWG	15.5 mi. (25 km)	11.8 mi. (19 km)
26 AWG	12.1 mi. (19.5 km)	9 mi. (14.5 km)

User Controls — (4) Front-mounted pushbuttons:
DIG (local digital loopback),
ANA (local analog loopback),
REM (remote digital loopback), and
PATT (bit error rate test);
(10) Internal:
(1) Dial for data rate;
(1) Four-position DIP switch for protocol, async word length, and stop-bit shortening;
(8) Jumpers:
Transmit clock source;
Carrier control;
Transmit level;
Transmit-line impedance;
Receive-line impedance;
Enable/disable analog-loopback command on Pin 18;
Pin 21 signal (RL for remote digital loopback or SQD for signal quality);
Connect/disconnect signal ground and chassis ground

Diagnostics — Continuous line-quality testing (results indicated with SQ LED and optionally with SQD signal);
V.52 compliant bit error rate testing with pseudo-random bit patterns (results indicated with SQ LED and optionally with SQD signal);
V.54-compliant loopback tests:
Local analog loopback, mechanically or electrically user-controllable;
Local digital loopback, mechanically user-controllable;
Remote digital loopback, mechanically or electrically user-controllable

Indicators — (7) Front-mounted LEDs: PWR (power), RTS, TD, RD, DCD, TEST, and SQ; also indicates line quality and BERT results with SQD signal on Pin 21 if that function is enabled

Connectors — (2) Rear-mounted:
(1) DB25 for cable to DTE;
(1) 5-position terminal block for 4-wire modem-to-modem line, including optional ground for cable shield

Temperature Tolerance — 32 to 158˚F (0 to 70˚C)

Humidity Tolerance — Up to 90% noncondensing

Enclosure — High-impact plastic

Protection — AC/DC overvoltage-protection circuits connected through transformers to transmit and receive lines

Fuse — 250 V, 250 mA slow-blow

Power — Directly from outlet through detachable 5-ft. (1.5-m) line cord and rear-mounted IEC 320 male inlet:
Input: 115 VAC, 47 to 63 Hz, up to 250 mA;
Consumption: 5 watts typical

Size — 1.6"H x 9.6"W x 7.6"D (4.1 x 24.4 x 19.3 cm)

Weight — 3.1 lb. (1.4 kg)

2. Introduction

2.1 Overview

The 19.2-kbps RS-232 Long-Haul Modem (LHM-19.2) is a medium-range, 4-wire voice-band modem operating at data rates up to 19,200 bps. It is optimized for metropolitan applications where the distance is too long for short-range modems, but insufficient to justify the expense of long-range modems.

The LHM-19.2 operates in full duplex. You can attach pairs of LHM-19.2s to conditioned or unconditioned 4-wire leased or private lines. They will be able to communicate at selectable data rates up to 19,200 bps, as far as 41 miles (65 km) over unconditioned lines (depending on the data rate and line quality), or as far as 62 miles (100 km) over conditioned lines (depending on the line quality only).

The LHM-19.2 uses an adaptive equalizer and 16-state 8-dimensional Trellis-coded modulation to achieve as close to error-free communication as possible. The LHM-19.2's transmit level is selectable in 3-dBm increments, over the range of 0 to –12 dBm. The modems are coupled to the attached 4-wire line through isolation transformers which, together with other circuitry, protect against AC or DC overvoltages.

Communication between LHM-19.2 pairs over the 4-wire link is always synchronous. Each LHM-19.2 can derive the transmit clock internally, externally (from the attached DTE), or by recovering it from the signal received from the other modem. (Receive clock is regenerated from the data.) Communication with the attached DTE can be either synchronous or asynchronous; when it's asynchronous, the LHM-19.2 performs V.14-compliant async-to-sync conversion.

For diagnostics, the LHM-19.2 performs continuous line tests. It indicates line quality with the SQ LED and (optionally) the RS-232 SQD signal: The LED stays ON and the signal stays high if quality is good, but if the bit error rate ever rises above 1×10^{-3}, the LED and signal flicker for intermittent errors or dim or even go dead for continuous errors. The LHM-19.2 can also perform V.54 testing, including local analog loopback and local and remote digital loopback. These tests can be controlled with the LHM-19.2's front-panel pushbuttons or by toggling the RS-232 LL and RL signals on Pins 18 and 21 of its DTE interface. Finally, the LHM-19.2 supports an internal pseudo-random V.52 Bit Error Rate Test pattern; it shows results with the SQ LED and SQD signal the same way it does for the line-quality tests.

On the next page, Figure 2-1 shows a standard dual-modem application, and Figure 2-2 shows a tail-circuit application using four modems.

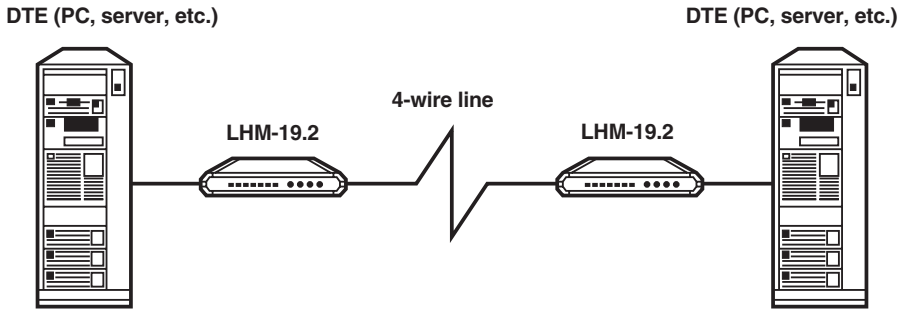


Figure 2-1. Two LHM-19.2s in a direct point-to-point application.

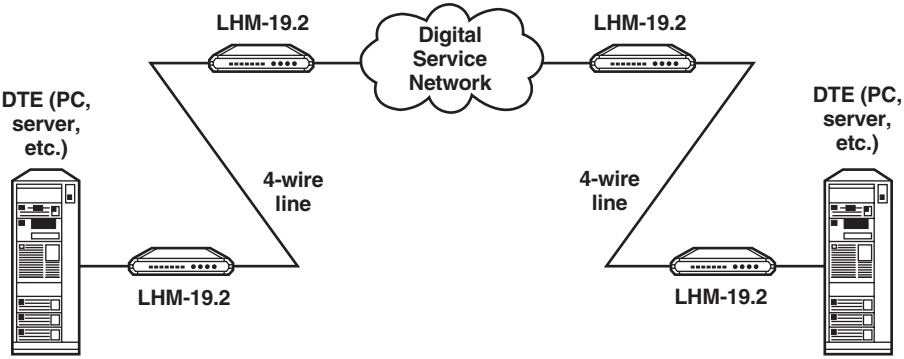


Figure 2-2. Four LHM-19.2s in a tail-circuit application.

2.2 Functions

This section describes some of the LHM-19.2's electronic functions, especially those you might need to configure (see **Chapter 3**). Refer to Figure 2-3.

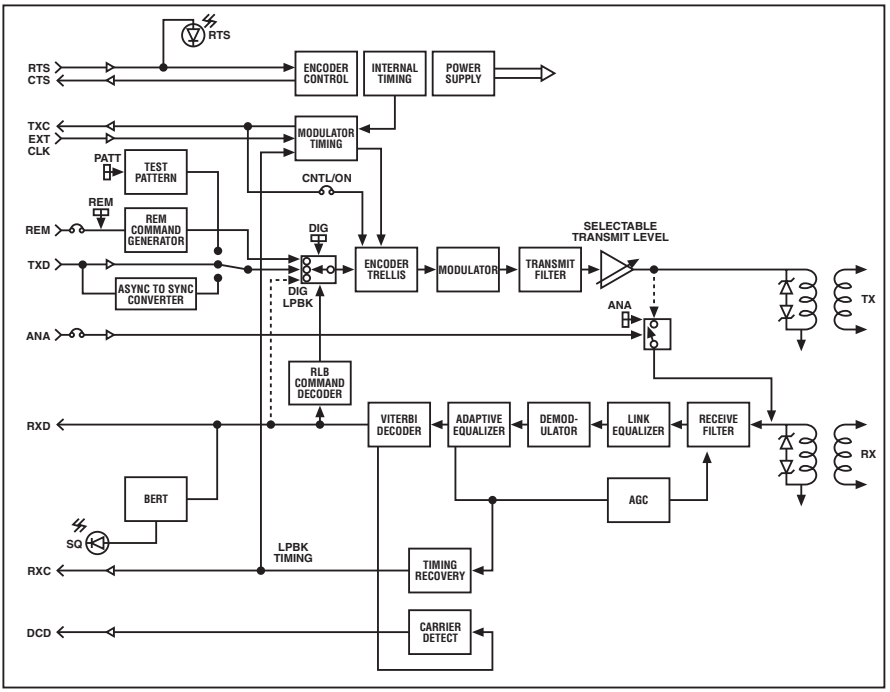


Figure 2-3. Block diagram for the LHM-19.2.

Timing Generator (Sync Clock)
This circuit is a PLL circuit. The LHM-19.2 can transmit data to the line at one of five selectable synchronous rates: 1.2, 2.4, 4.8, 9.6, or 19.2 kbps. You can use the XMT CLK jumper to select where the LHM-19.2 gets its transmit timing (sync clock) from:

- INT (internal clock from the LHM-19.2's own crystal oscillator)
- EXT(external clock from the attached DTE device, through RS-232 Pin 24)
- LOOP (receive clock recovered from receive signal and looped back)

In the vast majority of cases, one modem should be strapped to INT or EXT clock, while the other is set to LOOP clock.

Async-to-Sync Converter
If you configure the LHM-19.2 to accept asynchronous data and attach it to a DTE that sends async data, the LHM-19.2 uses its internal V.14-compliant async-to-sync converter to add clock timing to the data for transmission to the remote unit.

The V.14 standard specifies that differences between the LHM-19.2's sync line frequency and the DTE's async data rate should be compensated for by shortening or lengthening the stop bit of each async character. If the local modem's frequency is higher than the local DTE's, the modem's converter circuitry extends the stop bit. If the local modem's frequency is lower than the local DTE's, the modem's converter deletes one stop bit from every four or eight characters (settings identified as "25%" and "12.5%" respectively). At the other end of the line, the remote modem will add a stop bit shortened by 12.5% to the end of every character whose stop bit has been stripped before relaying the data to the remote DTE. The "12.5%" setting is suitable for overcoming frequency deviations up to 1.1%, and the "25%" setting is suitable for overcoming frequency deviations up to 2.3%.

Use position 4 of the LHM-19.2's 4-position DIP switch to select a 25% or 12.5% frequency-deviation setting. For proper operation of the async-to-sync converter, you'll also have to set the async character length by adjusting DIP-switch positions 2 and 3. See **Chapter 3**.

Encoder
The LHM-19.2's 16-state, 8-dimensional Trellis encoder encodes the input data from the DTE to a sequence of complex symbols ready for rendering into analog form.

Modulator
The modulator turns the input symbols from the encoder into analog signals using a QAM technique.

Transmit Filter
The transmit filter eliminates out-of-band replication resulting from conversion of the sample output obtained from the DSP to a continuous transmit signal.

XMT Level
Use the OUT LVL jumper to set the LHM-19.2's XMT level (signal level) to 0, –3, –6, –9, or –12 dBm. See **Chapter 3**.

Receiver
The LHM-19.2's receiver is comprised of several interlinked circuits, as Figure 2-3 shows:

- The *receive filter* removes out-of-band signals and prevents signal spectrum aliasing during analog-to-digital conversion.
- The receive signal then passes into a fixed pre-emphasized *line equalizer*.
- A *demodulator* samples the received analog signal into a baseband digital signal.
- An *adaptive variable equalizer* compensates for line distortion.
- An *automatic gain control (AGC)* circuit compensates for line attenuation.
- A *Viterbi decoder* turns the received symbols back into the original transmitted data.

V.54 Diagnostics
The LHM-19.2 performs V.54-compliant remote digital loopback and local analog loopback tests, as well as local digital loopback. Local digital loopback can be activated manually by pressing the DIG button on the local LHM-19.2's front panel. Remote digital loopback and local analog loopback can be activated manually from the local LHM-19.2's front panel (by pressing REM or ANA respectively) or through the DTE interface (by toggling the RL and LL signals on Pins 21 and 18). See **Sections 6.1.2** through **6.1.4**.

These loopbacks can be enabled or disabled separately by setting the LHM-19.2's LOOP—REM and LOOP—ANA jumpers. See **Chapter 3**.

During both of the digital loopbacks (but *not* local analog loopback), the modem that is looping data back to the other modem will lower the Data Set Ready (DSR) signal to the attached device.

V.52 Test-Pattern Generator
This feature allows for quick and easy testing of the local LHM-19.2 as well as the communication link between the modems. While an LHM-19.2 is in local analog loopback or remote digital loopback, you can press PATT pushbutton on its front panel to begin a bit error rate test. The test-pattern generator circuit transmits a pseudo-random pattern of bits and examines what it receives back. If it detects any errors, the LHM-19.2 flashes, dims, or turns OFF its SQ LED and (optionally) the SQD signal on Pin 21. You can even have a pair of LHM-19.2s perform this test during point-to-point operation by pressing the PATT buttons on both modems at the same time. (This will interrupt normal data transmission.) See **Section 6.1.1**.

3. Configuration

To set the LHM-19.2's internal jumpers and switches, take these steps, making sure that the modem is unplugged:

1. Loosen the two screws at the lower corners of the LHM-19.2's rear panel.
2. Slide the inside of the LHM-19.2 out of its housing, as if you were sliding a drawer open.
3. Adjust the jumpers and switches for the configuration you want. Refer to Figure 3-1 on the next page and Table 3-2 on the pages that follow.
4. Slide the unit back into its housing and retighten the retaining screw.

If you will be attaching a DTE to the LHM-19.2 that will communicate with it asynchronously, you need to configure the LHM-19.2 to expect the correct *total async word length* from the DTE. (This is done with positions 2 and 3 of DIP switch SW2.) To get the total word length, add the start bit, data bits, parity bit (if any), and stop bits, as shown in Table 3-1. (Round down 1.5 stop bits to 1.) The LHM-19.2 doesn't support words shorter than 8 bits or longer than 11 bits.

Table 3-1. Total async word length.

Start Bit	Data Bits	Parity	Stop Bit(s)	Total Bits
Always 1	5	None (0 bits)	2	8
		Even or odd (1 bit)	1 or 1.5	8
			2	9
	6	None (0 bits)	1 or 1.5	8
			2	9
		Even or odd (1 bit)	1 or 1.5	9
			2	10
	7	None (0 bits)	1 or 1.5	9
			2	10
		Even or odd (1 bit)	1 or 1.5	10
			2	11
	8	None (0 bits)	1 or 1.5	10
			2	11
		Even or odd (1 bit)	1 or 1.5	11

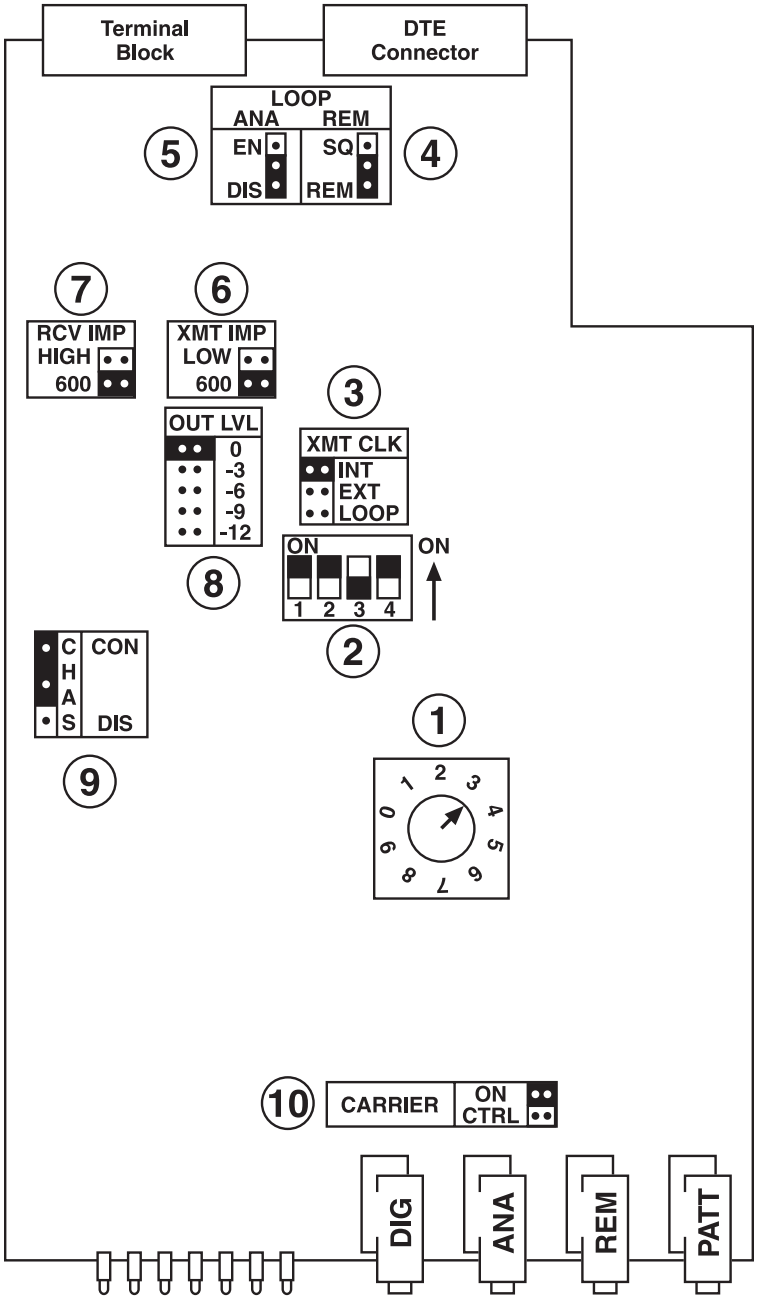


Figure 3-1. The LHM-19.2's circuit board.

Table 3-2. The LHM-19.2's configuration settings.

Number in Figure 3-1 and identity	Function	Possible settings	Factory-default setting
1 **Data-rate dial**	Select data rate.	0 = 1.2 kbps 1 = 2.4 kbps 2 = 4.8 kbps 3 = 9.6 kbps 4 = 19.2 kbps (other positions reserved)	9.6 kbps
2 **DIP switch SW2**			
Position 1	Select protocol.	SYNC - ON = Sync SYNC - OFF = Async*	Sync
Positions 2 & 3	Select async word length (see Table 3-1).	2 OFF, 3 OFF = 8 bits 2 OFF, 3 ON = 9 bits 2 ON, 3 OFF = 10 bits 2 ON, 3 ON = 11 bits	10 bits
Position 4	Select async stop-bit shortening.	ON = 25% OFF = 12.5%	12.5%
3 **XMT CLK**	Select sync clock source.	INT = Internal clock EXT = External clock from DTE on RS-232 Pin 21 LOOP = Receive clock (recovered from remote modem & looped back)	INT
4 **LOOP—REM**	Select RS-232 Pin 21 signal.†	SQ = Signal Quality (SQD) REM = Remote Digital Loopback (RL)	REM
5 **LOOP—ANA**	Enable/disable Local Analog Loopback (LL) signal (RS-232 Pin 18).	EN = LL enabled DIS = LL disabled	DIS

* Due to a quirk of the board's circuit architecture, when you select "SYNC - OFF" with DIP-switch position 1, you must set the XMT CLK jumper to "INT".

† It's not necessary to make use of either of these signals if you don't want to.

Table 3-2 (continued). The LHM-19.2's configuration settings.

Number in Figure 3-1 and identity	Function	Possible settings	Factory-default setting
6 **XMT IMP**	Select transmit-line impedance.	600 = 600 Ω LOW = Min. impedance*	600 Ω
7 **RCV IMP**	Select receive-line impedance.	600 = 600 Ω HIGH = Max. impedance*	600 Ω
8 **OUT LVL**	Select output level to the transmit line.	0 = 0 dBm –3 = –3 dBm –6 = –6 dBm –9 = –9 dBm –12 = –12 dBm	0 dBm
9 **CHAS GND**	Isolate/tie together chassis and signal grounds.	CON = Signal ground tied to chassis ground DIS = Signal ground disconnected from chassis ground	CON
10 **CARRIER**	Select carrier behavior.	ON = Carrier always ON LOW = Carrier controlled by RTS (ON only when RTS is high)	ON

* You might need to select these values if the impedance of the line cable you attach to the LHM-19.2 differs so greatly from 600 Ω that the modem can't compensate for it in the "600" setting. (This is one of the things that can be wrong when local loopback works but no data gets to the other end of the line cable.)

4. Installation

The 19.2-kbps RS-232 Long-Haul Modem comes with a 5-ft. (1.5-m) power cord and this manual. It's designed to be placed either on a flat surface or in a rack. Things to keep in mind about where you place it:

- It must be installed within 5 ft. (1.5 m) of an easily accessible grounded 3-wire 115-VAC outlet and within 50 feet (15.2 m) of the associated DTE. It isn't designed to be bolted down.
- Allow at least 36 inches (90 cm) of clearance in front of the LHM-19.2 so you can operate and maintain it. Be sure to leave 4 inches (10 cm) of clearance behind the unit for signal lines and interface cables.

If you're going to rackmount the LHM-19.2, follow the directions in **Section 4.1**. Otherwise, skip ahead to **Section 4.2**.

4.1 Rackmounting (Optional)

If you want to, you can install the LHM-19.2 in a l9" rack. It's 1U high (1.75", 4.5 cm) and slightly less than half as wide as the rack's available horizontal mounting space. Two different rackmount kits are available: You can use the RM516 kit to mount one LHM-19.2 by itself (see **Section 4.1.1**), or the RM523 kit to mount two LHM-19.2s side by side (see **Section 4.1.2**).

Make sure to disconnect each LHM-19.2 from AC power and from all data cables before rackmounting it. Only an experienced technician should attempt to install, operate, or maintain the LHM-19.2.

4.1.1 Rackmounting a Single LHM-19.2

The single-chassis rackmount kit RM516 includes one short bracket and one long bracket. You'll screw the brackets against the side walls of the LHM-19.2's case, as shown in Figure 4-1.

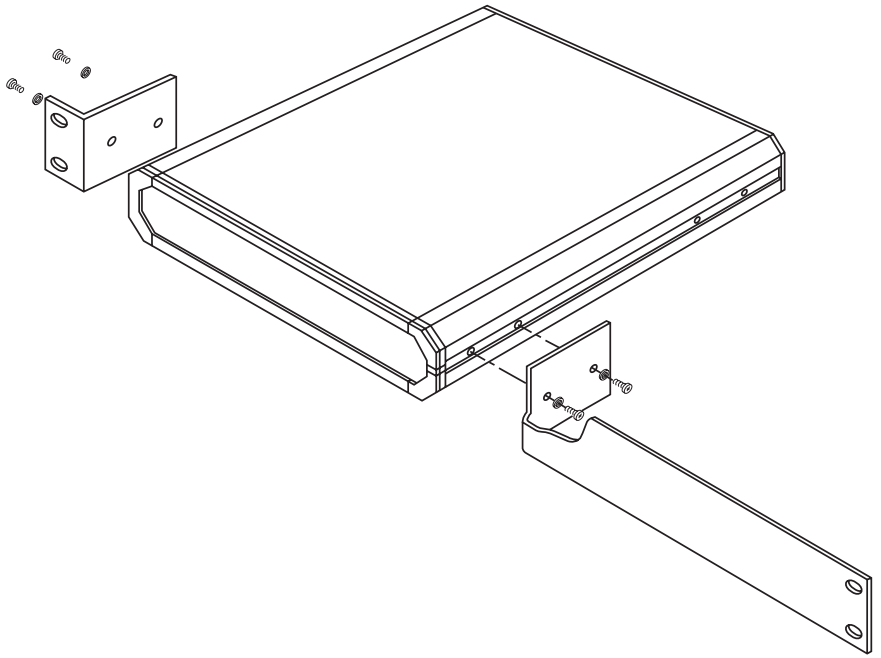


Figure 4-1. Preparing a single LHM-19.2 for mounting in a 19" rack.

Take these steps to install the LHM-19.2 in a 19" rack:

1. Use the four screws and four flat washers included with the RM516 kit to attach the kit's two brackets to the side walls of the LHM-19.2. Thread the screws into the two front holes on each side wall (nuts are already in place on the inside of the wall).

2. After attaching the brackets to the LHM-19.2, fasten the brackets to the side rails of the rack with your own screws, bolts, cage nuts, etc. (these aren't included with the kit).

4.1.2 Rackmounting Two LHM-19.2s Side by Side

The dual-chassis rackmount kit RM523 includes two rails for attaching the LHM-19.2s together, two short brackets, and various other hardware. Referring to Figures 4-2 and 4-3 on the next page, take these steps to install two LHM-19.2s side by side in a 19" rack:

1. Use two of the longer screws and two of the flat washers included with the RM523 kit to attach one of the kit's short brackets to the left-hand side wall of the LHM-19.2 intended to be on the left.

2. Repeat the procedure in step 1 to fasten the kit's other short bracket to the right-hand wall of the LHM-19.2 intended to be on the right.

3. Place one of the kit's two rails against the right-hand wall of the LHM-19.2 intended to be on the left, aligning the rail's holes with the holes in the wall.

4. Screw four of the kit's shorter Phillips-head screws through the rail into the holes on the unit wall.

5. Repeat the procedure in steps 3 and 4 to fasten the kit's other rail to the left-hand wall of the LHM-19.2 intended to on the right. **Make sure** that the wider rim of this rail is opposite the short rim of the other rail, so that they will slide together and interlock as shown in Figure 4-3!

6. Position the ends of the two rails so that one rail can slide into the other, then slide the units together until their front and rear panels are even with each other.

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

8. Fasten the short brackets to the side rails of the rack with your own screws, bolts, cage nuts, etc. (these aren't included with the kit).

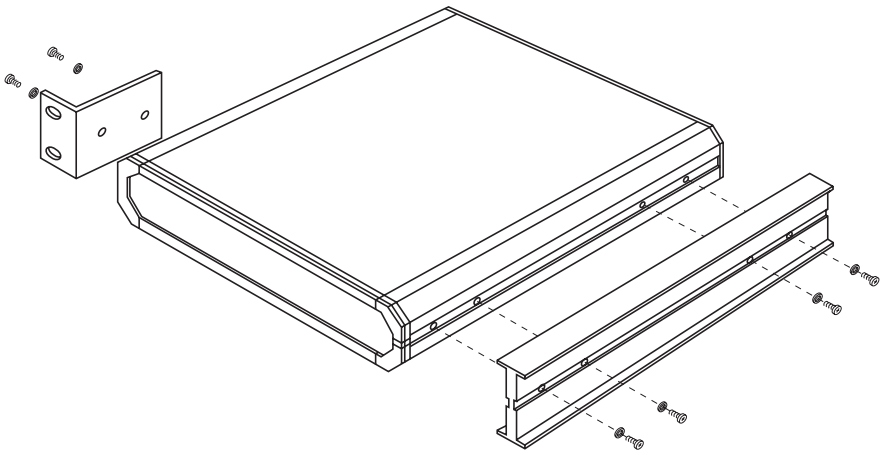


Figure 4-2. Preparing each LHM-19.2 for dual rackmounting.

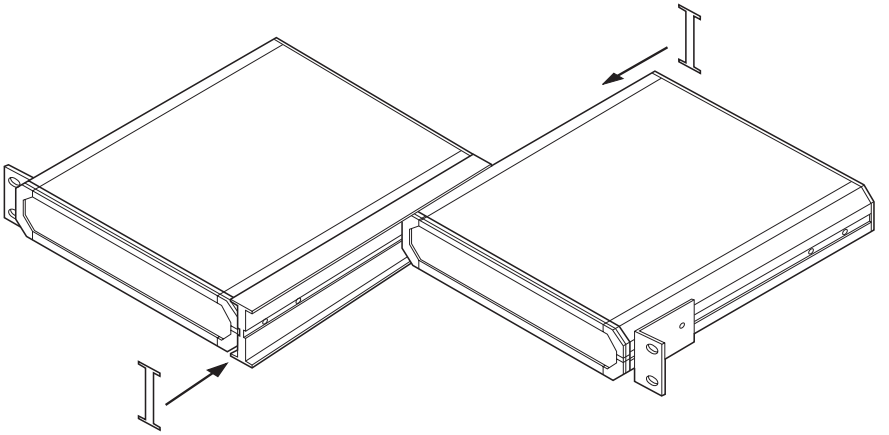


Figure 4-3. Fastening the two LHM-19.2s together.

4.2 Connecting Data Cables

Both of the LHM-19.2's data connectors are on its rear panel, shown in Figure 4-4.

One is a DB25 female RS-232 port that is pinned as DCE (see the **Appendix** for the full pinout), but is labeled "DTE" because for most applications you will plug a DTE into it. The type of cable you'll run from this port to your local RS-232 device will vary depending on what type of device it is. Here are some typical options:

- To a DB9 male serial port on an IBM PC compatible computer, you could use standard AT style modem cable such as product code EVMBMC.
- To a DB25 male serial port on such a computer, you could use PC style modem cable such as EVMBSM.
- To a DB25 female serial port on a DCE device (including another LHM-19.2), you could use a tail-circuit cable such as EHN255C-MM.

Call Black Box Technical Support for help with other types of RS-232 connections.

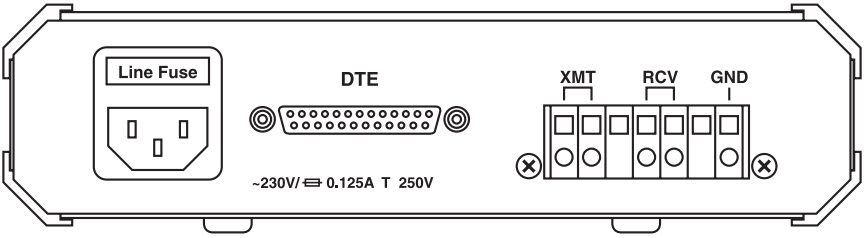
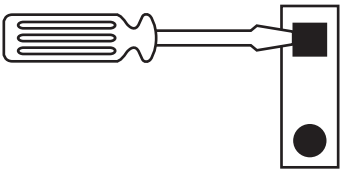


Figure 4-4. The LHM-19.2's rear panel.

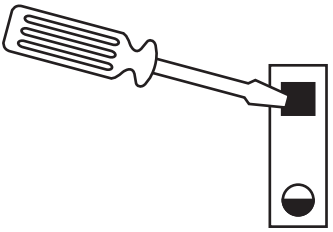
The other type of data connector on the rear panel is a 5-position terminal block. Attach the end of your data-line twisted-pair cable here. The transmit pair should be attached to the two terminals marked "XMT," the receive pair should be attached to the two terminals marked "RCV," and if your cable is shielded the shield should be attached to the "GND" terminal *at one end of the cable only.* (Do *not* attach the shield to ground at both ends of the cable—that could create a potentially damaging electrical "ground loop.") The XMT and RCV terminals aren't polarity-sensitive—at each end of the data line, you can attach either transmit wire to either XMT terminal, and either receive wire to either RCV terminal.

Attach each of the twisted-pair wires to one of the LHM-19.2's terminals this way:

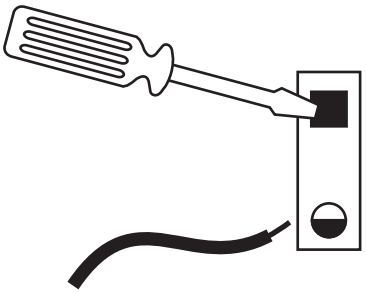
1. Insert the end of a screwdriver into the square hole above the terminal.

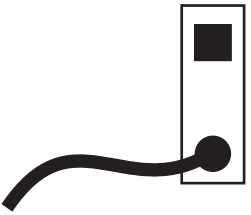


2. Lever the screwdriver handle upwards to put pressure on the element at the bottom of the square hole. The terminal's wire clamp will open.



3. Insert the stripped end of the wire and remove the screwdriver. The clamp will close and the wire will be securely connected.





4.3 Connecting Power

The LHM-19.2 gets its power through an included 5-ft. (1.5-m) power cord. After you read the Caution notices below, plug one end of this cord into the IEC 320 male inlet on the LHM-19.2's rear panel, then plug the other end into a working 115-VAC wall outlet. The LHM-19.2 will begin operating immediately; it has no ON/OFF switch. To power it OFF, unplug its power cord.

CAUTION!

The LHM-19.2 should always be grounded through the protective earth lead of the power cord.

The utility-power (mains) plug of the LHM-19.2's power cord should only be inserted in a socket outlet that has a protective earth contact. This protective action must not be negated by use of an extension cord or replacement power cord without a protective (grounding) conductor.

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

The LHM-19.2's line fuse is located in an integral fuse holder above the inlet on the rear panel (as shown in Figure 4-4 in Section 4.2**). Make sure that only fuses of the required rating (250V/250 mA [0.25 A] slow-blow, as marked on the rear panel) are used for replacement. Do not use repaired fuses or short-circuit the fuse holder. Always disconnect the power cord before removing or replacing the fuse.**

Whenever it is likely that the fuse has blown, make the LHM-19.2 inoperative and secure it against unintended operation until the fuse can be replaced.

5. Operation

5.1 Power-Up

Make sure that the 19.2-kbps RS-232 Long-Haul Modem is fully configured and installed (see **Chapters 3** and **4**). Then, if you haven't already done so, plug the LHM-19.2's power cord into a working AC outlet. The LHM-19.2 should begin operating immediately.

Once both the local and remote LHM-19.2s have been plugged in, verify that they're working properly by checking their front-panel LEDs. If the modems are both operating and passing data, the LEDs should look like this on both units:

- PWR, RTS, DCD, and SQ steadily lit
- TD and RD flashing or dark
- TEST dark

If the LEDs don't look like this, make sure that none of the front-panel buttons are pressed on either unit. Even if everything does seem OK, you might want to double-check by running the BERT and local analog loopback tests as described in **Section 6.1.1** and **6.1.2**.

5.2 The LHM-19.2's Front-Panel Indicators and Controls

Normally the LHM-19.2 will operate without requiring human intervention, relaying data from the attached device to the line or from the line to the device. But it does have LEDs so that its status can be monitored, and it also has pushbuttons that can be used to trigger diagnostic tests. These components are all on its front panel, shown in Figure 5-1. The numbers and letters in this illustration correspond to the numbers and letters under the "Button" and "LED" headings in Tables 5-1 and 5-2 on the next page, which explain the functions of each front-panel component.

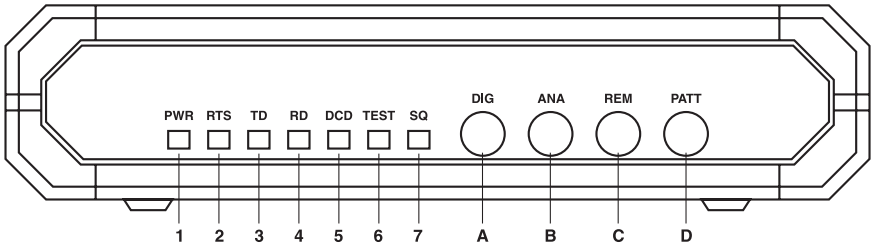


Figure 5-1. The LHM-19.2's front panel.

Table 5-1. The front-panel pushbuttons.

BUTTON	LABEL	FUNCTION
A	DIG	Pressing this Local Digital Loopback button causes the local LHM-19.2 to loop received data and clock to its transmitter. Data Set Ready goes low. This is equivalent to initiating Remote Digital Loopback (V.54 Loop 2) at the remote LHM-19.2. See **Section 6.1.4**.
B	ANA	Pressing this Local Analog Loopback button causes the local LHM-19.2 to loop its transmitter output back to its receiver (V.54 Loop 3). When the LOOP—ANA jumper (#5 in Figure 3-1) is set to EN, this loopback can also be controlled by toggling the LL signal (on Pin 18) from the attached device. See **Section 6.1.2**.
C	REM	Pressing this Remote Digital Loopback button causes the remote LHM-19.2 to loop received data and clock to its transmitter (V.54 Loop 2). Data Set Ready goes low. When the LOOP—REM jumper (#4 in Figure 3-1) is set to REM, this loopback can also be controlled by toggling the RL signal (on Pin 21) from the attached device. See **Section 6.1.3**.
D	PATT	Pressing this Test Pattern button causes the local LHM-19.2 to begin transmitting a V.52 BERT (bit error rate test) pattern. See **Section 6.1.1**.

Table 5-2. The front-panel indicators.

LED	LABEL	ITU V.24 CIRCUIT	FUNCTION
1	PWR	N/A	Green LED is steadily lit while power is present.
2	RTS	105	Yellow LED is steadily lit when the attached device activates Request to Send.
3	TD	103	Yellow LED is steadily lit when continuous SPACE is transmitted. It flickers when data is transmitted.
4	RD	104	Yellow LED is steadily lit when continuous SPACE is received. It flickers when real data is received. It goes dark during digital loopback tests.
5	DCD	109	Yellow LED is steadily lit while a valid receive-line signal is present.
6	TEST	142	Red LED is steadily lit during loopback tests and while the PATT button is pressed.
7	SQ	N/A	Yellow LED. During normal operation, is steadily lit while line quality is OK but flashes, dims, or goes dark when error rate rises above 1×10^{-3}. While PATT is pressed, is steadily lit while pattern matches but flashes, dims, or goes dark when errors occur.

5.3 Power-Down

To turn the LHM-19.2 off, unplug its power cord.

5.4 Reconfiguration

If at some point you need to reconfigure the LHM-19.2 to operate differently—with a new data rate or new clock source, for example—you can change the settings of its configuration controls. To do so, unplug the unit, then follow the procedure in **Chapter 3**.

6. Troubleshooting

6.1 Tests and Diagnostics

This section describes how the LHM-19.2's diagnostic tests work and explains how to isolate faults. The LHM-19.2 has ITU V.54 compliant diagnostic capabilities for performing local analog loopback and local and remote digital loopback. All three of these loopbacks can be controlled with the LHM-19.2's front-panel pushbuttons. If the LHM-19.2 is configured for it, the local analog and remote digital loopbacks can also be controlled by toggling the signals on Pins 18 or 21 of the DTE interface. The LHM-19.2 can perform a Bit Error Rate Test on the link using an internal pseudo-random test pattern. Finally, the LHM-19.2 tests the line quality continuously. For both the BERT and line-quality tests, the LHM-19.2 will use the SQ LED and (optionally) the SQD signal to indicate the results.

Use the LHM-19.2's loop-test buttons (DIG, ANA, and REM) and LED indicators to quickly check the modems, the attached devices, and the cables that interconnect them. Before doing any of these tests, make sure that everything is turned on and configured correctly. Also, if you're going to have a device attached to either LHM-19.2 electronically trigger a loopback or perform a BERT, verify that the device is operating well enough to be used for the purpose. If it isn't, either have it repaired, swap in a working substitute, or attach a tester to the LHM-19.2 instead.

Loop tests are best performed in the order presented in **Sections 6.1.2** through **6.1.4**.

6.1.1 PATT Button: Bit Error Rate Test (BERT)

While the LHM-19.2 is operating, press its PATT button to start a Bit Error Rate Test (BERT). This activates a circuit that (a) injects a bit pattern simulating random data onto the transmit line and (b) compares this pattern against what comes in on its receive line. (While this test is in progress, normal data transmission is suspended.) The LHM-19.2's front-panel SQ LED (and—if SQD signaling is enabled—its SQD output on Pin 21) will either be steadily ON (no errors), flicker (intermittent errors), or dim or go OFF (for continuous errors).

BERT can be activated at a single LHM-19.2 during a local analog loopback test, as shown in Figure 6-1 on the next page, or it can be activated simultaneously at the two LHM-19.2s on either end of a communication link, as shown in Figure 6-2.

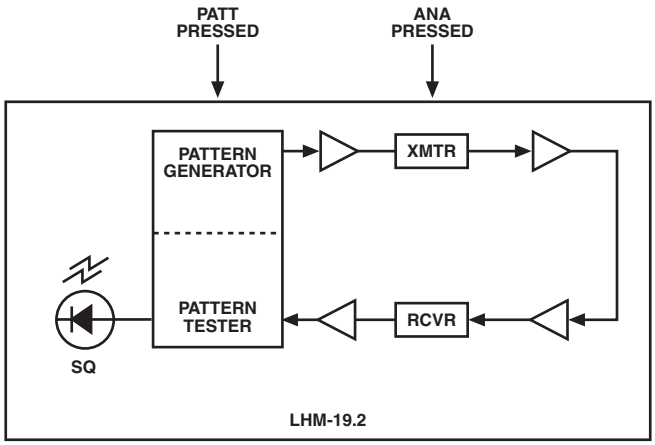


Figure 6-1. Single-modem BERT during local analog loopback.

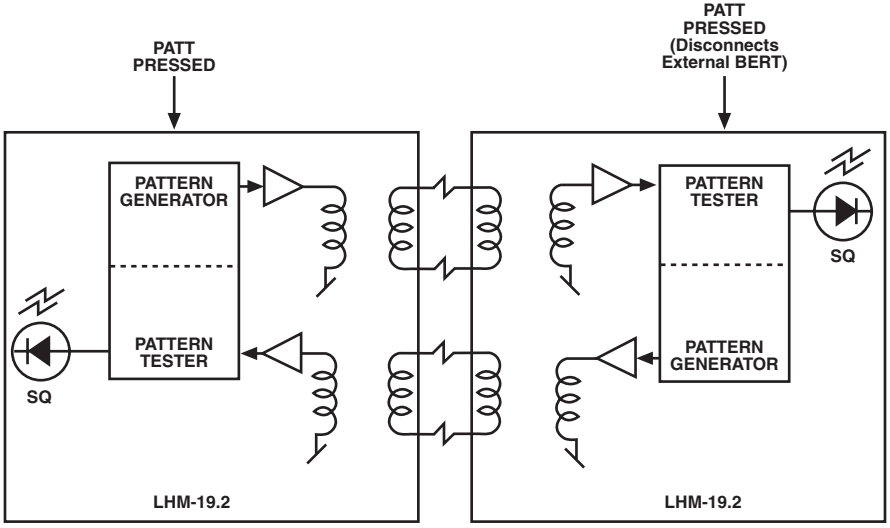


Figure 6-2. Dual-modem BERT.

6.1.2 ANA Button: Local Analog Loopback

This test checks the performance of the local LHM-19.2, the device attached to it, and the cabling between the LHM-19.2 and the device. Perform the test separately at the local and remote sites.

1. To run a local analog loopback test on an LHM-19.2, either press the ANA button on its front panel or (if the LOOP—ANA jumper is set to EN, as described in **Chapter 3**) have the attached device raise the signal to the LHM-19.2 on Pin 18 of the DTE interface.

   When you do this, the test should start and the LHM-19.2's TEST LED should light. The LHM-19.2's transmit output is now connected to its own receiver, as shown in Figure 6-3 on the next page.

2. If the attached device is able to to perform a bit error rate test (BERT) or otherwise compare its output with looped-back input, you might want to have it do so. Alternatively, you can plug a tester into the LHM-19.2 instead of the regularly attached device, then perform a BERT with the tester. (Don't simply rely on the LHM-19.2's own BERT—see **Section 6.1.1**—because if the LHM-19.2 is malfunctioning, you might get unreliable results.)

3. If the BERT indicates a problem, try swapping in different cables. If this doesn't help, there's probably something wrong with the LHM-19.2; call Black Box Technical Support.

   If the BERT doesn't indicate any problems but the attached device still does, follow the manufacturer's directions for testing the device. Also check your device-to-modem cables and make sure they are the proper type, and use the proper pinning, for the device.

4. Press the ANA pushbutton again, or lower the signal on Pin 18, to end this loopback.

5. Repeat steps 1 through 4 at the remote LHM-19.2.

When you're finished with this test, proceed with the digital loopback tests described in **Sections 6.1.3** and **6.1.4**.

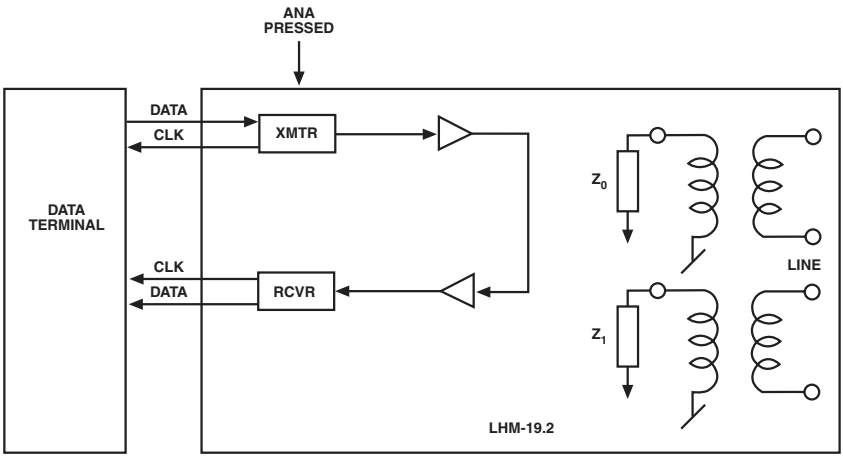


Figure 6-3. Local analog loopback.

6.1.3 REM Button: Remote Digital Loopback

This test checks the performance of both the local and remote LHM-19.2s, as well as the twisted-pair cabling between them.

1. To run a remote digital loopback test on a pair of LHM-19.2s, either press the REM button on the local LHM-19.2's front panel or (if the LOOP—REM jumper is set to REM, as described in **Chapter 3**) have the attached device raise the signal to the LHM-19.2 on Pin 21 of the DTE interface. (This has no effect unless the two modems are fully synchronized, so wait for a few seconds after you power them up before you start this test.)

   When you do this, the local LHM-19.2 will send a remote-loopback request to its remote counterpart. The test should start and both LHM-19.2s' TEST LEDs should light. The remote LHM-19.2's receiver output is now connected to its own transmitter, as shown in Figure 6-4 on the next page.

2. If the device attached to the local LHM-19.2 is able to perform a bit error rate test (BERT) or otherwise compare its output with looped-back input, you might want to have it do so. Alternatively, you can plug a tester into the local LHM-19.2 instead of the regularly attached device, then perform a BERT with the tester. (Don't simply rely on the local LHM-19.2's own BERT—see **Section 6.1.1**—because if that LHM-19.2 is malfunctioning, you might get unreliable results.)

3. If this BERT indicates a problem, but BERT performed at the local site while the local LHM-19.2 is in local analog loopback (see **Section 6.1.2**) does not, there is a transmission problem between the two LHM-19.2s. Try connecting the two modems with a known-good twisted-pair line. If this doesn't help, the line circuits in one or both modems are probably faulty; call Black Box Technical Support.

4. Press the REM pushbutton again, or lower the signal on Pin 21, to end this loopback.

When you're finished with this test, either repeat it at the remote site or proceed with local digital loopback as described in **Section 6.1.4**.

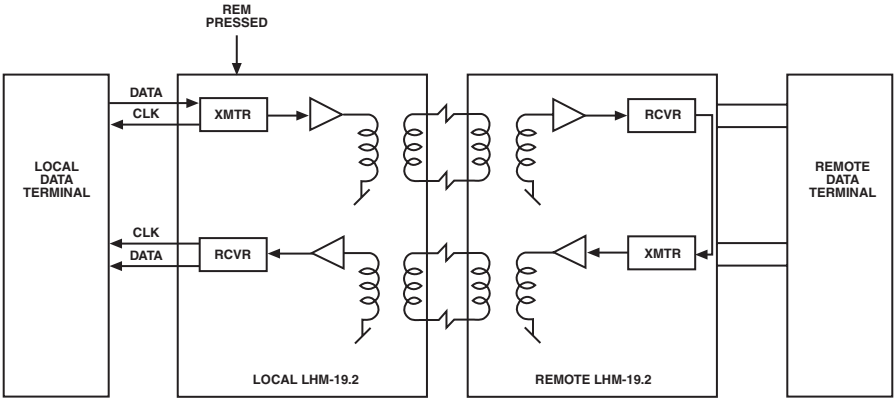


Figure 6-4. Remote digital loopback.

6.1.4 DIG Button: Local Digital Loopback

This test checks the performance of both the local and remote LHM-19.2s, as well as the twisted-pair cabling between them.

1. To run a local digital loopback test on a pair of LHM-19.2s, press the DIG button on the local LHM-19.2's front panel. (This has no effect unless the two modems are fully synchronized, so wait for a few seconds after you power them up before you start this test.) The test should start and both LHM-19.2s' TEST LEDs should light. The local LHM-19.2's receiver output is now connected to its own transmitter, as shown in Figure 6-5 on the next page.

2. If the device attached to the remote LHM-19.2 is able to perform a bit error rate test (BERT) or otherwise compare its output with looped-back input, you might want to have it do so. Alternatively, you can plug a tester into the remote LHM-19.2 instead of the regularly attached device, then perform a BERT with the tester. (Don't simply rely on the remote LHM-19.2's own BERT—see **Section 6.1.1**—because if that LHM-19.2 is malfunctioning, you might get unreliable results.)

3. If this BERT indicates a problem, but BERT performed at the remote site while the remote LHM-19.2 is in local analog loopback (see **Section 6.1.2**) does not, there is a transmission problem between the two LHM-19.2s. Try connecting the two modems with a known-good twisted-pair line. If this doesn't help, the line circuits in one or both modems are probably faulty; call Black Box Technical Support.

4. Press the DIG pushbutton again to end this loopback.

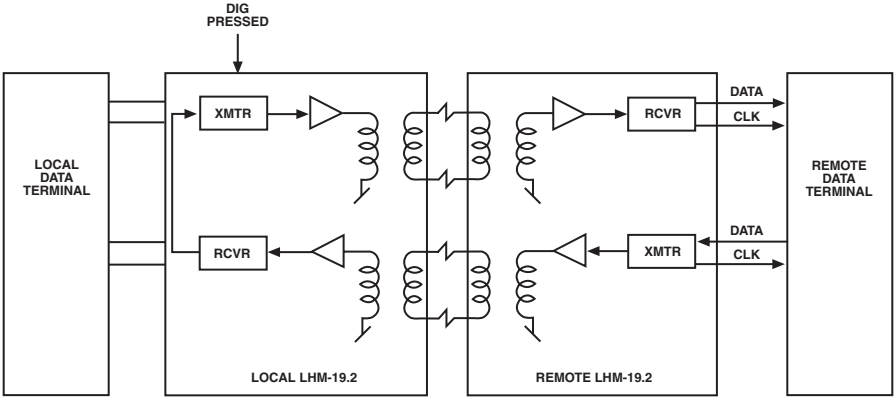


Figure 6-5. Local digital loopback.

6.2 Calling Black Box

If you determine that your LHM-19.2 is malfunctioning, *do not attempt to alter or repair the unit.* It contains no user-serviceable parts. Contact Black Box Technical Support at 724-746-5500.

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

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

6.3 Shipping and Packaging

If you need to transport or ship your LHM-19.2:

- Package it carefully. We recommend that you use the original container.
- If you are returning the LHM-19.2, make sure you include everything you received with it. Before you ship the unit back to us for whatever reason, contact Black Box to get a Return Authorization (RA) number.

Appendix: RS-232 Pinout

ITU V.24 Circ.	EIA/TIA RS-232 Circuit	DB25 Pin	Signal or Voltage	Description
101	AA	1	Shield [SHD]	Chassis ground. May be connected to Signal Ground or isolated from it—see **Chapter 3**.
102	AB	7	Signal Ground [SGND]	Common signal ground and DC power-supply ground. May be connected to Shield or isolated from it—see **Chapter 3.**
103	BA	2	Transmitted Data [TD]	Serial digital data sent to the modem from the attached device. If the attached device is also sending External Clock on Pin 24, transitions of this signal must occur on positive-going transitions of External Clock.
104	BB	3	Received Data [RD]	Serial digital data sent to the attached device from the modem. Data transitions occur on the rising edge of the clock.
105	CA	4	Request to Send [RTS]	The attached device raises this signal to the modem when it wants to send data.
106	CB	5	Clear to Send [CTS]	After receiving RTS on Pin 4, the modem raises this signal to the attached device when it is ready to receive data from the device.
107	CC	6	Data Set Ready [DSR]	While the modem is powered on, it keeps this signal high to the attached device except during digital loopback.

ITU V.24 Circ.	EIA/TIA RS-232 Circuit	DB25 Pin	Signal or Voltage	Description
109	CF	8	Receive Line Signal Detector [RLSD], a.k.a. Data Carrier Detect [DCD]	The modem keeps this signal high to the attached device except when the receive signal from the other modem is lost or when DSR on Pin 6 goes low.
N/A	N/A	9 10	+8 VDC –8 VDC	Output +8 volts. Output –8 volts.
113	DA	24	Transmitter Signal Element Timing (DTE) [TSETT], a.k.a. External Clock [EXTC]	Sync data-rate clock from the attached device to the modem. Positive clock transitions correspond to data transitions.
114	DB	15	Transmitter Signal Element Timing (DCE) [TSETC], a.k.a. Transmit Clock [TC]	Sync data-rate clock from the modem to the attached device. Positive clock transitions correspond to data transitions.
115	DD	17	Receiver Signal Element Timing (DCE) [RSETC], a.k.a. Receive Clock [RC]	Sync clock from the local modem to the remote modem and device. Positive clock transitions correspond to data transitions.
140 110	RL CG	21 21	Remote Loopback [RL] *or* Signal Quality Detector [SQD], depending on how the modem is set (see **Chapter 3**).	The modem responds to the raising of RL by sending a remote-loopback command to the remote modem. The modem lowers SQD when it detects errors on the line.
141	LL	18	Local Loopback [LL]	If configured to do so (see **Chapter 3**), the modem responds to the raising of this signal by going into local analog loopback. Refer to **Section 6.1.2**.
142	TM	25	Test Mode [TM]	The modem raises this signal to indicate that it is in test mode.

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